

2017 ELECTRICAL

Hybrid/EV Energy Storage - CT6

SPECIFICATIONS

FASTENER SPECIFICATIONS

Reusable Threaded Fastener Tightening Specifications

NOTE: <i>All fasteners listed in this table can be reused after removal.</i>	
Application	Specification
	Metric (English)
300-Volt Battery Positive and Negative Cable Retainer Fastener	9 N.m (80 lb in)
Auxiliary Air Conditioning Evaporator Intermediate Tube Fastener	5 N.m (44 lb in)
Battery Negative Strap Bolt	9 N.m (80 lb in)
Battery Tray Mounting Bolt	22 N.m (16 lb ft)
Drive Motor Battery Charger Fastener	22 N.m (16 lb ft)
Drive Motor Battery Charger Bracket Fastener	22 N.m (16 lb ft)
Drive Motor Battery Coolant/Air Separator Tray Bolt	2.5 N.m (22 lb in)
Fuel Tank Filler Pipe Shield Bolt	9 N.m (80 lb in)
Ground Strap Bolt	9 N.m (80 lb in)
High Voltage Battery Cover Bolt	9 N.m (80 lb in)
High Voltage Battery Cover Nut	9 N.m (80 lb in)
High Voltage Battery Cover Bracket Bolt	9 N.m (80 lb in)
High Voltage Battery Disconnect Relay Bolt	9 N.m (80 lb in)
High Voltage Battery Positive and Negative Cable to High Voltage Battery Disconnect Relay Fastener	9 N.m (80 lb in)
High Voltage Cover Bracket Bolt	9 N.m (80 lb in)
Hybrid Powertrain Control Module Nut	9 N.m (80 lb in)

SCHEMATIC WIRING DIAGRAMS

HYBRID/EV ENERGY STORAGE WIRING SCHEMATICS

Battery Energy Control Module Power, Ground and Data Communication

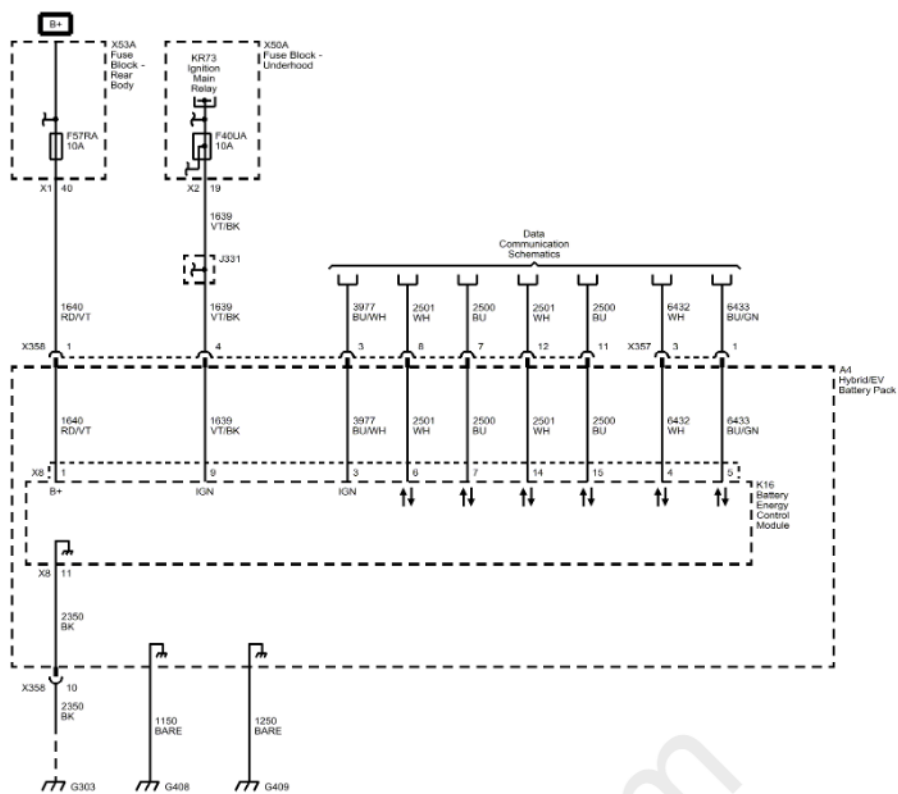


Fig. 1: Battery Energy Control Module Power, Ground and Data Communication
Courtesy of GENERAL MOTORS COMPANY

K114B Hybrid Powertrain Control Module 2 Power, Ground, Serial Data and Internal Battery Communication

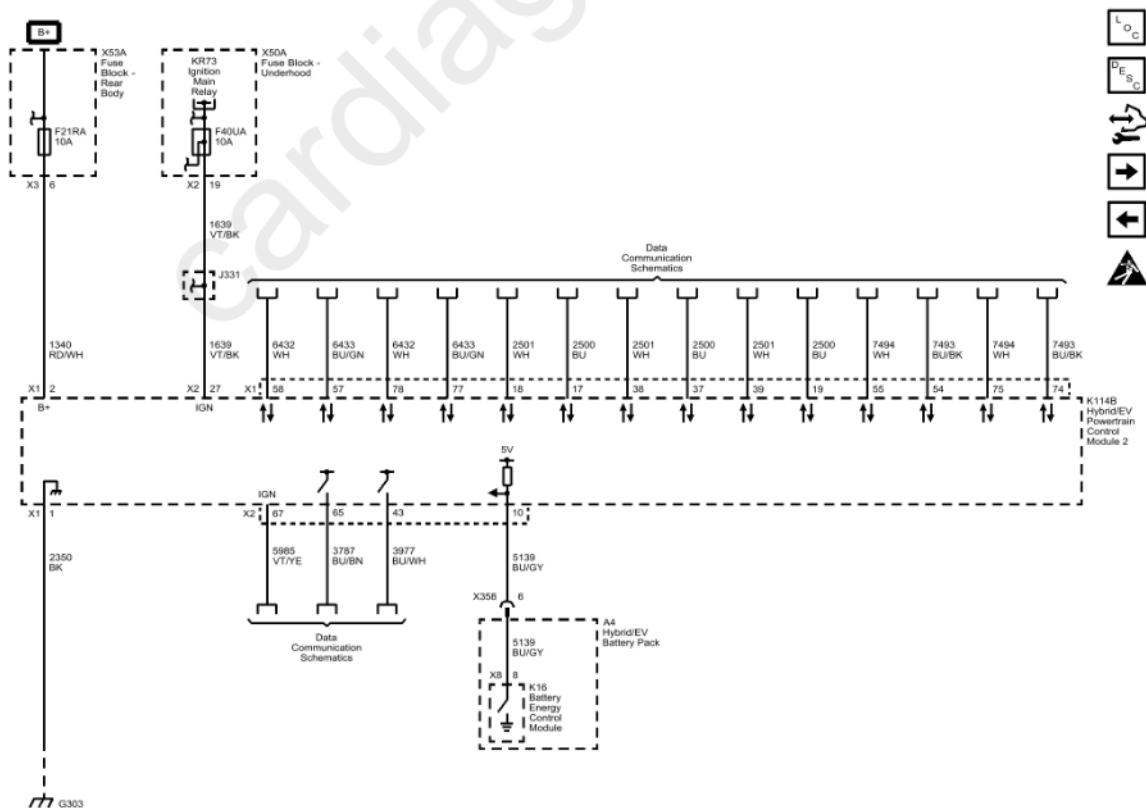


Fig. 2: K114B Hybrid Powertrain Control Module 2 Power, Ground, Serial Data and Internal Battery Communication
Courtesy of GENERAL MOTORS COMPANY

High Voltage Interlock Loop - Main

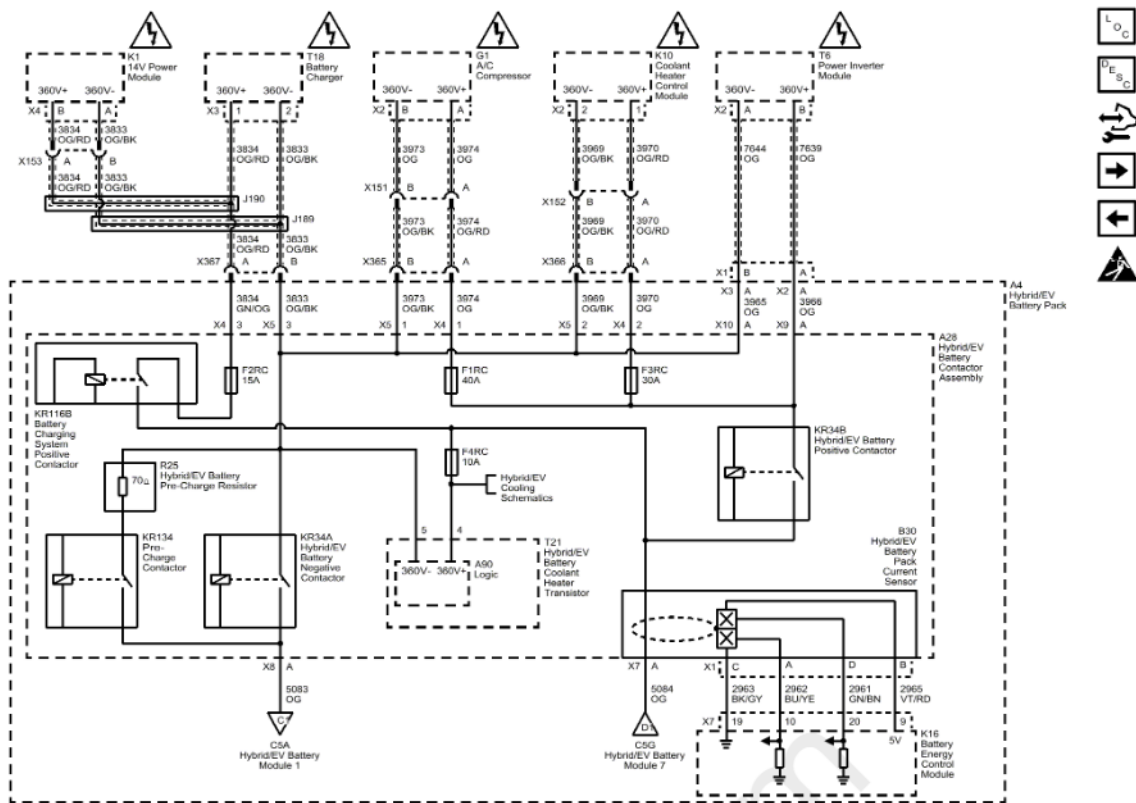


Fig. 5: High Current Management
Courtesy of GENERAL MOTORS COMPANY

Hybrid/EV Battery Section 1

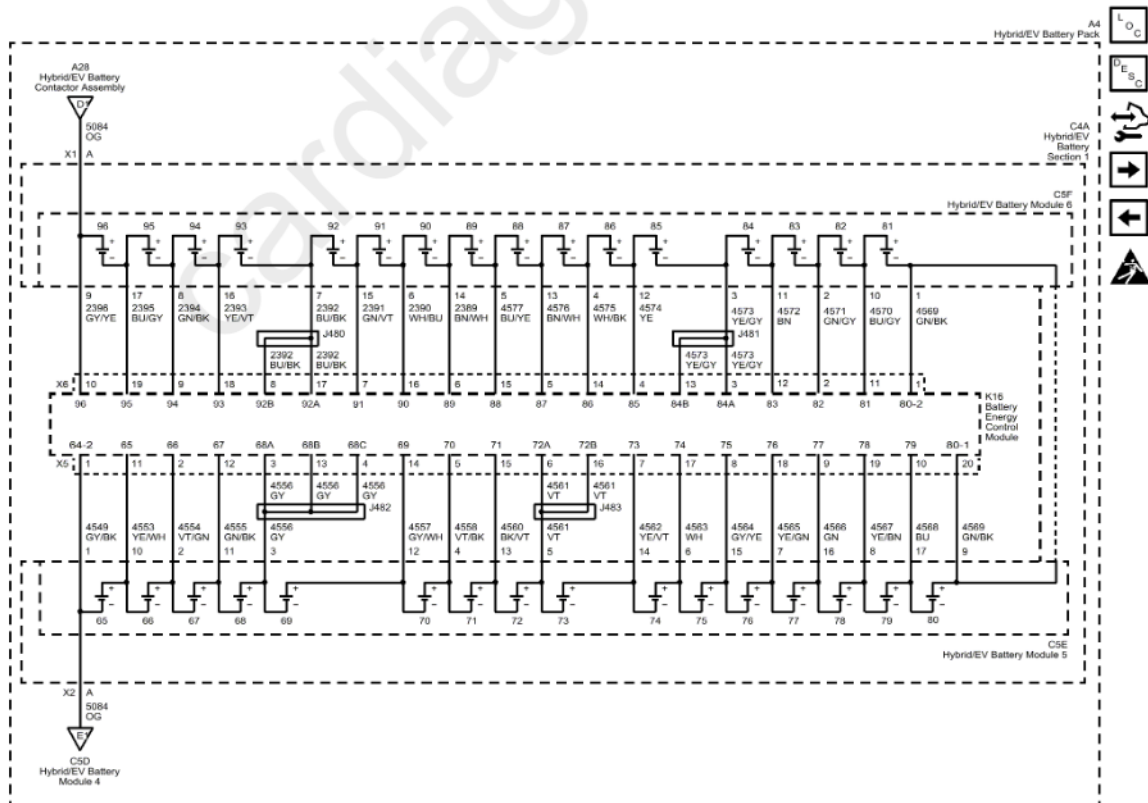


Fig. 6: Hybrid/EV Battery Section 1
Courtesy of GENERAL MOTORS COMPANY

Hybrid/EV Battery Section 2

Callout	Component Name
22	High Voltage Battery Disconnect Relay Bolt [2x]
23	Battery Tray Guide Bolt [2x]
24	High Voltage Battery Cover - Left Side
25	High Voltage Battery Cover - Front
26	Interface Control Module Bracket
27	Interface Control Module Bracket Bolt [2x]
28	Hybrid Powertrain Control Module 2
29	Hybrid Powertrain Control Module 2 Mounting Nut [4x]
30	High Voltage Battery Cover - Right Side
31	Battery Energy Control Module

HYBRID ENERGY STORAGE COMPONENT VIEWS

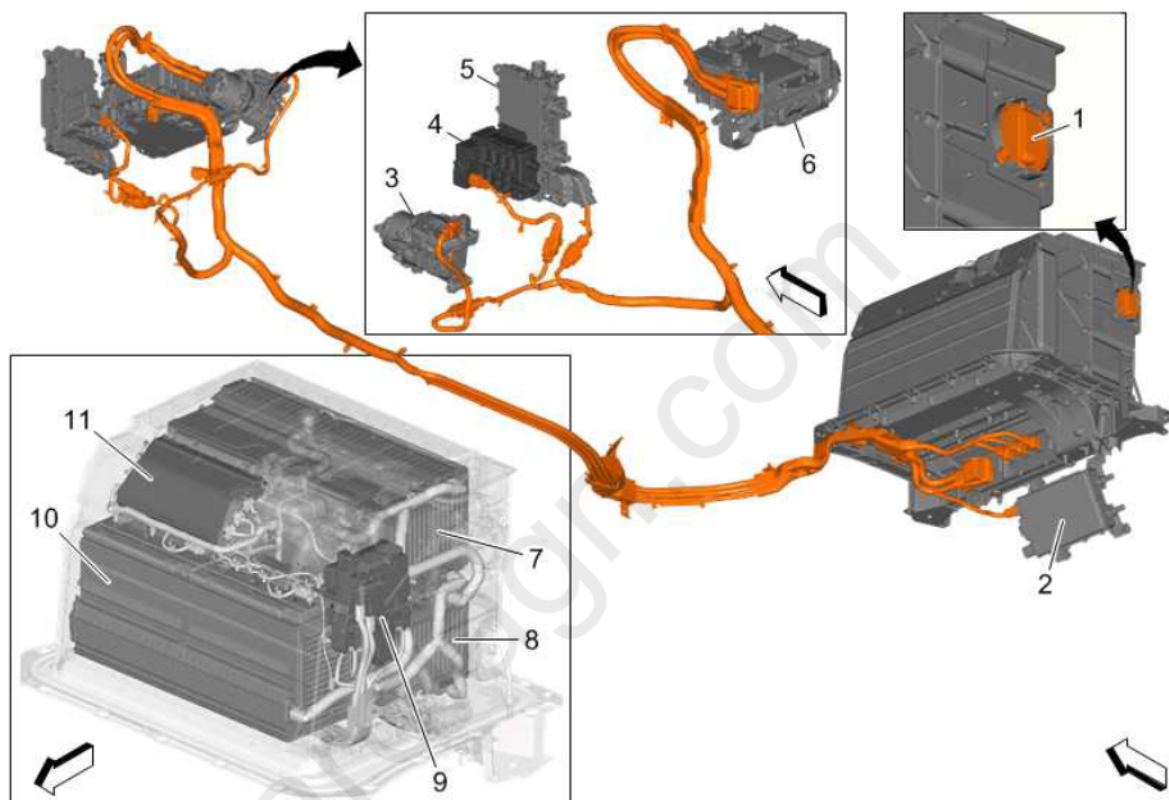


Fig. 10: Hybrid Energy Storage Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	S15 Manual Service Disconnect
2	T18 Battery Charger
3	G1 A/C Compressor
4	K10 Coolant Heater
5	K1 14V Power Module
6	T6 Power Inverter Module
7	C4B Hybrid/EV Battery Section 2
8	C4C Hybrid/EV Battery Section 3
9	A28 Hybrid/EV Battery Contactor Assembly
10	C4A Hybrid/EV Battery Section 1
11	K16 Battery Energy Control Module

DIAGNOSTIC INFORMATION AND PROCEDURES

HIGH VOLTAGE SAFETY

The High Voltage Safety procedure will perform the following tasks:

- Identify precautions when performing service or inspections.
- Identify labels for components, wire harness and connectors.
- Identify high voltage insulation glove inspection procedure.

When applicable, additional region-specific high voltage service requirements and/or Dangers will be located in the General Information, Safety Regulations service category and take precedence over the information presented here.

General High Voltage Dangers

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 1000 V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

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

NOTE: For European Region, a face shield is required in place of safety glasses.

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.

NOTE: For European Region, a special voltage tester such as the EL-52081 may be required. A multimeter that can measure current is prohibited.

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.

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 keyless entry transmitters and the manual service disconnect from the vehicle and secure in a place outside the vehicle.
- Always wear certified and tested high voltage insulation gloves when inspecting or testing any high voltage wires and components.
- Use the "One Hand" rule whenever possible:
 - Work with only one hand.
 - 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 ring-terminal style high voltage wires, protect and insulate the terminal ends immediately with the **EL-50209** high voltage terminal cover and ULÄ® 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 reinstalling the high voltage manual disconnect, 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, high voltage components such as the Energy Storage System and high voltage cables are affixed with "High Voltage" red danger and orange warning labels.

High Voltage Insulation Glove Inspection Procedure

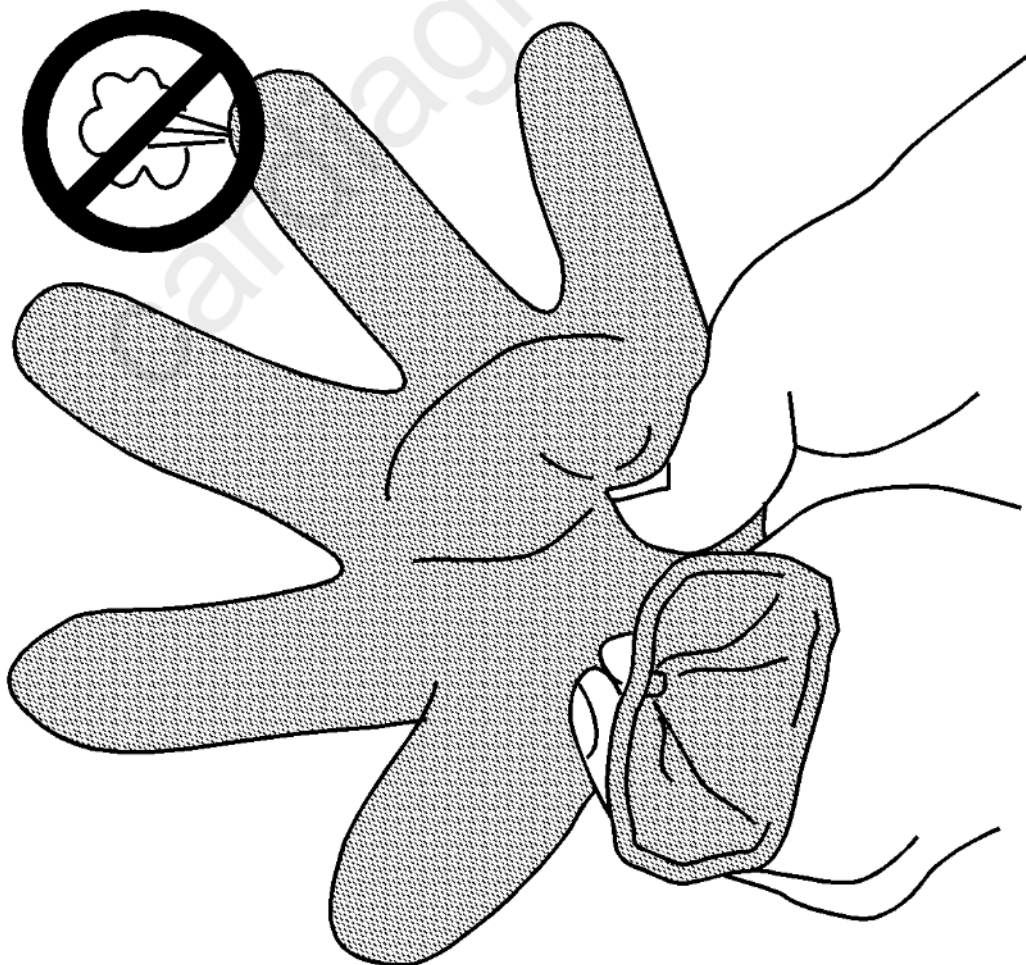


Fig. 11: Glove Inspection Procedure

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. Trap air in the glove and seal opening. Pinch or roll the opening closed tightly to prevent any air loss.
3. Press glove to increase pressure.
4. Inspect for the following conditions:
 - Pin holes
 - Air leaks
 - Wear, tears or abrasions
 - Damp or wet material
 - Expired certification
 - **If any of the above conditions are met**

Do not use the gloves.

- **If none of the above conditions are met**

5. All OK. Gloves are OK to use.

HIGH VOLTAGE DISABLING

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 High Voltage Disabling procedure will perform the following tasks:

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

The High Voltage Disabling procedure utilizes two possible methods to disable high voltage:

1. Scan Tool Method: The on-vehicle control module software, initiated by the GDS2 scan tool, disables and discharges high voltage outside of the Hybrid/EV battery pack.

NOTE: The High Voltage Disable procedure, regardless of the method, only de-energizes the high voltage circuits and components outside of the Hybrid/EV battery pack, dangerous voltage levels always exist within the Hybrid/EV battery pack.

2. DMM Method: If the GDS2 Scan Tool Method does not complete or cannot be implemented, A DMM-based physical measurement method is performed at certain high voltage connectors.

A successful GDS2 Scan Tool High Voltage Disable Procedure will:

1. Perform an analysis of the vehicle condition by verifying specific DTCs have run and passed.
2. Calculate the high voltage isolation resistance to the vehicle chassis.
3. Open the high voltage contactor relays and discharge the high voltage system by setting a crash event lockout. When this stage is reached the Clear Secured High Voltage DTCs procedure will have to be performed to enable the system again.
4. Latch a Service Lockout condition to prevent unintended enabling of the high voltage system.
5. Instruct you when to remove the manual service disconnect.

6. Indicate successful high voltage disabling by:

- Displaying a PROCEDURE COMPLETE message on the scan tool
- Displaying a CHECK VEHICLE'S HIGH VOLTAGE STATUS message on the scan tool which will require you to verify:
 - Vehicle is displaying an Instrument Cluster DIC message
 - Vehicle is sounding a continuous audible response from the vehicle Pedestrian Alert alarm
 - High Voltage Inverter Voltage parameter on scan tool indicates system high voltage has been lowered to a safe level.

An Unsuccessful GDS2 Scan Tool High Voltage Disable Procedure:

If vehicle conditions DO NOT permit the GDS2 scan tool procedure to complete, you will have to verify high voltage disabling by measuring the applicable connectors for safe voltage level with a DMM.

Diagnostic Aids

Review the [High Voltage Connectors](#) information for connector identification and the approved procedures for disconnecting and connecting high voltage connectors.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

- [COMPONENT CONNECTOR END VIEWS - INDEX](#)
- [INLINE HARNESS CONNECTOR END VIEWS - INDEX](#)

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

Circuit Testing

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

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

- Safety glasses with appropriate side shields when within 50 feet of the vehicle, either indoors or outdoors
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors
 - Visually and functionally inspect the gloves before use.

- Wear the Insulation gloves at all times when working with the high voltage battery assembly, whether the system is energized or not.

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

1. Review the high voltage safety information. Refer to [High Voltage Safety](#).
2. Disconnect and remove all 12 V Battery Chargers and the Charge Cable from the X98 Hybrid Battery Charger Receptacle.

NOTE: Ensure the 12V battery is fully charged and tested prior to continuing.

3. Access the GDS2 scan tool High Voltage Disable Procedure located under HPCM2 Control Functions.

NOTE: If vehicle conditions do not allow for GDS2 scan tool usage, proceed to GDS2 Scan Tool Procedure Unsuccessful below.

4. Perform the actions as specified within the GDS2 scan tool procedure.
5. WHEN INSTRUCTED by the GDS2 procedure, remove the S15 Manual Service Disconnect. Refer to [Drive Motor Battery High Voltage Manual Disconnect Lever Replacement](#). Place the S15 Manual Service Disconnect in a secure place outside the vehicle. Cover the exposed high voltage opening with UL listed or equivalent, insulation tape rated at a minimum of 600 V.

NOTE: If at any point the GDS2 scan tool displays a "PROCEDURE UNSUCCESSFUL" warning message or you lose communication, stop the GDS2 procedure and proceed to GDS2 Scan Tool Procedure Unsuccessful below.

6. Verify the GDS2 scan tool procedure completed successfully by observing a GDS2 scan tool "PROCEDURE COMPLETE" message followed by a "CHECK VEHICLE'S HIGH VOLTAGE STATUS" message. Verify these messages are combined with ALL the following conditions:

- Continuous Audible Vehicle Response of the Pedestrian Alert alarm
- DIC message
- High Voltage Inverter Voltage parameter on scan tool indicates system high voltage is less than 10 volts
- **If the procedure was unsuccessful**

Proceed to GDS2 Scan Tool Procedure Unsuccessful below.

- **If the procedure successfully completed**

1. Turn the vehicle power mode to OFF.
2. Disconnect the 12 V battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
Note: Disconnecting the 12 V battery is the only method to deactivate the audible vehicle response. The audible response will not resume when the 12 V battery is reconnected.
3. The high voltage circuits and components OUTSIDE of the Hybrid/EV battery pack are now disabled/discharged.

NOTE: You will have to perform the Clear Secured High Voltage DTCs GDS2 scan tool procedure in order to re-enable the high voltage system upon completion of the required vehicle servicing.

NOTE: Print the High Voltage Disable Confirmation table if necessary. Circle Steps Completed to identify which components have been disabled.

High Voltage Disable Confirmation Table

Was the GDS2 Scan Tool Procedure SUCCESSFUL?	Circle One:	NO	YES
	If YES, all high voltage external of the A4 Hybrid/EV Battery Pack is now disabled. Fill-out and Print form as necessary.		

	If NO, perform GDS2 Scan Tool Procedure Unsuccessful steps as required		
Confirm GDS2 Scan Tool Procedure Unsuccessful Steps Completed Below			
High Voltage Components you wish to Disable	GDS2 Scan Tool Procedure Unsuccessful Steps that must be completed	Steps Completed	
T6 Power Inverter Module and connectors	Steps 1-5 and 6-6.16	NO	YES
T12 Transmission and connectors	Steps 1-5 and 6-6.10	NO	YES
- A4 Hybrid/EV Battery Pack - external 300V cable A4 Hybrid/EV Battery Pack to T6 Power Inverter Module	Steps 1-5 and 8-8.17	NO	YES
K1 14V Power Module	Steps 1-5 and 10-10.6	NO	YES
T18 Battery Charger	Steps 1-5 and 7-7.6	NO	YES
300V cable - A4 Hybrid/EV Battery Pack to K1 14V Power Module and T18 Battery Charger	Steps 1-5 and 7-7.4	NO	YES
K10 Coolant Heater	Steps 1-5 and 11-11.6	NO	YES
300V cable - A4 Hybrid/EV Battery Pack to K10 Heater	Steps 1-5 and 11-11.4	NO	YES
G1 A/C Compressor	Steps 1-5 and 9-9.6	NO	YES
300V cable - A4 Hybrid/EV Battery Pack to G1 A/C Compressor	Steps 1-5 and 9-9.4	NO	YES
*Perform testing at each component as applicable			
Technician:			
VIN:			
License Plate:			

GDS2 Scan Tool Procedure Unsuccessful

1. Turn the vehicle power mode to OFF. Remove all keyless entry transmitters from the vehicle and secure in a place outside the vehicle.

NOTE: If the GDS2 Scan Tool Procedure was unsuccessful, follow each individual procedure below as applicable.

2. Attempt to start the vehicle with the Ignition Mode Switch.

- If the vehicle enters Propulsion System Active mode or the engine starts

Locate and remove all keyless entry transmitters from within the vehicle and return to the beginning of the GDS2 Scan Tool Procedure Unsuccessful procedure.

- If the vehicle did not enter Propulsion System Active mode and the engine did not start

3. Disconnect the 12 V battery. Refer to [Battery Negative Cable Disconnection and Connection](#)

NOTE: The 12 V battery must be disconnected to ensure proper test results.

NOTE: You must ensure Battery Maintenance Mode is not active before disconnecting the 12V battery.

4. Remove the S15 Manual Service Disconnect. Refer to [Drive Motor Battery High Voltage Manual Disconnect Lever Replacement](#). Place the S15 Manual Service Disconnect in a secure place outside the

vehicle. Cover the exposed high voltage opening with ULA® listed or equivalent, insulation tape rated at a minimum of 600 V.

5. Wait 5 min before continuing, to allow the high voltage capacitors to discharge.

NOTE: 5 min must elapse before removing any high voltage connectors. Removal of non high voltage components is allowed during this wait time.

6. Determine if high voltage disable for the T6 Power Inverter Module or T12 Transmission is required.

NOTE: The following steps will disable high voltage for the T6 Power Inverter Module or T12 Transmission.

- If high voltage disable for the T6 power inverter module or T12 transmission is required

1. Remove the Air Inlet Grille Panel.
2. Disconnect the T6 Power Inverter Module 56-way connector (2).

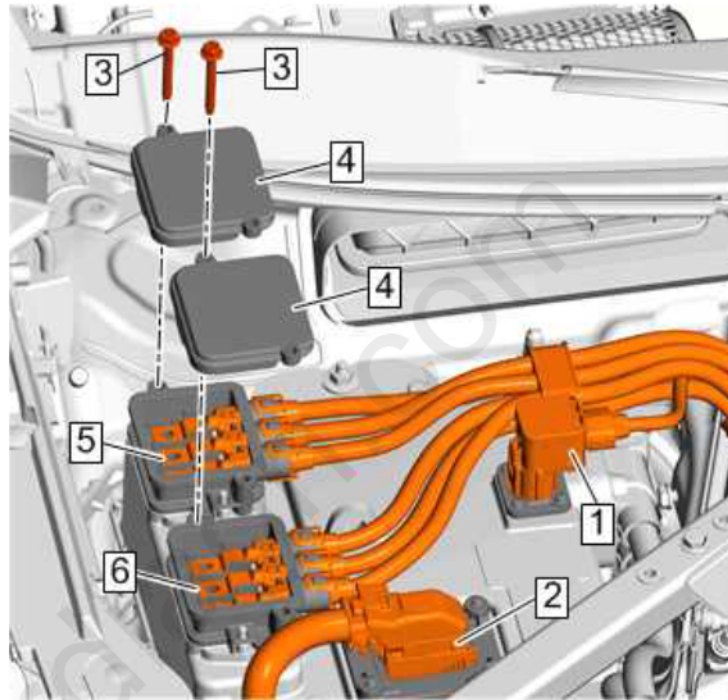


Fig. 12: T6 Power Inverter Module 56-Way Connector And T6 Power Inverter Module HV 3 Phase Transmission Fluid Pump Motor Connector
Courtesy of GENERAL MOTORS COMPANY

3. Remove the T6 Power Inverter Module HV drive motor 3 phase cable cover bolts (3) and HV cable covers (4).

NOTE: Wear your High Voltage Insulation gloves until you have determined that a high voltage exposure risk is no longer present.

4. Disconnect the T6 Power Inverter Module HV 3 phase transmission fluid pump motor connector (1).
5. Verify the test DMM by measuring a known good 9 to 12 V battery.

NOTE: A 9 V DC battery or the vehicle 12 V battery can be used to test the DMM.

- If the DMM does not properly measure the test battery, repair or replace the DMM and repeat all voltage measurements.
 - If the DMM properly measures the test battery
6. Verify the voltage measures less than 3 V at the T6 Power Inverter Module 3 phase drive motor connector (6) at the following points:

NOTE: Inspect the High Voltage 3 phase drive motor connection seal for deformation or damage. Always replace damaged seals and clean seal

remnants from the connector with a non-marring tool.

NOTE:

5 min must have elapsed since removing the S15 Manual Service Disconnect before continuing to allow the high voltage capacitors to discharge and ensure proper test results.

- High voltage 3 phase terminal U to vehicle chassis ground.
 - High voltage 3 phase terminal V to vehicle chassis ground.
 - High voltage 3 phase terminal W to vehicle chassis ground.
 - If 3 V or greater, there is a stuck closed contactor and a loss of isolation within the A4 Hybrid/EV Battery Pack. Refer to [Hybrid/EV Battery Voltage Present](#).
 - If less than 3 V
7. Verify the voltage measures less than 3 V at the T6 Power Inverter Module 3 phase drive motor connector (5) at the following points:
- High voltage 3 phase terminal U to vehicle chassis ground.
 - High voltage 3 phase terminal V to vehicle chassis ground.
 - High voltage 3 phase terminal W to vehicle chassis ground.
 - If 3 V or greater, there is a stuck closed contactor and a loss of isolation within the A4 Hybrid/EV Battery Pack. Refer to [Hybrid/EV Battery Voltage Present](#).
 - If less than 3 V
8. Verify the voltage measures less than 3 V at the T6 Power Inverter Module 3 phase transmission fluid pump motor connector (1) at the following points:
- High voltage 3 phase terminal U (module side) to vehicle chassis ground.
 - High voltage 3 phase terminal V (module side) to vehicle chassis ground.
 - High voltage 3 phase terminal W (module side) to vehicle chassis ground.
 - If 3 V or greater, there is a stuck closed contactor and a loss of isolation within the A4 Hybrid/EV Battery Pack. Refer to [Hybrid/EV Battery Voltage Present](#).
 - If less than 3 V
9. Verify the test DMM by measuring a known good 9 to 12 V battery.
- If the DMM does not properly measure the test battery, repair or replace the DMM and repeat all voltage measurements.
 - If the DMM properly measures the test battery
10. The T6 Power Inverter Module 3 phase circuits are now zero-volt tested. You may perform T12 Transmission service and exit the High Voltage Disabling procedure at this time but you **MUST** continue if T6 Power Inverter Module service is required.
- If you do not need to perform T6 power inverter module service, HV Disable for T12 Transmission is complete.
 - If you need to perform T6 power inverter module service
11. Perform the [Drive Motor Power Inverter Module Replacement](#) procedure steps necessary to raise the T6 power inverter module (1) enough to gain access to the HV DC lever lock connector (2).

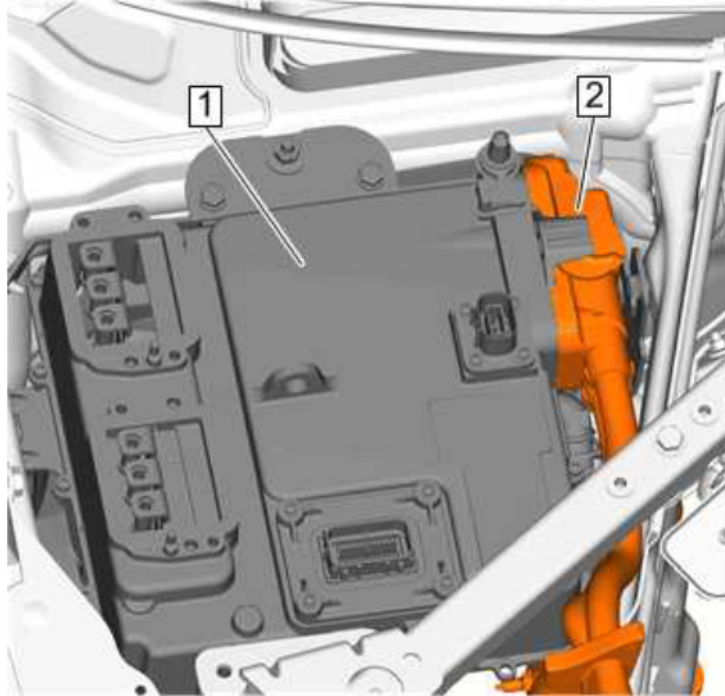


Fig. 13: HV DC Lever Lock Connector

Courtesy of GENERAL MOTORS COMPANY

12. Disconnect the A4 Hybrid/EV Battery Pack HV DC harness connector (2) at the T6 power inverter module (1).
13. Verify the voltage measures less than 3 V at the A4 Hybrid/EV Battery Pack harness connector at the following points:
 - High voltage DC (-360 V) negative terminal B to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A and high voltage DC (-360 V) negative terminal B.
 - If 3 V or greater, there is a stuck closed contactor and a loss of isolation within the A4 Hybrid/EV Battery Pack. Refer to **Hybrid/EV Battery Voltage Present**.
 - If less than 3 V
14. Verify the voltage measures less than 3 V at the T6 power inverter module connector at the following points:
 - High voltage DC (-360 V) negative terminal B to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A and high voltage DC (-360 V) negative terminal B.
 - If 3 V or greater, leave the DMM connected to the terminals until the voltage drops below 3 V to allow the high voltage capacitors to discharge. Continue to the next step once the voltage is below 3 V.
 - If less than 3 V
15. Verify the test DMM by measuring a known good 9 to 12 V battery.

NOTE: Discard any 300 V Battery Positive and Negative cable connector seal that may be deformed or damaged. Replace any seal that is deformed, missing or damaged.

NOTE: A 9 V DC battery or the vehicle 12 V battery can be used to test the DMM.

- If the DMM does not properly measure the test battery, repair or replace the DMM and repeat all voltage measurements.
 - If the DMM properly measures the test battery
16. The high voltage connectors at the T6 power inverter module are now zero-volt tested. You may perform T6 power inverter module service and exit the High Voltage Disabling procedure at this time

but you MUST continue if additional high voltage component service is required.

- If you do not need to perform additional high voltage component service, HV Disable for T6 power inverter module and T12 Transmission is complete.
 - If you need to perform additional high voltage component service
17. Perform the individual procedures for each component(s) to be serviced.
- **If high voltage disable for the T6 power inverter module or T12 transmission is not required or has been completed**
7. Determine if high voltage disable for the T18 Battery Charger is required.

NOTE: The following steps will disable high voltage for the T18 Battery Charger.

- **If high voltage disable for the T18 Battery Charger is required**

1. Raise the vehicle.
2. Disconnect the high voltage direct current (DC) connector X3 (1) at the T18 Battery Charger (2).

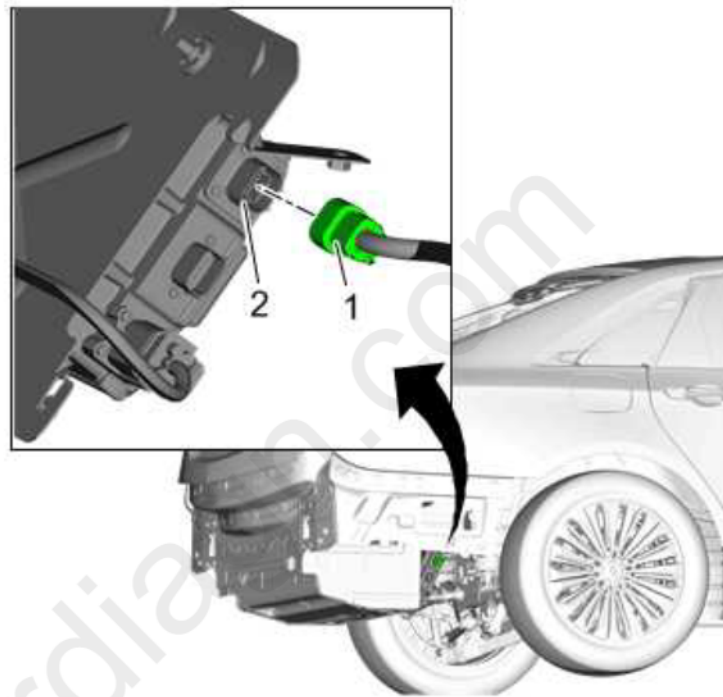


Fig. 14: High Voltage Direct Current (DC) Connector X3
Courtesy of GENERAL MOTORS COMPANY

3. Verify the test DMM by measuring a known good 9 to 12 V battery.

NOTE: A 9 V DC battery or the vehicle 12 V battery can be used to test the DMM.

- If the DMM does not properly measure the test battery, repair or replace the DMM and repeat all voltage measurements.
 - If the DMM properly measures the test battery
4. Verify the voltage measures less than 3 V at the high voltage DC harness connector X3 (1) at the following points:
- High voltage DC (-360 V) negative terminal B to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A and high voltage DC (-360 V) negative terminal B.
 - If 3 V or greater, there is a stuck closed contactor and a loss of isolation within the A4 Hybrid/EV Battery Pack. Refer to [Hybrid/EV Battery Voltage Present](#).
 - If less than 3 V
5. Verify the voltage measures less than 3 V at the T18 Battery Charger connector X3 (2) at the following points:

- High voltage DC (-360 V) negative terminal B to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A and high voltage DC (-360 V) negative terminal B.
 - If 3 V or greater, leave the DMM connected to the terminals until the voltage drops below 3 V to allow the high voltage capacitors to discharge. Continue to the next step once the voltage is below 3 V.
 - If less than 3 V
- The high voltage connectors at the T18 battery charger are now zero-volt tested. You may perform T18 battery charger service and exit the High Voltage Disabling procedure at this time but you **MUST** continue if additional high voltage component service is required.
 - If you do not need to perform additional high voltage component service, HV Disable for T18 Battery Charger is complete.
 - If you need to perform additional high voltage component service
 - Perform the individual procedures for each component(s) to be serviced.
 - **If high voltage disable for the T18 Battery Charger is not required or has been completed**
 - Determine if high voltage disable for the A4 Hybrid/EV Battery Pack is required.

NOTE: The following steps will disable high voltage for the A4 Hybrid/EV Battery Pack.

- **If high voltage disable for the A4 Hybrid/EV Battery Pack is required**

- Raise the vehicle.
- Remove underbody components as required to gain access to the A4 Hybrid/EV Battery Pack high voltage connectors.

NOTE: If removal of the A4 Hybrid/EV Battery Pack is planned you must disable HV at the T18 Battery Charger first.

- Disconnect the high voltage direct current (DC) lever lock connector X1 (7) at the A4 Hybrid/EV Battery Pack (8).

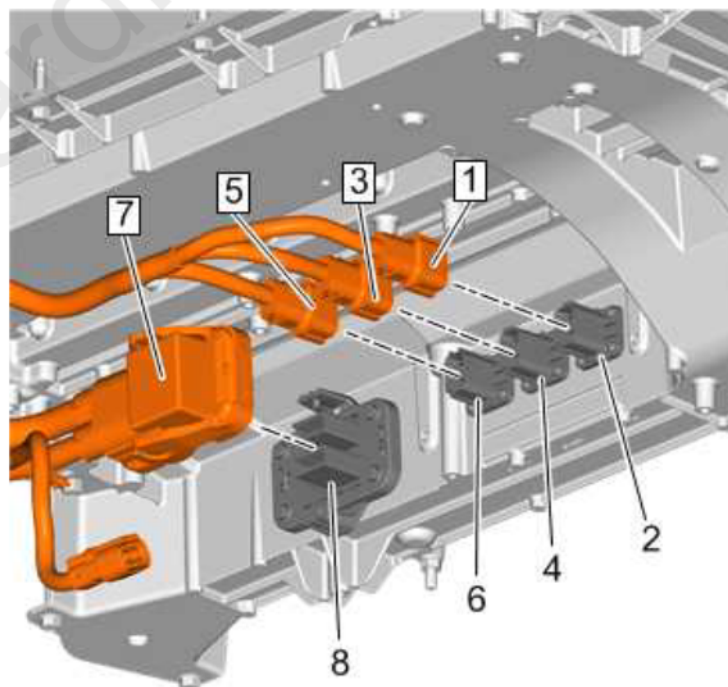


Fig. 15: High Voltage Direct Current (DC) Lever Lock Connector X1, A4 Hybrid/EV Battery Pack Harness Connector X367, A4 Hybrid/EV Battery Pack Harness Connector X366, High Voltage DC Connector X365

Courtesy of GENERAL MOTORS COMPANY

- Verify the test DMM by measuring a known good 9 to 12 V battery.

NOTE: A 9 V DC battery or the vehicle 12 V battery can be used to test the DMM.

- If the DMM does not properly measure the test battery, repair or replace the DMM and repeat all voltage measurements.
 - If the DMM properly measures the test battery
5. Verify the voltage measures less than 3 V at the high voltage DC harness connector X1 (7) at the following points:
 - High voltage DC (-360 V) negative terminal B to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A and high voltage DC (-360 V) negative terminal B.
 - If 3 V or greater, leave the DMM connected to the terminals until the voltage drops below 3 V to allow the high voltage capacitors to discharge. Continue to the next step once the voltage is below 3 V.
 - If less than 3 V
 6. Verify the voltage measures less than 3 V at the A4 Hybrid/EV Battery Pack connector X1 (8) at the following points:
 - High voltage DC (-360 V) negative terminal B to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A and high voltage DC (-360 V) negative terminal B.
 - If 3 V or greater, there is a stuck closed contactor and a loss of isolation within the A4 Hybrid/EV Battery Pack. Refer to [Hybrid/EV Battery Voltage Present](#).
 - If less than 3 V
 7. Disconnect the high voltage DC connector X367 (5) at the A4 Hybrid/EV Battery Pack.
 8. Verify the voltage measures less than 3 V at the A4 Hybrid/EV Battery Pack harness connector X367 (5) at the following points:
 - High voltage DC (-360 V) negative terminal B to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A and high voltage DC (-360 V) negative terminal B.
 - If 3 V or greater, leave the DMM connected to the terminals until the voltage drops below 3 V to allow the high voltage capacitors to discharge. Continue to the next step once the voltage is below 3 V.
 - If less than 3 V
 9. Verify the voltage measures less than 3 V at the A4 Hybrid/EV Battery Pack connector X367 (6) at the following points:
 - High voltage DC (-360 V) negative terminal B to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A and high voltage DC (-360 V) negative terminal B.
 - If 3 V or greater, there is a stuck closed contactor and a loss of isolation within the A4 Hybrid/EV Battery Pack. Refer to [Hybrid/EV Battery Voltage Present](#).
 - If less than 3 V
 10. Disconnect the high voltage DC connector X366 (3) at the A4 Hybrid/EV Battery Pack.
 11. Verify the voltage measures less than 3 V at the A4 Hybrid/EV Battery Pack harness connector X366 (3) at the following points:
 - High voltage DC (-360 V) negative terminal B to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A and high voltage DC (-360 V) negative terminal B.

- If 3 V or greater, leave the DMM connected to the terminals until the voltage drops below 3 V to allow the high voltage capacitors to discharge. Continue to the next step once the voltage is below 3 V.
 - If less than 3 V
12. Verify the voltage measures less than 3 V at the A4 Hybrid/EV Battery Pack connector X366 (4) at the following points:
 - High voltage DC (-360 V) negative terminal B to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A and high voltage DC (-360 V) negative terminal B.
 - If 3 V or greater, there is a stuck closed contactor and a loss of isolation within the A4 Hybrid/EV Battery Pack. Refer to [Hybrid/EV Battery Voltage Present](#).
 - If less than 3 V
 13. Disconnect the high voltage DC connector X365 (1) at the A4 Hybrid/EV Battery Pack.
 14. Verify the voltage measures less than 3 V at the A4 Hybrid/EV Battery Pack harness connector X365 (1) at the following points:
 - High voltage DC (-360 V) negative terminal B to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A and high voltage DC (-360 V) negative terminal B.
 - If 3 V or greater, leave the DMM connected to the terminals until the voltage drops below 3 V to allow the high voltage capacitors to discharge. Continue to the next step once the voltage is below 3 V.
 - If less than 3 V
 15. Verify the voltage measures less than 3 V at the A4 Hybrid/EV Battery Pack connector X365 (2) at the following points:
 - High voltage DC (-360 V) negative terminal B to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A and high voltage DC (-360 V) negative terminal B.
 - If 3 V or greater, there is a stuck closed contactor and a loss of isolation within the A4 Hybrid/EV Battery Pack. Refer to [Hybrid/EV Battery Voltage Present](#).
 - If less than 3 V
 16. Verify the test DMM by measuring a known good 9 to 12 V battery.

NOTE: **A 9 V DC battery or the vehicle 12 V battery can be used to test the DMM.**

- If the DMM does not properly measure the test battery, repair or replace the DMM and repeat all voltage measurements.
 - If the DMM properly measures the test battery
17. The high voltage connectors at the A4 Hybrid/EV Battery Pack are now zero-volt tested. You may perform A4 Hybrid/EV Battery Pack service and exit the High Voltage Disabling procedure at this time but you **MUST** continue if additional high voltage component service is required.
 - If you do not need to perform additional high voltage component service, HV Disable for A4 Hybrid/EV Battery Pack is complete.
 - If you need to perform additional high voltage component service
 18. Perform the individual procedures for each component(s) to be serviced.
 - **If high voltage disable for the A4 Hybrid/EV Battery Pack is not required or has been completed**
9. Determine if high voltage disable for the G1 A/C Compressor is required.

NOTE: **The following steps will disable high voltage for the G1 A/C Compressor.**

- If high voltage disable for the G1 A/C Compressor is required

1. Raise the vehicle.
2. Disconnect the high voltage direct current (DC) inline connector X151 (1, 2) located beneath the engine bay.

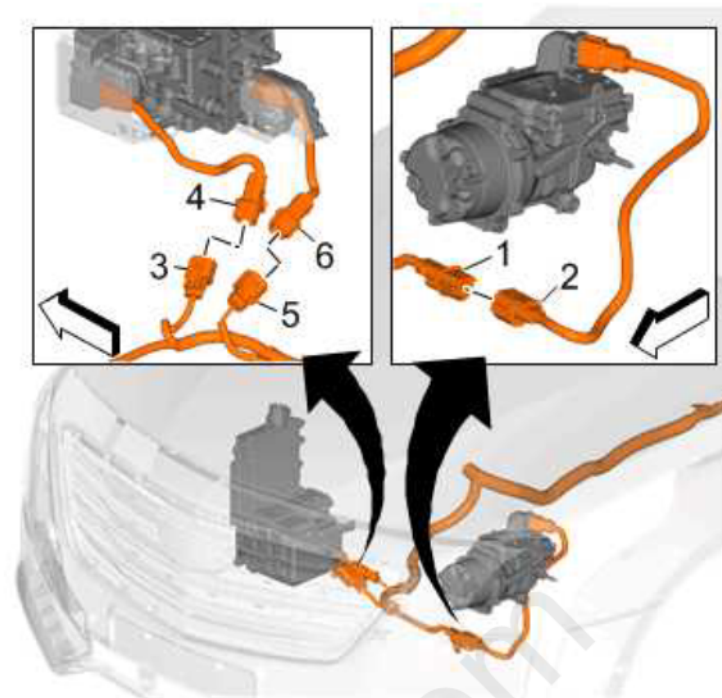


Fig. 16: High Voltage Direct Current (DC) Inline Connector X151
 Courtesy of GENERAL MOTORS COMPANY

3. Verify the test DMM by measuring a known good 9 to 12 V battery.

NOTE: A 9 V DC battery or the vehicle 12 V battery can be used to test the DMM.

- If the DMM does not properly measure the test battery, repair or replace the DMM and repeat all voltage measurements.
 - If the DMM properly measures the test battery
4. Verify the voltage measures less than 3 V at the high voltage DC harness connector X151, hybrid/EV battery pack side (1), at the following points:
 - High voltage DC (-360 V) negative terminal B to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A and high voltage DC (-360 V) negative terminal B.
 - If 3 V or greater, there is a stuck closed contactor and a loss of isolation within the A4 Hybrid/EV Battery Pack. Refer to [Hybrid/EV Battery Voltage Present](#).
 - If less than 3 V
 5. Verify the voltage measures less than 3 V at the high voltage DC harness connector X151, G1 A/C Compressor side (2), at the following points:
 - High voltage DC (-360 V) negative terminal B to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A and high voltage DC (-360 V) negative terminal B.
 - If 3 V or greater, leave the DMM connected to the terminals until the voltage drops below 3 V to allow the high voltage capacitors to discharge. Continue to the next step once the voltage is below 3 V.
 - If less than 3 V
 6. The high voltage connectors for the G1 A/C Compressor are now zero-volt tested. You may perform G1 A/C Compressor service and exit the High Voltage Disabling procedure at this time but you MUST continue if additional high voltage component service is required.

- If you do not need to perform additional high voltage component service, HV Disable for G1 A/C Compressor is complete.
 - If you need to perform additional high voltage component service
7. Perform the individual procedures for each component(s) to be serviced.
 - **If high voltage disable for the G1 A/C Compressor is not required or has been completed**
 10. Determine if high voltage disable for the K1 14V Power Module is required.

NOTE: The following steps will disable high voltage for the K1 14V Power Module.

- **If high voltage disable for the K1 14V Power Module is required**

1. Raise the vehicle.
2. Disconnect the high voltage direct current (DC) inline connector X153 (5, 6) located beneath the engine bay.

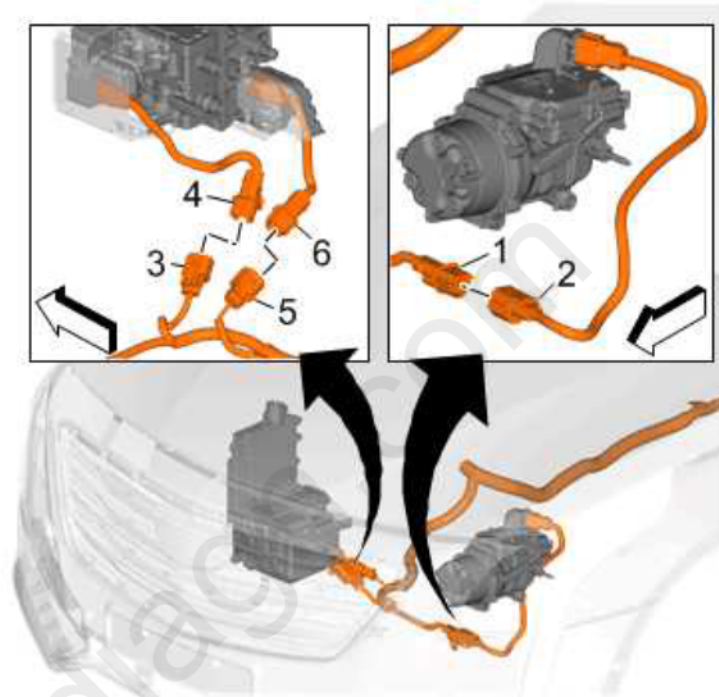


Fig. 17: High Voltage Direct Current (DC) Inline Connector X153
Courtesy of GENERAL MOTORS COMPANY

3. Verify the test DMM by measuring a known good 9 to 12 V battery.

NOTE: A 9 V DC battery or the vehicle 12 V battery can be used to test the DMM.

- If the DMM does not properly measure the test battery, repair or replace the DMM and repeat all voltage measurements.
 - If the DMM properly measures the test battery
4. Verify the voltage measures less than 3 V at the high voltage DC harness connector X153 (5), hybrid/EV battery pack side, at the following points:
 - High voltage DC (-360 V) negative terminal B to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A and high voltage DC (-360 V) negative terminal B.
 - If 3 V or greater, there is a stuck closed contactor and a loss of isolation within the A4 Hybrid/EV Battery Pack. Refer to [Hybrid/EV Battery Voltage Present](#).
 - If less than 3 V
 5. Verify the voltage measures less than 3 V at the high voltage DC harness connector X153 (6), K1 14V Power Module side, at the following points:
 - High voltage DC (-360 V) negative terminal B to vehicle chassis ground.

- High voltage DC (+360 V) positive terminal A to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A and high voltage DC (-360 V) negative terminal B.
 - If 3 V or greater, leave the DMM connected to the terminals until the voltage drops below 3 V to allow the high voltage capacitors to discharge. Continue to the next step once the voltage is below 3 V.
 - If less than 3 V
6. The high voltage connectors for the K1 14V Power Module are now zero-volt tested. You may perform K1 14V Power Module service and exit the High Voltage Disabling procedure at this time but you **MUST** continue if additional high voltage component service is required.
 - If you do not need to perform additional high voltage component service, HV Disable for K1 14V Power Module is complete.
 - If you need to perform additional high voltage component service
 7. Perform the individual procedures for each component(s) to be serviced.
 - **If high voltage disable for the K1 14V Power Module is not required or has been completed**
 11. Determine if high voltage disable for the K10 Coolant Heater is required.

NOTE: The following steps will disable high voltage for the K10 Coolant Heater.

- **If high voltage disable for the K10 Coolant Heater is required**

1. Raise the vehicle.
2. Disconnect the high voltage direct current (DC) inline connector X152 (3, 4) located beneath the engine bay.

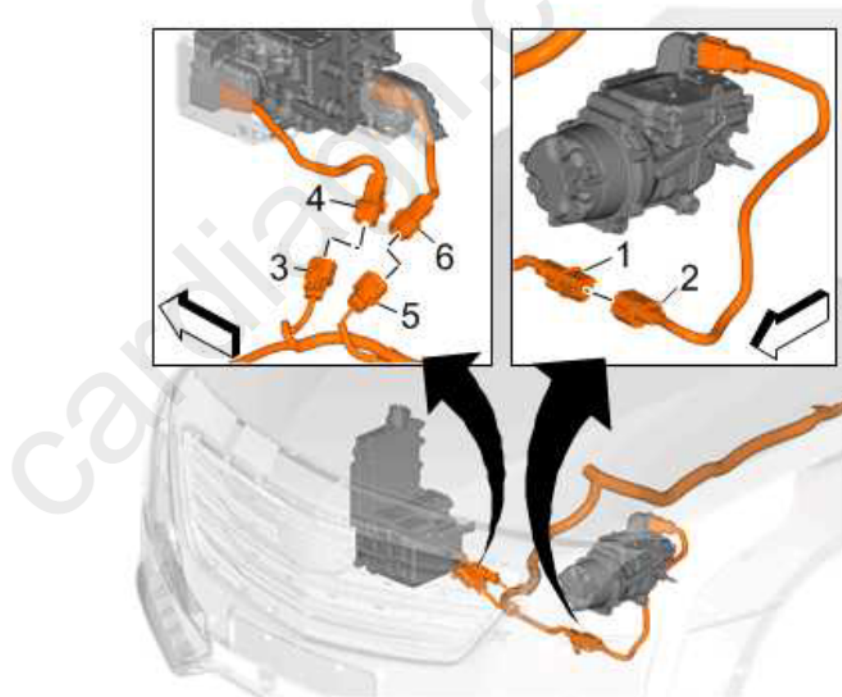


Fig. 18: High Voltage Direct Current (DC) Inline Connector X152
 Courtesy of GENERAL MOTORS COMPANY

3. Verify the test DMM by measuring a known good 9 to 12 V battery.

NOTE: A 9 V DC battery or the vehicle 12 V battery can be used to test the DMM.

- If the DMM does not properly measure the test battery, repair or replace the DMM and repeat all voltage measurements.
 - If the DMM properly measures the test battery
4. Verify the voltage measures less than 3 V at the high voltage DC harness connector X152 (3), hybrid/EV battery pack side, at the following points:
 - High voltage DC (-360 V) negative terminal B to vehicle chassis ground.

- High voltage DC (+360 V) positive terminal A to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A and high voltage DC (-360 V) negative terminal B.
 - If 3 V or greater, there is a stuck closed contactor and a loss of isolation within the A4 Hybrid/EV Battery Pack. Refer to [Hybrid/EV Battery Voltage Present](#).
 - If less than 3 V
5. Verify the voltage measures less than 3 V at the high voltage DC harness connector X152 (4), K10 Coolant Heater side, at the following points:
 - High voltage DC (-360 V) negative terminal B to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A to vehicle chassis ground.
 - High voltage DC (+360 V) positive terminal A and high voltage DC (-360 V) negative terminal B.
 - If 3 V or greater, leave the DMM connected to the terminals until the voltage drops below 3 V to allow the high voltage capacitors to discharge. Continue to the next step once the voltage is below 3 V.
 - If less than 3 V
 6. The high voltage connectors for the K10 Coolant Heater are now zero-volt tested. You may perform K10 Coolant Heater service and exit the High Voltage Disabling procedure at this time but you **MUST** continue if additional high voltage component service is required.
 - If you do not need to perform additional high voltage component service, HV Disable for K10 Coolant Heater is complete.
 - If you need to perform additional high voltage component service
 7. Perform the individual procedures for each component(s) to be serviced.
 - **If high voltage disable for the K10 Coolant Heater is not required or has been completed**
 12. Print the High Voltage Disable Confirmation table and place a completed copy in the vehicle to identify which high voltage components have been disabled, as necessary.

HIGH VOLTAGE ENABLING

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 High Voltage Enabling procedure will perform the following tasks:

- Identify how to enable high voltage.
- Verify high voltage system integrity and that all connectors are installed.

Diagnostic Aids

Review the [High Voltage Connectors](#) information for connector identification and the approved procedures for disconnecting and connecting high voltage connectors.

Reference Information

Schematic Reference

[Hybrid/EV Energy Storage Schematics](#)

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX](#)

Description and Operation

Electrical Information Reference

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

Scan Tool Reference

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

Circuit/System Testing

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

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

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

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

1. Review the high voltage safety information prior to performing the High Voltage Enabling procedure. Refer to [High Voltage Safety](#).
2. Ensure that the 12 V battery is disconnected. Refer to [Battery Negative Cable Disconnection and Connection](#)
3. After finishing work on the high voltage systems and before installing the S15 Manual Service Disconnect, inspect for the following:

NOTE:

- Always tighten the high voltage fasteners to the specified torque. Insufficient or excessive torque will cause malfunctions or damage.
- The high voltage connectors that have been disconnected do not require a specific sequence when connecting.

- Verify that all tools or loose components have been removed.
 - Inspect any disconnected 300 V Battery Positive and Negative cable seals for being deformed, missing or damaged. Replace any seals that are deformed, missing or damaged.
 - Verify high voltage system integrity and that all connectors are installed.
 - Verify that all high voltage interlock circuit connectors and covers are installed.
 - Install any components or connectors that have been removed or replaced during diagnosis.
4. Install the S15 Manual Service Disconnect (1). Refer to [Drive Motor Battery High Voltage Manual Disconnect Lever Replacement](#)
 5. Connect the 12 V battery. Refer to [Battery Negative Cable Disconnection and Connection](#) .
 6. Vehicle in Service Mode.
 7. Verify if the A4 Hybrid/EV Battery Pack or the K16 Battery Energy Control Module has been replaced.
 - If the A4 Hybrid/EV Battery Pack or the K16 Battery Energy Control Module has been replaced

Program the K16 Battery Energy Control Module. Refer to [Battery Energy Control Module Programming and Setup](#) . Continue to the next step once programming is complete.

- **If the A4 Hybrid/EV Battery Pack or the K16 Battery Energy Control Module has not been replaced**

8. Verify if the [High Voltage Disabling](#) procedure performed prior to vehicle repair utilized the GDS2 scan tool method.

- **If the GDS2 scan tool high voltage disabling procedure was performed, the high voltage contactor relays are in a lockout state.**

Perform the [Clear Secured High Voltage DTCs](#) procedure and return to the next step.

- **If the DMM Method high voltage disabling procedure was performed**

9. Vehicle in Service Mode, perform the driver window express learn and clear all DTC Information with a scan tool. Refer to [Window Motor Programming - Express Function](#) .

10. Vehicle OFF and all vehicle systems OFF. It may take up to 5 min for all vehicle systems to power down.

11. Vehicle in Service Mode.

12. Verify with a scan tool no DTCs are set.

- **If any DTCs are set**

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

- **If no DTCs are set**

13. Vehicle ON. Open the hood to start and idle the engine for 2 min.

14. Vehicle OFF and wait 5 min.

15. Vehicle in Service Mode. Verify with the scan tool the Hybrid/EV Powertrain Control Module and K114B Hybrid/EV Powertrain Control Module 2 DTC Information that the following DTCs have Ran Since Code Clear and have not set:

- Motor position sensor learn DTCs P0C17 and P0C18.
- Contactor DTCs P0AD9, P0ADD, P0D0A and P1EBD.
- Discharge and Pre-charge DTCs P0C76, P0C77, P0C78 and P0AFB.
- High voltage loss of isolation DTCs P0AA6, P1AE6, P1AF0 and P1AF2.
- **If any DTCs are set**

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

- **If the DTCs have Not Ran Since Code Clear**

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

2. Verify with the scan tool the Hybrid/EV Powertrain Control Module and K114B Hybrid/EV Powertrain Control Module 2 DTC Information that the specified DTCs have Ran Since Code Clear and have not set:

- If any DTCs are set, refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
- If the DTCs have Ran and Passed

3. Test drive the vehicle and verify no DTCs are set.

- **If the DTCs have Ran and Passed**

16. Test drive the vehicle and verify no DTCs are set.

HIGH VOLTAGE CONNECTORS

Connector Type Identification

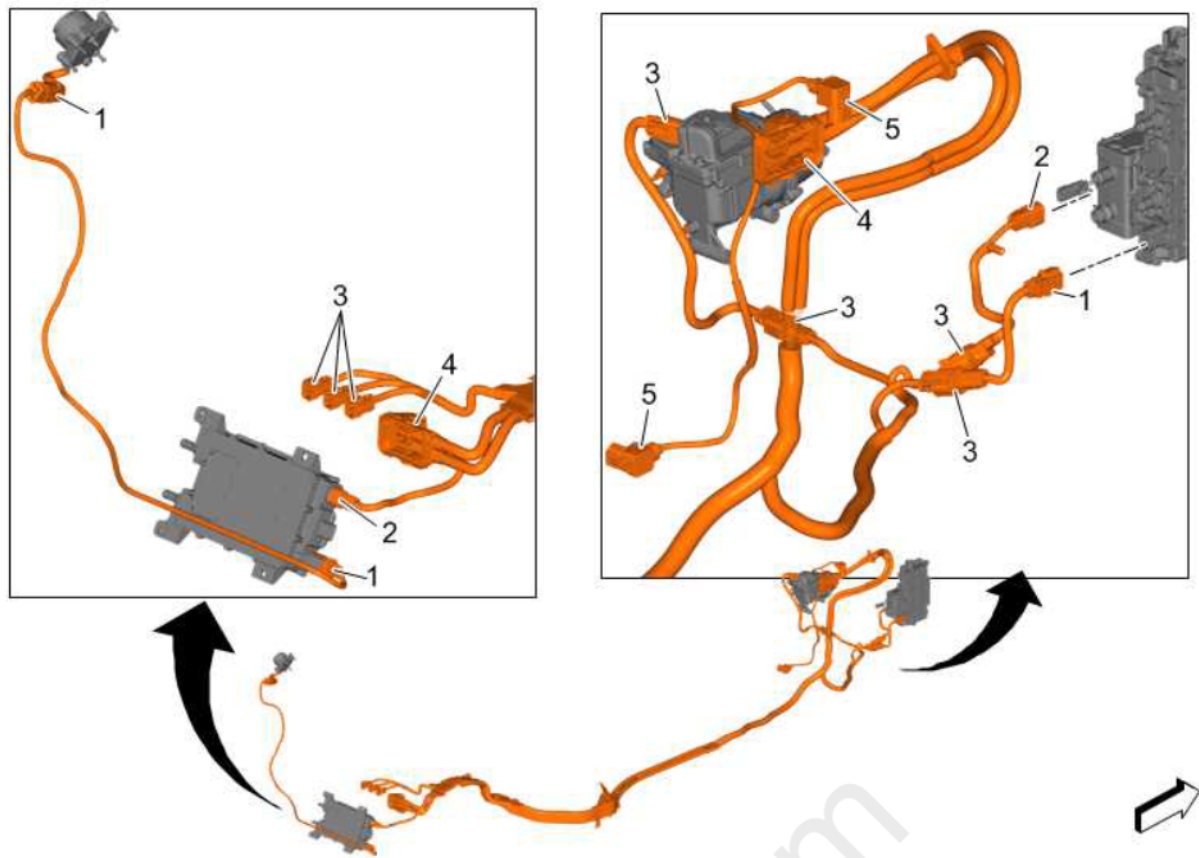


Fig. 19: Connector Type Identification

Courtesy of GENERAL MOTORS COMPANY

Connector Type		Connector Location							
		T6 Power Inverter Module	G5 Transmission Fluid Pump - Electric Auxiliary	A4 Hybrid/EV Battery Pack	G1 A/C Compressor	K10 Coolant Heater Control Module	K1 14V Power Module	T18 Battery Charger	X98 Hybrid/EV Battery Charger Receptacle
Callout	Connector								
1	HV280	-	-	-	-	-	-	X2	X1
2	AMP+HVA280	-	-	-	-	X2	-	X3	-
3	HVA280 1 click	-	-	X365, X366, X367	X2, X151	X152	X4, X153	-	-
4	PP2000 90 NFS	X2	-	X1	-	-	-	-	-
5	HVA280 3PM	X5	X1	-	-	-	-	-	-

WARNING:

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

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

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

WARNING:

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

Review the high voltage safety information. Refer to [High Voltage Safety](#).

HV280 Connector Procedure

HV280 Disconnect Procedure

1. Pull the connector position assurance (CPA) (1) tab back from the locked position to the pre-stage position. There will be an audible click sound when the CPA tab is in the correct position.

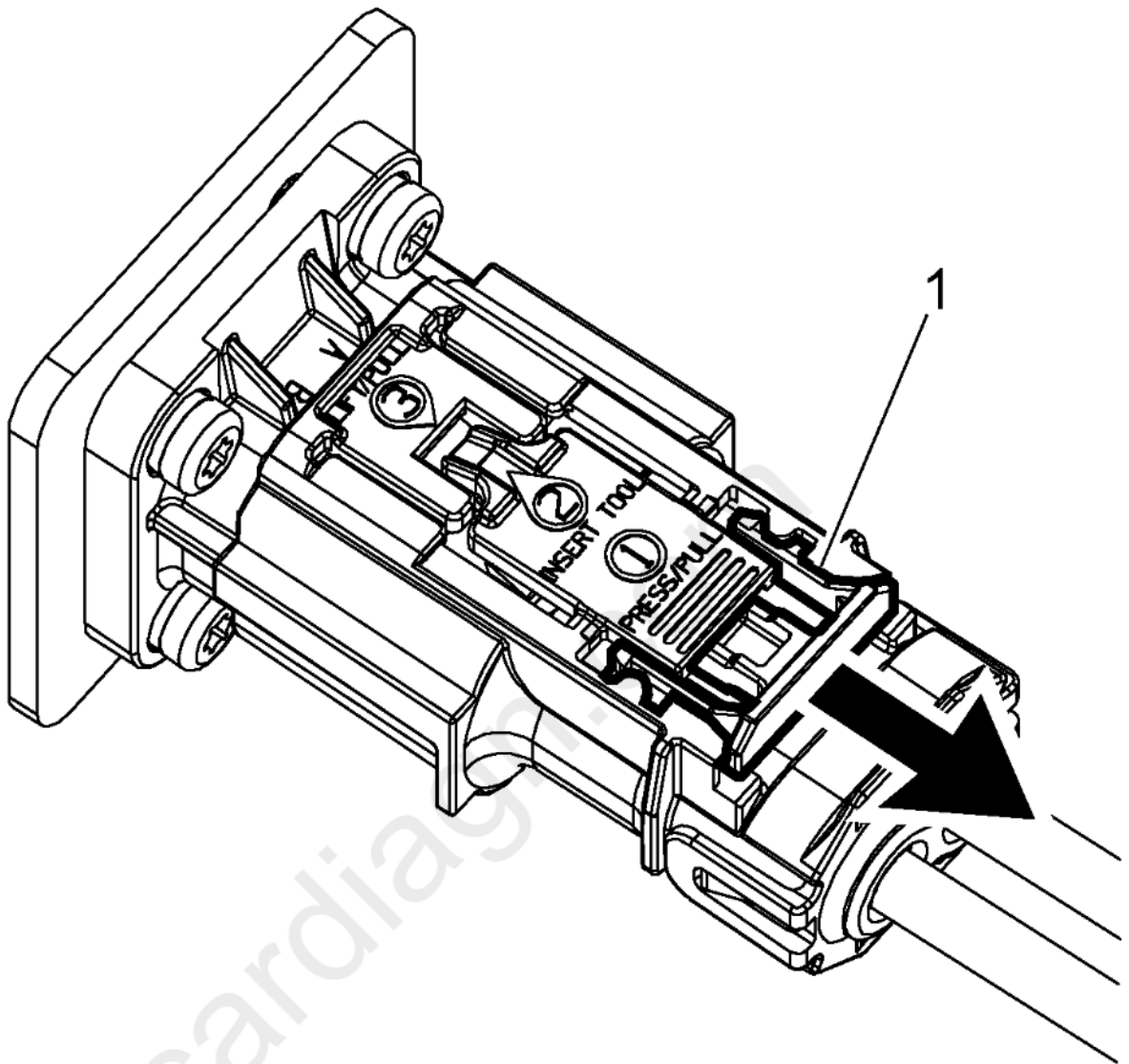


Fig. 20: Connector Position Assurance (CPA) Tab

Courtesy of GENERAL MOTORS COMPANY

2. Press firmly on the back of the female connector lock (1) and hold down, while pulling the female connector (2) assembly halfway apart, until the connector is in the partial-mate position.

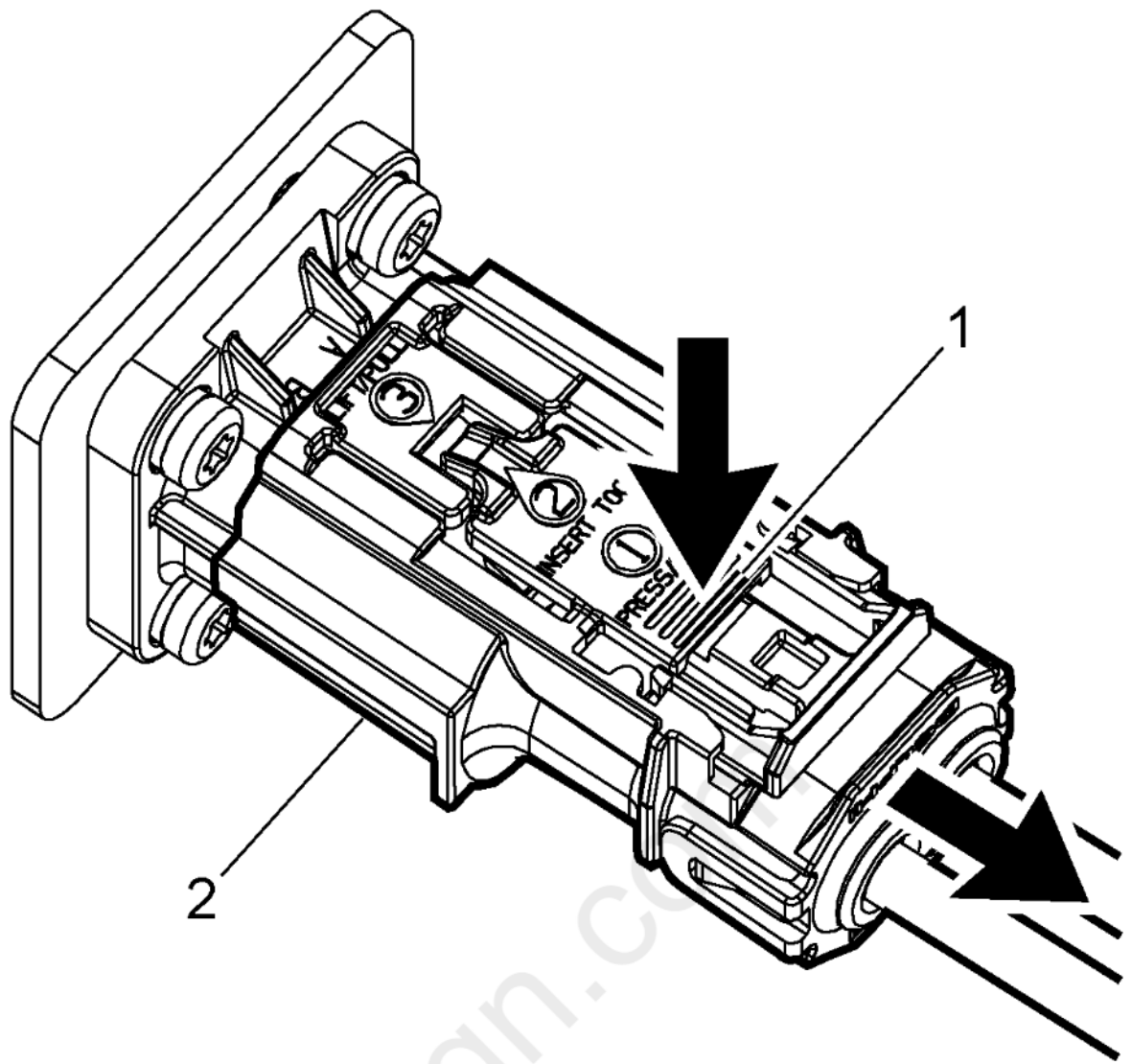


Fig. 21: Female Connector And Female Connector Lock

Courtesy of GENERAL MOTORS COMPANY

NOTE: Pull on the sides of the connectors only. The connector will stop in a partial-mate position when performing the next step.

3. Insert a suitable tool into the slot under the second connector lock (1). Using the tool as a lever, release the female connector by gently raising the second connector lock. An audible click or clicks will be heard on both sides of the connector as the second lock is released.

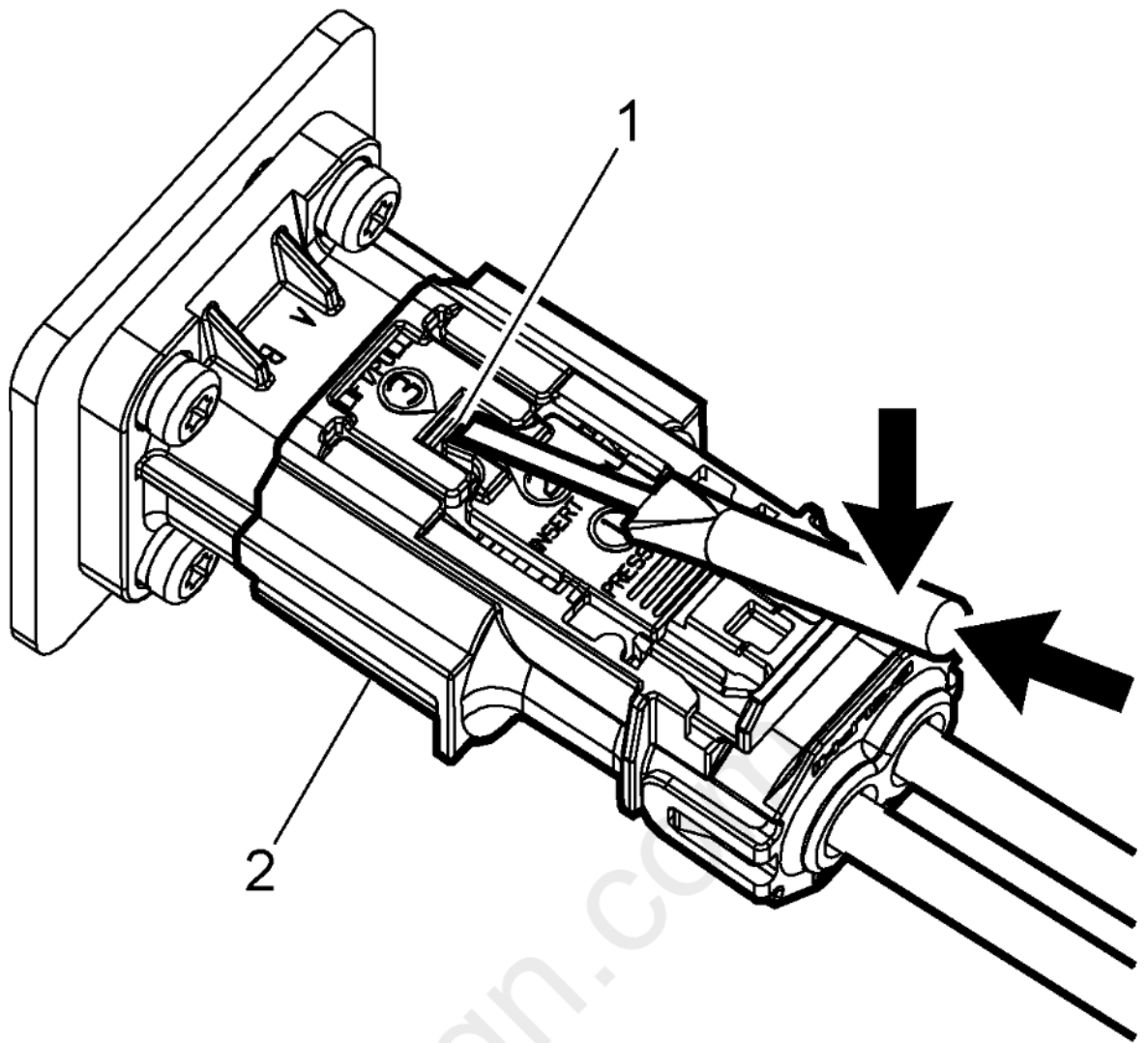


Fig. 22: Second Connector Lock And Female Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE: If the connector does not separate easily when pulled after the second connector lock is released, check that both sides of the second connector lock have been released.

