

2017 ELECTRICAL

Hybrid/EV Controls - CT6

SPECIFICATIONS

FASTENER SPECIFICATIONS

Reusable Threaded Fastener Tightening Specifications

NOTE:

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

Application	Specification
	Metric (English)
Accessory DC Power Control Module Bolt	22 N.m (16 lb ft)
Accessory DC Power Control Module Bracket Bolt	9 N.m (80 lb in)
Accessory DC Power Control Module Bracket Nut	9 N.m (80 lb in)
Accessory DC Power Control Module High Voltage Connector Protector Bolt	9 N.m (80 lb in)
Drive Motor Power Inverter Module 3-Phase Cable Retainer Nut	9 N.m (80 lb in)
Drive Motor Power Inverter Module 3-Phase Cable Terminal Bolt	9 N.m (80 lb in)
Drive Motor Power Inverter Module Bracket Fastener	22 N.m (16 lb ft)
Generator Cable to Accessory DC Power Control Module Nut	12 N.m (106 lb in)
Ground Cable to Accessory DC Power Control Module Nut	12 N.m (106 lb in)
Harness Ground Terminal Bolt	9 N.m (80 lb in)
High Voltage Cable Connector Cover Bolt	9 N.m (80 lb in)
Interface Control Module Bracket Bolt	9 N.m (80 lb in)