4. Remove the tool and pull the female connector (2) to fully disconnect.

HV280 Connect Procedure

1. Align the connector with the index features (2) and install the connector by pushing on the sides of the connector (3).

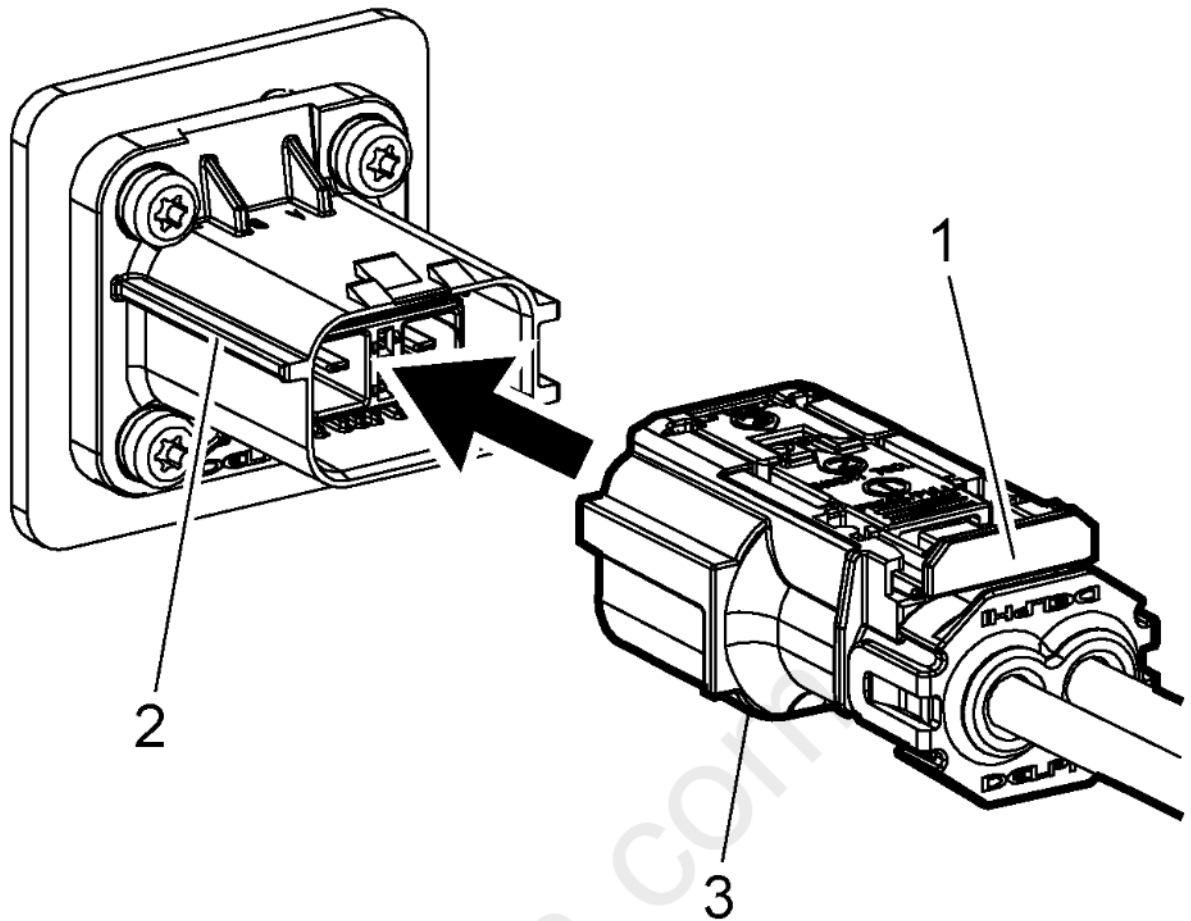


Fig. 23: Connector Position Assurance (CPA) Tab, Index Guides And Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Ensure the CPA tab (1) is in the pre-stage position.
- The connector will be fully mated when a series of 2 audible clicks is heard.

2. Push the CPA tab (1) forward from the pre-stage position to the locked position.

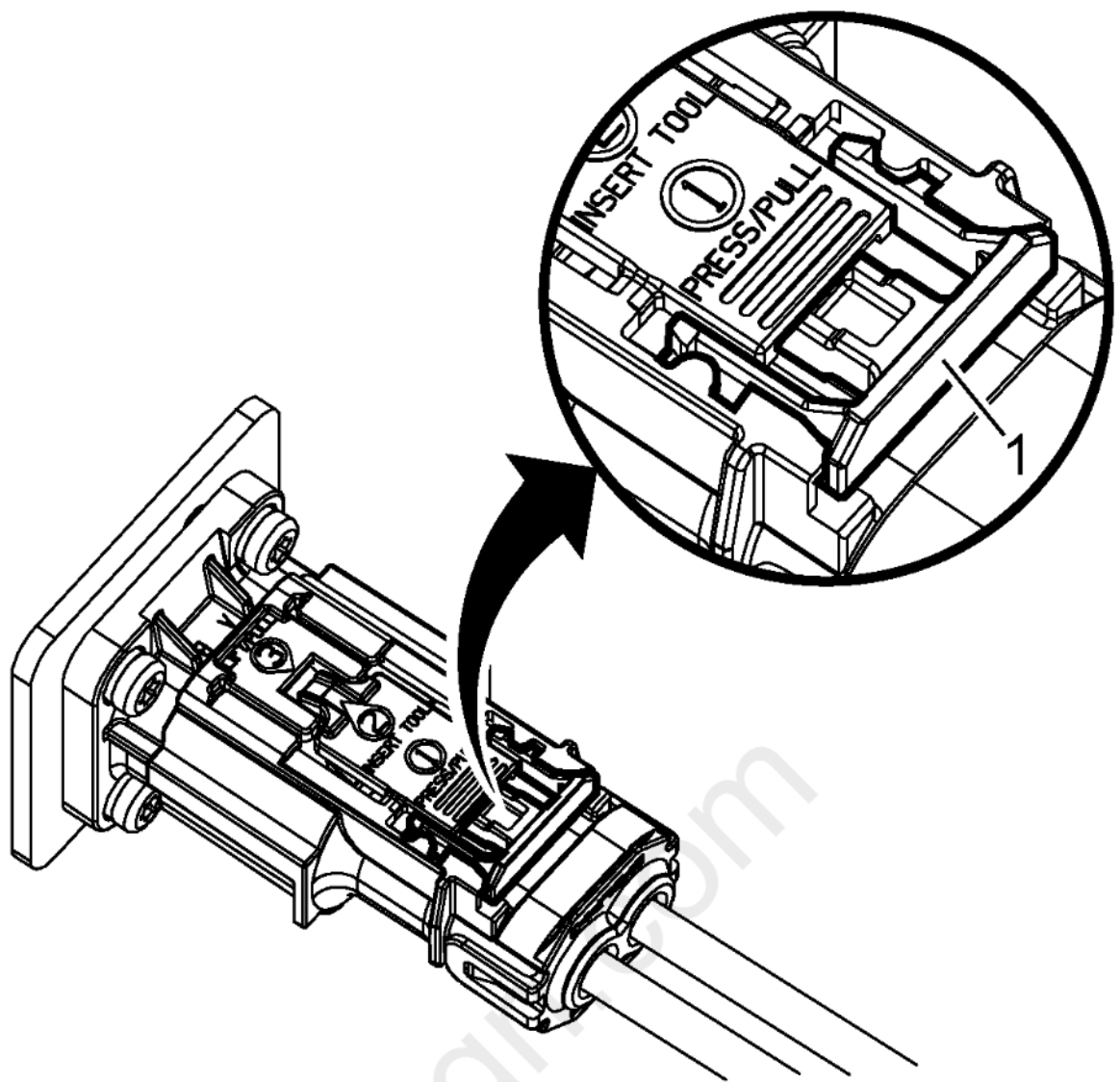


Fig. 24: Connector Position Assurance (CPA) Tab

Courtesy of GENERAL MOTORS COMPANY

NOTE: There will be an audible click sound when the CPA tab is placed in the locked position. The CPA tab and connector body touch when fully seated.

AMP+HVA280 Connector Procedure

AMP+HVA280 Disconnect Procedure

1. Pull the connector position assurance (CPA) (1) tab back from the locked position to the pre-stage position. There will be an audible click sound when the CPA tab is in the correct position.

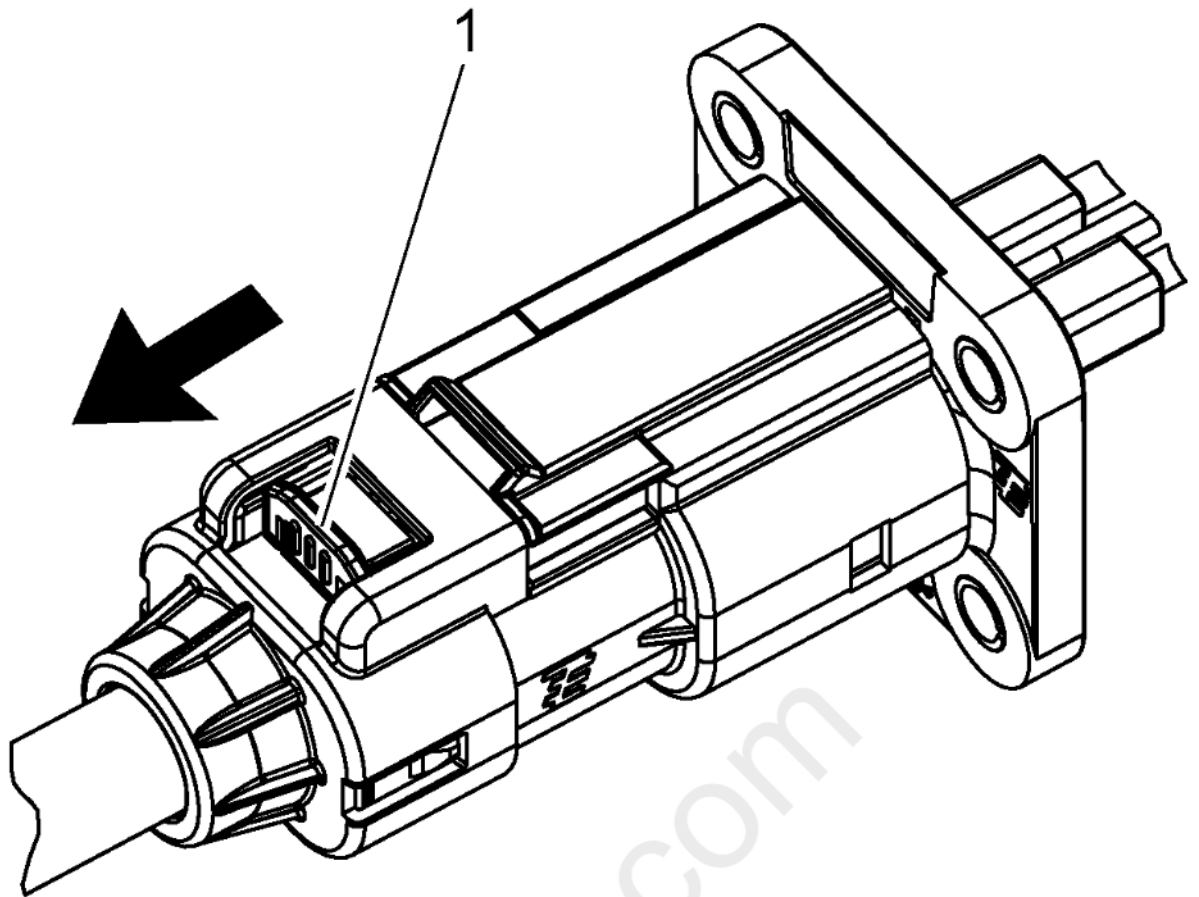


Fig. 25: Connector Position Assurance (CPA) Tab
Courtesy of GENERAL MOTORS COMPANY

2. Press firmly on the back of the female connector lock (1) and hold down, while pulling the female connector (2) assembly halfway apart, until the connector is in the partial-mate position.

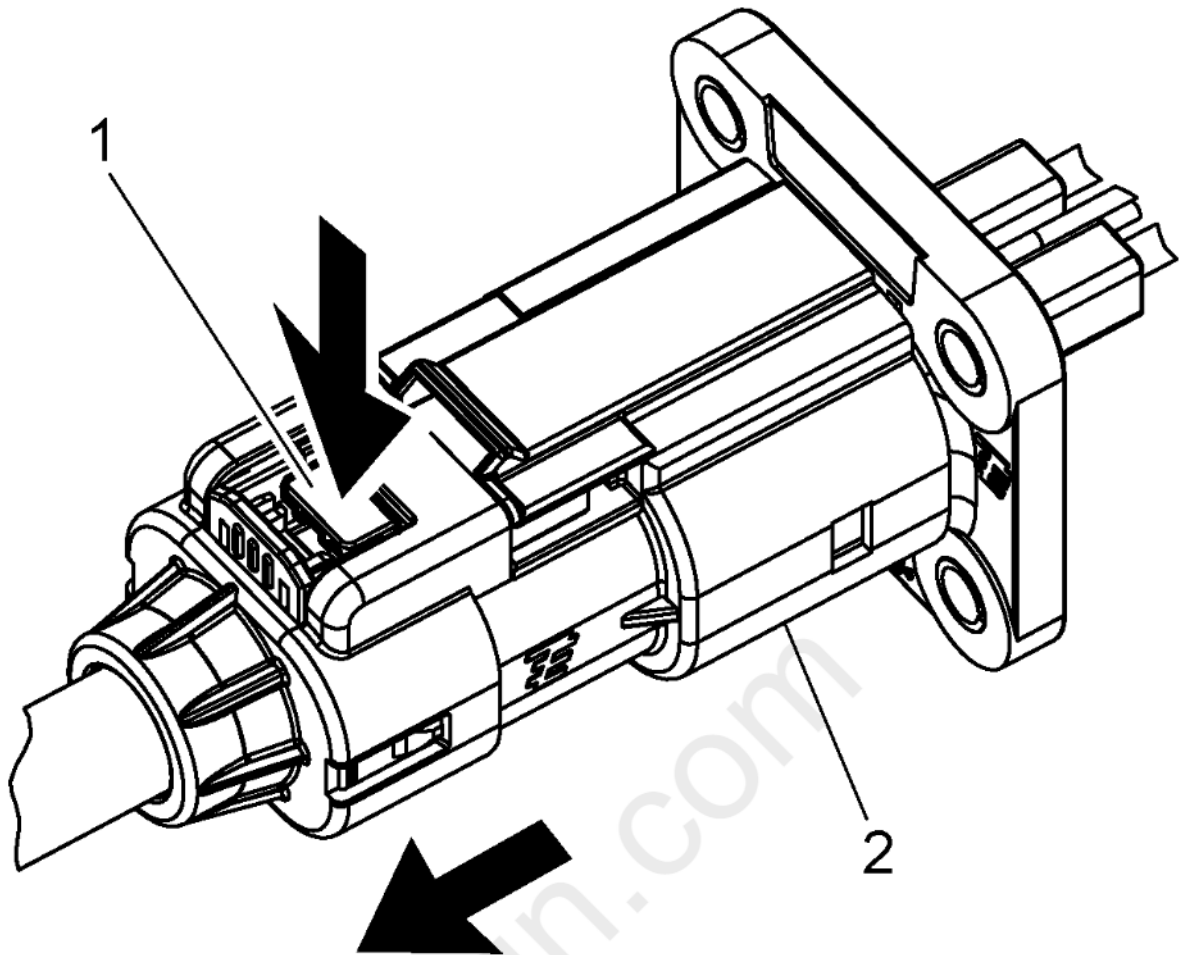


Fig. 26: Female Connector Lock And Female Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE: Pull on the sides of the connectors only. The connector will stop in a partial-mate position when performing the next step.

3. Insert a suitable tool into the slot (1) and depress the second connector lock. An audible click will be heard as the second lock is released.

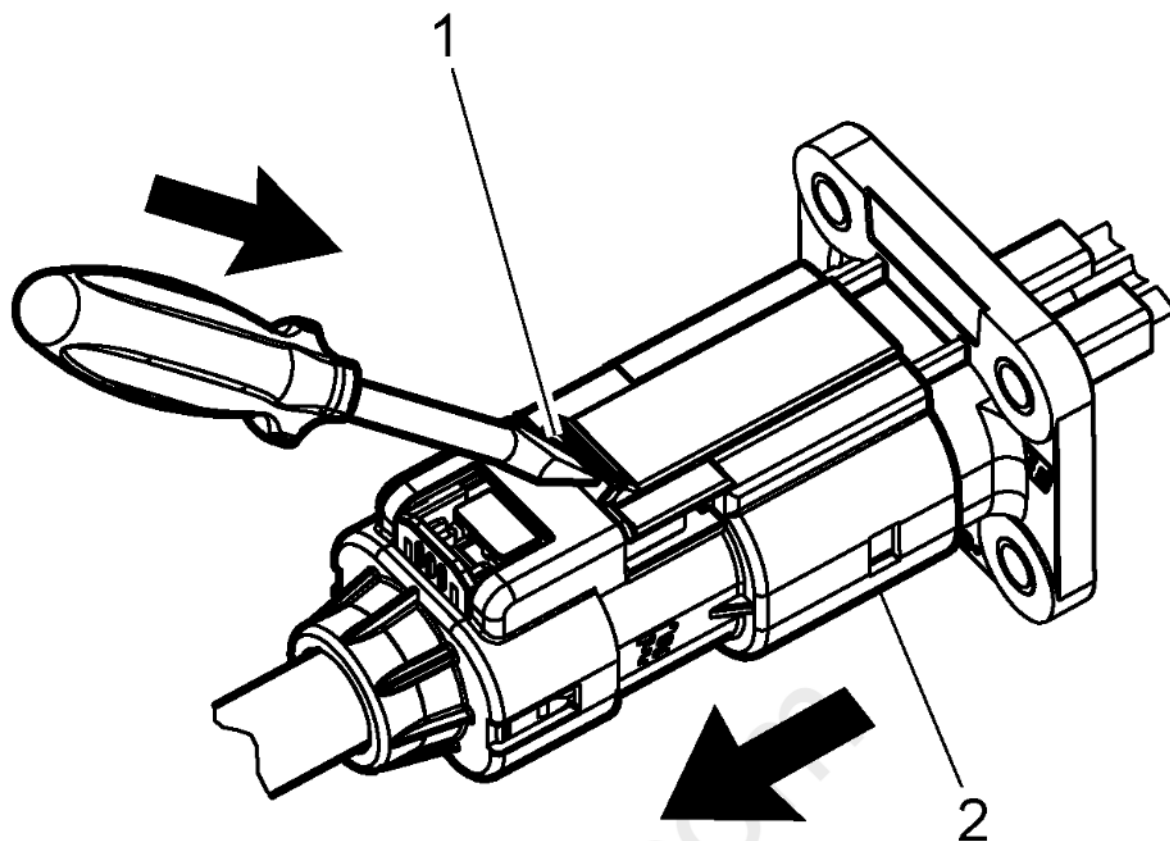


Fig. 27: Depressing Second Connector Lock To Disconnect Female Connector
Courtesy of GENERAL MOTORS COMPANY

4. Remove the tool and pull the female connector (2) to fully disconnect.

AMP+HVA280 Connect Procedure

1. Align the connector with the index features (2) and install the connector by pushing on the sides of the connector (3).

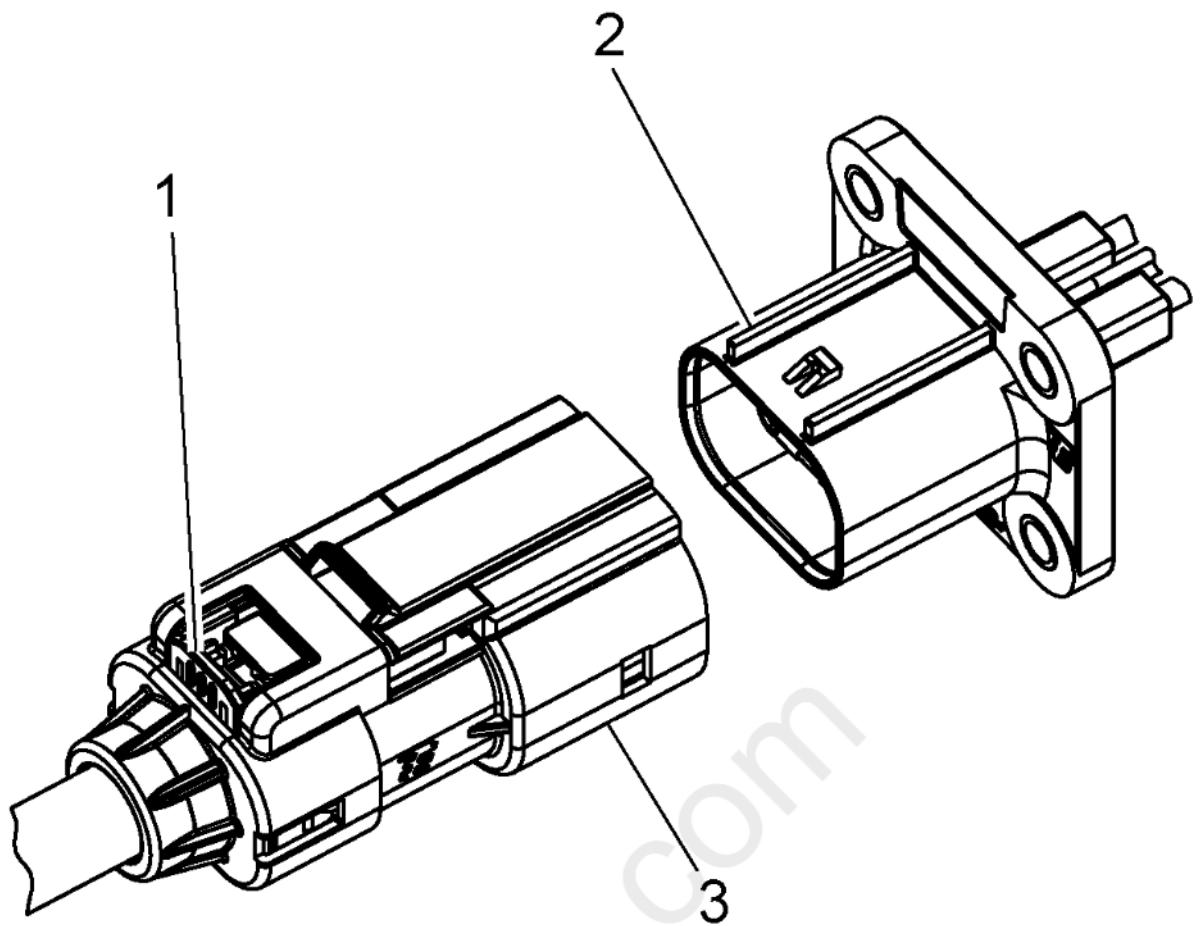


Fig. 28: Connector Position Assurance (CPA) Tab, Index Guides And Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Ensure the CPA tab (1) is in the pre-stage position.
- The connector will be fully mated when a series of two audible clicks is heard.

2. Push the CPA tab (1) forward from the pre-stage position to the locked position.

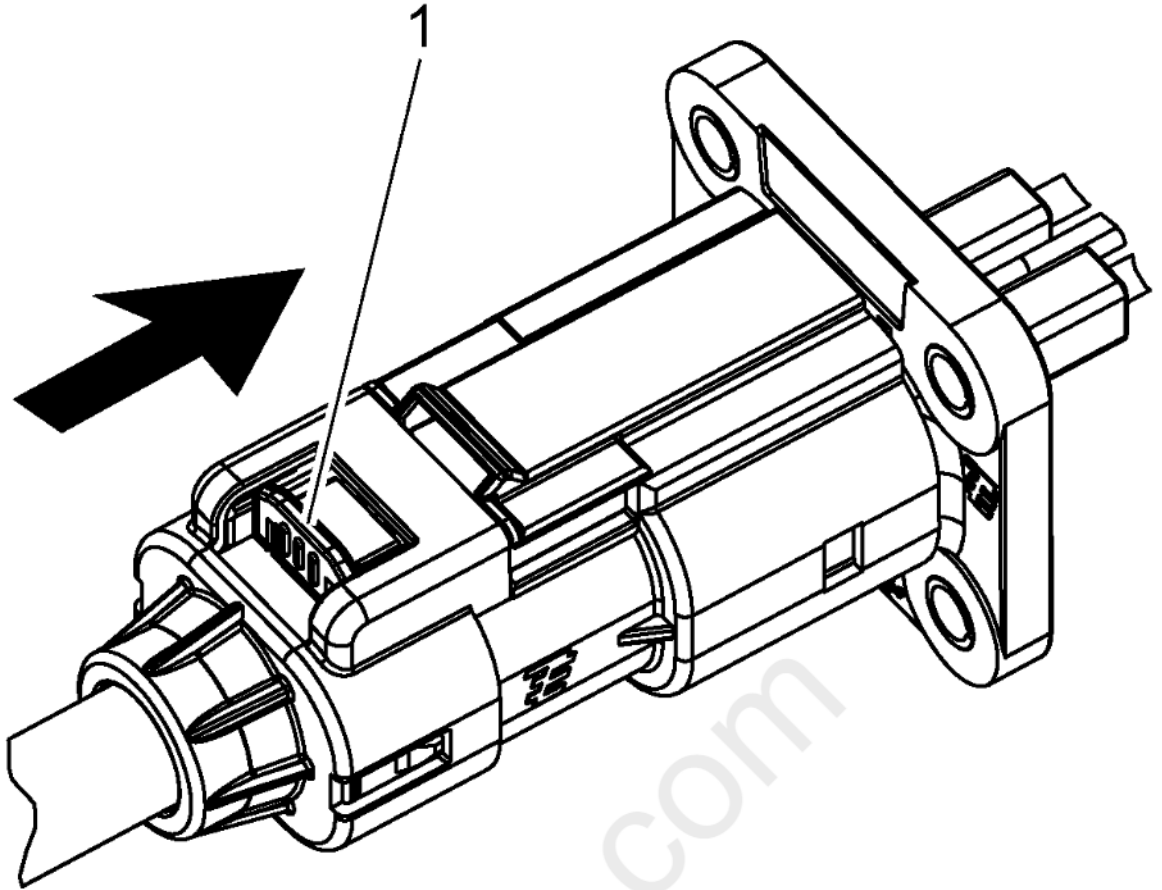


Fig. 29: Connector Position Assurance (CPA) Tab

Courtesy of GENERAL MOTORS COMPANY

NOTE: There will be an audible click sound when the CPA tab is placed in the locked position. The CPA tab and connector body touch when fully seated.

HVA280 1 click

HVA280 1 click Disconnect Procedure

1. Pull the connector position assurance (CPA) tab (1) back from the locked position to the pre-stage position. There will be an audible click sound when the CPA tab is in the correct position.

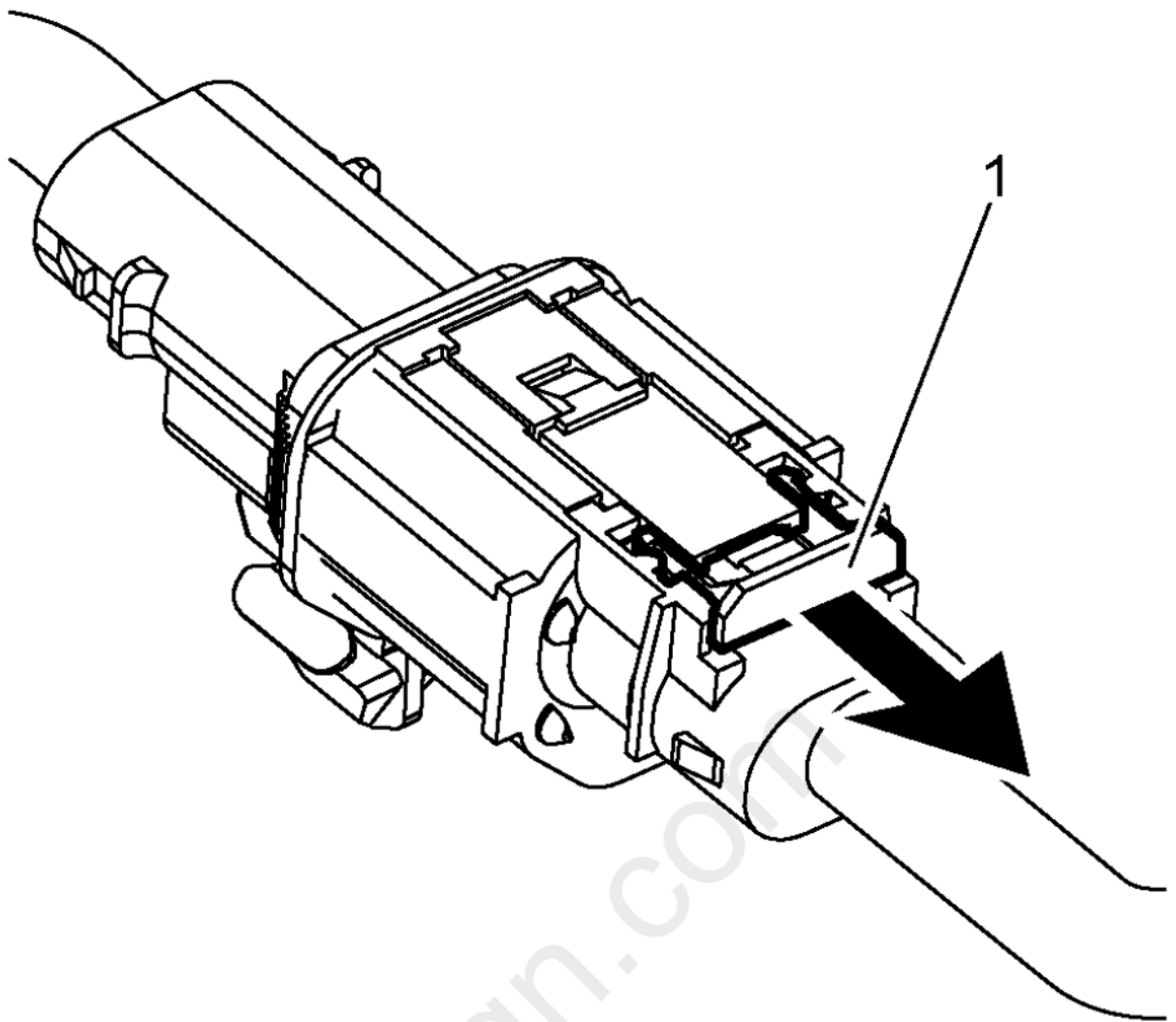


Fig. 30: Connector Position Assurance (CPA) Tab
Courtesy of GENERAL MOTORS COMPANY

2. Depress the primary lock feature (1) to release the lock and pull back on the female connector (2) to disconnect the connector completely.

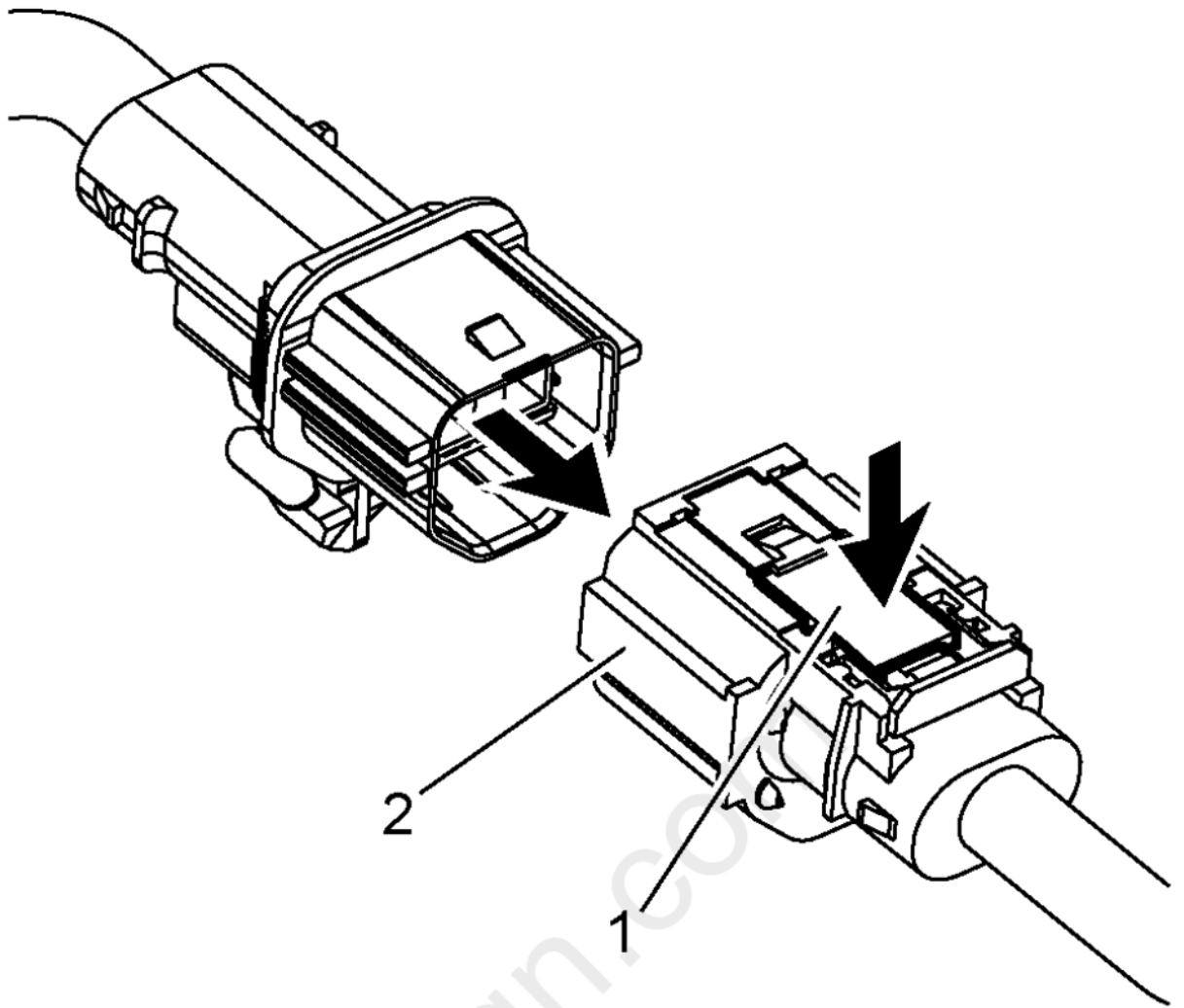


Fig. 31: Primary Lock Feature And Female Connector
Courtesy of GENERAL MOTORS COMPANY

HVA280 1 Click Connect Procedure

1. Align the connector with the index features (2) and install the connector by pushing on the sides of the connector (1). There will be an audible click sound when the connector lock is secured.

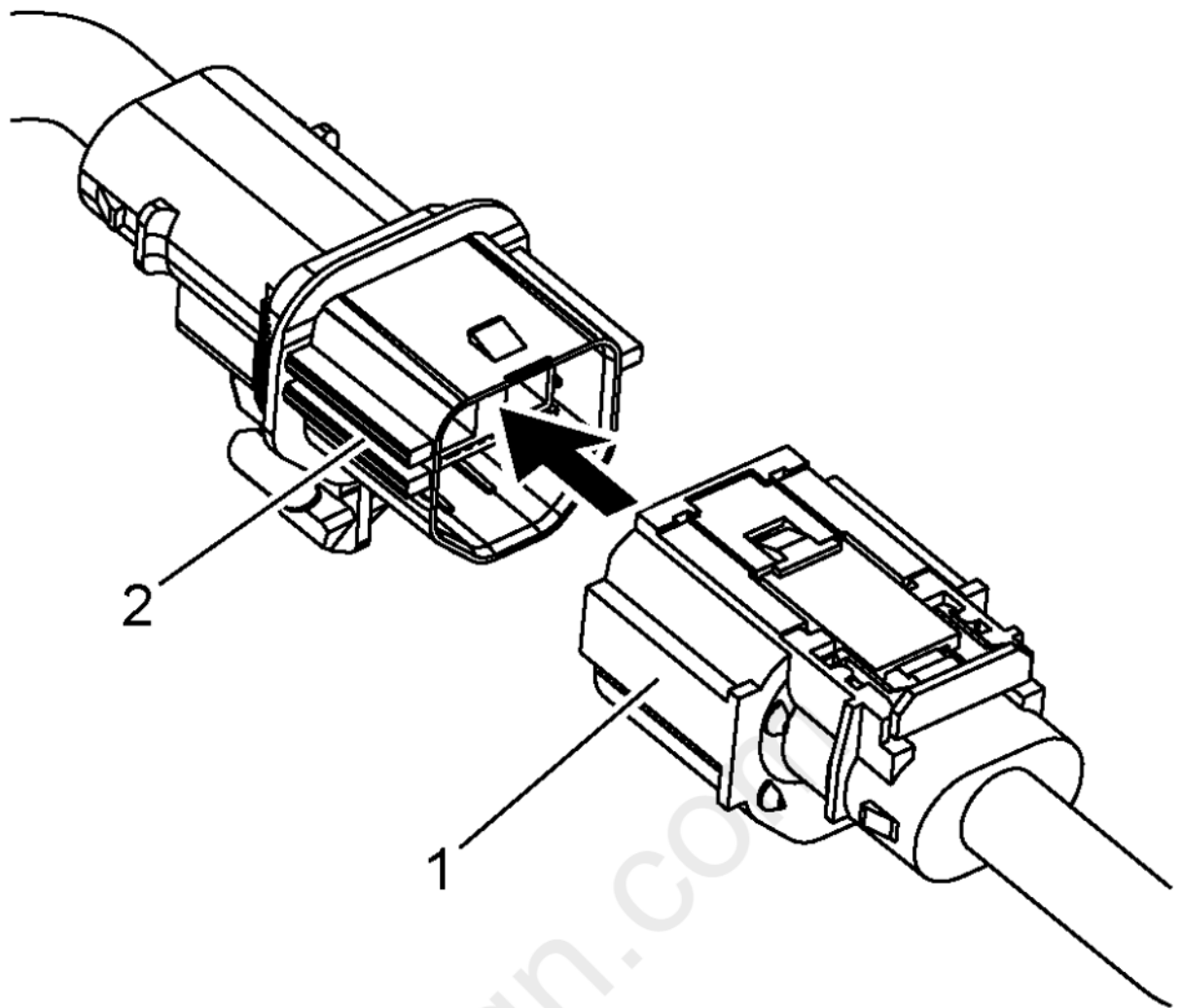


Fig. 32: Index Features

Courtesy of GENERAL MOTORS COMPANY

2. Push the CPA tab (1) to lock the connector in the full-stage position. There will be an audible click sound when the CPA tab is secured.

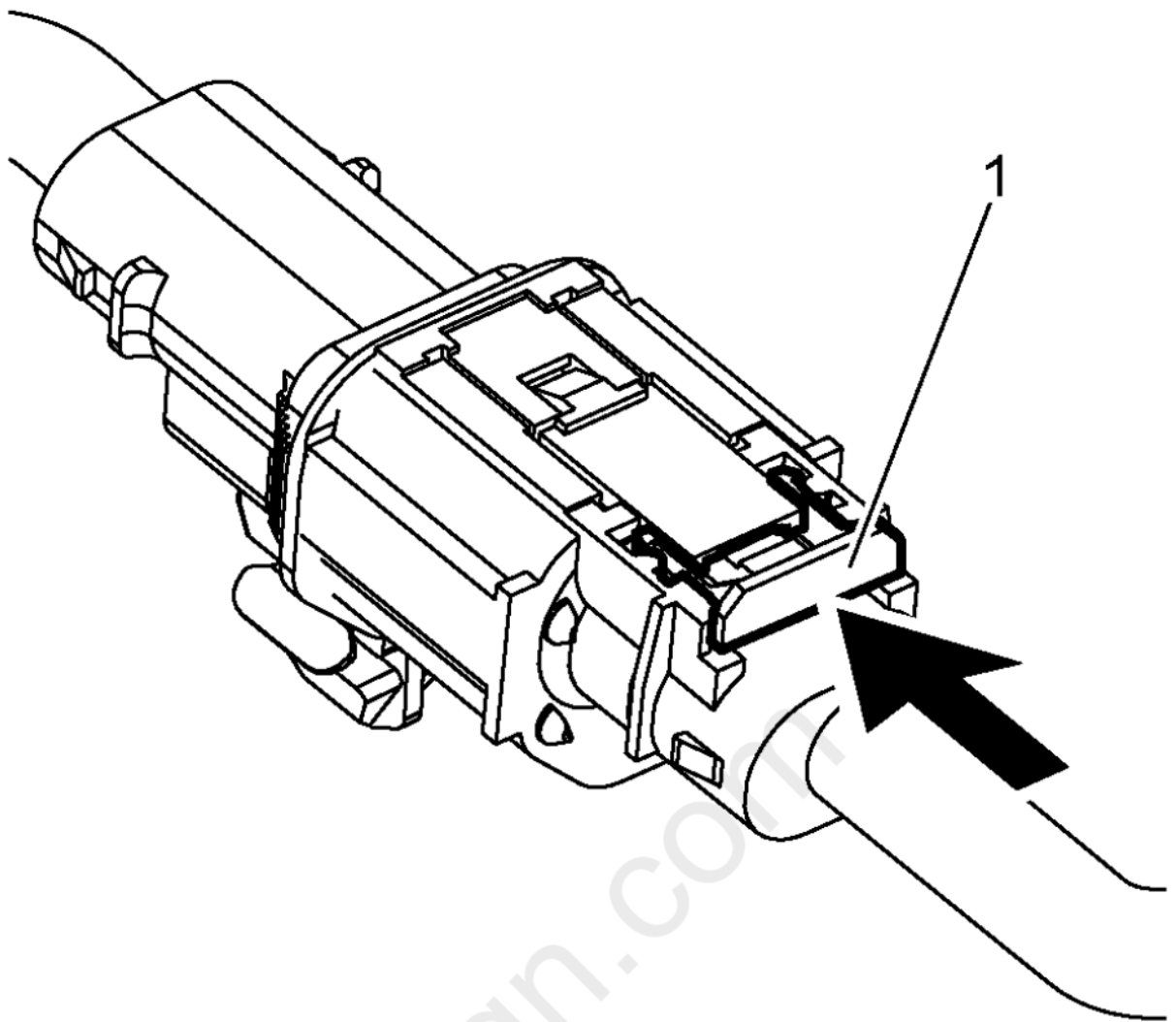


Fig. 33: CPA Tab

Courtesy of GENERAL MOTORS COMPANY

PP2000 90 NFS Connector Procedure

PP2000 90 NFS Disconnect Procedure

1. Place a suitable tool, such as a small flat-blade screwdriver, through the opening (1) at the front of the lever and extend the tip down to near the base of the connector (2).

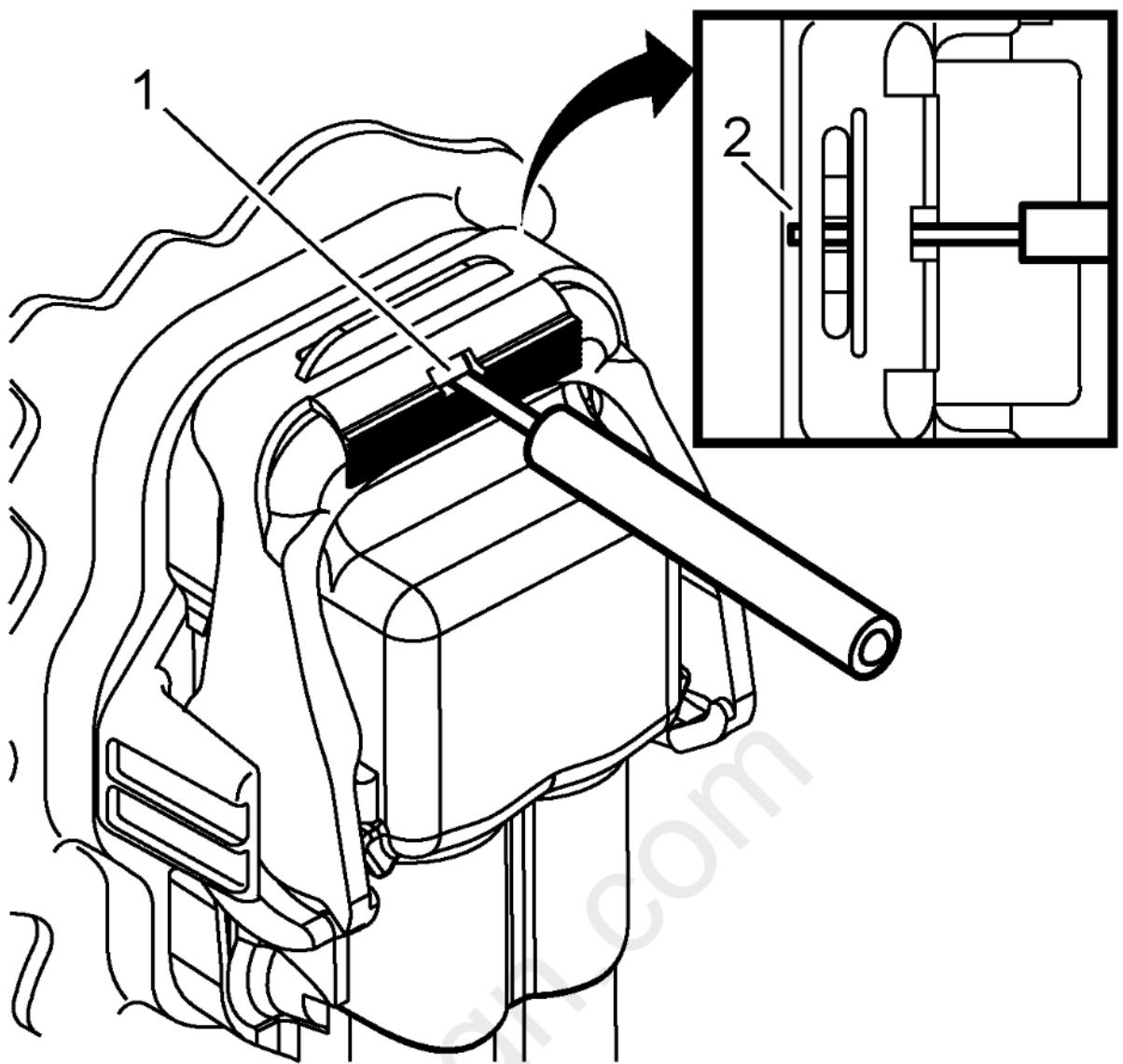


Fig. 34: Using Tool Through Opening To Unlock Lever
Courtesy of GENERAL MOTORS COMPANY

2. Rotate the tool slightly in either direction to unlock the lever.
3. Rotate the lever (1) to place the connector in a partial-mate position.

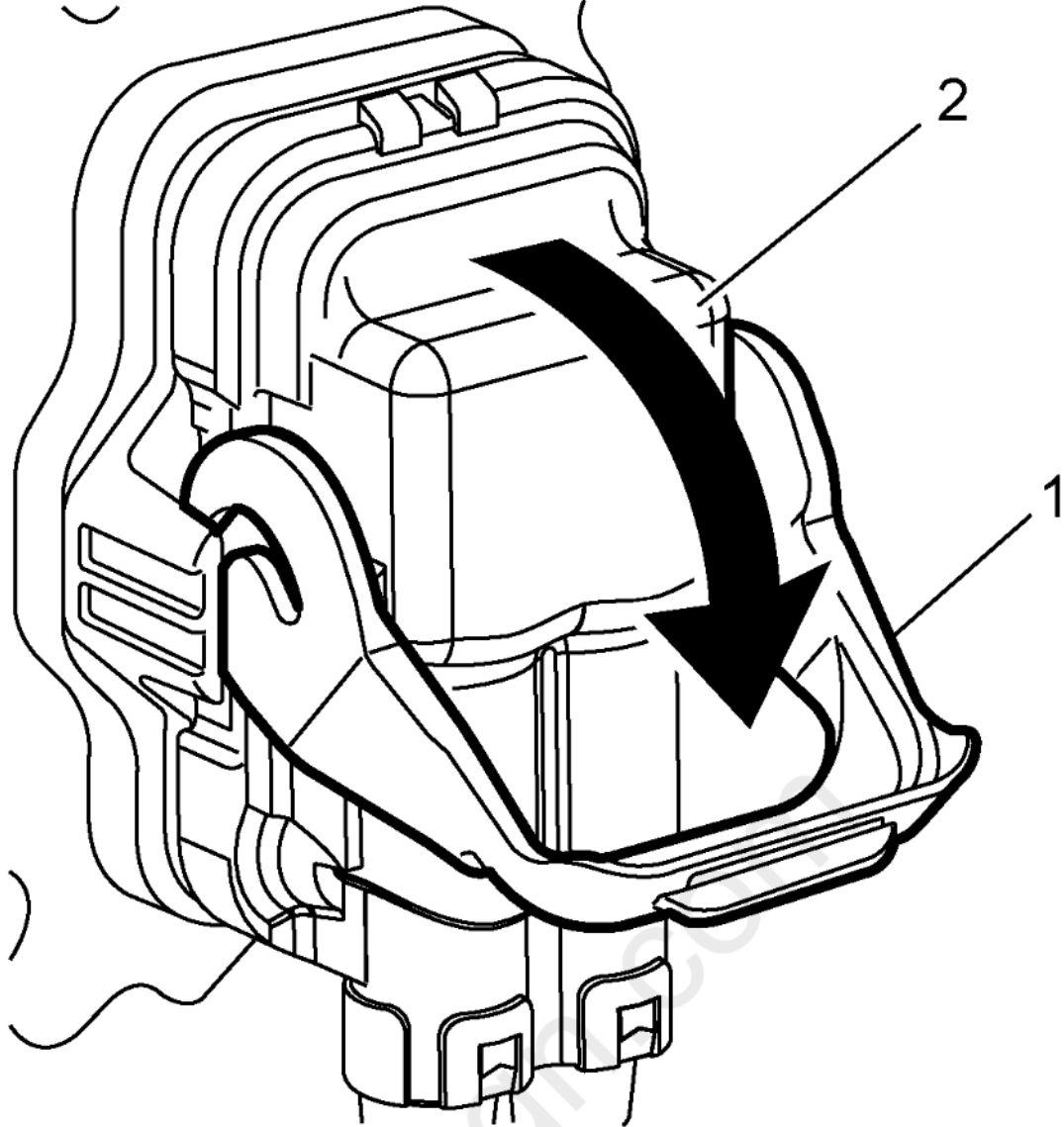


Fig. 35: Lever And Female Connector

Courtesy of GENERAL MOTORS COMPANY

4. Remove the female connector (2) to complete the disconnection.
5. Inspect the High Voltage DC harness connector for seal residue or debris. Clean as necessary.

NOTE: Always clean seal remnants from the connector with a non-marring tool.

6. Inspect the High Voltage DC header connector seal for deformation or damage. Replace the DC connector header when seal damage is observed.

PP2000 90 NFS Connect Procedure

1. Ensure the lever is in the pre-stage assembly position (1).

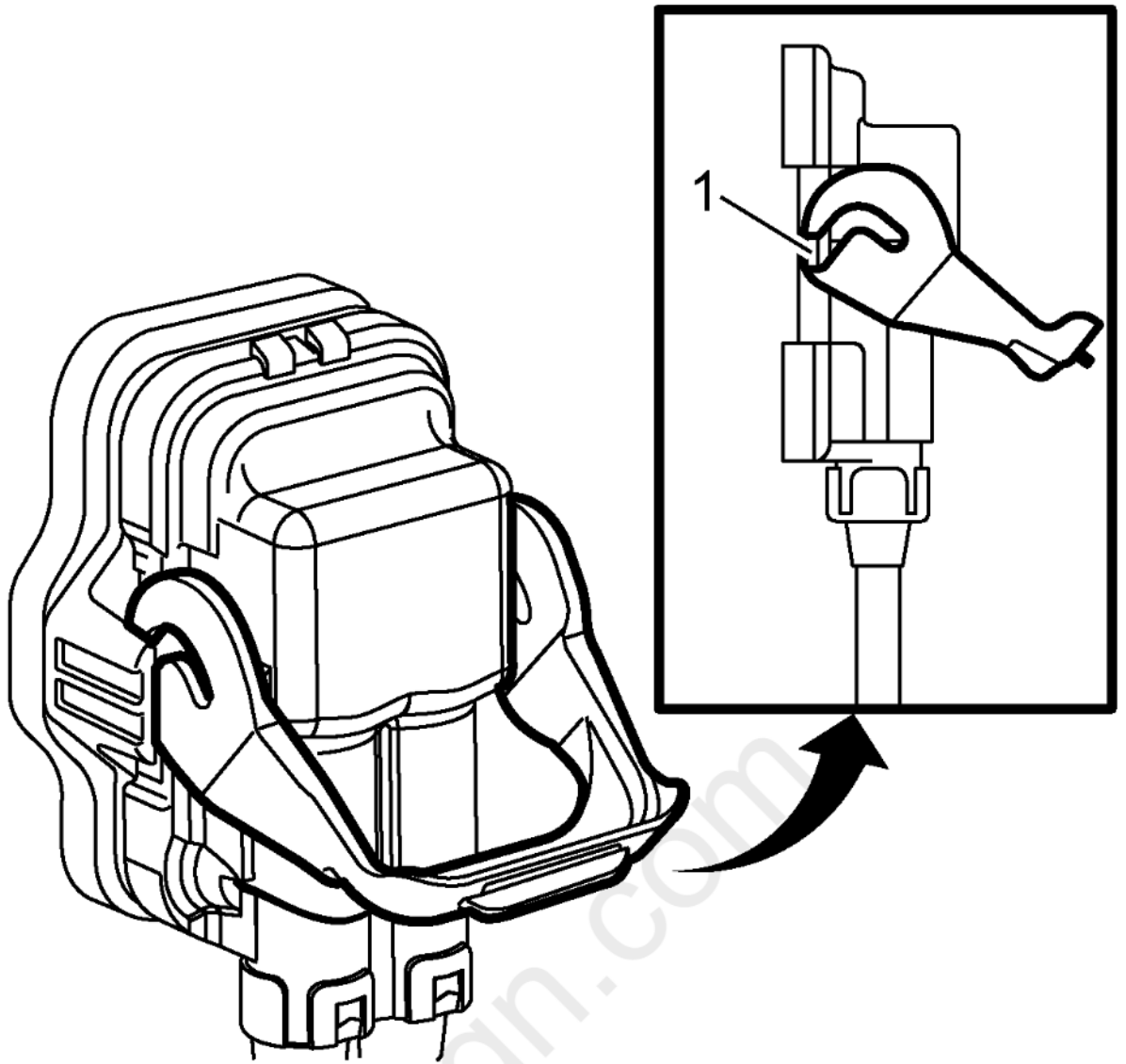


Fig. 36: Lever In Pre-Stage Assembly Position

Courtesy of GENERAL MOTORS COMPANY

2. Install the female connector (1) in the partial-mate position.

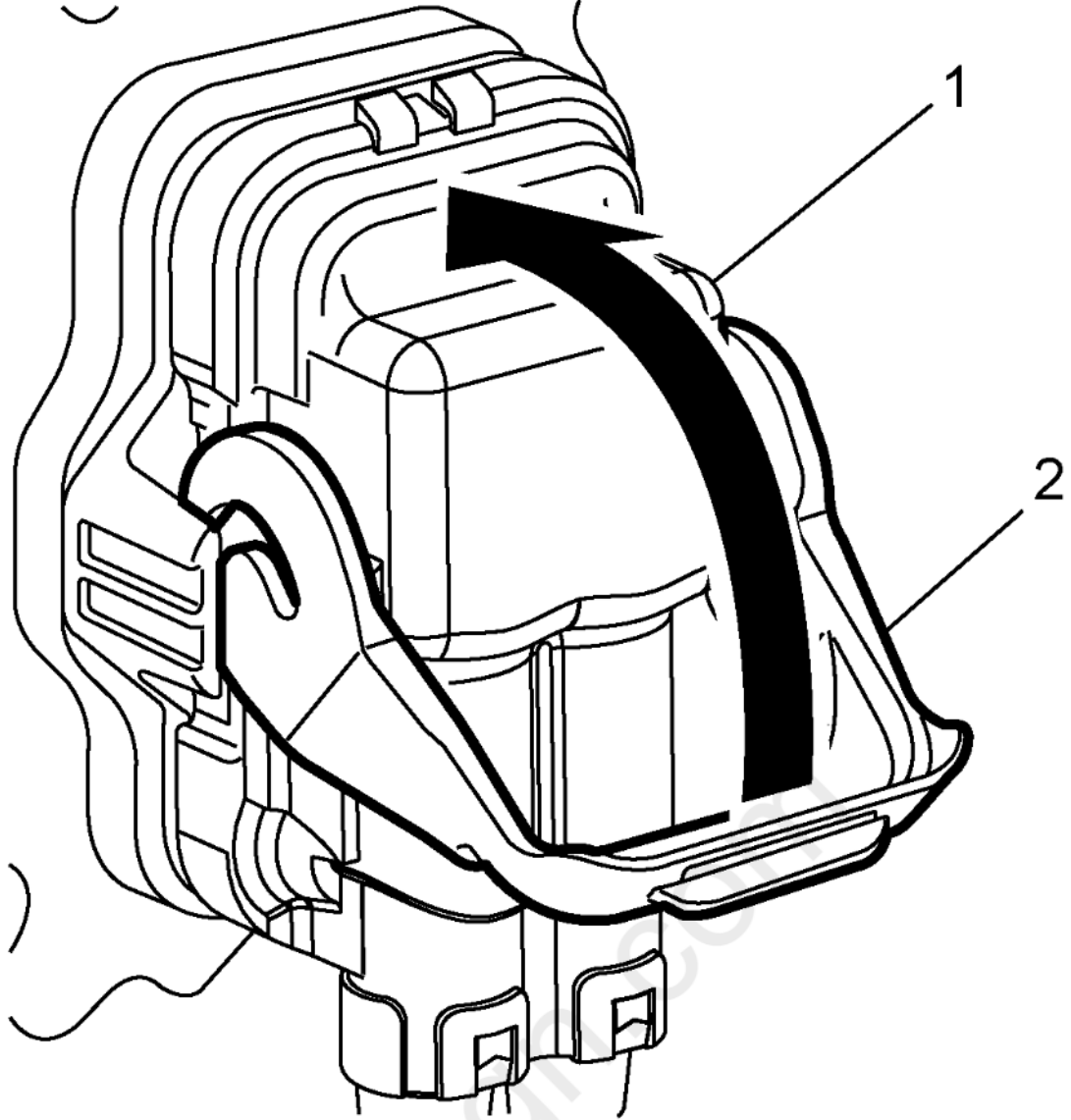


Fig. 37: Female Connector And Lever

Courtesy of GENERAL MOTORS COMPANY

3. Rotate the lever (2) to place the connector in the full-mate position. There will be a very audible click sound when the lever locks in the full-stage position.

HVA280 3PM Connector Procedure

HVA280 3PM Disconnect Procedure

1. Use a small suitable screwdriver (1) to unlock the locking tab (2) from the hook (3). Push the screwdriver slightly in arrow direction.

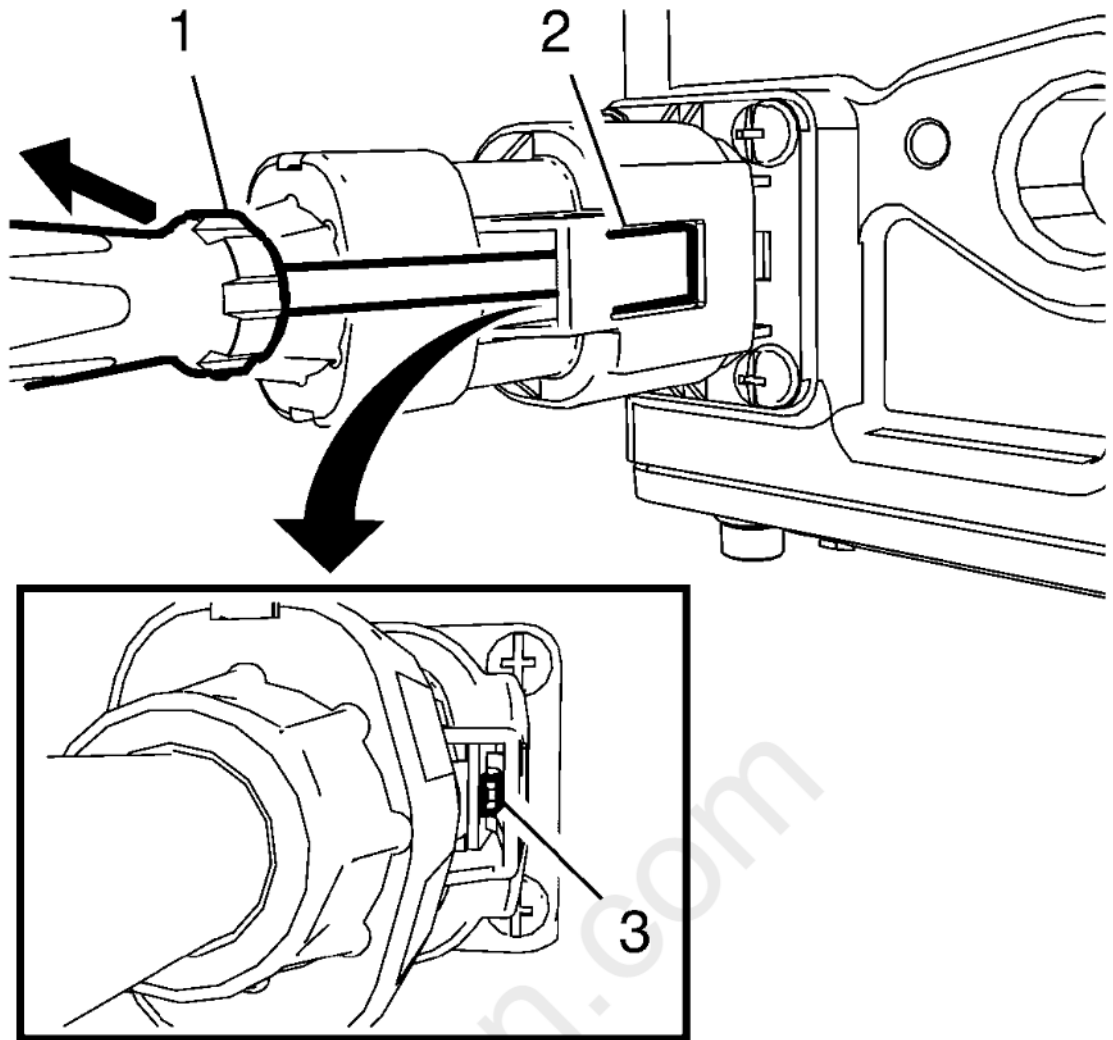


Fig. 38: Locking Tab And Hook

Courtesy of GENERAL MOTORS COMPANY

2. Pull the connector rearward to disconnect.

HVA280 3PM Connect Procedure

NOTE: Mind the 2 guides (3) at each connector.

Push the connector until the locking tab (1) locks to the hook (2).

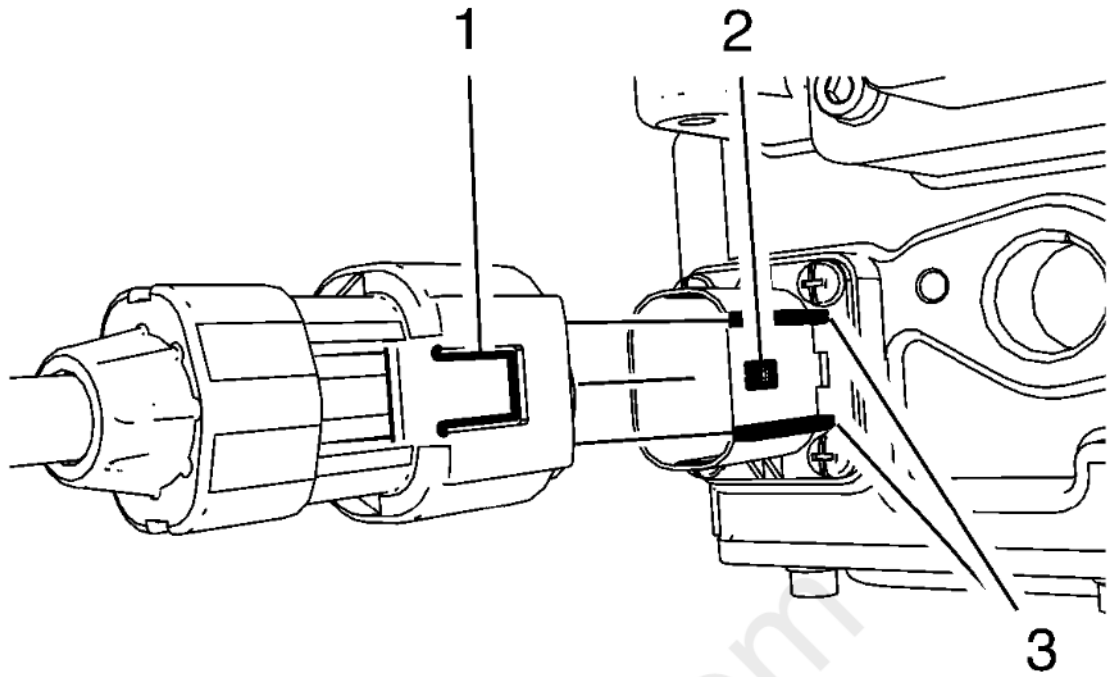


Fig. 39: Locking Tab And Hook

Courtesy of GENERAL MOTORS COMPANY

DTC P0A7F: HYBRID/EV BATTERY PACK LIFE

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 P0A7F

Hybrid/EV Battery Pack Life

Circuit/System Description

The hybrid/EV powertrain control module 2 calculates the high voltage battery pack capability and determines the high voltage battery pack end of life.

Conditions for Running the DTC

- Vehicle ON.
- The system voltage is greater than 10.2 V.
- Hybrid battery temperature is greater than 20°C (68°F).
- Hybrid battery temperature is less than 50°C (122°F).
- Hybrid battery state of charge is between 15% and 100%.

- When the hybrid/EV powertrain control module 2 calculates the actual battery power has exceeded the power limits multiplied by seconds of duration is greater than 80%.
- None of the following DTCs are set: P0A9C, P0A9D, P0A9E, P0ABB, P0ABC, P0ABD, P0AC1, P0AC2, P0AC6, P0AC7, P0AC8, P0ACB, P0ACC, P0ACD, P0AE9, P0AEA, P0AEB, P0BC3, P0BC4, P0BC5, P0C34, P0C35, P0C36, P0C7D, P0C7E, P0C7F, P0C82, P0C83, P0C84, P0C89, P0C8A, P0C8B, P0C8E, P0C8F, P0C90, P0C93, P0C94, P0C95, P0C98, P0C99, P0C9A, P0CA9, P0CAA, P0CAB, P0CAE, P0CAF, P0CB0, P0CB3, P0CB4, P0CB5, P0CB8, P0CB9, P0CBA, P1EBA, U0111, U185A, U2401, U2603, U2604, U2605 or U2606.

Conditions for Setting the DTC

- Battery voltage and current is varying. Requires more than 10 minutes of city driving.
- The hybrid/EV powertrain control module 2 calculates the power limits is less than the KW end of life power threshold.

Action Taken When the DTC Sets

DTC P0A7F is a type B DTC.

Conditions for Clearing the DTC

DTC P0A7F is a type B DTC.

Diagnostic Aids

Removing the manual service disconnect before disconnecting the 12 V battery may cause a DTC P0A7F to set.

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. Verify that no other DTCs are set.

NOTE: Removing the manual service disconnect before disconnecting the 12 V battery may cause a DTC P0A7F to set. Incorrectly performing the High Voltage Disabling procedure steps will cause false DTCs to set and result in misdiagnosis of vehicle components.

- If any other DTCs are set

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

- No other DTCs are set

2. Verify DTC P0A7F is set.

- If DTC P0A7F is set

1. Clear the DTC. Vehicle OFF, disconnect the 12 V battery. Refer to [Battery Negative Cable Disconnection and Connection](#)
2. Wait 30 seconds. Reconnect the 12 V battery. Refer to [Battery Negative Cable Disconnection and Connection](#)
3. Review and operate the vehicle according to the DTC Conditions for Running. Operate the vehicle for more than 10 minutes of city driving.
4. Verify that DTC P0A7F does not reset.
 - If DTC P0A7F resets, replace the A4 hybrid/EV battery pack.
 - If DTC P0A7F does not reset
5. All OK.

- If DTC P0A7F is not set

3. All OK.

Repair Instructions

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

- [High Voltage Battery Replacement and Shipping Preparation](#)
- [Control Module References](#) for battery energy control module and hybrid battery interface control modules replacement, programming and setup.

DTC P0AA1, P0AA4, P0AD9, P0ADD, P0AE4, P0D09, P0D0A, P1EBD, P1EC0 OR P1EC3: HYBRID/EV BATTERY CONTROL CIRCUIT

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: [Diagnostic System Check - Vehicle](#)
- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC P0AA1

Hybrid/EV Battery Positive Contactor Circuit Stuck Closed

DTC P0AA4

Hybrid/EV Battery Negative Contactor Circuit Stuck Closed

DTC P0AD9

Hybrid/EV Battery Positive Contactor Control Circuit

DTC P0ADD

DTC P0AE4

Hybrid/EV Battery Precharge Contactor Control Circuit

DTC P0D0A

Battery Charging System Positive Contactor Control Circuit

DTC P0D09

Battery Charging System Positive Contactor Stuck Open

DTC P1EBD

Battery Charging System Contactor(s) Stuck Open

DTC P1EC0

Hybrid/EV Battery System Contactor(s) Stuck Open

DTC P1EC3

Hybrid/EV Battery Pack Heater Transistor Control Circuit

Circuit/System Description

The hybrid/EV battery contains 4 high voltage contactors and 1 solid state relay (transistor). The high voltage contactors and transistor allow the high voltage DC batteries to be connected to the vehicle or contain the high voltage DC within the hybrid/EV battery assembly. The 4 high voltage contactors consist of a main positive high voltage contactor, main negative high voltage contactor, charge positive high voltage contactor and a precharge negative high voltage contactor. The transistor controls the battery heater high voltage positive circuit. The contactors and transistor close and open in a specific sequence controlled by the hybrid/EV powertrain control module 2. The hybrid/EV powertrain control module 2 supplies voltage to the control circuit for each high voltage contactor/transistor. Ground is provided through a vehicle ground external of the high voltage battery.

Conditions for Running the DTC

P0AA1

- The 12 V battery voltage is greater than 10.2 V.
- The main negative contactor is open.
- The main positive contactor has been open for more than 2 minutes.
- The charger positive contactor has been open for more than 2 minutes.
- None of the following DTCs are set; P0ABB, P0ABC, P0ABD, P0AF8 or P1A07.

P0AA4

- The 12 V battery voltage is greater than 10.2 V.
- The main negative contactor is open.
- The main positive contactor has been open for more than 2 minutes.
- The charger positive contactor has been open for more than 2 minutes.
- Active battery heating is not enabled.
- None of the following DTCs are set; P0ABB, P0ABC, P0ABD, P0AF8 or P1A07.

P0AD9, P0ADD, P0AE4, P0D0A, P1EC3 and P1EBD

The 12 V battery voltage is greater than 10.2 V.

P0D09

- During precharge mode.

- The negative contactor is open.
- The charger contactor is closed.
- Negative bus voltage is greater than 40 V.

P1EC0

- The 12 V battery voltage is greater than 10.2 V.
- The main positive and negative contactors have been closed for more than 1 second.
- The charger positive contactor is closed.
- None of the following DTCs are set; P1AE8, P1AE9 or P1AEC.

Conditions for Setting the DTC

P0AA1

The positive bus voltage is greater than 30 V.

P0AA4

The negative bus voltage is greater than 30 V.

P0AD9, P0ADD and P0D0A

The hybrid/EV powertrain control module 2 has detected an open or short to voltage in the control circuit for the corresponding contactor.

P0AE4

The hybrid/EV powertrain control module 2 has detected a short to voltage in the control circuit.

P0D09

The battery charger sensed voltage is less than 10 V.

P1EBD

The battery charger sensed voltage is less than 80% of hybrid/EV battery voltage.

P1EC0

The main bus voltage is less than 80% of hybrid/EV battery voltage.

P1EC3

The hybrid/EV powertrain control module 2 has detected an open, short to ground or short to voltage in the heater transistor control circuit.

Actions Taken When the DTC Sets

- DTCs P0D09, P1EBD or P1EC0 are type A DTCs.
- DTCs P0AA1, P0AA4, P0AD9, P0ADD, P0AE4, P0D0A or P1EC3 are type B DTCs.

Conditions for Clearing the DTC

- DTCs P0D09, P1EBD or P1EC0 are type A DTCs.
- DTCs P0AA1, P0AA4, P0AD9, P0ADD, P0AE4, P0D0A or P1EC3 are type B DTCs.

Diagnostic Aids

DTC P1EC3 will prevent battery heating and the vehicle will be unable to start in cold weather with battery temperatures below -25°C (-13°F).

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.

Circuit/System Verification

1. Vehicle in Service Mode.
2. Verify that DTC P0AA1, P0AA4, P0AD9, P0ADD, P0AE4, P0AFA, P0D0A, P0D09, P1EBD, P1EC0 or P1EC3 is not set.
 - **If any of the DTCs are set**
Refer to Circuit/System Testing.
 - **If none of the DTCs are set**
3. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.

NOTE: The following setup steps must be performed exactly in order to exercise the contactors.

4. OPEN the driver door using outside door handle. Leave driver door OPEN.
5. PRESS and HOLD the brake pedal.

NOTE: The brake pedal must remain depressed throughout the remainder of the contactor steps.

6. Command the Hybrid/EV Battery Contactors ALL OPEN with a scan tool.

NOTE: DO NOT press the power button and enter Vehicle in Service Mode.

7. Disconnect the S15 Manual Service Disconnect.
8. Command the Hybrid/EV Battery Negative Contactor CLOSED and ALL OPEN with a scan tool while listening for the contactor to close and open.

NOTE: DO NOT use the Release Control button to turn OFF any of the contactors. Once the Release Control button is pushed the Circuit/System Verification will need to be restarted from the beginning.

9. Verify the Hybrid/EV Battery Negative Contactor should be heard closing and opening.

- **If the Hybrid/EV Battery Negative Contactor does not open and close**

Refer to Circuit/System Testing.

- **If the Hybrid/EV Battery Negative Contactor does open and close**

10. Command the Hybrid/EV Battery Positive Contactor CLOSED and ALL OPEN with a scan tool while listening for the contactor to close and open.

11. Verify the Hybrid/EV Battery Positive Contactor should be heard closing and opening.

- **If the Hybrid/EV Battery Positive Contactor does not open and close**

Refer to Circuit/System Testing.

- **If the Hybrid/EV Battery Positive Contactor does open and close**

12. Command the Hybrid/EV Battery Precharge Contactor CLOSED and ALL OPEN with a scan tool while listening for the contactor to close and open.

13. Verify the Hybrid/EV Battery Precharge Contactor should be heard opening and closing.

- **If the Hybrid/EV Battery Precharge Contactor does not open and close**

Refer to Circuit/System Testing.

- **If the Hybrid/EV Battery Precharge Contactor does open and close**

14. Command the Hybrid/EV Battery Charger Contactor CLOSED and ALL OPEN with a scan tool while listening for the contactor to close and open.

15. Verify the Hybrid/EV Battery Charger Contactor should be heard opening and closing.

- **If the Hybrid/EV Battery Charger Contactor does not open and close**

Refer to Circuit/System Testing.

- **If the Hybrid/EV Battery Charger Contactor does open and close**

16. Verify the scan tool hybrid/EV powertrain control module 1 High Voltage Circuit and hybrid/EV powertrain control module 2 Hybrid/EV Battery Pack Voltage is within 10 V of each other.

- **If not within 10 V of each other**

Refer to Circuit/System Testing.

- **If within 10 V of each other**

17. Vehicle OFF.

18. Verify the scan tool hybrid/EV powertrain control module 1 High Voltage Circuit parameter is less than 3 V and hybrid/EV powertrain control module 2 Hybrid/EV Battery Pack Voltage is between 205-419 V.

- **If not within the specified ranges**

Refer to Circuit/System Testing.

- **If within the specified ranges**

19. All OK.

Circuit/System Testing

DTC P0AA1, P0AA4, P0AD9, P0ADD, P0AE4, P0D0A, P0D09, P1EBD or P1EC0 Contactor Diagnosis

1. Vehicle OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.

2. Disconnect the X358 harness connector at the A4 Hybrid/EV Battery Pack.

3. Test for less than 10 Ω between the ground circuit terminal 5 and ground.

- **If more than 10 Ω**

1. Vehicle OFF.

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

- If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **If less than 10 Ω**
4. Verify that a test lamp illuminates between the B+ circuit terminal 1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Vehicle OFF.
 2. Test for less than 2 Ω in the B+ circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Vehicle OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the A4 Hybrid/EV Battery Pack.
 - **If the test lamp illuminates**
 5. Vehicle OFF, disconnect the X357 harness connector at the A4 Hybrid/EV Battery Pack. Vehicle in Service Mode.
 6. Verify that a test lamp does not illuminate between each A4 Hybrid/EV Battery Pack harness connector control circuit terminals listed below and ground:
 - Terminal 2 X357
 - Terminal 4 X357
 - Terminal 6 X357
 - Terminal 7 X357
 - **If the test lamp illuminates on any circuit**
 1. Vehicle OFF, disconnect the X1 harness connector at the K114B Hybrid Powertrain Control Module 2. Vehicle in Service Mode.
 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 K114B Hybrid Powertrain Control Module 2.
 - **If the test lamp does not illuminate on all circuits**
 7. Vehicle OFF, disconnect the X1 harness connector at the K114B Hybrid Powertrain Control Module 2.
 8. Test for infinite resistance between each A4 Hybrid/EV Battery Pack harness connector control circuit terminals listed below and ground:
 - Terminal 2 X357
 - Terminal 4 X357
 - Terminal 6 X357
 - Terminal 7 X357
 - **If less than infinite resistance on either circuit**

Repair the short to ground on the circuit.
 - **If infinite resistance on both circuits**
 9. Test for less than 2 Ω between the harness connector terminals listed below:
 - Terminal 2 X357 at the A4 Hybrid/EV Battery Pack and terminal 9 X1 at the K114B Hybrid Powertrain Control Module 2
 - Terminal 4 X357 at the A4 Hybrid/EV Battery Pack and terminal 6 X1 at the K114B Hybrid Powertrain Control Module 2
 - Terminal 6 X357 at the A4 Hybrid/EV Battery Pack and terminal 8 X1 at the K114B Hybrid Powertrain Control Module 2
 - Terminal 7 X357 at the A4 Hybrid/EV Battery Pack and terminal 3 X1 at the K114B Hybrid Powertrain Control Module 2
 - **If 2 Ω or greater on any circuit**

Repair the open/high resistance in the circuit.

- **If less than 2 Ω on all circuits**

10. Replace the A4 Hybrid/EV Battery Pack.

11. Verify that DTC P0C78 or P3061 does not set while operating the vehicle within the Conditions for Running the DTC.

- **If DTC P0C78 or P3061 sets**

Replace the K114B Hybrid Powertrain Control Module 2.

- **If DTC P0C78 or P3061 does not set**

12. All OK.

P1EC3 - Hybrid/EV Battery Pack Heater Transistor Diagnosis

1. Vehicle in Service Mode.

2. Verify that DTC P0AA1, P0AA4, P0AD9, P0ADD, P0AE4, P0D0A, P0D09, P1EBD or P1EC0, is not set.

- **If any contactor DTC is set**

Refer to the appropriate contactor Circuit/System Testing.

- **If no contactor DTC is set**

3. Vehicle OFF, disconnect the X358 harness connector at the A4 Hybrid/EV Battery Pack.

4. Vehicle in Service Mode.

5. Verify that a test lamp does not illuminate between the A4 Hybrid/EV Battery Pack harness control circuit terminal 2 and ground.

- **If the test lamp illuminates**

1. Vehicle OFF, disconnect the X1 harness connector at the K114B Hybrid Powertrain Control Module 2. Vehicle in Service Mode.

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 K114B Hybrid Powertrain Control Module 2.

- **If the test lamp does not illuminate**

6. Vehicle OFF, disconnect the X1 harness connector at the K114B Hybrid Powertrain Control Module 2.

7. Test for infinite resistance between the A4 Hybrid/EV Battery Pack harness control circuit terminal 2 and ground.

- **If less than infinite resistance**

Repair the short to ground on the circuit.

- **If infinite resistance**

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

- **If 2 Ω or greater**

Repair the open/high resistance in the circuit.

- **If less than 2 Ω**

8. Replace the A4 Hybrid/EV Battery Pack.

9. Verify that DTC P1EC3 does not set while operating the vehicle within the Conditions for Running the DTC.

- **If the DTC is set**

Replace the K114B Hybrid Powertrain Control Module 2.

- **If the DTC is not set**

10. All OK.

Repair Instructions

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

- [High Voltage Battery Replacement and Shipping Preparation](#) for A4 Hybrid/EV Battery Pack replacement.
- [Control Module References](#) for K114B hybrid/EV powertrain control module 2 replacement, programming and setup.

DTC P0AA6 OR P1AE6: HYBRID/EV BATTERY VOLTAGE SYSTEM ISOLATION

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: [Diagnostic System Check - Vehicle](#)
- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC P0AA6

Hybrid/EV Battery Voltage System Isolation Lost

DTC P1AE6

Battery Energy Control Module Hybrid/EV Battery Voltage Isolation Sensor Circuit

Circuit/System Description

The vehicle is equipped with a high voltage isolation monitor feature. The purpose of the battery energy control module high voltage isolation monitor circuit is to test the resistance between the high voltage positive and negative direct current (DC) bus and chassis ground. The battery energy control module isolation monitoring method is sometimes referred to as the active isolation monitor. The hybrid powertrain control module 2 requests the battery energy control module to perform this test. Measurement values are reported to the hybrid powertrain control module 2, which makes the determination of an isolation fault.

The isolation check for P0AA6 Hybrid Battery Voltage System Isolation Lost runs when all the contactors are open. This check monitors isolation in the battery system. This check runs only once during the time that the hybrid powertrain control module 2 is awake and runs after the contactors have been open for 35 seconds. This monitor typically runs when the vehicle is turned off after a drive. It could also run when the vehicle is first started, if there is a long enough period between the hybrid powertrain control module 2 waking up and the main contactors closing.

The battery energy control module runs an internal self check of this sensor circuit. When this test fails, DTC P1AE6 will be set.

Conditions for Running the DTC

P0AA6

- The hybrid powertrain control module 2 and battery energy control module are awake and communicating
- All the contactors have been open for 35 seconds.

P1AE6

- The 12 V battery voltage is greater than 9 V.
- The hybrid powertrain control module 2 and battery energy control module are awake and communicating.
- The hybrid powertrain control module 2 has requested the battery energy control module to run the isolation test.
- The main contactors are open.
- DTC U185B is not set.

Conditions for Setting the DTC

P0AA6

- The battery energy control module has detected active isolation resistance is less than 325K Ω if P0AA6 has not failed or less than 425K Ω if P0AA6 has failed at least once.
- 5 out of 10 tests have failed.

P1AE6

The battery energy control module has detected a fault with the active isolation sensing circuits.

Actions Taken When the DTC Sets

P0AA6 and P1AE6 are Type A DTCs.

Conditions for Clearing the DTC

- P0AA6 and P1AE6 are Type A DTCs.
- P0AA6 requires one passing test at greater than 425K Ω resistance.

Diagnostic Aids

- A single high voltage contactor stuck closed may set this DTC.
- Condensation or water intrusion into the hybrid/EV battery pack may cause P0AA6 or P1AE6 to set.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

- [COMPONENT CONNECTOR END VIEWS - INDEX](#)
- [INLINE HARNESS 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. Verify that DTC P0A7E, P0AA1, P0AA4, P0AD9, P0ADD, P0AE4, P0C32, P0D0A, P0D09, P1EBD, P1EC0 or P1EC3 is not set.
 - **If any DTC is set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
 - **If none of the DTCs are set**
2. Verify that DTC P1AE6 is set and P0AA6 is not set.
 - **If DTC P1AE6 is set without DTC P0AA6**
Replace the K16 Battery Energy Control Module.
 - **If both DTCs are set or only DTC P0AA6 is set**
3. Verify with a scan tool the hybrid powertrain control module 2, Isolation Test Resistance parameter is greater than 425 k Ω .
 - **If the parameter is 425 k Ω or less**
Refer to Circuit/System Testing.
 - **If the parameter is greater than 425 k Ω**
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.

1. Vehicle OFF, disable the high voltage at the A4 Hybrid/EV Battery Pack. Refer to [High Voltage Disabling](#).
2. Replace the A4 Hybrid/EV Battery Pack.

Repair Instructions

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

- [High Voltage Battery Replacement and Shipping Preparation](#) for A4 Hybrid/EV Battery Pack replacement.
- [Control Module References](#) for K16 battery energy control module replacement, programming and setup.

DTC P0ABB, P0ABC OR P0ABD: HYBRID/EV BATTERY VOLTAGE SENSOR

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: [Diagnostic System Check - Vehicle](#)
- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC 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 powertrain control module 2 monitors individual cell voltage readings from the battery energy control module. The battery energy control module monitors the voltage of the 96 battery cell groups. Voltage sense lines are attached to each individual cell group and these sense lines terminate at a connector located on the top surface of the battery section. A voltage sense harness joins this connector to the battery energy control module.

Conditions for Running the DTC

P0ABB

- The hybrid/EV powertrain control module 2 and battery energy control module are awake and communicating.
- DTC U0111 or U185A is not set.

P0ABC and P0ABD

- The hybrid/EV powertrain control module 2 and battery energy control module are awake and communicating.
- The 12 V battery voltage is greater than 9 V.

Conditions for Setting the DTC

P0ABB

The hybrid/EV powertrain control module 2 detects difference of 12 V between the average cell group voltage multiplied by 96 and the voltage measured at battery side of the main contactors.

P0ABC

The battery energy control module detects the terminal voltage is less than 24 V on the battery side of the main contactors.

P0ABD

The battery energy control module detects the terminal voltage is greater than 479 V on the battery side of the main contactors.

Actions Taken When the DTC Sets

- DTCs P0ABB, P0ABC and P0ABD are Type A DTCs.
- The vehicle will operate in a reduced power mode and the extended range mode.

Conditions for Clearing the DTC

DTCs P0ABB, P0ABC and P0ABD are Type A DTCs.

Diagnostic Aids

- The hybrid/EV battery pack high voltage manual service disconnect is out, not installed correctly or a blown manual service disconnect fuse may cause P0ABB and/or P0ABC to set.
- The hybrid/EV battery pack high voltage manual service disconnect was removed, out of sequence or was out during a service procedure with the 12 V battery connected may cause P0ABB and/or P0ABC to set.
- The Hybrid/EV Battery Section schematics in Energy Storage identify the battery section and voltage sense circuit terminal locations appropriate to each cell group.

CAUTION: The battery energy control modules internal cell balancing circuitry is powered by the cell group voltage sense circuits. In order to prevent an unrecoverable, unbalanced Hybrid/EV battery section or internal control module damage, always take the following actions:

1. Disconnect ALL of the battery energy control module connectors prior to disconnecting any Hybrid/EV battery section connector.
2. Reconnect all the Hybrid/EV battery section connectors prior to reconnecting the battery energy control module connectors.
3. Disconnect and reconnect the battery energy control module connectors ONLY in the sequence provided in Repair Instructions.

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

1. Vehicle in Service Mode.

2. Verify that no other DTCs are set.

- If any DTCs are set

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

- If no other DTCs are set

3. Verify and record with a scan tool, the battery energy control module Hybrid Battery Pack Terminal 1 Voltage parameter and the hybrid/EV powertrain control module 2 Hybrid Battery Pack Voltage parameters are between 205-419 V and within 12 V of each other.

- If not within the specified range and not within 12 V of each other

Refer to Circuit/System Testing.

- If within the specified range and within 12 V of each other

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.

1. Vehicle OFF, disable the high voltage at the A4 Hybrid/EV Battery Pack. Refer to [High Voltage Disabling](#)
2. Remove the S15 Manual Service Disconnect.
3. Test for less than 10 Ω across the S15 Manual Service Disconnect fuse terminals.

- If 10 Ω or greater

Replace the S15 Manual Service Disconnect.

- If less than 10 Ω

4. Replace the A4 hybrid/EV battery pack.

Repair Instructions

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

- [Drive Motor Battery High Voltage Manual Disconnect Lever Replacement](#) for S15 manual service disconnect replacement.

- [High Voltage Battery Replacement and Shipping Preparation](#) for A4 Hybrid/EV Battery Pack replacement.

DTC P0AC1, P0AC2, P0B10, P0B11, P0B13, P1EBA OR P1EBB: HYBRID/EV BATTERY LOW/HIGH RESOLUTION CURRENT SENSOR CIRCUIT

Diagnostic Instructions

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

DTC Descriptor

DTC P0AC1

Hybrid/EV Battery Low Resolution Current Sensor Circuit Low Voltage

DTC P0AC2

Hybrid/EV Battery Low Resolution Current Sensor Circuit High Voltage

DTC P0B10

Hybrid/EV Battery High Resolution Current Sensor Circuit Low Voltage

DTC P0B11

Hybrid/EV Battery High Resolution Current Sensor Circuit High Voltage

DTC P0B13

Hybrid/EV Battery Low Resolution Current Sensor - High Resolution Current Sensor Not Plausible

DTC P1EBA

Hybrid/EV Battery Low Resolution Current Sensor Exceeded Learning Limit

DTC P1EBB

Hybrid/EV Battery High Resolution Current Sensor Exceeded Learning Limit

Circuit/System Description

The hybrid/EV battery current sensor is mounted inside the hybrid/EV battery pack. The positive high voltage cable that goes to the positive contactor relay passes through the hybrid/EV battery pack current sensor. The hybrid/EV battery pack current sensor detects the amperage that flows in and out of the hybrid/EV batteries. The battery energy control module supplies and monitors a 5 V reference signal to the hybrid/EV battery pack current sensor. The hybrid/EV battery pack current sensor returns a signal between 0 and 5 V to the battery energy control module. The hybrid/EV battery pack current sensor signal is in proportion to the amperage going in and out of the hybrid/EV battery pack. The hybrid/EV battery pack current sensor has 2 measurement ranges in order to maintain accuracy. The ranges are low resolution and high resolution. The measurement ranges of the hybrid/EV battery pack current sensor have some overlap with each other. A signal voltage of the high resolution hybrid/EV battery pack current sensor greater than 2.5 V indicates that the hybrid/EV battery is being charged and a signal voltage less than 2.5 V indicates discharging. A signal voltage of the low resolution hybrid/EV battery pack current sensor greater than 3.24 V indicates that the hybrid/EV battery is being charged and a signal voltage less than 3.24 V indicates discharging. The high resolution measures from -20 to +20 A. The low resolution measures from -500 to +230 A.

Conditions for Running the DTC

P0AC1, P0AC2, P0B10 and P0B11

- The 12 V battery voltage is greater than 9 V.
- The battery energy control module is awake and communicating.

P0B13

- The hybrid/EV battery low resolution current sensor or the hybrid/EV battery high resolution current sensor value is between -20 and +20 A.
- None of the following DTCs are set: P0AC1, P0AC2, P1EBA, P0B10, P0B11, P1EBB, U0111, U185A.

P1EBA and P1EBB

- Runs during battery energy control module initialization.
- The 12 V battery voltage is greater than 9 V.
- The high voltage main and charger contactors are open (during wake-up).
- DTC U185B is not set.

Conditions for Setting the DTC

P0AC1

The battery energy control module detects that the hybrid/EV battery pack current sensor low resolution is less than -555 A.

P0AC2

The battery energy control module detects that the hybrid/EV battery pack current sensor low resolution is greater than +285 A.

P0B10

The battery energy control module detects that the hybrid/EV battery pack current sensor high resolution is less than -23 A.

P0B11

The battery energy control module detects that the hybrid/EV battery pack current sensor high resolution is greater than +23 A.

P0B13

The difference between the Hybrid/EV Battery's low resolution current sensor value and its high resolution current sensor value is greater than 10 A.

P1EBA

The battery energy control module detects that the Pack Current Low Resolution Offset is greater than the calibration Low Resolution Offset of 8 A.

P1EBB

The battery energy control module detects that the Pack Current High Resolution Offset is greater than the calibration High Resolution Offset of 2.5 A.

Action Taken When the DTC Sets

- DTC P0AC1, P0AC2, P0B10, P0B11, P1EBA and P1EBB are type A DTCs.
- The vehicle will operate in a reduced power mode.

Conditions for Clearing the DTC

DTC P0AC1, P0AC2, P0B10, P0B11, P1EBA and P1EBB are type A DTCs.

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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. Vehicle in Service Mode, all accessories OFF.
2. Verify the scan tool battery energy control module Hybrid/EV Battery Pack Low Resolution Current Sensor parameter is between -555 A and +285 A and changes with the amount of current draw on the hybrid/EV battery pack.

NOTE: Typical current in a parked vehicle with the Vehicle in Service Mode and all accessories OFF is between 1 A and 10 A.

- **If not within the specified range**

Refer to Circuit/System Testing.

- **If within the specified range**

3. Verify the scan tool Hybrid/EV Battery Pack High Resolution Current Sensor parameter is between -23 A and +23 A and changes with the amount of current draw on the hybrid/EV battery pack.

NOTE: Typical current in a parked vehicle with the Vehicle in Service Mode and all accessories OFF is between 1 A and 10 A.

- **If not within the specified range**

Refer to Circuit/System Testing.

- **If within the specified range**

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.

1. Vehicle OFF, disable the high voltage at the A4 Hybrid/EV Battery Pack. Refer to [High Voltage Disabling](#)
2. Replace the A4 Hybrid/EV Battery Pack.

Repair Instructions

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

[High Voltage Battery Replacement and Shipping Preparation](#) for A4 Hybrid/EV Battery Pack replacement.

DTC P0AF8: HYBRID SYSTEM VOLTAGE

Diagnostic Instructions

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

DTC Descriptor

DTC P0AF8

Hybrid System Voltage

Circuit/System Description

The hybrid battery contains 192 individual cells. Two cells are welded together in parallel and called a cell group. There are a total of 96 cell groups in the hybrid battery 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 355 V direct current. The battery cell groups are joined to form 3 distinct sections. The first 32 battery cell groups make up battery section 1. This section is the forward-most section and contains battery cell groups 65 through 96. The next 32 battery cell groups make up battery section 2. This section is located on top of section 3 and contains battery cell groups 33 through 64. Located beneath battery section 2 is section number 3 and it contains the remaining 32 battery cell groups 1 through 32. The battery sections also contain two temperature sensors, with one sensor located at each end of the section.

The battery energy control module monitors the voltage of the 96 battery cell groups. The voltage sense lines are attached to each individual cell group and these sense lines terminate at a connector located on the top surface of the battery section. A voltage sense harness joins this connector to the battery energy control module.

The battery energy control module will determine when a fault condition is present. Diagnostics and system status are communicated from the battery energy control module to the hybrid powertrain control module 2 through

serial data. The hybrid powertrain control module 2 is the host controller for diagnostic trouble code information.

Conditions for Running the DTC

- The hybrid/EV battery main contactors are closed.
- None of the following DTCs are set; P0ABB, P0ABC, P0ABD, P1AF5, P1AF7, P1B0C, P1B41, P1B42, P1B44, P1ED1, P1EF1, P1E1B, U0111, U185A or U1817.

OR

- Battery charging is active.
- None of the following DTCs are set; P0ABB, P0ABC, P0ABD, P0D4E, P0D4F, P0D5C, P16C5, P1EEB, P1EEC, P1ECE, U0111 or U185A.

Conditions for Setting the DTC

- The difference between the Hybrid/EV Battery pack voltage and the hybrid/EV powertrain control module 1 bus voltage is greater than 16 V.

OR

- The difference between the Hybrid/EV Battery pack voltage and the charger module's bus voltage is greater than 16 V.

Action Taken When the DTC Sets

- DTC P0AF8 is a type A DTC.
- The vehicle will operate in a reduced power mode.

Conditions for Clearing the DTC

DTC P0AF8 is a type A DTC.

Diagnostic Aids

- An open charger fuse may cause DTC P0AF8 to set.
- DTC P1EC0 may set a DTC P0AF8 if the vehicle is ON or vehicle in service mode while the contactors are stuck OPEN

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

[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. Verify that no other DTCs are set.
 - **If any DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)
 - **If no DTCs are set**
2. Ensure the battery charge cord is not connected.
3. Vehicle ON.
4. Verify with a scan tool, the hybrid/EV powertrain control module 1 High Voltage Circuit and the battery energy control module Hybrid Battery Pack Terminal 1 Voltage are within 16 V of each other and DTC P0AF8 did not reset.

NOTE: **The contactors must be closed.**

- **If the parameters are not within 16 V of each other or DTC P0AF8 is set**

Refer to Circuit/System Testing, Battery Main Bus Diagnostics.
 - **If the parameters are within 16 V of each other and DTC P0AF8 is not set**
5. Connect the battery charge cord.
 6. Verify with a scan tool, the hybrid/EV powertrain control module 2 Battery Charger High Output and the battery energy control module Hybrid Battery Pack Terminal 1 Voltage are within 16 V of each other and DTC P0AF8 did not reset.
 - **If the parameters are not within 16 V of each other or DTC P0AF8 is set**

Refer to Circuit/System Testing, Battery Charger Bus Diagnostics.
 - **If the parameters are within 16 V of each other and DTC P0AF8 is not set**
 7. 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.

Battery Charger Bus Diagnostics

1. Vehicle OFF, disable the high voltage at the T18 Battery Charger and the K1 14V Power Module. Refer to [High Voltage Disabling](#).
2. Disconnect the T18 Battery Charger high voltage DC connector.
3. Disconnect the K1 14V Power Module high voltage connector.
4. Disconnect the X367 harness connector at the A4 Hybrid/EV Battery Pack.

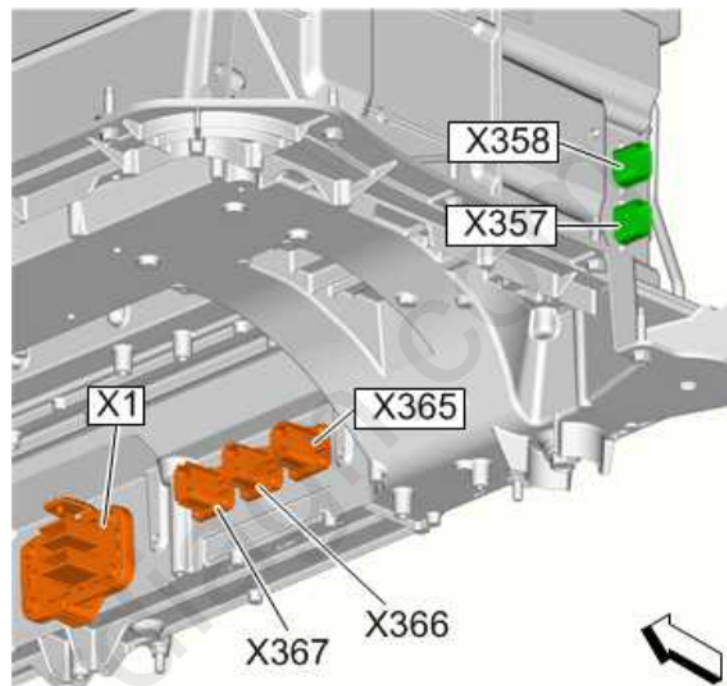


Fig. 40: X367 Harness Connector

Courtesy of GENERAL MOTORS COMPANY

5. Test for infinite resistance between the terminals the High voltage DC (+360 V) positive terminal A and the high voltage DC (-360 V) negative terminal B X367 harness connector.
 - **If less than infinite resistance**
 Replace the high voltage DC cables. After the repair is complete with a scan tool, the [Clear Secured High Voltage DTCs](#) reset function must be performed.
 - **If infinite resistance**
6. Test for less than 10 Ω between the terminals listed below:
 - High voltage DC (-360 V) negative terminal B harness connector at the T18 Battery Charger and the high voltage DC (-360 V) negative terminal B X367 harness connector at the A4 Hybrid/EV Battery Pack.
 - High voltage DC (+360 V) positive terminal A harness connector at the T18 Battery Charger and the high voltage DC (+360 V) negative terminal A X367 harness connector at the A4 Hybrid/EV Battery Pack.
 - **If 10 Ω or greater**
 Replace the high voltage DC cables. After the repair is complete with a scan tool, the [Clear Secured High Voltage DTCs](#) reset function must be performed.

- **If less than 10 Ω**

7. Replace the T18 Battery Charger and the fuse, if open.

8. Verify that DTC P0AF8 does not set while operating the vehicle within the Conditions for Running the DTC.

- **If DTC P0AF8 sets**

Replace the K1 14V Power Module and the fuse, if open.

- **If DTC P0AF8 does not set**

9. Verify that DTC P0AF8 does not set while operating the vehicle within the Conditions for Running the DTC.

- **If DTC P0AF8 sets**

Replace the high voltage battery disconnect relay assembly.

- **If DTC P0AF8 does not set**

10. All OK.

Battery Main Bus Diagnostics

1. Vehicle OFF, disable the high voltage at the T6 Power Inverter Module and the A4 Hybrid/EV Battery Pack. Refer to [High Voltage Disabling](#).

2. Disconnect the X1 harness connector at the A4 Hybrid/EV Battery Pack.

3. Disconnect the high voltage DC connector at the T6 power inverter module.

4. Test for infinite resistance between the terminals the High voltage DC (+360 V) positive terminal A and the high voltage DC (-360 V) negative terminal B X1 harness connector.

- **If less than infinite resistance**

Replace the high voltage DC cables. After the repair is complete with a scan tool, the [Clear Secured High Voltage DTCs](#) reset function must be performed.

- **If infinite resistance**

5. Test for less than 10 Ω between the terminals listed below:

- High voltage DC (-360 V) negative terminal B X1 harness connector at the A4 Hybrid/EV Battery Pack and the high voltage DC (-360 V) negative terminal B harness connector at the T6 Power Inverter Module.
- High voltage DC (+360 V) positive terminal A X1 harness connector at the A4 Hybrid/EV Battery Pack and the high voltage DC (+360 V) negative terminal A harness connector at the T6 Power Inverter Module.

- **If 10 Ω or greater**

Replace the high voltage DC cables. After the repair is complete with a scan tool, the [Clear Secured High Voltage DTCs](#) reset function must be performed.

- **If less than 10 Ω**

6. Replace the T6 Power Inverter Module.

7. Verify that DTC P0AF8 does not set while operating the vehicle within the Conditions for Running the DTC.

- **If DTC P0AF8 sets**

Replace the high voltage battery disconnect relay assembly.

- **If DTC P0AF8 does not set**

8. All OK.

Repair Instructions

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

- [300-Volt Battery Positive and Negative Cable Replacement](#)
- [Drive Motor Battery Charger Replacement](#) for T18 Battery Charger replacement.
- [Accessory DC Power Control Module Replacement](#) for K1 14V Power Module replacement.
- [High Voltage Battery Disconnect Relay Replacement](#) for high voltage battery disconnect relay assembly.
- [Control Module References](#) for T6 power inverter module replacement, programming and setup.

DTC P0AFA OR P0AFB: HYBRID/EV BATTERY SYSTEM VOLTAGE

Diagnostic Instructions

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

DTC Descriptor

DTC P0AFA

Hybrid/EV Battery System Voltage Low Voltage

DTC P0AFB

Hybrid/EV Battery System Voltage High Voltage

Circuit/System Description

The battery energy control module monitors the hybrid/EV battery voltage at the battery side of the high voltage main contactors for low and high voltage conditions.

Conditions for Running the DTC

- The battery energy control module is awake and communicating.
- None of the following DTCs are set; P0ABC, P0ABD, P0ABB, U0111, U185A.

Conditions for Setting the DTC

P0AFA

The Hybrid Battery Pack Voltage is less than 164.9 V at temperatures greater than 0°C (32°F), 155 V at temperatures between 0°C (32°F) and -20°C (-4°F) or 148.9 V at temperatures less than -20°C (-4°F).

P0AFB

The Hybrid Battery Pack Voltage is greater than 440.5 V at temperatures greater than 20°C (68°F), 439.9 V at temperatures between 20°C (68°F) and 10°C (50°F) or 438.3 V at temperatures less than 10°C (50°F).

Action Taken When the DTC Sets

- DTCs P0AFA and P0AFB are type A DTCs.
- The vehicle will operate in a reduced power mode.
- Once the vehicle has been turned OFF, the hybrid/EV powertrain control module 2 will not CLOSE the high voltage contactors until the DTC has been cleared.

Conditions for Clearing the DTC

- DTCs P0AFA and P0AFB are type A DTCs.
- The [Clear Secured High Voltage DTCs](#) reset function must be performed with a scan tool before clear codes.

Diagnostic Aids

CAUTION:

The battery energy control modules internal cell balancing circuitry is powered by the cell group voltage sense circuits. In order to prevent an unrecoverable,

unbalanced Hybrid/EV battery section or internal control module damage, always take the following actions:

1. Disconnect ALL of the battery energy control module connectors prior to disconnecting any Hybrid/EV battery section connector.
2. Reconnect all the Hybrid/EV battery section connectors prior to reconnecting the battery energy control module connectors.
3. Disconnect and reconnect the battery energy control module connectors ONLY in the sequence provided in Repair Instructions.

The hybrid/EV battery pack high voltage manual service disconnect is not installed correctly or a blown manual service disconnect fuse will cause P0AFA to set.

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[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. Vehicle in Service Mode.
2. Verify that DTC P0AA1, P0AD9, P0ADD, P0AE2, P0AE4, P0B3B, P0B3C, P0B3D, P0B3E, P0B40, P0B41, P0B42, P0B43, P0B45, P0B46, P0B47, P0B48, P0B4A, P0B4B, P0B4D, P0B4C, P0B4F, P0B50, P0B51, P0B52, P0B54, P0B55, P0B56, P0B57, P0B59, P0B5A, P0B5B, P0B5C, P0B5E, P0B60, P0B5F, P0B61, P0B63, P0B64, P0B65, P0B66, P0B69, P0B68, P0B6A, P0B6D, P0B6B, P0B6E, P0B70, P0B6F, P0B72, P0B74, P0B73, P0B75, P0B77, P0B78, P0B79, P0B7A, P0B7D, P0B7C, 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, P0BA1, P0BA0, P0BA2, P0BA4, P0BA5, P0BA6, P0BA7, P0BA9, P0BAA, P0BAB, P0BAC, P0BAE, P0BAF, P0BB0, P0BB1, P0BB3, P0BB4, P0BB5, P0BB6, P0BB8, P0BB9, P0BBA, P0BBB, P0D0A, P0D11, P1B16, P1B17, P1B18, P1B19, P1B1A, P1B1B, P1B1C, P1B1D, P1B1E, P1B1F, P1B20, P1B21, P1B22, P1B23, P1B24, P1B25, P1B26, P1B27, P1B28, P1B29, P1B2B, P1B2A, P1B2C, P1B2D, P1B45, P1B46, P1B47,

P1B48, P1B49, P1B4A, P1B4B, P1B4C, P1B4D, P1B4E, P1B4F, P1B50, P1B51, P1B52, P1B53, P1B54, P1B55, P1B56, P1B57, P1B58, P1B59, P1B5A, P1B5B, P1B5C, P1B5D, P1B5E, P1B5F, P1B60, P1B61, P1B62, P1B63, P1B64, P1B65, P1B66, P1B67, P1B68, P1B69, P1B6A, P1B6B, P1B6C, P1B6D, P1B6E, P1B6F, P1B70, P1B71, P1B72, P1B73, P1B74, P1B75, P1B76, P1B77, P1B78, P1B79, P1B7A, P1B7B, P1B7C, P1B7D, P1B7E, P1B7F, P1B80, P1B81, P1B82, P1B83, P1B84, P1B85, P1B86, P1B87, P1B88, P1B89, P1B8A, P1B8B, P1B8C, P1B8D, P1B8E, P1B8F, P1B90, P1B91, P1B92, P1B93, P1B94, P1B95, P1B97, P1B96, P1B98, P1B99, P1B9A, P1B9B, P1B9C, P1B9D, P1B9E, P1B9F, P1BA0, P1BA1, P1BA2, P1BA3, P1BA4, P1BA5, P1BA6, P1BA7, P1BA8, P1BA9, P1BAB, P1BAA, P1BAC, P1BAD, P1BAE, P1BAF, P1BB0, P1BB1, P1BB2, P1BB3, P1BB4, P1BB5, P1BB6, P1BB7, P1BB8, P1BB9, P1BBA, P1BBB, P1BBC, P1BBD, P1BBE, P1BBF, P1BC0, P1BC1, P1BC2, P1BC3, P1BC4, P1BC5, P1BC6, P1BC7, P1BC8, P1BC9, P1BCA, P1BCB, P1BCC, P1BCE, P1BCD, P1BCF, P1BD0, P1BD2, P1BD1, P1BD3, P1BD4, P1BD5, P1BD6, P1BD7, P1BD8, P1BD9, P1BDA, P1BDB, P1BDD, P1BDC, P1BDE, P1BDF, P1BE1, P1BE0, P1BE3, P1BE2, P1BE4, P1BE5, P1BE6, P1BE7, P1BE8, P1BE9, P1BEA, P1BEB, P1BEC, P1BED, P1BEE, P1BF0, P1BEF, P1BF1, P1BF2, P1BF4, P1BF3, P1BF5, P1BF6, P1BF7, P1BF8, P1BF9, P1BFA, P1BFB, P1BFC, P1BFD, P1BFE, P1E01, P1E02, P1E03, P1E04, P1E05, P1E06, P1E4C, P1E4D, P1E4E, P1E4F, P1E50, P1E51, P1E52, P1E53, P1E54, P1E55, P1E56, P1E57, P1E58, P1E59, P1E5A, P1E5B, P1E5C, P1E5D, P1E5E, P1E5F, P1E60, P1E62, P1E61, P1E63, P1E64, P1E65, P1E66, P1E67, P1E68, P1E69, P1E6A, P1E6B, P1E6D, P1E6C, P1E6E, P1E6F, P1E70, P1E71, P1E72, P1E73, P1E74, P1E76, P1E75, P1E77, P1E78, P1E79, P1E7A, P1E7B, P1E7C, P1E7D, P1E7E, P1E7F, P1E80, P1E81, P1E82, P1E83, P1E84, P1E85, P1E86, P1E87, P1E88, P1E89, P1E8A, P1EBC, P1EBF, P1EC0, P1EC3, P1EC4, P1EC5, U2603, U2604, U2605, U2606 or U2401 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

3. Verify the scan tool Hybrid/EV Battery Pack Terminal 1 Voltage is between 148.9-440.5 V.

- If not within the specified range

Refer to Circuit/System Testing.

- If within the specified range

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.

1. Vehicle OFF, disable the high voltage at the A4 Hybrid/EV Battery Pack. Refer to [High Voltage Disabling](#)
2. Remove the S15 manual service disconnect.
3. Test for less than 10 Ω across the S15 manual service disconnect fuse terminals.

- **If 10 Ω or greater**

Replace the S15 manual service disconnect and repeat Circuit/System Verification.

- **If less than 10 Ω**

4. Replace the A4 hybrid/EV battery pack.

Repair Instructions

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

- [Drive Motor Battery High Voltage Manual Disconnect Lever Replacement](#)
- [High Voltage Battery Replacement and Shipping Preparation](#) for A4 Hybrid/EV Battery Pack replacement.

DTC P0B3B-P0BBB, P1B16-P1B2D, P1B45-P1BFE, P1E01-P1E06 OR P1E4C-P1E8B: HYBRID/EV BATTERY CIRCUIT

Diagnostic Instructions

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

DTC Descriptor

DTC 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

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Hybrid/EV Battery 16 Circuit Performance

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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

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Hybrid/EV Battery 30 Circuit

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Hybrid/EV Battery 31 Circuit

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Hybrid/EV Battery 32 Circuit

DTC P1B45

Hybrid/EV Battery 33 Circuit Performance

DTC P1B46

Hybrid/EV Battery 33 Circuit Low Voltage

DTC P1B47

Hybrid/EV Battery 33 Circuit High Voltage

DTC P1B48

Hybrid/EV Battery 34 Circuit Performance

DTC P1B49

Hybrid/EV Battery 34 Circuit Low Voltage

DTC P1B4A

Hybrid/EV Battery 34 Circuit High Voltage

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Hybrid/EV Battery 35 Circuit Performance

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Hybrid/EV Battery 45 Circuit Performance

DTC P1B6A

Hybrid/EV Battery 45 Circuit Low Voltage

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Hybrid/EV Battery 45 Circuit High Voltage

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Hybrid/EV Battery 46 Circuit Performance

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Hybrid/EV Battery 46 Circuit Low Voltage

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Hybrid/EV Battery 57 Circuit Performance

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DTC P1B8F

Hybrid/EV Battery 57 Circuit High Voltage

DTC P1B90

Hybrid/EV Battery 58 Circuit Performance

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Hybrid/EV Battery 58 Circuit Low Voltage

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Hybrid/EV Battery 60 Circuit Low Voltage

DTC P1B98

Hybrid/EV Battery 60 Circuit High Voltage

DTC P1B99

Hybrid/EV Battery 61 Circuit Performance

DTC P1B9A

Hybrid/EV Battery 61 Circuit Low Voltage

DTC P1B9B

Hybrid/EV Battery 61 Circuit High Voltage

DTC P1B9C

Hybrid/EV Battery 62 Circuit Performance

DTC P1B9D

Hybrid/EV Battery 62 Circuit Low Voltage

DTC P1B9E

Hybrid/EV Battery 62 Circuit High Voltage

DTC P1B9F

Hybrid/EV Battery 63 Circuit Performance

DTC P1BA0

Hybrid/EV Battery 63 Circuit Low Voltage

DTC P1BA1

Hybrid/EV Battery 63 Circuit High Voltage

DTC P1BA2

Hybrid/EV Battery 64 Circuit Performance

DTC P1BA3

Hybrid/EV Battery 64 Circuit Low Voltage

DTC P1BA4

Hybrid/EV Battery 64 Circuit High Voltage

DTC P1BA5

Hybrid/EV Battery 65 Circuit Performance

DTC P1BA6

Hybrid/EV Battery 65 Circuit Low Voltage

DTC P1BA7

Hybrid/EV Battery 65 Circuit High Voltage

DTC P1BA8

Hybrid/EV Battery 66 Circuit Performance

DTC P1BA9

Hybrid/EV Battery 66 Circuit Low Voltage

DTC P1BAA

Hybrid/EV Battery 66 Circuit High Voltage

DTC P1BAB

Hybrid/EV Battery 67 Circuit Performance

DTC P1BAC

Hybrid/EV Battery 67 Circuit Low Voltage

DTC P1BAD

Hybrid/EV Battery 67 Circuit High Voltage

DTC P1BAE

Hybrid/EV Battery 68 Circuit Performance

DTC P1BAF

Hybrid/EV Battery 68 Circuit Low Voltage

DTC P1BB0

Hybrid/EV Battery 68 Circuit High Voltage

DTC P1BB1

Hybrid/EV Battery 69 Circuit Performance

DTC P1BB2

Hybrid/EV Battery 69 Circuit Low Voltage

DTC P1BB3

Hybrid/EV Battery 69 Circuit High Voltage

DTC P1BB4

Hybrid/EV Battery 70 Circuit Performance

DTC P1BB5

Hybrid/EV Battery 70 Circuit Low Voltage

DTC P1BB6

Hybrid/EV Battery 70 Circuit High Voltage

DTC P1BB7

Hybrid/EV Battery 71 Circuit Performance

DTC P1BB8

Hybrid/EV Battery 71 Circuit Low Voltage

DTC P1BB9

Hybrid/EV Battery 71 Circuit High Voltage

DTC P1BBA

Hybrid/EV Battery 72 Circuit Performance

DTC P1BBB

Hybrid/EV Battery 72 Circuit Low Voltage

DTC P1BBC

Hybrid/EV Battery 72 Circuit High Voltage

DTC P1BBD

Hybrid/EV Battery 73 Circuit Performance

DTC P1BBE

Hybrid/EV Battery 73 Circuit Low Voltage

DTC P1BBF

Hybrid/EV Battery 73 Circuit High Voltage

DTC P1BC0

Hybrid/EV Battery 74 Circuit Performance

DTC P1BC1

Hybrid/EV Battery 74 Circuit Low Voltage

DTC P1BC2

Hybrid/EV Battery 74 Circuit High Voltage

DTC P1BC3

Hybrid/EV Battery 75 Circuit Performance

DTC P1BC4

Hybrid/EV Battery 75 Circuit Low Voltage

DTC P1BC5

Hybrid/EV Battery 75 Circuit High Voltage

DTC P1BC6

Hybrid/EV Battery 76 Circuit Performance

DTC P1BC7

Hybrid/EV Battery 76 Circuit Low Voltage

DTC P1BC8

Hybrid/EV Battery 76 Circuit High Voltage

DTC P1BC9

Hybrid/EV Battery 77 Circuit Performance

DTC P1BCA

Hybrid/EV Battery 77 Circuit Low Voltage

DTC P1BCB

Hybrid/EV Battery 77 Circuit High Voltage

DTC P1BCC

Hybrid/EV Battery 78 Circuit Performance

DTC P1BCD

Hybrid/EV Battery 78 Circuit Low Voltage

DTC P1BCE

Hybrid/EV Battery 78 Circuit High Voltage

DTC P1BCF

Hybrid/EV Battery 79 Circuit Performance

DTC P1BD0

Hybrid/EV Battery 79 Circuit Low Voltage

DTC P1BD1

Hybrid/EV Battery 79 Circuit High Voltage

DTC P1BD2

Hybrid/EV Battery 80 Circuit Performance

DTC P1BD3

Hybrid/EV Battery 80 Circuit Low Voltage

DTC P1BD4

Hybrid/EV Battery 80 Circuit High Voltage

DTC P1BD5

Hybrid/EV Battery 81 Circuit Performance

DTC P1BD6

Hybrid/EV Battery 81 Circuit Low Voltage

DTC P1BD7

Hybrid/EV Battery 81 Circuit High Voltage

DTC P1BD8

Hybrid/EV Battery 82 Circuit Performance

DTC P1BD9

Hybrid/EV Battery 82 Circuit Low Voltage

DTC P1BDA

Hybrid/EV Battery 82 Circuit High Voltage

DTC P1BDB

Hybrid/EV Battery 83 Circuit Performance

DTC P1BDC

Hybrid/EV Battery 83 Circuit Low Voltage

DTC P1BDD

Hybrid/EV Battery 83 Circuit High Voltage

DTC P1BDE

Hybrid/EV Battery 84 Circuit Performance

DTC P1BDF

Hybrid/EV Battery 84 Circuit Low Voltage

DTC P1BE0

Hybrid/EV Battery 84 Circuit High Voltage

DTC P1BE1

Hybrid/EV Battery 85 Circuit Performance

DTC P1BE2

Hybrid/EV Battery 85 Circuit Low Voltage

DTC P1BE3

Hybrid/EV Battery 85 Circuit High Voltage

DTC P1BE4

Hybrid/EV Battery 86 Circuit Performance

DTC P1BE5

Hybrid/EV Battery 86 Circuit Low Voltage

DTC P1BE6

Hybrid/EV Battery 86 Circuit High Voltage

DTC P1BE7

Hybrid/EV Battery 87 Circuit Performance

DTC P1BE8

Hybrid/EV Battery 87 Circuit Low Voltage

DTC P1BE9

Hybrid/EV Battery 87 Circuit High Voltage

DTC P1BEA

Hybrid/EV Battery 88 Circuit Performance

DTC P1BEB

Hybrid/EV Battery 88 Circuit Low Voltage

DTC P1BEC

Hybrid/EV Battery 88 Circuit High Voltage

DTC P1BED

Hybrid/EV Battery 89 Circuit Performance

DTC P1BEE

Hybrid/EV Battery 89 Circuit Low Voltage

DTC P1BEF

Hybrid/EV Battery 89 Circuit High Voltage

DTC P1BF0

Hybrid/EV Battery 90 Circuit Performance

DTC P1BF1

Hybrid/EV Battery 90 Circuit Low Voltage

DTC P1BF2

Hybrid/EV Battery 90 Circuit High Voltage

DTC P1BF3

Hybrid/EV Battery 91 Circuit Performance

DTC P1BF4

Hybrid/EV Battery 91 Circuit Low Voltage

DTC P1BF5

Hybrid/EV Battery 91 Circuit High Voltage

DTC P1BF6

Hybrid/EV Battery 92 Circuit Performance

DTC P1BF7

Hybrid/EV Battery 92 Circuit Low Voltage

DTC P1BF8

Hybrid/EV Battery 92 Circuit High Voltage

DTC P1BF9

Hybrid/EV Battery 93 Circuit Performance

DTC P1BFA

Hybrid/EV Battery 93 Circuit Low Voltage

DTC P1BFB

Hybrid/EV Battery 93 Circuit High Voltage

DTC P1BFC

Hybrid/EV Battery 94 Circuit Performance

DTC P1BFD

Hybrid/EV Battery 94 Circuit Low Voltage

DTC P1BFE

Hybrid/EV Battery 94 Circuit High Voltage

DTC P1E01

Hybrid/EV Battery 95 Circuit Performance

DTC P1E02

Hybrid/EV Battery 95 Circuit Low Voltage

DTC P1E03

Hybrid/EV Battery 95 Circuit High Voltage

DTC P1E04

Hybrid/EV Battery 96 Circuit Performance

DTC P1E05

Hybrid/EV Battery 96 Circuit Low Voltage

DTC P1E06

Hybrid/EV Battery 96 Circuit High Voltage

DTC P1E4C

Hybrid/EV Battery 33 Circuit

DTC P1E4D

Hybrid/EV Battery 34 Circuit

DTC P1E4E

Hybrid/EV Battery 35 Circuit

DTC P1E4F

Hybrid/EV Battery 36 Circuit

DTC P1E50

Hybrid/EV Battery 37 Circuit

DTC P1E51

Hybrid/EV Battery 38 Circuit

DTC P1E52

Hybrid/EV Battery 39 Circuit

DTC P1E53

Hybrid/EV Battery 40 Circuit

DTC P1E54

Hybrid/EV Battery 41 Circuit

DTC P1E55

Hybrid/EV Battery 42 Circuit

DTC P1E56

Hybrid/EV Battery 43 Circuit

DTC P1E57

Hybrid/EV Battery 44 Circuit

DTC P1E58

Hybrid/EV Battery 45 Circuit

DTC P1E59

Hybrid/EV Battery 46 Circuit

DTC P1E5A

Hybrid/EV Battery 47 Circuit

DTC P1E5B

Hybrid/EV Battery 48 Circuit

DTC P1E5C

Hybrid/EV Battery 49 Circuit

DTC P1E5D

Hybrid/EV Battery 50 Circuit

DTC P1E5E

Hybrid/EV Battery 51 Circuit

DTC P1E5F

Hybrid/EV Battery 52 Circuit

DTC P1E60

Hybrid/EV Battery 53 Circuit

DTC P1E61

Hybrid/EV Battery 54 Circuit

DTC P1E62

Hybrid/EV Battery 55 Circuit

DTC P1E63

Hybrid/EV Battery 56 Circuit

DTC P1E64

Hybrid/EV Battery 57 Circuit

DTC P1E65

Hybrid/EV Battery 58 Circuit

DTC P1E66

Hybrid/EV Battery 59 Circuit

DTC P1E67

Hybrid/EV Battery 60 Circuit

DTC P1E68

Hybrid/EV Battery 61 Circuit

DTC P1E69

Hybrid/EV Battery 62 Circuit

DTC P1E6A

Hybrid/EV Battery 63 Circuit

DTC P1E6B

Hybrid/EV Battery 64 Circuit

DTC P1E6C

Hybrid/EV Battery 65 Circuit

DTC P1E6D

Hybrid/EV Battery 66 Circuit

DTC P1E6E

Hybrid/EV Battery 67 Circuit

DTC P1E6F

Hybrid/EV Battery 68 Circuit

DTC P1E70

Hybrid/EV Battery 69 Circuit

DTC P1E71

Hybrid/EV Battery 70 Circuit

DTC P1E72

Hybrid/EV Battery 71 Circuit

DTC P1E73

Hybrid/EV Battery 72 Circuit

DTC P1E74

Hybrid/EV Battery 73 Circuit

DTC P1E75

Hybrid/EV Battery 74 Circuit

DTC P1E76

Hybrid/EV Battery 75 Circuit

DTC P1E77

Hybrid/EV Battery 76 Circuit

DTC P1E78

Hybrid/EV Battery 77 Circuit

DTC P1E79

Hybrid/EV Battery 78 Circuit

DTC P1E7A

Hybrid/EV Battery 79 Circuit

DTC P1E7B

Hybrid/EV Battery 80 Circuit

DTC P1E7C

Hybrid/EV Battery 81 Circuit

DTC P1E7D

Hybrid/EV Battery 82 Circuit

DTC P1E7E

Hybrid/EV Battery 83 Circuit

DTC P1E7F

Hybrid/EV Battery 84 Circuit

DTC P1E80

Hybrid/EV Battery 85 Circuit

DTC P1E81

Hybrid/EV Battery 86 Circuit

DTC P1E82

Hybrid/EV Battery 87 Circuit

DTC P1E83

Hybrid/EV Battery 88 Circuit

DTC P1E84

Hybrid/EV Battery 89 Circuit

DTC P1E85

Hybrid/EV Battery 90 Circuit

DTC P1E86

Hybrid/EV Battery 91 Circuit

DTC P1E87

Hybrid/EV Battery 92 Circuit

DTC P1E88

Hybrid/EV Battery 93 Circuit

DTC P1E89

Hybrid/EV Battery 94 Circuit

DTC P1E8A

Hybrid/EV Battery 95 Circuit

DTC P1E8B

Hybrid/EV Battery 96 Circuit

Circuit/System Description

The hybrid battery contains 192 individual cells. Two cells are welded together in parallel and called a cell group. There are a total of 96 cell groups in the hybrid battery 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 355 V direct current. The battery cell groups are joined to form 3 distinct sections. The first 32 battery cell groups make up battery section 1. This section is the forward-most section and contains battery cell groups 65 through 96. The next 32 battery cell groups make up battery section 2. This section is located on top of section 3 and contains battery cell groups 33 through 64. Located beneath battery section 2 is section number 3 and it contains the remaining 32 battery cell groups 1 through 32. The battery sections also contain two temperature sensors, with one sensor located at each end of the section.

The battery energy control module monitors the voltage of the 96 battery cell groups. The voltage sense lines are attached to each individual cell group and these sense lines terminate at a connector located on the top surface of the battery section. A voltage sense harness joins this connector to the battery energy control module.

The battery energy control module will determine when a fault condition is present. Diagnostics and system status are communicated from the battery energy control module to the hybrid powertrain control module 2 through serial data. The hybrid powertrain control module 2 is the host controller for diagnostic trouble code information.

Conditions for Running the DTC

DTC P0B3B, P0B3D, P0B3E, P0B40, P0B42, P0B43, P0B45, P0B47, P0B48, P0B4A, P0B4C, P0B4D, P0B4F, P0B51, P0B54, P0B52, P0B56, P0B57, P0B59, P0B5B, P0B5C, P0B5E, P0B60, P0B61, P0B63, P0B65, P0B66, P0B68, P0B6A, P0B6B, P0B6D, P0B6F, P0B70, P0B72, P0B74, P0B75, P0B77, P0B79, P0B7A, P0B7C, P0B7E, P0B7F, P0B81, P0B83, P0B84, P0B86, P0B88, P0B89, P0B8B, P0B8D, P0B8E, P0B90, P0B92, P0B93, P0B95, P0B97, P0B98, P0B9A, P0B9C, P0B9D, P0B9F, P0BA1, P0BA2, P0BA4, P0BA6, P0BA7, P0BA9, P0BAB, P0BAC, P0BAE, P0BB0, P0BB1, P0BB3, P0BB5, P0BB6, P0BB8, P0BBA, P0BBB, P1B17, P1B18, P1B1A, P1B1B, P1B1D, P1B1E, P1B20, P1B21, P1B23, P1B24, P1B26, P1B27, P1B28, P1B29, P1B2A, P1B2B, P1B2C, P1B2D, P1B46, P1B47, P1B4A, P1B4C, P1B4D, P1B4F, P1B50, P1B52, P1B53, P1B55, P1B56, P1B58, P1B59, P1B5B, P1B5C, P1B5E, P1B5F, P1B61, P1B64, P1B62, P1B65, P1B67, P1B68, P1B6A, P1B6B, P1B6D, P1B6E, P1B70, P1B71, P1B73, P1B74, P1B76, P1B77, P1B79, P1B7A, P1B7C, P1B7D, P1B7F, P1B80, P1B82, P1B83, P1B85, P1B86, P1B88, P1B89, P1B8B, P1B8C, P1B8E, P1B8F, P1B91, P1B92, P1B94, P1B95, P1B97, P1B98, P1B9A, P1B9B, P1B9D, P1B9E, P1BA0, P1BA1, P1BA3, P1BA4, P1BA6, P1BA7, P1BA9, P1BAA, P1BAC, P1BAD, P1BAF, P1BB0, P1BB2, P1BB3, P1BB5, P1BB6, P1BB8, P1BB9, P1BBB, P1BBC, P1BBE, P1BBF, P1BC1, P1BC2, P1BC4, P1BC5, P1BC7, P1BC8, P1BCA, P1BCB, P1BCD, P1BCE, P1BD0, P1BD1, P1BD3, P1BD4, P1BD6, P1BD7, P1BD9, P1BDA, P1BDC, P1BDD, P1BDE, P1BE0, P1BE2, P1BE3, P1BE5, P1BE6, P1BE8, P1BE9, P1BEB, P1BEC, P1BEE, P1BEF, P1BF1, P1BF2, P1BF4, P1BF5, P1BF7, P1BF8, P1BFA, P1BFB, P1BFD, P1BFE, P1E02, P1E03, P1E05, P1E06, P1E4C, P1E4D, P1E4E, P1E4F, P1E50, P1E51, P1E52, P1E53, P1E54, P1E55, P1E56, P1E57, P1E58, P1E59, P1E5A, P1E5B, P1E5C, P1E5D, P1E5E, P1E5F, P1E60, P1E61, P1E62, P1E63, P1E64, P1E65, P1E66, P1E67, P1E68, P1E69, P1E6A, P1E6B, P1E6C, P1E6D, P1E6E, P1E6F, P1E70, P1E71, P1E72, P1E73, P1E74, P1E75, P1E76, P1E77, P1E78, P1E79, P1E7A, P1E7B, P1E7C, P1E7D, P1E7E, P1E7F, P1E80, P1E81, P1E82, P1E83, P1E84, P1E85, P1E86, P1E87, P1E88, P1E89, P1E8A, P1E8B

All of the following conditions exist:

- Vehicle in Service Mode, Vehicle ON or Engine Running.
- The hybrid/EV battery energy control module is awake and communicating.
- None of the following DTCs are set: P1A07, P1E8E, P1E8F, P1E90, P1E91, P1E92, P1E93, P1E94, P1E95, P1E96, P1E97, P1E98, P1E99, P1E9A, P1E9B, P1E9C, P1E9D, P1E9E, P1E9F, P1EA0, P1EA1, P1EA2, P1EA3, P1EA4, P1EA5, P1EB1, P1EB2, P1EB3, P1EB4, P1EB5, U2402, U2603, U2604, U2605, U2606, U2617, U2618, U2619, U2620, U2621, U2622, U2623, U2624.

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, P1B19, P1B1F, P1B25, P1B45, P1B48, P1B4B, P1B4E, P1B51, P1B54, P1B57, P1B5A, P1B5D, P1B60, P1B63, P1B66, P1B69, P1B6C, P1B6F, P1B72, P1B75, P1B78, P1B7B, P1B7E, P1B81, P1B84, P1B87, P1B8A, P1B8D, P1B90, P1B93, P1B96, P1B99, P1B9C, P1B9F, P1BA2, P1BA5, P1BA8, P1BAB, P1BAE, P1BB1, P1BB4, P1BB7, P1BBA, P1BBD, P1BC0, P1BC3, P1BC6, P1BC9, P1BCC, P1BCE, P1BD2, P1BD5, P1BD8, P1BDB, P1BDE, P1BE1, P1BE4, P1BE7, P1BEA, P1BED, P1BF0, P1BF3, P1BF6, P1BF9, P1BFC, P1E01, P1E04

All of the following conditions exist:

- Vehicle ON.
- There is a change in the Voltage and Current readings.
- DTC U185A is not set.

Conditions for Setting the DTC

Battery Circuit

- 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, P1E4C, P1E4D, P1E4E, P1E4F, P1E50, P1E51, P1E52, P1E53, P1E54, P1E55, P1E56, P1E57, P1E58, P1E59, P1E5A, P1E5B, P1E5C, P1E5D, P1E5E, P1E5F, P1E60, P1E61, P1E62, P1E63, P1E64, P1E65, P1E66, P1E67, P1E68, P1E69, P1E6A, P1E6B, P1E6C,

P1E6D, P1E6E, P1E6F, P1E70, P1E71, P1E72, P1E73, P1E74, P1E75, P1E76, P1E77, P1E78, P1E79, P1E7A, P1E7B, P1E7C, P1E7D, P1E7E, P1E7F, P1E80, P1E81, P1E82, P1E83, P1E84, P1E85, P1E86, P1E87, P1E88, P1E89, P1E8A, P1E8B are Type A DTCs.

- The hybrid/EV battery energy control module detects high resistance on the circuit.

Circuit Performance

- 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, P1B19, P1B1F, P1B25, P1B45, P1B48, P1B4B, P1B4E, P1B51, P1B54, P1B57, P1B5A, P1B5D, P1B60, P1B63, P1B66, P1B69, P1B6C, P1B6F, P1B72, P1B75, P1B78, P1B7B, P1B7E, P1B81, P1B84, P1B87, P1B8A, P1B8D, P1B90, P1B93, P1B96, P1B99, P1B9C, P1B9F, P1BA2, P1BA5, P1BA8, P1BAB, P1BAE, P1BB1, P1BB4, P1BB7, P1BBA, P1BBD, P1BC0, P1BC3, P1BC6, P1BC9, P1BCC, P1BCF, P1BD2, P1BD5, P1BD8, P1BDB, P1BDE, P1BE1, P1BE4, P1BE7, P1BEA, P1BED, P1BF0, P1BF3, P1BF6, P1BF9, P1BFC, P1E01, P1E04 are Type A DTCs.
- The faulted cell group does not change voltage.

Low Voltage

- 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, P1B46, P1B4C, P1B4F, P1B52, P1B55, P1B58, P1B5B, P1B5E, P1B61, P1B64, P1B67, P1B6A, P1B6D, P1B70, P1B73, P1B76, P1B79, P1B7C, P1B7F, P1B82, P1B85, P1B88, P1B8B, P1B8E, P1B91, P1B94, P1B97, P1B9A, P1B9D, P1BA0, P1BA3, P1BA6, P1BA9, P1BAC, P1BAF, P1BB2, P1BB5, P1BB8, P1BBB, P1BBE, P1BC1, P1BC4, P1BC7, P1BCA, P1BCD, P1BD0, P1BD3, P1BD6, P1BD9, P1BDC, P1BDF, P1BE2, P1BE5, P1BE8, P1BEB, P1BEE, P1BF1, P1BF4, P1BF7, P1BFA, P1BFD, P1E02, P1E05 are Type A DTCs.
- Any hybrid/EV battery voltage signal is less than 0.2 V.

High Voltage

- 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, P1B47, P1B4A, P1B4D, P1B50, P1B53, P1B56, P1B59, P1B5C, P1B5F, P1B62, P1B65, P1B68, P1B6B, P1B6E, P1B71, P1B74, P1B77, P1B7A, P1B7D, P1B80, P1B83, P1B86, P1B89, P1B8C, P1B8F, P1B92, P1B95, P1B98, P1B9B, P1B9E, P1BA1, P1BA4, P1BA7, P1BAA, P1BAD, P1BB0, P1BB3, P1BB6, P1BB9, P1BBC, P1BBF, P1BC2, P1BC5, P1BC8, P1BCB, P1BCE, P1BD1, P1BD4, P1BD7, P1BDA, P1BDD, P1BE0, P1BE3, P1BE6, P1BE6, P1BE9, P1BEC, P1BEF, P1BF2, P1BF5, P1BF8, P1BFB, P1BFE, P1E03, P1E06 are Type A DTCs.
- Any hybrid/EV battery voltage signal is greater than 4.8 V.

Action Taken When the DTC Sets

- DTC P0B3B-P0BBB, P1B16-P1B2D, P1B45-P1BFE, P1E01-P1E06 or P1E4C-P1E8B are type A DTCs.
- If any of these DTCs are set, the vehicle will operate in a reduced power mode.
- Battery Circuit, Low Voltage or High Voltage DTCs set: Once the vehicle has been turned OFF, the hybrid/EV powertrain control module 2 will not CLOSE the high voltage contactors until the DTC has been cleared.

Conditions for Clearing the DTC

- DTC P0B3B-P0BBB, P1B16-P1B2D, P1B45-P1BFE, P1E01-P1E06 or P1E4C-P1E8B are type A DTCs.
- Vehicle must be cycled from ON to OFF.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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. Vehicle in Service Mode.
2. Verify the scan tool Hybrid/EV Battery 1-96 voltages are between 3.45-4.05 V and all readings are within 0.03 V of each other.
 - **If not between 3.45-4.05 V or not within 0.03 V of each other**
Refer to Circuit/System Testing.
 - **If between 3.45-4.05 V and within 0.03 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.

1. Vehicle OFF, disable high voltage at the A4 hybrid/EV battery pack. Refer to [High Voltage Disabling](#)
2. Replace the A4 hybrid/EV battery pack.

Repair Instructions

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

[High Voltage Battery Replacement and Shipping Preparation](#) for A4 Hybrid/EV Battery Pack replacement.

DTC P0C78 OR P3061: HYBRID/EV BATTERY SYSTEM PRECHARGE

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: [Diagnostic System Check - Vehicle](#)
- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC P0C78

Hybrid/EV Battery System Precharge Time Too Long

DTC P3061

Hybrid/EV Battery Precharge High Current

Circuit/System Description

The hybrid/EV battery contains 4 high voltage contactors and 1 solid state relay (transistor). The high voltage contactors and transistor allow the high voltage DC batteries to be connected to the vehicle or contain the high voltage DC within the hybrid/EV battery assembly. The 4 high voltage contactors consist of a main positive high voltage contactor, main negative high voltage contactor, charge positive high voltage contactor and a precharge negative high voltage contactor. The transistor controls the battery heater high voltage positive circuit. The contactors and transistor close and open in a specific sequence controlled by the hybrid/EV powertrain control module 2. The hybrid/EV powertrain control module 2 supplies voltage to the control circuit for the high voltage contactors/transistors.

Conditions for Running the DTC

P0C78

- Battery voltage sensor has not failed.
- Bus voltage sensor has not failed.

P3061

- Battery voltage sensor has not failed.
- Battery current sensor has not failed.
- Precharge is active.

Conditions for Setting the DTC

P0C78

The bus voltage has not reached 95% of battery voltage in 700 ms.

P3061

The bus current is greater than 3 amps for 88 ms during precharge.

Actions Taken When the DTC Sets

- DTC P0C78 and P3061 are type A DTCs.
- The hybrid/EV powertrain control module 2 opens the high voltage contactors.

Conditions for Clearing the DTC

DTC P0C78 and P3061 are type A DTCs.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS 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. Vehicle in Service Mode.
2. Verify that DTC P0AA1, P0AA4, P0AD9, P0ADD, P0AE4, P0AFA, P0D0A, P0D09, P1EBD, P1EC0 or P1EC3 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**

3. Verify DTC P0C78 or P3061 is not set.

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

Refer to Circuit/System Testing.

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

4. All OK.

1. Vehicle OFF, disable the high voltage at the K10 Coolant Heater, G1 A/C Compressor and the K1 14V Power Module. Refer to [High Voltage Disabling](#).

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.

2. Disconnect the X151, X152 and X153 inline high voltage harness connectors.

NOTE: These connectors should have been disconnected during the High Voltage Disabling procedure.

3. Test for greater than 1M Ω between the HV DC circuit terminal A and HV DC circuit terminal B at each connector, module side.

NOTE: The high voltage jumper connector directly at each module must be connected to the module.

- If less than 1 M Ω

Replace the applicable module and also the A28 Hybrid/EV Battery Contactor Assembly.

- If more than 1 M Ω

4. Disable the high voltage at the T18 Battery Charger. Refer to [High Voltage Disabling](#).

5. Disconnect the T18 Battery Charger HV DC connector X3.

NOTE: This connector should have been disconnected during the High Voltage Disabling procedure.

6. Test for greater than 1 M Ω between the HV DC circuit terminal A and HV DC circuit terminal B, module side.

- If less than 1 M Ω

Replace the T18 Battery Charger and also the A28 Hybrid/EV Battery Contactor Assembly.

- If more than 1 M Ω

7. Replace the T6 Power Inverter Module and also the A28 Hybrid/EV Battery Contactor Assembly.

Repair Instructions

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

- [High Voltage Battery Disconnect Relay Replacement](#) for A28 Hybrid/EV Battery Contactor Assembly.
- [Heater Coolant Heater Replacement \(LTG with HP9\)](#) for K10 Coolant Heater replacement.
- [Control Module References](#) for G1 A/C Compressor, K1 14V Power Module, T6 Power Inverter Module and T18 Battery Charger replacement, programming and setup.

DTC P1A07, P1E93, P1E99, P1E9F, P1EA5, P1FC3-P1FC8, P3035 OR P3040: HYBRID/EV BATTERY INTERFACE CONTROL MODULE REFERENCE CIRCUIT

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: [Diagnostic System Check - Vehicle](#)
- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC P1A07

Battery Energy Control Module 5 V Reference Circuit

DTC P1E93

Hybrid/EV Battery Interface Control Module 1 5 V Reference Circuit

DTC P1E99

Hybrid/EV Battery Interface Control Module 2 5 V Reference Circuit

DTC P1E9F

Hybrid/EV Battery Interface Control Module 3 5 V Reference Circuit

DTC P1EA5

Hybrid/EV Battery Interface Control Module 4 5 V Reference Circuit

DTC P1FC3

Hybrid/EV Battery Interface Control Module 5 5 V Reference Circuit

DTC P1FC4

Hybrid/EV Battery Interface Control Module 6 5 V Reference Circuit

DTC P1FC5

Hybrid/EV Battery Interface Control Module 7 5 V Reference Circuit

DTC P1FC6

Hybrid/EV Battery Interface Control Module 8 5 V Reference Circuit

DTC P1FC7

Hybrid/EV Battery Interface Control Module 9 5 V Reference Circuit

DTC P1FC8

Hybrid/EV Battery Interface Control Module 10 5 V Reference Circuit

DTC P3035

Hybrid/EV Battery Interface Control Module 11 5 V Reference Circuit

DTC P3040

Hybrid/EV Battery Interface Control Module 12 5 V Reference Circuit

Circuit/System Description

The hybrid battery contains 192 individual cells. Two cells are welded together in parallel and called a cell group. There are a total of 96 cell groups in the hybrid battery assembly.

The battery energy control module monitors the voltage of the 96 battery cell groups. The voltage sense lines are attached to each individual cell group and these sense lines terminate at a connector located on the top surface of the battery section. A voltage sense harness joins this connector to the battery energy control module.

The battery energy control module contains internal interface control modules that monitor specific cell groups.

The battery energy control module will determine when a fault condition is present. Diagnostics and system status are communicated from the battery energy control module to the hybrid powertrain control module 2 through serial data. The hybrid powertrain control module 2 is the host controller for diagnostic trouble code information.

Conditions for Running the DTC

P1A07

- The battery energy control module is awake and communicating.
- The 12 V battery voltage greater than or equal to 9 V.

P1E93, P1E99, P1E9F, P1EA5, P1FC3, P1FC4, P1FC5, P1FC6, P1FC7, P1FC8, P3035 and P3040

- The battery energy control module is awake and communicating.
- None of the following DTCs are set; U2603, U2604, U2605, U2606, U2617, U2618, U2619, U2620, U2621, U2622, U2623, U2624

Conditions for Setting the DTC

P1A07, P1E93, P1E99, P1E9F, P1EA5, P1FC3, P1FC4, P1FC5, P1FC6, P1FC7, P1FC8, P3035 and P3040

The battery energy control module has detected an internal 5V reference circuit voltage is less than 2.8 V or greater than 3.2 V.

Actions Taken When the DTC Sets

- DTCs P1A07 P1E93, P1E99, P1E9F, P1EA5, P1FC3, P1FC4, P1FC5, P1FC6, P1FC7, P1FC8, P3035 and P3040 are Type A DTCs.
- The vehicle will operate in a reduced power mode.

Conditions for Clearing the DTC

DTCs P1A07 P1E93, P1E99, P1E9F, P1EA5, P1FC3, P1FC4, P1FC5, P1FC6, P1FC7, P1FC8, P3035 and P3040 are Type A DTCs.

Reference Information

Description and Operation

Drive Motor Battery System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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 will perform the following tasks:

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

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

1. Verify that DTC P1A07, P1E93, P1E99, P1E9F, P1EA5, P1FC3, P1FC4, P1FC5, P1FC6, P1FC7, P1FC8, P3035 or P3040 is not set.
 - If DTC P1A07, P1E93, P1E99, P1E9F, P1EA5, P1FC3, P1FC4, P1FC5, P1FC6, P1FC7, P1FC8, P3035 or P3040 is set
 1. Disable the high voltage at the A4 Hybrid/EV Battery Pack. Refer to [High Voltage Disabling](#).
 2. Replace the K16 Battery Energy Control Module ensuring you reconnect the connectors in the sequence provided in Repair Instructions. Refer to [Battery Energy Control Module Replacement](#).
 - If none of the DTCs are set
2. All OK.

Repair Instructions

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

[Control Module References](#) for K16 battery energy control module programming and setup.

DTC P1E92, P1E98, P1E9E, P1EA4, P1FC9, P1FCA-P1FCE, P3036 OR P3041: HYBRID/EV BATTERY INTERFACE CONTROL MODULE CELL BALANCING CIRCUIT

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: [Diagnostic System Check - Vehicle](#)
- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC P1E92

Hybrid/EV Battery Interface Control Module 1 Cell Balancing Circuit

DTC P1E98

Hybrid/EV Battery Interface Control Module 2 Cell Balancing Circuit

DTC P1E9E

DTC P1EA4

Hybrid/EV Battery Interface Control Module 4 Cell Balancing Circuit

DTC P1FC9

Hybrid/EV Battery Interface Control Module 5 Cell Balancing Circuit

DTC P1FCA

Hybrid/EV Battery Interface Control Module 6 Cell Balancing Circuit

DTC P1FCB

Hybrid/EV Battery Interface Control Module 7 Cell Balancing Circuit

DTC P1FCC

Hybrid/EV Battery Interface Control Module 8 Cell Balancing Circuit

DTC P1FCD

Hybrid/EV Battery Interface Control Module 9 Cell Balancing Circuit

DTC P1FCE

Hybrid/EV Battery Interface Control Module 10 Cell Balancing Circuit

DTC P3036

Hybrid/EV Battery Interface Control Module 11 Cell Balancing Circuit

DTC P3041

Hybrid/EV Battery Interface Control Module 12 Cell Balancing Circuit

Circuit/System Description

To maintain a similar state of charge on the cell groups, the hybrid/EV powertrain control module 2 looks at the cell group voltages and determines which cell groups need energy removed in order to maintain the battery groups at a similar state of charge. This is known as cell balancing. There is a transistor switched resistor wired in parallel with the cell group internal to the hybrid/EV battery interface control module portion of the battery energy control module. The hybrid/EV powertrain control module 2 sends a command to the hybrid/EV battery energy control module to begin cell balancing.

Conditions for Running the DTC

- The hybrid/EV battery energy control module is awake and communicating.
- The high voltage fault circuit diagnostic is not running.
- The cell balancing circuit is greater than 3.0 V.
- None of the following DTCs are set, P1E8E, P1E94, P1E9A, P1EA0, P1FBD, P1FBE, P1FBF, P1FC0, P1FC1, P1FC2, P3037, P3042, U2603, U2604, U2605, U2606, U2617, U2618, U2619, U2620, U2621, U2622, U2623 or U2624.

Conditions for Setting the DTC

The battery energy control module has detected an internal cell balancing switch fault.

Actions Taken When the DTC Sets

- DTCs P1E92, P1E98, P1E9E, P1EA4, P1FC9, P1FCA, P1FCB, P1FCC, P1FCD, P1FCE, P3036 and P3041 are Type A DTCs.

- Cell balancing is disabled.
- The vehicle will operate in a reduced power mode.

Conditions for Clearing the DTC

DTCs P1E92, P1E98, P1E9E, P1EA4, P1FC9, P1FCA, P1FCB, P1FCC, P1FCD, P1FCE, P3036 and P3041 are Type A DTCs.

Reference Information

Description and Operation

Drive Motor Battery System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

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 will perform the following tasks:

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

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

1. Verify that no other DTCs are set.

- **If any other DTCs are set**

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

- **If no other DTCs are set**

2. Verify that DTC P1E92, P1E98, P1E9E, P1EA4, P1FC9, P1FCA, P1FCB, P1FCC, P1FCD, P1FCE, P3036 or P3041 is set.

- **DTC P1E92, P1E98, P1E9E, P1EA4, P1FC9, P1FCA, P1FCB, P1FCC, P1FCD, P1FCE, P3036 or P3041 is set**

1. Disable the high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Replace the K16 Battery Energy Control Module ensuring you reconnect the connectors in the sequence provided in Repair Instructions. Refer to Battery Energy Control Module Replacement.

- **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 K16 battery energy control module replacement, programming and setup.

DTC P1EAB OR P1EAC: HYBRID/EV BATTERY CELL

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

DTC P1EAC

Hybrid/EV Battery Cell Overvoltage Signal Circuit Performance

Circuit/System Description

The 2nd protection circuit is a redundant method to monitor cell group overvoltage. The 2nd protection circuit is the actual hardwire signal from the hybrid/EV battery energy control module to the hybrid/EV powertrain control module 2. The hybrid/EV powertrain control module 2 monitors this line to determine when a cell group overvoltage condition exists, independently of the cell group diagnostic trouble codes transmitted via serial data from the battery energy control module to the hybrid powertrain control module 2.

The 2nd protection self test diagnostic is used to check the signal circuit. The hybrid/EV battery energy control module performs this test, once, every power up cycle. When run/crank input signal transitions high and after a calibrated delay, the hybrid/EV battery energy control module informs the hybrid/EV powertrain control module 2, via serial data communication bus that it is about to run the diagnostics on the 2nd protection circuit. The hybrid/EV battery energy control module then proceeds to command, via internal serial data, each of its internal hybrid/EV battery interface control modules to run the check on its hardwire output. Each of the four hybrid/EV battery interface control modules pulls the signal circuit low and releases it, in sequence. If any pulses are missing, the hybrid/EV battery energy control module sets a related fault and sends this information to the hybrid/EV powertrain control module 2 on the serial data. Additionally, the hybrid powertrain control module 2 monitors the 2nd protection circuit for opens, shorts to ground and shorts to voltage.

Conditions for Running the DTC

P1EAB

- The hybrid/EV battery energy control module and hybrid/EV powertrain control module 2 are awake and communicating.
- DTC 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, P1B46, P1B49, P1B4C, P1B4F, P1B52, P1B55, P1B58, P1B5B, P1B5E, P1B61, P1B64, P1B67, P1B6A, P1B6D, P1B70, P1B73, P1B76, P1B79, P1B7C, P1B7F, P1B82, P1B85, P1B88, P1B8B, P1B8E, P1B91, P1B94, P1B97, P1B9A, P1B9D, P1BA0, P1BA3, P1BA6, P1BA9, P1BAC, P1BAF, P1BB2, P1BB5, P1BB8, P1BBB, P1BBE, P1BC1, P1BC4, P1BC7, P1BCA, P1BCD, P1BD0, P1BD3, P1BD6, P1BD9, P1BDC, P1BDF, P1BE2, P1BE5, P1BE8, P1BEB, P1BEE, P1BF1, P1BF4, P1BF7, P1BFA, P1BFD, P1E02, P1E05, 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, P1B47, P1B4A, P1B4D, P1B50, P1B53, P1B56, P1B59, P1B5C, P1B5F, P1B62, P1B65, P1B68, P1B6B, P1B6E, P1B71, P1B74, P1B77, P1B7A, P1B7D, P1B80, P1B83, P1B86, P1B89, P1B8C, P1B8F, P1B92, P1B95, P1B98, P1B9B, P1B9E, P1BA1, P1BA4, P1BA7, P1BAA, P1BAD, P1BB0, P1BB3, P1BB6, P1BB9, P1BBC, P1BBF, P1BC2, P1BC5, P1BC8, P1BCB, P1BCE, P1BD1, P1BD4, P1BD7, P1BDA, P1BDD, P1BE0, P1BE3, P1BE6, P1BE9, P1BEC, P1BEF, P1BF2, P1BF5, P1BF8, P1BFB, P1BFE, P1E03, P1E06, P0B3B, P0B40, P0B45, P0B4A, P0B4F, P0B54, P0B59, P0B5E, P0B63, P0B68, P0B6D, P0B77, P0B7C, P0B81, P0B86, P0B8B, P0B95, P0B9A, P0B9F, P0BA4, P0BA9, P0BAE,

P0BB3, P0BB8, P1B28, P1B29, P1B2A, P1B2B, P1B2C, P1B2D, P1E4C, P1E4D, P1E4E, P1E4F, P1E50, P1E51, P1E52, P1E53, P1E54, P1E56, P1E57, P1E58, P1E59, P1E5A, P1E5B, P1E5C, P1E5D, P1E5E, P1E5F, P1E60, P1E61, P1E62, P1E63, P1E64, P1E65, P1E66, P1E67, P1E68, P1E69, P1E6A, P1E6B, P1E6C, P1E6E, P1E6F, P1E70, P1E71, P1E72, P1E73, P1E74, P1E75, P1E76, P1E77, P1E78, P1E79, P1E7A, P1E7B, P1E7C, P1E7D, P1E7E, P1E7F, P1E80, P1E81, P1E82, P1E83, P1E84, P1E86, P1E87, P1E88, P1E89, P1E8A, U2603, U2604, U2605, U2606, U2617, U2618, U2619, U2620, U2621, U2622, U2623, U2624, P1EB1, P1EB2, P1EB3, P1EB4, P1EB5, P1FA6, P1FA7, P1FA8, P1FA9, P1FAA, P1FAB, P3030, P303B, U0111 or U185A is not set

- The 12 V battery voltage is greater than or equal to 10.2 V.
- Vehicle must be cycled from Vehicle OFF to Vehicle ON.
- Vehicle is ON for greater than 5 seconds.
- Hybrid powertrain control module 1 detects high voltage bus is greater than 312 V.
- Battery charging is not active.

P1EAC

- The hybrid/EV battery energy control module and hybrid/EV powertrain control module 2 are awake and communicating.
- DTC U0111 or U185A is not set.
- The 12 V battery voltage greater than or equal to 10.2 V.
- Vehicle must be cycled from Vehicle OFF to Vehicle ON.
- Vehicle is ON for greater than 5 seconds.

Conditions for Setting the DTC

P1EAB

A cell group voltage of greater than 4.5 V is detected.

OR

The hybrid powertrain control module 2 has detected a fault with the 2nd protection circuit.

P1EAC

The hybrid/EV powertrain control module 2 has detected a fault with the 2nd protection circuit.

Action Taken When the DTC Sets

- DTCs P1EAB and P1EAC are type A DTCs.
- If any of these DTCs are set, the vehicle will operate in a reduced power mode.

P1EAB

Once the vehicle has been turned OFF, the hybrid/EV powertrain control module 2 will lock out the high voltage contactors until the **Clear Secured High Voltage DTCs** procedure has been performed.

Conditions for Clearing the DTC

- DTCs P1EAB and P1EAC are type A DTCs.
- Vehicle Power cycled from ON to OFF after code clear.

P1EAB

After the repair for DTC P1EAB, with a scan tool, perform the **Clear Secured High Voltage DTCs** repair instruction.

Diagnostic Aids

CAUTION: The battery energy control modules internal cell balancing circuitry is powered by the cell group voltage sense circuits. In order to prevent an unrecoverable,

unbalanced Hybrid/EV battery section or internal control module damage, always take the following actions:

1. Disconnect ALL of the battery energy control module connectors prior to disconnecting any Hybrid/EV battery section connector.
2. Reconnect all the Hybrid/EV battery section connectors prior to reconnecting the battery energy control module connectors.
3. Disconnect and reconnect the battery energy control module connectors ONLY in the sequence provided in Repair Instructions.

The Hybrid/EV Battery Section schematics in Energy Storage identify the battery section and voltage sense circuit terminal locations appropriate to each cell group and corresponding DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

- [COMPONENT CONNECTOR END VIEWS - INDEX](#)
- [INLINE HARNESS 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-50211** Low Voltage Jumper Harness Extension

Equivalent regional tools: [Special Tools](#).

Circuit/System Verification

1. Vehicle in Service Mode.
2. Verify that DTC P0B3B, P0B3D, P0B3E, P0B40, P0B42, P0B43, P0B45, P0B47, P0B48, P0B4A, P0B4C, P0B4D, P0B4F, P0B51, P0B54, P0B52, P0B56, P0B57, P0B59, P0B5B, P0B5C, P0B5E, P0B60, P0B61, P0B63, P0B65, P0B66, P0B68, P0B6A, P0B6B, P0B6D, P0B6F, P0B70, P0B72, P0B74, P0B75, P0B77, P0B79, P0B7A, P0B7C, P0B7E, P0B7F, P0B81, P0B83, P0B84, P0B86, P0B88, P0B89, P0B8B, P0B8D, P0B8E, P0B90, P0B92, P0B93, P0B95, P0B97, P0B98, P0B9A, P0B9C, P0B9D, P0B9F, P0BA1, P0BA2, P0BA4, P0BA6, P0BA7, P0BA9, P0BAB, P0BAC, P0BAE, P0BB0, P0BB1, P0BB3, P0BB5, P0BB6, P0BB8, P0BBA, P0BBB, P1B17, P1B18, P1B1A, P1B1B, P1B1D, P1B1E, P1B20, P1B21, P1B23, P1B24, P1B26, P1B27, P1B28, P1B29, P1B2A, P1B2B, P1B2C, P1B2D, P1B46, P1B47, P1B4A, P1B4C, P1B4D,

P1B4F, P1B50, P1B52, P1B53, P1B55, P1B56, P1B58, P1B59, P1B5B, P1B5C, P1B5E, P1B5F, P1B61, P1B64, P1B62, P1B65, P1B67, P1B68, P1B6A, P1B6B, P1B6D, P1B6E, P1B70, P1B71, P1B73, P1B74, P1B76, P1B77, P1B79, P1B7A, P1B7C, P1B7D, P1B7F, P1B80, P1B82, P1B83, P1B85, P1B86, P1B88, P1B89, P1B8B, P1B8C, P1B8E, P1B8F, P1B91, P1B92, P1B94, P1B95, P1B97, P1B98, P1B9A, P1B9B, P1B9D, P1B9E, P1BA0, P1BA1, P1BA3, P1BA4, P1BA6, P1BA7, P1BA9, P1BAA, P1BAC, P1BAD, P1BAF, P1BB0, P1BB2, P1BB3, P1BB5, P1BB6, P1BB8, P1BB9, P1BBB, P1BBC, P1BBE, P1BBF, P1BC1, P1BC2, P1BC4, P1BC5, P1BC7, P1BC8, P1BCA, P1BCB, P1BCD, P1BCE, P1BD0, P1BD1, P1BD3, P1BD4, P1BD6, P1BD7, P1BD9, P1BDA, P1BDC, P1BDD, P1BDF, P1BE0, P1BE2, P1BE3, P1BE5, P1BE6, P1BE8, P1BE9, P1BEB, P1BEC, P1BEE, P1BEF, P1BF1, P1BF2, P1BF4, P1BF5, P1BF7, P1BF8, P1BFA, P1BFB, P1BFD, P1BFE, P1E02, P1E03, P1E05, P1E06, P1E4C, P1E4D, P1E4E, P1E4F, P1E50, P1E51, P1E52, P1E53, P1E54, P1E55, P1E56, P1E57, P1E58, P1E59, P1E5A, P1E5B, P1E5C, P1E5D, P1E5E, P1E5F, P1E60, P1E61, P1E62, P1E63, P1E64, P1E65, P1E66, P1E67, P1E68, P1E69, P1E6A, P1E6B, P1E6C, P1E6D, P1E6E, P1E6F, P1E70, P1E71, P1E72, P1E73, P1E74, P1E75, P1E76, P1E77, P1E78, P1E79, P1E7A, P1E7B, P1E7C, P1E7D, P1E7E, P1E7F, P1E80, P1E81, P1E82, P1E83, P1E84, P1E85, P1E86, P1E87, P1E88, P1E89, P1E8A, U2603, U2604, U2605 or U2606 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

3. Verify that DTC P1EAB or P1EAC is not set.

- If DTC P1EAB or P1EAC is set

Refer to Circuit/System Testing

- If DTC P1EAB or P1EAC is not set

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.

1. Vehicle in Service Mode.

2. Verify the hybrid/EV powertrain control module 2 scan tool Maximum Hybrid/EV Battery Module Voltage parameter is 4.5 V or less.

- If greater than 4.5 V

Replace the A4 Hybrid/EV Battery Pack.

- **If 4.5 V or less**

3. Vehicle OFF, disable the high voltage at the A4 Hybrid/EV Battery Pack. Refer to [High Voltage Disabling](#).
4. Connect the 12 V battery. Disconnect the X358 harness connector at the A4 Hybrid/EV Battery Pack. Vehicle in Service Mode.

NOTE: Connecting the 12 V battery with the manual service disconnect removed will set DTCs.