SCHEMATIC WIRING DIAGRAMS

HYBRID/EV CONTROLS WIRING SCHEMATICS

Power, Ground and Serial Data

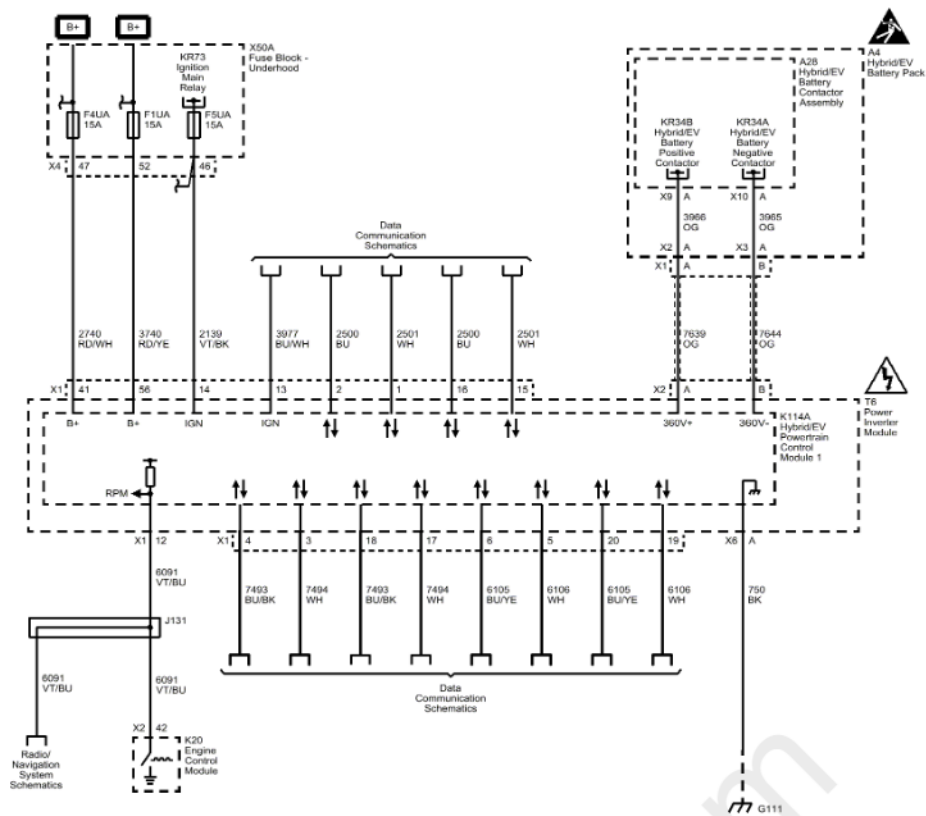


Fig. 1: Power, Ground and Serial Data
Courtesy of GENERAL MOTORS COMPANY

Drive Motor Monitoring

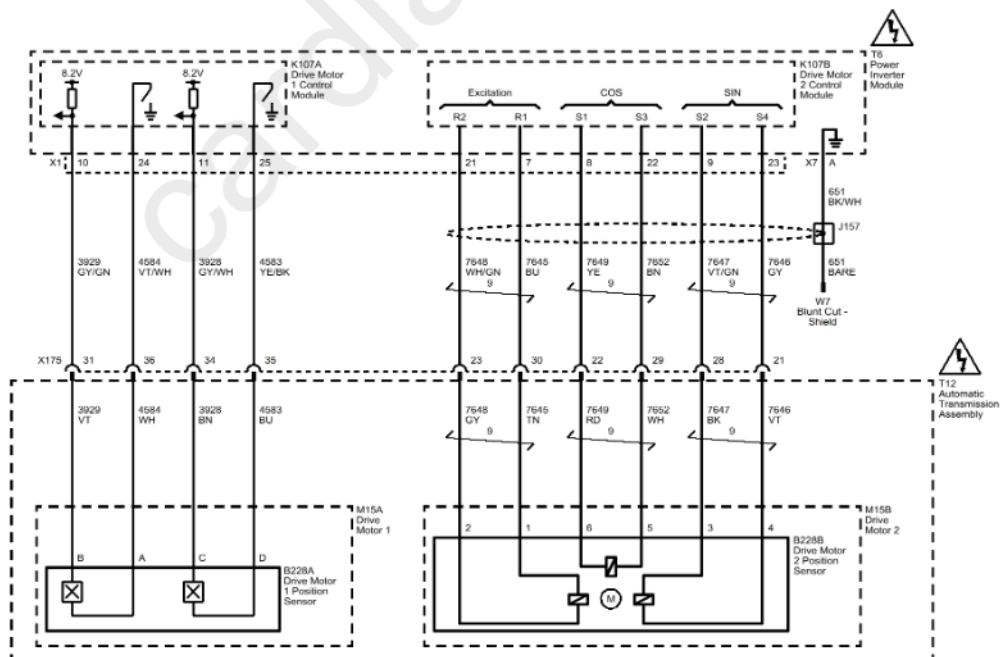


Fig. 2: Drive Motor Monitoring
Courtesy of GENERAL MOTORS COMPANY

Drive Motors and Auxiliary Transmission Fluid Pump Controls

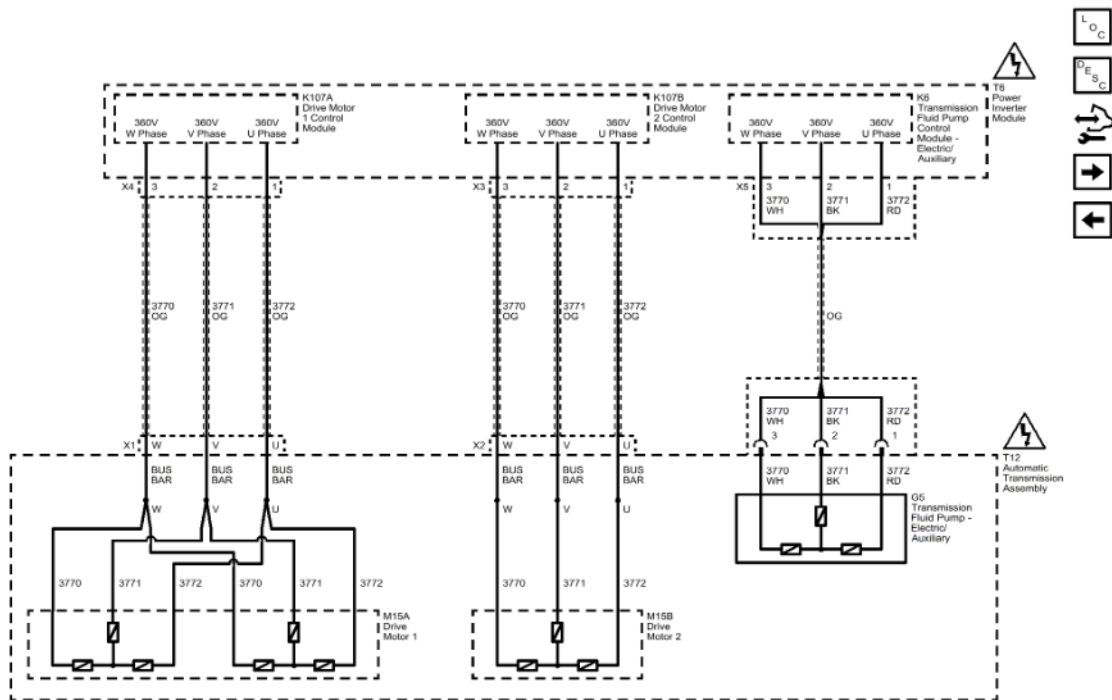


Fig. 3: Drive Motors and Auxiliary Transmission Fluid Pump Controls
Courtesy of GENERAL MOTORS COMPANY

Transmission Internal Mode Switch

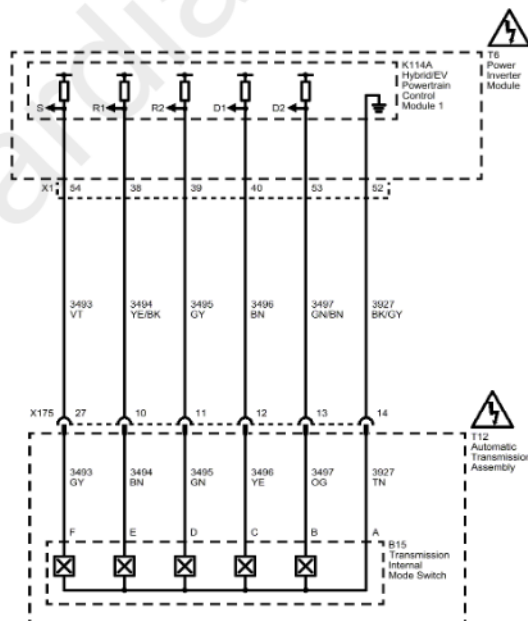


Fig. 4: Transmission Internal Mode Switch
Courtesy of GENERAL MOTORS COMPANY

COMPONENT LOCATOR

Hybrid Control Electronic Component Views

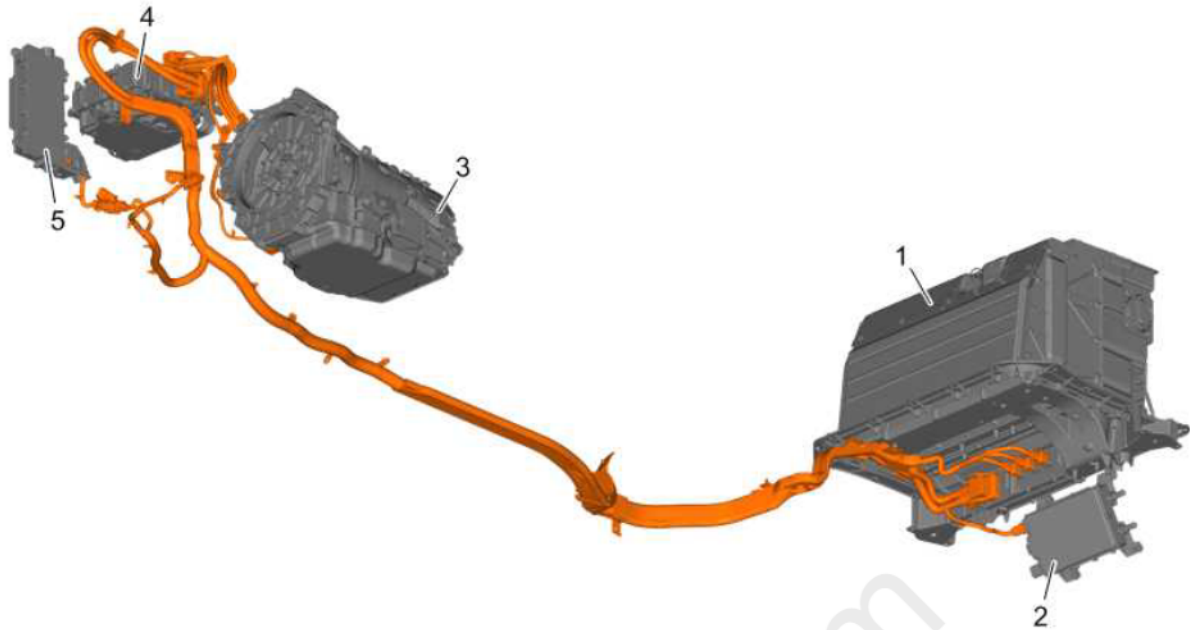


Fig. 5: Hybrid Control Electronic Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	High Voltage Battery
2	T18 Battery Charger
3	T12 Automatic Transmission Assembly
4	T6 Power Inverter Module
5	K1 14V Power Module

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0335 OR P0336: CRANKSHAFT POSITION SENSOR

Diagnostic Instructions

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

DTC Descriptor

DTC P0335

Crankshaft Position Sensor Circuit

DTC P0336

Crankshaft Position Sensor Performance

Circuit/System Description

The crankshaft position sensor circuits consist of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit and an output signal circuit. The crankshaft position sensor is a magnetic

biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes of invisible magnetic segments on the edge of the crankshaft position reluctor ring mounted on the crankshaft. Each magnetic segment on the ring is spaced at a 60 segment spacing with 2 missing spaces for a reference gap. The crankshaft position sensor produces an ON/OFF DC voltage of varying frequency, with 58 output pulses per crankshaft revolution. The frequency of the crankshaft position sensor output depends on the velocity of the crankshaft. The crankshaft position sensor sends a digital signal, which represents an image of the crankshaft reluctor ring, to the ECM as each segment on the ring rotates past the crankshaft position sensor. The ECM uses each crankshaft position signal pulse to determine crankshaft speed and decodes the crankshaft reluctor ring reference gap to identify crankshaft position. This information is then used to determine the optimum ignition and injection points of the engine. The ECM also uses crankshaft position sensor output information to determine the camshaft relative position to the crankshaft, to control camshaft phasing and to detect cylinder misfire.

The ECM also generates and sends a replicated signal over a dedicated line to the hybrid/EV powertrain control module 1.

The hybrid/EV powertrain control module 1 uses crankshaft speed and position to confirm internal combustion engine (ICE) status in various modes; for example to confirm Autostart and Autostop functionality. In addition to the signal sent over the dedicated line, this information is also sent from the ECM to the hybrid/EV powertrain control module 1 over serial data. The serial data status will be used by the hybrid/EV powertrain control module 1 in the event of a failure of this circuit.

Conditions for Running the DTC

P0335 or P0336

The vehicle is ON.

Conditions for Setting the DTC

P0335

No signal from the crank sensor for more than 1.4 seconds.

P0336

The signal from the crank sensor is invalid for more than 1.4 seconds.

OR

15 crankshaft sensor resync events occur in less than 10 seconds.

Action Taken When the DTC Sets

DTCs P0335 and P0336 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0335 and P0336 are Type B DTCs.

Diagnostic Aids

A high resistance ground for either the power inverter module, often referred to as the drive motor generator power inverter module or the ECM may cause these DTCs to set intermittently. Inspect all grounds for good, secure connections.