5. Test for 4.8-5.2 V between the signal circuit terminal 6 and ground.

- **If less than 4.8 V**

1. Vehicle OFF, disconnect the X2 harness connector at the K114B Hybrid Powertrain Control Module 2.
2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K114B Hybrid Powertrain Control Module 2. After the repair, with a scan tool, perform the [Clear Secured High Voltage DTCs](#) repair instruction.

- **If 5.2 V or greater**

1. Vehicle OFF, disconnect the X2 harness connector at the K114B Hybrid Powertrain Control Module 2. Vehicle in Service Mode.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K114B Hybrid Powertrain Control Module 2. After the repair, with a scan tool, perform the [Clear Secured High Voltage DTCs](#) repair instruction.

- **If between 4.8-5.2 V**

6. Vehicle OFF, remove the A4 Hybrid/EV Battery Pack Cover. Refer to [High Voltage Battery Cover Replacement \(Top Cover\)](#), [High Voltage Battery Cover Replacement \(Front Cover\)](#), [High Voltage Battery Cover Replacement \(Left Side\)](#) and/or [High Voltage Battery Cover Replacement \(Right Side\)](#).
7. Connect **EL-50211** Low Voltage Jumper Harness Extension. Disconnect the X8 harness connector at the K16 Battery Energy Control Module. Vehicle in Service Mode.
8. Test for 4.8-5.2 V between the signal circuit terminal 8 and ground.

- **If not within the specified range**

Replace the A4 Hybrid/EV Battery Pack. After the repair, with a scan tool, perform the [Clear Secured High Voltage DTCs](#) repair instruction.

- **If within the specified range**

9. Replace the K16 Battery Energy Control Module ensuring you reconnect the connectors in the sequence provided in Repair Instructions. Refer to [Battery Energy Control Module Replacement](#).

Repair Instructions

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

- [High Voltage Battery Replacement and Shipping Preparation](#) for A4 Hybrid/EV Battery Pack replacement.
- [Control Module References](#) for K16 battery energy control module or K114B hybrid/EV powertrain control module 2 replacement, programming and setup.

DTC P1EAD-P1EB0 OR P3240-P3253: HYBRID/EV BATTERY INTERFACE CONTROL MODULE CELL OVERVOLTAGE

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: [Diagnostic System Check - Vehicle](#)
- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC P1EAD

Hybrid/EV Battery Interface Control Module 1 Cell Overvoltage Signal Circuit

DTC P1EAE

Hybrid/EV Battery Interface Control Module 2 Cell Overvoltage Signal Circuit

DTC P1EAF

Hybrid/EV Battery Interface Control Module 3 Cell Overvoltage Signal Circuit

DTC P1EB0

Hybrid/EV Battery Interface Control Module 4 Cell Overvoltage Signal Circuit

DTC P3240

Hybrid/EV Battery Interface Control Module 1 Cell Overvoltage

DTC P3241

Hybrid/EV Battery Interface Control Module 2 Cell Overvoltage

DTC P3242

Hybrid/EV Battery Interface Control Module 3 Cell Overvoltage

DTC P3243

Hybrid/EV Battery Interface Control Module 4 Cell Overvoltage

DTC P3244

Hybrid/EV Battery Interface Control Module 5 Cell Overvoltage

DTC P3245

Hybrid/EV Battery Interface Control Module 5 Cell Overvoltage Signal Circuit

DTC P3246

Hybrid/EV Battery Interface Control Module 6 Cell Overvoltage

DTC P3247

Hybrid/EV Battery Interface Control Module 6 Cell Overvoltage Signal Circuit

DTC P3248

Hybrid/EV Battery Interface Control Module 7 Cell Overvoltage

DTC P3249

Hybrid/EV Battery Interface Control Module 7 Cell Overvoltage Signal Circuit

DTC P324A

DTC P324B

Hybrid/EV Battery Interface Control Module 8 Cell Overvoltage Signal Circuit

DTC P324C

Hybrid/EV Battery Interface Control Module 9 Cell Overvoltage

DTC P324D

Hybrid/EV Battery Interface Control Module 9 Cell Overvoltage Signal Circuit

DTC P324E

Hybrid/EV Battery Interface Control Module 10 Cell Overvoltage

DTC P324F

Hybrid/EV Battery Interface Control Module 10 Cell Overvoltage Signal Circuit

DTC P3250

Hybrid/EV Battery Interface Control Module 11 Cell Overvoltage

DTC P3251

Hybrid/EV Battery Interface Control Module 11 Cell Overvoltage Signal Circuit

DTC P3252

Hybrid/EV Battery Interface Control Module 12 Cell Overvoltage

DTC P3253

Hybrid/EV Battery Interface Control Module 12 Cell Overvoltage Signal Circuit

Circuit/System Description

The hybrid battery contains 192 individual cells. Two cells are welded together in parallel and called a cell group. There are a total of 96 cell groups in the hybrid battery assembly.

The battery energy control module monitors the voltage of the 96 battery cell groups. The voltage sense lines are attached to each individual cell group and these sense lines terminate at a connector located on the top surface of the battery section. A voltage sense harness joins this connector to the battery energy control module.

The battery energy control module contains internal interface control modules that monitor specific cell groups.

The battery energy control module will determine when a fault condition is present. Diagnostics and system status are communicated from the battery energy control module to the hybrid powertrain control module 2 through serial data. The hybrid powertrain control module 2 is the host controller for diagnostic trouble code information.

Conditions for Running the DTC

P1EAD, P1EAE, P1EAF, P1EB0, P3240, P3241, P3242, P3243, P3244, P3245, P3246, P3247, P3248, P3249, P324A, P324B, P324C, P324D, P324E, P324F, P3250, P3251, P3252 and P3253

- The battery energy control module is awake and communicating.
- The 12 V battery voltage greater than or equal to 10.2 V.
- The high voltage bus as measured by the hybrid powertrain control module 1 is greater than 312V.
- None of the following DTCs are set; 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, P1E4C, P1E4D, P1E4E, P1E4F, P1E50, P1E51, P1E52, P1E53, P1E54, P1E55, P1E56, P1E57, P1E58, P1E59,

P1E5A, P1E5B, P1E5C, P1E5D, P1E5E, P1E5F, P1E60, P1E61, P1E62, P1E63, P1E64, P1E65, P1E66, P1E67, P1E68, P1E69, P1E6A, P1E6B, P1E6C, P1E6D, P1E6E, P1E6F, P1E70, P1E71, P1E72, P1E73, P1E74, P1E75, P1E76, P1E77, P1E78, P1E79, P1E7A, P1E7B, P1E7C, P1E7D, P1E7E, P1E7F, P1E80, P1E81, P1E82, P1E83, P1E84, P1E85, P1E86, P1E87, P1E88, P1E89, P1E8A, P1E8B, U2603, U2604, U2605, U2606, U2617, U2618, U2619, U2620, U2621, U2622, U2623 or U2624.

Conditions for Setting the DTC

P1EAD, P1EAE, P1EAF, P1EB0, P3245, P3247, P3249, P324B, P324D, P324F, P3251 and P3253

The battery energy control module has not detected a response from the internal interface control module overvoltage signal circuit test that occurs within 50 seconds of key-ON.

P3240, P3241, P3242, P3243, P3244, P3246, P3248, P324A, P324C, P324E, P3250 and P3252

The battery energy control module has detected a cell group voltage of greater than 4.5V.

OR

The battery energy control module detects a failure of the internal interface control module overvoltage signal circuit.

Actions Taken When the DTC Sets

DTCs P1EAD, P1EAE, P1EAF, P1EB0, P3240, P3241, P3242, P3243, P3244, P3245, P3246, P3247, P3248, P3249, P324A, P324B, P324C, P324D, P324E, P324F, P3250, P3251, P3252 and P3253 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P1EAD, P1EAE, P1EAF, P1EB0, P3240, P3241, P3242, P3243, P3244, P3245, P3246, P3247, P3248, P3249, P324A, P324B, P324C, P324D, P324E, P324F, P3250, P3251, P3252 and P3253 are Type A DTCs.

DTCs P3240, P3241, P3242, P3243, P3244, P3246, P3248, P324A, P324C, P324E, P3250 and P3252

The **Clear Secured High Voltage DTCs** reset function must be performed with a scan tool before clear codes.

Reference Information

Description and Operation

Drive Motor Battery System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

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 will perform the following tasks:

- Identify how to disable high voltage.

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

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

1. Verify that DTC P1EAD, P1EAE, P1EAF, P1EB0, P3245, P3247, P3249, P324B, P324D, P324F, P3251 or P3253 is not set.
 - **If DTC P1EAD, P1EAE, P1EAF, P1EB0, P3245, P3247, P3249, P324B, P324D, P324F, P3251 or P3253 is set**
 1. Disable the high voltage at the A4 Hybrid/EV Battery Pack. Refer to [High Voltage Disabling](#).
 2. Replace the K16 Battery Energy Control Module ensuring you reconnect the connectors in the sequence provided in Repair Instructions. Refer to [Battery Energy Control Module Replacement](#).
 - **If none of the DTCs are set**
2. Perform the [Clear Secured High Voltage DTCs](#) repair instruction.
3. Verify that DTC P3240, P3241, P3242, P3243, P3244, P3246, P3248, P324A, P324C, P324E, P3250 or P3252 is not set.
 - **If DTC P3240, P3241, P3242, P3243, P3244, P3246, P3248, P324A, P324C, P324E, P3250 or P3252 is set**
 1. Disable the high voltage at the A4 Hybrid/EV Battery Pack. Refer to [High Voltage Disabling](#).
 2. Replace the A4 Hybrid/EV Battery Pack.
 - **If none of the DTCs are set**
4. All OK.

Repair Instructions

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

- [High Voltage Battery Replacement and Shipping Preparation](#) for A4 hybrid/EV battery pack.
- [Control Module References](#) for K16 battery energy control module programming and setup.

DTC P1FD5-P1FF2, P3038-P303A OR P3043-P3045: HYBRID/EV BATTERY INTERFACE CONTROL MODULE VOLTAGE SENSOR

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: [Diagnostic System Check - Vehicle](#)
- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC P1FD5

Hybrid/EV Battery Interface Control Module 1 Voltage Sensor Circuit Low Voltage

DTC P1FD6

Hybrid/EV Battery Interface Control Module 2 Voltage Sensor Circuit Low Voltage

DTC P1FD7

Hybrid/EV Battery Interface Control Module 3 Voltage Sensor Circuit Low Voltage

DTC P1FD8

Hybrid/EV Battery Interface Control Module 4 Voltage Sensor Circuit Low Voltage

DTC P1FD9

Hybrid/EV Battery Interface Control Module 5 Voltage Sensor Circuit Low Voltage

DTC P1FDA

Hybrid/EV Battery Interface Control Module 6 Voltage Sensor Circuit Low Voltage

DTC P1FDB

Hybrid/EV Battery Interface Control Module 7 Voltage Sensor Circuit Low Voltage

DTC P1FDC

Hybrid/EV Battery Interface Control Module 8 Voltage Sensor Circuit Low Voltage

DTC P1FDD

Hybrid/EV Battery Interface Control Module 9 Voltage Sensor Circuit Low Voltage

DTC P1FDE

Hybrid/EV Battery Interface Control Module 10 Voltage Sensor Circuit Low Voltage

DTC P1FDF

Hybrid/EV Battery Interface Control Module 1 Voltage Sensor Circuit High Voltage

DTC P1FE0

Hybrid/EV Battery Interface Control Module 2 Voltage Sensor Circuit High Voltage

DTC P1FE1

Hybrid/EV Battery Interface Control Module 3 Voltage Sensor Circuit High Voltage

DTC P1FE2

Hybrid/EV Battery Interface Control Module 4 Voltage Sensor Circuit High Voltage

DTC P1FE3

Hybrid/EV Battery Interface Control Module 5 Voltage Sensor Circuit High Voltage

DTC P1FE4

Hybrid/EV Battery Interface Control Module 6 Voltage Sensor Circuit High Voltage

DTC P1FE5

Hybrid/EV Battery Interface Control Module 7 Voltage Sensor Circuit High Voltage

DTC P1FE6

Hybrid/EV Battery Interface Control Module 8 Voltage Sensor Circuit High Voltage

DTC P1FE7

Hybrid/EV Battery Interface Control Module 9 Voltage Sensor Circuit High Voltage

DTC P1FE8

Hybrid/EV Battery Interface Control Module 10 Voltage Sensor Circuit High Voltage

DTC P1FE9

Hybrid/EV Battery Interface Control Module 1 Voltage Sensor Performance

DTC P1FEA

Hybrid/EV Battery Interface Control Module 2 Voltage Sensor Performance

DTC P1FEB

Hybrid/EV Battery Interface Control Module 3 Voltage Sensor Performance

DTC P1FEC

Hybrid/EV Battery Interface Control Module 4 Voltage Sensor Performance

DTC P1FED

Hybrid/EV Battery Interface Control Module 5 Voltage Sensor Performance

DTC P1FEE

Hybrid/EV Battery Interface Control Module 6 Voltage Sensor Performance

DTC P1FEF

Hybrid/EV Battery Interface Control Module 7 Voltage Sensor Performance

DTC P1FF0

Hybrid/EV Battery Interface Control Module 8 Voltage Sensor Performance

DTC P1FF1

Hybrid/EV Battery Interface Control Module 9 Voltage Sensor Performance

DTC P1FF2

Hybrid/EV Battery Interface Control Module 10 Voltage Sensor Performance

DTC P3038

Hybrid/EV Battery Interface Control Module 11 Voltage Sensor Circuit Low Voltage

DTC P3039

Hybrid/EV Battery Interface Control Module 11 Voltage Sensor Circuit High Voltage

DTC P303A

Hybrid/EV Battery Interface Control Module 11 Voltage Sensor Circuit Performance

DTC P3043

Hybrid/EV Battery Interface Control Module 12 Voltage Sensor Circuit Low Voltage

DTC P3044

Hybrid/EV Battery Interface Control Module 12 Voltage Sensor Circuit High Voltage

DTC P3045

Hybrid/EV Battery Interface Control Module 12 Voltage Sensor Circuit Performance

Circuit/System Description

The hybrid battery contains 192 individual cells. Two cells are welded together in parallel and called a cell group. There are a total of 96 cell groups in the hybrid battery assembly.

The battery energy control module monitors the voltage of the 96 battery cell groups. The voltage sense lines are attached to each individual cell group and these sense lines terminate at a connector located on the top surface of the battery section. A voltage sense harness joins this connector to the battery energy control module.

The battery energy control module contains internal interface control modules that monitor specific cell groups.

The battery energy control module will determine when a fault condition is present. Diagnostics and system status are communicated from the battery energy control module to the hybrid powertrain control module 2 through serial data. The hybrid powertrain control module 2 is the host controller for diagnostic trouble code information.

Conditions for Running the DTC

P1FD5, P1FD6, P1FD7, P1FD8, P1FD9, P1FDA, P1FDB, P1FDC, P1FDD, P1FDE, P1FDE, P1FE0, P1FE1, P1FE2, P1FE3, P1FE4, P1FE5, P1FE6, P1FE7, P1FE8, P3038, P3039, P3043 and P3044

- The hybrid/EV battery energy control module and hybrid/EV powertrain control module 2 are awake and communicating.
- None of the hybrid/EV battery energy control module loss of communication with hybrid/EV battery interface control module 1-12 DTCs are set.
- None of the hybrid/EV battery interface control module 1-12 performance DTCs are set.

P1FE9, P1FEA, P1FEB, P1FEC, P1FED, P1FEE, P1FEF, P1FF0, P1FF1, P1FF2, P303A and P3045

- The hybrid/EV battery energy control module and hybrid/EV powertrain control module 2 are awake and communicating.
- None of the hybrid/EV battery energy control module loss of communication with hybrid/EV battery interface control module 1-12 DTCs are set.
- None of the hybrid/EV battery interface control module 1-12 performance DTCs are set.
- None of the hybrid/EV battery 1-96 circuit low voltage DTCs are set.
- None of the hybrid/EV battery 1-96 circuit high voltage DTCs are set.
- None of the hybrid/EV battery 1-96 circuit DTCs are set.

Conditions for Setting the DTC

P1FD5, P1FD6, P1FD7, P1FD8, P1FD9, P1FDA, P1FDB, P1FDC, P1FDD, P1FDE, P3038 and P3043

A hybrid/EV battery interface control module has detected the voltage sum of 8 cell groups in a section are less than 1.5 V.

P1FDE, P1FE0, P1FE1, P1FE2, P1FE3, P1FE4, P1FE5, P1FE6, P1FE7, P1FE8, P3039 and P3044

A hybrid/EV battery interface control module has detected the voltage sum of 8 cell groups in a section are greater than 48.5 V.

P1FE9, P1FEA, P1FEB, P1FEC, P1FED, P1FEE, P1FEF, P1FF0, P1FF1, P1FF2, P303A and P3045

A hybrid/EV battery interface control module has detected a deviation between the module voltage sum of a half section minus the voltage sum of 8 individual cell groups in a section is greater than 0.6 V

Actions Taken When the DTC Sets

- DTCs P1FD5, P1FD6, P1FD7, P1FD8, P1FD9, P1FDA, P1FDB, P1FDC, P1FDD, P1FDE, P1FDE, P1FE0, P1FE1, P1FE2, P1FE3, P1FE4, P1FE5, P1FE6, P1FE7, P1FE8, P1FE9, P1FEA, P1FEB, P1FEC, P1FED, P1FEE, P1FEF, P1FF0, P1FF1, P1FF2, P3038, P3039, P303A, P3043, P3044 and P3045 are Type A DTCs.
- The vehicle will operate in a reduced power mode.
- Once the vehicle has been turned OFF, the hybrid/EV powertrain control module 2 will not CLOSE the high voltage contactors until the DTC has been cleared.

Conditions for Clearing the DTC

DTCs P1FD5, P1FD6, P1FD7, P1FD8, P1FD9, P1FDA, P1FDB, P1FDC, P1FDD, P1FDE, P1FDE, P1FE0, P1FE1, P1FE2, P1FE3, P1FE4, P1FE5, P1FE6, P1FE7, P1FE8, P1FE9, P1FEA, P1FEB, P1FEC, P1FED, P1FEE,

P1FEF, P1FF0, P1FF1, P1FF2, P3038, P3039, P303A, P3043, P3044 and P3045 are Type A DTCs.

Reference Information

Description and Operation

Drive Motor Battery System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

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 will perform the following tasks:

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

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

1. Verify that DTC P1FD5-P1FF2, P3038, P3039, P303A or P3043-P3045 is not set.
 - **If DTC P1FD5-P1FF2, P3038, P3039, P303A or P3043-P3045 is set**
 1. Vehicle OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to [High Voltage Disabling](#).
 2. Replace the K16 Battery Energy Control Module ensuring you reconnect the connectors in the sequence provided in Repair Instructions. Refer to [Battery Energy Control Module Replacement](#).
 - **If none of the DTCs are set**
2. All OK.

Repair Instructions

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

[Control Module References](#) for K16 battery energy control module replacement, programming and setup.

DTC P1F17: SYSTEM ISOLATION/IMPACT SENSOR FAULT - HYBRID/EV BATTERY SYSTEM CONTACTORS

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 P1F17

System Isolation / Impact Sensor Fault - Hybrid/EV Battery System Contactors Open

Circuit/System Description

The hybrid/EV powertrain control module 2 will set DTC P1F17 if the hybrid/EV powertrain control module 1 has detected a passive loss of isolation in combination with the supplemental inflatable restraint sensors are not working or has lost communications with the hybrid/EV powertrain control module 1 and the supplemental inflatable restraint module.

Conditions for Running the DTC

Vehicle ON.

Conditions for Setting the DTC

- DTC P1AF0, P1AF2 or P1E22 is set in the hybrid/EV powertrain control module 1.
AND
- DTCs B0083-B0088 are set in the supplemental inflatable restraint module.
OR
- DTC P1AF0, P1AF2 or P1E22 is set in the hybrid/EV powertrain control module 1.
AND
- DTC U184E is set.
OR
- The hybrid/EV powertrain control module 2 has lost communications with the hybrid/EV powertrain control module 1 and the supplemental inflatable restraint module.
AND
- DTC U184E is set.
OR
- The hybrid/EV powertrain control module 2 has lost communications with the hybrid/EV powertrain control module 1.
AND
- DTCs B0083-B0088 are set in the supplemental inflatable restraint module.

Action Taken When the DTC Sets

- DTC P1F17 is a type A DTC.
- The hybrid/EV powertrain control module 2 opens the high voltage contactors.

Conditions for Clearing the DTC

- DTC P1F17 is a type A DTC.
- The **Clear Secured High Voltage DTCs** reset function must be performed with a scan tool before clear codes.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Drive Motor Battery System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Vehicle in Service Mode.
2. Verify that no other DTCs are set.
 - **If any other DTCs are set**
Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**
 - **If none of the DTCs are set**
3. Verify that DTC P1F17 is not set.
 - **If DTC P1F17 is set**
 1. Verify the K36 Inflatable Restraint Sensing And Diagnostic Module is programmed with the correct software calibration.
 - If the correct software is not installed, program the K36 Inflatable Restraint Sensing And Diagnostic Module.
 - If the correct software is installed
 2. Perform the **Clear Secured High Voltage DTCs** repair instruction.
 3. Verify that DTC P1F17 does not set while operating the vehicle within the Conditions for Running the DTC.
 - If DTC P1F17 is set, replace the K114B Hybrid Powertrain Control Module 2.
 - If DTC P1F17 is not set
 4. All OK.
 - **If DTC P1F17 is not set**
4. All OK.

Repair Instructions

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

Control Module References for hybrid/EV powertrain control module 2 and inflatable restraint sensing and diagnostic module replacement, programming and setup.

LOSS OF ISOLATION ON THE HIGH VOLTAGE MAIN BUS

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**
- An overview of each diagnostic category can be found here: **Diagnostic Procedure Instructions**

Circuit/System Description

Vehicles equipped with high voltage energy storage are designed with the high voltage circuits isolated from the vehicle chassis. If either the positive or negative high voltage Direct Current (DC) circuits or any of the high voltage Alternating Current (AC) phase circuits lose this isolation to the vehicle chassis, one or more diagnostic trouble codes (DTCs) may set.

The vehicle utilizes Passive and Active isolation testing to determine the amount of isolation between the high voltage and the chassis.

Passive isolation testing is performed within the power inverter module and tests whenever the high voltage main contactors are closed. Utilizing a high impedance resistor network, passive isolation detection monitors all high voltage components including the hybrid/EV battery pack and isolation loss results in DTCs P1AF0, P1AF2 and/or P1E22. Real-time status of passive isolation detection can be determined by observing the delta between the Positive Supply Isolation Voltage and Negative Supply Isolation Voltage scan tool parameters. The parameters are displayed by any of the Motor Control Modules.

Active isolation testing is performed by the hybrid powertrain control module 2 and tests after the high voltage main contactors open. Utilizing a switched resistance, active isolation detection monitors the internal Hybrid/EV battery pack as well as the charging system direct current (DC) high voltage circuits and isolation loss results in DTC P0AA6. Status for the prior active isolation detection event can be determined by observing the hybrid powertrain control module 2 Isolation Test Resistance scan tool parameter. Real-time status observation requires the HPCM2 scan tool control function Hybrid/EV Battery Pack Isolation Test.

Diagnosis for isolation requires testing with high voltage potential. Special insulation testing multimeters such as the **EL-50772** utilize their own internal high voltage and must be used to test the isolation capability of high voltage components and circuits. Refer to [Troubleshooting With an Insulation Multimeter](#).

Diagnostic Aids

Prior to disabling high voltage:

Monitoring certain scan tool parameters when high voltage is active may help to identify which high voltage components and circuits have lost their chassis isolation. The Vehicle Information selection within the HPCM2 scan tool Data Display contains many parameters related to isolation diagnosis. The Drive Motor 1 Control Module Positive Supply Isolation Voltage and Drive Motor 1 Control Module Negative Supply Isolation Voltage parameters provide a real-time indication of isolation status. The parameters will shift in respect to one another relative to the level of isolation loss. The greater the delta or difference, between parameters, the less isolation exists between high voltage and the vehicle chassis.

Isolation Loss between HV Components and Chassis, Positive Side*

Isolation between HV Bus and Chassis	Normal Vehicle	10M	5M	1M	500K	200K Approximate Passive Isolation DTC set point	100K	None - Direct Short
Positive Isolation Parameter*	198V	180V	165V	110V	75V	35V	20V	0V
Negative Isolation Parameter*	192V	210V	225V	280V	315V	355V	370V	390V
Delta Between Parameters	0-15V	30V	60V	170V	240V	320V	350V	390V

*Typical values observed with a fully charged pack, 390V. A short to the positive bus is shown, a short to the negative bus would display inverted voltages of similar value.

Certain isolation loss concerns may only appear during high moisture environmental conditions. Drive the vehicle thru an underbody spraying-style car wash while monitoring the delta between Positive Supply Isolation Voltage and the Negative Supply Isolation Voltage scan tool parameters.

Isolation loss might only occur when a high voltage device is active. Use the High Voltage Component Test Method table and operate each HV component while monitoring the delta between Positive Supply Isolation Voltage and the Negative Supply Isolation Voltage scan tool parameters.

High Voltage Component Test Methods

HV Component	Scan Tool Parameter	Most Complete Test Method
G1 Electric A/C Compressor	Power Requested by Electric A/C Compressor from Hybrid/EV Battery Pack (HPCM2)	HVAC Cabin Controls and Monitor Isolation Voltage Parameter Delta
K10 Coolant Heater	Power Requested by Electric Passenger Compartment Heater from Hybrid/EV Battery Pack (HPCM2)	HVAC Cabin Controls and Monitor Isolation Voltage Parameter Delta
E54 Battery Heater*	Hybrid/EV Battery Pack Heater Power Command (HPCM2)	Hybrid/EV Battery Pack Heater Power GDS2 Scan Tool Control Function (HPCM2) and Monitor Isolation Voltage Parameter Delta*
		Review the DTC P1EC6 Conditions for Running and Monitor Isolation Voltage Parameter Delta while heater is commanded ON*
T18 Battery Charger	Active During Charge	Insulation Multimeter
K1 14V Power Module	14V Module High Voltage Circuit Current (HPCM1)	Insulation Multimeter
T6 Power Inverter Module	N/A - Always Active with High Voltage Enabled	Insulation Multimeter
M15A, M15B Drive Motors	N/A - Always Active with High Voltage Enabled	Insulation Multimeter
G5 Transmission Fluid Pump	N/A - Always Active with High Voltage Enabled	Insulation Multimeter
A4 Battery Pack - Internal Side of Contactors	Isolation Concern Results in DTC P0AA6	
*Because the E54 Battery Heater is always connected to the positive bus, an isolation fault may result in a delta decrease when commanded ON.		

After disabling high voltage:

High Voltage cables disconnected at each end from their respective modules must be tested with the insulation meter connected to their shield circuit and not to vehicle chassis.

The **EL-50772** insulation meter, when set to the 500V scale, indicates 550MΩ when measuring infinite or open circuit conditions. An equivalent meter may display 'infinite' value in a different manner.

Reference Information

Schematic Reference

- [Hybrid/EV Energy Storage Schematics](#)
- [Hybrid/EV Controls Schematics](#)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Hybrid/EV System High Voltage Isolation Description for:

- Passive Isolation circuit detail
- Active Isolation circuit detail
- Complete High Voltage system schematic

Electrical Information Reference

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

1. Remove all vehicle chargers.
2. Vehicle ON.
3. Verify that DTC P0AA1, P0AA4, P0AD9, P0ADD, P0AE4, P0D09, P0D0A, P1EBD, P1EC0 or P1EC3 is not set.

- **If any DTC is set**

Refer to **DTC P0AA1, P0AA4, P0AD9, P0ADD, P0AE4, P0D09, P0D0A, P1EBD, P1EC0 or P1EC3**.

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

4. Verify that DTC P0AA6 or P1AE6 is not set.

- **If any DTC is set**

Refer to **DTC P0AA6 or P1AE6**.

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

5. Vehicle ON, observe the scan tool Drive Motor 1 Positive Supply Isolation Voltage and the Drive Motor 1 Negative Supply Isolation Voltage scan tool parameters.

NOTE: High voltage must be enabled to obtain accurate results.

6. Is the delta or difference, between the Positive Supply Isolation Voltage and the Negative Supply Isolation Voltage scan tool parameters greater than 15 volts?

- **If the delta is greater than 15 volts**

Using the High Voltage Component Test Methods table as a guide, observe and record which components are active. Refer to Circuit/System Testing.

- **If the delta is 15 volts or less**

7. Using the High Voltage Component Test Method table as a guide, turn ON devices one at a time while monitoring the isolation voltage delta.

8. Is the delta between the Positive Supply Isolation Voltage and the Negative Supply Isolation Voltage scan tool parameters greater than 15 volts when a component is active?

- **If the delta is greater than 15 volts**

Observe and record which components are active. Refer to Circuit/System Testing.

- **If the delta is 15 volts or less**

9. Turn the vehicle OFF, open and close the drivers door and wait two minutes.

10. PRESS and HOLD the brake pedal and activate the HPCM2 scan tool control function Hybrid/EV Battery Pack Isolation Test. The battery pack isolation test will complete in less than a minute. Verify the Isolation Test Resistance parameter when the test is complete is greater than 425K ohms.

- **If the resistance is 425K or less**

Refer to **DTC P0AA6 or P1AE6**.

- If the resistance is greater than 425K ohms

11. Vehicle OFF. Connect the vehicle charge cord. Ensure charge mode is active.
12. With charge mode already active, Vehicle ON and observe the scan tool Drive Motor 1 Positive Supply Isolation Voltage and the Drive Motor 1 Negative Supply Isolation Voltage scan tool parameters.
13. Is the delta between the Positive Supply Isolation Voltage and the Negative Supply Isolation Voltage scan tool parameters greater than 15 volts?

- If the delta is greater than 15 volts

Refer to Circuit/System Testing.

- If the delta is less than 15 volts

14. All OK, review Diagnostic Aids.

Circuit/System Testing

1. Disable the high voltage for servicing at the G1 Air Conditioning Compressor, K10 Coolant Heater, K1 14V Power Module and T18 Battery Charger. Refer to [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: Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

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

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

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.

NOTE: Wear your High Voltage Insulation gloves until you have determined that a high voltage exposure risk is no longer present.

2. Ensure only the **EL-50772** Insulation Multimeter or equivalent is used with this procedure. Select the Isolation Test setting, then select the 500V range. Refer to [Troubleshooting With an Insulation Multimeter](#) for important usage instructions.

NOTE: Only perform the following continuity tests using the **EL-50772** Insulation Multimeter or equivalent.

3. Disconnect the high voltage direct current (DC) harness connector X3 at the T18 Battery Charger if not already disconnected during the High Voltage Disabling procedure.
4. Test for 550 MΩ between the circuit terminals listed below and chassis ground:
 - T18 Battery Charger module connector X3 terminal A +300V, at the module
 - T18 Battery Charger module connector X3 terminal B -300V, at the module

- **If less than 550 MΩ**

Replace the T18 Battery Charger.

- **If 550 MΩ**

5. Disconnect the X151, X152 and X153 inline high voltage harness connectors if not already disconnected during the High Voltage Disabling procedure.
6. Test for 550 MΩ between the circuit terminals listed below and cable shield, using the **EL-50772** Insulation Multimeter :

NOTE: **The high voltage jumper connector directly at each module must be connected to the module.**

- K1 14V Power Module jumper harness connector X153 terminal A +300V, module side.
- K1 14V Power Module jumper harness connector X153 terminal B -300V, module side.

- **If less than 550 MΩ**

1. Disconnect the high voltage harness connector at the K1 14V Power Module.
2. Retest for 550 MΩ between the circuit terminals listed below and cable shield:
 - K1 14V Power Module jumper harness connector X153 terminal A +300V
 - K1 14V Power Module jumper harness connector X153 terminal B -300V
 - If 550 MΩ, replace the K1 14V Power Module.
 - If less than 550 MΩ, replace the 300V DC cable jumper assembly.

- **If 550 MΩ**

7. Test for 550 MΩ between the circuit terminals listed below and cable shield:
 - K10 Heater module jumper harness connector X152 Terminal A +300V, module side
 - K10 Heater module jumper harness connector X152 Terminal B -300V, module side

- **If less than 550 MΩ**

1. Disconnect the high voltage connector at the K10 Heater module.
2. Retest for 550 MΩ between the circuit terminals listed below and cable shield:
 - K10 Heater module jumper harness connector X152 Terminal A +300V
 - K10 Heater module jumper harness connector X152 Terminal B -300V
 - If 550 MΩ, replace the K10 Heater module.
 - If less than 550 MΩ, replace the 300V DC cable assembly.

- **If 550 MΩ**

8. Test for 550 MΩ between the circuit terminals listed below and cable shield:

NOTE: **There may be up to a 5 second delay for proper test results to be displayed, always Press and Hold the EL-50772 test button until maximum measurement values are observed.**

- G1 A/C Compressor module jumper harness connector X151 Terminal A +300V, module side
- G1 A/C Compressor module jumper harness connector X151 Terminal B -300V, module side
- If less than 550 MΩ

1. Disconnect the high voltage connector at the G1 A/C Compressor.
2. Retest for 550 MΩ between the circuit terminals listed below and cable shield:
 - G1 A/C Compressor module jumper harness connector X151 Terminal A +300V
 - G1 A/C Compressor module jumper harness connector X151 Terminal B -300V
 - If 550 MΩ, replace the G1 A/C Compressor
 - If less than 550 MΩ, replace the 300V DC cable jumper assembly

- **If 550 MΩ**

9. Disable high voltage for servicing at the T6 Power Inverter Module. Refer to [High Voltage Disabling](#).
10. Disconnect the 3 phase cable connectors from the T6 Power Inverter Module if not already disconnected during the High Voltage Disabling procedure.

NOTE: Testing of the drive motors and transmission fluid pump motor cannot be performed while connected to the T6 Power Inverter Module.

11. Test for 550 MΩ between each M15B Drive Motor 2, 3 phase cable ring terminal and the cable shield:

NOTE: There may be up to a 5 second delay for proper test results to be displayed, always Press and Hold the EL-50772 test button until maximum measurement values are observed.

- Terminal 1 (U) 300V
- Terminal 2 (V) 300V
- Terminal 3 (W) 300V
- **If less than 550 MΩ**

Replace the M15B Drive Motor 2 and the 3 phase cable assembly.

- **If 550 MΩ**

12. Test for 550 MΩ between each M15A Drive Motor 1, 3 phase cable ring terminal and the cable shield:

- Terminal 1 (U) 300V
- Terminal 2 (V) 300V
- Terminal 3 (W) 300V
- **If less than 550 MΩ**

Replace the M15A Drive Motor 1 and the 3 phase cable assembly.

- **If 550 MΩ**

13. Test for 550 MΩ between the G5 Transmission Fluid Pump 3 phase cable harness circuit terminals listed below and cable shield:

- Terminal 1 (U) 300V
- Terminal 2 (V) 300V
- Terminal 3 (W) 300V
- **If less than 550 MΩ**

Replace the G5 Transmission Fluid Pump and the 3 phase cable assembly.

- **If 550 MΩ**

14. Disconnect the high voltage direct current (DC) cable connector X2 from the T6 Power Inverter Module if not already disconnected during the High Voltage Disabling procedure.

15. Test for 1.1 MΩ or greater between each T6 Power Inverter Module high voltage circuit terminal, 3 phase AC and DC and the chassis of the power inverter module.

- **If less than 1.1 MΩ**

Replace the T6 Power Inverter Module.

- **If 1.1 MΩ or greater**

16. Disable high voltage for servicing at the A4 Hybrid/EV battery pack assembly. Refer to [High Voltage Disabling](#).

17. Disconnect all high voltage connectors at the A4 Hybrid/EV Battery Pack if not already disconnected during the High Voltage Disabling procedure.

18. Test for 550 MΩ between the circuit terminals listed below and cable shield:

NOTE: The high voltage direct current (DC) connector X2 at the T6 Power Inverter Module must remain disconnected.

- A4 Hybrid/EV Battery Pack connector X1 terminal A +300V, harness side
- A4 Hybrid/EV Battery Pack connector X1 terminal B -300V, harness side
- **If less than 550 MΩ**

Replace the 300V DC cable assembly.

- **If 550 MΩ**

19. Test for 550 MΩ between the circuit terminals listed below and cable shield:

- A4 Hybrid/EV Battery Pack connector X365 terminal A +300V, harness side
- A4 Hybrid/EV Battery Pack connector X365 terminal B -300V, harness side
- **If less than 550 MΩ**

Replace the 300V DC cable assembly.

- **If 550 MΩ**

20. Test for 550 MΩ between the circuit terminals listed below and cable shield:

- A4 Hybrid/EV Battery Pack connector X366 terminal A +300V, harness side
- A4 Hybrid/EV Battery Pack connector X366 terminal B -300V, harness side
- **If less than 550 MΩ**

Replace the 300V DC cable assembly.

- **If 550 MΩ**

21. Test for 550 MΩ between the circuit terminals listed below and cable shield:

- A4 Hybrid/EV Battery Pack connector X367 terminal A +300V, harness side
- A4 Hybrid/EV Battery Pack connector X367 terminal B -300V, harness side
- **If less than 550 MΩ**

Replace the 300V DC cable assembly.

- **If 550 MΩ**

22. Replace the A4 Hybrid/EV Battery Pack.

Component Testing

1. Perform component testing only after high voltage is disabled.
2. Testing of the drive motors and transmission fluid pump must be performed disconnected from the power inverter module.
3. Test with the **EL-50772** insulation multimeter or equivalent, set only at 500V.

HV Component	Component Setup	Insulation Multimeter Test Point	EL-50772 Expected Results
G1 Electric A/C Compressor	None	1. HV Pos+ terminal to compressor housing/HV Neg- terminal to compressor housing 2. Test continuously for several seconds until maximum measurement is obtained.	550 MΩ
K10 Coolant Heater	Plug one coolant port and fill with coolant	HV Pos+ terminal to cable shield/HV Neg- terminal to cable shield	550 MΩ
E54 Battery Heater	Not serviceable separately from A4 Hybrid/EV Battery Pack	-	-
T18 Battery Charger	None	HV DC Pos+ terminal to module housing/HV DC Neg- terminal to module housing	550 MΩ

HV Component	Component Setup	Insulation Multimeter Test Point	EL-50772 Expected Results
K1 14V Power Module	None	HV Pos+ terminal to module housing/HV Neg- terminal to module housing	550 MΩ
T6 Power Inverter Module	None	- Each HV terminal, both AC and DC, to module housing. - Test continuously for several seconds until maximum measurement is obtained.	1.1 to 1.2 MΩ
M15A, M15B Drive Motors	Must be electrically disconnected from T6 Power Inverter Module during test	- Any HV 3 phase terminal to stator ground. - Test continuously for several seconds until maximum measurement is obtained.	550 MΩ
G5 Transmission Fluid Pump	Disconnect cable from T6 Power Inverter Module	- Any HV 3 phase terminal to stator ground. - Test continuously for several seconds until maximum measurement is obtained.	550 MΩ
300-V Battery Positive and Negative Cables	Disconnect cables at both ends	HV Pos+ terminal to cable shield/HV Neg- terminal to cable shield	550 MΩ

Repair Instructions

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

- [300-Volt Battery Positive and Negative Cable Replacement](#)
- [Air Conditioning and Drive Motor Battery Cooling Compressor Replacement](#)
- [Heater Coolant Heater Replacement \(LTG with HP9\)](#)
- [Accessory DC Power Control Module Replacement](#)
- [Drive Motor Removal - 1st Position](#)
- [Drive Motor Removal - 2nd Position](#)
- [Transmission Fluid Pump Replacement](#)
- [High Voltage Battery Replacement and Shipping Preparation](#) for A4 Hybrid/EV Battery Pack replacement
- [Control Module References](#) for the T6 power inverter 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

The hybrid/EV battery contains 4 high voltage contactors and 1 transistor. The high voltage contactors and transistor allow the high voltage DC batteries to be connected to the vehicle or safely contain the high voltage DC within the hybrid/EV battery assembly. The 4 high voltage contactors consist of a main positive high voltage contactor, main negative high voltage contactor, charge positive high voltage contactor and precharge negative high voltage contactor. The transistor controls the battery heater. The contactors and transistor close and open in a specific sequence controlled by the hybrid/EV powertrain control module 2. The hybrid/EV powertrain control module 2 supplies voltage to the control circuit for each high voltage contactor/transistor. Ground is provided through a vehicle ground external of the high voltage battery.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

- [COMPONENT CONNECTOR END VIEWS - INDEX](#)
- [Testing for Intermittent Conditions and Poor Connections](#)

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 1000 V 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: 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.

1. Review the high voltage safety information prior to performing the High Voltage Disabling procedure. Refer to [High Voltage Safety](#).
2. Verify the High Voltage Disabling procedure has been performed and the S15 manual service disconnect has been removed.

- The procedure has not been performed

Refer to [High Voltage Disabling](#) before continuing to the next step.

- The procedure has been performed

3. Disconnect the low voltage (X357) and (X358) harness connectors at the A4 Hybrid/EV Battery Pack. Connect the 12 V battery. Vehicle in Service Mode.

NOTE: Connecting the 12 V battery while leaving the S15 manual service disconnect out will set DTCs. Clear these DTCs after all repairs are complete.

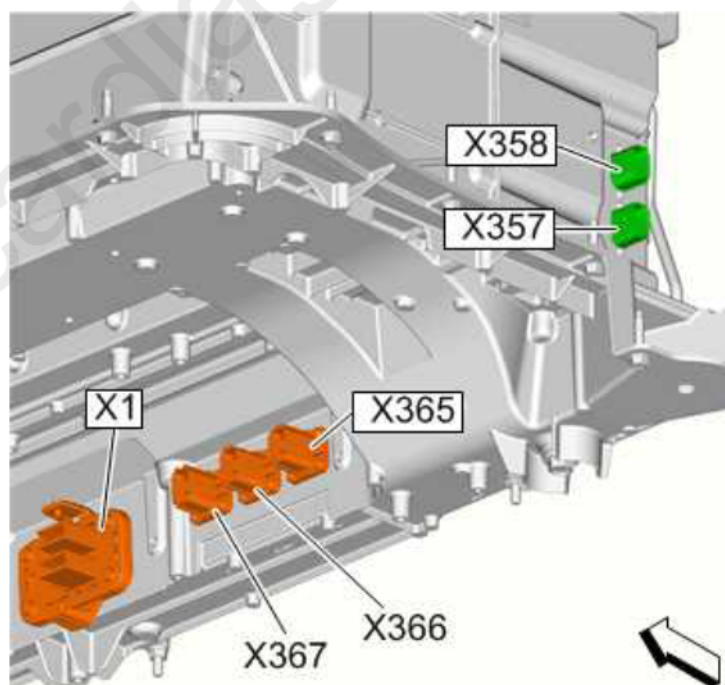


Fig. 41: Harness Connectors

Courtesy of GENERAL MOTORS COMPANY

4. Test for less than 9.5 V at the following points and ground:
 - X357, Terminal 2
 - X357, Terminal 4
 - X357, Terminal 6
 - X357, Terminal 7

- **If 9.5 V or greater**
 1. Vehicle OFF, disconnect the X1 harness connector at the K114B Hybrid Powertrain Control Module 2. Vehicle in Service Mode.
 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 K114B Hybrid Powertrain Control Module 2.
 - **If less than 9.5 V**
- 5. Vehicle OFF.
- 6. Test the DMM by measuring a known good 9 to 12 V battery.

NOTE:

- **Wear your High Voltage Insulation gloves until you have determined that a high voltage exposure risk is no longer present.**
- **A 9 V battery or the vehicles 12 V battery can be used to test the DMM.**
- **If the DMM does not properly measure the test battery**
Repair or replace the DMM and repeat all voltage measurements.
- **If the DMM does properly measure the test battery**
- 7. Replace the A4 Hybrid/EV Battery Pack. There is a stuck closed contactor and a loss of isolation within the A4 Hybrid/EV Battery Pack.

Repair Instructions

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

[High Voltage Battery Replacement and Shipping Preparation](#) for A4 Hybrid/EV Battery Pack replacement.

TROUBLESHOOTING WITH AN INSULATION MULTIMETER

Special Tools

EL-50772 Insulation Multimeter

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

Diagnosis for isolation loss requires insulation testing with high voltage potential. Special multimeters that utilize their own built-in high voltage, such as the **EL-50772** Insulation Multimeter, test the isolation capability of high voltage components and circuits. Understanding an insulation multimeter and how it functions is necessary to obtain proper test results.

How to Use the Insulation Multimeter

1. Read all instructions and warnings that came with your insulation multimeter.
2. Plug into the correct ports (1, 2) for insulation testing. This is easy to get wrong especially if you use the **EL-50772** for standard DMM testing too. Do NOT use ports (3, 4) for insulation testing.

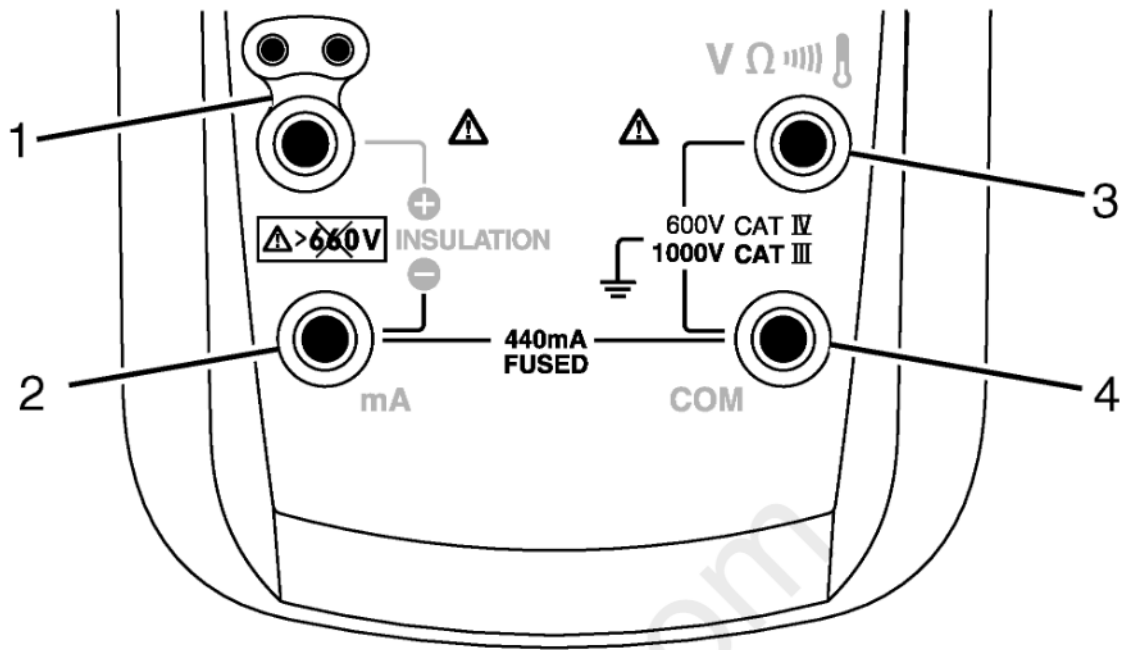


Fig. 42: Ports

Courtesy of GENERAL MOTORS COMPANY

3. Always test at the 500V range.
4. With the test leads not connected to anything, press and hold test button to know how your meter displays an infinite measurement. The **EL-50772** will display 550 MΩ when measuring an open circuit while set to the 500V range.

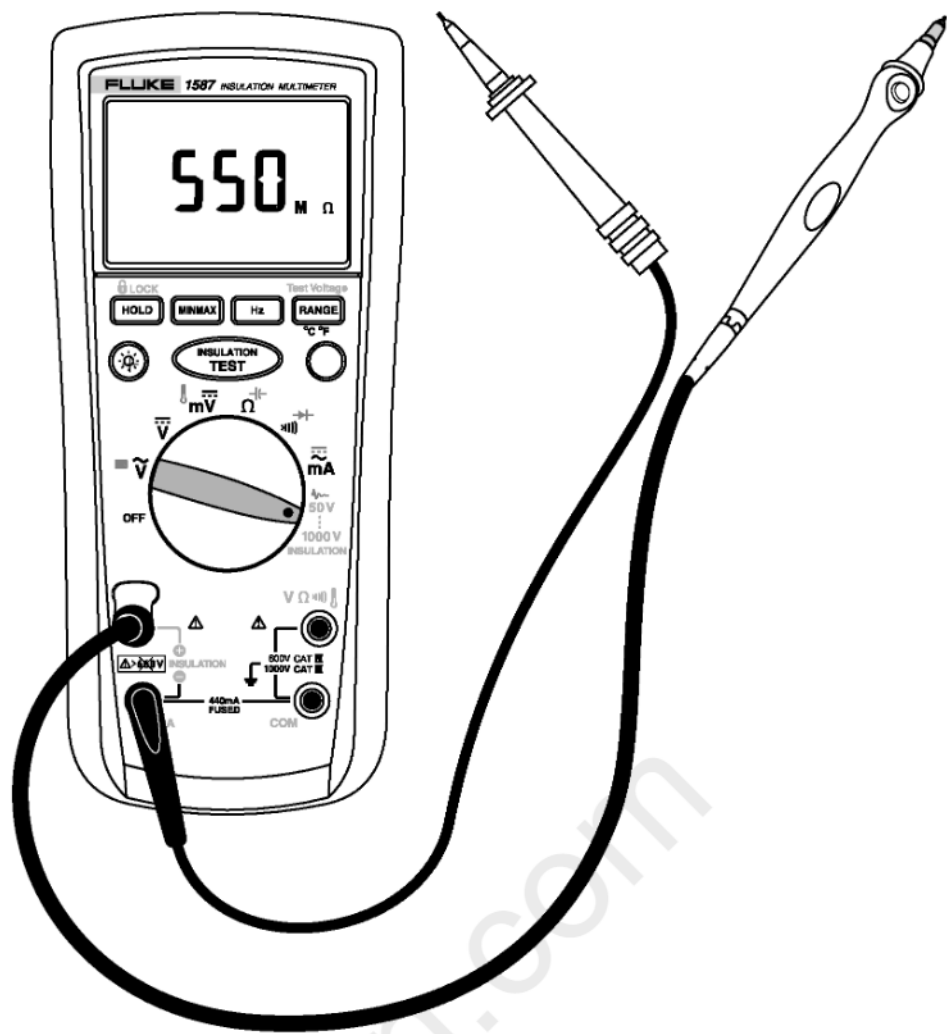


Fig. 43: Insulation Multimeter (550)

Courtesy of GENERAL MOTORS COMPANY

5. With the test leads connected together, press and hold test button to know how your meter displays continuity. The **EL-50772** will display 0.0 Ω.
6. When performing insulation testing you need a good ground reference. When possible use an alligator clamp to attach the ground lead. Typically, the reference point will be to vehicle chassis except cable testing which requires connection to the cable shield termination at the connector and not to the chassis.

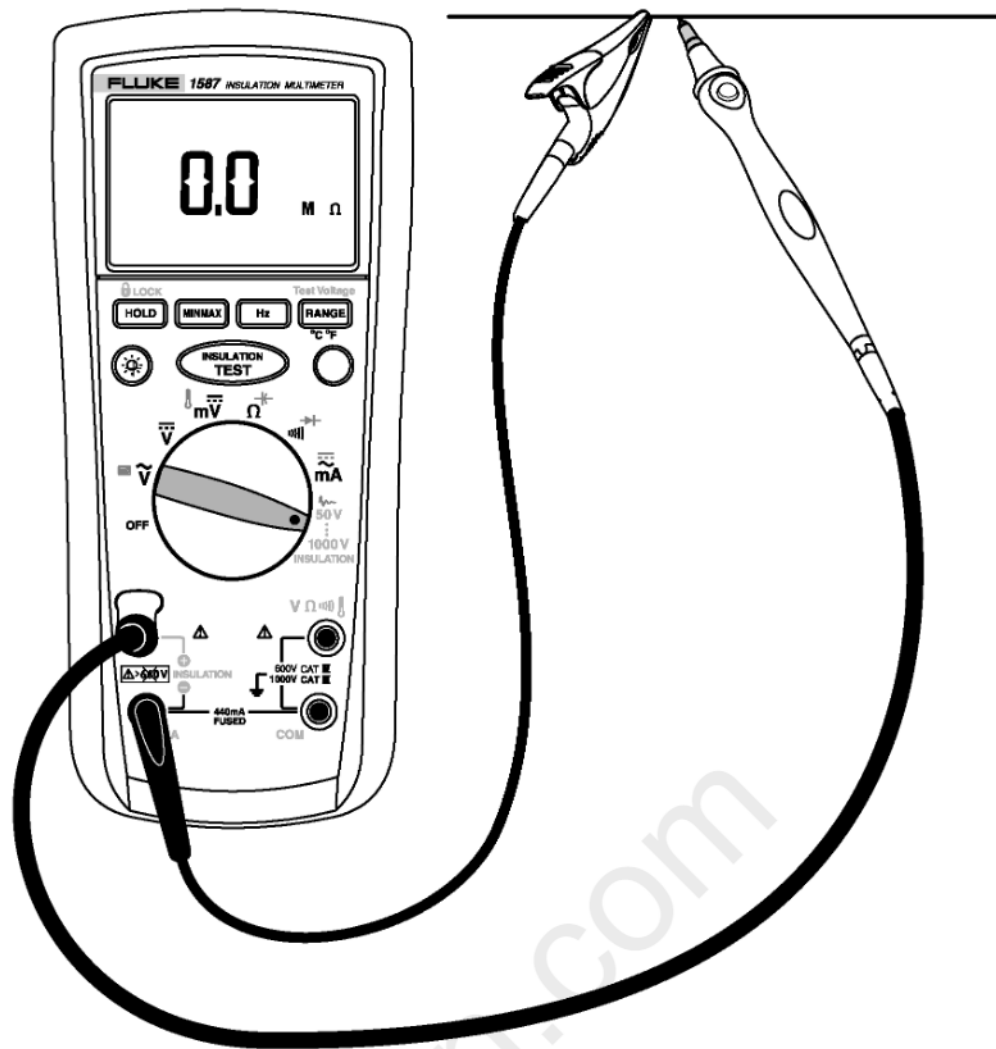


Fig. 44: View Of Insulation Multimeter (0.0)

Courtesy of GENERAL MOTORS COMPANY

7. Verify your ground connection prior to every test measurement at a suitable ground location near your test point. The **EL-50772** should display 0.0 Ω, indicating continuity.
8. When testing components with large capacitance or inductance, such as certain modules and larger motor stators, it may be necessary to hold the test for a few seconds until the maximum resistance value is displayed.

REPAIR INSTRUCTIONS

HIGH VOLTAGE SYSTEM INSPECTION

Circuit/System Description

WARNING: Damage to a Lithium Ion hybrid/EV battery pack could result in fire, loss of electrical isolation or exposure to high voltage. Until the high voltage system inspection has been completed, store the vehicle with hybrid/EV battery pack installed outside in a secure area away from buildings and other vehicles and protected from rain, snow and other moisture. Remove the hybrid/EV battery pack high voltage manual disconnect lever and store it in a secure place outside the vehicle. Cover the exposed high voltage opening with UL[®] listed or equivalent, insulation tape rated at a minimum of 600 V.

Failure to follow these precautions could result in personal injury, death and property damage.

The Inspection Process

The high voltage system and Hybrid/EV battery pack inspection process consists of two levels of inspection:

1. Component Initial Inspection

2. High Voltage Operation Inspection

Results of the inspection processes may result in:

- Hybrid/EV Battery Depower
- Repair or replacement and recycling of the Hybrid/EV Battery
- Replacement of high voltage components

Vehicle Collision Detection/High Voltage Lockout

The supplemental inflatable restraint system supplements the protection offered by the seat belts. The supplemental inflatable restraint sensing and diagnostic module determines the severity of a collision with the assistance of impact sensors located at strategic points on the vehicle. The hybrid powertrain control module 2 will open the high voltage contactor relays, placing the vehicle in a high voltage lockout state and disabling the vehicle whenever a crash event of sufficient intensity has been detected.

The supplemental inflatable restraint module transmits through serial data to the hybrid powertrain control module 2 both the crash event status and whenever a sensor fault is detected.

NOTE: The Crash Event Detected/Air Bag Deployed high voltage lockout state will remain active until cleared by the Clear Secured High Voltage DTCs procedure.

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

High Voltage Battery Moisture Exposure

The Lithium Ion hybrid/EV battery pack should be depowered whenever internal components have been exposed to moisture, whether due to vehicle flood, coolant leakage within the hybrid/EV battery pack assembly, etc.

Reference Information

Schematic Reference

- [Hybrid/EV Energy Storage Schematics](#)
- [Hybrid/EV Controls Schematics](#)
- [Plug-In Charging Schematics](#)

Description and Operation

[Drive Motor Battery System Description](#)

Scan Tool Reference

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

Special Tools

- EL-48900 HEV Safety Kit
- EL-50332 EV/HEV Battery Service Tool
- J-35616-35 Test Probes

Equivalent regional tools: [Special Tools](#).

Component Initial Inspection

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.

1. Disconnect the 12V battery.
2. Remove the S15 Manual Service Disconnect. If vehicle damage does not allow for access to the S15 Manual Service Disconnect, remove the damaged portion of the vehicle until such time as the S15 Manual Service Disconnect can be removed. Refer to [Drive Motor Battery High Voltage Manual Disconnect Lever Replacement](#).
3. Inspect the Hybrid/EV battery pack for evidence of exposure to fire, either directly or in close proximity.
 - **If exposure to fire is evident**
 1. Depowering of the Hybrid/EV battery pack is recommended. Maintain post-crash 50 foot vehicle isolation until depowering completion. See Battery Depower after inspection is complete.
 2. After depowering, repair or replace and recycle battery as applicable. Vehicle dismantlers should refer to www.recyclemymybattery.com.

NOTE: Never return a damaged battery pack or section to the Warranty Parts Center (WPC), Electronic Service Center (ESC) or Battery Service Center (BSC).

3. Continue with inspection.
 - **If not exposed to fire**
4. Inspect the Hybrid/EV battery pack enclosure for damage including foreign object intrusion.
 - **If damage is evident**
 1. Depowering of the Hybrid/EV battery pack and/or damaged module section is recommended. Maintain post-crash 50 foot vehicle isolation until depowering completion. See Battery Depower after inspection is complete.
 2. After depowering, repair or replace and recycle battery as applicable. Vehicle dismantlers should refer to www.recyclemymybattery.com.

NOTE: Never return a damaged battery pack or section to the Warranty Parts Center (WPC), Electronic Service Center (ESC) or Battery Service

3. Continue with inspection.

- **If not damaged**

5. Inspect the vehicle for exposure to water at a level higher than the bottom of the Hybrid/EV battery pack.

- **If the vehicle was exposed to flood**

1. Remove the battery drain plug, capture and discard any drained fluid.

2. Ensure the vehicle is oriented properly to assist in fluid extraction.

- If fluid is present

1. Depowering of the Hybrid/EV battery pack is recommended. Maintain post-crash 50 foot vehicle isolation until depowering completion. See Battery Depower after inspection is complete.

2. After depowering, repair or replace and recycle battery as applicable. Vehicle dismantlers should refer to www.recyclemybattery.com.

NOTE: Never return a damaged battery pack or section to the Warranty Parts Center (WPC), Electronic Service Center (ESC) or Battery Service Center (BSC).

3. Continue with inspection.

- If fluid was not present

Install a new drain plug and continue with inspection.

- **If the vehicle was not flooded**

6. Inspect the battery coolant system for proper level.

- **If battery coolant level is low**

1. Verify if the low coolant is the result of system damage external of the A4 Hybrid/EV battery pack.

- If the cooling system external of the A4 Hybrid/EV Battery Pack is not damaged and/or leaking

1. Remove the battery drain plug, capture and discard any drained fluid.

2. Ensure the vehicle is oriented properly to assist in fluid extraction.

- If fluid is present

3. Depowering of the Hybrid/EV battery pack is recommended. Maintain post-crash 50 foot vehicle isolation until depowering completion. See Battery Depower after inspection is complete.

4. After depowering, repair or replace and recycle battery as applicable. Vehicle dismantlers should refer to www.recyclemybattery.com.

NOTE: Never return a damaged battery pack or section to the Warranty Parts Center (WPC), Electronic Service Center (ESC) or Battery Service Center (BSC).

5. Continue with inspection.

- If fluid is not present

6. Install a new drain plug and continue with inspection.

- If the cooling system external of the A4 Hybrid/EV Battery Pack is damaged and/or leaking

2. Continue with inspection.

- **If the battery coolant system is at the proper level**

7. Inspect each high voltage component listed below for visible damage. Record the results on the High Voltage Component Inspection Table below.

NOTE: Post-crash 50 foot vehicle isolation is no longer required if the Hybrid/EV battery pack did not exhibit damage assessed in the steps above.

- G1 Electric A/C Compressor

- K1 14V Power Module
- K10 Coolant Heater
- T6 Power Inverter Module
- T18 Battery Charger
- Transmission case
- All High voltage orange cables
- **If any high voltage component inspection failed and Hybrid/EV battery Depower is recommended**

Disconnect the damaged components from the high voltage bus before attempting in-vehicle depowering of the Hybrid/EV battery pack. In extreme cases depowering may need to occur by connecting directly within the Hybrid/EV battery pack with the cover removed. See Battery Depower below.

- **If any high voltage component inspection failed and Hybrid/EV battery Depower is NOT recommended**
 1. Perform the [High Voltage Disabling](#) procedure and replace the damaged components before attempting to operate the vehicle
 2. Once you have confirmed or repaired all high voltage component visual integrity, perform High Voltage Operation Inspection below.
- **If all high voltage component inspection passed**

Perform High Voltage Operation Inspection below.

High Voltage Component Inspection Table

High Voltage Component	Inspection (passed/failed)
G1 Electric A/C Compressor	-
K1 14V Power Module	-
K10 Coolant Heater	-
T6 Power Inverter Module	-
T18 Battery Charger	-
Transmission case	-
All High voltage orange cables	-

High Voltage Operation Inspection

1. Verify you have successfully passed the Component Initial Inspection.

NOTE: The vehicle must have a functioning 12V system and serial data communications to continue.

- **If the Component Initial Inspection has failed or not been performed**

DO NOT CONTINUE. Restart the Inspection procedure.

- **If the Component Initial Inspection has passed**

2. Install the S15 Manual Service Disconnect. Refer to [Drive Motor Battery High Voltage Manual Disconnect Lever Replacement](#).
3. Connect the 12V battery.
4. Vehicle in Service Mode. With a scan tool select the Hybrid/EV powertrain Control Module 2, Hybrid Battery Pack Contactor Open Reasons data list. Verify if either the Crash Event Detected or Air Bag Deployed parameters indicate YES.
 - **If either parameter displays YES**

The high voltage contactors may be prevented from closing. The vehicle will not start. Perform the Clear Secured High Voltage DTCs procedure and proceed to the next step.

- **If BOTH parameters indicate NO**

5. Vehicle ON. With a scan tool check for the following HV system DTCs: Contactor DTCs P0AA1, P0AA4, P0AD9, P0ADD, P0AE1, P0D0A, P0D09, P1EBD, P1EC0, P1EC3, Isolation DTCs P0AA6, P1AE6, P1AF0 or P1AF2, Precharge DTCs P0C76, P0C78 or P3061.

- **If any DTCs are set**

Perform the applicable DTC diagnosis/repair. refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)

- **If any of the listed DTCs have not run**

Review the applicable Conditions for Running the DTC.

- **If all the specified DTCs have ran and passed**

High Voltage System Inspection passed.

Battery Depower

WARNING:

Damage to a Lithium Ion hybrid/EV battery pack could result in fire, loss of electrical isolation or exposure to high voltage. Store the vehicle with hybrid/EV battery pack installed or the hybrid/EV battery pack assembly outside in a secure area away from buildings and other vehicles and protected from rain, snow and other moisture until the hybrid/EV battery pack has been discharged. Remove the hybrid/EV battery pack high voltage manual disconnect lever and store it in a secure place outside the vehicle. Cover the exposed high voltage opening with UL® listed or equivalent, insulation tape rated at a minimum of 600 V. Contact the GM Technical Assistance Center for discharge instructions prior to storage and shipping of the hybrid/EV battery pack.

Failure to follow these precautions could result in personal injury, death and property damage.

NOTE:

Depowering of the battery:

- Will NOT reduce battery voltage to a safe level. The battery will contain high voltage after depower procedure is complete.
- Reduces the state of charge to the lowest level thus reducing the likelihood of a battery fire.
- Requires special tool EL-50332 battery service tool.
- Allows for future recovery of the battery after an internal battery inspection and/or repair is completed.

NOTE:

Depowering is not required if TOTAL hybrid/EV battery pack voltage as either monitored by the hybrid powertrain control module 2 scan tool Hybrid/EV Battery Pack High Voltage parameter or measured with a DMM directly at the battery sections is 285 volts or less.

Depowering can occur with the Hybrid/EV battery pack in or out of the vehicle. You can configure the EL-50332 high voltage connections to the Hybrid/EV battery pack at any of the following locations:

- High Voltage G1 A/C Compressor module jumper harness in-line connection under engine bay with **EL-50332-345 ***
- High Voltage T18 Battery Charger connection in the rear underneath area with **EL-50332-340 ***
- High Voltage T18 Battery Charger connection directly at Hybrid/EV Battery Pack with **EL-50332-335 ***
- Directly at internal battery pack terminals with **EL-50332-170**

*Also requires connection to the contactor relay control circuits with **EL-50332-135** and **EL-50332-270** .

In-Vehicle or Hybrid/EV Battery Pack Cover Installed Depower Instructions

1. Ensure the integrity of the vehicles high voltage system.

NOTE:

- The EL-50332 will close the Hybrid/EV battery pack contactors. You must verify the vehicles high voltage system integrity prior to enabling high voltage. Disconnect visually damaged high voltage components/cables from the high voltage system before attempting in-vehicle depowering.
- You must be able to connect to the hybrid/EV battery pack low voltage connectors.
- Wear your Personal Protective Equipment for the duration of the battery depower event.

2. Connect the **EL-50332** to the contactor control circuits at the hybrid/EV battery pack low voltage connectors X357 and X358 with the **EL-50332-270** interface module and **50332-135** harness.
3. Connect the **EL-50332** to the applicable high voltage connector.
4. Install the manual service disconnect lever.
5. Follow the **EL-50332** on-screen prompts until depower is completed.
6. Remove the manual service disconnect lever.

NOTE:

Post-crash 50 foot vehicle isolation is no longer required upon successful depower completion.

7. Repair, replace or recycle the hybrid/EV battery pack as applicable. Vehicle dismantlers should refer to www.recyclemybattery.com.

NOTE:

Never return a damaged battery pack or section to the Warranty Parts Center (WPC), Electronic Service Center (ESC) or Battery Service Center (BSC).

8. Replace any damaged components noted in the High Voltage Component Inspection before attempting to operate the vehicle.
9. Perform the High Voltage Operation Inspection before attempting to operate the vehicle.

Hybrid/EV Battery Pack Removed Depower Instructions

1. Remove the hybrid/EV battery pack top cover.

NOTE:

This procedure is only necessary if damage to the A4 Hybrid/EV Battery Pack high voltage contactor relays or the external high voltage connector prevents In-Vehicle/Battery Pack Cover Installed Depowering.

2. Connect the **EL-50332** to the hybrid/EV battery pack low voltage connectors X357 and X358 with the **EL-50332-270** interface module and **EL-50332-135** harness.
3. Connect the **EL-50332-145** black banana jack harness (1) and the **EL-50332-150** red banana jack harness (2) to the A28 Hybrid/EV Battery Contactor Assembly terminals C5A and C5G using the **EL-50332-170** high voltage alligator clamps (3).

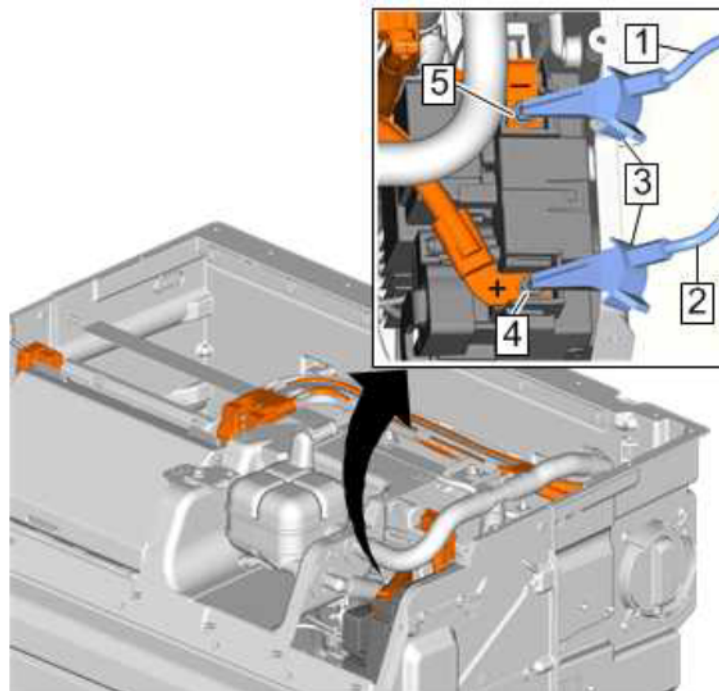


Fig. 45: Black Banana Jack Harness, Red Banana Jack Harness And High Voltage Alligator Clamps
 Courtesy of GENERAL MOTORS COMPANY

4. Install the manual service disconnect lever.
5. Follow the **EL-50332** on-screen prompts until depower is completed.
6. Remove the manual service disconnect lever.

NOTE: Post-crash 50 foot vehicle isolation is no longer required upon successful depower completion.

7. Repair, replace or recycle the hybrid/EV battery pack as applicable. Vehicle dismantlers should refer to www.recyclemybattery.com.

NOTE: Never return a damaged battery pack or section to the Warranty Parts Center (WPC), Electronic Service Center (ESC) or Battery Service Center (BSC).

8. Replace any damaged components noted in the High Voltage Component Inspection before attempting to operate the vehicle.
9. Perform the High Voltage Operation Inspection before attempting to operate the vehicle.

DRIVE MOTOR BATTERY CONVENIENCE CHARGER BRACKET REPLACEMENT

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.

Removal Procedure

1. Disable the high voltage system. Refer to [High Voltage Disabling](#)
2. Place a drain pan under the vehicle.

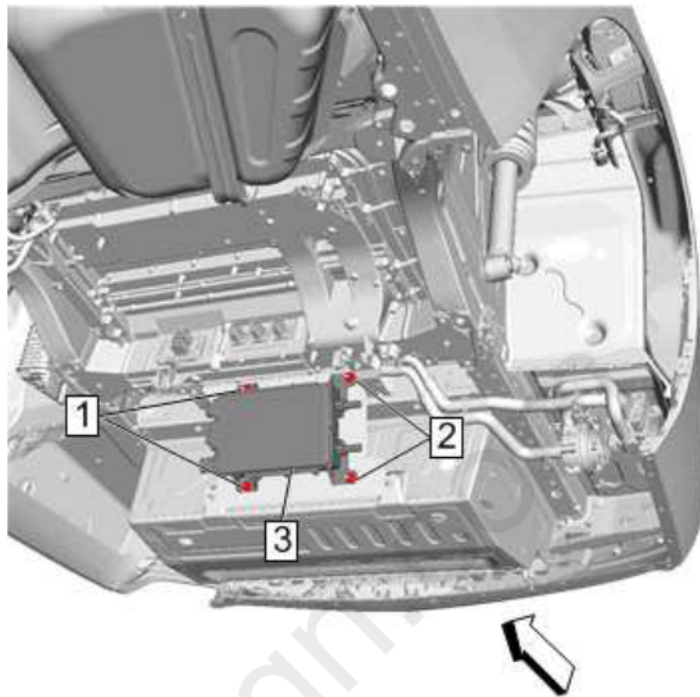


Fig. 46: Drive Motor Battery Charger And Fasteners
 Courtesy of GENERAL MOTORS COMPANY

3. Drive Motor Battery Charger (3)» Remove - [Drive Motor Battery Charger Replacement](#)
4. Drive Motor Battery Convenience Charger Fastener (1)» Remove [4x]

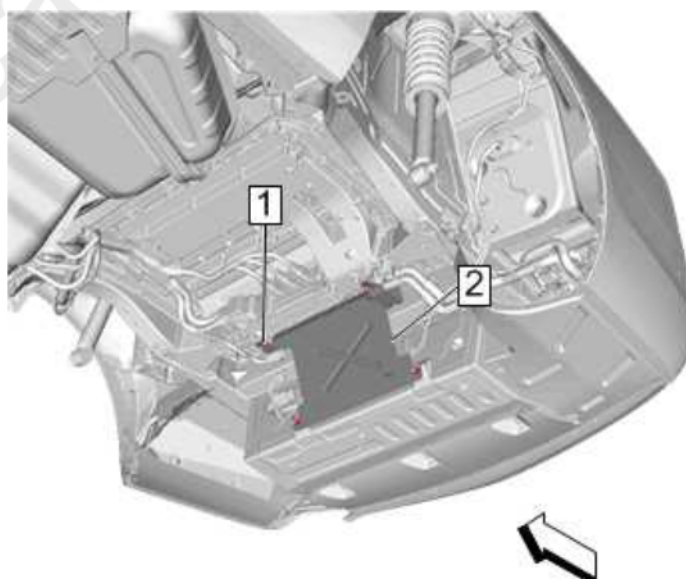


Fig. 47: Drive Motor Battery Convenience Charger Bracket
 Courtesy of GENERAL MOTORS COMPANY

5. Drive Motor Battery Convenience Charger Bracket (2)» Remove

Installation Procedure

1. Drive Motor Battery Convenience Charger Bracket (2)» Install

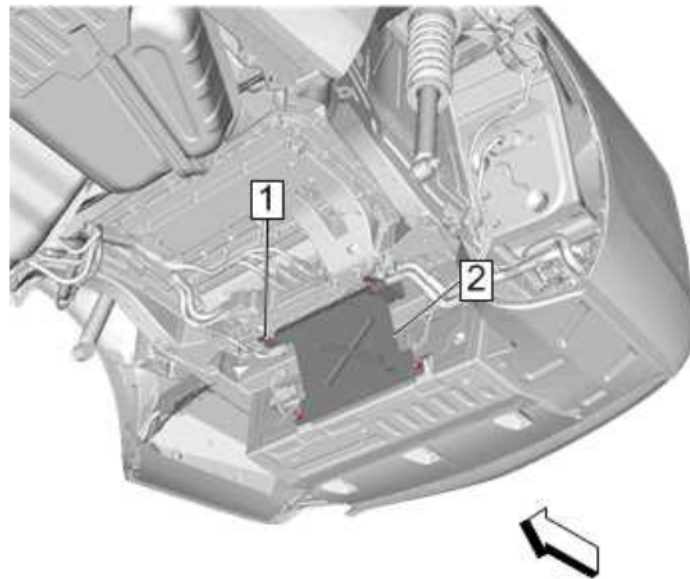


Fig. 48: Drive Motor Battery Convenience Charger Bracket
Courtesy of GENERAL MOTORS COMPANY

2. Drive Motor Battery Convenience Charger Bracket Fastener (1)» Install and tighten [4x] 22 N.m (16 lb ft)
3. Drive Motor Battery Charger (3)» Install - [Drive Motor Battery Charger Replacement](#)

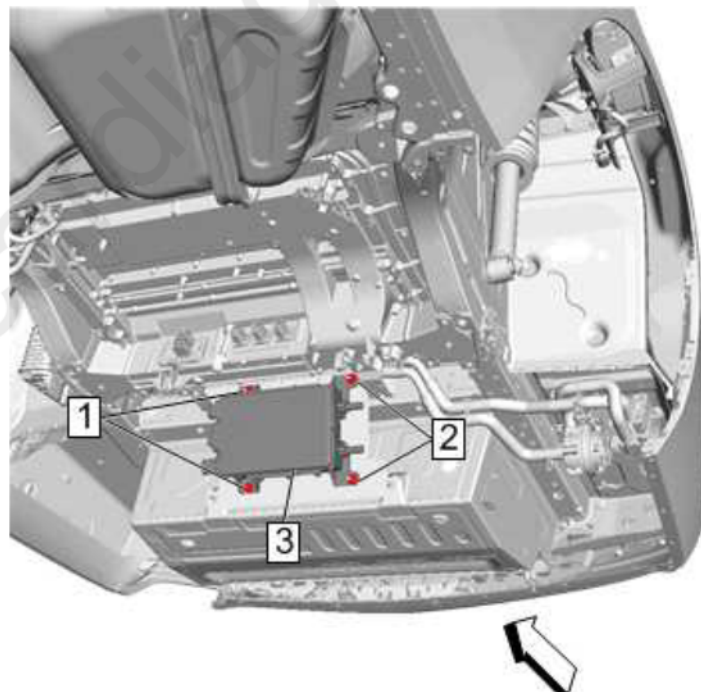


Fig. 49: Drive Motor Battery Charger And Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Enable the high voltage system. Refer to [High Voltage Enabling](#)

DRIVE MOTOR BATTERY HIGH VOLTAGE MANUAL DISCONNECT LEVER REPLACEMENT

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.