Reference Information

Schematic Reference

- [Hybrid/EV Controls Schematics](#)
- [Engine Controls Schematics](#)

Connector End View Reference

Description and Operation

- [Electronic Ignition System Description](#)
- [Hybrid Modes of Operation Description](#)

Electrical Information Reference

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

DTC Type Reference

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

Scan Tool Reference

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

Special Tools

- **EL-35616** Terminal Test Kit
- **EL-38522** Variable Signal Generator

Equivalent regional tools: [Special Tools](#)

[Circuit/System Verification](#)

1. Engine Running, observe the hybrid/EV powertrain control module Engine Speed parameter with a scan tool.
2. Verify the Engine Speed parameter displays the current engine speed, matching the tachometer and/or the ECM Engine Speed parameter.
 - **If the hybrid/EV powertrain control module Engine Speed parameter displays a value other than the current engine speed**

Refer to Circuit/System Testing.
 - **If the Engine Speed parameter displays a value matching the current engine speed**
3. All OK

[Circuit/System Testing](#)

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 X2 harness connector at the K20 ECM.
3. Using the **EL 35616** terminal test kit, connect the **EL 38522** variable signal generator red lead to the Crankshaft 60X Sensor Signal circuit terminal 42 at the harness. Connect the **EL 38522** variable signal generator black lead to ground.
4. Set the **EL 38522** variable signal generator SIGNAL to 12v, FREQUENCY to 30 Hz and DUTY CYCLE to NORMAL, 50 percent. Plug power cord in to vehicle being tested or another power source.
5. Vehicle ON.
6. Verify with a scan tool the hybrid/EV powertrain control module Crankshaft Position Resync Counter parameter displays a constantly changing value.

NOTE: With the variable signal generator set at 30 Hz, the Crankshaft Position Resync Counter should cycle from 0-255 in 8.5 seconds.

- **If parameter does not display a constantly changing value**

1. Vehicle OFF, disconnect **EL 38522** variable signal generator red and black leads, disconnect the X1 harness connector at the T6 power inverter module, vehicle ON.
2. Test for less than 1 V between the signal circuit terminal 12 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Vehicle OFF.
4. Test for infinite resistance between the signal circuit terminal 12 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
5. 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 T6 power inverter module.

- **If parameter displays a constantly changing value**

7. Replace the K20 ECM.

Repair Instructions

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

Control Module References for engine control module or T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup

DTC P0506 OR P0507: IDLE SPEED LOW/HIGH

Diagnostic Instructions

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

DTC Descriptors

DTC P0506

Idle Speed Low

DTC P0507

Idle Speed High

Circuit/System Description

The hybrid/EV powertrain control module 1 determines the engine idling speed which varies based on the hybrid/EV battery pack state of charge. The engine control module (ECM) achieves throttle positioning by providing a pulse width modulated voltage to the throttle actuator motor. The throttle blade is spring loaded in both directions and the default position is slightly open. The hybrid/EV powertrain control module 1 can detect a condition where the engine is cranking but does not start or has stalled or if the engine speed does not match the commanded speed.

The throttle actuator control (TAC) motor is controlled by the ECM. The DC motor located in the throttle body drives the throttle blade. In order to decrease engine speed, along with spark and fuel delivery changes the ECM commands the throttle closed reducing air flow into the engine and the engine speed decreases. In order to increase engine speed, the ECM commands the throttle plate open allowing more air to pass the throttle plate. If the hybrid/EV powertrain control module 1 detects the actual engine speed is not within a predetermined range of the commanded engine speed, this DTC sets.

Conditions for Running the DTC

P0506

- DTCs P0722, P077B, P0A3F, P0A40, P0A45, P0A46, P0C52, P0C53, P0C57, P0C58, P0C5C, P0C5D, P0C61, P0C62, P1B03, P1B04, P215C are not set.
- The accelerator pedal position is valid.
- The accelerator pedal position is less than or equal to 1 percent.
- The engine is running.
- The vehicle speed is less than 2 km/h (1.2 mph).
- The engine coolant temperature (ECT) is 60Â°C (140Â°F) or greater.
- The commanded engine speed is steady within 50 RPM.

P0507

- DTCs P0722, P077B, P0A3F, P0A40, P0A45, P0A46, P0C52, P0C53, P0C57, P0C58, P0C5C, P0C5D, P0C61, P0C62, P1B03, P1B04 and P215C are not set.
- The engine coolant temperature is 60Â°C (140Â°F) or greater.
- The commanded engine idle speed is greater than 25 RPM.

Conditions for Setting the DTC

P0506

The actual engine speed is at least 95 RPM less than the commanded engine speed.

P0507

The actual engine speed is at least 190 RPM greater than the commanded engine speed for 10 seconds.

Action Taken When the DTC Sets

DTCs P0506 and P0507 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0506 and P0507 are Type B DTCs.

Diagnostic Aids

- A stalling condition can cause DTC P0506 to set.
- An intermittent B14A Transmission Output Shaft Speed Sensor signal can cause DTC P0507 to set.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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

Circuit/System Verification

1. Verify 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 none of the conditions listed below exist:

P0506

- Excess deposits in the Q38 Throttle Body. Refer to [Throttle Body Cleaning](#) .
- Restricted exhaust
- Mechanical conditions that limit engine speed
- A stuck closed throttle valve.
- Parasitic load on the engine - For example, a transmission condition, a belt driven accessory condition.
- **If a condition exists**

Repair as necessary.

- **If no condition exists**

3. All OK

P0507

- Vacuum leaks
- A throttle valve that does not close correctly
- Verify the correct operation of the crankcase ventilation system. Inspect for the following conditions:
 - The routing of the positive crankcase ventilation (PCV) system
 - Vacuum leaks in the PCV system
- **If a condition exists**

Repair as necessary.

- **If no condition exists**

4. All OK

Repair Instructions

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

DTC P0601-P0604, P0606, P062F, P16F2, P1EB6 OR P1EB7: CONTROL MODULE MEMORY

Diagnostic Instructions

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

DTC Descriptors

DTC P0601

Control Module Read Only Memory Performance

DTC P0602

Control Module Not Programmed

DTC P0603

Control Module Long Term Memory Reset

DTC P0604

Control Module Random Access Memory Performance

DTC P0606

Control Module Processor Performance

DTC P062F

Control Module Long Term Memory Performance

DTC P16F2

Control Module Transmission Direction Switch Input Circuitry Performance

DTC P1EB6

Drive Motor 1 Control Module Long Term Memory Reset

DTC P1EB7

Drive Motor 2 Control Module Long Term Memory Reset

Circuit/System Description

This is an internal fault detection of the hybrid/EV powertrain control module 1 or drive motor control modules. The hybrid/EV powertrain control module 1 and both drive motor control modules are internal to the power inverter module, often referred to as the drive motor generator power inverter module and not serviced separately. This fault is handled inside the power inverter module and no external circuits are involved.

Conditions for Running the DTC

- The vehicle is ON.
- The system voltage is greater than 9.5V.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

Action Taken When the DTC Sets

- DTCs P0601-P0604, P0606, P16F2, P1EB6 and P1EB7 are Type A DTCs.
- DTC P062F is a Type B DTC.

DTCs P0601, P0602, P0604, P0606, P16F2, P16F3 and P16F4

The hybrid/EV powertrain control module 1 requests the hybrid/EV powertrain control module 2 to open the high voltage contactor relays.

Conditions for Clearing the DTC

- DTCs P0601-P0604, P0606, P16F2, P1EB6 and P1EB7 are Type A DTCs.
- DTC P062F is a Type B DTC.

Reference Information

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

DTC Type Reference

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

[Circuit/System Verification](#)

1. Vehicle ON.
2. Verify DTC P0562 is not set.

- **If the DTC is set**

Refer to [DTC B1325, B1330, B1517, C0800, C0899, C0900, C12E1, C12E2, P0561-P0563, P1A0C, P1A0D or P1EFC](#) .

- **If the DTC is not set**

3. Verify DTC P0601-P0604, P0606, P062F, P16F2, P1EB6 or P1EB7 is not set.

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

1. Program the T6 Power Inverter Module.
2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set

3. All OK.

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

4. All OK.

[Repair Instructions](#)

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P061A OR P061B: CONTROL MODULE TORQUE PERFORMANCE

[Diagnostic Instructions](#)

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

[DTC Descriptors](#)

DTC P061A

Control Module Torque System Circuitry Performance

DTC P061B

Control Module Torque Calculation Performance

[Circuit/System Description](#)

The hybrid/EV powertrain control module 1 is responsible for vehicle torque management. To accomplish this, the hybrid/EV powertrain control module 1 constantly monitors all aspects of requested and actual

delivered torque from involved controllers. If a torque management fault is detected, propulsion power will be reduced or shut down. The hybrid/EV powertrain control module 1 is internal to the power inverter module, often referred to as the drive motor generator power inverter module and is not serviced separately. This fault is handled inside the power inverter module and no external circuits are involved.

Conditions for Running the DTC

- The vehicle is ON.
- The system voltage is at least 9.5 V.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

Action Taken When the DTC Sets

DTCs P061A or P061B are Type A DTCs.

P061A

Regenerative Braking will be disabled.

P061B

The hybrid/EV powertrain control module 1 requests the hybrid/EV powertrain control module 2 to open the high voltage contactor relays.

Conditions for Clearing the DTC

DTCs P061A and P061B are Type A DTCs.

Reference Information

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P0562 is not set.

- **If the DTC is set**

Refer to [DTC B1325, B1330, B1517, C0800, C0899, C0900, C12E1, C12E2, P0561-P0563, P1A0C, P1A0D or P1EFC](#) .

- **If the DTC is not set**

3. Verify DTC P061A or P061B is not set.

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

Replace the T6 Power Inverter Module.

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

4. All OK

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P06A4 OR P06A5: SENSOR REFERENCE VOLTAGE

Diagnostic Instructions

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

DTC Descriptors

DTC P06A4

Sensor Reference Voltage 4 Low Voltage

DTC P06A5

Sensor Reference Voltage 4 High Voltage

Circuit/System Description

This is an internal fault detection of the hybrid/EV powertrain control module 1 or drive motor control modules. The hybrid/EV powertrain control module 1 and both drive motor control modules are internal to the power inverter module, often referred to as the drive motor generator power inverter module and not serviced separately. This fault is handled inside the power inverter module and no external circuits are involved.

Conditions for Running the DTC

The hybrid powertrain control module 1 is awake.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

Action Taken When the DTC Sets

- DTCs P06A4 and P06A5 are Type A DTCs.
- Propulsion is disabled.

Conditions for Clearing the DTC

DTCs P06A4 and P06A5 are Type A DTCs.

Reference Information

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.

2. Verify DTC P0562 is not set.

- **If the DTC is set**

Refer to **DTC B1325, B1330, B1517, C0800, C0899, C0900, C12E1, C12E2, P0561-P0563, P1A0C, P1A0D or P1EFC** .

- **If the DTC is not set**

3. Verify DTC P0601-P0604, P0606, P062F, P16F2, P1EB6 or P1EB7 is not set.

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

1. Program the T6 Power Inverter Module.

2. Verify the DTC does not set.

- If the DTC sets, replace the T6 Power Inverter Module.
- If the DTC does not set

3. All OK.

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

4. All OK.

Repair Instructions

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

Control Module References for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P06AF: TORQUE MANAGEMENT SYSTEM PERFORMANCE - FORCED ENGINE SHUTDOWN

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 P06AF

Torque Management System Performance - Forced Engine Shutdown

Circuit/System Description

The hybrid/EV powertrain control module 1 monitors a state of health message that the ECM transmits to verify the ECM is functioning properly. The hybrid/EV powertrain control module 1 is part of the power inverter module, often referred to as the drive motor generator power inverter module and is not serviced separately.

Conditions for Running the DTC

The Vehicle is On.

Conditions for Setting the DTC

The hybrid/EV powertrain control module 1 does not detect a valid state of health message from the ECM.

Action Taken When the DTC Sets

- DTC P06AF is a Type A DTC.
- Propulsion is disabled.

Conditions for Clearing the DTC

DTC P06AF is a Type A DTC.

Reference Information

Schematic Reference

- [Hybrid/EV Controls Schematics](#)
- [Engine Controls Schematics](#)
- [Data Communication Schematics](#)

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX](#)

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 ON.
2. Verify DTC P0606 is not set.
 - **If the DTC is set**
Refer to [DTC P0601-P0604, P0606, P062F, P16F2, P1EB6 or P1EB7](#).
 - **If the DTC is not set**
3. Verify DTC P06AF is not set.
 - **If the DTC is set**
 1. Program the T6 Power Inverter Module.
 2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 3. Verify the DTC does not set.
 - If the DTC sets, continue to Circuit/System Testing.
 - If the DTC does not set.
 - **If the DTC is not set**
4. All OK.

Circuit/System Testing

1. Vehicle OFF.

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

2. Disconnect the X1 harness connector at the T6 Power Inverter Module and disconnect the X1 harness at the K20 ECM.
3. Test for less than 2 Ω on the serial data circuits listed below end to end.
 - T6 Power Inverter Module X1 connector terminal 1 to K20 ECM X1 connector terminal 6

- T6 Power Inverter Module X1 connector terminal 2 to K20 ECM X1 connector terminal 7
- **If 2 Ω or greater**

Repair the open/high resistance in the circuit.

- **If less than 2 Ω**

4. Replace the K20 ECM.

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

6. Verify the DTC does not set.

- **If the DTC sets**

Replace the T6 Power Inverter Module.

- **If the DTC does not set**

7. All OK

Repair Instructions

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

[Control Module References](#) for K20 ECM or T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup

DTC P06B1, P06B2, P06B4, P06B5, P06E7 OR P06E8: SENSOR SUPPLY VOLTAGE 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 P06B1

Sensor Supply Voltage Circuit 1 Low Voltage

DTC P06B2

Sensor Supply Voltage Circuit 1 High Voltage

DTC P06B4

Sensor Supply Voltage Circuit 2 Low Voltage

DTC P06B5

Sensor Supply Voltage Circuit 2 High Voltage

DTC P06E7

Sensor Supply Voltage Circuit 3 Low Voltage

DTC P06E8

Sensor Supply Voltage Circuit 3 High Voltage

Circuit/System Description

The Hybrid/EV powertrain control module 1 and motor control modules share an internal 15 V reference power supply in order to operate the drive motor sensors processors. This fault is handled inside the power

inverter module, often referred to as the drive motor generator power inverter module and no external circuits are involved. The control modules listed below are part of the power inverter module and are not serviced separately:

- Drive motor 1 control module
- Drive motor 2 control module
- Hybrid/EV powertrain control module 1

Conditions for Running the DTC

The vehicle is ON.

Conditions for Setting the DTC

P06B1, P06B4 or P06E7

The reference voltage is less than 12 V for 1 s.

P06B2, P06B5 or P06E8

The reference voltage is greater than 18 V for 1 s.

Actions Taken When the DTC Sets

DTCs P06B1, P06B2, P06B4, P06B5, P06E7 and P06E8 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P06B1, P06B2, P06B4, P06B5, P06E7 and P06E8 are Type B DTCs.