Removal Procedure

1. Drive Motor Battery Cover» Remove - [Drive Motor Battery Cover Replacement \(With HP9\)](#)
2. Drive Motor Battery High Voltage Manual Disconnect Lever (1)» Rotate Left

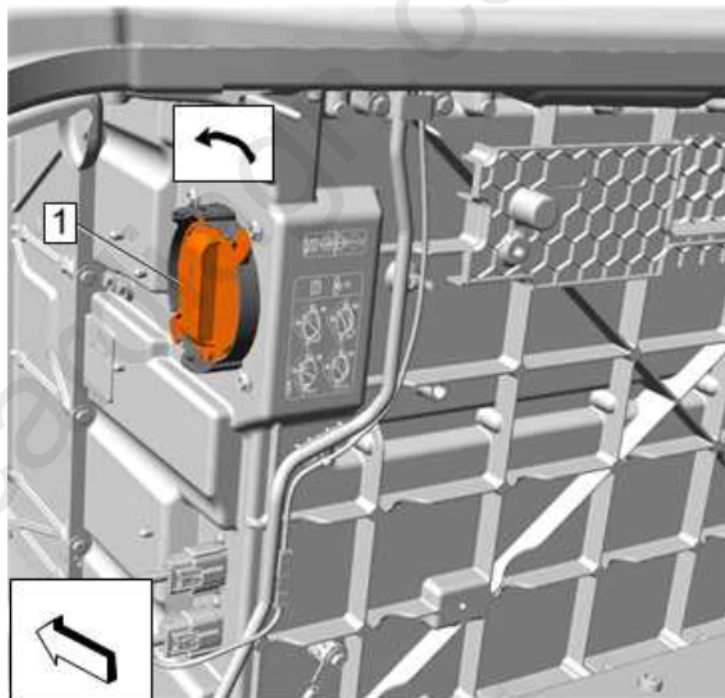


Fig. 50: Drive Motor Battery High Voltage Manual Disconnect Lever
Courtesy of GENERAL MOTORS COMPANY

3. Drive Motor Battery High Voltage Manual Disconnect Lever» Pull Outwards

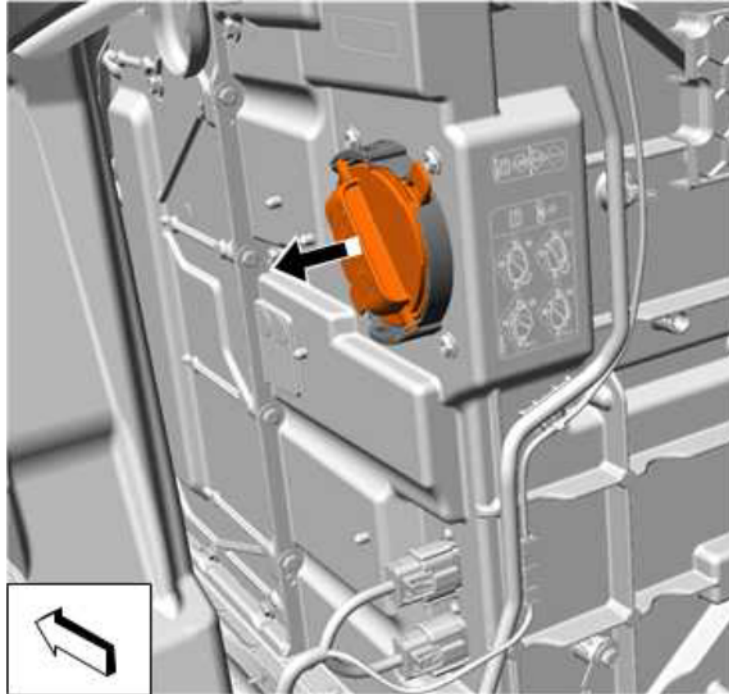


Fig. 51: Drive Motor Battery High Voltage Manual Disconnect Lever
Courtesy of GENERAL MOTORS COMPANY

4. Drive Motor Battery High Voltage Manual Disconnect Lever (1) » Rotate Left

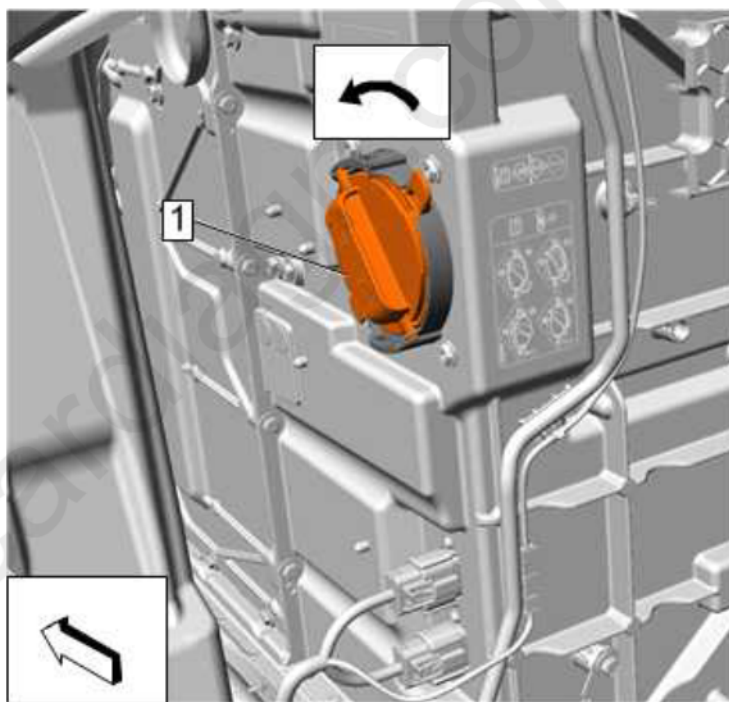


Fig. 52: Drive Motor Battery High Voltage Manual Disconnect Lever
Courtesy of GENERAL MOTORS COMPANY

5. Drive Motor Battery High Voltage Manual Disconnect Lever (1) » Remove

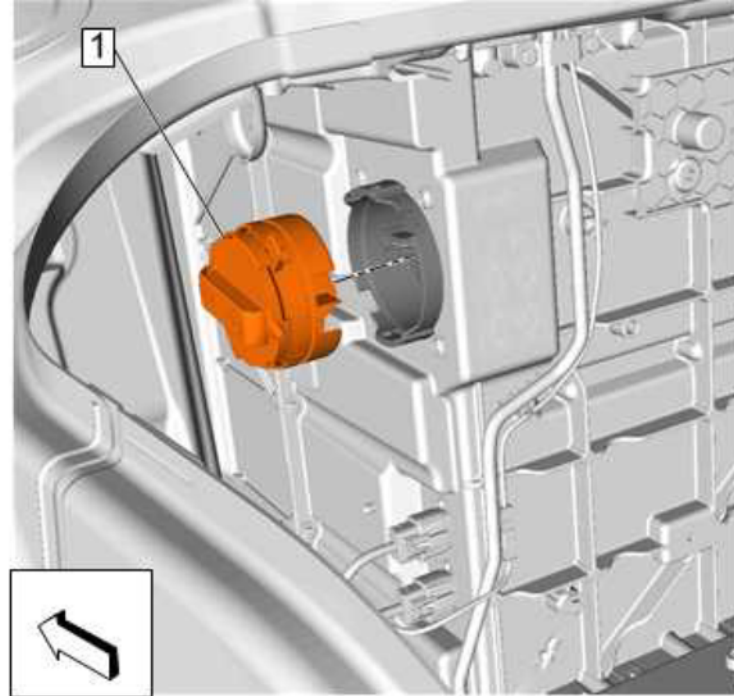


Fig. 53: Drive Motor Battery High Voltage Manual Disconnect Lever
 Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

1. Drive Motor Battery High Voltage Manual Disconnect Lever (1) » Install

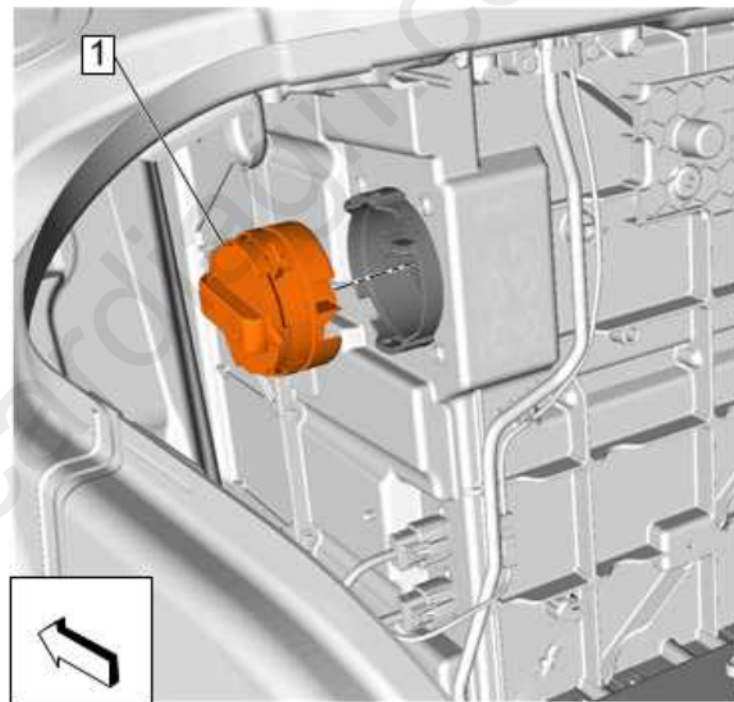


Fig. 54: Drive Motor Battery High Voltage Manual Disconnect Lever
 Courtesy of GENERAL MOTORS COMPANY

2. Drive Motor Battery High Voltage Manual Disconnect Lever (1) » Rotate Right

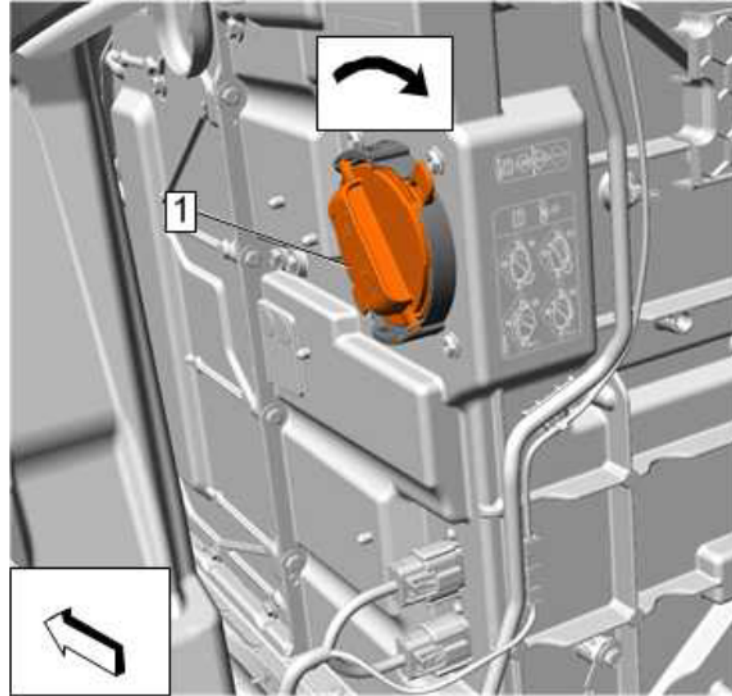


Fig. 55: Drive Motor Battery High Voltage Manual Disconnect Lever
Courtesy of GENERAL MOTORS COMPANY

3. Drive Motor Battery High Voltage Manual Disconnect Lever (1) » Push In

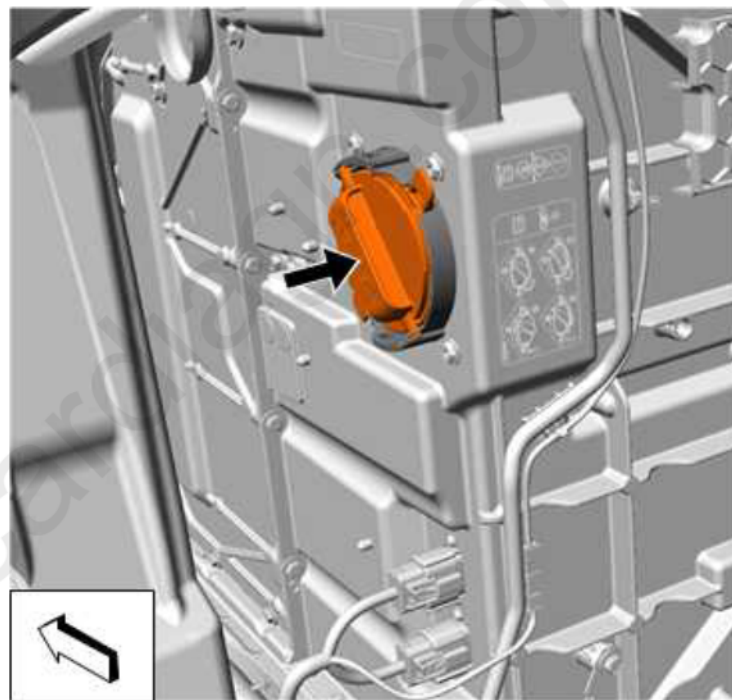


Fig. 56: Drive Motor Battery High Voltage Manual Disconnect Lever
Courtesy of GENERAL MOTORS COMPANY

4. Drive Motor Battery High Voltage Manual Disconnect Lever (1) » Rotate Right

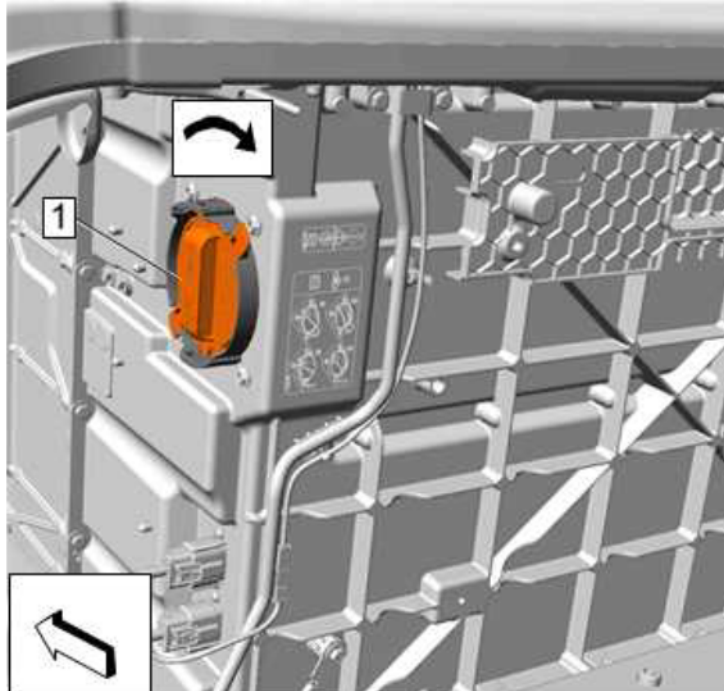


Fig. 57: Drive Motor Battery High Voltage Manual Disconnect Lever
 Courtesy of GENERAL MOTORS COMPANY

5. Pull outward on the handle to ensure the lever is in the locked position.
6. Drive Motor Battery Cover» Install - [Drive Motor Battery Cover Replacement \(With HP9\)](#)

HIGH VOLTAGE BATTERY COVER REPLACEMENT (TOP COVER)

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

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

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

Removal Procedure

1. Disable the high voltage system. Refer to [High Voltage Disabling](#)
2. High Voltage Battery (1)» Remove - [High Voltage Battery Replacement and Shipping Preparation](#)

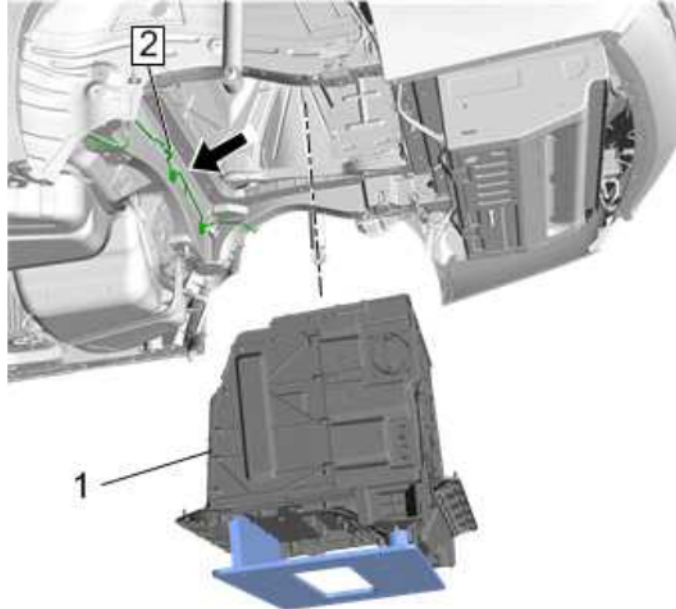


Fig. 58: High Voltage Battery

Courtesy of GENERAL MOTORS COMPANY

3. Body Wiring Harness Extension Harness (1)» Remove - **Body Wiring Harness Extension Harness Replacement**

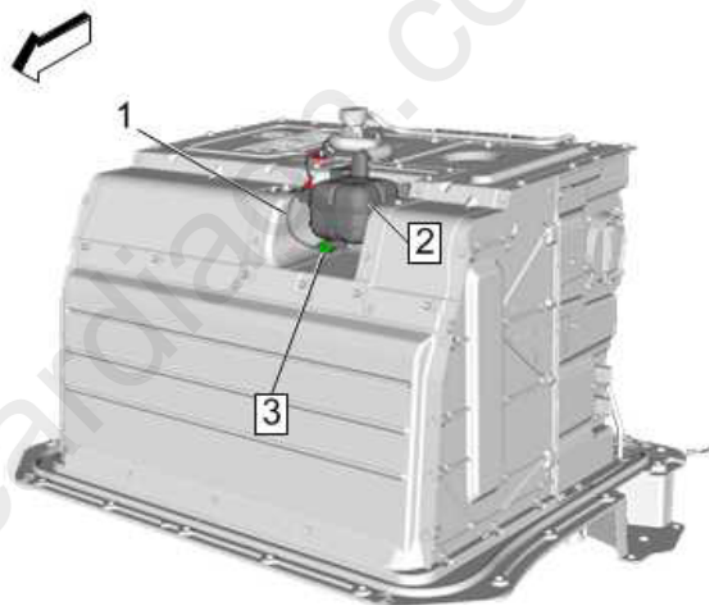


Fig. 59: Body Wiring Harness Extension Harness

Courtesy of GENERAL MOTORS COMPANY

4. Engine Coolant Air Bleed Hose Clamp (1)» Disengage - **Hose Clamp Replacement Guidelines - Spring Type**

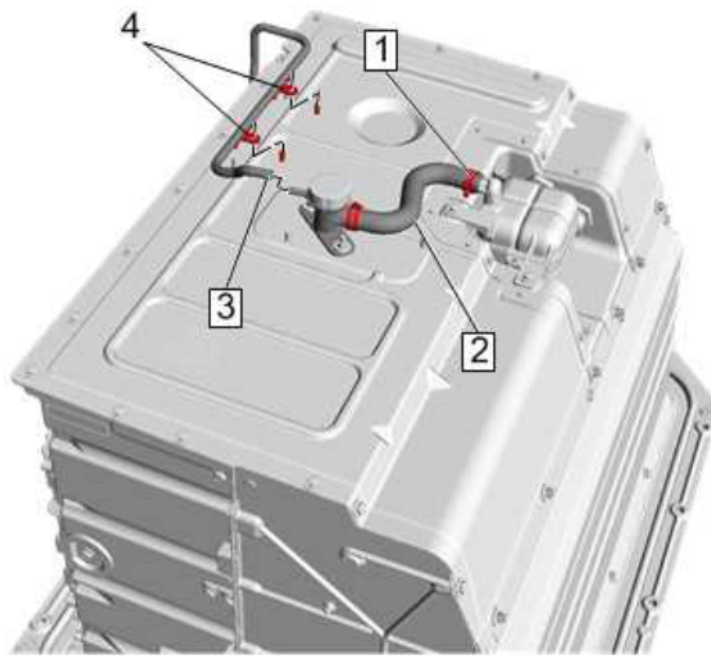


Fig. 60: Engine Coolant Air Bleed Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Engine Coolant Air Bleed Hose (2)» Remove
6. Heater Vent Hose Retainer (4)» Disengage
7. Heater Vent Hose (3)» Remove
8. High Voltage Battery Cover Nut (1)» Remove [5x]

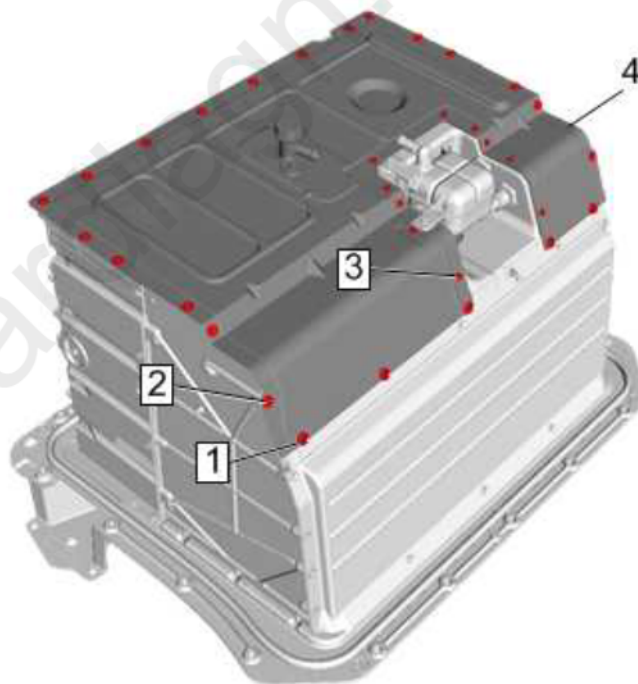


Fig. 61: High Voltage Battery Cover Nuts And Bolts
Courtesy of GENERAL MOTORS COMPANY

9. High Voltage Battery Cover Bolt (2)» Remove [18x]
10. Drive Motor Battery Coolant/Air Separator Tray Bolt (3)» Remove [11x]
11. High Voltage Battery Cover (4)» Remove

Installation Procedure

1. High Voltage Battery Cover (4)» Install

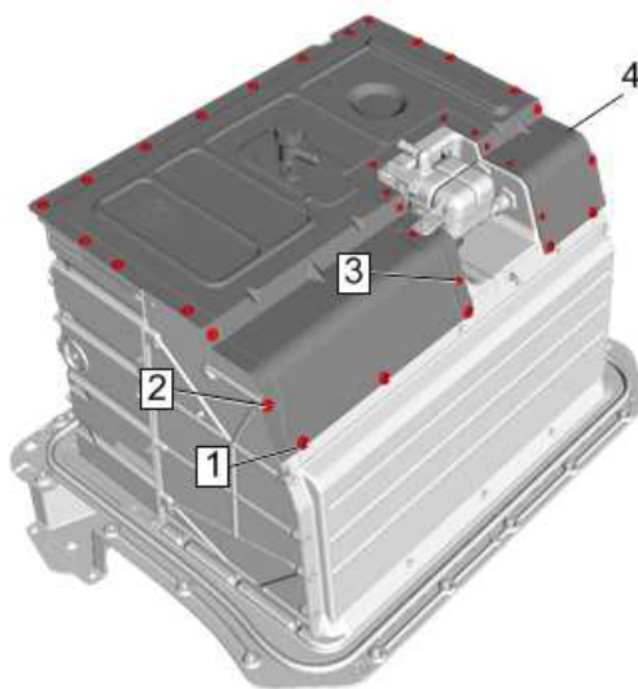


Fig. 62: High Voltage Battery Cover Nuts And Bolts
 Courtesy of GENERAL MOTORS COMPANY

2. High Voltage Battery Cover Bolt (2)» Install and tighten [18x] 9 N.m (80 lb in)

CAUTION: Refer to **Fastener Caution**

3. Drive Motor Battery Coolant/Air Separator Tray Bolt (3)» Install and tighten [11x] 2.5 N.m (22 lb in)
4. High Voltage Battery Cover Nut (1)» Install and tighten [5x] 9 N.m (80 lb in)
5. Engine Coolant Air Bleed Hose (2)» Install

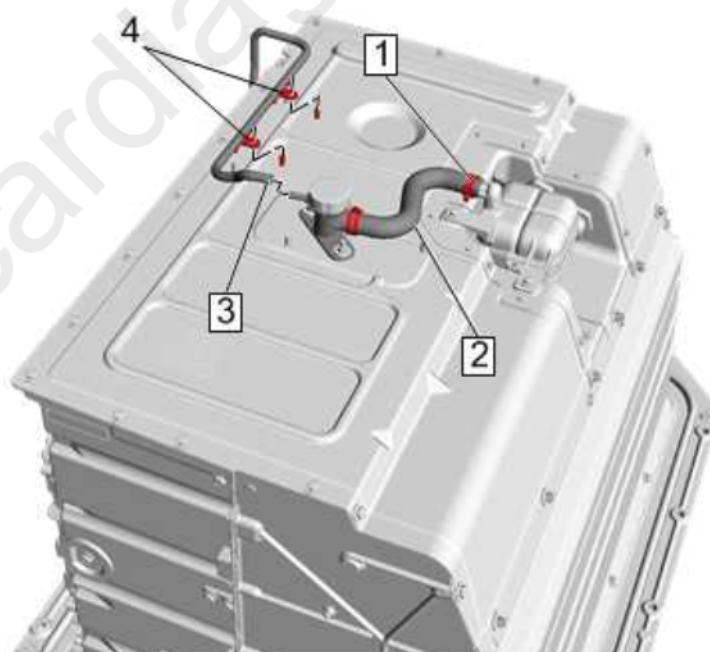


Fig. 63: Engine Coolant Air Bleed Hose Clamp
 Courtesy of GENERAL MOTORS COMPANY

6. Engine Coolant Air Bleed Hose Clamp (1)» Engage - **Hose Clamp Replacement Guidelines - Spring Type**
7. Heater Vent Hose (3)» Install
8. Heater Vent Hose Retainer (4)» Engage
9. Body Wiring Harness Extension Harness (1)» Install - **Body Wiring Harness Extension Harness Replacement**

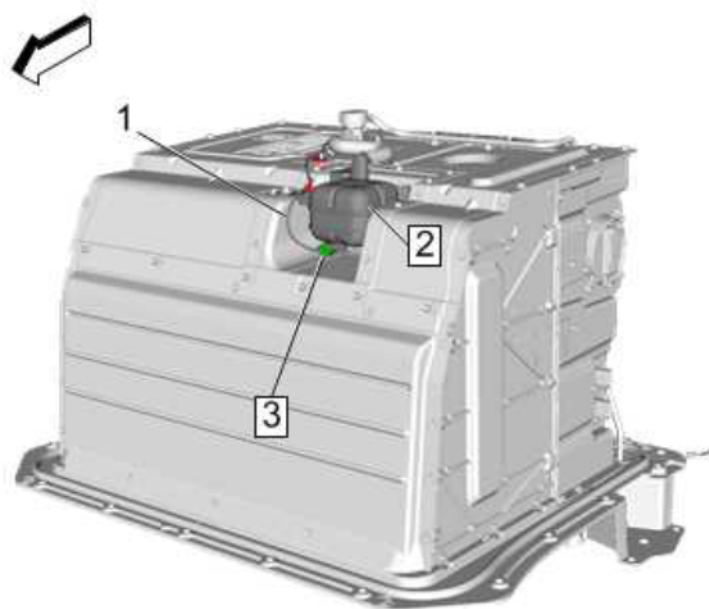


Fig. 64: Body Wiring Harness Extension Harness
 Courtesy of GENERAL MOTORS COMPANY

10. High Voltage Battery (1)» Install - [High Voltage Battery Replacement and Shipping Preparation](#)

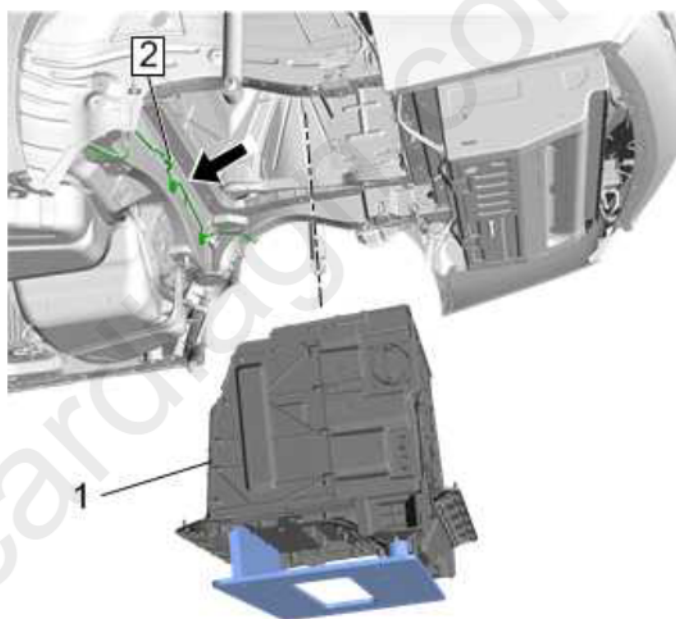


Fig. 65: High Voltage Battery
 Courtesy of GENERAL MOTORS COMPANY

11. Enable the high voltage system. Refer to [High Voltage Enabling](#)

HIGH VOLTAGE BATTERY COVER REPLACEMENT (FRONT COVER)

WARNING:

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

- Safety glasses with appropriate side shields when within 50 feet of the vehicle, either indoors or outdoors
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors
 - Visually and functionally inspect the gloves before use.

- Wear the Insulation gloves at all times when working with the high voltage battery assembly, whether the system is energized or not.

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

Removal Procedure

1. Disable the high voltage system. Refer to [High Voltage Disabling](#)
2. High Voltage Battery (1)» Remove - [High Voltage Battery Replacement and Shipping Preparation](#)

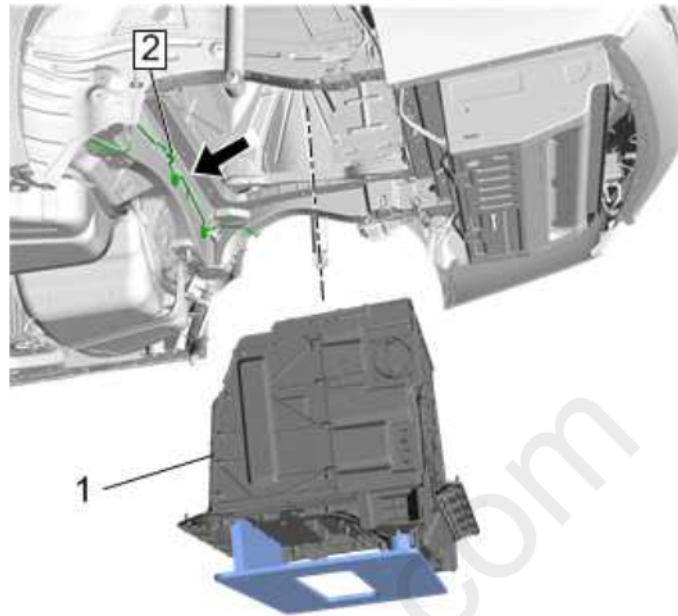


Fig. 66: High Voltage Battery

Courtesy of GENERAL MOTORS COMPANY

3. Body Wiring Harness Extension Harness (1)» Remove - [Body Wiring Harness Extension Harness Replacement](#)

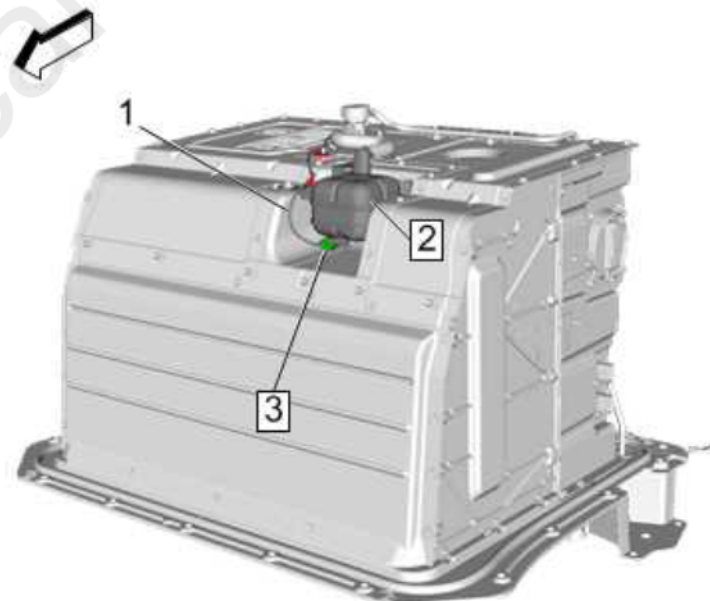


Fig. 67: Body Wiring Harness Extension Harness

Courtesy of GENERAL MOTORS COMPANY

4. Engine Coolant Air Bleed Hose Clamp (1)» Disengage [2x] - [Hose Clamp Replacement Guidelines - Spring Type](#)

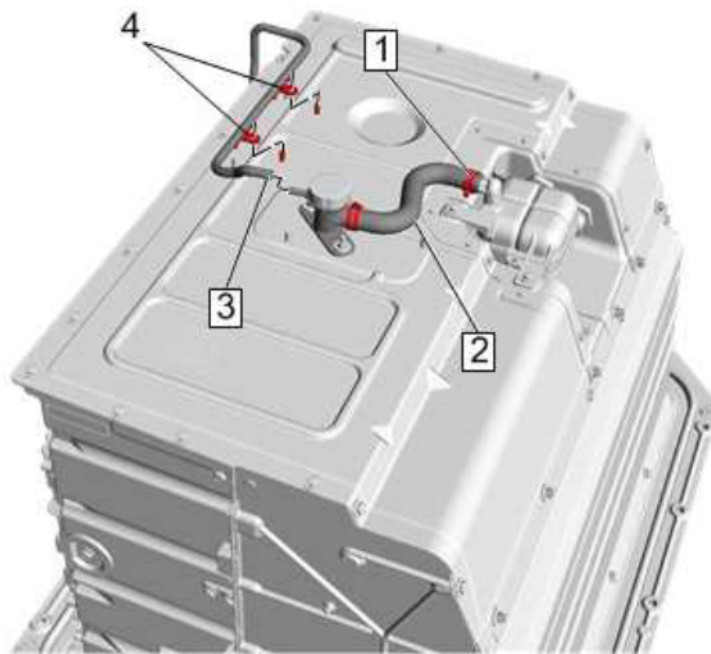


Fig. 68: Engine Coolant Air Bleed Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Engine Coolant Air Bleed Hose (2)» Remove
6. Heater Vent Hose Retainer (4)» Disengage
7. Heater Vent Hose (3)» Remove
8. High Voltage Battery Cover Nut (1)» Remove [5x]

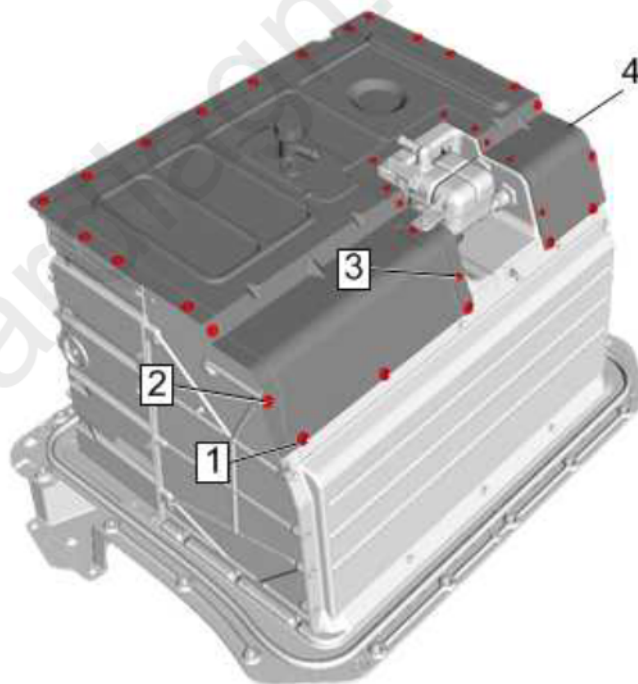


Fig. 69: High Voltage Battery Cover Nuts And Bolts
Courtesy of GENERAL MOTORS COMPANY

9. High Voltage Battery Cover Bolt (2)» Remove [18x]
10. Drive Motor Battery Coolant/Air Separator Tray Bolt (3)» Remove [11x]
11. High Voltage Battery Cover (4)» Remove
12. High Voltage Battery Cover Bolt (1)» Remove [14x]

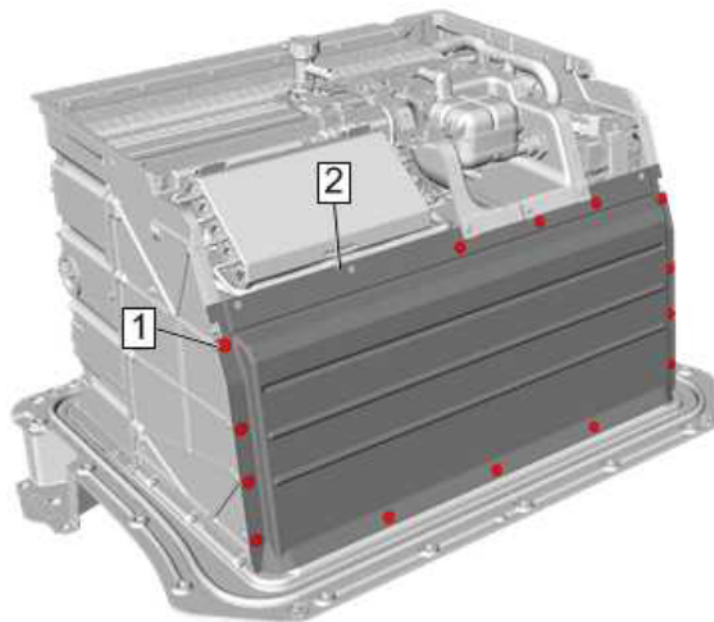


Fig. 70: High Voltage Battery Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

13. High Voltage Battery Cover (2)» Remove

Installation Procedure

1. High Voltage Battery Cover (2)» Install

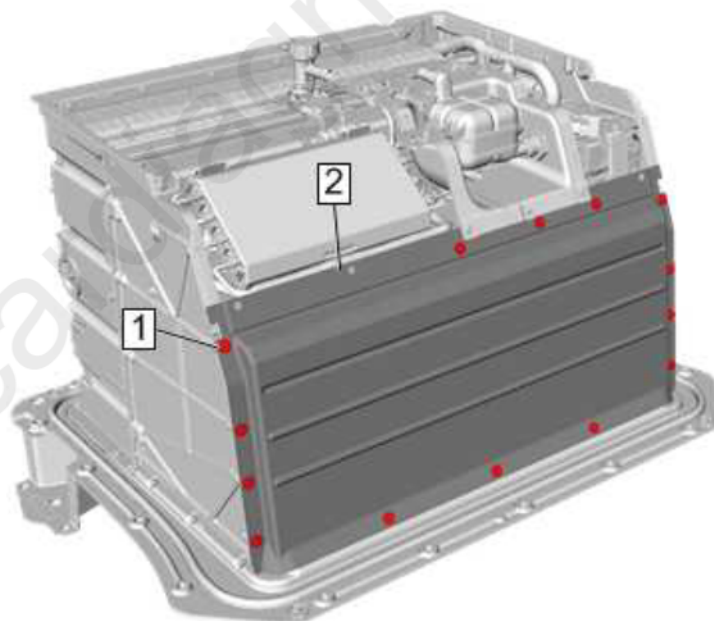


Fig. 71: High Voltage Battery Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

2. High Voltage Battery Cover Bolt (1)» Install and tighten [14x] 9 N.m (80 lb in)

CAUTION: Refer to **Fastener Caution**

3. High Voltage Battery Cover (4)» Install

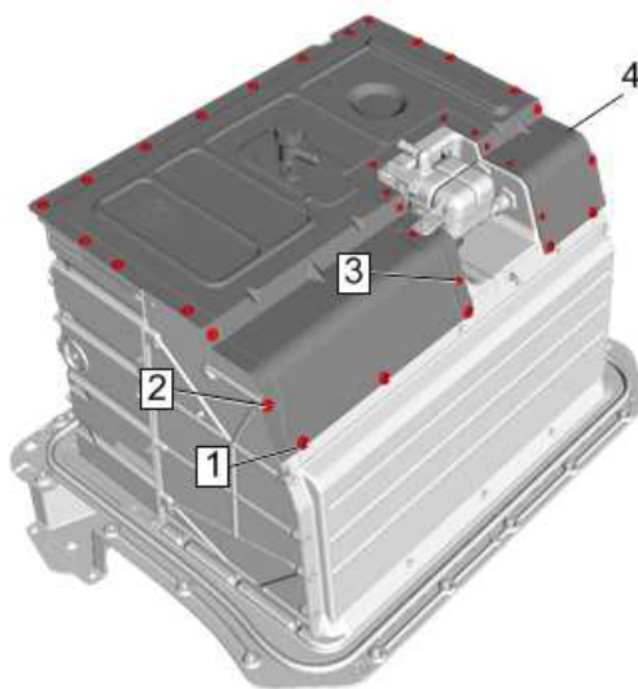


Fig. 72: High Voltage Battery Cover Nuts And Bolts
 Courtesy of GENERAL MOTORS COMPANY

- 4. High Voltage Battery Cover Bolt (2)» Install and tighten [18x] 9 N.m (80 lb in)
- 5. Drive Motor Battery Coolant/Air Separator Tray Bolt (3)» Install and tighten [11x] 2.5 N.m (22 lb in)
- 6. High Voltage Battery Cover Nut (1)» Install and tighten [5x] 9 N.m (80 lb in)
- 7. Engine Coolant Air Bleed Hose (2)» Install

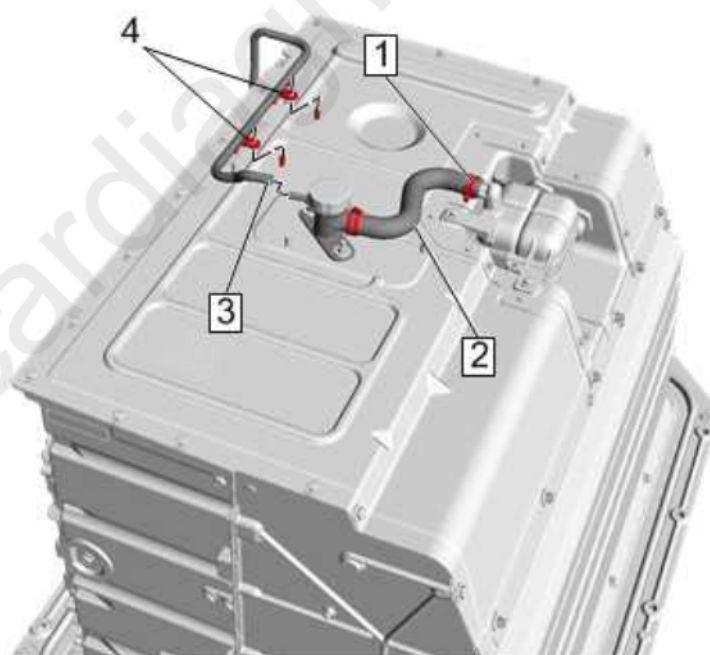


Fig. 73: Engine Coolant Air Bleed Hose Clamp
 Courtesy of GENERAL MOTORS COMPANY

- 8. Engine Coolant Air Bleed Hose Clamp (1)» Engage [2x] [Hose Clamp Replacement Guidelines - Spring Type](#)
- 9. Heater Vent Hose (3)» Install
- 10. Heater Vent Hose Retainer (4)» Engage
- 11. Body Wiring Harness Extension Harness (1)» Install - [Body Wiring Harness Extension Harness Replacement](#)

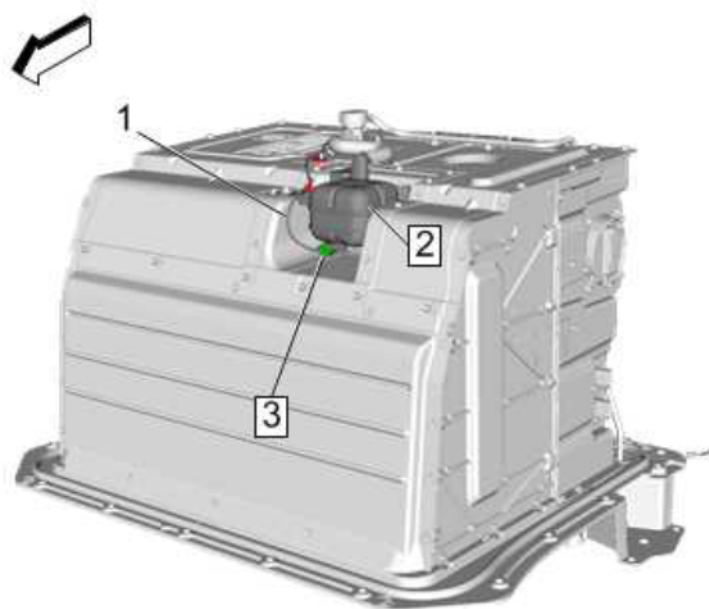


Fig. 74: Body Wiring Harness Extension Harness
 Courtesy of GENERAL MOTORS COMPANY

12. High Voltage Battery (1)» Install - [High Voltage Battery Replacement and Shipping Preparation](#)

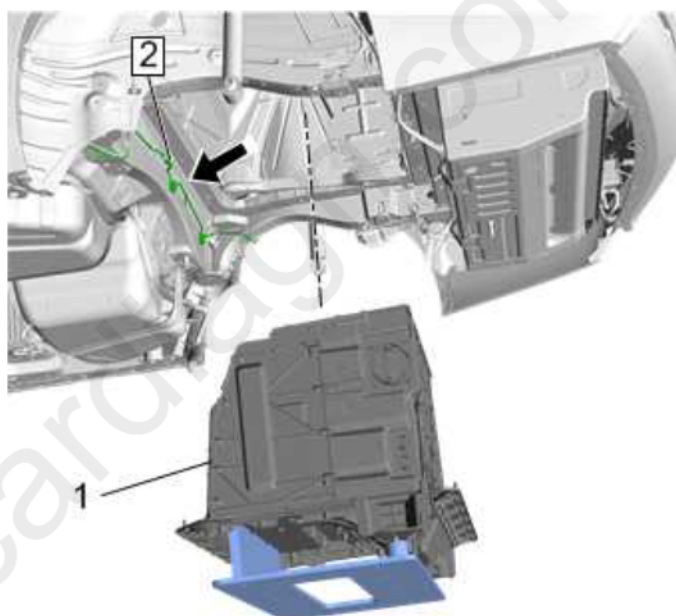


Fig. 75: High Voltage Battery
 Courtesy of GENERAL MOTORS COMPANY

13. Enable the high voltage system. Refer to [High Voltage Enabling](#)

HIGH VOLTAGE BATTERY COVER REPLACEMENT (LEFT SIDE)

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

- Safety glasses with appropriate side shields when within 50 feet of the vehicle, either indoors or outdoors
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors
 - Visually and functionally inspect the gloves before use.

- Wear the Insulation gloves at all times when working with the high voltage battery assembly, whether the system is energized or not.

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

Removal Procedure

1. Disable the high voltage system. Refer to [High Voltage Disabling](#)
2. High Voltage Battery (1)» Remove - [High Voltage Battery Replacement and Shipping Preparation](#)

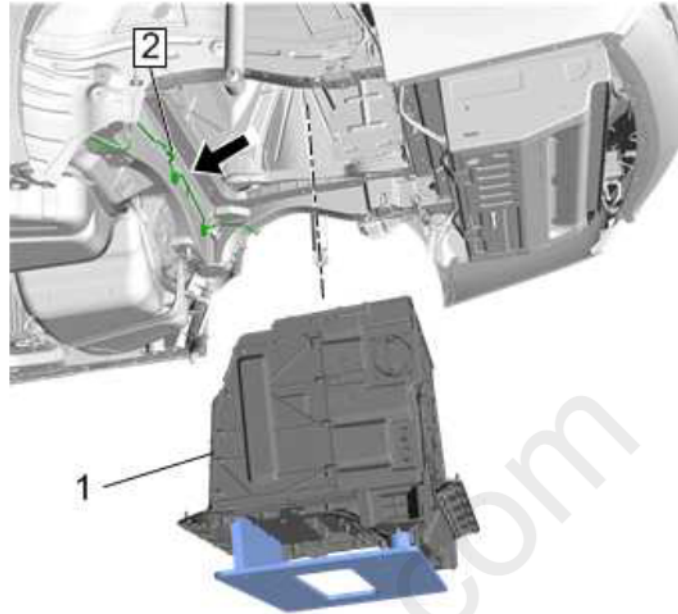


Fig. 76: High Voltage Battery

Courtesy of GENERAL MOTORS COMPANY

3. Body Wiring Harness Extension Harness (1)» Remove - [Body Wiring Harness Extension Harness Replacement](#)

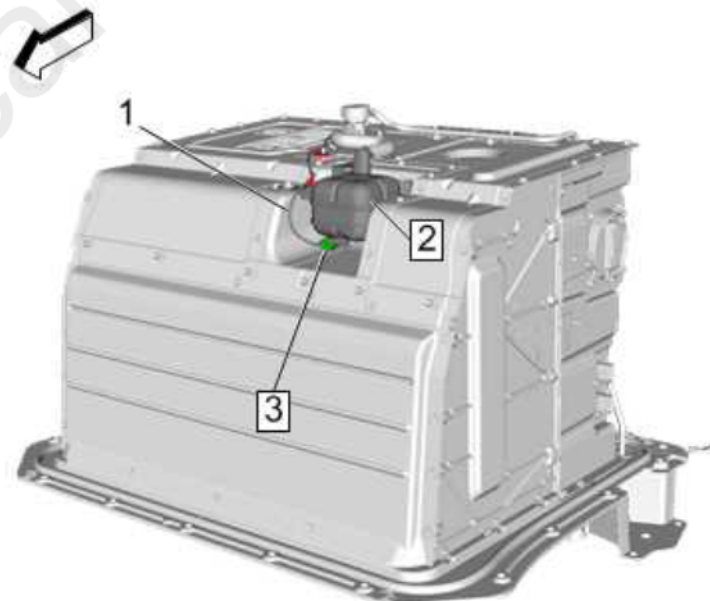


Fig. 77: Body Wiring Harness Extension Harness

Courtesy of GENERAL MOTORS COMPANY

4. Engine Coolant Air Bleed Hose Clamp (1)» Disengage - [Hose Clamp Replacement Guidelines - Spring Type](#)

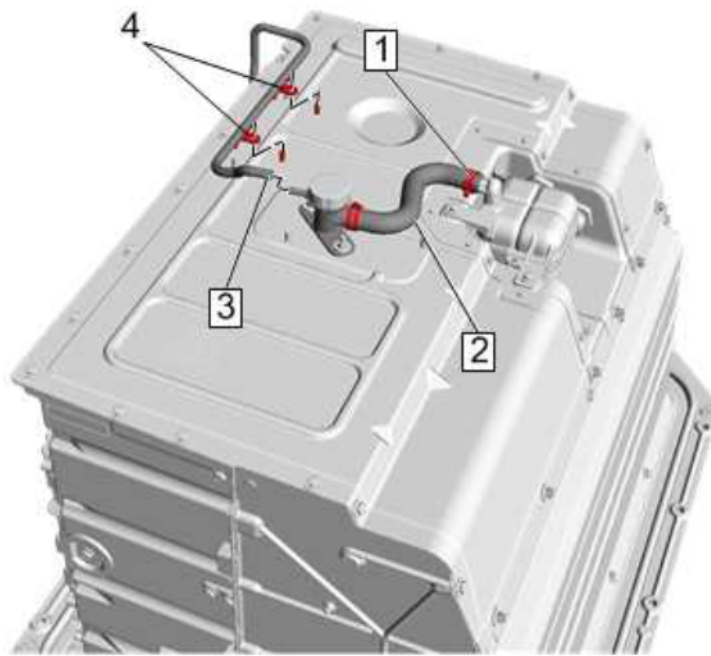


Fig. 78: Engine Coolant Air Bleed Hose Clamp
 Courtesy of GENERAL MOTORS COMPANY

- 5. Engine Coolant Air Bleed Hose (2)» Remove
- 6. Heater Vent Hose Retainer (4)» Disengage
- 7. Heater Vent Hose (3)» Remove
- 8. High Voltage Battery Cover Nut (1)» Remove [5x]

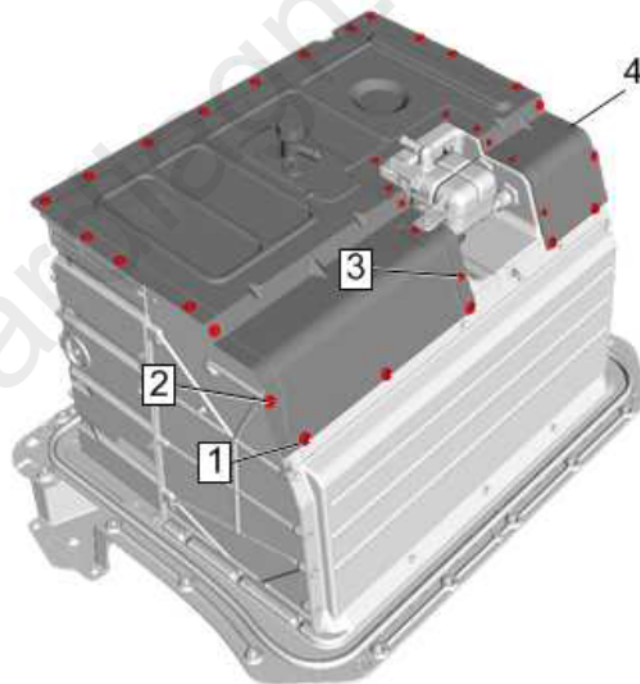


Fig. 79: High Voltage Battery Cover Nuts And Bolts
 Courtesy of GENERAL MOTORS COMPANY

- 9. High Voltage Battery Cover Bolt (2)» Remove [18x]
- 10. Drive Motor Battery Coolant/Air Separator Tray Bolt (3)» Remove [11x]
- 11. High Voltage Battery Cover (4)» Remove
- 12. High Voltage Battery Cover Bolt (1)» Remove [14x]

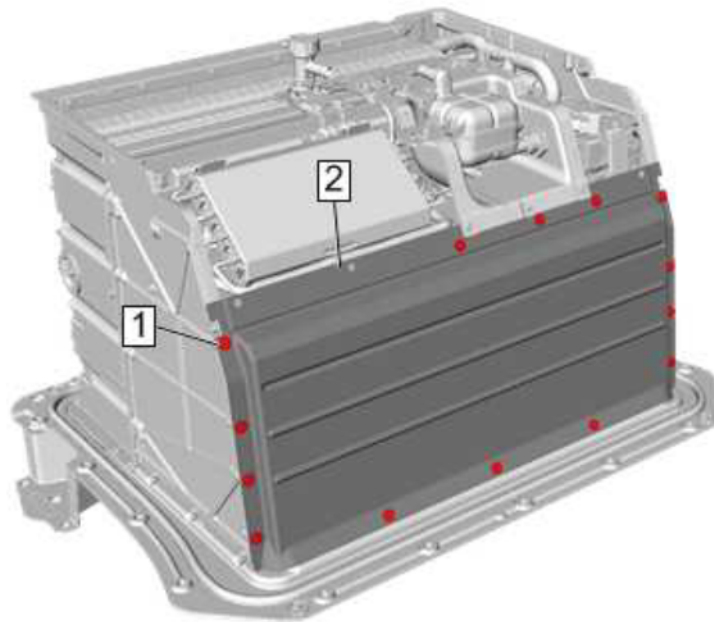


Fig. 80: High Voltage Battery Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

13. High Voltage Battery Cover (2)» Remove
14. High Voltage Battery Cover Bolt (2)» Remove [9x]

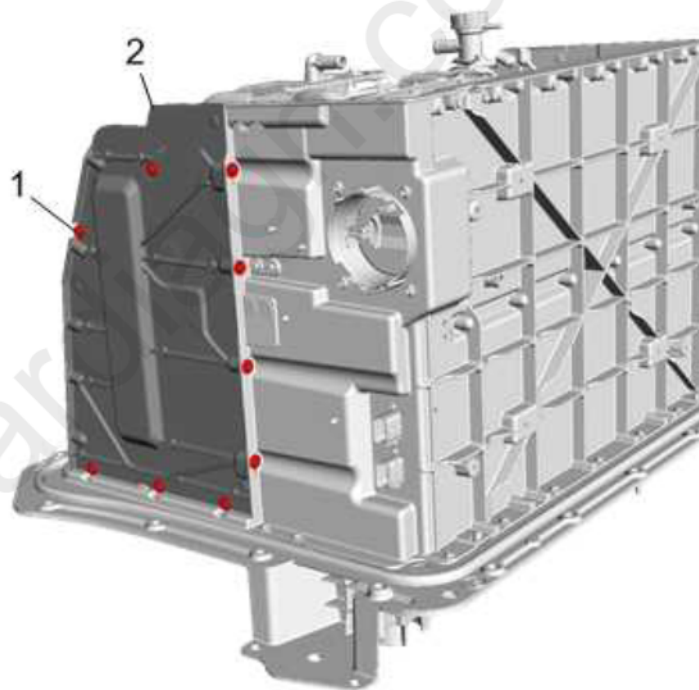


Fig. 81: High Voltage Battery Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

15. High Voltage Battery Cover (2)» Remove

Installation Procedure

1. High Voltage Battery Cover (2)» Install

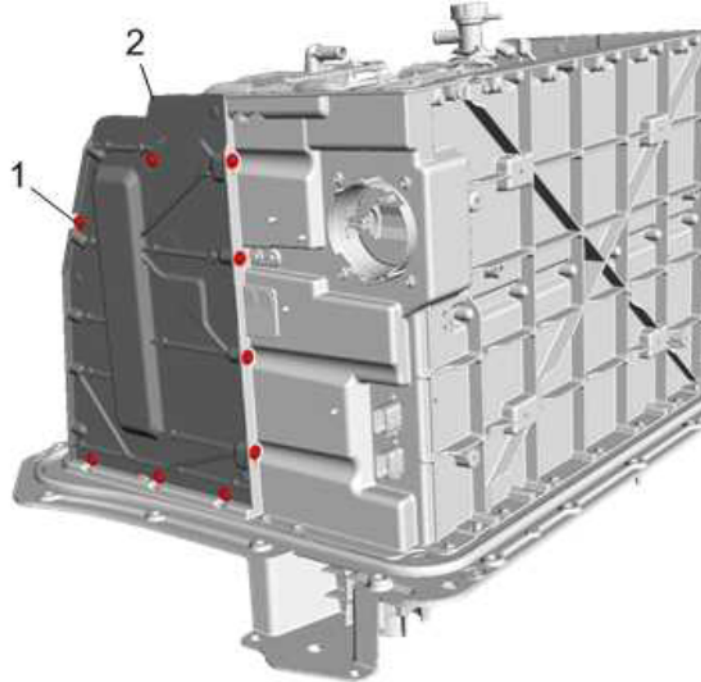


Fig. 82: High Voltage Battery Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

2. High Voltage Battery Cover Bolt (2)» Install and tighten [9x] 9 N.m (80 lb in)

CAUTION: Refer to **Fastener Caution**

3. High Voltage Battery Cover (2)» Install

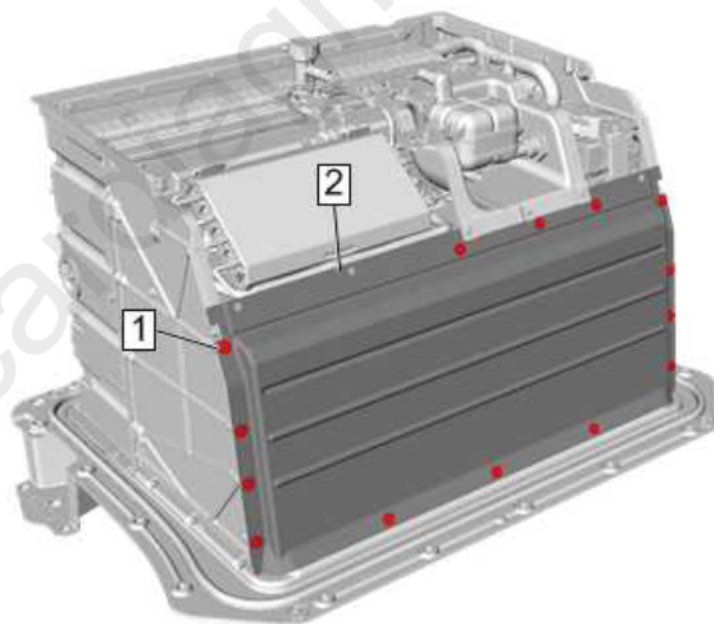


Fig. 83: High Voltage Battery Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

4. High Voltage Battery Cover Bolt (1)» Install and tighten [14x] 9 N.m (80 lb in)
5. High Voltage Battery Cover (4)» Install

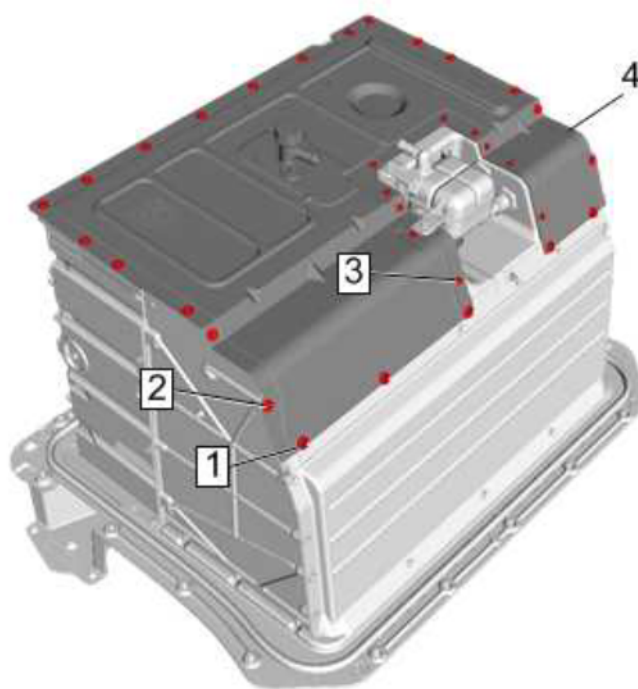


Fig. 84: High Voltage Battery Cover Nuts And Bolts
Courtesy of GENERAL MOTORS COMPANY

- 6. High Voltage Battery Cover Bolt (2)» Install and tighten [18x] 9 N.m (80 lb in)
- 7. Drive Motor Battery Coolant/Air Separator Tray Bolt (3)» Install and tighten [11x] 2.5 N.m (22 lb in)
- 8. High Voltage Battery Cover Nut (1)» Install and tighten [5x] 9 N.m (80 lb in)
- 9. Engine Coolant Air Bleed Hose (2)» Install

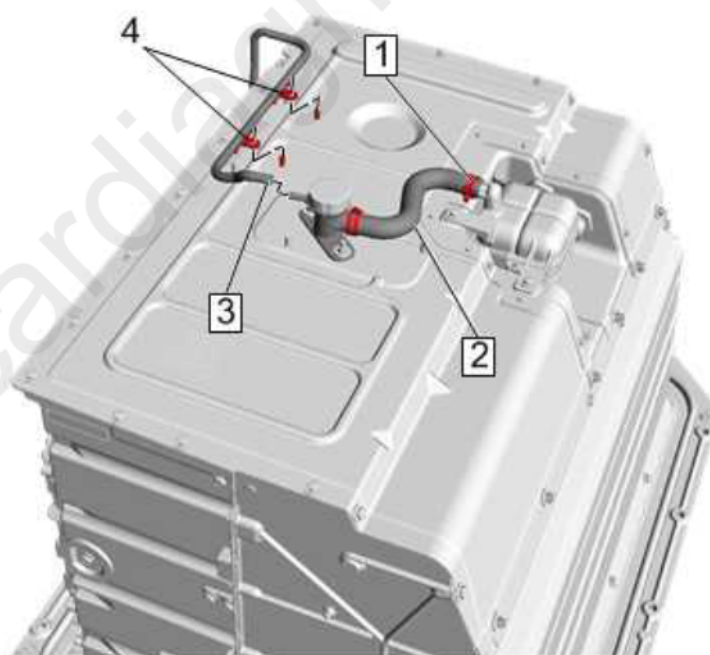


Fig. 85: Engine Coolant Air Bleed Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

- 10. Engine Coolant Air Bleed Hose Clamp (1)» Engage [2x] - **Hose Clamp Replacement Guidelines - Spring Type**
- 11. Heater Vent Hose (3)» Install
- 12. Heater Vent Hose Retainer (4)» Engage
- 13. Body Wiring Harness Extension Harness (1)» Install - **Body Wiring Harness Extension Harness Replacement**

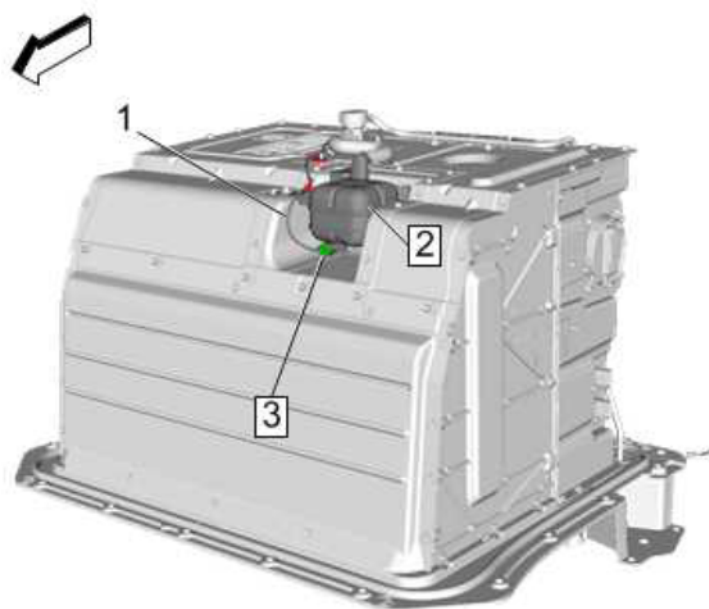


Fig. 86: Body Wiring Harness Extension Harness
 Courtesy of GENERAL MOTORS COMPANY

14. High Voltage Battery (1)» Install - [High Voltage Battery Replacement and Shipping Preparation](#)

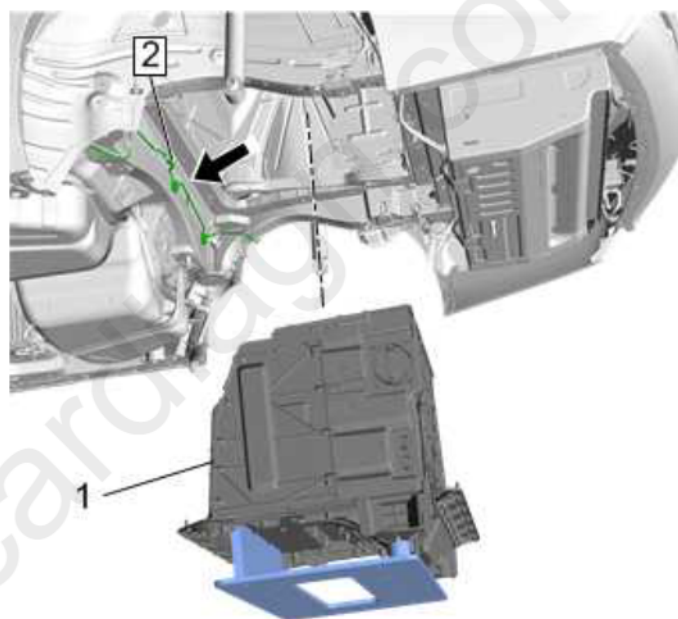


Fig. 87: High Voltage Battery
 Courtesy of GENERAL MOTORS COMPANY

15. Enable the high voltage system. Refer to [High Voltage Enabling](#)

HIGH VOLTAGE BATTERY COVER REPLACEMENT (RIGHT SIDE)

WARNING:

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

- Safety glasses with appropriate side shields when within 50 feet of the vehicle, either indoors or outdoors
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors
 - Visually and functionally inspect the gloves before use.

- Wear the Insulation gloves at all times when working with the high voltage battery assembly, whether the system is energized or not.

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

Removal Procedure

1. Disable the high voltage system. Refer to [High Voltage Disabling](#)
2. High Voltage Battery (1) » Remove - [High Voltage Battery Replacement and Shipping Preparation](#)

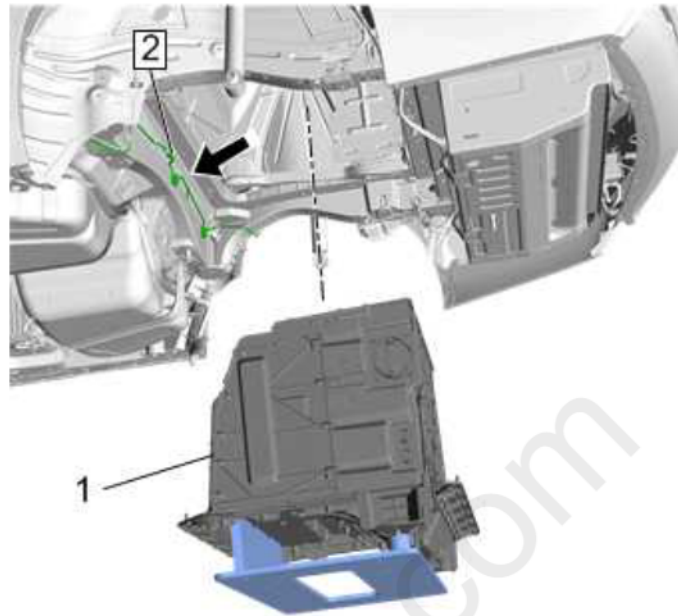


Fig. 88: High Voltage Battery

Courtesy of GENERAL MOTORS COMPANY

3. Body Wiring Harness Extension Harness (1) » Remove - [Body Wiring Harness Extension Harness Replacement](#)

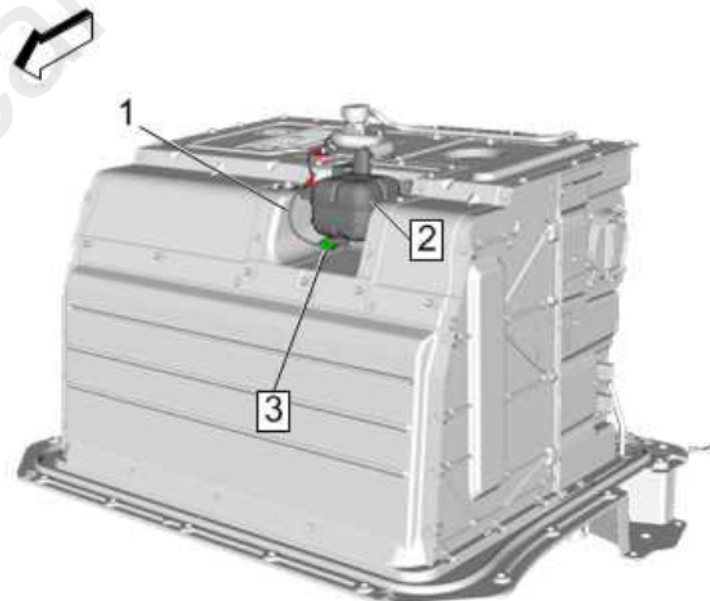


Fig. 89: Body Wiring Harness Extension Harness

Courtesy of GENERAL MOTORS COMPANY

4. Engine Coolant Air Bleed Hose Clamp (1) » Disengage [2x] - [Hose Clamp Replacement Guidelines - Spring Type](#)

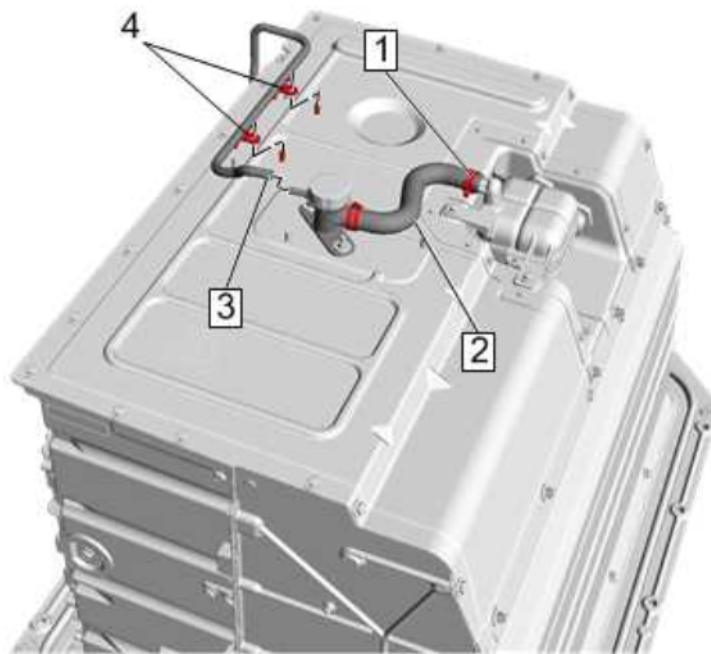


Fig. 90: Engine Coolant Air Bleed Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Engine Coolant Air Bleed Hose (2)» Remove
6. Heater Vent Hose Retainer (4)» Disengage
7. Heater Vent Hose (3)» Remove
8. High Voltage Battery Cover Nut (1)» Remove [5x]

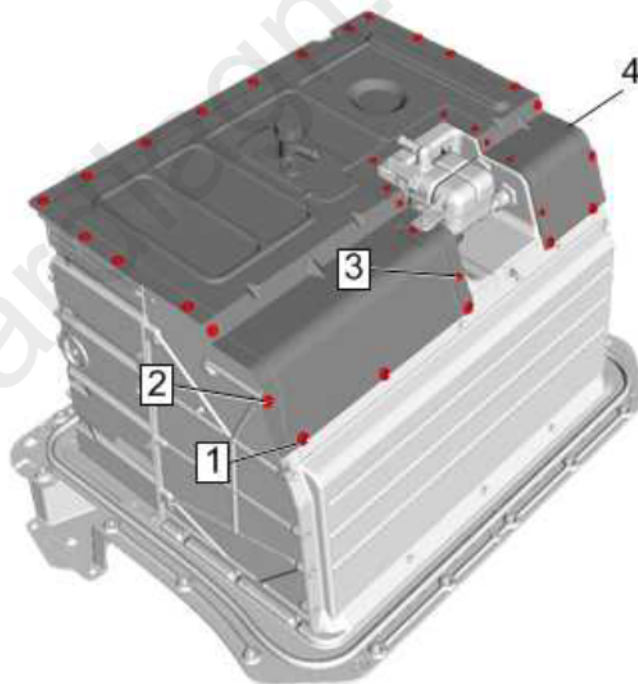


Fig. 91: High Voltage Battery Cover Nuts And Bolts
Courtesy of GENERAL MOTORS COMPANY

9. High Voltage Battery Cover Bolt (2)» Remove [18x]
10. Drive Motor Battery Coolant/Air Separator Tray Bolt (3)» Remove [11x]
11. High Voltage Battery Cover (4)» Remove
12. High Voltage Battery Cover Bolt (1)» Remove [14x]

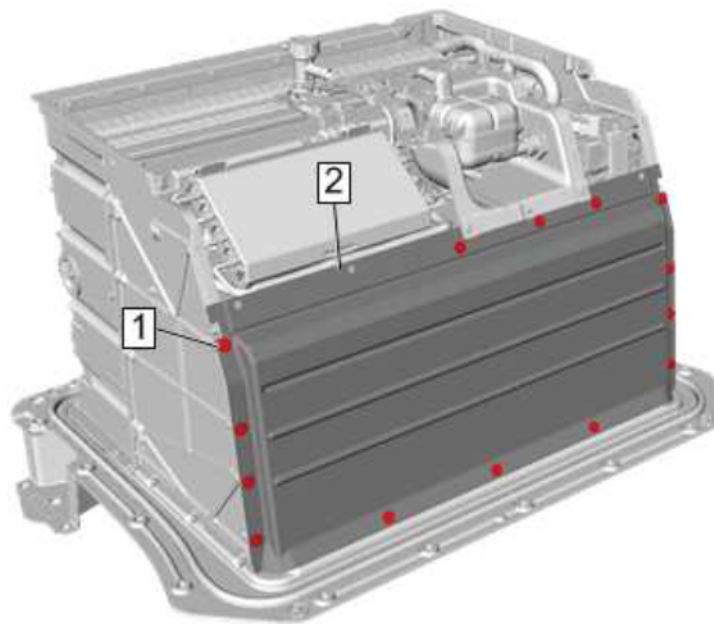


Fig. 92: High Voltage Battery Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

13. High Voltage Battery Cover (2)» Remove
14. High Voltage Battery Cover Nut (1)» Remove

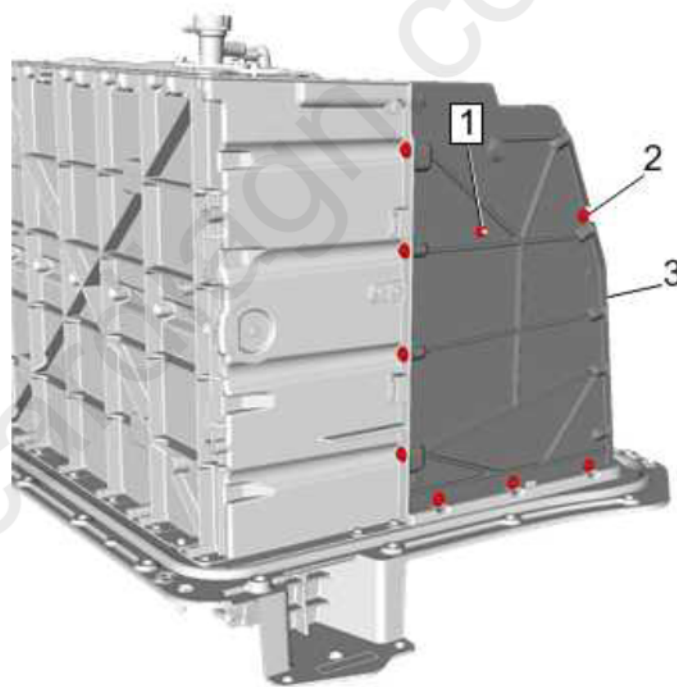


Fig. 93: High Voltage Battery Cover Bolts And Nut
Courtesy of GENERAL MOTORS COMPANY

15. High Voltage Battery Cover Bolt (2)» Remove [8x]
16. High Voltage Battery Cover (3)» Remove

Installation Procedure

1. High Voltage Battery Cover (3)» Install

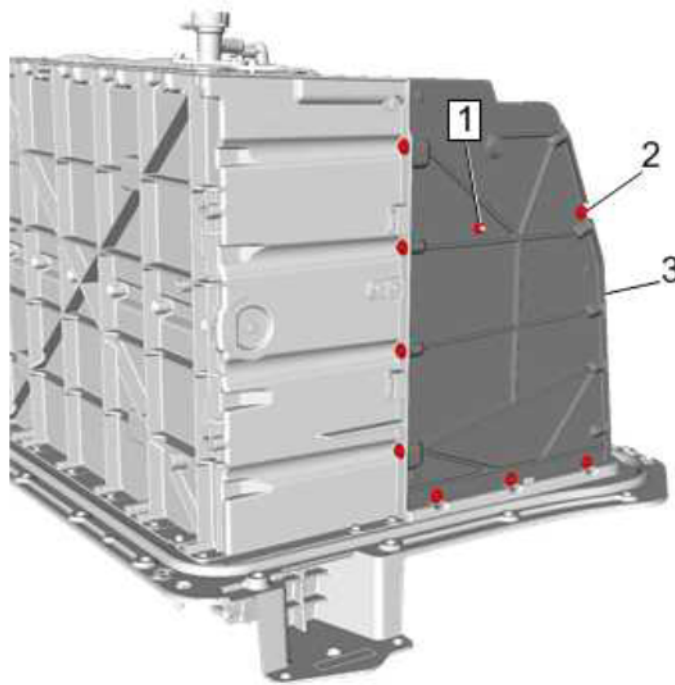


Fig. 94: High Voltage Battery Cover Bolts And Nut
Courtesy of GENERAL MOTORS COMPANY

2. High Voltage Battery Cover Bolt (2)» Install and tighten [8x] 9 N.m (80 lb in)

CAUTION: Refer to **Fastener Caution**

3. High Voltage Battery Cover Nut (1)» Install and tighten 9 N.m (80 lb in)
4. High Voltage Battery Cover (2)» Install

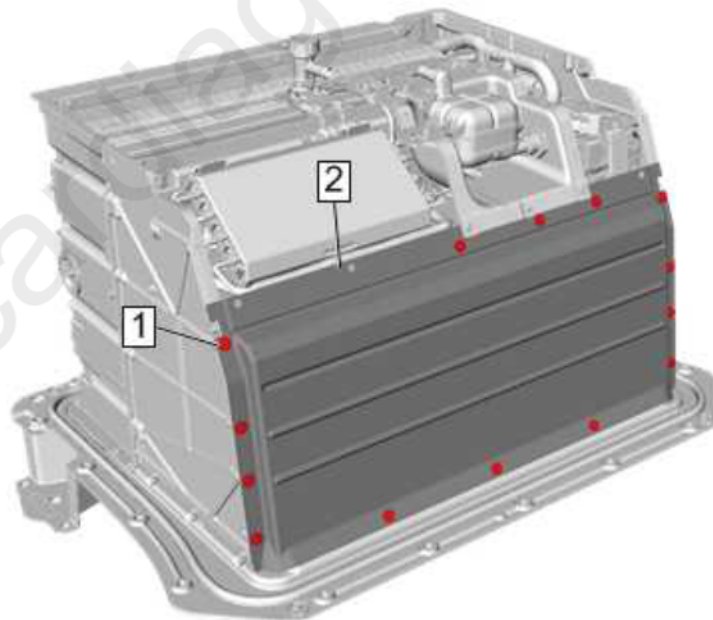


Fig. 95: High Voltage Battery Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

5. High Voltage Battery Cover Bolt (1)» Install and tighten [14x] 9 N.m (80 lb in)
6. High Voltage Battery Cover (4)» Install

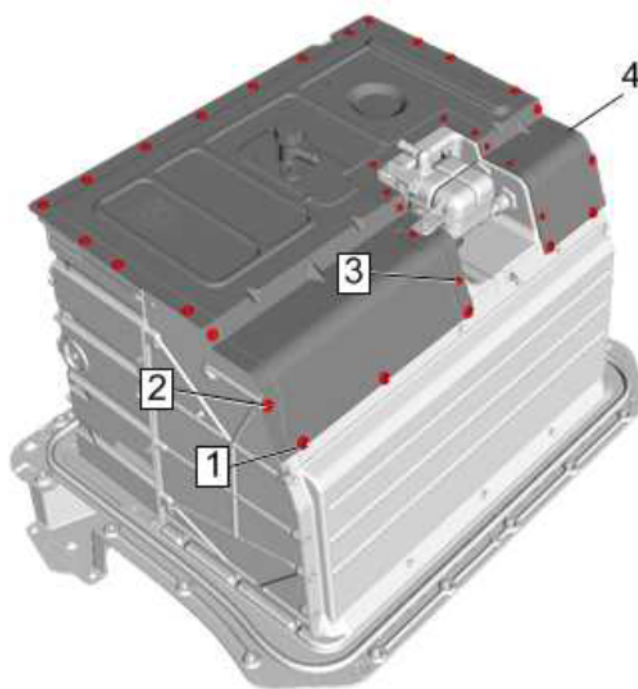


Fig. 96: High Voltage Battery Cover Nuts And Bolts
Courtesy of GENERAL MOTORS COMPANY

7. High Voltage Battery Cover Bolt (2)» Install and tighten [18x] 9 N.m (80 lb in)
8. Drive Motor Battery Coolant/Air Separator Tray Bolt (3)» Install and tighten [11x] 2.5 N.m (22 lb in)
9. High Voltage Battery Cover Nut (1)» Install and tighten [5x] 9 N.m (80 lb in)
10. Engine Coolant Air Bleed Hose (2)» Install

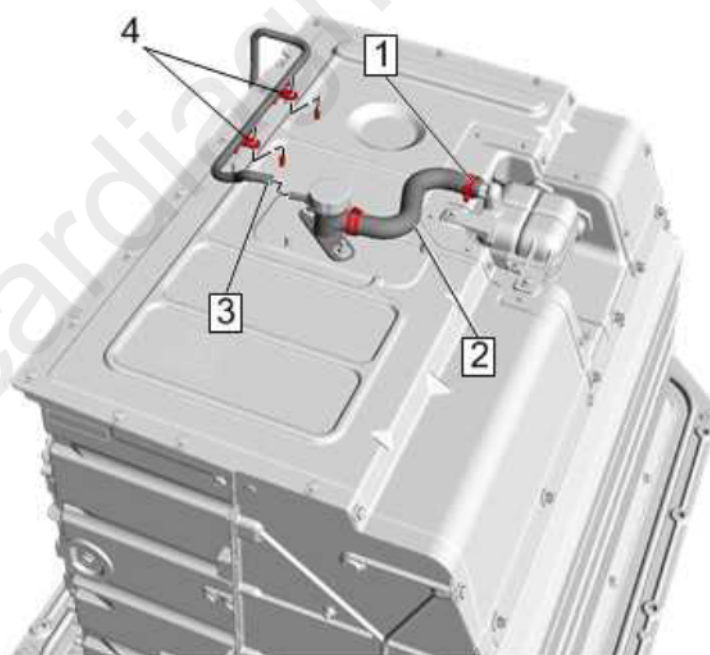


Fig. 97: Engine Coolant Air Bleed Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

11. Engine Coolant Air Bleed Hose Clamp (1)» Engage [2x] - **Hose Clamp Replacement Guidelines - Spring Type**
12. Heater Vent Hose (3)» Install
13. Heater Vent Hose Retainer (4)» Engage
14. Body Wiring Harness Extension Harness (1)» Install - **Body Wiring Harness Extension Harness Replacement**

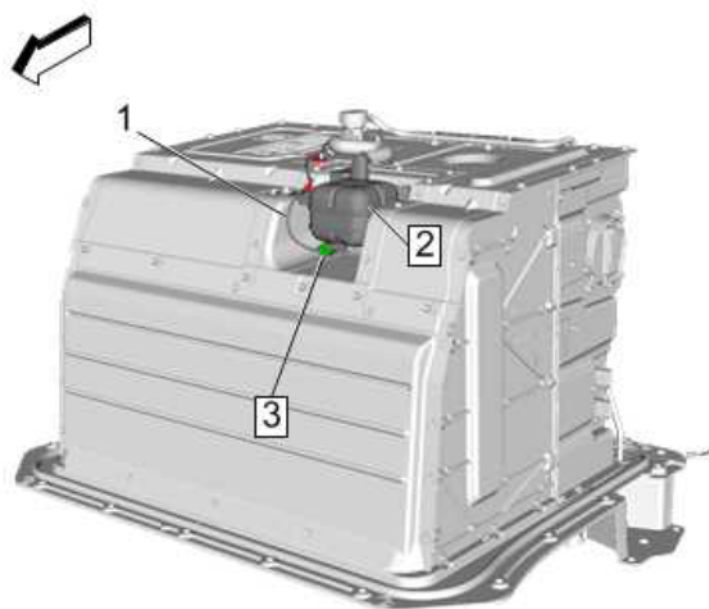


Fig. 98: Body Wiring Harness Extension Harness
 Courtesy of GENERAL MOTORS COMPANY

15. High Voltage Battery (1)» Install - [High Voltage Battery Replacement and Shipping Preparation](#)

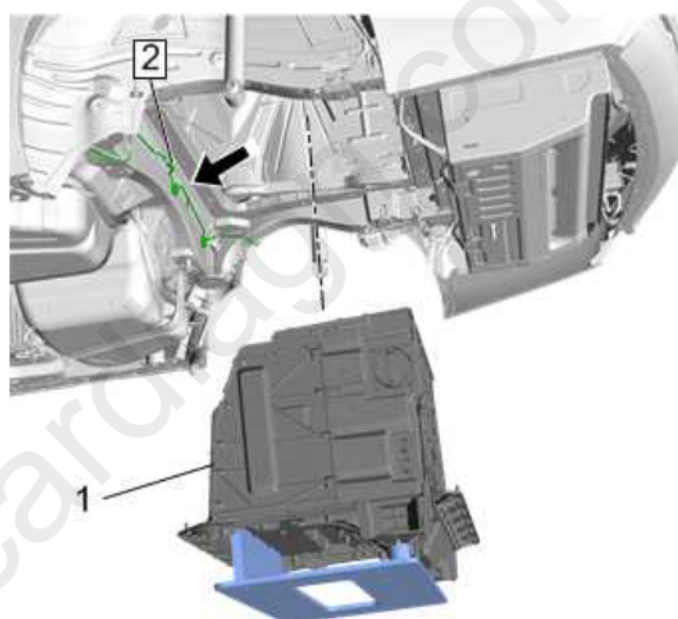


Fig. 99: High Voltage Battery
 Courtesy of GENERAL MOTORS COMPANY

16. Enable the high voltage system. Refer to [High Voltage Enabling](#)

HIGH VOLTAGE BATTERY COVER SEAL REPLACEMENT

Removal Procedure

1. Disable the high voltage system. Refer to [High Voltage Disabling](#)
2. High Voltage Battery (1)» Remove - [High Voltage Battery Replacement and Shipping Preparation](#)

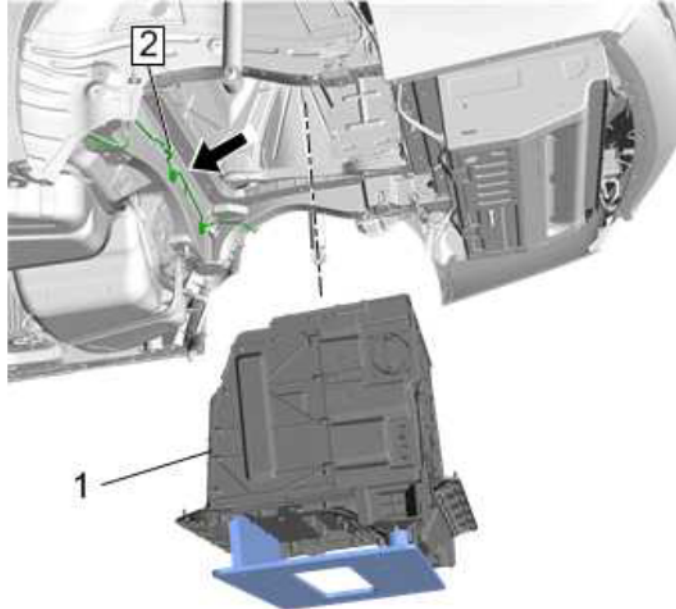


Fig. 100: High Voltage Battery

Courtesy of GENERAL MOTORS COMPANY

3. High Voltage Battery Seal (1)» Remove

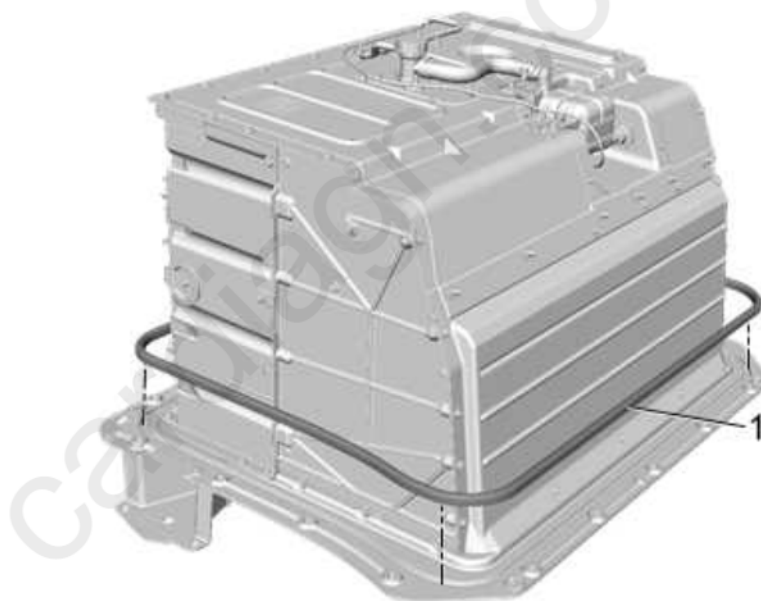


Fig. 101: High Voltage Battery Seal

Courtesy of GENERAL MOTORS COMPANY

4. Remove and clean any adhesive remaining on the high voltage battery tray.

Installation Procedure

1. High Voltage Battery Seal (1)» Install

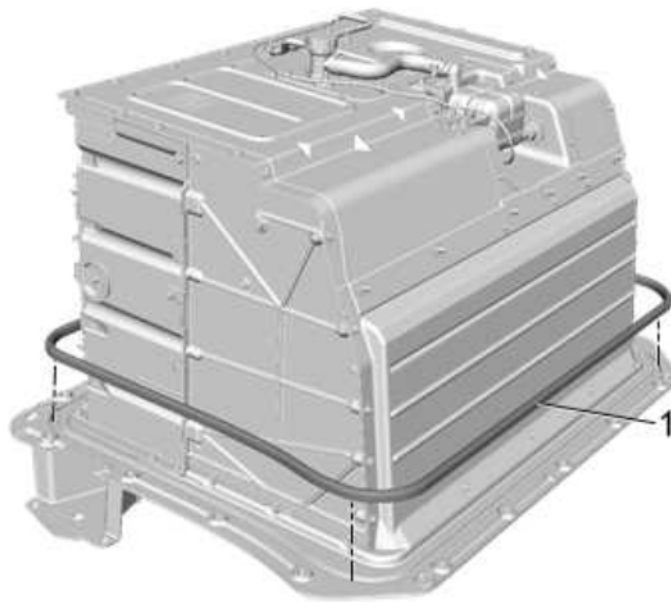


Fig. 102: High Voltage Battery Seal

Courtesy of GENERAL MOTORS COMPANY

2. High Voltage Battery (1)» Install - [High Voltage Battery Replacement and Shipping Preparation](#)

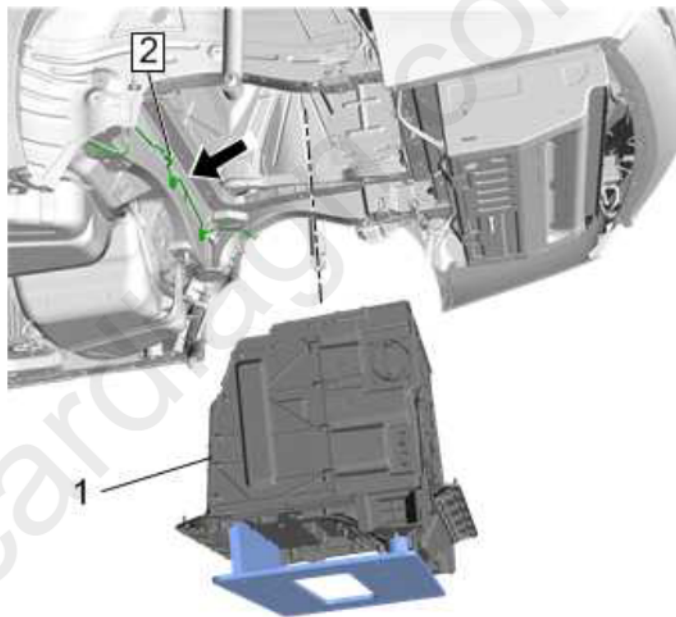


Fig. 103: High Voltage Battery

Courtesy of GENERAL MOTORS COMPANY

3. Enable the high voltage system. Refer to [High Voltage Enabling](#)

BATTERY ENERGY CONTROL MODULE REPLACEMENT

WARNING:

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

- Safety glasses with appropriate side shields when within 50 feet of the vehicle, either indoors or outdoors
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors
 - Visually and functionally inspect the gloves before use.

- Wear the Insulation gloves at all times when working with the high voltage battery assembly, whether the system is energized or not.

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

Removal Procedure

1. Disable the high voltage system. Refer to [High Voltage Disabling](#)
2. High Voltage Battery (1) » Remove - [High Voltage Battery Replacement and Shipping Preparation](#)

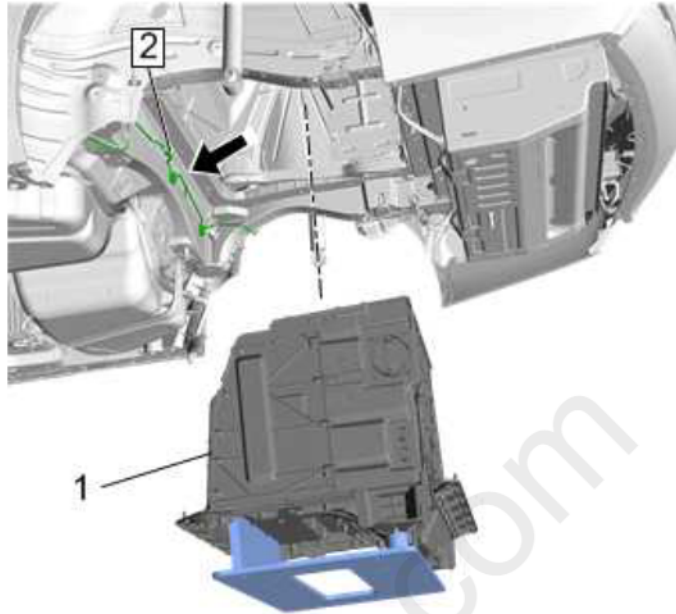


Fig. 104: High Voltage Battery

Courtesy of GENERAL MOTORS COMPANY

3. High Voltage Top Cover (4) » Remove - [High Voltage Battery Cover Replacement \(Top Cover\)](#)[High Voltage Battery Cover Replacement \(Front Cover\)](#)[High Voltage Battery Cover Replacement \(Left Side\)](#)[High Voltage Battery Cover Replacement \(Right Side\)](#)

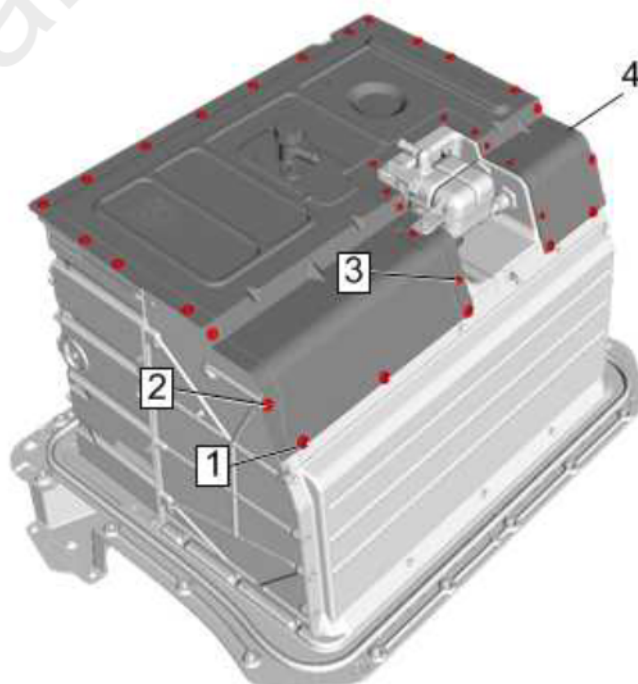


Fig. 105: High Voltage Battery Cover Nuts And Bolts

Courtesy of GENERAL MOTORS COMPANY

4. Release the retaining tabs. (1)

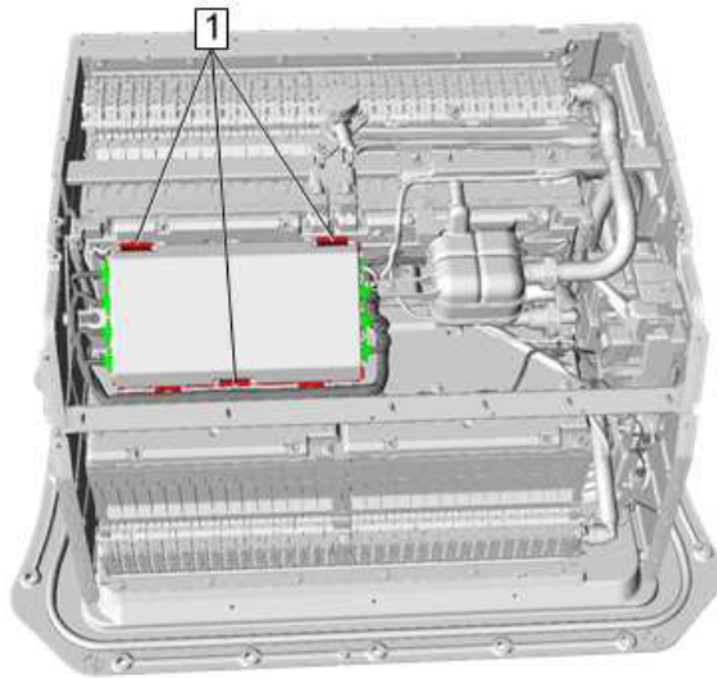


Fig. 106: Retaining Tabs

Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the electrical connectors in the sequence shown.

CAUTION:

The battery energy control modules internal cell balancing circuitry is powered by the cell group voltage sense circuits. In order to prevent an unrecoverable, unbalanced Hybrid/EV battery section or internal control module damage, always take the following actions:

1. Disconnect ALL of the battery energy control module connectors prior to disconnecting any Hybrid/EV battery section connector.
2. Reconnect all the Hybrid/EV battery section connectors prior to reconnecting the battery energy control module connectors.
3. Disconnect and reconnect the battery energy control module connectors ONLY in the sequence provided in Repair Instructions.

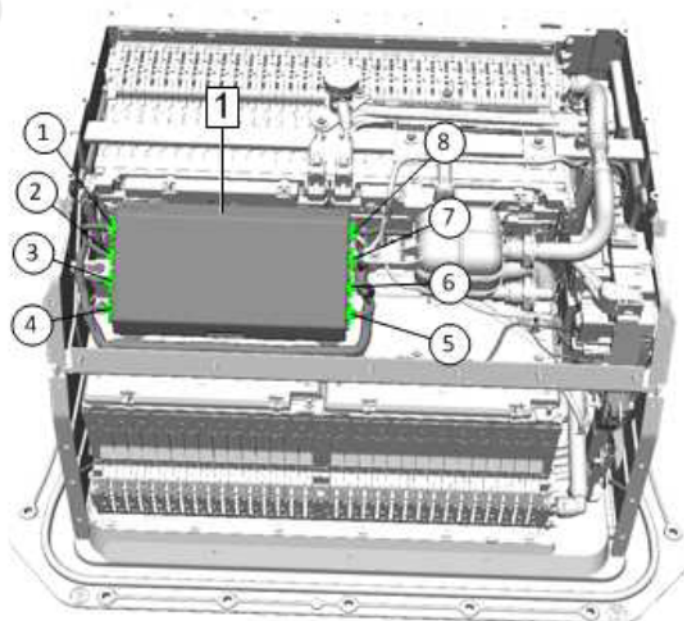


Fig. 107: Battery Energy Control Module And Electrical Connectors

Courtesy of GENERAL MOTORS COMPANY

6. Battery Energy Control Module (1) Remove

1. Connect the electrical connectors in the sequence shown.

CAUTION:

The battery energy control modules internal cell balancing circuitry is powered by the cell group voltage sense circuits. In order to prevent an unrecoverable, unbalanced Hybrid/EV battery section or internal control module damage, always take the following actions:

1. Disconnect ALL of the battery energy control module connectors prior to disconnecting any Hybrid/EV battery section connector.
2. Reconnect all the Hybrid/EV battery section connectors prior to reconnecting the battery energy control module connectors.
3. Disconnect and reconnect the battery energy control module connectors ONLY in the sequence provided in Repair Instructions.

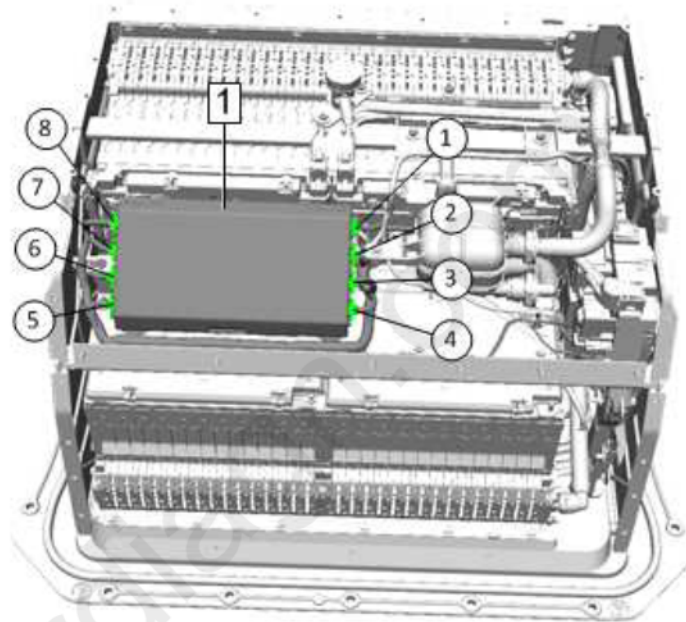


Fig. 108: Battery Energy Control Module And Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

2. Engage the retaining tabs. (1)

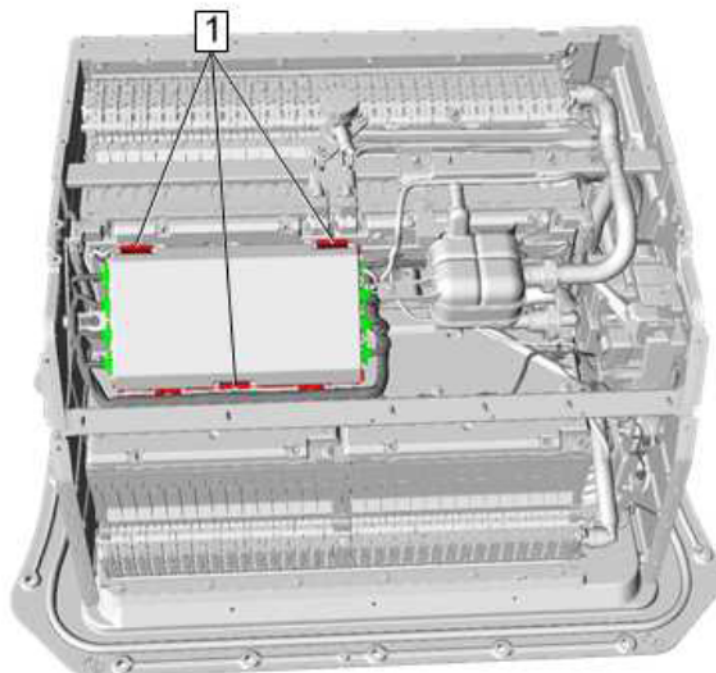


Fig. 109: Retaining Tabs

Courtesy of GENERAL MOTORS COMPANY

3. High Voltage Top Cover (4)» Install - [High Voltage Battery Cover Replacement \(Top Cover\)](#)[High Voltage Battery Cover Replacement \(Front Cover\)](#)[High Voltage Battery Cover Replacement \(Left Side\)](#)[High Voltage Battery Cover Replacement \(Right Side\)](#)

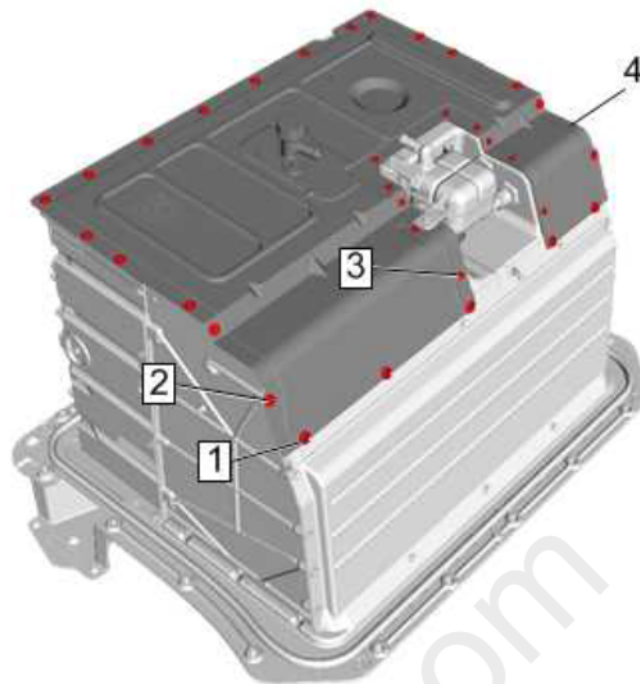


Fig. 110: High Voltage Battery Cover Nuts And Bolts

Courtesy of GENERAL MOTORS COMPANY

4. High Voltage Battery (1)» Install - [High Voltage Battery Replacement and Shipping Preparation](#)

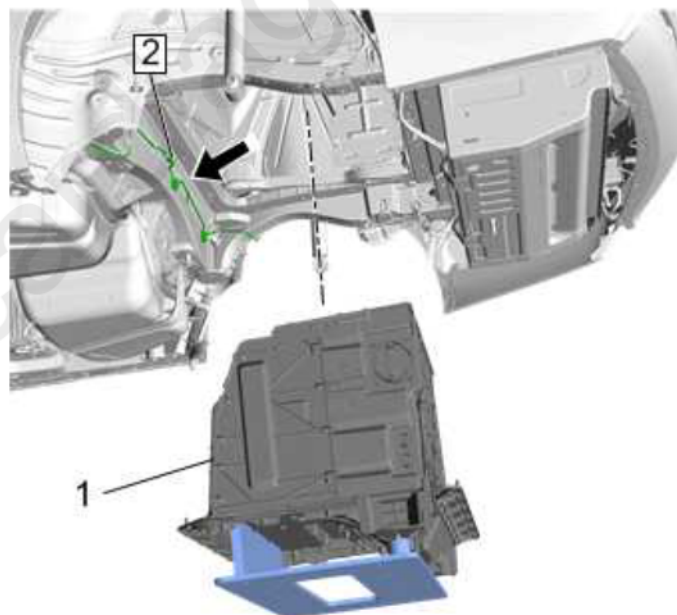


Fig. 111: High Voltage Battery

Courtesy of GENERAL MOTORS COMPANY

5. Enable the high voltage system. Refer to [High Voltage Enabling](#)
6. Reprogram the battery energy control module, refer to [Control Module References](#)

HYBRID POWERTRAIN CONTROL MODULE 2 REPLACEMENT

Removal Procedure

1. Drive Motor Battery CoverA» Remove - [Drive Motor Battery Cover Replacement \(With HP9\)](#)
2. Disable the high voltage system. Refer to [High Voltage Disabling](#)
3. Electrical Connector (1)» Disconnect [2x]

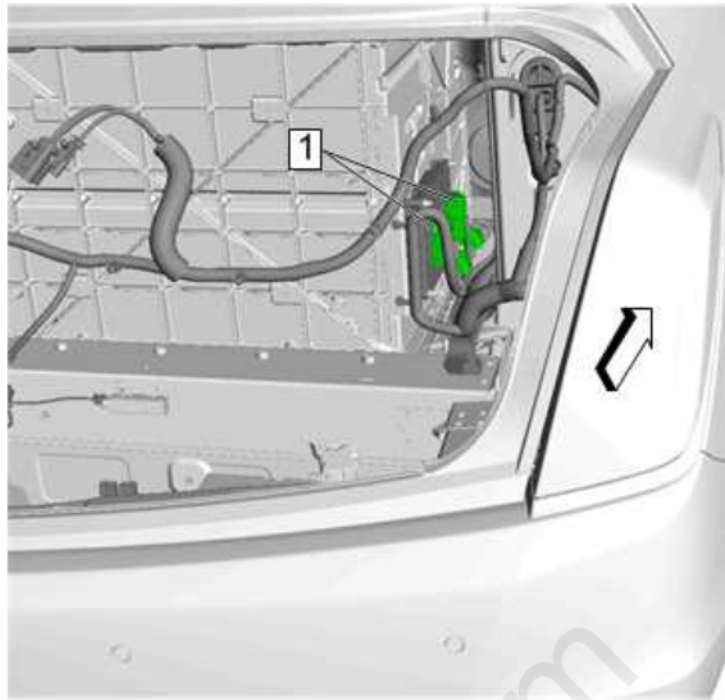


Fig. 112: Electrical Connectors

Courtesy of GENERAL MOTORS COMPANY

4. Hybrid Powertrain Control Module 2 Mounting Nut (1)» Remove [4x]

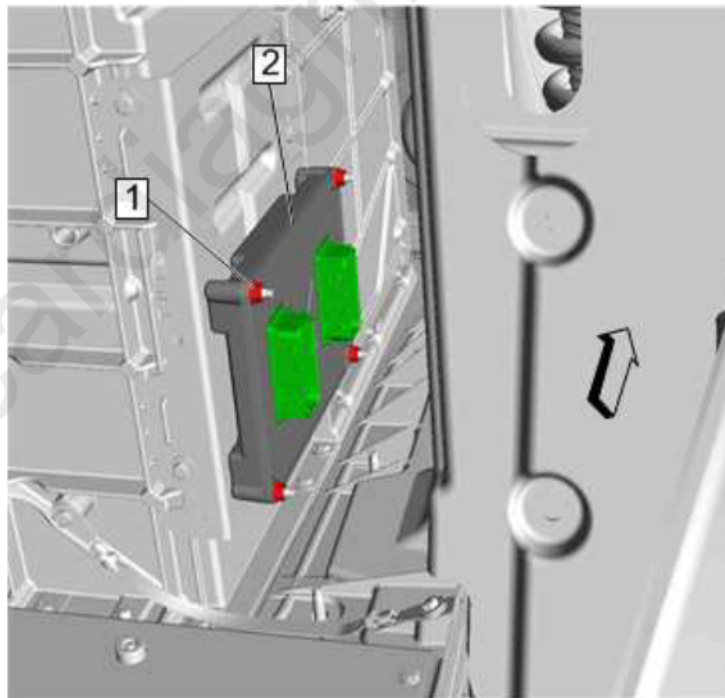


Fig. 113: Hybrid Powertrain Control Module 2 Mounting Nuts

Courtesy of GENERAL MOTORS COMPANY

5. Hybrid Powertrain Control Module 2 (2)» Remove

Installation Procedure

1. Hybrid Powertrain Control Module 2 (2)» Install

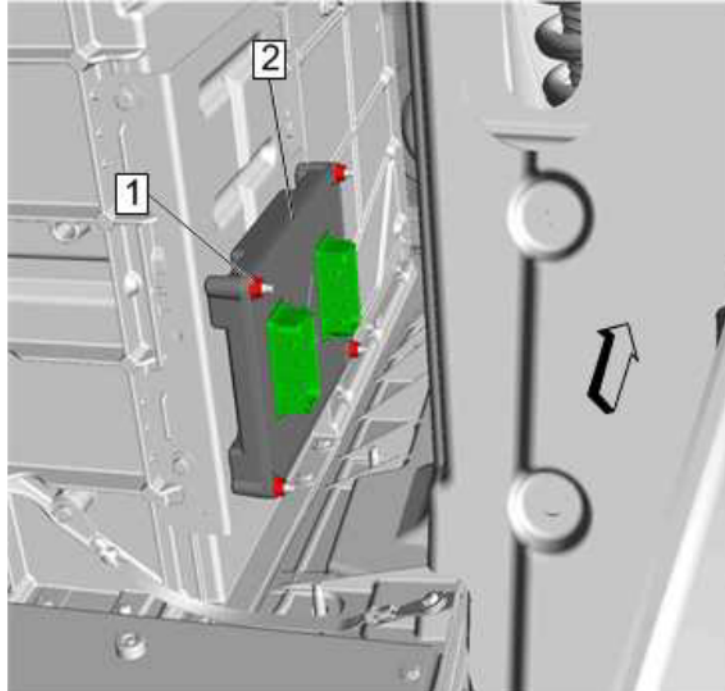


Fig. 114: Hybrid Powertrain Control Module 2 Mounting Nuts
 Courtesy of GENERAL MOTORS COMPANY

2. Hybrid Powertrain Control Module 2 Mounting Nut (1)» Install and tighten [4x] 9 N.m (80 lb in)

CAUTION: Refer to [Fastener Caution](#)

3. Electrical Connector (1)» Connect [2x]

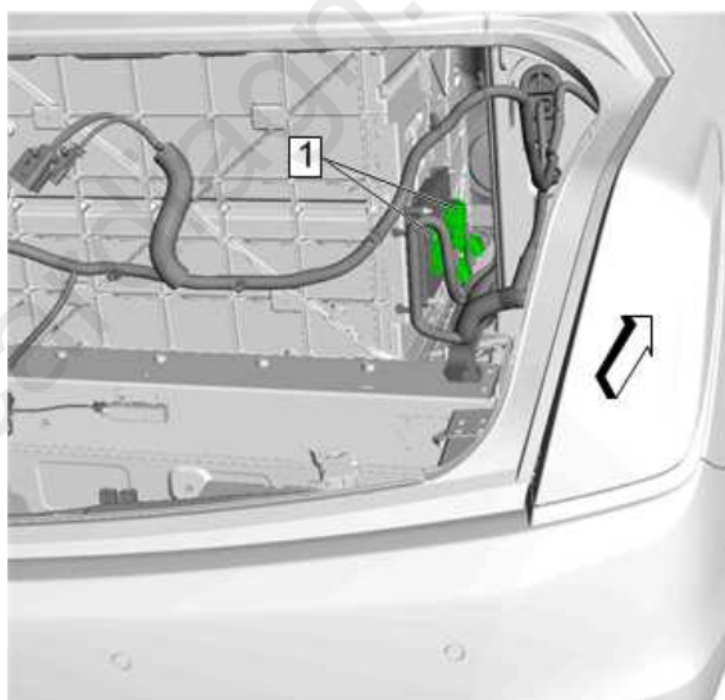


Fig. 115: Electrical Connectors
 Courtesy of GENERAL MOTORS COMPANY

4. Enable the high voltage system. Refer to [High Voltage Enabling](#)
5. Drive Motor Battery Cover» Install - [Drive Motor Battery Cover Replacement \(With HP9\)](#)
6. Reprogram the hybrid powertrain control module 2, refer to [Control Module References](#)

300-VOLT BATTERY POSITIVE AND NEGATIVE CABLE REPLACEMENT

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.

Removal Procedure

1. Disable the high voltage system. Refer to [High Voltage Disabling](#)
2. Fuel Tank (1)» Remove - [Fuel Tank Replacement](#)

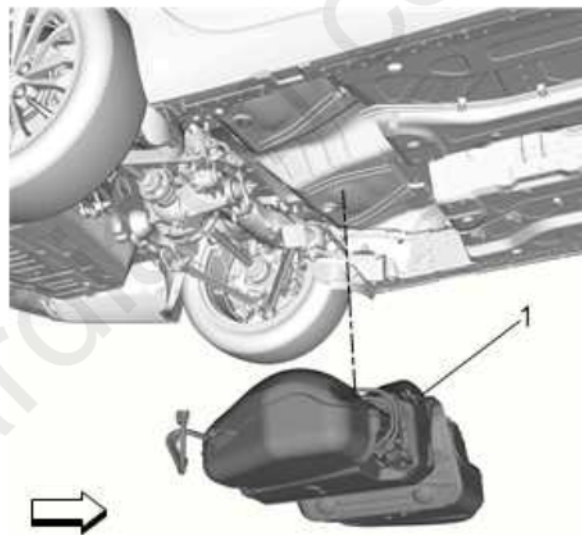


Fig. 116: Fuel Tank

Courtesy of GENERAL MOTORS COMPANY

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

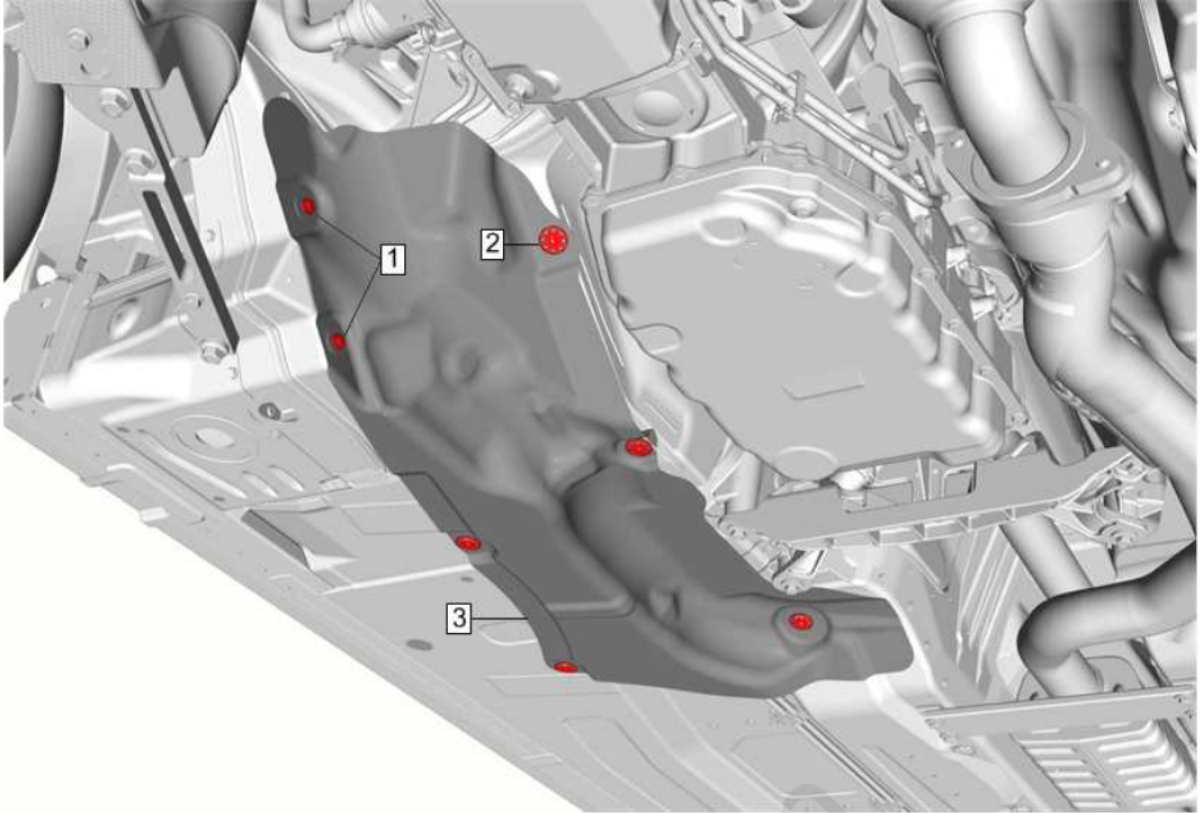


Fig. 117: Front Body Exhaust Heat Shield
 Courtesy of GENERAL MOTORS COMPANY

4. Electrical Connector (1) » Disconnect [5x]

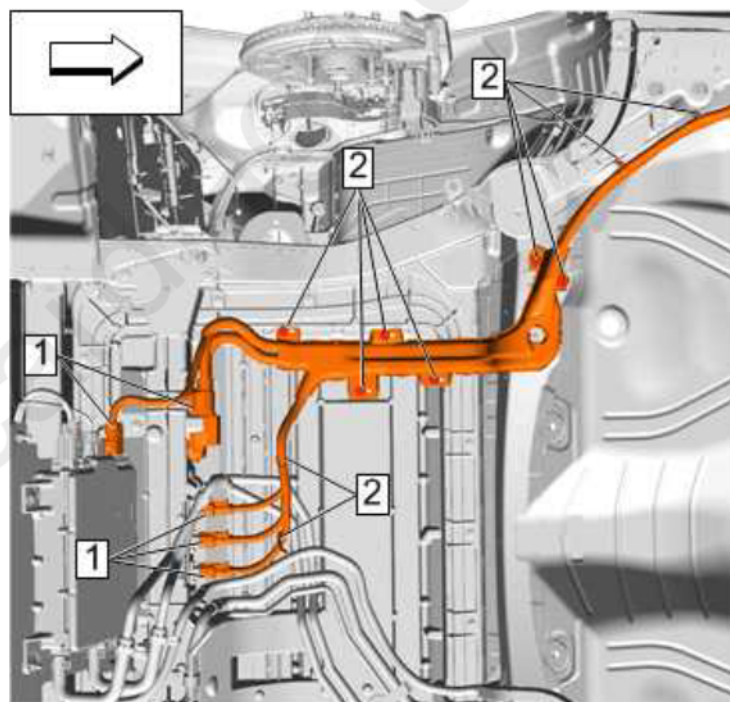


Fig. 118: Electrical Connectors
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Rear cradle and suspension removed for clarity.

- 5. Retainer (2) » Disengage [10x]
- 6. Battery Positive and Negative Cable Bolt (1) » Remove

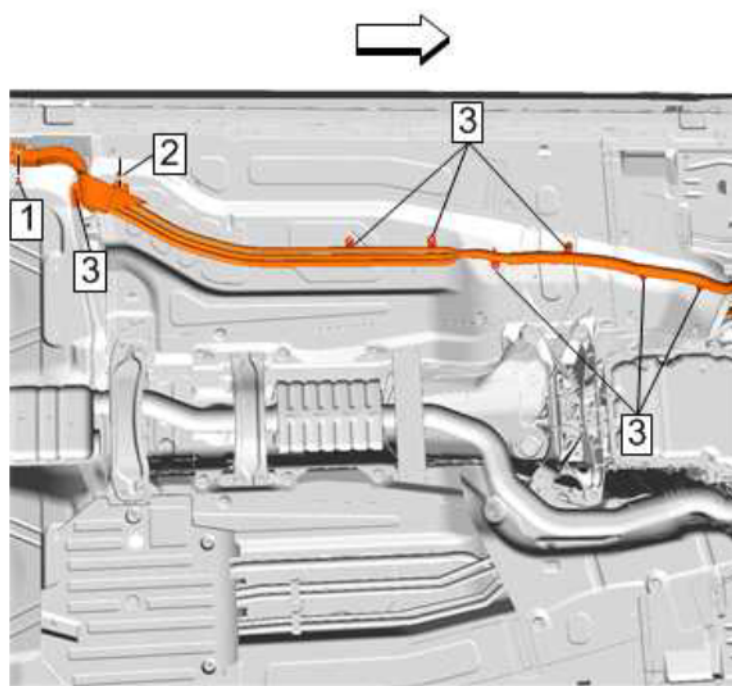


Fig. 119: Battery Positive and Negative Cable Bolt And Nut With Retainers
 Courtesy of GENERAL MOTORS COMPANY

- 7. Battery Positive and Negative Cable Nut (2)» Remove
- 8. Retainer (3)» Disengage [7x]
- 9. Air Inlet Grille Panel (2)» Remove - [Air Inlet Grille Panel Replacement](#)

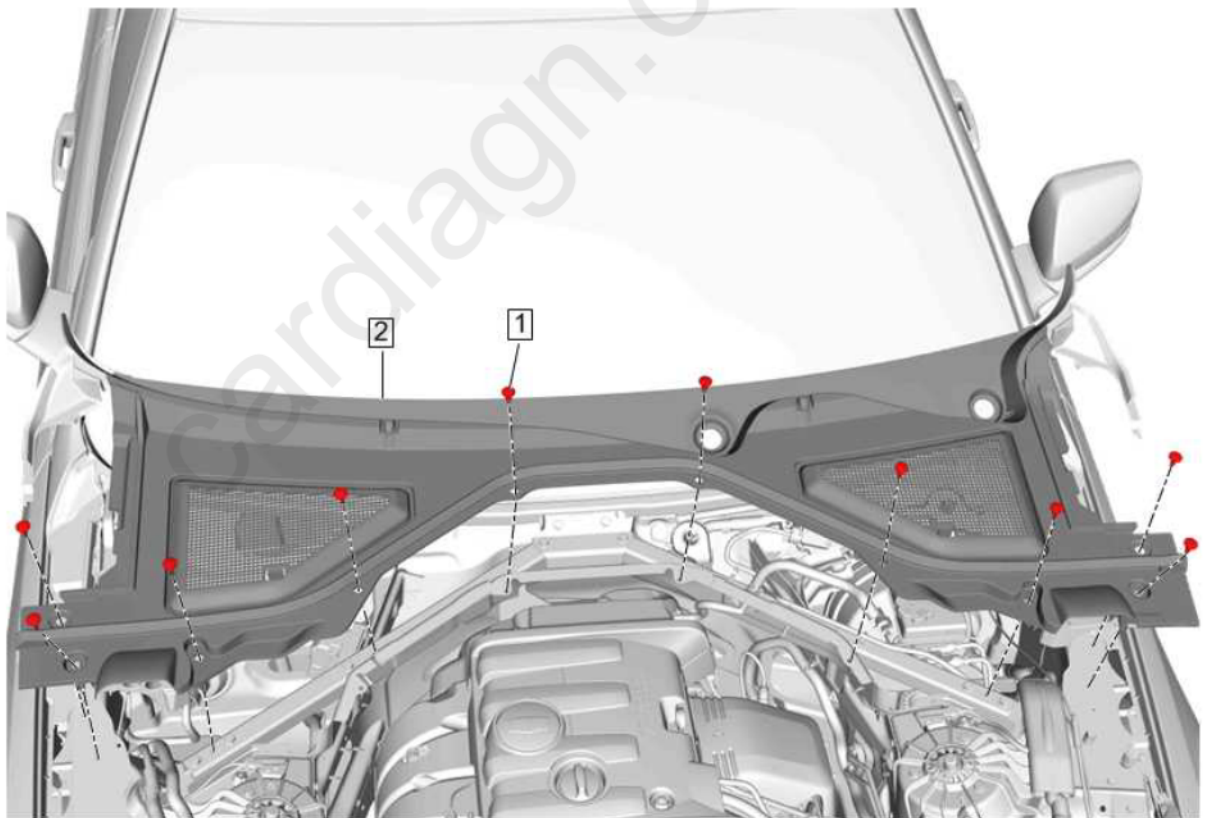


Fig. 120: Air Inlet Grille Panel
 Courtesy of GENERAL MOTORS COMPANY

- 10. Battery Positive and Negative Cable Bolt (2)» Remove

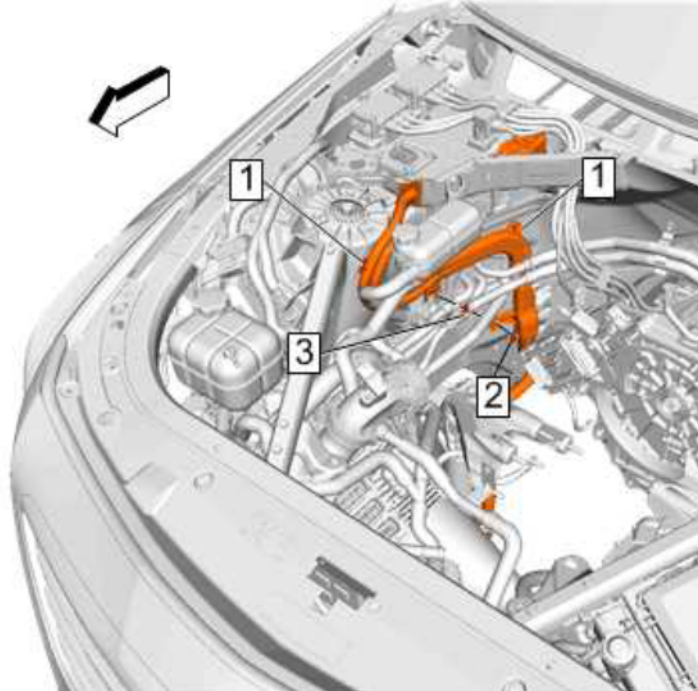


Fig. 121: Battery Positive and Negative Cable Bolt And Nut With Retainers
 Courtesy of GENERAL MOTORS COMPANY

11. Battery Positive and Negative Cable Nut (3) » Remove
12. Retainer (1) » Disengage [2x]
13. Grommet (1) » Disengage

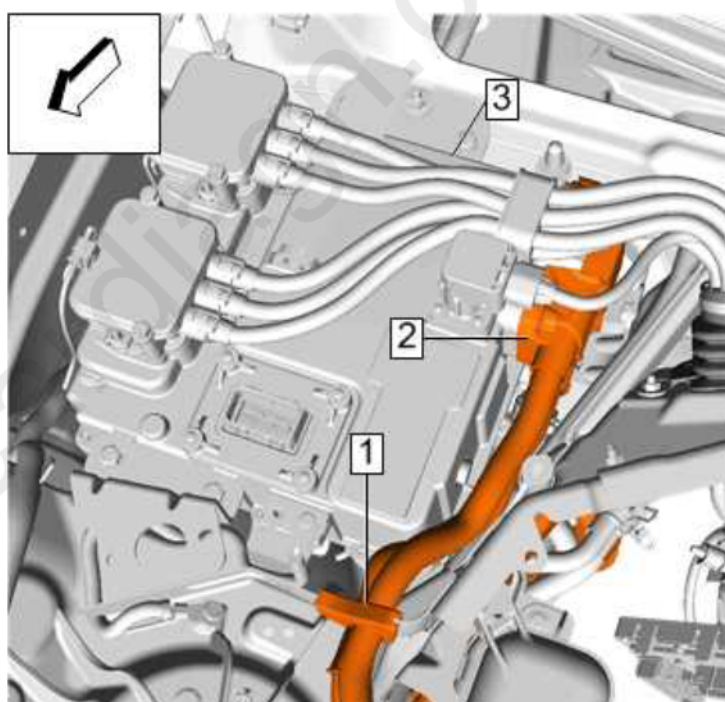


Fig. 122: Grommet And Electrical Connector
 Courtesy of GENERAL MOTORS COMPANY

14. Electrical Connector (2) @ Drive Motor Power Inverter Module (3) » Disconnect
15. Drive Motor Power Inverter Module Cooling Inlet Hose » Remove - **Drive Motor Power Inverter Module Cooling Inlet Hose Replacement (Drive Motor Power Inverter Module to Heater Inlet Pipe Connector) Drive Motor Power Inverter Module Cooling Inlet Hose Replacement (Heater Inlet Pipe Connector Auxiliary Air Conditioning Evaporator Intermediate Tube to Heater Inlet Pipe Connector)**
16. Drive Motor Power Inverter Module Cooling Outlet Hose » Remove - **Drive Motor Power Inverter Module Cooling Outlet Hose Replacement**
17. Electrical Connector (2) » Disconnect [3x]

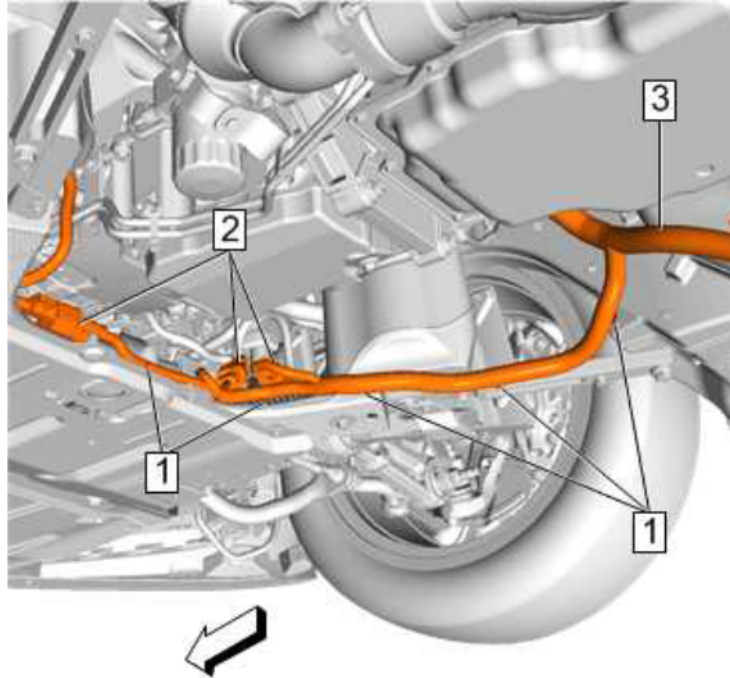


Fig. 123: Electrical Connector, Retainers With Battery Positive And Negative Cable
Courtesy of GENERAL MOTORS COMPANY

- 18. Retainer (1) » Disengage [5x]
- 19. 300-Volt Battery Positive and Negative Cable (3) » Remove

Installation Procedure

- 1. 300-Volt Battery Positive and Negative Cable (3) » Install

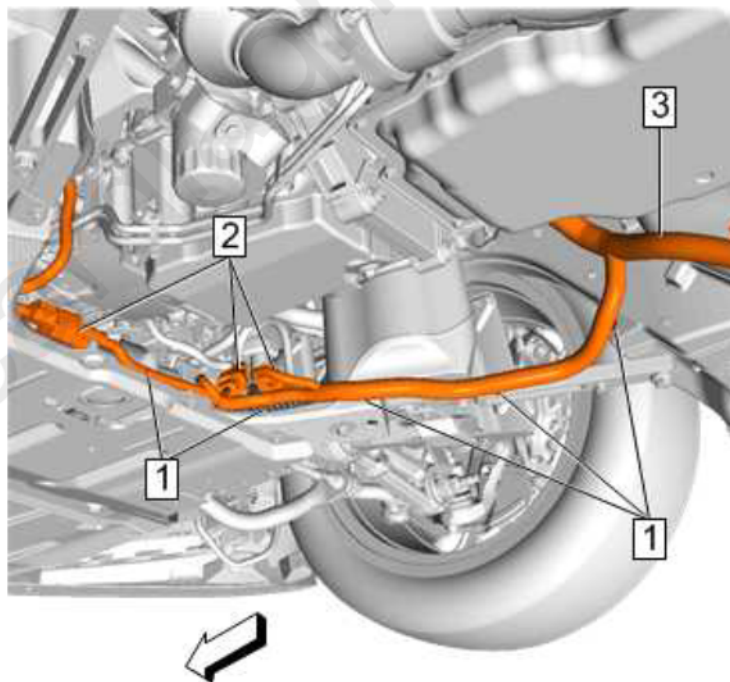


Fig. 124: Electrical Connector, Retainers With Battery Positive And Negative Cable
Courtesy of GENERAL MOTORS COMPANY

- 2. Electrical Connector (2) » Connect [3x]
- 3. Retainer (1) » Engage [5x]
- 4. Grommet (1) » Engage

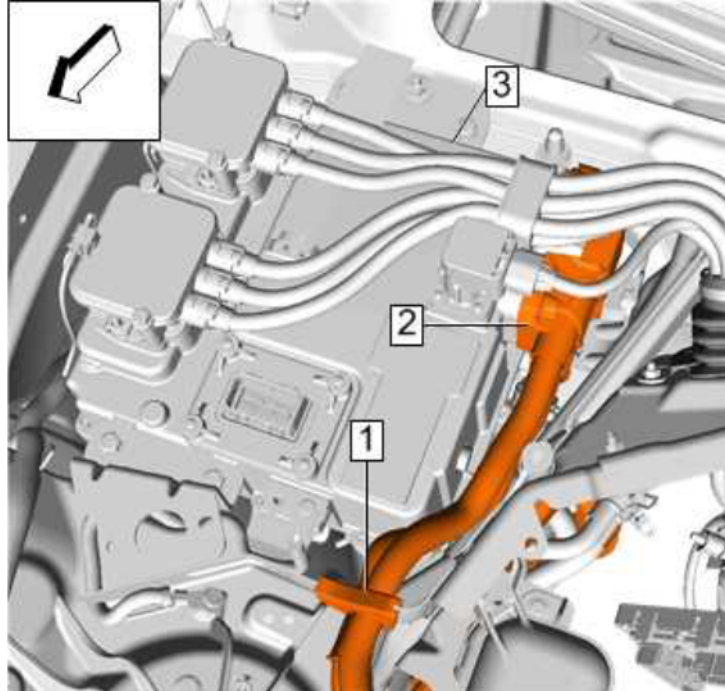


Fig. 125: Grommet And Electrical Connector

Courtesy of GENERAL MOTORS COMPANY

5. Electrical Connector (2) @ Drive Motor Power Inverter Module (3) » Connect
6. Drive Motor Power Inverter Module Cooling Inlet Hose » Install - **Drive Motor Power Inverter Module Cooling Inlet Hose Replacement (Drive Motor Power Inverter Module to Heater Inlet Pipe Connector) Drive Motor Power Inverter Module Cooling Inlet Hose Replacement (Heater Inlet Pipe Connector Auxiliary Air Conditioning Evaporator Intermediate Tube to Heater Inlet Pipe Connector)**
7. Drive Motor Power Inverter Module Cooling Outlet Hose » Install - **Drive Motor Power Inverter Module Cooling Outlet Hose Replacement**
8. Battery Positive and Negative Cable Bolt (2) » Install and tighten

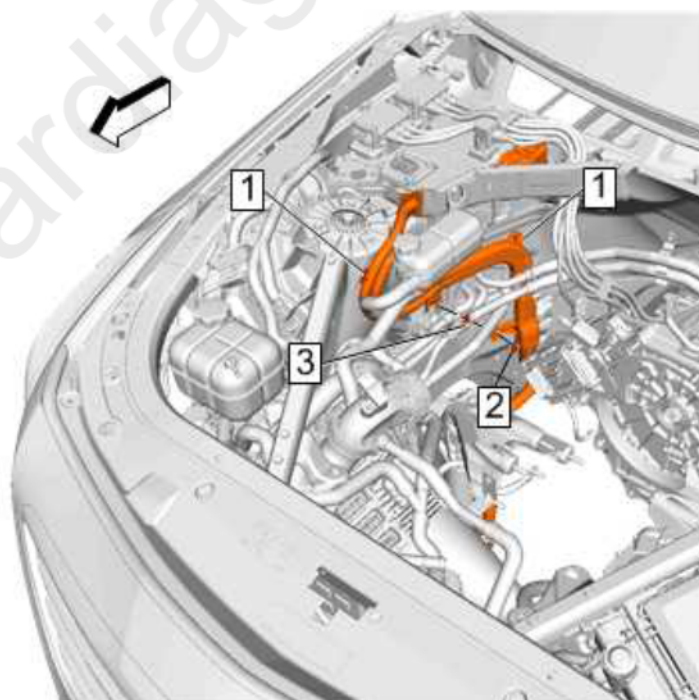


Fig. 126: Battery Positive and Negative Cable Bolt And Nut With Retainers

Courtesy of GENERAL MOTORS COMPANY

NOTE: Critical high voltage fastener. Perform second torque verification check following re-assembly.

- First Pass: 9 N.m (80 lb in)

CAUTION: Refer to **Fastener Caution**

- Final Pass: 9 N.m (80 lb in)

9. Battery Positive and Negative Cable Nut (3)» Install and tighten

NOTE: Critical high voltage fastener. Perform second torque verification check following re-assembly.

- First Pass: 9 N.m (80 lb in)
- Final Pass: 9 N.m (80 lb in)

10. Retainer (1)» Engage [2x]

11. Air Inlet Grille Panel (2)» Install - [Air Inlet Grille Panel Replacement](#)

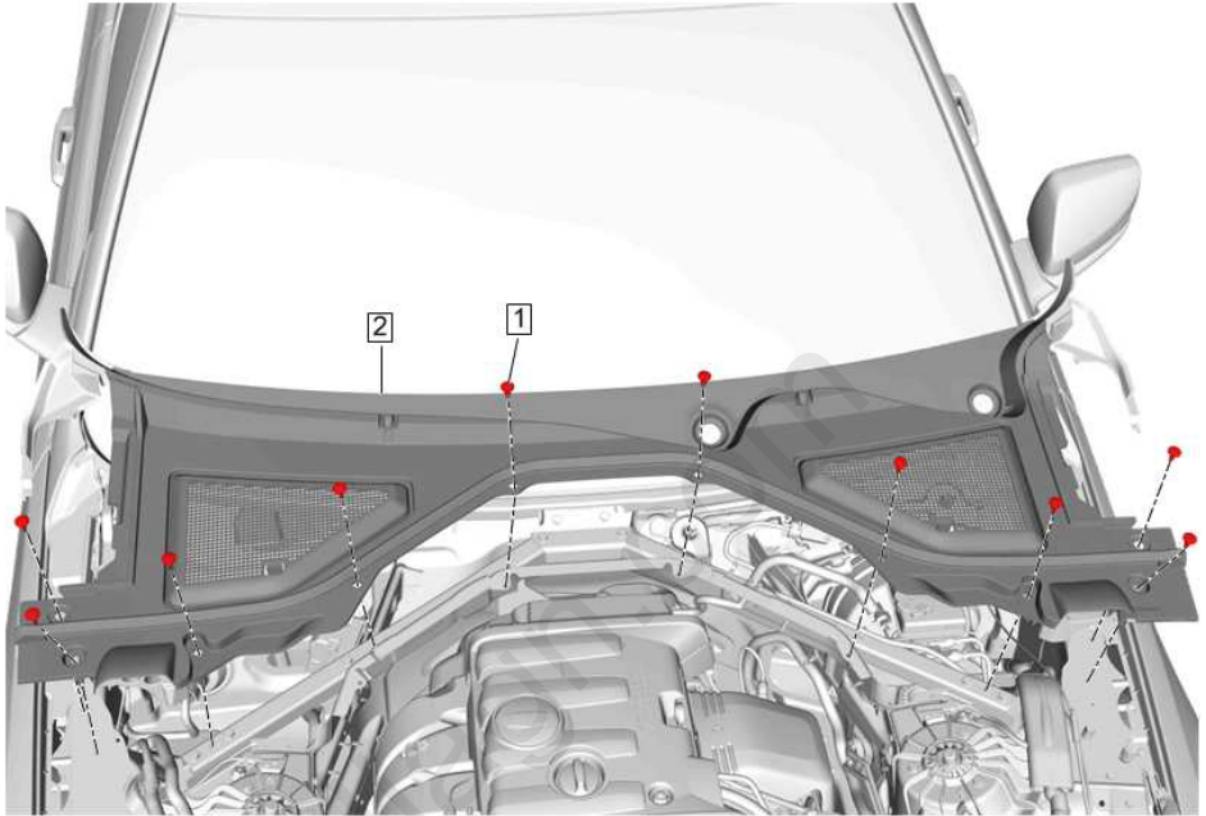


Fig. 127: Air Inlet Grille Panel
Courtesy of GENERAL MOTORS COMPANY

12. Retainer (3)» Engage [7x]

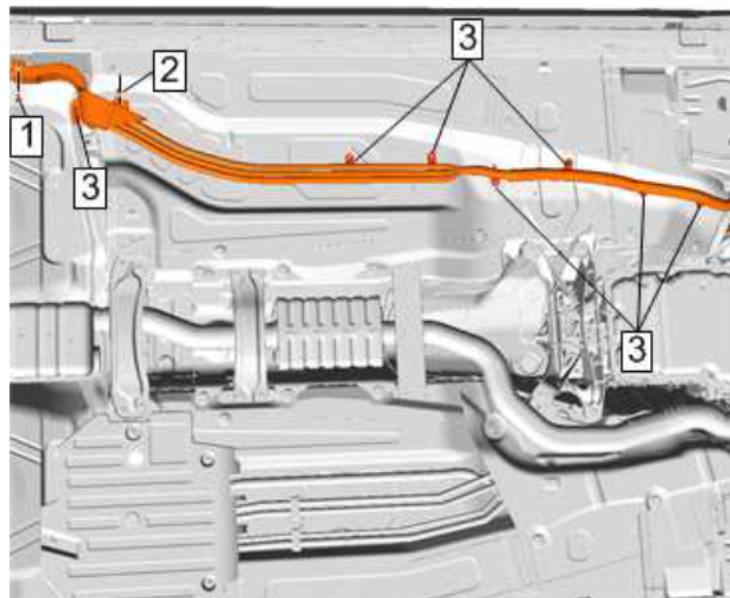


Fig. 128: Battery Positive and Negative Cable Bolt And Nut With Retainers
Courtesy of GENERAL MOTORS COMPANY

13. Battery Positive and Negative Cable Nut (2)» Install and tighten

NOTE: Critical high voltage fastener. Perform second torque verification check following re-assembly.

- First Pass: 9 N.m (80 lb in)
- Final Pass: 9 N.m (80 lb in)

14. Battery Positive and Negative Cable Bolt (1)» Install and tighten

NOTE: Critical high voltage fastener. Perform second torque verification check following re-assembly.

- First Pass: 9 N.m (80 lb in)
- Final Pass: 9 N.m (80 lb in)

15. Electrical Connector (1)» Connect [5x]

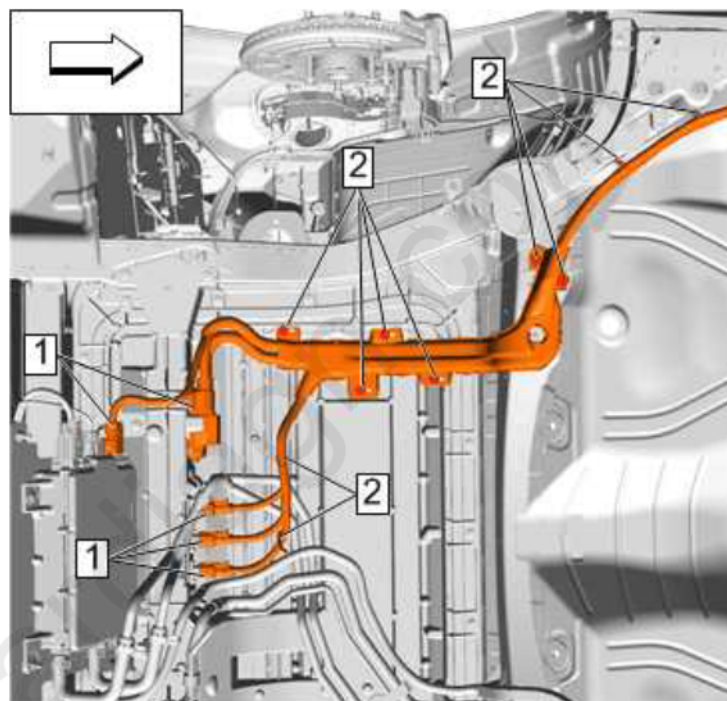


Fig. 129: Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

NOTE: Rear cradle and suspension removed for clarity.

16. Retainer (2)» Engage [10x]

17. Front Body Exhaust Heat Shield - Right (3)» Install - **Front Body Exhaust Heat Shield Replacement (Right Side, LTG)** **Front Body Exhaust Heat Shield Replacement (Right Side, LGW, LGX)**

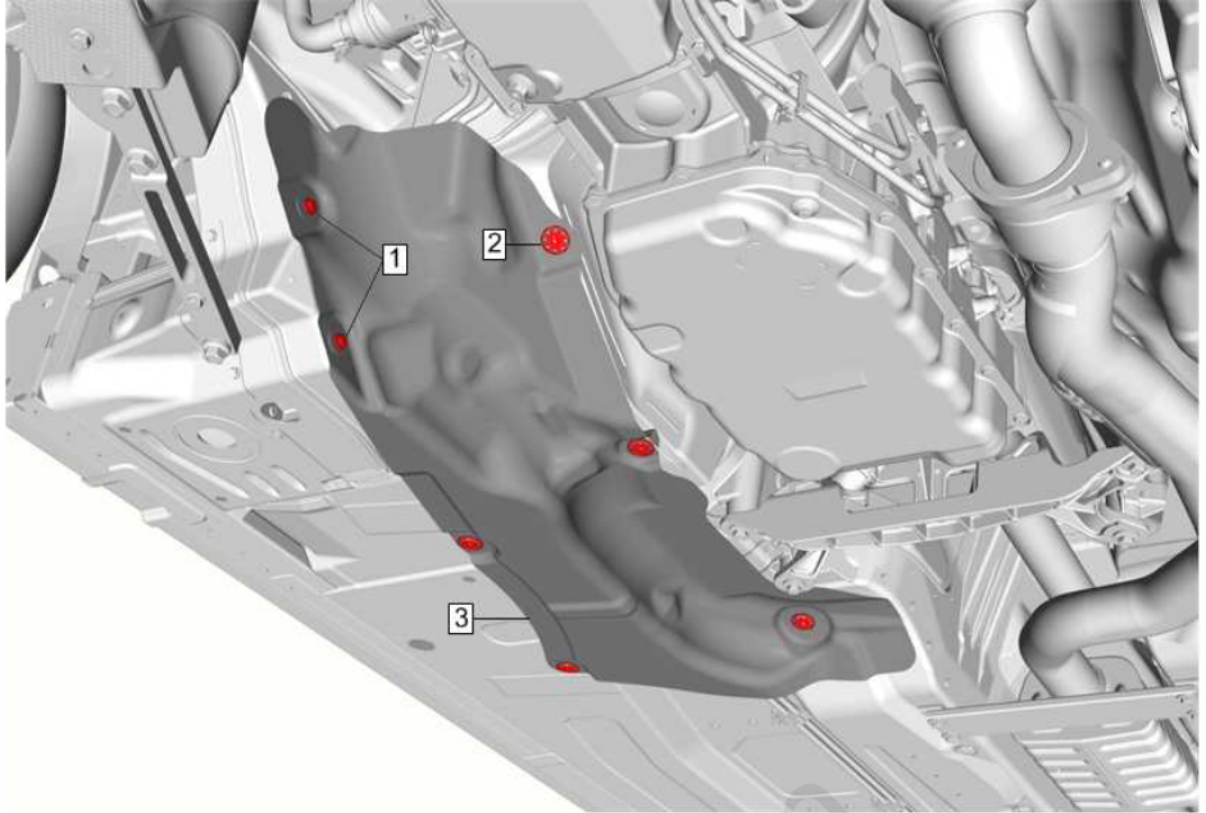


Fig. 130: Front Body Exhaust Heat Shield
 Courtesy of GENERAL MOTORS COMPANY

18. Fuel Tank (1) » Install - [Fuel Tank Replacement](#)

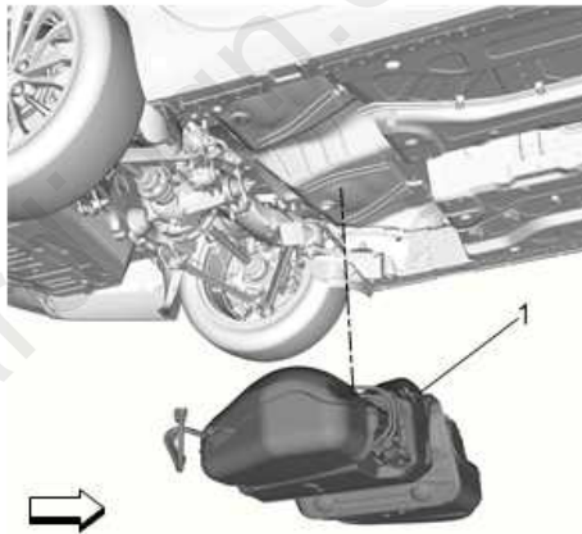


Fig. 131: Fuel Tank
 Courtesy of GENERAL MOTORS COMPANY

19. Enable the high voltage system. Refer to [High Voltage Enabling](#)

HIGH VOLTAGE BATTERY REPLACEMENT AND SHIPPING PREPARATION

Special Tools

- EL-39580 Support Stand
- EL-51865 Battery Pack Support Fixture
- EL-51102 High Voltage Battery Lift Bar Tilter
- EL-51102-30 High Voltage Battery Lift Bar Tilter Eye-Bolt Kit
- EL-51102-50 High Voltage Battery Lift Bar Straps

Equivalent regional tools: [Special Tools](#)

1. Open the fuel tank door (1).

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.

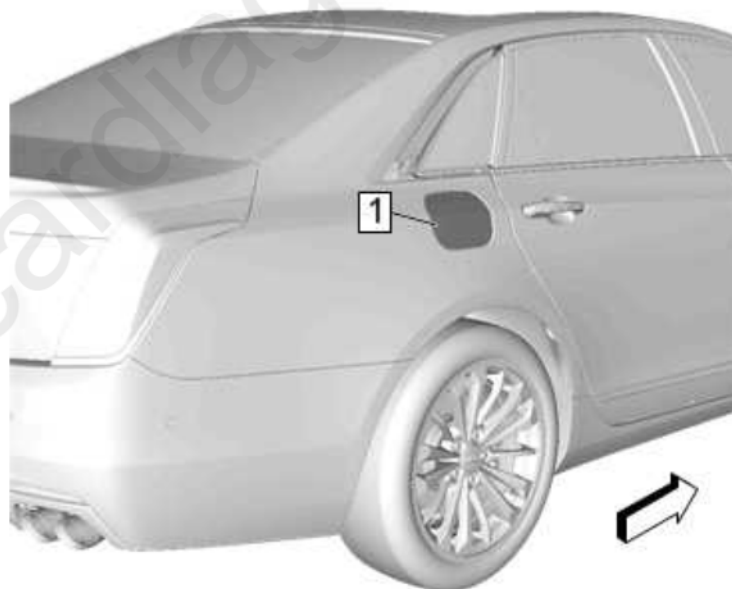


Fig. 132: Fuel Tank Door

Courtesy of GENERAL MOTORS COMPANY

2. Drive Motor Battery Cover (4)» Remove - [Drive Motor Battery Cover Replacement \(With HP9\)](#)

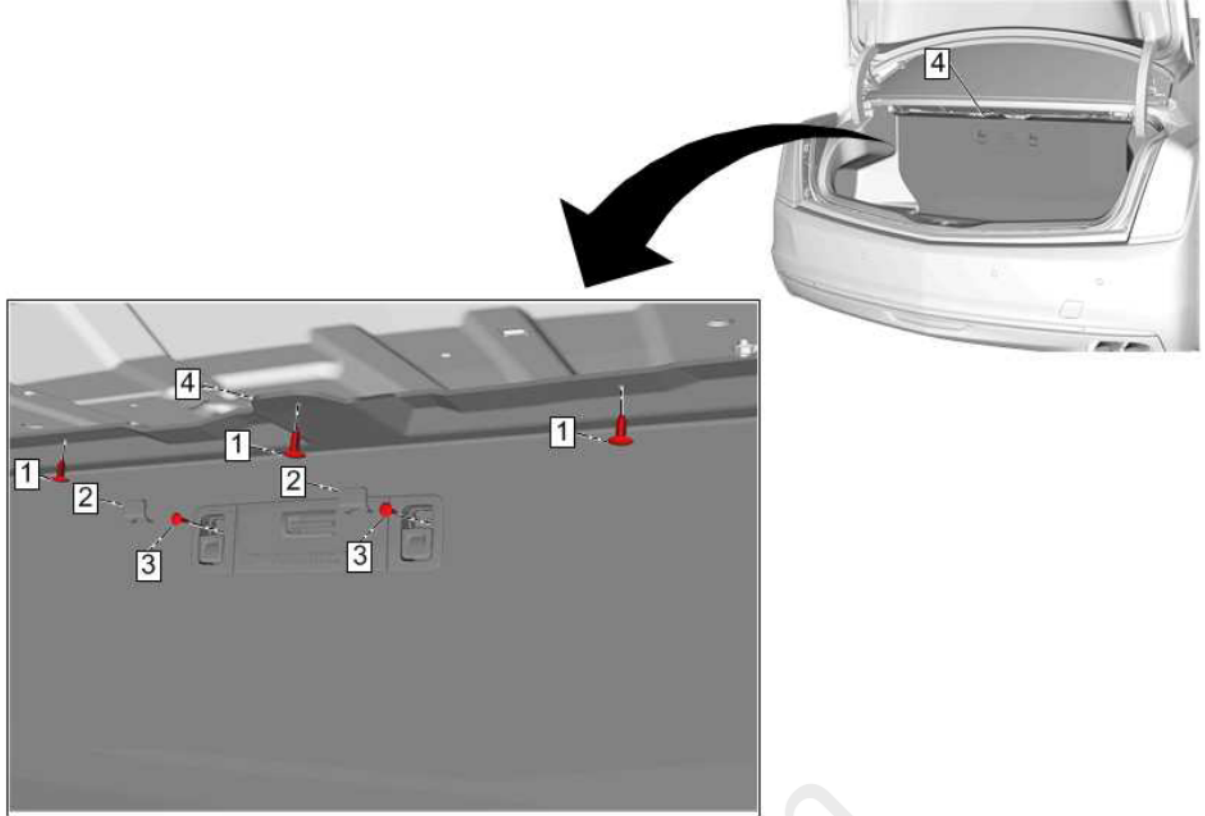


Fig. 133: Drive Motor Battery Cover (With HP9)

Courtesy of GENERAL MOTORS COMPANY

3. Disable the high voltage system. Refer to [High Voltage Disabling](#)
4. Drain the high voltage battery system. Refer to [High Voltage Battery Drain and Filling \(Without Heater Vent Hose Quick Connect\)](#) and/or [High Voltage Battery Drain and Filling \(With Heater Vent Hose Quick Connect\)](#)
5. High Voltage Battery Cover Bracket Bolt (2)» Remove [2x]

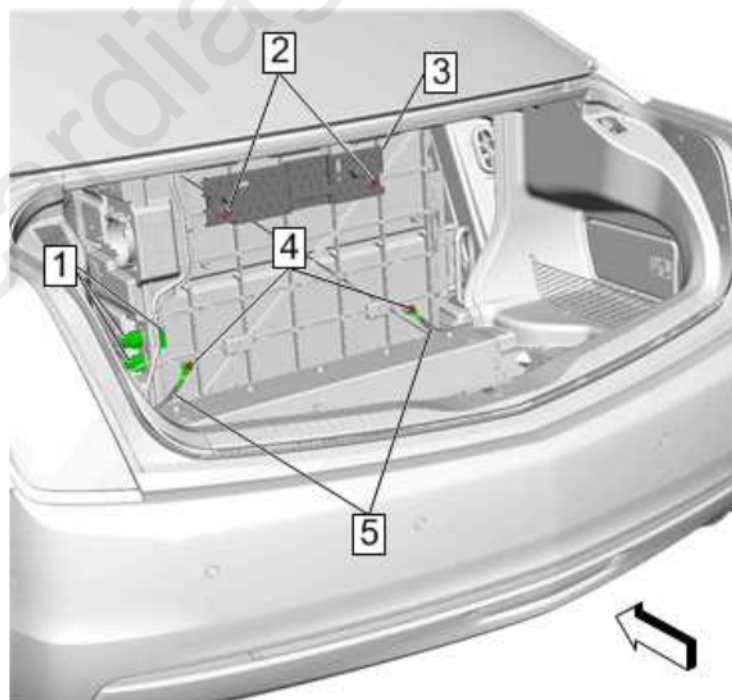


Fig. 134: High Voltage Battery Cover Bracket Bolts, Electrical Connectors And Ground Strap Bolts

Courtesy of GENERAL MOTORS COMPANY

6. High Voltage Battery Cover Bracket (3)» Remove
7. Electrical Connector (1)» Disconnect [3x]
8. Ground Strap Bolt (4)» Remove [2x]
9. Ground Strap (5)» Reposition away [2x]
10. Retainer (1)» Disengage [2x]

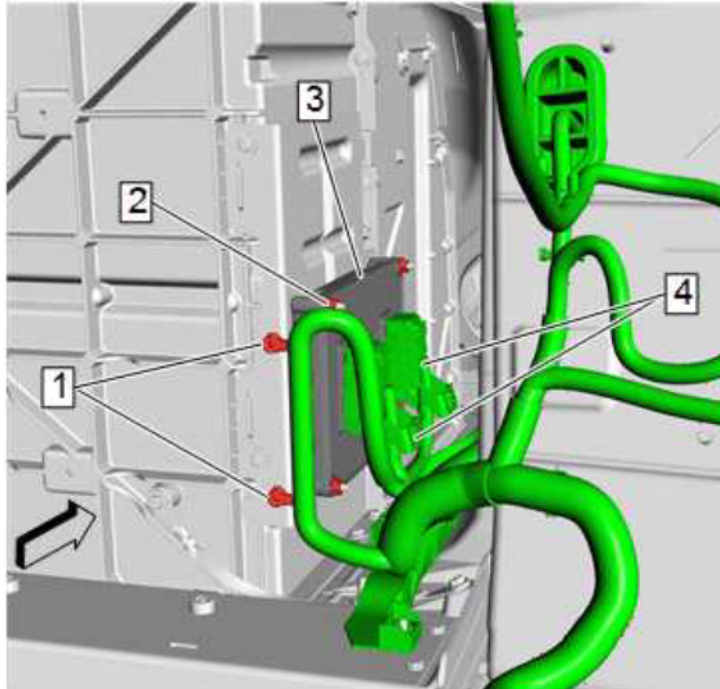


Fig. 135: Hybrid Powertrain Control Module 2 Mounting Nuts And Retainers
Courtesy of GENERAL MOTORS COMPANY

11. Hybrid Powertrain Control Module 2 Mounting Nut (2) » Remove [4x]
12. Hybrid Powertrain Control Module 2 (3) » Reposition away
13. Remove the rear wheels. Refer to [Tire and Wheel Removal and Installation](#)
14. Rear Suspension Cradle (1) » Remove - [Rear Suspension Cradle Replacement](#)

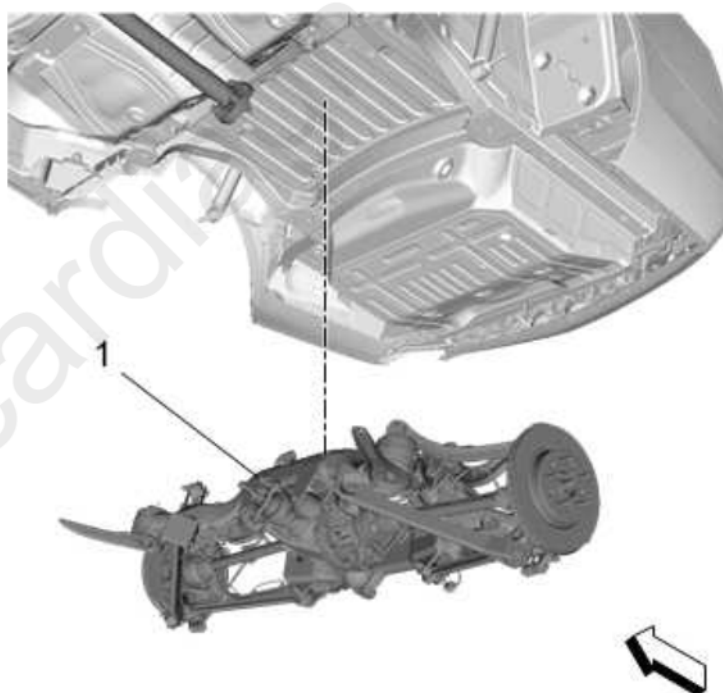


Fig. 136: Rear Suspension Cradle
Courtesy of GENERAL MOTORS COMPANY

15. Disconnect and plug the fuel tank hoses (1). Refer to [Fuel Tank Replacement](#)

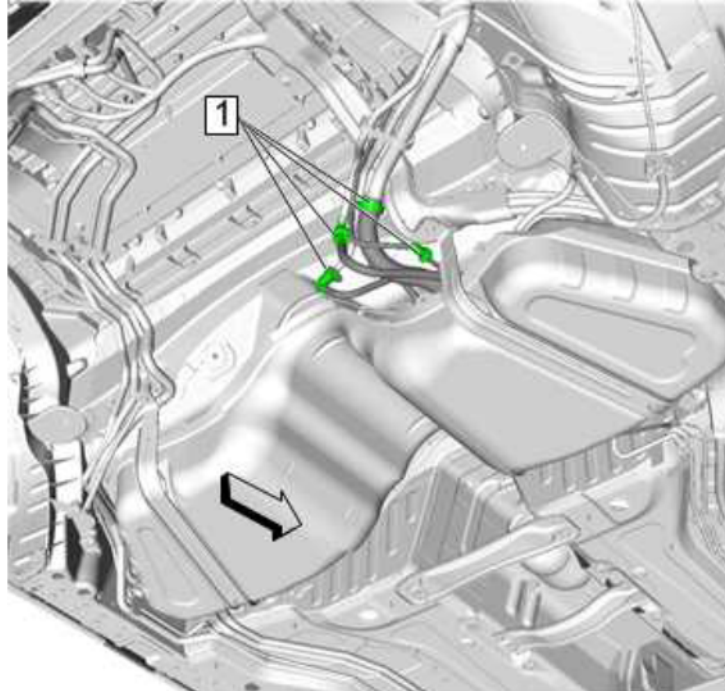


Fig. 137: Fuel Tank Hoses

Courtesy of GENERAL MOTORS COMPANY

16. Fuel Tank Filler Pipe Shield Bolt» Remove [2x]

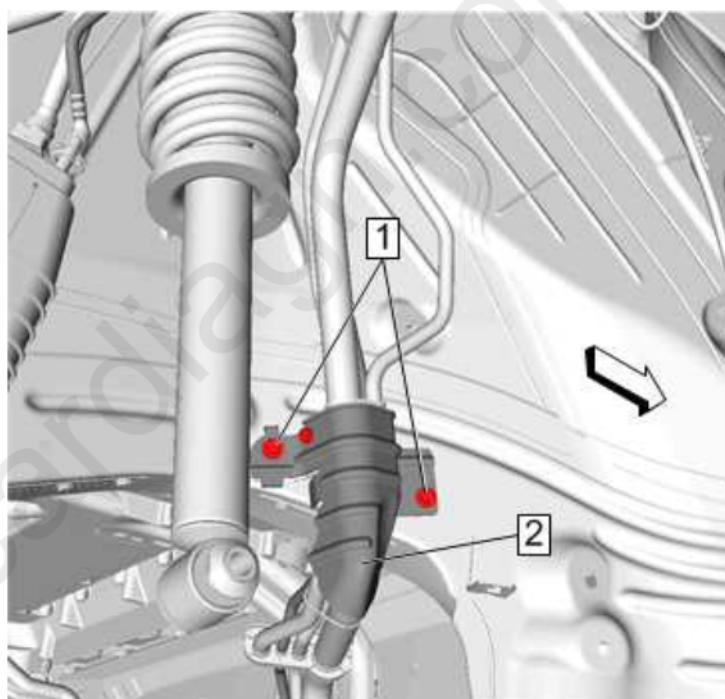


Fig. 138: Fuel Tank Filler Pipe Shield Bolts

Courtesy of GENERAL MOTORS COMPANY

17. Fuel Tank Filler Pipe Shield» Reposition away
18. Place a drain pan under the vehicle.

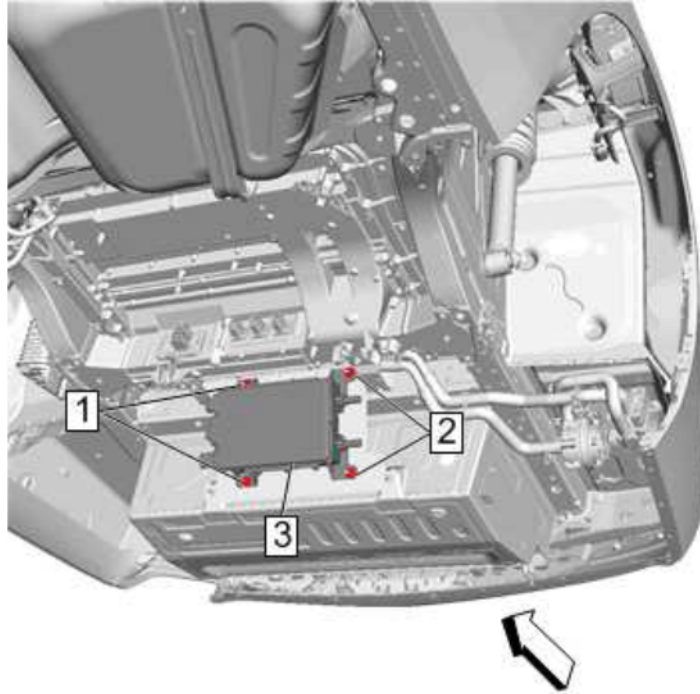


Fig. 139: Drive Motor Battery Charger And Fasteners
 Courtesy of GENERAL MOTORS COMPANY

- 19. Drive Motor Battery Charger (3)» Remove - **Drive Motor Battery Charger Replacement**
- 20. Drive Motor Battery Convenience Charger Fastener (1)» Remove [4x]

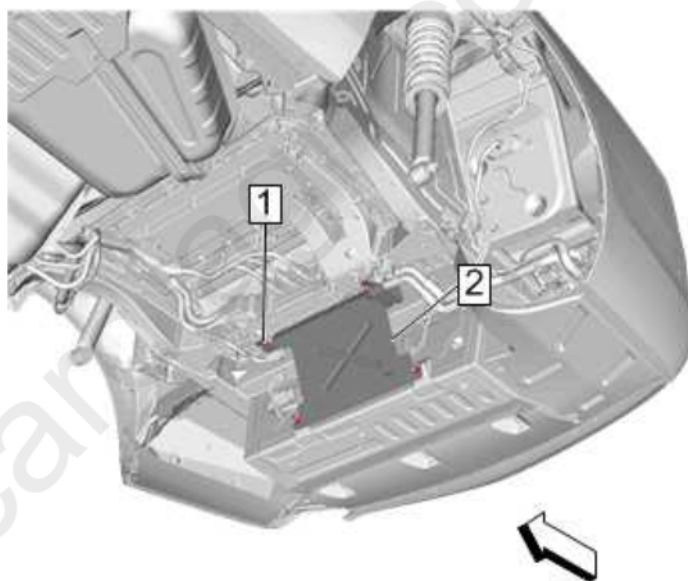


Fig. 140: Drive Motor Battery Convenience Charger Bracket
 Courtesy of GENERAL MOTORS COMPANY

- 21. Drive Motor Battery Convenience Charger Bracket (2)» Remove
- 22. Auxiliary Air Conditioning Evaporator Intermediate Tube Bolt (1)» Remove [3x]

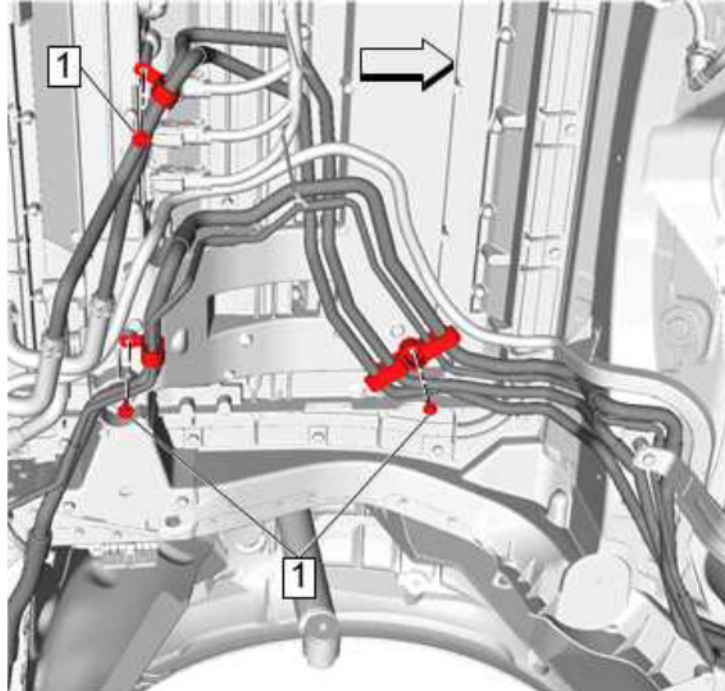


Fig. 141: Auxiliary Air Conditioning Evaporator Intermediate Tube Bolts
Courtesy of GENERAL MOTORS COMPANY

23. Auxiliary Air Conditioning Evaporator Intermediate Tube Bolt (1) » Remove

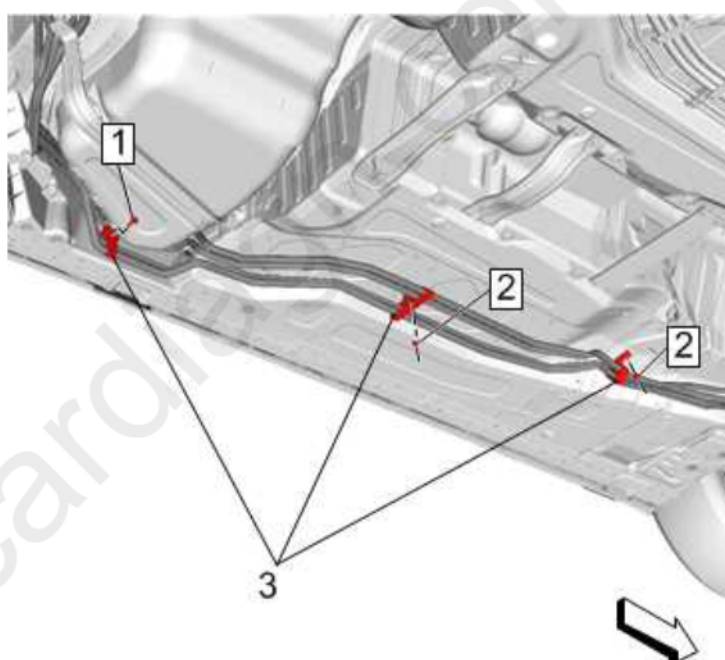


Fig. 142: Auxiliary Air Conditioning Evaporator Intermediate Tube With Bolt, Tube Nuts And Clamps
Courtesy of GENERAL MOTORS COMPANY

- 24. Auxiliary Air Conditioning Evaporator Intermediate Tube Nut (2) » Remove [2x]
- 25. Auxiliary Air Conditioning Evaporator Intermediate Tube Clamp (3) » Disengage [3x]
- 26. Place a suitable jack under the fuel tank.