Diagnostic Aids

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

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P06B1, P06B2, P06B4, P06B5, P06E7 or P06E8 is not set.
 - **If any of the DTCs are set**
 1. Program the T6 Power Inverter Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
 3. All OK
 - **If none of the DTCs are set**
3. All OK

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Control Module References for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P0A1B OR P0A1C: DRIVE MOTOR CONTROL MODULE PERFORMANCE

Diagnostic Instructions

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

DTC Descriptors

DTC P0A1B

Drive Motor 1 Control Module Performance

DTC P0A1C

Drive Motor 2 Control Module Performance

Circuit/System Description

The power inverter module is often referred to as the drive motor generator power inverter module. This is a fault detection of the power inverter module's internal motor control modules. This fault is handled inside the power inverter module; no external circuits are involved. The motor control modules are part of the power inverter module and are not serviced separately.

Conditions for Running the DTC

- The vehicle is ON.
- The system voltage is greater than 9.5 V.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

Action Taken When the DTC Sets

- DTCs P0A1B and P0A1C are Type A DTCs.
- Propulsion is disabled.

Conditions for Clearing the DTC

DTCs P0A1B and P0A1C are Type A DTCs.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P0A1B or P0A1C is not set.
 - **If any of the DTCs are set**
 1. Program the T6 Power Inverter Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
 3. All OK
 - **If none of the DTCs are set**
3. All OK

Repair Instructions

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

Control Module References for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P0A3F, P0C52, P0C53, P0C5C OR P0C5D: DRIVE MOTOR 1 POSITION 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 Descriptors

DTC P0A3F

Drive Motor 1 Position Sensor Circuit

DTC P0C52

Drive Motor 1 Position Sensor Circuit 1 Low Voltage

DTC P0C53

Drive Motor 1 Position Sensor Circuit 1 High Voltage

DTC P0C5C

Drive Motor 1 Position Sensor Circuit 2 Low Voltage

DTC P0C5D

Drive Motor 1 Position Sensor Circuit 2 High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Position Speed Direction Sensor Circuit 1	P0A3F, P0C52	P0A3F	P0A3F, P0C53	-
Position Speed Direction Sensor Circuit 2	P0A3F, P0C5C	P0A3F	P0A3F, P0C5D	-

Circuit/System Description

The drive motor 1 position sensor is monitored by the motor 1 control module. The motor control module monitors the angular position, speed and direction of the drive motor rotor based upon the signals of the sensor. The drive motor 1 position sensor is part of the drive motor assembly and is not serviced separately.

Conditions for Running the DTC

P0A3F, P0C53, P0C5D

Sensor circuit low side output is commanded ON.

P0C52, P0C5C

Sensor circuit low side output is commanded OFF.

Conditions for Setting the DTC

P0A3F

Loss of signal on position speed direction sensor circuit 1 or 2.

P0C52

Position speed direction sensor circuit 1 is less than 7.8 V.

P0C53

Position speed direction sensor circuit 1 is greater than 1.0 V.

P0C5C

Position speed direction sensor circuit 2 is less than 7.8 V.

P0C5D

Position speed direction sensor circuit 2 is greater than 1.0 V.

Action Taken When the DTC Sets

- For Type A DTCs, The hybrid/EV powertrain control module 1 commands Generator Function Inoperative state. The vehicle will continue to run in electric mode if there is sufficient hybrid/EV battery state of charge.
- DTCs P0A3F, P0C53 and P0C5D are Type A DTCs.
- DTCs P0C52 and P0C5C are Type B DTCs.

Conditions for Clearing the DTC

- DTCs P0A3F, P0C53 and P0C5D are Type A DTCs.
- DTCs P0C52 and P0C5C are Type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

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

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Vehicle OFF, disconnect the X175 harness connector at the transmission.

NOTE: If the a/trans wiring harness assembly circuits fail the circuit tests, replace the harness; do not repair.

2. Vehicle ON.

3. Test for 7.8-8.6 V between the circuit terminals listed below:

- Terminal 31 and 36
- Terminal 34 and 35
- **If less than 7.8 V**

1. Vehicle OFF, disconnect the X1 harness connector at the T6 Power Inverter Module.

2. Test for infinite resistance between the 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 circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the T6 Power Inverter Module.

• **If greater than 8.6 V**

1. Vehicle OFF, disconnect the X1 harness connector at the T6 Power Inverter Module, Vehicle ON.

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

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the T6 Power Inverter Module.

• **If between 7.8-8.6 V**

4. Vehicle OFF, disconnect the harness connector at the B228A Drive Motor 1 Position Sensor. Connect the X175 harness connector at the transmission. Vehicle ON.

5. Test for 7.8-8.6 V between the circuit terminals listed below:

- Terminal A and B
- Terminal C and D
 - If not between 7.8-8.6 V, replace the a/trans wiring harness assembly.
 - If between 7.8-8.6 V, replace the B228A Drive Motor 1 Position Sensor.

6. Verify DTC P0A3F, P0C52, P0C53, P0C5C or P0C5D is not set.

• **If any of the DTCs are set**

1. Program the T6 Power Inverter Module.

2. Verify the DTC does not set.

- If the DTC sets, replace the T6 Power Inverter Module.
- If the DTC does not set

3. All OK.

• **If none of the DTCs are set**

7. All OK.

Repair Instructions

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

- [Drive Motor Removal - 1st Position](#) for B228A Drive Motor 1 Position Sensor replacement.
- [Transmission Control Wiring Harness Removal](#) for A/Trans Wiring Harness Assembly replacement.
- [Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P0A45, P0A46, P0C57, P0C58, P0C61, P0C62 OR P1B04: DRIVE MOTOR 2 POSITION SENSOR

Diagnostic Instructions

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

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0A45

Drive Motor 2 Position Sensor Circuit

DTC P0A46

Drive Motor 2 Position Sensor Performance

DTC P0C57

Drive Motor 2 Position Sensor Circuit 1 Low Voltage

DTC P0C58

Drive Motor 2 Position Sensor Circuit 1 High Voltage

DTC P0C61

Drive Motor 2 Position Sensor Circuit 2 Low Voltage

DTC P0C62

Drive Motor 2 Position Sensor Circuit 2 High Voltage

DTC P1B04

Drive Motor 2 Position Sensor Circuit Tracking Lost

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Reference* - Excitation	P0A45	P0A45	P0A45	P0A46, P1B04
Signal* - Circuit 1	P0A45, P0C57	P0A45	P0A45, P0C58	P0A46, P1B04
Signal* - Circuit 2	P0A45, P0C61	P0A45	P0A45, P0C62	P0A46, P1B04
*Represents a differential circuit consisting of a pair of wires. See Circuit/System Description and schematic for detailed description.				

Circuit/System Description

The drive motor position sensor is monitored by the motor control module. The motor control module monitors the angular position, speed and direction of the drive motor rotor based upon the signals of the resolver-type position sensor. The position sensor contains a drive coil, two driven coils and an irregular shaped metallic rotor. The metallic rotor is mechanically attached to the shaft of the drive motor. At vehicle ON, the motor control module outputs a 7 V AC, 10 kHz excitation signal to the drive coil. The drive coil excitation signal creates a magnetic field surrounding the two driven coils and the irregular shaped rotor. The motor control module then monitors the two driven coil circuits for return signals, often referred to as Sine and Cosine waveforms, abbreviated SIN and COS. The position of the irregular metallic rotor causes the magnetically-induced return signals of the driven coils to vary in size and shape. A comparison of the two driven coils signals allows the motor control module to determine the exact position, speed and direction of the drive motor rotor. The drive motor 2 position sensor is part of the drive motor assembly and is not serviced separately.

Conditions for Running the DTC

The vehicle is ON.

Conditions for Setting the DTC

P0A45

SIN or COS signal is less than 2.3V for 0.20-0.40 s in a 2 s window. The motor control module is unable to track the motor position based upon the sensor signals.