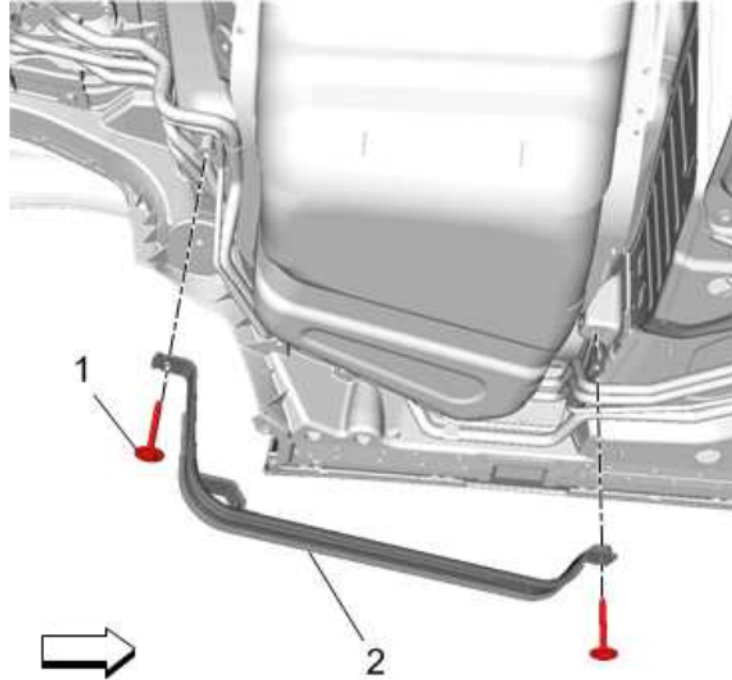


Fig. 143: Left Side Fuel Tank Strap
Courtesy of GENERAL MOTORS COMPANY

27. Remove the left side fuel tank strap (2). Refer to [Fuel Tank Replacement](#)
28. Place a drain pan under coolant hoses.

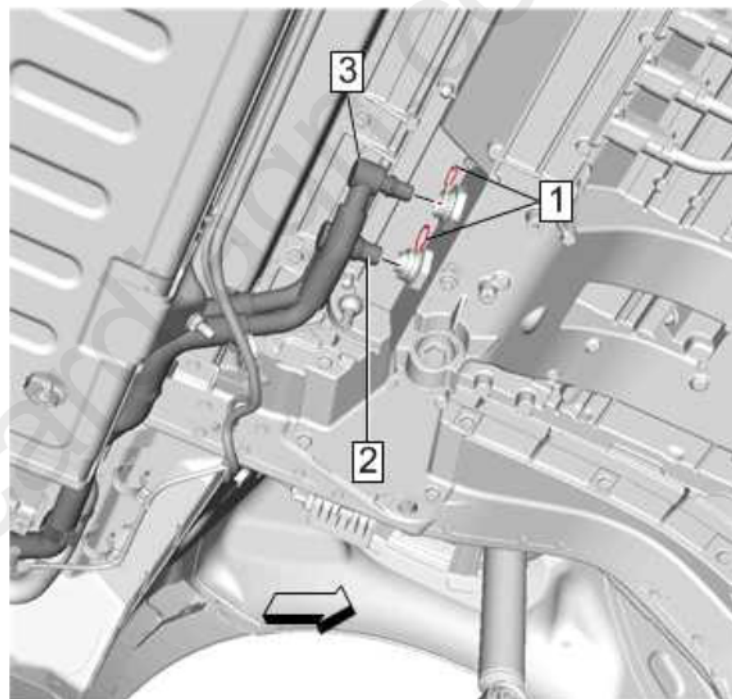


Fig. 144: Retainers, Driver Motor Battery Outlet Hose And Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

29. Retainer (1) » Disengage [2x]
30. Drive Motor Battery Outlet Hose (3) » Remove
31. Drive Motor Battery Inlet Hose (2) » Remove
32. If the high voltage battery is being replaced, drain the coolant from the high voltage battery. Refer to [High Voltage Battery Drain and Filling \(Without Heater Vent Hose Quick Connect\)](#) and/or [High Voltage Battery Drain and Filling \(With Heater Vent Hose Quick Connect\)](#)
33. Plug the coolant hoses and high voltage battery.
34. Drive Motor Battery Coolant Pump Bracket Nut (1) » Remove [4x]

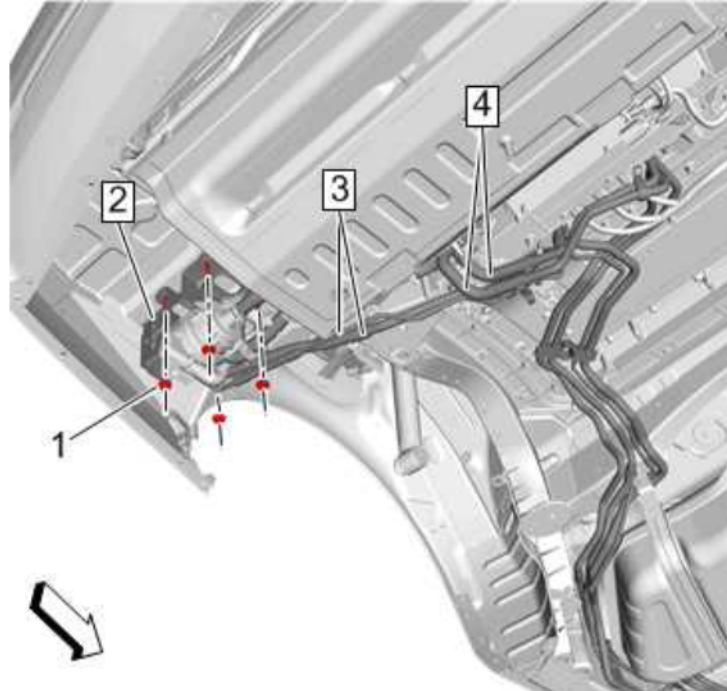


Fig. 145: Drive Motor Battery Coolant Pump Bracket Nuts
Courtesy of GENERAL MOTORS COMPANY

35. Drive Motor Battery Coolant Pump Bracket (2)» Remove
36. Secure the drive motor battery coolant pump bracket (2); the drive motor battery radiator inlet/outlet hoses (4) and the auxiliary air conditioning evaporative intermediate tubes (3) to the chassis or body.
37. Battery Positive Cable Retainer (1)» Disengage [9x]

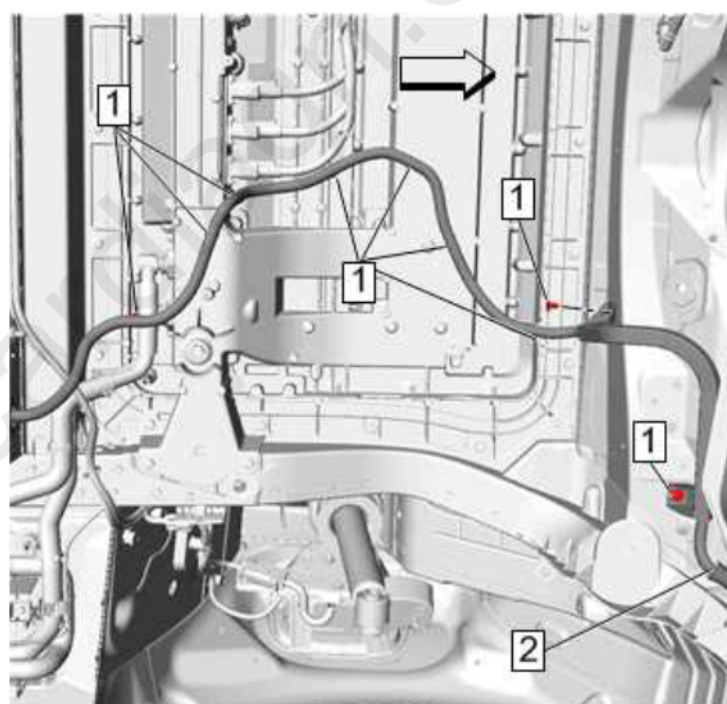


Fig. 146: Battery Positive Cable Retainers
Courtesy of GENERAL MOTORS COMPANY

38. Battery Positive Cable (2)» Reposition away
39. Loosely install the left side fuel tank strap.
40. Remove the right side fuel tank strap (2). Refer to [Fuel Tank Replacement](#)

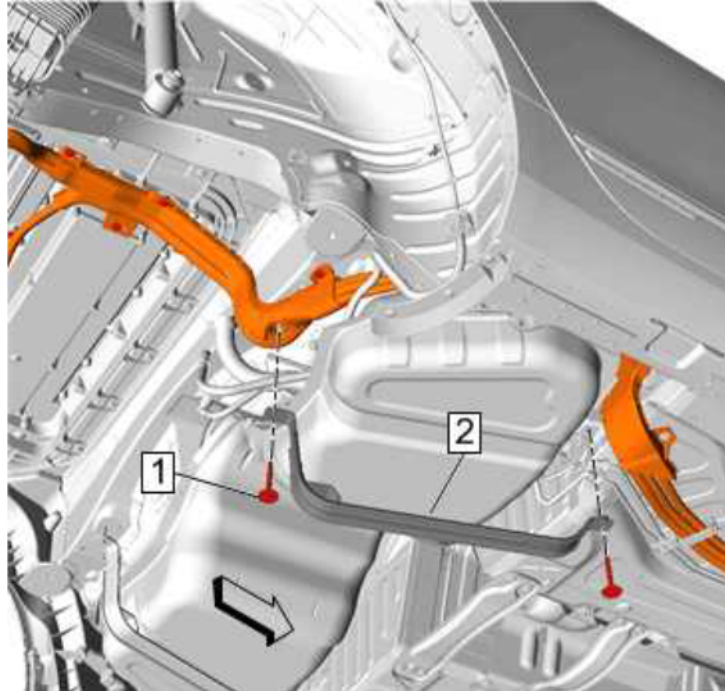


Fig. 147: Right Side Fuel Tank Strap
Courtesy of GENERAL MOTORS COMPANY

41. Electrical Connector (1) @ High Voltage Battery (2)» Disconnect [4x]

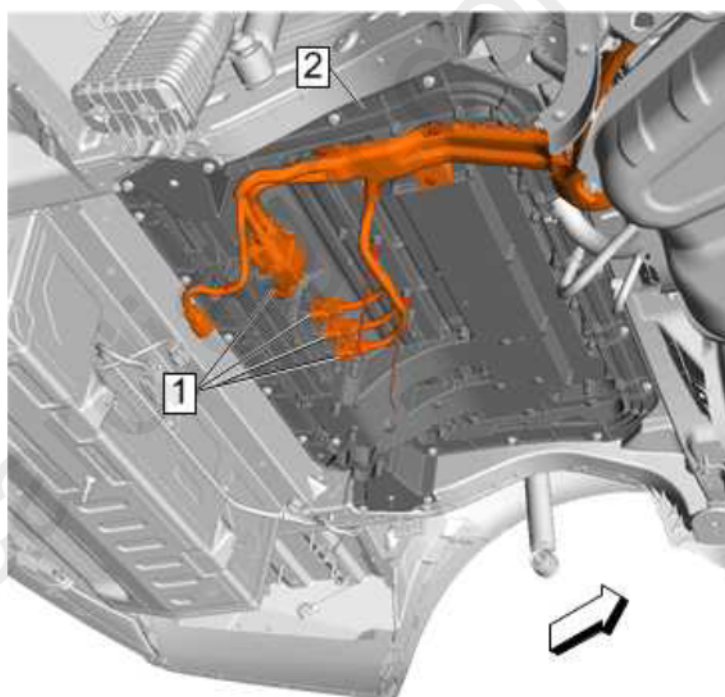


Fig. 148: Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

42. Retainer (1)» Disengage [7x]

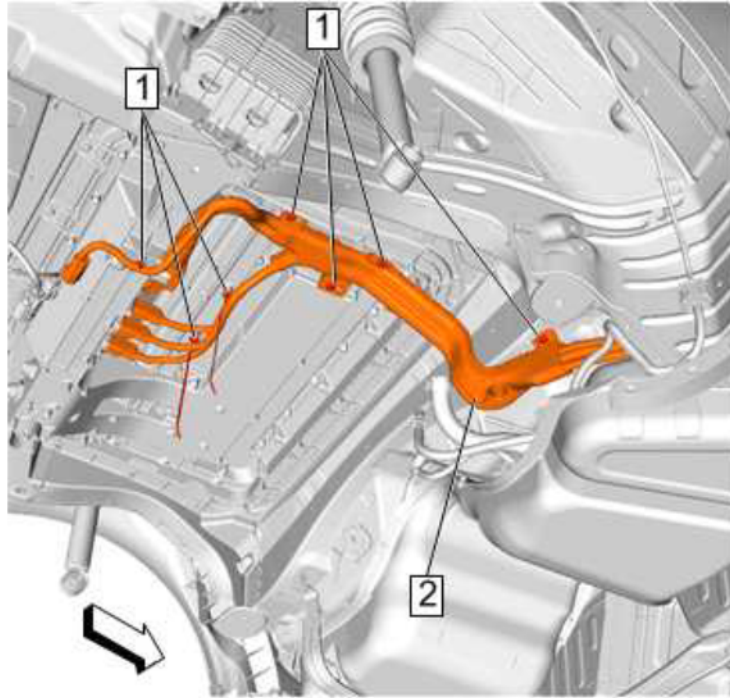


Fig. 149: Retainers

Courtesy of GENERAL MOTORS COMPANY

43. 300-Volt Battery Positive and Negative Cable (2)» Reposition away
44. Loosely install the right side fuel tank strap.
45. Remove the fuel tank support jack.
46. Secure the **EL-51865** Battery Pack Support Fixture to a suitable support stand
47. Battery Tray Mounting Bolt (1)» Remove [8x]

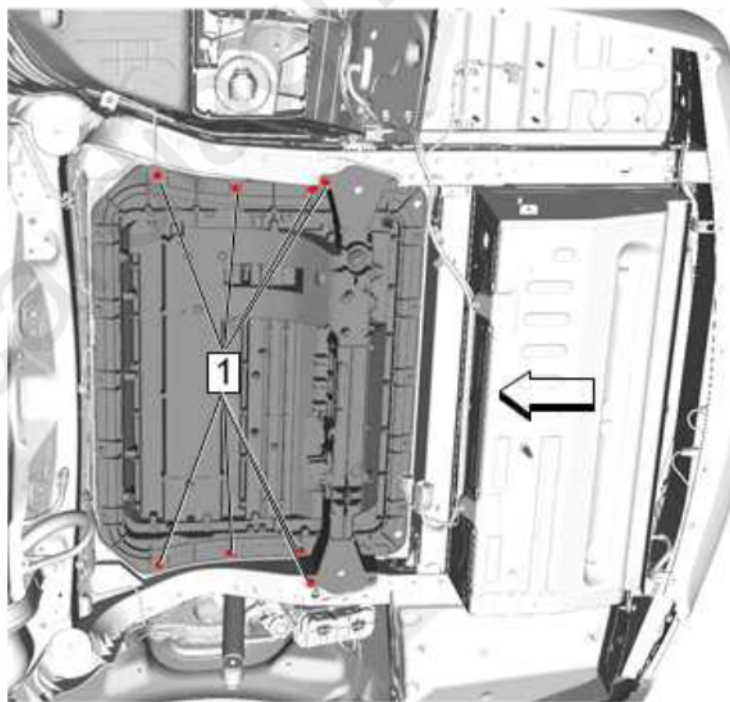


Fig. 150: Battery Tray Mounting Bolts

Courtesy of GENERAL MOTORS COMPANY

48. Slowly raise the **EL-51865** Battery Pack Support Fixture (1) so the support mounts (2) align with the holes in the high voltage battery tray.

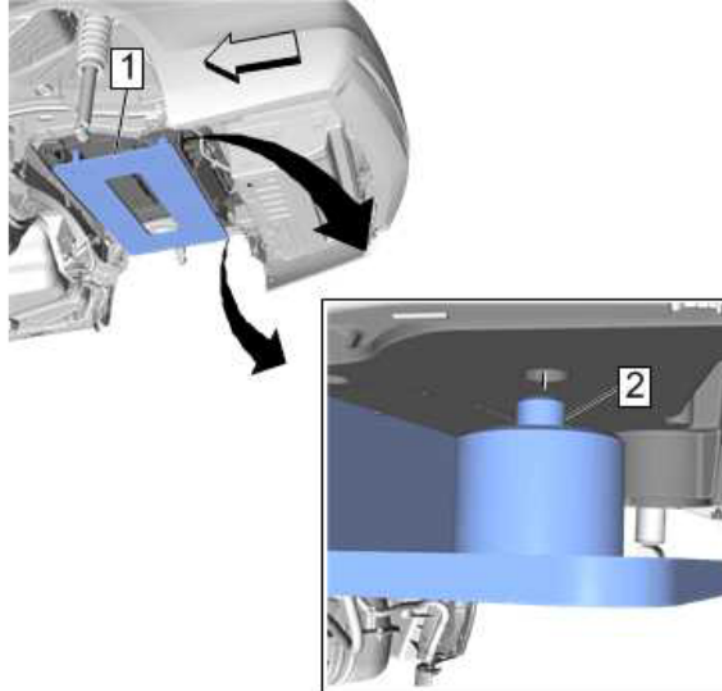


Fig. 151: Battery Pack Support Fixture
 Courtesy of GENERAL MOTORS COMPANY

NOTE: The high voltage battery mass is approximately 181 kg (399 lbs)

49. Battery Tray Mounting Bolt (1) » Remove [14x]

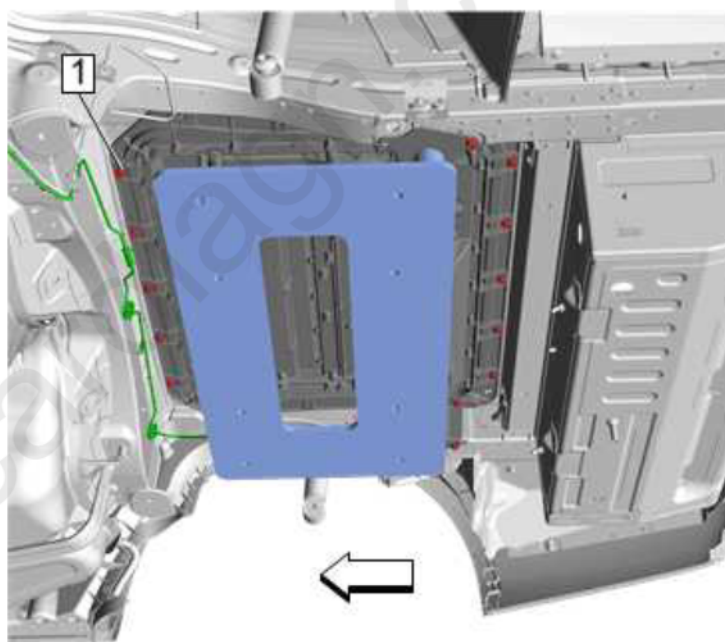


Fig. 152: Battery Tray Mounting Bolts
 Courtesy of GENERAL MOTORS COMPANY

50. Slowly lower the high voltage battery (1) taking care not to make contact with the brake pipes (2).

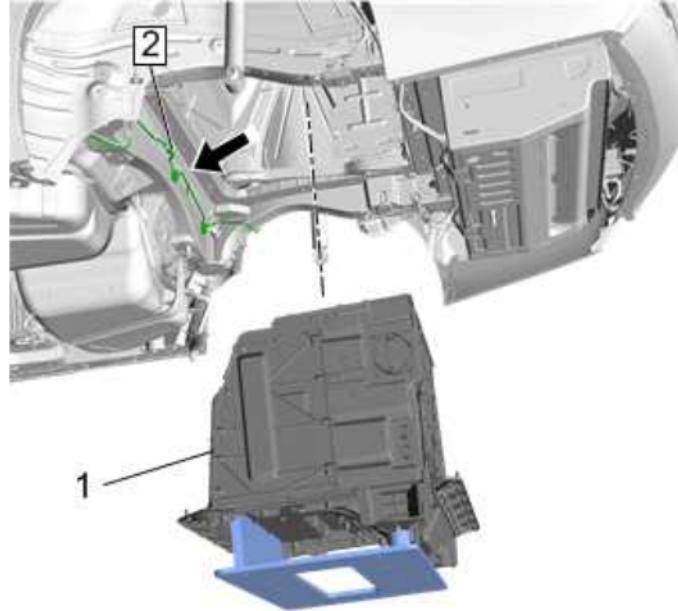


Fig. 153: High Voltage Battery

Courtesy of GENERAL MOTORS COMPANY

51. Secure high voltage battery to the support table with straps.
52. Cover the manual disconnect terminals with tape.
53. Connect the coolant bleeder and drain the coolant from the high voltage battery.
54. Using the **EL-51102-30** High Voltage Battery Lift Bar Tilter Eye-Bolt Kit install the 2 front eye-bolts (1); washers (2) and nuts (3). Tighten the nuts (3) to 9 N.m (80 lb in)



Fig. 154: Front Eye-Bolts, Washers And Nuts

Courtesy of GENERAL MOTORS COMPANY

55. Using the **EL-51102-30** High Voltage Battery Lift Bar Tilter Eye-Bolt Kit, install the 2 rear eye-bolts (1); washers (2) and nuts (3). Tighten the nuts (3) to 9 N.m (80 lb in)

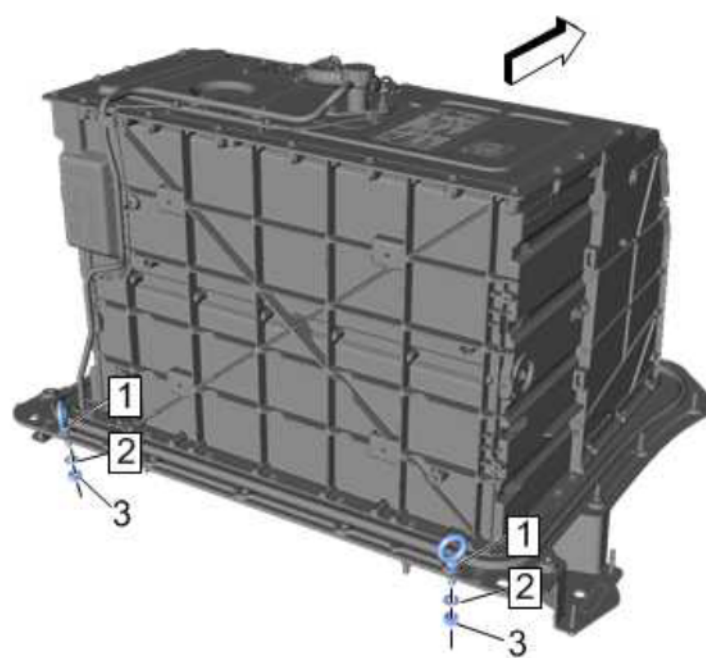


Fig. 155: Rear Eye-Bolts, Washers And Nuts
 Courtesy of GENERAL MOTORS COMPANY

56. Attach the **EL-51102** High Voltage Battery Lift Bar Tilter to a suitable lifting crane.

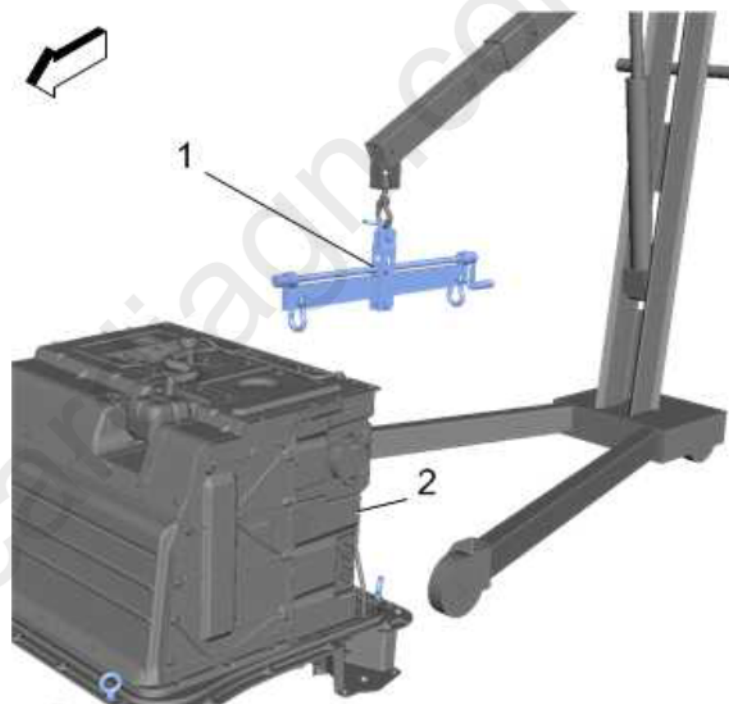


Fig. 156: High Voltage Battery Lift Bar Tilter
 Courtesy of GENERAL MOTORS COMPANY

NOTE: The lift bar tilter must be positioned front to back as shown or improper weight balancing may cause damage to the high voltage battery.

57. Position the **EL-51102** High Voltage Battery Lift Bar Tilter over the high voltage battery making sure it is perpendicular to the high voltage battery as shown.
58. Install the 4 **EL-51102-50** High Voltage Battery Lift Bar Straps (1), to the installed eye-bolts and lift bar tilter (2).

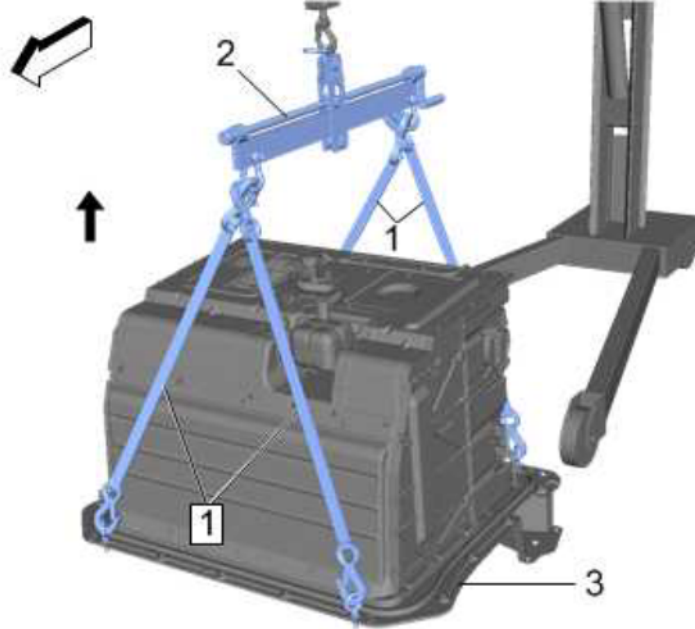


Fig. 157: High Voltage Battery Lift Bar Straps
Courtesy of GENERAL MOTORS COMPANY

59. With the aid of a second technician, carefully raise the high voltage battery and transport to a secure area.
60. If the high voltage battery is being replaced, perform the following:
 - Install coolant plugs (1) in the coolant lines. Coolant plugs can be removed from the new service battery assembly and installed in the returned battery. Additional coolant plugs (GM p/n 22770854) can be ordered if they are needed.
 - Install the S15 Manual Service Disconnect (MSD) Cover (2). The MSD cover can be removed from the new service battery assembly and installed in the returned battery. Additional MSD covers (GM p/n 22770856) can be ordered if they are needed.

NOTE:

The failed battery must be removed and returned with a battery assembly lifting fixture. This lifting fixture will be attached to the failed battery and placed in the shipping container. Each new service battery will come with a battery assembly lifting fixture for use during installation. You will keep this fixture for servicing future battery removals

- Install the High Voltage Connector Cover. The high voltage connector cover can be removed from the service battery and installed on the returned battery. If the service battery assembly did not come with a high voltage connector cover, additional covers can be ordered by calling 1-800 GM TOOLS.

Installation Procedure

1. Slowly raise the high voltage battery into position (1) taking care not to make contact with the brake pipes (2).

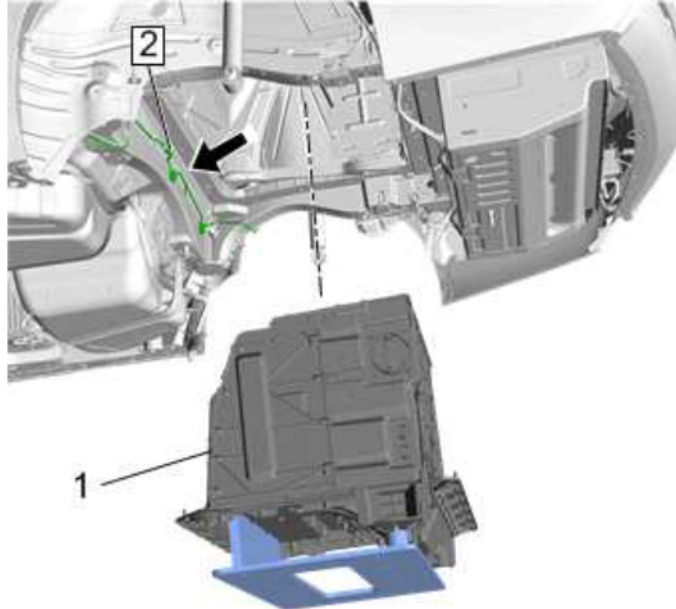


Fig. 158: High Voltage Battery

Courtesy of GENERAL MOTORS COMPANY

2. Battery Tray Mounting Bolt (1) » Install and tighten [14x] 22 N.m (16 lb ft)

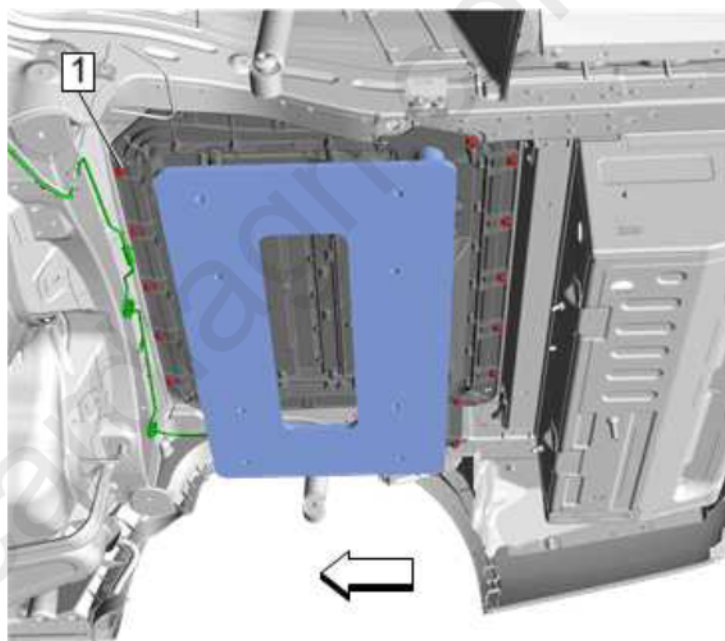


Fig. 159: Battery Tray Mounting Bolts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution**

3. Remove the **EL-51865** Battery Pack Support Fixture
4. Battery Tray Mounting Bolt (1) » Install and tighten [8x] 22 N.m (16 lb ft)

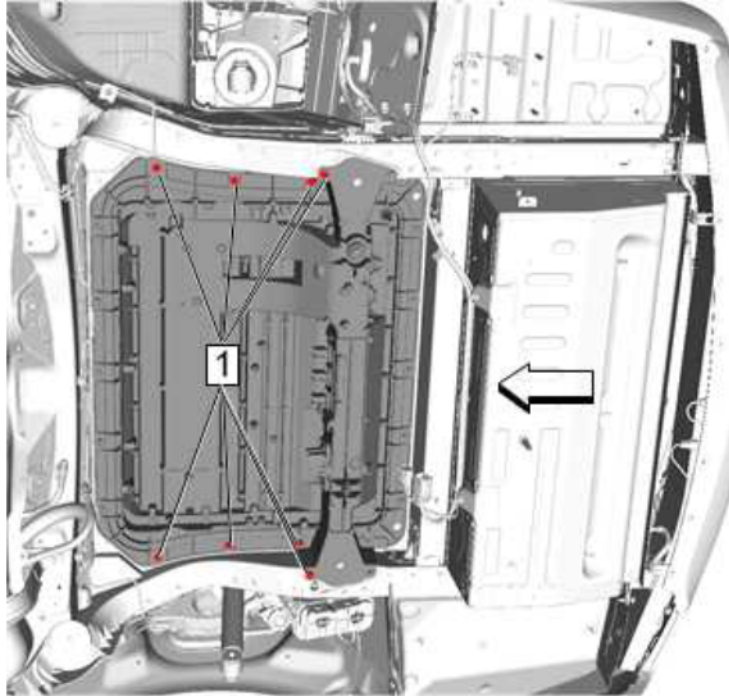


Fig. 160: Battery Tray Mounting Bolts
 Courtesy of GENERAL MOTORS COMPANY

5. Place a suitable jack under the fuel tank.
6. Remove the right side fuel tank strap (2). Refer to [Fuel Tank Replacement](#)

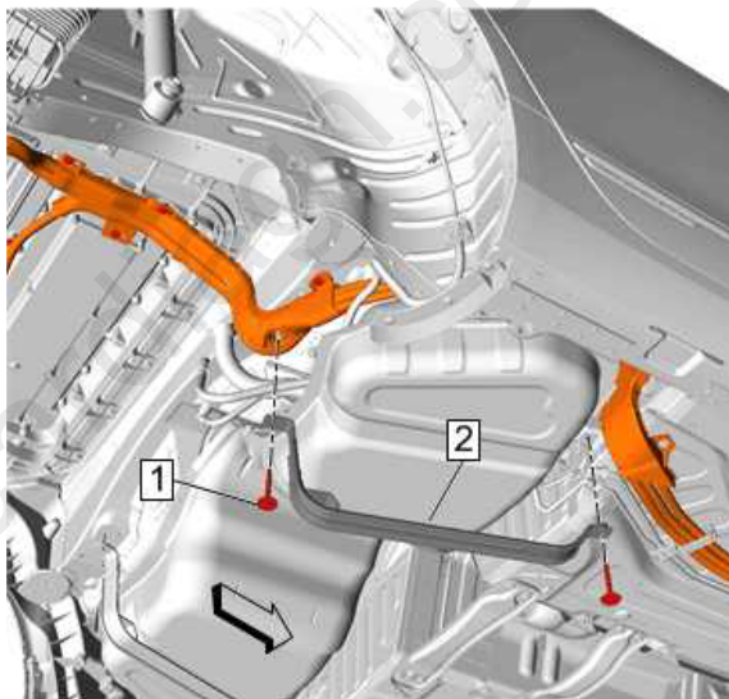


Fig. 161: Right Side Fuel Tank Strap
 Courtesy of GENERAL MOTORS COMPANY

7. Retainer (1) Engage [7x]

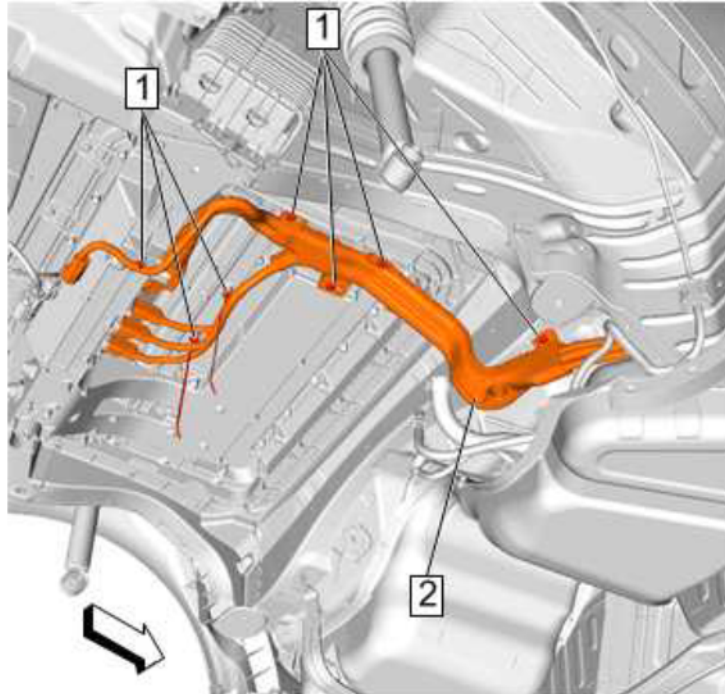


Fig. 162: Retainers

Courtesy of GENERAL MOTORS COMPANY

8. Electrical Connector (1) @ High Voltage Battery (2) » Connect [4x]

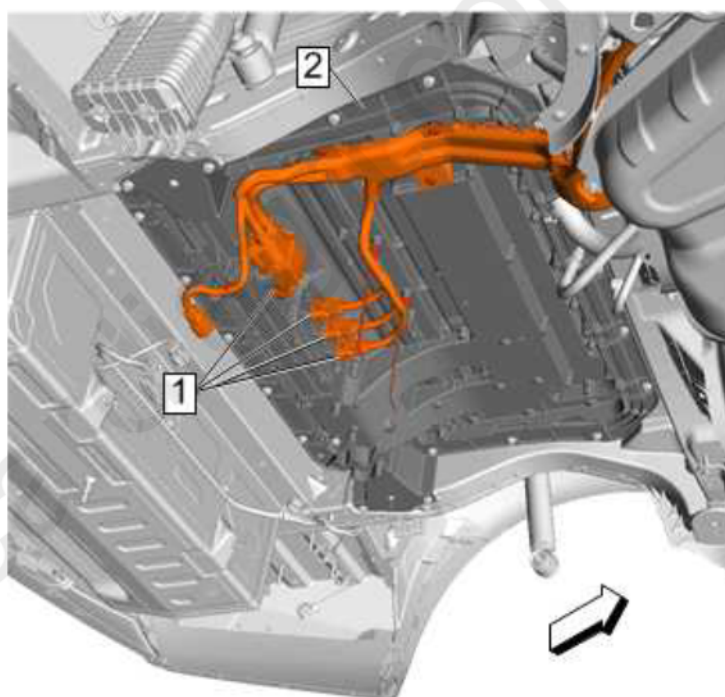


Fig. 163: Electrical Connectors

Courtesy of GENERAL MOTORS COMPANY

9. Fuel Tank Filler Pipe Shield Bolt » Install and tighten [2x] 9 N.m (80 lb in)

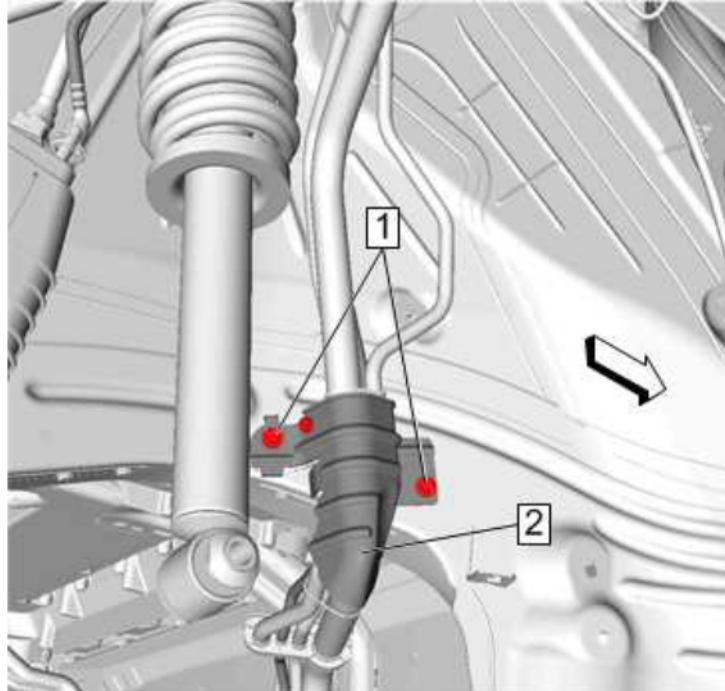


Fig. 164: Fuel Tank Filler Pipe Shield Bolts
 Courtesy of GENERAL MOTORS COMPANY

10. Connect the fuel tank hoses (1). Refer to [Fuel Tank Replacement](#)

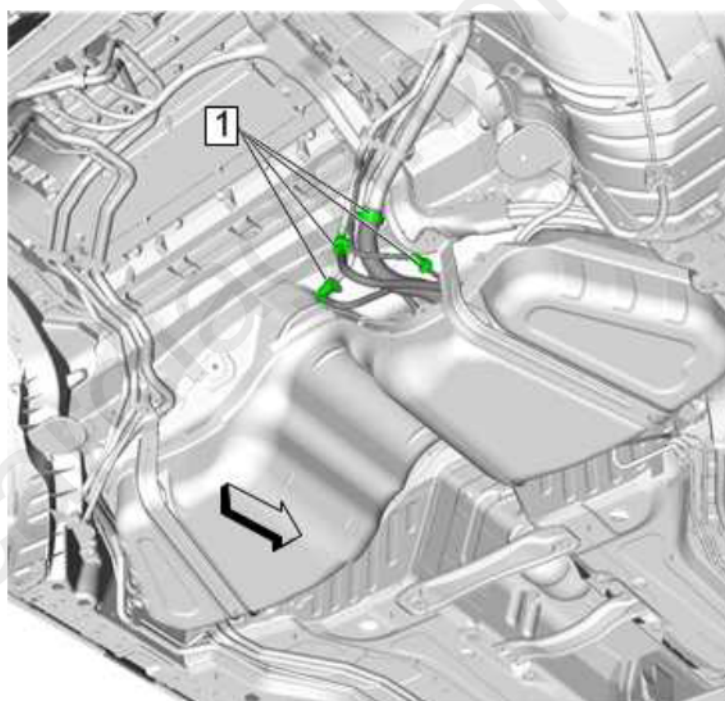


Fig. 165: Fuel Tank Hoses
 Courtesy of GENERAL MOTORS COMPANY

11. Install the right side fuel tank strap (2). Refer to [Fuel Tank Replacement](#)

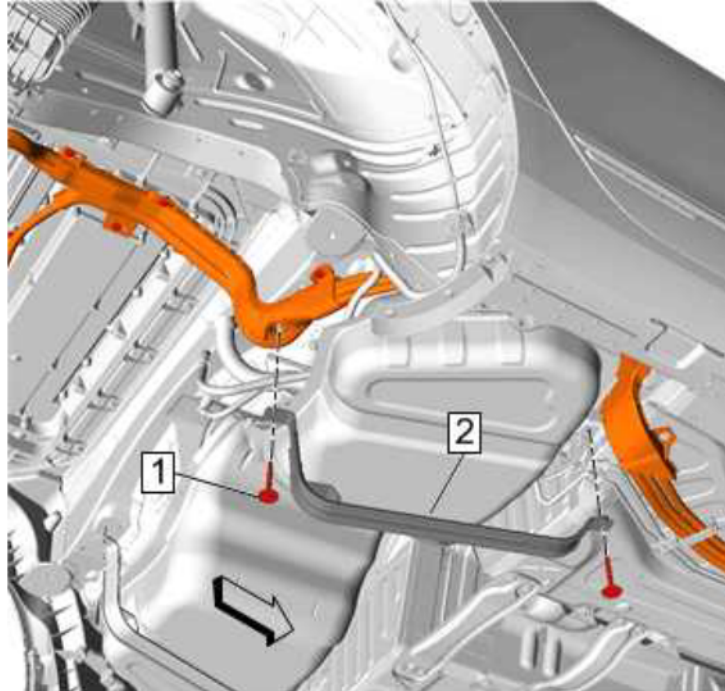


Fig. 166: Right Side Fuel Tank Strap

Courtesy of GENERAL MOTORS COMPANY

12. Install the left side fuel tank strap (2). Refer to [Fuel Tank Replacement](#)

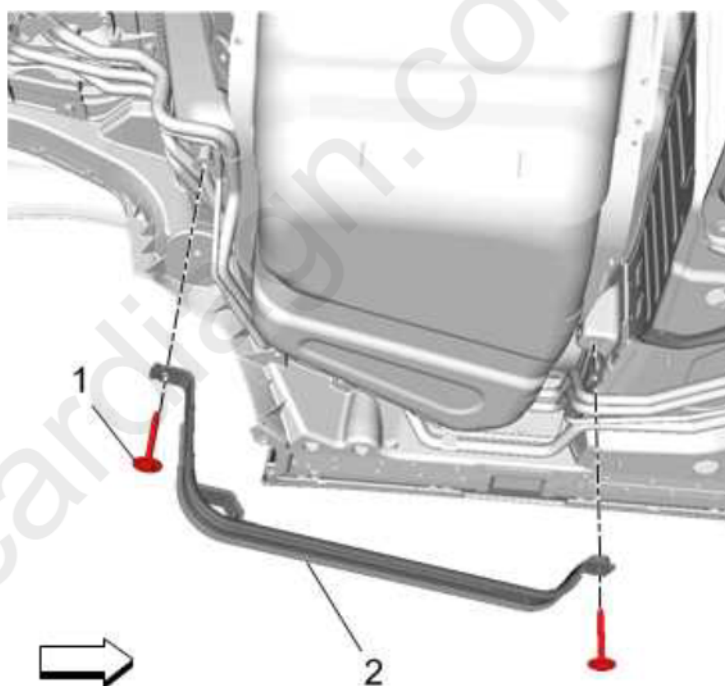


Fig. 167: Left Side Fuel Tank Strap

Courtesy of GENERAL MOTORS COMPANY

13. Battery Positive Cable Retainer (1) » Engage [9x]

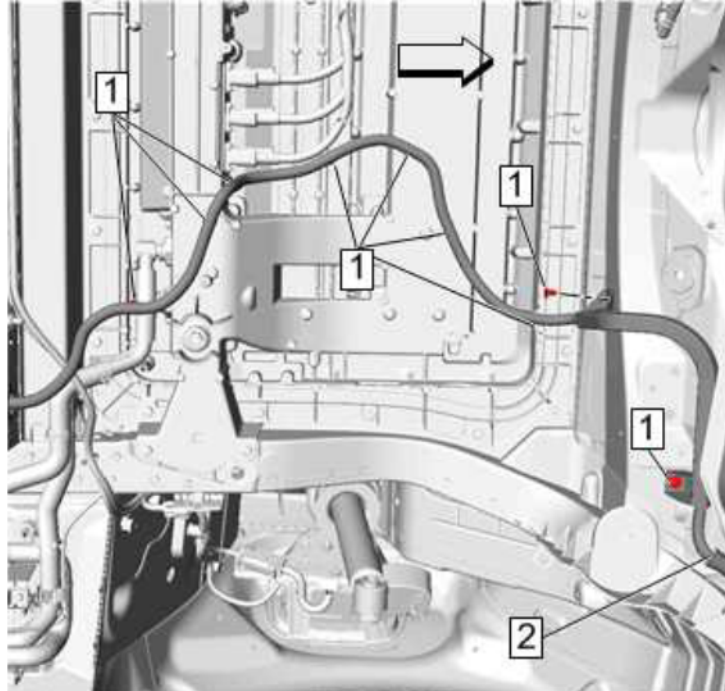


Fig. 168: Battery Positive Cable Retainers
Courtesy of GENERAL MOTORS COMPANY

14. Drive Motor Battery Coolant Pump Bracket (2) » Remove

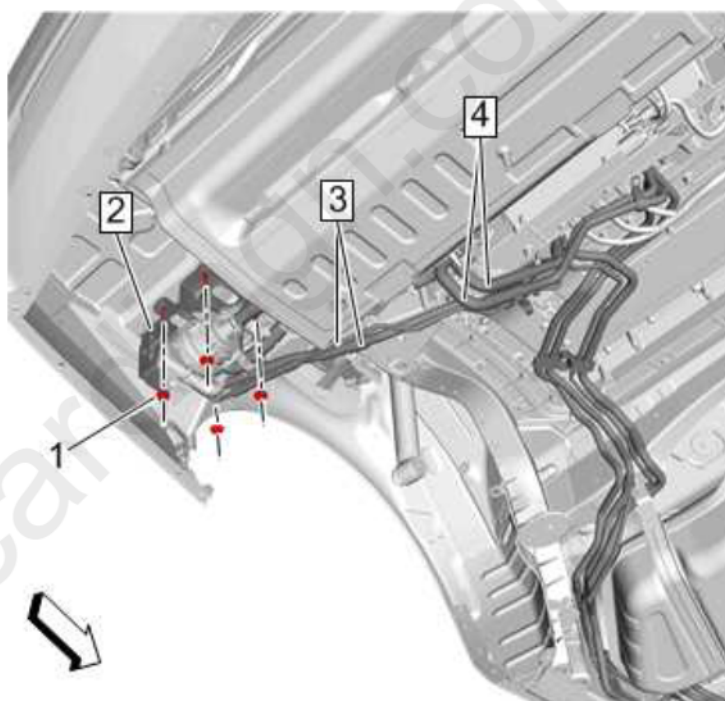


Fig. 169: Drive Motor Battery Coolant Pump Bracket Nuts
Courtesy of GENERAL MOTORS COMPANY

15. Drive Motor Battery Coolant Pump Bracket Nut (1) » Install and tighten 22 N.m (16 lb ft) [4x]
 16. Auxiliary Air Conditioning Evaporator Intermediate Tube Clamp (3) » Engage [3x]

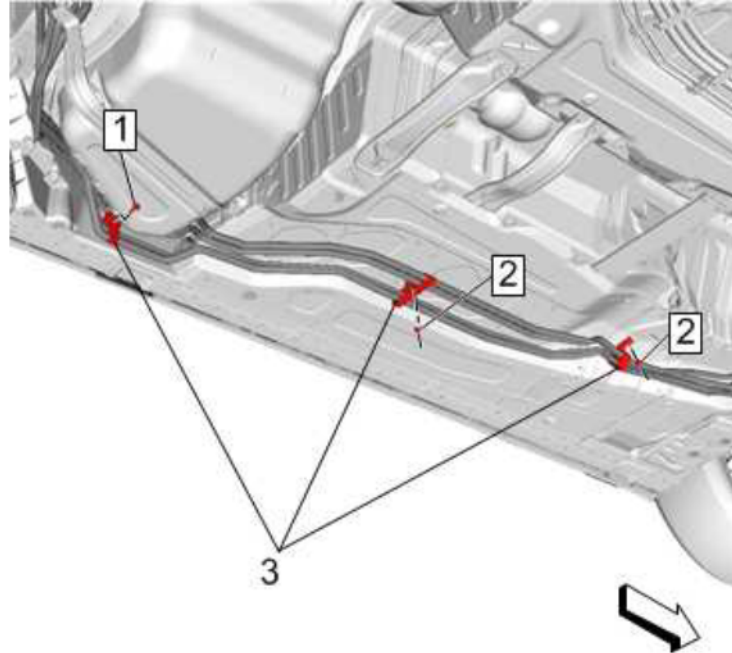


Fig. 170: Auxiliary Air Conditioning Evaporator Intermediate Tube With Bolt, Tube Nuts And Clamps

Courtesy of GENERAL MOTORS COMPANY

17. Auxiliary Air Conditioning Evaporator Intermediate Tube Nut (2)» Install and tighten [2x] 5 N.m (44 lb in)
18. Auxiliary Air Conditioning Evaporator Intermediate Tube Bolt (1)» Install and tighten [2x] 5 N.m (44 lb in)
19. Auxiliary Air Conditioning Evaporator Intermediate Tube Bolt (1)» Install and tighten [3x] 5 N.m (44 lb in)

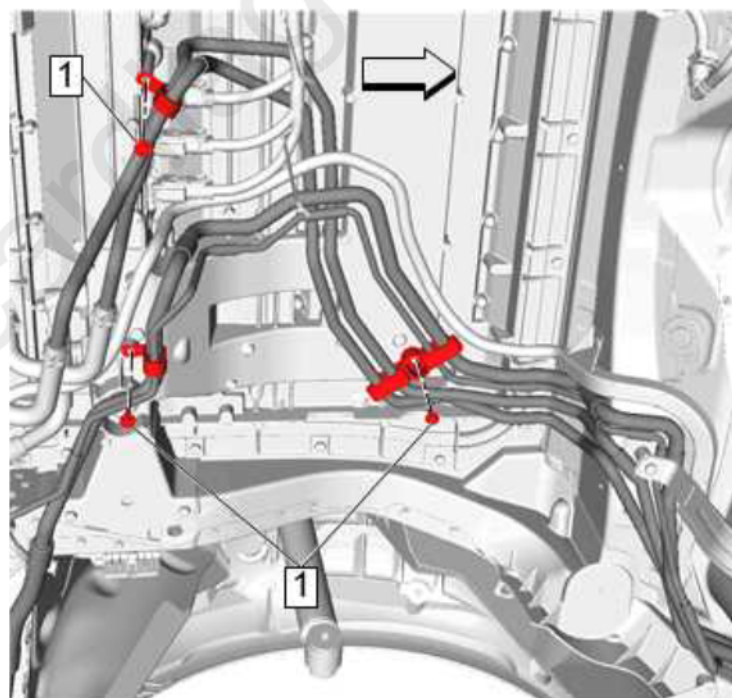


Fig. 171: Auxiliary Air Conditioning Evaporator Intermediate Tube Bolts

Courtesy of GENERAL MOTORS COMPANY

20. Drive Motor Battery Inlet Hose (2)» Install

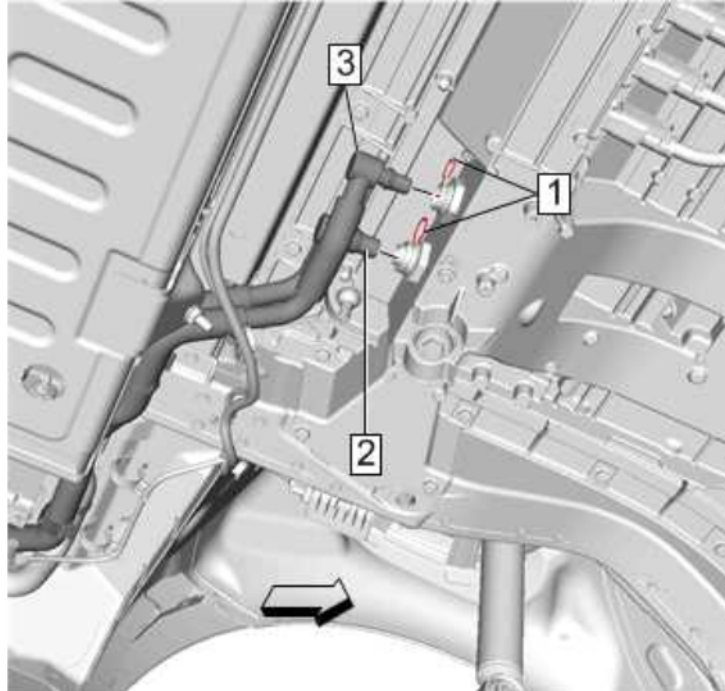


Fig. 172: Drive Motor Battery Inlet Hose And Drive Motor Battery Outlet Hose With Retainers
Courtesy of GENERAL MOTORS COMPANY

- 21. Drive Motor Battery Outlet Hose (3)» Install
- 22. Retainer (1)» Engage [2x]
- 23. Drive Motor Battery Convenience Charger Bracket (2)» Install

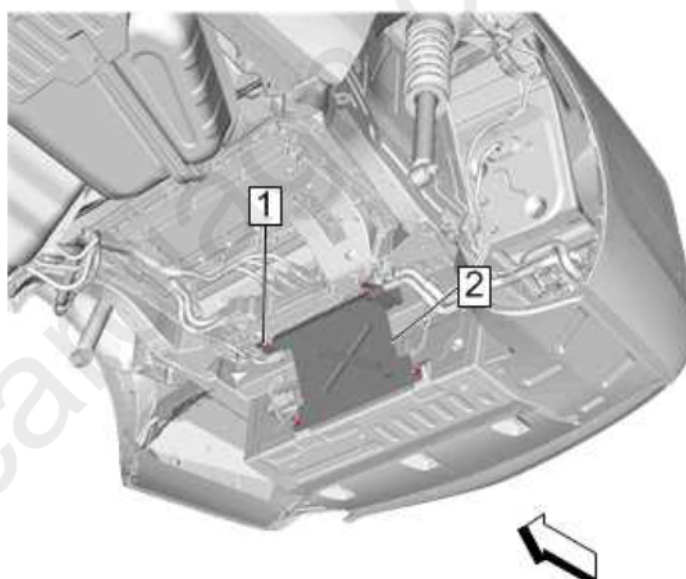


Fig. 173: Drive Motor Battery Convenience Charger Bracket
Courtesy of GENERAL MOTORS COMPANY

- 24. Drive Motor Battery Convenience Charger Bracket Fastener (1)» Install and tighten [4x] 22 N.m (16 lb ft)
- 25. Drive Motor Battery Charger (3)» Install - **Drive Motor Battery Charger Replacement**

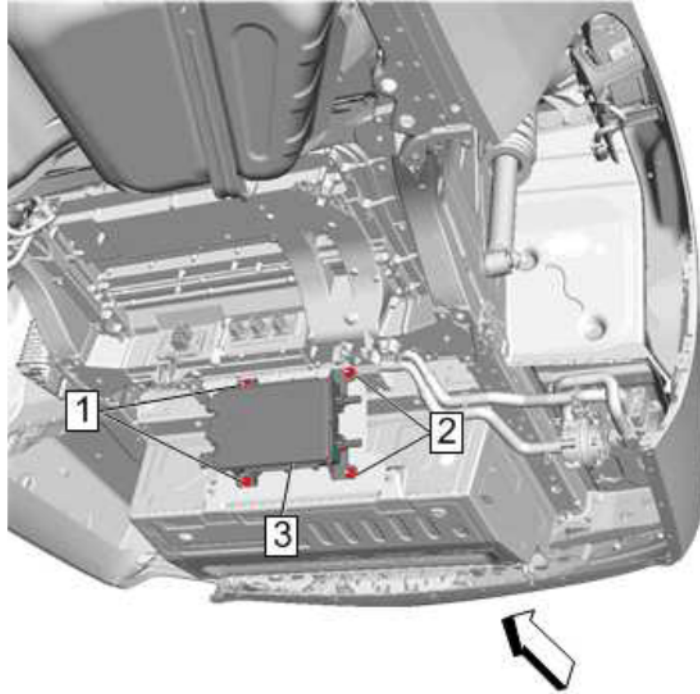


Fig. 174: Drive Motor Battery Charger And Fasteners
 Courtesy of GENERAL MOTORS COMPANY

26. Rear Suspension Cradle (1)» Install - [Rear Suspension Cradle Replacement](#)

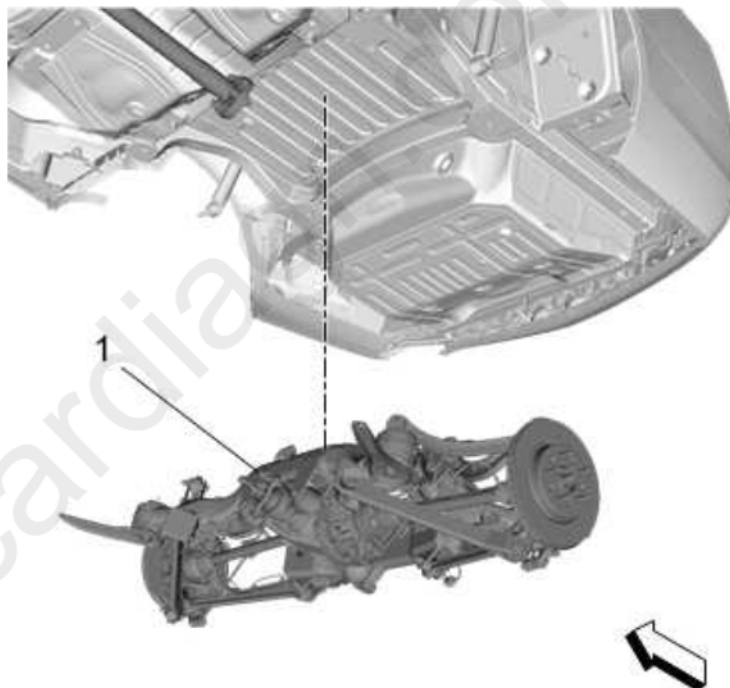


Fig. 175: Rear Suspension Cradle
 Courtesy of GENERAL MOTORS COMPANY

27. Rear Wheelhouse Liner (2)» Install - [Rear Wheelhouse Liner Replacement \(LTG\)](#) [Rear Wheelhouse Liner Replacement \(LGX, LGW\)](#)

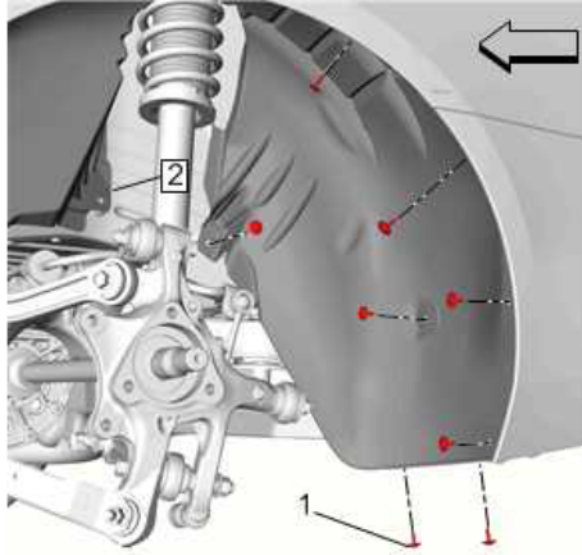


Fig. 176: Rear Wheelhouse Liner
 Courtesy of GENERAL MOTORS COMPANY

28. Remove the rear wheels. Refer to [Tire and Wheel Removal and Installation](#)
29. Hybrid Powertrain Control Module 2 (3)» Install

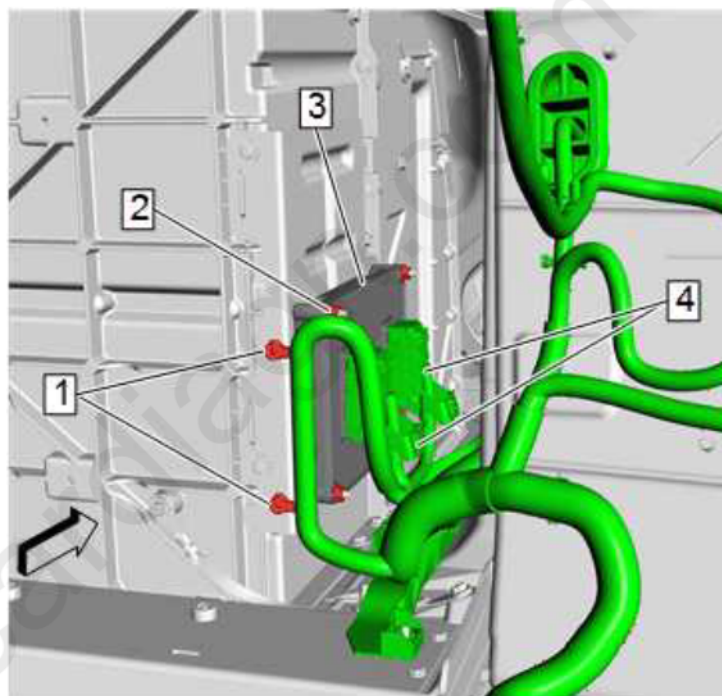


Fig. 177: Hybrid Powertrain Control Module 2 Mounting Nuts And Retainers
 Courtesy of GENERAL MOTORS COMPANY

30. Hybrid Powertrain Control Module 2 Mounting Nut (2)» Install and tighten [4x] 9 N.m (80 lb in)
31. Retainer (1)» Engage [2x]
32. Ground Strap (5)» Install [2x]

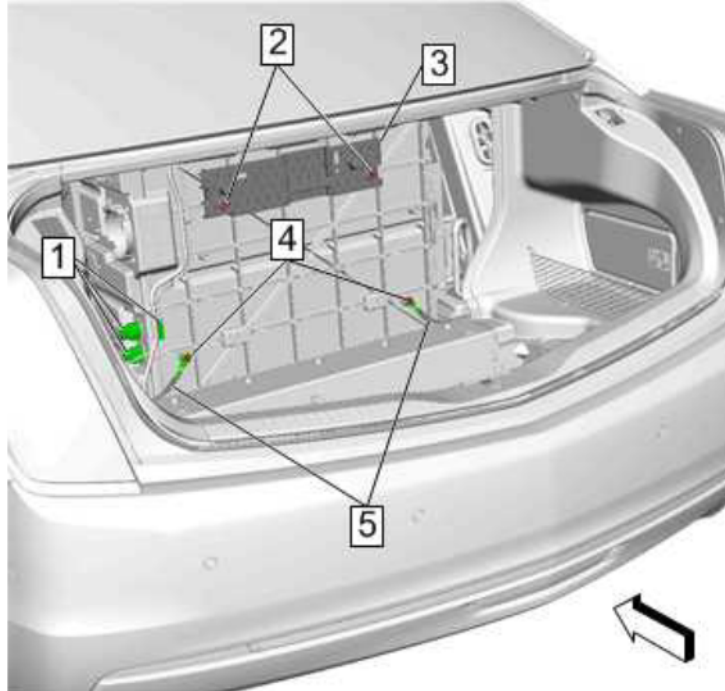


Fig. 178: High Voltage Battery Cover Bracket Bolts, Electrical Connectors And Ground Strap Bolts
 Courtesy of GENERAL MOTORS COMPANY

33. Ground Strap Bolt (4)» Install and tighten [2x] 9 N.m (80 lb in)
34. High Voltage Battery Cover Bracket (3)» Install
35. High Voltage Battery Cover Bracket Bolt (2)» Install and tighten [2x] 9 N.m (80 lb in)
36. Electrical Connector (1)» Connect [3x]
37. Fill the high voltage battery with coolant. Refer to [High Voltage Battery Drain and Filling \(Without Heater Vent Hose Quick Connect\)](#) and/or [High Voltage Battery Drain and Filling \(With Heater Vent Hose Quick Connect\)](#)
38. If necessary, fill the drive motor battery charger module. Refer to [Power Electronics and Auxiliary Radiator Drain and Fill \(LTG HP9\)](#)
39. Drive Motor Battery Cover (4)» Install - [Drive Motor Battery Cover Replacement \(With HP9\)](#)

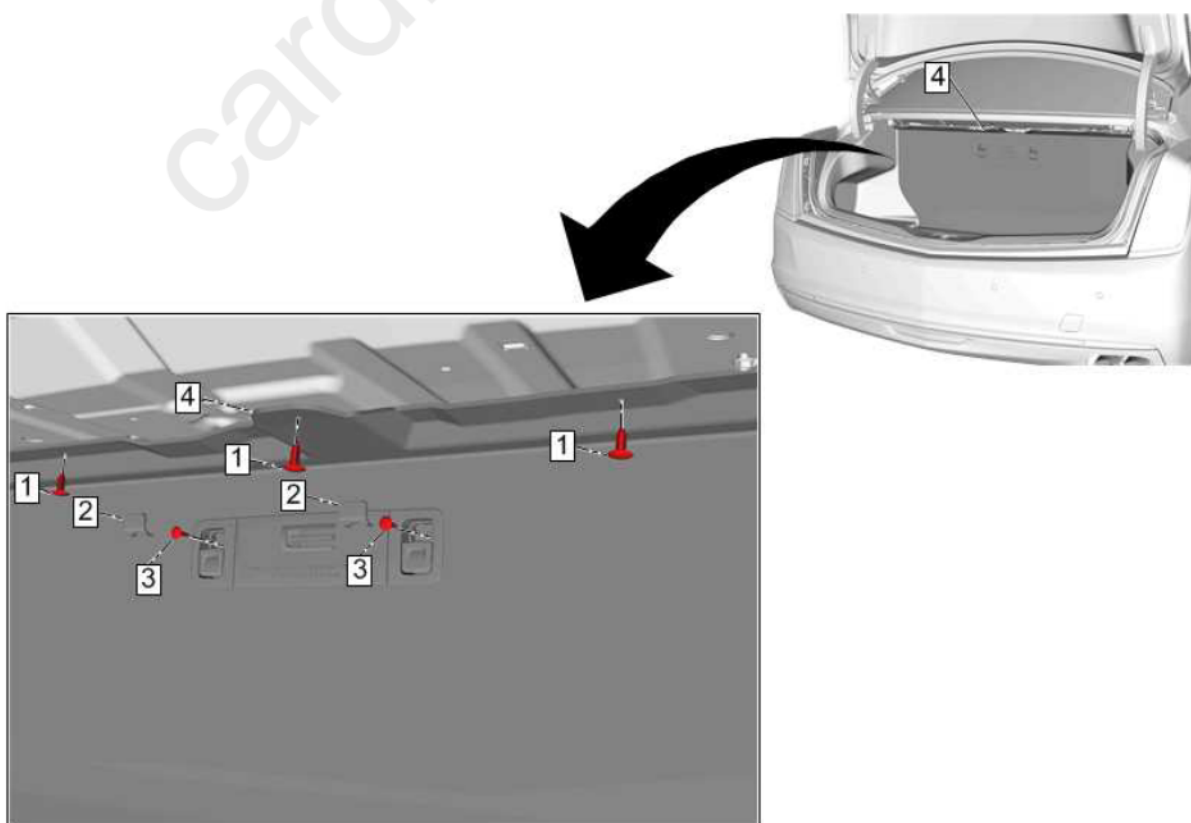


Fig. 179: Drive Motor Battery Cover (With HP9)
 Courtesy of GENERAL MOTORS COMPANY

40. Enable the high voltage system. Refer to [High Voltage Enabling](#)

41. Close the fuel tank door (1).

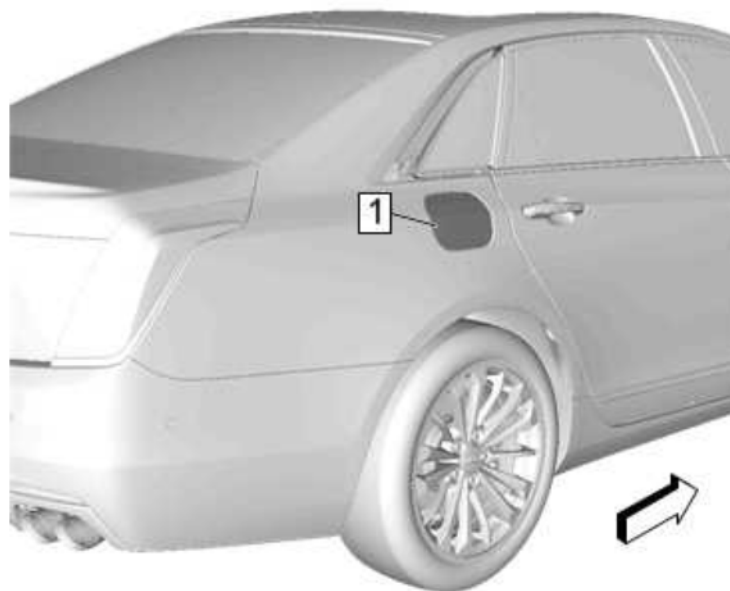


Fig. 180: Fuel Tank Door

Courtesy of GENERAL MOTORS COMPANY

- 42. Check the high voltage battery cooling system for leaks, refer to [High Voltage Battery Cooling System Leak Testing](#)
- 43. Reprogram the battery energy control module, refer to [Control Module References](#)
- 44. Reprogram the HPCM2, refer to [Control Module References](#)
- 45. Clear the secured high voltage DTC's. Refer to [Clear Secured High Voltage DTCs](#)
- 46. If required, perform the battery Hybrid/EV battery pack capacity learn procedure. Refer to [Hybrid/EV Battery Pack Capacity Learn](#)

NOTE: Refer to Diagnostic Aids to determine when, if required procedure should be performed.