P0A46

SIN or COS signal is greater than 4V for 0.20-0.40 s in a 2 s window. The motor control module detects a degraded motor position sensor signal.

P0C57 or P0C61

Circuit voltage is less than 0.5 V for 0.25 s in a 0.375 s window.

P0C58 or P0C62

Circuit voltage is greater than 3.5 V for 0.25 s in a 0.375 s window.

P1B04

The motor control module is unable to track the motor position based upon the sensor signals for 0.20-0.40 s in a 2 s window.

Action Taken When the DTC Sets

DTCs P0A45, P0A46, P0C57, P0C58, P0C61, P0C62 and P1B04 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0A45, P0A46, P0C57, P0C58, P0C61, P0C62 and P1B04 are Type A DTCs.

Diagnostic Aids

- The drive motor position sensor circuits operate at very low current. These circuits are susceptible to moisture intrusion, corrosion and terminal damage. Extreme care must be taken when probing terminals and manipulating harnesses. Poor terminal connections can result in intermittent operation.
- If the customer comments that the problem occurs only during moist environmental conditions: rain, snow, vehicle wash, etc., inspect the sensor wiring for signs of water intrusion.
- The sensor circuit loops are a twisted pair with each pair covered in a foil shield. The shield circuits outside of the transmission are grounded to a stud on the power inverter module, often referred to as the drive motor generator power inverter module.
- The drive motor position sensor harness circuits are shielded. Improperly grounded shield circuits may cause inaccurate sensor signals.
- These DTCs may set in the case of a Drive Motor 2 bearing failure. Ask if the customer has transmission noise complaints or inspect the bearing for wear if necessary.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

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

Electrical Information Reference

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

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Vehicle OFF, disconnect the X175 harness connectors at the transmission.

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

2. Vehicle ON.

3. Test for 0.5-3.5 V between the signal circuit terminals listed below and ground:

- Signal circuit 1 terminal 22
- Signal circuit 1 terminal 29
- Signal circuit 2 terminal 21
- Signal circuit 2 terminal 28
- **If less than 0.5 V**

1. Vehicle OFF, disconnect the X1 harness connector at the T6 Power Inverter Module.

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

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

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

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the T6 Power Inverter Module.

- **If greater than 3.5 V**

1. Vehicle OFF, disconnect the X1 harness connector at the T6 Power Inverter Module, Vehicle ON.

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

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the T6 Power Inverter Module.

- **If between 0.5-3.5V**

4. Test for 6-8 V DC between the reference circuit terminals listed below and ground:

- Terminal 23
- Terminal 30

- **If less than 6 V**

1. Vehicle OFF, disconnect the X1 harness connector at the T6 Power Inverter Module.

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

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

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

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the T6 Power Inverter Module.

- **If greater than 8 V**

1. Vehicle OFF, disconnect the X1 harness connector at the T6 Power Inverter Module, Vehicle ON.

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

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the T6 Power Inverter Module.

- **If between 6-8 V**
- 5. Vehicle OFF, connect the X175 harness connectors at the transmission, vehicle ON.
- 6. Verify DTC P0A45, P0A46, P0C57, P0C58, P0C61, P0C62 or P1B04 is not set.
 - **If any of the DTCs are set**
 1. Program the T6 Power Inverter Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set
 3. All OK.
 - **If none of the DTCs are set**
- 7. All OK.

Component Testing

1. Vehicle ON.

NOTE: If the a/trans wiring harness assembly circuits fail the circuit tests, replace the harness; do not repair.

2. Verify that DTC P1AF0, P1AF2, P1B43, P1B44, P1E1E, P1E22, P1B0B or P1B0C 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. Vehicle OFF, disconnect the X175 harness connector at the transmission.
4. Test for 10-25 Ω between the reference circuit terminal 23 and the reference circuit terminal 30.
 - **If less than 10 Ω**
 1. Disconnect the harness connector at the B228B Drive Motor 2 Position Sensor.
 2. Test for infinite resistance between the reference circuit terminal 23 and the reference circuit terminal 30.
 - If less than infinite resistance, replace the a/trans wiring harness assembly.
 - If infinite resistance, replace the B228B Drive Motor 2 Position Sensor.
 - **If greater than 25 Ω**
 1. Disconnect the harness connector at the B228B Drive Motor 2 Position Sensor.
 2. Test for less than 2 Ω in the reference circuits end to end.
 - If 2 Ω or greater, replace the a/trans wiring harness assembly.
 - If less than 2 Ω , replace the B228B Drive Motor 2 Position Sensor.
 - **If between 10-25 Ω**
5. Test for 15-45 Ω between the signal circuit 1 terminal 22 and the signal circuit 1 terminal 29.
 - **If less than 15 Ω**
 1. Disconnect the harness connector at the B228B Drive Motor 2 Position Sensor.
 2. Test for infinite resistance between the signal circuit 1 terminal 22 and the signal circuit 1 terminal 29.
 - If less than infinite resistance, replace the a/trans wiring harness assembly.
 - If infinite resistance, replace the B228B Drive Motor 2 Position Sensor.
 - **If greater than 45 Ω**
 1. Disconnect the harness connector at the B228B Drive Motor 2 Position Sensor.
 2. Test for less than 2 Ω in the signal circuits end to end.
 - If 2 Ω or greater, replace the a/trans wiring harness assembly.
 - If less than 2 Ω , replace the B228B Drive Motor 2 Position Sensor.
 - **If between 15-45 Ω**

6. Test for 15-45 Ω between the signal circuit 2 terminal 21 and the signal circuit 2 terminal 28.

- **If less than 15 Ω**

1. Disconnect the harness connector at the B228B Drive Motor 2 Position Sensor.
2. Test for infinite resistance between the signal circuit 2 terminal 21 and the signal circuit 2 terminal 28.
 - If less than infinite resistance, replace the a/trans wiring harness assembly.
 - If infinite resistance, replace the B228B Drive Motor 2 Position Sensor.

- **If greater than 45 Ω**

1. Disconnect the harness connector at the B228B Drive Motor 2 Position Sensor.
2. Test for less than 2 Ω in the signal circuits end to end.
 - If 2 Ω or greater, replace the a/trans wiring harness assembly.
 - If less than 2 Ω , replace the B228B Drive Motor 2 Position Sensor.

- **If between 15-45 Ω**

7. Test for greater than 10, 000 Ω between the terminals listed below and ground:

- Reference circuit terminal 23
- Reference circuit terminal 30
- Signal circuit 1 terminal 22
- Signal circuit 1 terminal 29
- Signal circuit 2 terminal 21
- Signal circuit 2 terminal 28

- **If less than 10, 000 Ω**

1. Disconnect the harness connector at the B228B Drive Motor 2 Position Sensor.
2. Test for less than infinite resistance between the appropriate terminal and ground.
 - If less than infinite resistance, replace the a/trans wiring harness assembly.
 - If infinite resistance, replace the B228B Drive Motor 2 Position Sensor.

- **If 10, 000 Ω or greater**

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

- Terminals 23 and 28
- Terminals 23 and 22
- Terminals 22 and 28

- **If less than infinite resistance**

1. Disconnect the harness connector at the B228B Drive Motor 2 Position Sensor.
2. Test for less than infinite resistance between the appropriate terminals.
 - If less than infinite resistance, replace the a/trans wiring harness assembly.
 - If infinite resistance, replace the B228B Drive Motor 2 Position Sensor.

- **If infinite resistance**

9. Refer to Circuit/System Testing.

Repair Instructions

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

- **Drive Motor Removal - 2nd Position** for B228B Drive Motor 2 Position Sensor replacement.
- **Transmission Control Wiring Harness Removal** for A/Trans Wiring Harness Assembly replacement.
- **Control Module References** for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P0A5E, P0A61, P0A64, P0A67, P0A6A OR P0A6D: DRIVE MOTOR PHASE LOW CURRENT

Diagnostic Instructions

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

DTC Descriptors

DTC P0A5E

Drive Motor 1 Phase U Low Current

DTC P0A61

Drive Motor 1 Phase V Low Current

DTC P0A64

Drive Motor 1 Phase W Low Current

DTC P0A67

Drive Motor 2 Phase U Low Current

DTC P0A6A

Drive Motor 2 Phase V Low Current

DTC P0A6D

Drive Motor 2 Phase W Low Current

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains the motor control modules and the hybrid/EV powertrain control module 1. Each motor control module operates its respective drive motor based upon hybrid/EV powertrain control module 1 commands. Each motor control module controls the speed, direction and output torque of its respective drive motor through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. Each drive motor operates utilizing 3-phase alternating current (AC) electricity. Each insulated gate bipolar transistor operates a single phase of the drive motor. Each phase is individually identified as U, V and W. Each motor control module monitors the current of each phase in order to detect power inverter module fault conditions.

Conditions for Running the DTC

The vehicle is ON.

Conditions for Setting the DTC

One or more phase currents are less than 9.0 A.

Action Taken When the DTC Sets

- DTCs P0A5E, P0A61, P0A64, P0A67, P0A6A and P0A6D are Type A DTCs.
- Propulsion is disabled.

Conditions for Clearing the DTC

DTCs P0A5E, P0A61, P0A64, P0A67, P0A6A and P0A6D are Type A DTCs.

Reference Information

Schematic Reference

[Hybrid/EV Controls Schematics](#)

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

DTC Type Reference

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

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P0A5E, P0A61, P0A64, P0A67, P0A6A and P0A6D is not set.
 - **If any of the DTCs are set**
 1. Clear the DTC, vehicle OFF for 2 minutes to allow all control modules to shut down.
 2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 3. Verify the DTC does not set.
 - If the DTC sets, continue to Circuit/System Testing.
 - If the DTC does not set
 4. All OK.
 - **If none of the DTCs are set**
3. All OK.

Circuit/System Testing

1. Perform the [High Voltage Disabling](#) procedure for servicing the T6 Power Inverter Module or T12 Transmission.

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.

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

2. Remove the 3 phase AC cables from the T6 Power Inverter Module. Refer to [Drive Motor Power Inverter Module 3 Phase Cable Replacement](#).
3. Test for infinite resistance between each of the AC circuit terminals listed below and ground for each phase of the appropriate M15 Drive Motor:

NOTE: This test is performed at the cable terminals and not the module terminals.

Drive Motor 1

- X4 Terminal 3 phase W
- X4 Terminal 2 phase V
- X4 Terminal 1 phase U

Drive Motor 2

- X5 Terminal 3 phase W
- X5 Terminal 2 phase V
- X5 Terminal 1 phase U
- **If less than infinite resistance**

1. Disconnect the harness connector at the T12 Automatic Transmission Assembly.

NOTE: Ensure the cable connector terminals are not touching the transmission motor terminals.

2. Test for infinite resistance between each of the AC circuit terminals listed below and ground for each phase of the appropriate M15 Drive Motor:

NOTE: This test is performed at the cable terminals and not the transmission motor terminals.

Drive Motor 1

- X4 Terminal 1 phase U
- X4 Terminal 2 phase V
- X4 Terminal 3 phase W

Drive Motor 2

- X5 Terminal 1 phase U
- X5 Terminal 2 phase V
- X5 Terminal 3 phase W
- If less than infinite resistance, replace the Drive Motor Power Inverter Module 3-Phase Cable.
- If infinite resistance for all AC circuits, replace the appropriate M15 Drive Motor.
- **If infinite resistance**

4. Test for less than 1 Ω between the AC circuit terminals listed below, for each M15 Drive Motor 3 phase connector:

NOTE: Select the DMM relative mode to ensure the highest meter accuracy of this very low resistance measurement.

- Terminal 1 phase U to terminal 2 phase V
- Terminal 1 phase U to terminal 3 phase W
- Terminal 2 phase V to terminal 3 phase W
- **If 1 Ω or greater**

Replace the M15 Drive Motor.

1. Disconnect the 3 phase harness connectors at the T12 Automatic Transmission Assembly and position slightly away from the transmission.

NOTE: Ensure the cable connector terminals are not touching the transmission motor terminals.

2. Test for less than 2 Ω between each of the AC circuit terminals listed below end to end:

Drive Motor 1

- X1 phase U to X4 terminal 1
- X1 phase V to X4 terminal 2
- X1 phase W to X4 terminal 3

Drive Motor 2

- X2 phase U to X3 terminal 1
 - X2 phase V to X3 terminal 2
 - X2 phase W to X3 terminal 3
 - If greater than 2 Ω , replace the Drive Motor Power Inverter Module 3-Phase Cable.
 - If 2 Ω or less, replace the appropriate M15 Drive Motor.
 - **If less than 1 Ω**
5. Reassemble the vehicle.
 6. Verify the DTC does not set.
 - **If the DTC sets**
 1. Perform each of the operations listed below one at a time until the fault is corrected.
 - Replace the appropriate M15 Drive Motor and the 3 phase cable assembly.
 - Replace the T6 Power Inverter Module.
 2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 3. Repeat the DTC check.
 - **If the DTC does not set**
 7. All OK.

Repair Instructions

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

- [Drive Motor Power Inverter Module 3 Phase Cable Replacement](#)
- [Drive Motor Removal - 1st Position](#) for M15 A Drive Motor 1 replacement
- [Drive Motor Removal - 2nd Position](#) for M15 B Drive Motor 2 replacement
- [Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P0A78 OR P0A79: DRIVE MOTOR INVERTER PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P0A78

Drive Motor 1 Inverter Performance

DTC P0A79

Drive Motor 2 Inverter Performance

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains the motor control modules and the hybrid/EV powertrain control module 1. Each motor control module operates its respective drive motor based upon hybrid/EV powertrain control module 1 commands. Each

motor control module controls the speed, direction and output torque of its respective drive motor through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. Each drive motor operates utilizing 3-phase alternating current (AC) electricity. Each insulated gate bipolar transistor operates a single phase of the drive motor. Each phase is individually identified as U, V and W. Each motor control module monitors the current of each phase in order to detect power inverter module over current conditions.

Conditions for Running the DTC

The high voltage contactor relays are closed.

Conditions for Setting the DTC

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

Actions Taken When the DTC Sets

DTCs P0A78 and P0A79 are Type A DTCs.

P0A79

Propulsion is disabled.

Conditions for Clearing the DTC

DTCs P0A78 and P0A79 are Type A DTCs.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P0A78 or P0A79 is not set.
 - **If any of the DTCs are set**
 1. Clear the DTC, vehicle OFF for 2 minutes to allow all control modules to shut down.
 2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 3. Verify the DTC does not set.
 - If the DTC sets, continue to Circuit/System Testing.
 - If the DTC does not set
 - **If none of the DTCs are set**
4. All OK.

Circuit/System Testing

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

1. Perform the **High Voltage Disabling** procedure for servicing the T6 Power Inverter Module or T12 Transmission.

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.

2. Remove the T6 Power Inverter Module. Refer to **Drive Motor Power Inverter Module Replacement**.
3. Test for infinite resistance between each of the AC circuit terminals listed below and ground for each phase of the appropriate M15 Drive Motor:

Drive Motor 1

- X4 Terminal 3 phase W
- X4 Terminal 2 phase V
- X4 Terminal 1 phase U

Drive Motor 2

- X5 Terminal 3 phase W
- X5 Terminal 2 phase V
- X5 Terminal 1 phase U
- **If less than infinite resistance**

1. Disconnect the harness connector at the T12 Automatic Transmission Assembly.
2. Test for infinite resistance between each of the AC circuit terminals listed below and ground for each phase of the appropriate M15 Drive Motor:

Drive Motor 1

- X4 Terminal 1 phase U
- X4 Terminal 2 phase V
- X4 Terminal 3 phase W

Drive Motor 2

- X5 Terminal 1 phase U
- X5 Terminal 2 phase V
- X5 Terminal 3 phase W
- If less than infinite resistance

Replace the Drive Motor Power Inverter Module 3 Phase Cable.