HIGH VOLTAGE BATTERY COVER BRACKET REPLACEMENT



Fig. 181: High Voltage Battery Cover Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Drive Motor Battery Cover Replacement (With HP9)	
1	High Voltage Battery Cover Bracket Bolt [2x] CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)
2	High Voltage Battery Cover Bracket

HIGH VOLTAGE BATTERY DISCONNECT RELAY REPLACEMENT

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

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

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

Removal Procedure

1. Disable the high voltage system. Refer to [High Voltage Disabling](#)
2. High Voltage Battery (1) Remove - [High Voltage Battery Replacement and Shipping Preparation](#)

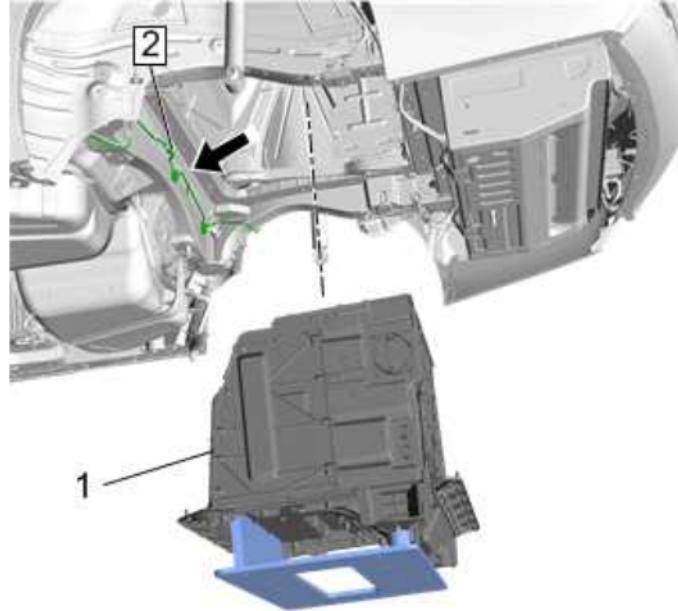


Fig. 182: High Voltage Battery

Courtesy of GENERAL MOTORS COMPANY

3. High Voltage Left Side Cover (2) » Remove - [High Voltage Battery Cover Replacement \(Top Cover\)](#)[High Voltage Battery Cover Replacement \(Front Cover\)](#)[High Voltage Battery Cover Replacement \(Left Side\)](#)[High Voltage Battery Cover Replacement \(Right Side\)](#)

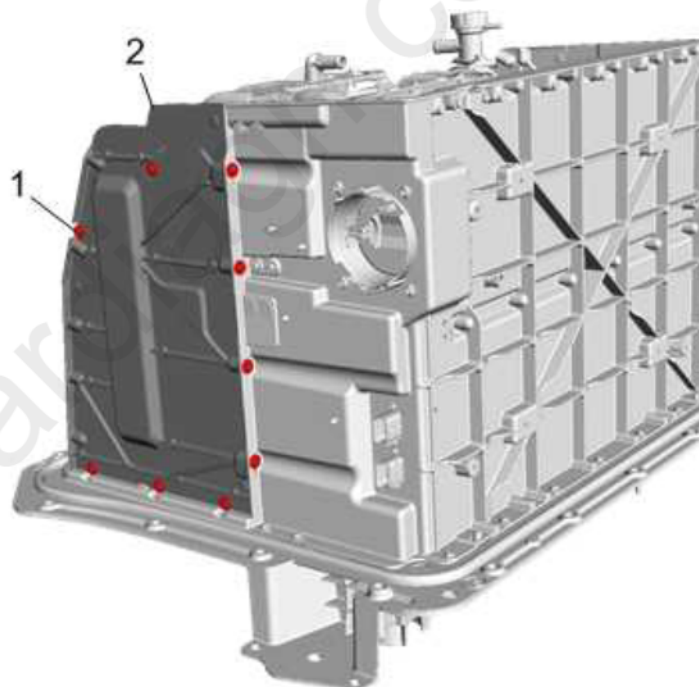


Fig. 183: High Voltage Battery Cover Bolts

Courtesy of GENERAL MOTORS COMPANY

4. Open the high voltage terminal covers. (1)

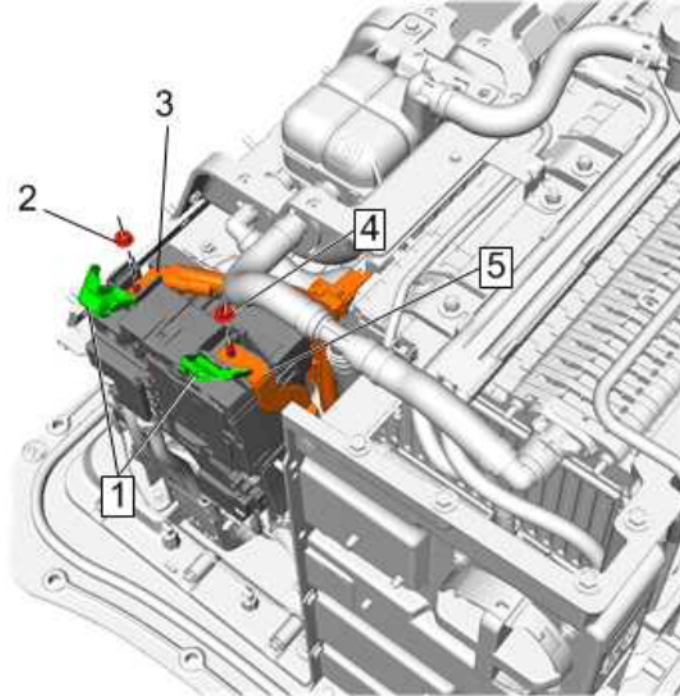


Fig. 184: High Voltage Terminal Covers, High Voltage Battery Positive Cable And High Voltage Battery Negative Cable With Fasteners

Courtesy of GENERAL MOTORS COMPANY

5. High Voltage Battery Positive Cable Fastener (2)» Remove
6. High Voltage Battery Positive Cable (3)» Remove
7. High Voltage Battery Negative Cable Fastener (4)» Remove
8. High Voltage Battery Negative Cable (5)» Remove
9. High Voltage Battery Positive Cable Terminal Cover (1)» Open

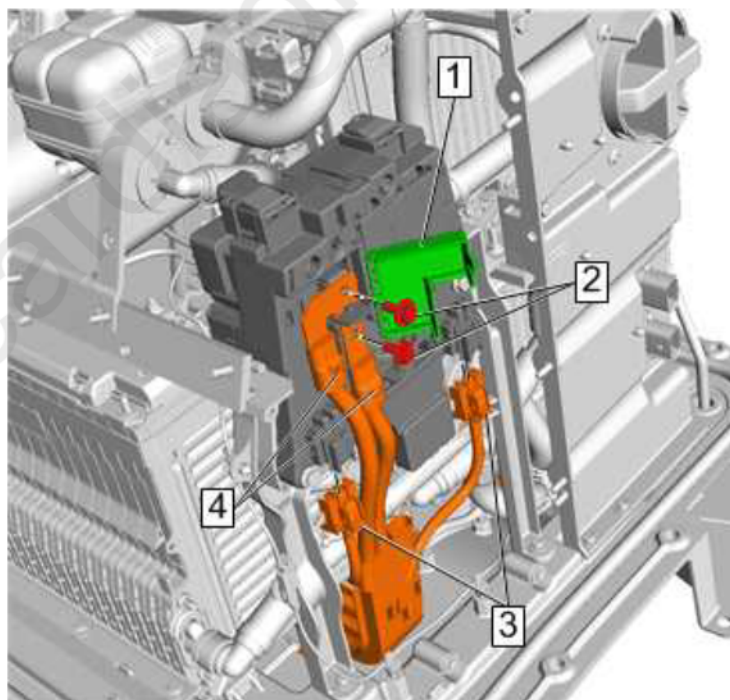


Fig. 185: Electrical Connectors, High Voltage Battery Positive Cables With Terminal Cover And Bolts

Courtesy of GENERAL MOTORS COMPANY

10. High Voltage Battery Positive Bolt (2)» Remove [2x]
11. High Voltage Battery Positive Cable [4]» Remove [2x]
12. Electrical Connector (3)» Disconnect [2x]
13. High Voltage Battery Disconnect Relay Bolt (1)» Remove [2x]

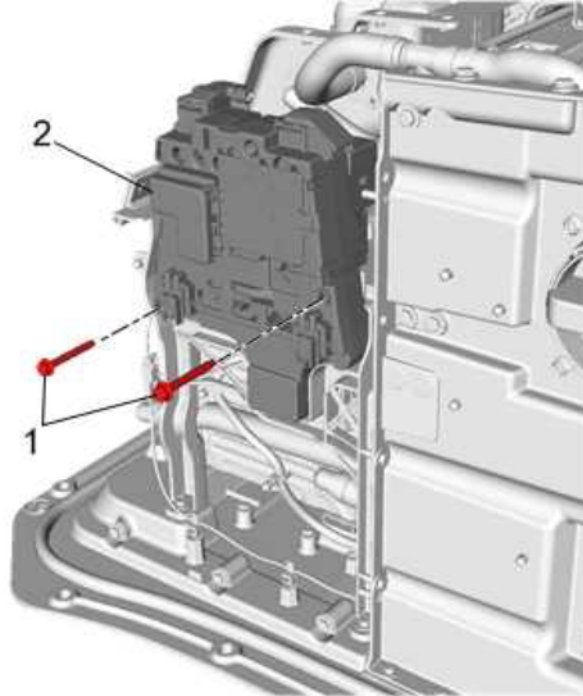


Fig. 186: High Voltage Battery Disconnect Relay Bolts
Courtesy of GENERAL MOTORS COMPANY

14. Slowly remove the high voltage battery disconnect relay (2) to access the rear connectors.
15. Electrical Connector (1) » Disconnect [3x]

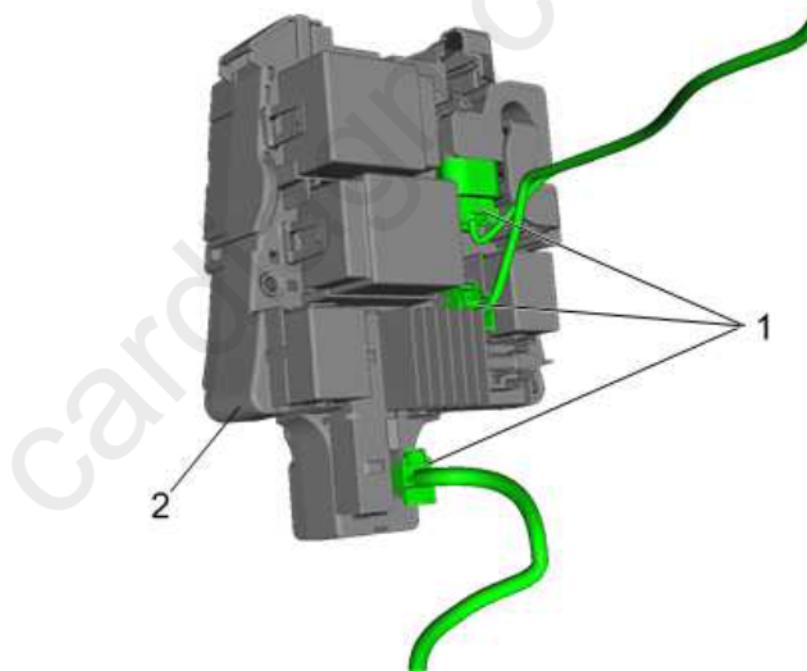


Fig. 187: Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

16. High Voltage Battery Disconnect Relay (2) » Remove

Installation Procedure

1. Electrical Connector (1) » Connect [3x]

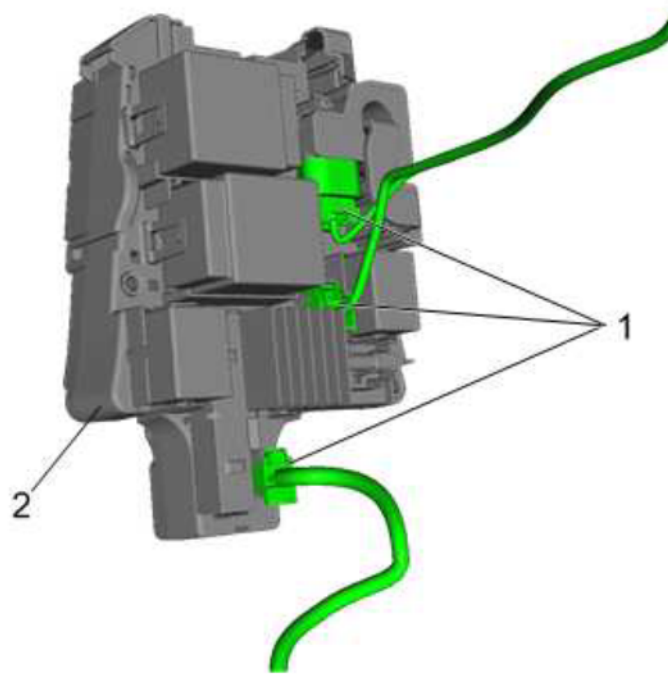


Fig. 188: Electrical Connectors

Courtesy of GENERAL MOTORS COMPANY

2. High Voltage Battery Disconnect Relay (2)» Install
3. High Voltage Battery Disconnect Relay Bolt (1)» Install and tighten [2x] 9 N.m (80 lb in)

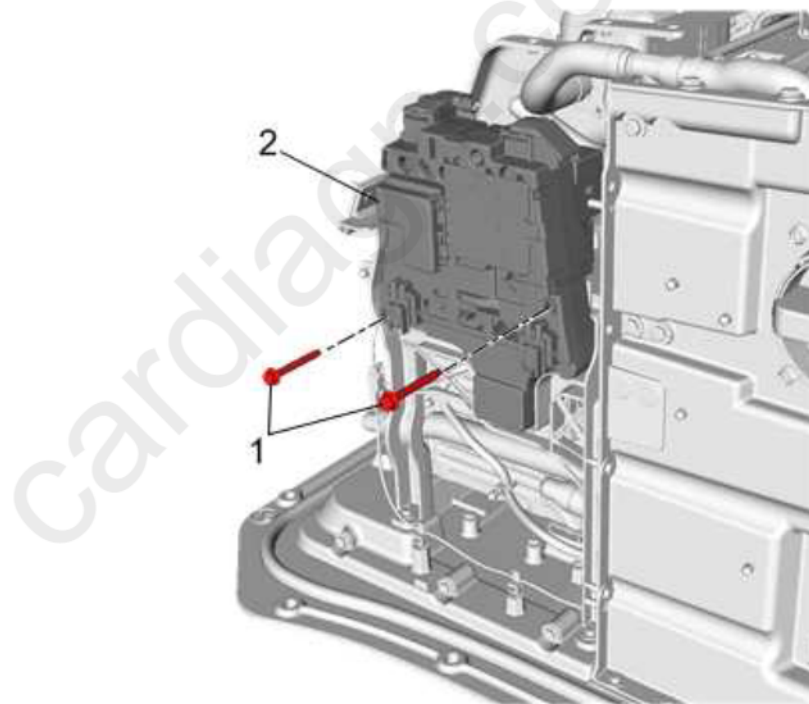


Fig. 189: High Voltage Battery Disconnect Relay Bolts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

4. Electrical Connector (3)» Connect [2x]

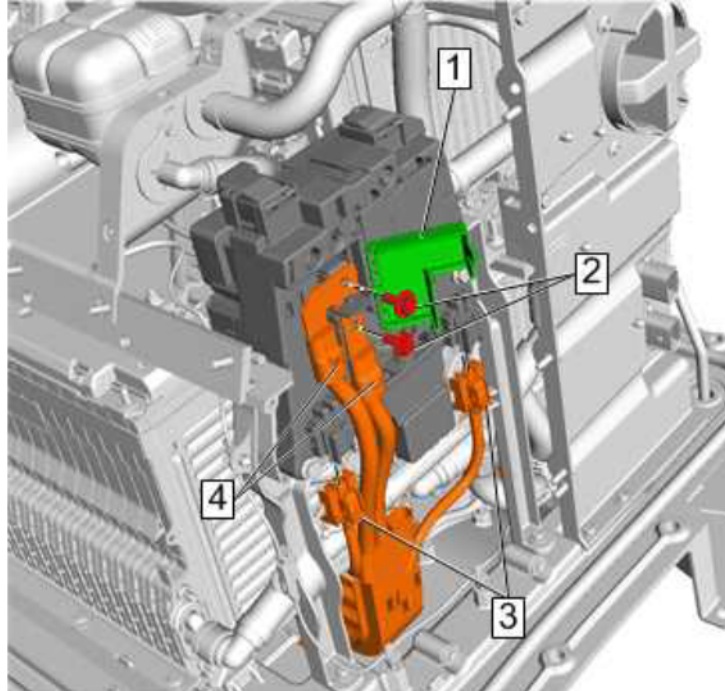


Fig. 190: Electrical Connectors

Courtesy of GENERAL MOTORS COMPANY

5. High Voltage Battery Positive Cable [4x] » Install [2x]
6. High Voltage Battery Positive Bolt (2) » Tighten [2x]

NOTE: Critical high voltage fastener. Perform second torque verification following re-assembly.

- First Pass: 9 N.m (80 lb in)
- Final Pass: 9 N.m (80 lb in)

7. High Voltage Battery Positive Cable Terminal Cover (1) » Close
8. High Voltage Battery Positive Cable (3) » Install

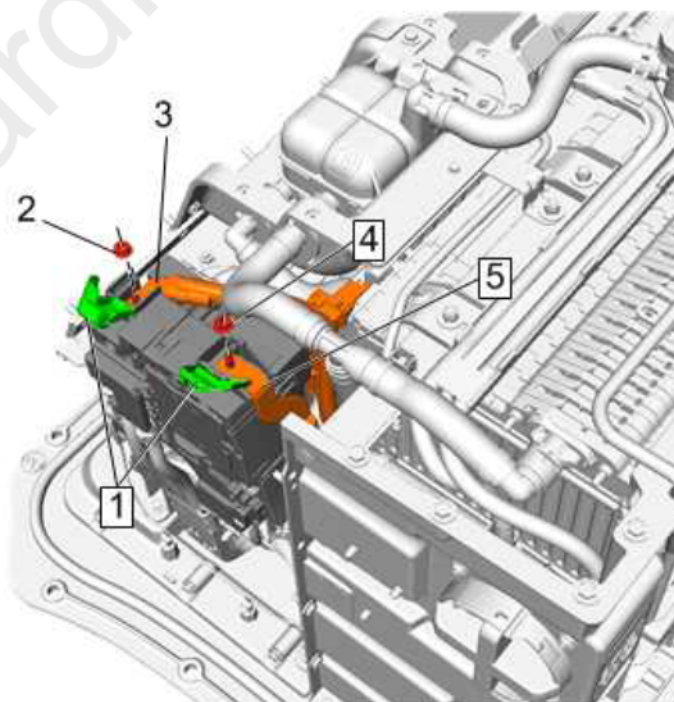


Fig. 191: High Voltage Terminal Covers, High Voltage Battery Positive Cable And High Voltage Battery Negative Cable With Fasteners

Courtesy of GENERAL MOTORS COMPANY

9. High Voltage Battery Positive Cable Fastener (2) » Tighten

NOTE: Critical high voltage fastener. Perform second torque verification following

re-assembly.

- First Pass: 9 N.m (80 lb in)
- Final Pass: 9 N.m (80 lb in)

10. High Voltage Battery Negative Cable (5)» Install

11. High Voltage Battery Negative Cable Fastener (4)» Tighten

NOTE: Critical high voltage fastener. Perform second torque verification following re-assembly.

- First Pass: 9 N.m (80 lb in)
- Final Pass: 9 N.m (80 lb in)

12. Close the high voltage terminal covers. (1)

13. High Voltage Left Side Cover (2)» Install - [High Voltage Battery Cover Replacement \(Left Side\)](#)

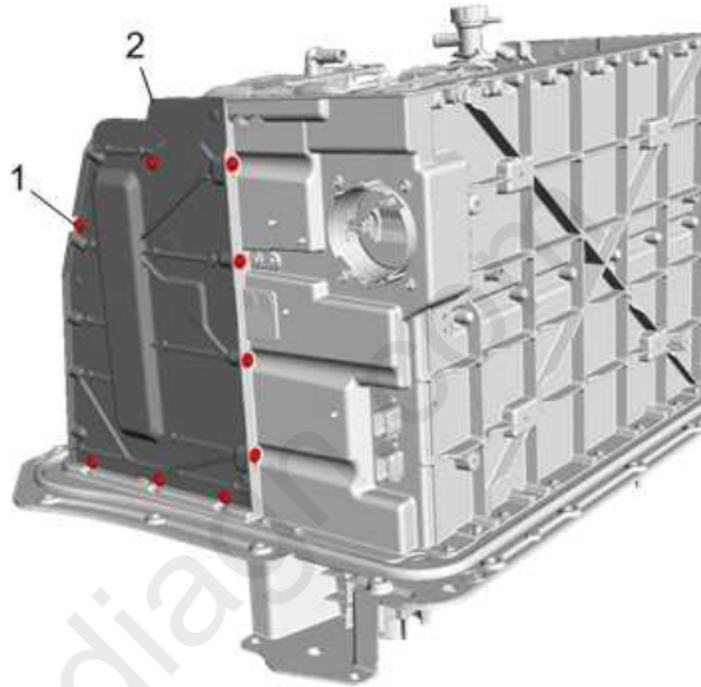
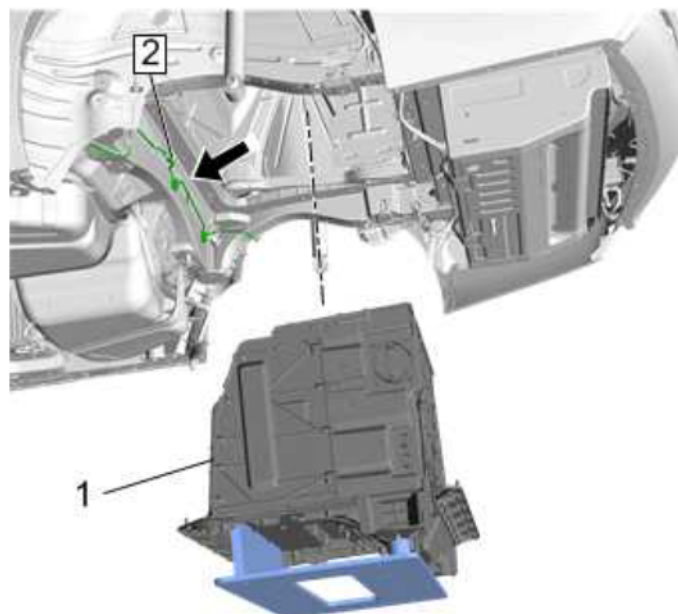


Fig. 192: High Voltage Battery Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

14. High Voltage Battery (1)» Install - [High Voltage Battery Replacement and Shipping Preparation](#)



15. Enable the high voltage system. Refer to [High Voltage Enabling](#)

HIGH VOLTAGE BATTERY DISCONNECT RELAY FUSE REPLACEMENT (REAR FUSE)

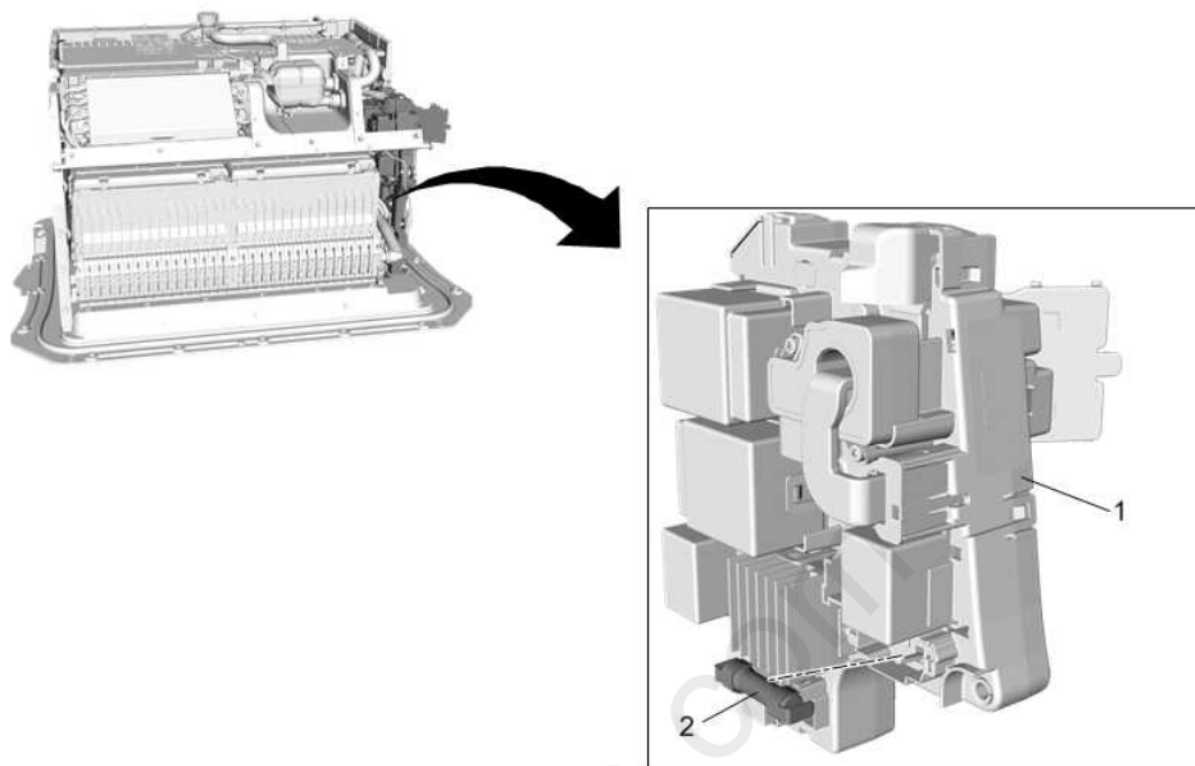


Fig. 194: High Voltage Battery Disconnect Relay Fuse (Rear Fuse)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures	
WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed. The High Voltage Disabling procedure includes the following steps:	
• Identify how to disable high voltage. • Identify how to test for the presence of high voltage. • Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.	
Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:	
• Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors. • Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors. • Visually and functionally inspect the gloves before use. • Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.	
Failure to follow the procedures may result in serious injury or death.	

1. Disable the high voltage system. Refer to [High Voltage Disabling](#)
2. Remove the high voltage battery front cover. Refer to [High Voltage Battery Cover Replacement \(Front Cover\)](#)

1	High Voltage Battery Disconnect Relay
2	10 Amp Fuse - RESS Heater

HIGH VOLTAGE BATTERY DISCONNECT RELAY FUSE REPLACEMENT (FRONT FUSES)

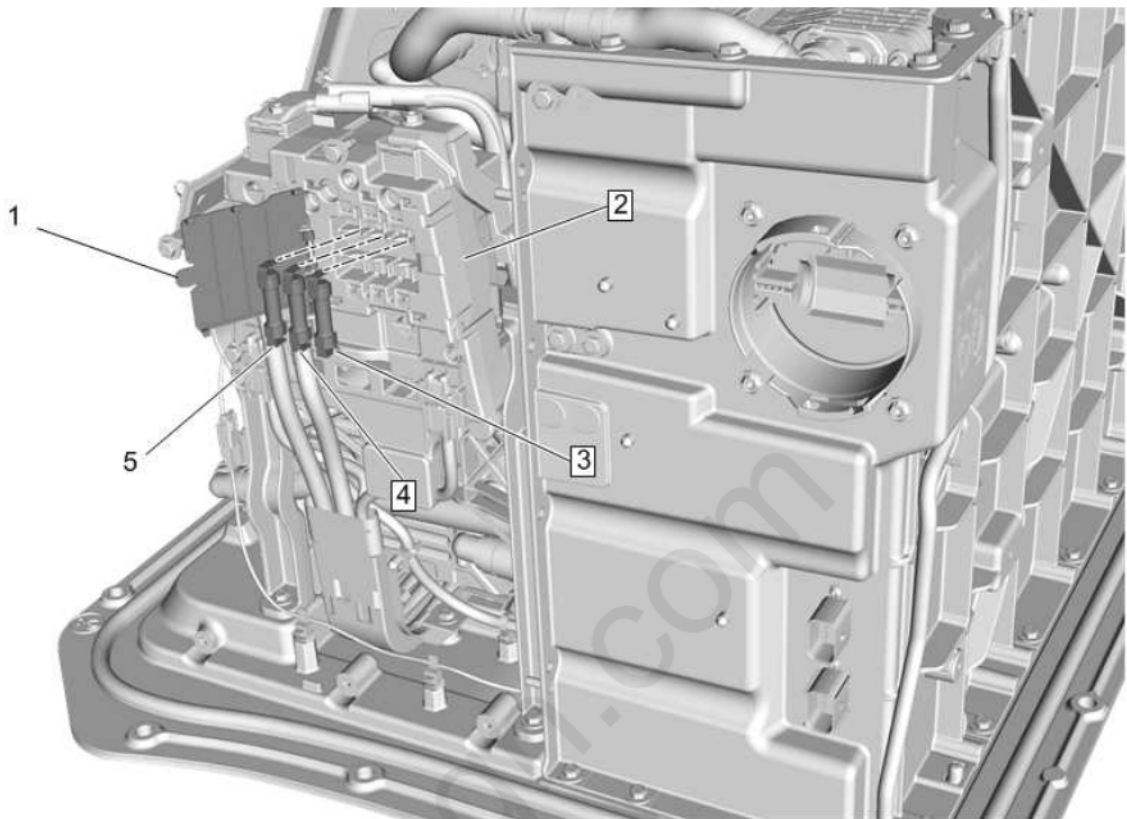


Fig. 195: High Voltage Battery Disconnect Relay Fuse (Front Fuses)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures	
WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed. The High Voltage Disabling procedure includes the following steps: - Identify how to disable high voltage. - Identify how to test for the presence of high voltage. - Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.	
Before working on any high voltage system, be sure to wear the following Personal Protection Equipment: - Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors. - Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors. - Visually and functionally inspect the gloves before use. - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.	

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

1. Disable the high voltage system. Refer to [High Voltage Disabling](#)
2. Remove the high voltage battery left side cover. Refer to [High Voltage Battery Cover Replacement \(Left Side\)](#)

1	Fuse Cover
2	High Voltage Battery Disconnect Relay
3	30 Amp Fuse - HV Cabin Heater Control Module
4	15 Amp Fuse - HV On Board Charging Module
5	40 Amp Fuse - HV A/C Compressor

BODY WIRING HARNESS EXTENSION HARNESS REPLACEMENT

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.

Removal Procedure

1. Disable the high voltage system. Refer to [High Voltage Disabling](#)
2. High Voltage Battery (1) Remove - [High Voltage Battery Replacement and Shipping Preparation](#)

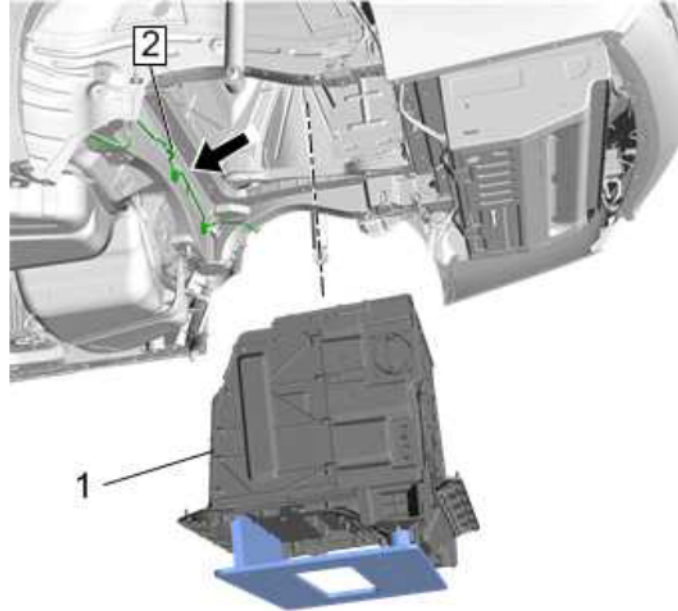


Fig. 196: High Voltage Battery

Courtesy of GENERAL MOTORS COMPANY

3. Retainer (1)» Disengage [7x]

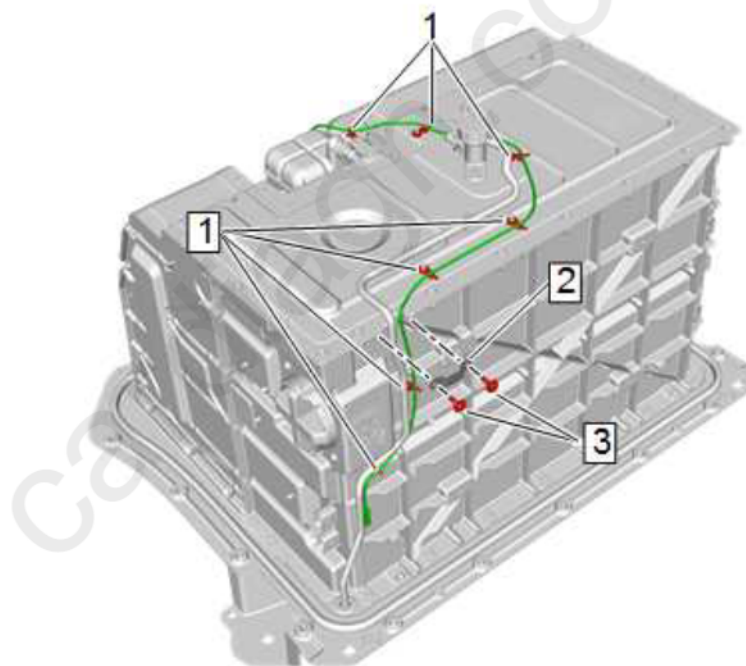


Fig. 197: Retainers

Courtesy of GENERAL MOTORS COMPANY

4. Electrical Connector (3) @ Drive Motor Battery Coolant/Air Separator (2)» Disconnect

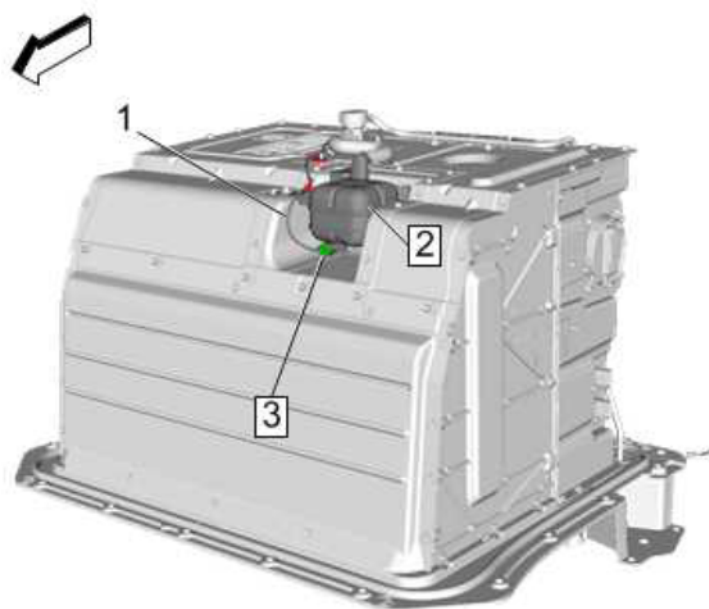


Fig. 198: Body Wiring Harness Extension Harness
Courtesy of GENERAL MOTORS COMPANY

5. Body Wiring Harness Extension Harness (1)» Remove

Installation Procedure

1. Body Wiring Harness Extension Harness (1)» Install

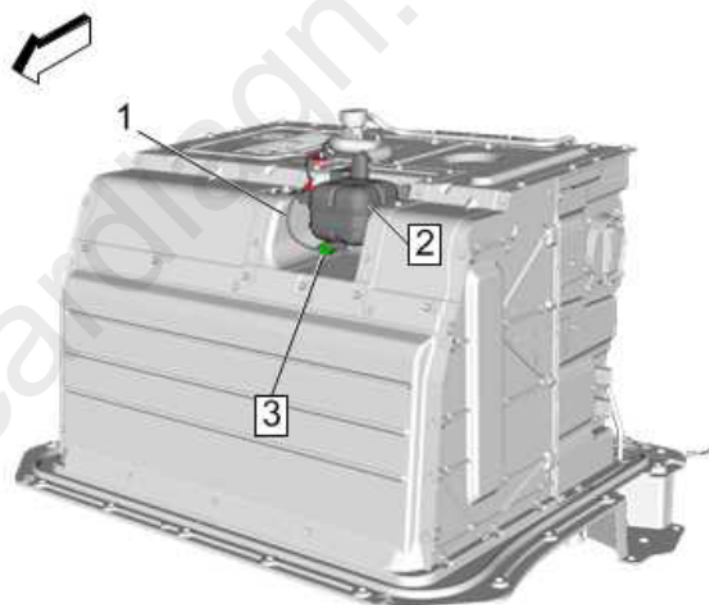


Fig. 199: Body Wiring Harness Extension Harness
Courtesy of GENERAL MOTORS COMPANY

2. Electrical Connector (3) @ Drive Motor Battery Coolant/Air Separator (2)» Connect
3. Retainer (1)» Engage [7x]

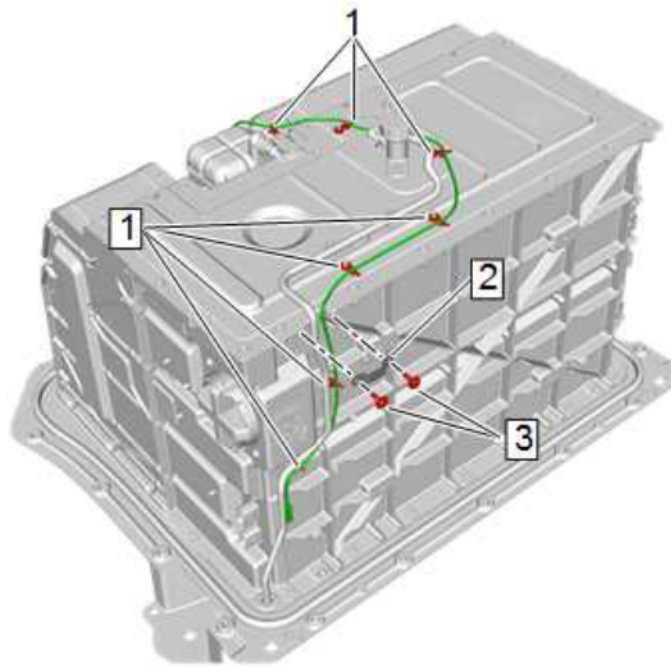


Fig. 200: Retainers

Courtesy of GENERAL MOTORS COMPANY

4. High Voltage Battery (1)» Install - **High Voltage Battery Replacement and Shipping Preparation**

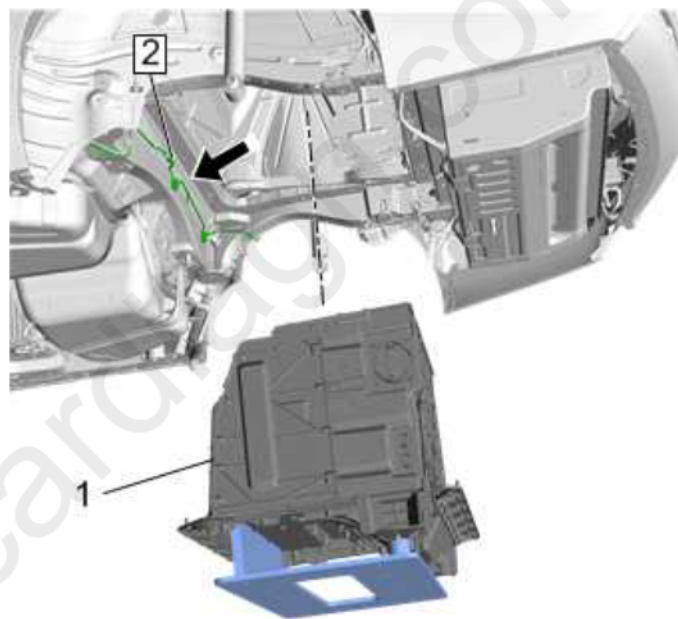


Fig. 201: High Voltage Battery

Courtesy of GENERAL MOTORS COMPANY

BATTERY NEGATIVE STRAP REPLACEMENT

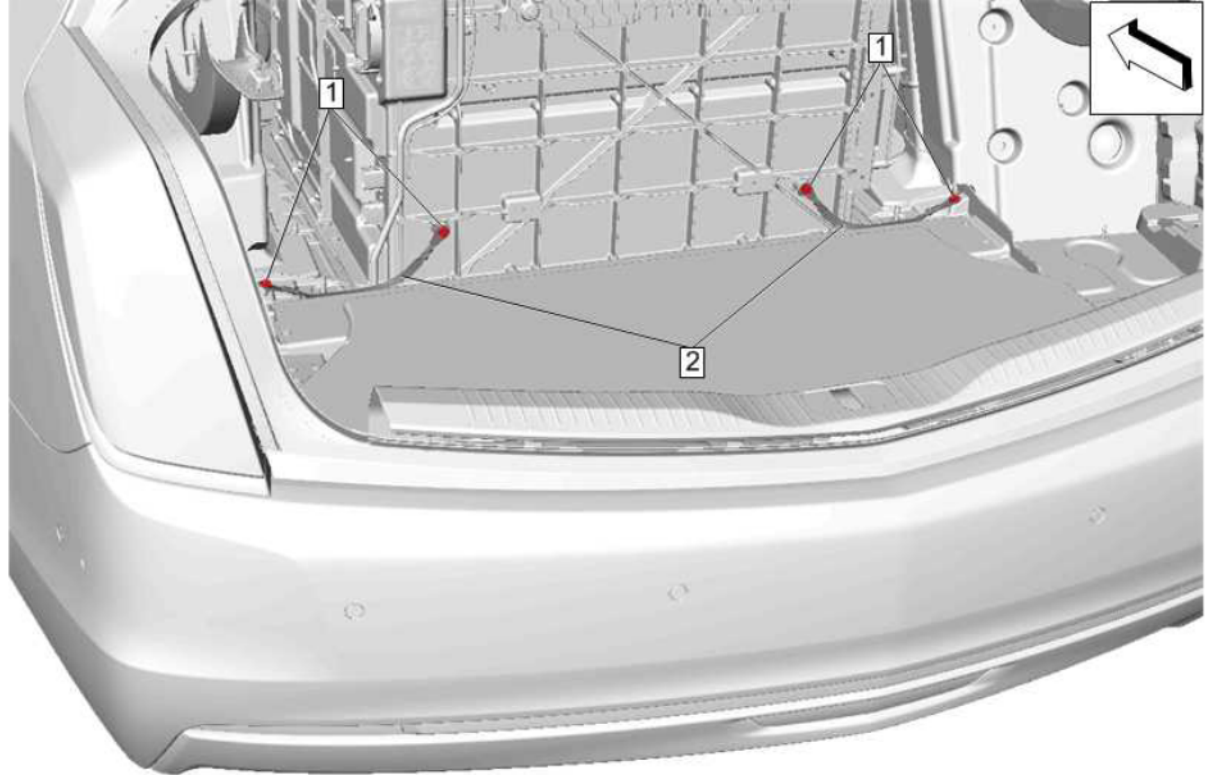


Fig. 202: Battery Negative Strap

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Drive Motor Battery Cover Replacement (With HP9)	
1	Body Ground Strap Bolt [4x] CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)
2	Battery Negative Strap [2x]

CLEAR SECURED HIGH VOLTAGE DTCS

Circuit/System Description

The hybrid powertrain control modules 1 and 2 independently monitor for high voltage safety conditions such as airbag deploy events and certain high voltage system faults. When either module identifies one of these conditions, a DTC may set and the vehicle is placed into a 'high voltage lockout' state. While in the lockout state, the high voltage contactor relays are prevented from closing.

The purpose of the high voltage lockout state is to allow for high voltage system inspection prior to re-enabling. A complete inspection of the high voltage system and components must be performed if the vehicle has been involved in a collision. Perform the **High Voltage System Inspection** procedure, if necessary, prior to clearing a Secured High Voltage DTCs/lockout state.

Diagnostic Aids

- The following conditions may result in a HV lockout state without a corresponding DTC:
 - High voltage component replacement
 - Low 12 V battery event
 - SPS programming event
 - Airbag deployment/crash event detected: The Inflatable Restraint Sensing and Diagnostic Module may or may not set a DTC but will continue to broadcast a crash event status until reset.

- Performing a scan tool DTC Clear may clear the diagnostic that set the HV lockout state, but will not reset the lockout.
- Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.
- The Clear Secured High Voltage DTCs procedure must be completed when the following components, as applicable, are replaced:
 - K16 Hybrid/EV Battery Energy Control Module
 - K112A - K112H Hybrid/EV Battery Interface Control Module
 - A4 Hybrid/EV Battery Pack
 - K114A Hybrid/EV Powertrain Control Module 1
 - K114B Hybrid/EV Powertrain Control Module 2

Contactor Open Reasons Reset

The hybrid/EV powertrain control module 2, Hybrid/EV Battery Contactor Open Reasons scan tool parameter list identifies all past events that commanded contactors open. The parameters can only be reset by either reprogramming the hybrid/EV powertrain control module 2 or by performing the scan tool Hybrid/EV Battery Contactor Open Reasons Reset function. To aid in possible future intermittent diagnosis, the parameters should be reset to NO once all diagnostic procedures are successfully completed.

Scan Tool Hybrid/EV Battery Contactor Open Reasons Reset Function

1. Complete the Circuit System Verification and Testing as necessary.

NOTE: The hybrid/EV system must be able to enter a Propulsion Active state.

2. Remove any chargers and as applicable, the charge cord.
3. Vehicle OFF, wait 5 minutes.
4. Disengage the S15 Manual Service Disconnect to the first position to open the high voltage interlock loop circuit.

NOTE: It is not necessary to completely remove the S15 Manual Service Disconnect.

5. Service Mode, enable the scan tool reset function.
6. Vehicle OFF, wait 5 minutes.
7. Fully engage the S15 Manual Service Disconnect.
8. Start the vehicle and Clear Vehicle DTCs.

Reference Information

Special Tools

EL-49642 SPS Programming Support Tool

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

Circuit/System Verification

1. Vehicle ON.
2. With a scan tool, verify the Hybrid/EV Powertrain Control Module 2 parameters Hybrid/EV Battery Positive Contactor Command and Hybrid/EV Battery Negative Contactor Command each indicate Closed.

- **If the contactors are not commanded Closed**

Refer to Circuit/System Testing.

- **If the contactors are commanded Closed**

3. A Secured High Voltage DTC HV lockout state is not present. All OK.

Circuit/System Testing

The Clear Secured High Voltage DTCs reset process requires scan tool interaction with **two or three different control modules in sequence** and can be completed using the following steps:

1. Install **EL-49642** SPS programming support tool.
2. Vehicle in Service Mode. With a scan tool select the Hybrid/EV Powertrain Control Module 2, Hybrid Battery Pack Contactor Open Reasons data list. Verify if either the Crash Event Detected or Air Bag Deployed parameters indicate YES.
 - **If either parameter displays YES**
 1. Perform the **High Voltage System Inspection** procedure.
 2. If the results of the inspection procedure support enabling of the high voltage system, perform the Inflatable Restraint and Sensing Diagnostic Module function Reset High Voltage Disable Request After Crash Event Detected.
 3. Turn the vehicle OFF for 5 minutes.
 4. Proceed to next step.
 - **If BOTH parameters indicate NO**
3. Vehicle in Service Mode. With a scan tool, clear All DTCs.
4. With a scan tool, select Hybrid/EV Powertrain Control Module 2 Control Functions list. Select Clear Secured High Voltage DTCs and follow the on-screen instructions waiting 45 seconds before exiting the screen.

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.

5. With a scan tool, select Hybrid/EV Powertrain Control Module Control Functions list. Select Clear Secured High Voltage DTCs. Select Continue button waiting 45 seconds before exiting the screen.
6. With a scan tool, select Hybrid/EV Powertrain Control Module 2 Control Functions list. Select Clear Secured High Voltage DTCs and follow the on-screen instructions.
7. With a scan tool, clear All DTCs.
8. Allow the Hybrid/EV powertrain Control Modules to enter sleep mode by performing the following:
 1. Turn the vehicle OFF.
 2. Ensure the scan tool is not communicating with any control modules by returning to the Home screen.
 3. Ensure the scan tool is accessible without having to open doors or otherwise cause control module wake-up.
 4. Shut all doors. Do NOT depress the brake pedal or activate any vehicle controls such as the parking lights, fuel door release, etc.
 5. Wait 5 minutes with the vehicle in the prescribed condition so that the modules may enter sleep mode.

NOTE: Sleep mode is usually entered within two minutes after shutting off the vehicle. However, activating vehicle features such as Refuel Mode may extend this time up to 30 minutes.

9. With a scan tool, verify the Hybrid/EV Powertrain Control Module 2 has gone to sleep by ensuring communication is not present.
 - **If communication is present**

Repeat the previous step.
 - **If communication is not present**
10. Start the vehicle.
11. Verify that no DTCs are set.
 - **If any DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**.
 - **If no DTCs are set**

HYBRID/EV BATTERY PACK CAPACITY LEARN

Circuit/System Description

The Hybrid Powertrain Control Module 2 learns the battery capacity as the Hybrid/EV battery pack is discharged and charged. Once learned, the capacity value is allowed to change over a long period of time, as the battery ages.

Replacement of the battery pack, all battery sections or the Hybrid Powertrain Control Module 2 requires capacity learning at a faster rate than normal.

To enable hardware replacement, the Hybrid Powertrain Control Module 2 can be placed into a fast learn mode with the scan tool.

Activating the fast Capacity Learn mode will reset the battery capacity to a much lower value and subsequent charge/discharge cycles will then learn the capacity back up to the proper value. Initially this may have a noticeable effect on EV range until the capacity learning for the new hardware begins. It may take several battery pack depletions and charges for a maximum EV range to be learned/displayed.

Diagnostic Aids

The Hybrid/EV Battery Pack Capacity Learn procedure must be completed when the following components are replaced:

- Hybrid Powertrain Control Module 2
- Hybrid/EV Battery Pack
- All battery sections

Whenever the Hybrid/EV Battery Pack Capacity Learn is activated the vehicle needs to be operated in a normal manner in order to learn an accurate battery capacity value.

NEVER disconnect the 12V battery supply to the vehicle or the Hybrid Powertrain Control Module 2 after initially activating the Hybrid/EV Battery Pack Capacity Learn. Loss of 12V power will force the Hybrid Powertrain Control Module 2 to store the current capacity value as accurate and will also disable fast learning. The process needs to complete without 12V battery interruption for the best results. Repeat the Hybrid/EV Battery Pack Capacity Learn any time 12V battery interruption occurs prior to operating the vehicle by driving and/or charging. It is possible to observe whether an update has occurred by looking at the battery capacity after charging and/or driving the vehicle.

Hybrid/EV Battery Pack Capacity Learn

NOTE: Hybrid/EV Battery Pack Capacity Learn should **ONLY** be activated when the battery pack, **ALL** battery sections or the Hybrid Powertrain Control Module 2 has been replaced.

The Hybrid/EV Battery Pack Capacity Learn procedure can be activated with a scan tool using the following steps:

1. Vehicle On
2. With a scan tool, select Hybrid Powertrain Control Module 2 Configuration/Reset Functions. Select the Learn Functions - Hybrid/EV Battery Pack Capacity Learn and command a Learn.
3. Observe and record the alphanumeric value in the Hybrid/EV Battery Pack Capacity scan tool parameter.
4. Connect the vehicle charge cord and completely charge the hybrid/EV battery pack.
5. The vehicle is OK to return to the customer. Inform the customer that their EV range will continue to learn as the vehicle is operated normally. Longer drive trips followed by full charging will allow the fastest learn.
6. If the customer returns with an EV Range concern, contact technical assistance.

HYBRID/EV BATTERY SYSTEM VERIFICATION

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

Hybrid/EV Battery System Verification

After major internal A4 Hybrid/EV Battery Pack repairs the technician may use the **EL-50332** Hybrid/EV Battery Service Tool to verify proper cell group voltage and temperature connection/operation prior to installing the battery pack cover and/or installing the battery pack into the vehicle.

The **EL-50332** Hybrid/EV Battery Service Tool communicates with the battery energy control module through the A4 Hybrid/EV Battery Pack low voltage connectors. The tool displays battery cell group voltages for the 96 battery cell groups along with the calculated voltage difference between the highest and lowest readings. The tool also displays the temperatures read by the thermistors located within the battery sections.

Diagnostic Aids

Hybrid/EV Battery System Verification requires that the battery pack is removed from the vehicle and that the battery energy control module contains software. If you are installing a service replacement battery energy control module, connect the battery pack to the vehicle with the **EL-50211** Low Voltage Jumper Harness Extension and program the battery energy control module prior to performing Hybrid/EV Battery System Verification. Perform the [Clear Secured High Voltage DTCs](#) procedure after successfully programming the service replacement battery energy control module.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

Testing for Intermittent Conditions and Poor Connections

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-50211** Low Voltage Jumper Harness Extension
- **EL-50332** Hybrid/EV Battery Service Tool
- **EL-50332-10** 220V Power Cable - China
- **EL-50332-125** Vehicle Interface Module Low Voltage 24-Pin Cable
- **EL-50332-135** Hybrid/EV Battery Contactor Assembly Interface Cable
- **EL-50332-175** 120 V Power Cable

- EL-50332-175 120 V Power Cable - EU
- EL-50332-180 250 V Power Cable - AUS
- EL-50332-270 Vehicle Interface Module 2

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 1000 V 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.

WARNING: Damage to a Lithium Ion hybrid/EV battery pack could result in fire, loss of electrical isolation or exposure to high voltage. Until the high voltage system inspection has been completed, store the vehicle with hybrid/EV battery pack installed outside in a secure area away from buildings and other vehicles and protected from rain, snow and other moisture. Remove the hybrid/EV battery pack high voltage manual disconnect lever and store it in a secure place outside the vehicle. Cover the exposed high voltage opening with UL® listed or equivalent, insulation tape rated at a minimum of 600 V.

Failure to follow these precautions could result in personal injury, death and property damage.

1. Connect the EL-50332-125 to the EL-50332-270 .

NOTE: Before performing the Hybrid/EV Battery System Verification, make sure all of the external EL-50332 components are in good condition and working

order.

2. Connect the **EL-50332-125** to the **EL-50332** .
3. Connect the appropriate regional power cord to the **EL-50332** .
4. Connect the power cord into a known good power outlet.
5. Turn ON the **EL-50332** using the power switch.
6. At the MAIN MENU, select PACK INFO, press the SELECT soft key.
7. At the PACK INFO TYPE menu, select ONE-SHOT, press the NEXT soft key.

NOTE: **Selecting One-shot will take and display a single snapshot of the battery parameters, selecting Continuous will display live parameter values.**

8. At the MANUFACTURER menu, select correct BRAND, press the NEXT soft key.
9. At the MODEL menu, select correct MODEL, press the NEXT soft key.
10. At the COMM CONNECTION menu, select HYBRID BATTERY CONTACTOR ASSEMBLY, press the NEXT soft key.
11. Connect the **EL-50332-135** to the A4 Hybrid/EV Battery Pack.
12. Connect the **EL-50332-135** to the **EL-50332-270** , press the NEXT soft key.
13. At the PACK INFO menu, scroll down to the DELTA VCELL parameter. Record and verify the DELTA VCELL is less than 0.1 V.

- **If the DELTA VCELL is 0.1 V or greater**

There is an internal battery pack concern. Inspect for conditions such as improper internal wiring connections or improper cell balancing service procedures.

- **The DELTA VCELL is less than 0.1 V**

14. Record and verify all of the battery temperature sensor readings are within 6°C (10.8°F) of each other.

- **If any of the battery temperature sensor readings are 6°C (10.8°F) or greater of each other**

There is an internal battery pack concern. Inspect for conditions such as improper internal wiring connections or damaged components.

- **The battery temperature sensor readings are within 6°C (10.8°F) of each other**

15. All OK.

DESCRIPTION AND OPERATION

DRIVE MOTOR BATTERY SYSTEM DESCRIPTION

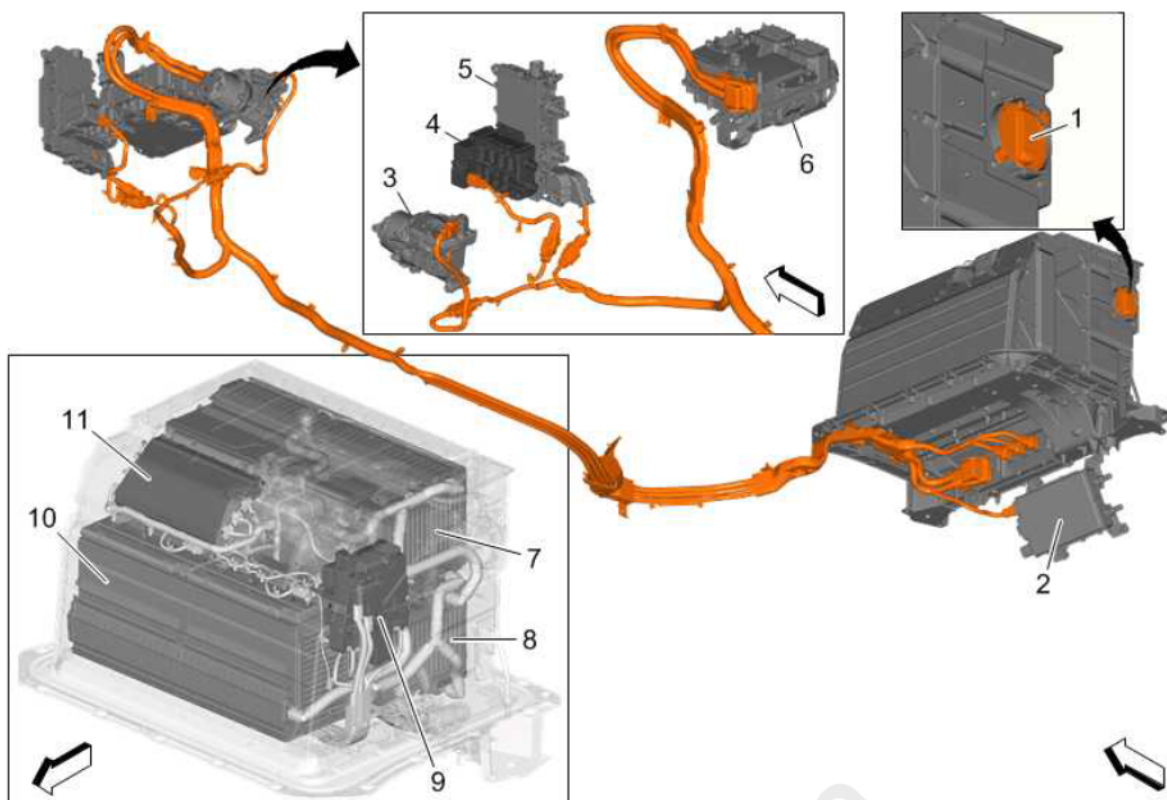


Fig. 203: Drive Motor Battery System
Courtesy of GENERAL MOTORS COMPANY

Hybrid/EV Electronics Cooling System

Callout	Schematic Reference or Generic Name	Scan Tool Reference	Service Part Name
1	S15 Manual Service Disconnect	N/A	Drive Motor Battery High Voltage Manual Disconnect Lever
2	T18 Battery Charger	Battery Charger	Drive Motor Battery Charger
3	K10 Coolant Heater Control Module	Electric Passenger Compartment Heater	Heater Coolant Heater
4	K1 14V Power Module	14V Power Module	Accessory DC Power Control Module
5	T6 Power Inverter Module	- Hybrid Powertrain Control Module - Drive Motor Control Module 1 - Drive Motor Control Module 2	Drive Motor Power Inverter Module
6	G1 A/C Compressor	Electric A/C Compressor Control Module	Air Conditioning and Drive Motor Battery Cooling Compressor
7	C4B Hybrid/EV Battery Section 2	N/A	Cell Battery Assembly
8	C4C Hybrid/EV Battery Section 3	N/A	Cell Battery Assembly
9	A28 Hybrid/EV Battery Contactor Assembly	N/A	High Voltage Battery Disconnect Relay
10	C4A Hybrid/EV Battery Section 1	N/A	Cell Battery Assembly
11	K16 Battery Energy Control Module	Battery Energy Control Module	Battery Energy Control Module

Overview

The high voltage hybrid/EV battery contains 192 individual lithium-ion cells. Two cells are welded together in parallel and called a cell group. There are a total of 96 cell groups in the hybrid/EV battery 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 355 V direct current. The battery cell groups are joined to form 3 distinct sections. The first 32 battery cell groups make up C4A hybrid/EV battery section 1. This section is the forward-most section and contains battery cell groups 65 through 96. The next 32 battery cell groups make up C4B hybrid/EV battery section 2. This section is located on top of section 3 and contains battery cell groups 33 through 64. Located beneath battery section 2 is C4C hybrid/EV battery section 3 and it contains the remaining 32 battery cell groups 1 through 32. The battery sections also contain two temperature sensors, with one sensor located at each end of the section for a Hybrid/EV battery pack total of six temperature sensors.

Located within the high voltage Hybrid/EV battery pack, the K16 battery energy control module monitors the temperature, current and voltage of the 96 battery cell groups. The voltage sense lines are attached to each individual cell group and these sense lines terminate at a connector located on the top surface of the battery section. A voltage sense harness joins this connector to the K16 battery energy control module.

The K16 battery energy control module will determine when a fault condition is present. Diagnostics and system status are communicated from the K16 battery energy control module to the K114B hybrid powertrain control module 2 through serial data. The K114B hybrid powertrain control module 2 is the host controller for K16 battery energy control module diagnostic trouble code information.

Location

The high voltage hybrid/EV battery is installed from beneath the vehicle, into the rear storage compartment. The K16 battery energy control module, a current sensor and the high voltage contactors are located within the hybrid battery assembly. The K114B hybrid powertrain control module 2 is mounted to the exterior of the hybrid/EV battery assembly, accessible within the rear storage compartment.

High Voltage Control

The hybrid/EV battery contains 4 high voltage contactors and 1 solid state relay (transistor). The high voltage contactors and transistor allow the high voltage DC batteries to be connected to the vehicle or contain the high voltage DC within the hybrid/EV battery assembly. The 4 high voltage contactors consist of a main positive high voltage contactor, main negative high voltage contactor, charge positive high voltage contactor and a precharge negative high voltage contactor. The transistor controls the battery heater high voltage negative circuit. The high voltage contactors and transistor are located within the A28 hybrid/EV battery contactor assembly.

In order to prevent large in-rush current to capacitors located in the vehicles high voltage components, the contactors close in a specific precharge sequence controlled by the K114B hybrid/EV powertrain control module 2.

Contactor Close Sequence (Precharge)

1. Plug-In Charge Positive Contactor
2. Main Positive Contactor
3. Precharge Negative Contactor
4. Main Negative Contactor

NOTE: Wait for bus high voltage to attain almost the same level as hybrid/EV battery voltage.

5. The precharge contactor opens when bus voltage and hybrid/EV battery voltage are equal.

Thermal Management

The hybrid/EV battery is cooled and heated with pre-mixed DEX-COOLÂ®, which is a 50/50 mixture of DEX-COOLÂ® and de-ionized water. A refrigerant/coolant heat exchanger (chiller) and the G1 A/C compressor cools down the high voltage hybrid/EV battery. A high voltage heater inside the hybrid/EV battery can also heat the coolant entering the hybrid/EV battery when needed. Refer to [Hybrid/EV Cooling System Description and Operation](#).

HYBRID/EV SYSTEM HIGH VOLTAGE ISOLATION DESCRIPTION

Loss of Isolation Description

Vehicles equipped with high voltage storage and propulsion capability are designed with the high voltage circuits isolated from the vehicle chassis. If either the positive or negative high voltage Direct Current (DC) circuits or any of the high voltage Alternating Current (AC) phase circuits lose this isolation to the vehicle chassis, one or more diagnostic trouble codes (DTCs) may set.

Similar to typical 12V vehicle systems, loss of isolation can be as simple as a direct conductor-to-chassis short. Unlike 12V systems however, the potential within high voltage systems means that insulation breakdown is also a cause for loss of isolation. Therefore diagnosis for isolation loss requires testing with high voltage potential. Special multi-meters that utilize their own built-in high voltage, such as the **EL-50772** Insulation Multimeter, are used to test the isolation capability of high voltage components and circuits. Additionally, monitoring certain scan tool parameters when high voltage is active may also help to identify which high voltage components and circuits may have lost their chassis isolation.

Vehicle Loss of Isolation Detection

The vehicle performs two independent tests for isolation:

1. Passive isolation testing which is performed within the power inverter module by the hybrid powertrain control module 1.
2. Active isolation testing which is performed within the Hybrid/EV battery pack by the hybrid powertrain control module 2.

Passive Isolation Testing

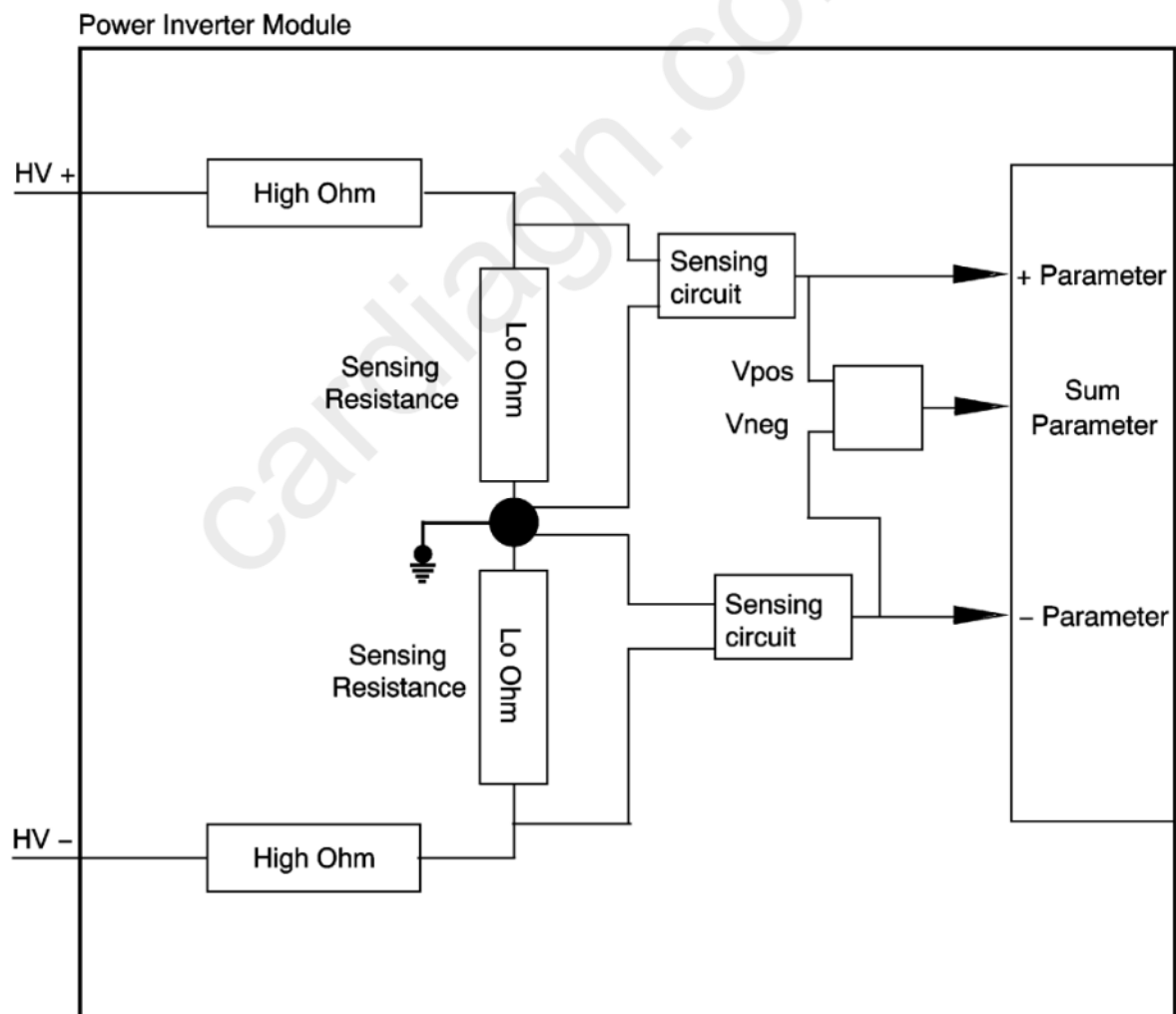


Fig. 204: Power Inverter Module Operation Graph
Courtesy of GENERAL MOTORS COMPANY

The power inverter module continuously performs isolation testing whenever high voltage to the module is present. The power inverter module has one isolation sensing circuit although the drive motor and aux pump control modules monitor and display the sensor data redundantly. The Positive Supply Isolation Voltage and the Negative Supply Isolation Voltage scan tool parameters give a real-time indication of Isolation status. Under

normal operating conditions each of the parameters will indicate about half of the total Hybrid/EV battery pack high voltage potential. When a loss of isolation condition is observed, the Voltage scan tool parameter values will shift in respect to each other. When the voltage shift exceeds a set ratio, DTCs P1AF0, P1AF2 or P1E22 will set.

NOTE: Some high voltage components contain internal switching or inverter circuits that can interrupt a portion of their high voltage circuitry. If such a component, for example the passenger cabin heater, is OFF its complete internal circuitry is not being monitored. Likewise, these internally switched components cannot be fully tested off-vehicle with the EL-50772 Insulation Multimeter or equivalent.

Scan Tool Parameters

- Drive Motor 1 Positive Supply Isolation Voltage
- Drive Motor 1 Negative Supply Isolation Voltage
- Drive Motor 2 Positive Supply Isolation Voltage
- Drive Motor 2 Negative Supply Isolation Voltage
- Aux Trans Fluid Pump Positive Supply Isolation Voltage
- Aux Trans Fluid Pump Negative Supply Isolation Voltage

The power inverter module isolation sensing circuit communicates one value, which is displayed redundantly by three different modules. The data within the parameters for each module is identical.

Isolation Loss between HV Components and Chassis, Positive Side*

Isolation between HV Bus and Chassis	Normal Vehicle	10M	5M	1M	500K	200K Approximate DTC set	100K	None - Direct Short
Positive Isolation parameter*	198V	180V	165V	110V	75V	35V	20V	0V
Negative Isolation parameter*	192V	210V	225V	280V	315V	355V	370V	390V
Difference Between Parameters	0-15V	30V	60V	170V	240V	320V	350V	390V

*Typical values observed with a fully charged pack, 390V. A short to the positive bus is shown, a short to the negative bus would display inverted voltages of similar value.

Active Isolation Testing

Active isolation testing is dedicated to monitoring the internal Hybrid/EV battery pack HV circuits. The battery energy control module switches fixed resistors between the high voltage system and vehicle chassis. The difference between the switched-to-chassis state and the unswitched state is used to calculate a resistance-to-chassis value. When resistance-to-chassis decreases below a set value, DTC P0AA6 will set.

Active isolation testing occurs when the main high voltage contactor relays are open. For this reason most testing of the Hybrid/EV battery pack occurs just after the vehicle is shut off following a drive trip. The Isolation Test Resistance scan tool parameter indicates the resistance-to-chassis calculation determined when the last Active isolation test was performed.

High Voltage System

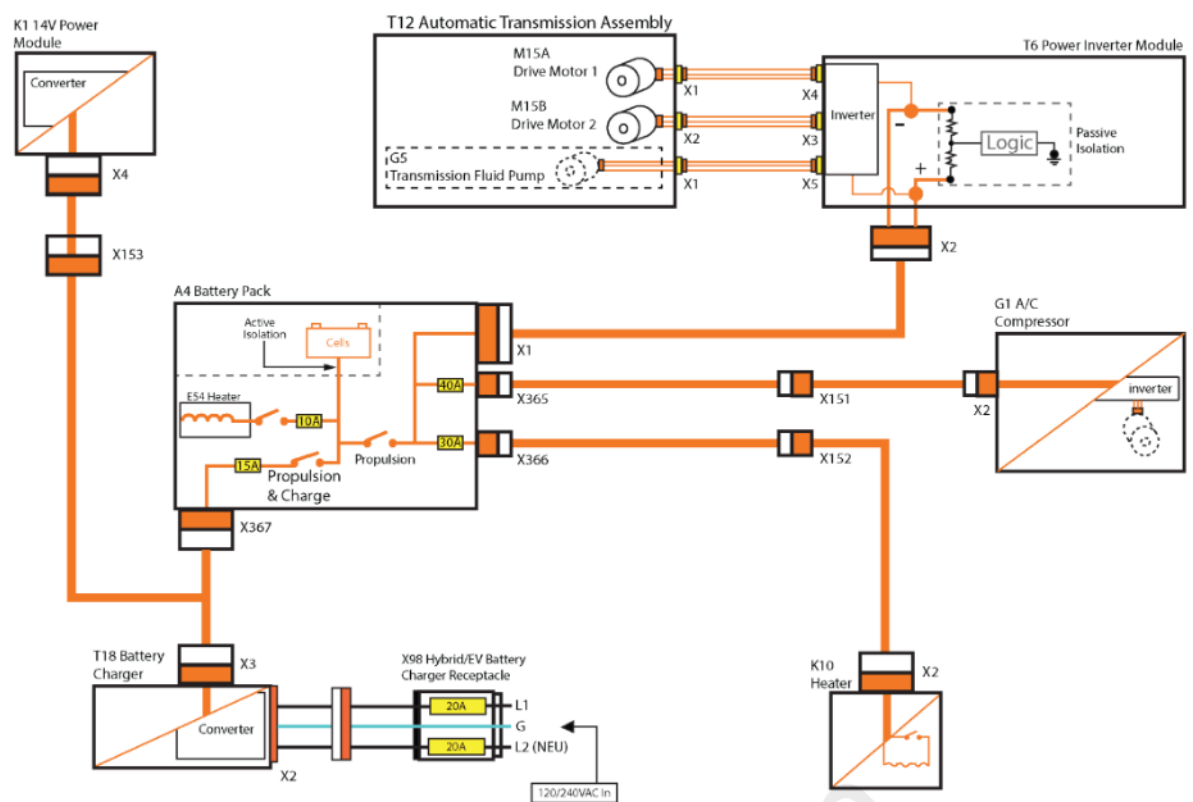


Fig. 205: High Voltage System Hydraulic Diagram
 Courtesy of GENERAL MOTORS COMPANY

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/Description
	EL-48900 HEV Safety Kit
	EL-50211 Low Voltage Jumper Harness

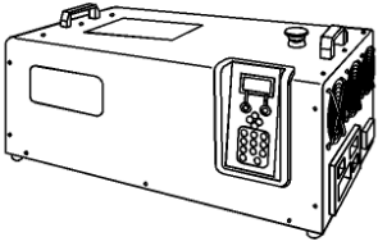
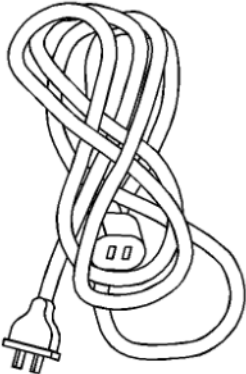
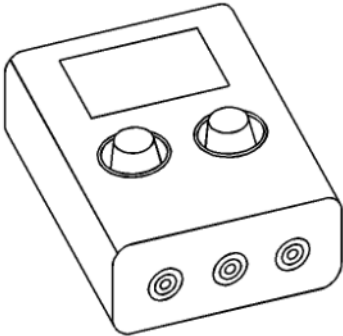
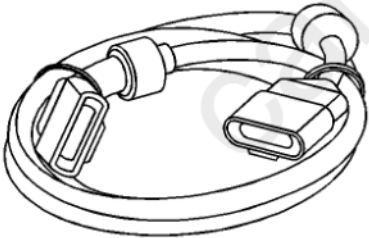
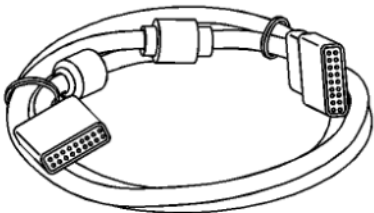
Illustration	Tool Number/Description
	EL-50332 Hybrid/EV Battery Service Tool
	EL-50332-10 220 V Power Cable
	EL-50332-105 Universal Fuse Box
	EL-50332-120 High Voltage Interface Cable
	EL-50332-125 Vehicle Interface Module Low Voltage 24-Pin Cable

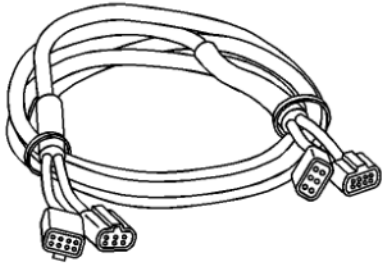
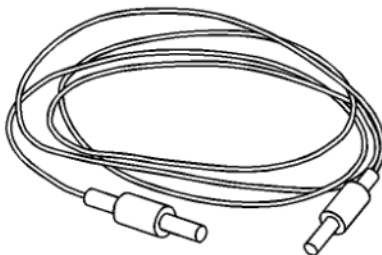
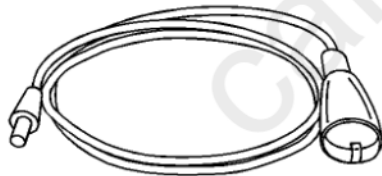
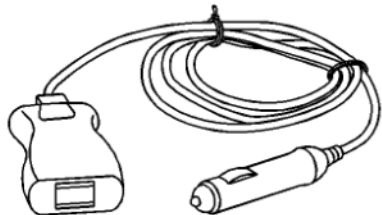
Illustration	Tool Number/Description
	EL-50332-135 Hybrid/EV Battery Contactor Assembly Interface Cable
	EL-50332-145 Black Banana Jack Cable
	EL-50332-150 Red Banana Jack Cable
	EL-50332-155 Green Banana Jack Cable
	EL-50332-160 12 V Auxiliary Power Cable

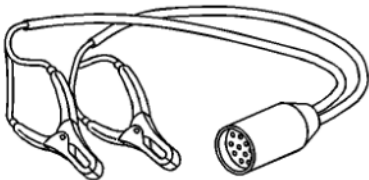
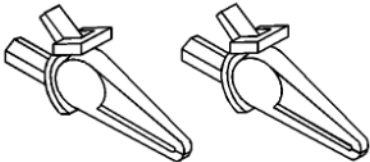
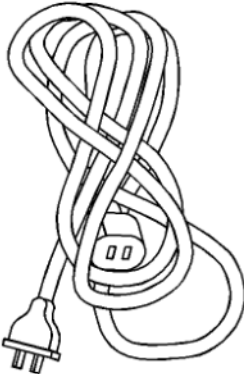
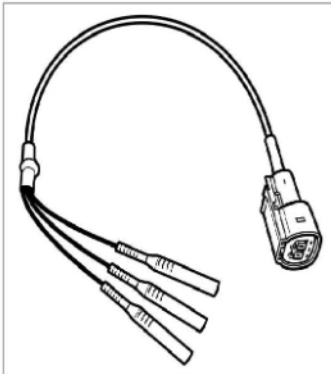
Illustration	Tool Number/Description
	EL-50332-165 12 V Auxiliary Clamps Adapter Cable
	EL-50332-170 High Voltage Alligator Clamps
	EL-50332-175 120 V Power Cable
	EL-50332-270 Vehicle Interface Module 2
	EL-50332-335 High Voltage Battery Bulkhead Interface Cable

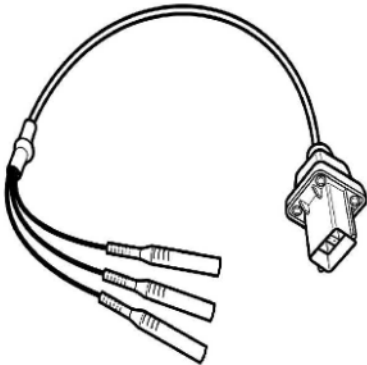
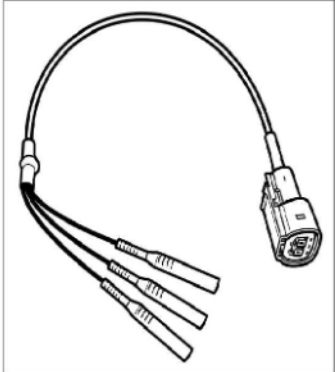
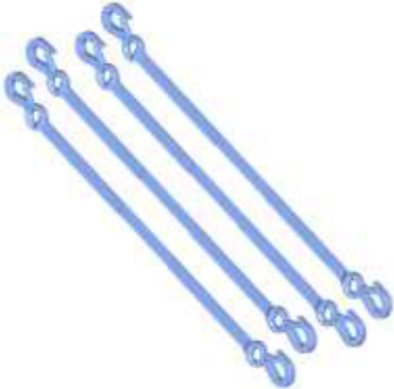
Illustration	Tool Number/Description
	EL-50332-340 Battery Charger High Voltage Interface Cable
	EL-50332-345 Inline A/C Compressor High Voltage Interface Cable
	EL-50772 Insulation Multimeter
	EL-51102 High Voltage Battery Lift Bar Tilter
	EL-51102-30 High Voltage Battery Lift Bar Eye-Bolt Kit

Illustration	Tool Number/Description
	EL-51102-50 High Voltage Battery Lift Bar Straps
	EL-51865 Battery Pack Support Fixture

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