- If infinite resistance
3. Replace the M15 Drive Motor.
 - **If infinite resistance for all AC circuits**
 1. Perform each of the operations listed below one at a time until the fault is corrected.
 1. Replace the T6 Power Inverter Module.
 2. Replace the M15 Drive Motor.
 2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 3. Repeat the DTC check.
 - **If the DTC does not set**
 4. All OK.

Repair Instructions

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

- [Drive Motor Power Inverter Module 3 Phase Cable Replacement](#)
- [Drive Motor Removal - 1st Position](#) for Drive Motor 1 replacement
- [Drive Motor Removal - 2nd Position](#) for Drive Motor 2 replacement
- [Control Module References](#) for Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P0AB9: HYBRID/EV SYSTEM PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P0AB9

Hybrid/EV System Performance

Circuit/System Description

This vehicle does not use a 12V starter motor to crank the internal combustion engine. A much more powerful 360V motor located within the transmission is utilized to crank the engine. This motor, drive motor 1, can rotate the engine to operating speed within just a few hundred milliseconds. The hybrid/EV powertrain control module 1 can detect a condition where the engine is cranking but does not start or has stalled.

Conditions for Running the DTC

The vehicle is attempting an Autostart or Autostop.

Conditions for Setting the DTC

The hybrid/EV powertrain control module 1 detects that crankshaft position sensor engine speed has not risen above the commanded cranking speed indicating the engine has failed to start or the hybrid/EV powertrain control module 1 detects crankshaft position sensor engine speed has fallen below a specific minimum speed indicating the engine has stalled.

Actions Taken When the DTC Sets

DTC P0AB9 is a Type A DTC.

Cranks But Does Not Start

When system commands engine Crank, the hybrid/EV powertrain control module 1 will command drive motor 1 to rotate the engine. The drive motor will continue to rotate the engine at a specific RPM until the engine starts and causes increased engine RPM. The hybrid/EV powertrain control module 1 will cease engine rotation if an increase in engine RPM is not observed after several seconds. This function may have the appearance of a start/stall condition.

- Commanded engine torque is greater than 20 N.m (15 lb ft)
- Low fuel level condition not set
- Fuel level sensors DTCs not set
- Engine CMP or CKP sensor DTCs not set
- DTC P16E0 not set

Engine Stall

If a stall occurs after a successful engine start, the hybrid/EV powertrain control module 1 will recognize the drop in engine RPM and command drive motor 1 to maintain engine RPM in an attempt to restart the engine. Drive motor 1 will continue to rotate the engine until the hybrid/EV powertrain control module 1 commands it to stop. The engine may be rotated for many minutes after the actual engine stall condition occurred and is typically stopped only after the hybrid/EV battery state of charge gets too low. This function may have the appearance of a running engine.

- Engine is running
- Low fuel level condition not set
- Fuel level sensors DTCs not set
- Engine CMP or CKP sensor DTCs not set
- DTC P16E0 not set

Conditions for Clearing the DTC

DTC P0AB9 is a Type A DTC.

Diagnostic Aids

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

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

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

This DTC may set if the vehicle is powered off while driving.

Circuit/System Verification

1. Vehicle ON. Operate the hood release to open the hood. Depress and hold the accelerator pedal for more than 5 seconds. Under normal operation, the engine should start and run.
2. Verify the engine starts and runs for at least 20 seconds.

- **If the engine fails to start and run for at least 20 seconds**

Diagnose the engine and transmission systems. Perform the **Engine Cranks But Does Not Run**.

- **If the engine starts and runs for at least 20 seconds**

3. Verify DTC P0AB9 is not set.

- **If the DTC is set**

1. Program the T6 Power Inverter Module.
2. Verify the DTC does not set.

- If the DTC sets, replace the T6 Power Inverter Module.
- If the DTC does not set.

3. All OK

- **If the DTC is not set**

4. All OK

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P0AEE, P0AEF, P0AF0, P0AF3-P0AF5, P0BD2-P0BD4, P0BD7-P0BD9, P0BDC-P0BDE OR P0BE1-P0BE3: DRIVE MOTOR INVERTER TEMPERATURE SENSOR

Diagnostic Instructions

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

DTC Descriptor

DTC P0AEE

Drive Motor Inverter Temperature Sensor 1 Performance

DTC P0AEF

Drive Motor Inverter Temperature Sensor 1 Circuit Low Voltage

DTC P0AF0

Drive Motor Inverter Temperature Sensor 1 Circuit High Voltage

DTC P0AF3

Drive Motor Inverter Temperature Sensor 2 Performance

DTC P0AF4

Drive Motor Inverter Temperature Sensor 2 Circuit Low Voltage

DTC P0AF5

Drive Motor Inverter Temperature Sensor 2 Circuit High Voltage

DTC P0BD2

Drive Motor Inverter Temperature Sensor 3 Performance

DTC P0BD3

Drive Motor Inverter Temperature Sensor 3 Circuit Low Voltage

DTC P0BD4

Drive Motor Inverter Temperature Sensor 3 Circuit High Voltage

DTC P0BD7

Drive Motor Inverter Temperature Sensor 4 Performance

DTC P0BD8

Drive Motor Inverter Temperature Sensor 4 Circuit Low Voltage

DTC P0BD9

Drive Motor Inverter Temperature Sensor 4 Circuit High Voltage

DTC P0BDC

Drive Motor Inverter Temperature Sensor 5 Performance

DTC P0BDD

Drive Motor Inverter Temperature Sensor 5 Circuit Low Voltage

DTC P0BDE

Drive Motor Inverter Temperature Sensor 5 Circuit High Voltage

DTC P0BE1

Drive Motor Inverter Temperature Sensor 6 Performance

DTC P0BE2

Drive Motor Inverter Temperature Sensor 6 Circuit Low Voltage

DTC P0BE3

Drive Motor Inverter Temperature Sensor 6 Circuit High Voltage

Circuit/System Description

This is an internal fault detection of the power inverter module, often referred to as the drive motor generator power inverter module. This fault is handled inside the power inverter module and no external circuits are involved.

Conditions for Running the DTC

P0AEE, P0AF3, P0BD2, P0BD7, P0BDC and P0BE1

- Vehicle ON after the vehicle has been OFF for 6 hours.
- Temperature average of the inverter phase temperature sensors is greater than 20°C (68°F).
- DTCs P0AEF, P0AF0, P0AF4, P0AF5, P0BD3, P0BD4, P0BD8, P0BD9, P0BDD, P0BDE, P0BE2 and P0BE3 are not set.

P0AEF, P0AF4, P0BD3, P0BD8, P0BDD and P0BE2

The vehicle is ON.

P0AF0, P0AF5, P0BD4, P0BD9, P0BDE and P0BE3

- The vehicle is ON.
- Inverter warmup time is 90 s or greater.

Conditions for Setting the DTC

P0AEE, P0AF3, P0BD2, P0BD7, P0BDC and P0BE1

- A 20°C (36°F) difference is observed between the individual inverter phase temperature sensor and the average of the power electronics coolant and transmission fluid temperatures.
- The above condition is present for 5 s.

P0AEF, P0AF4, P0BD3, P0BD8, P0BDD and P0BE2

The inverter phase temperature sensor is greater than 144°C (291°F) for 7 s.

P0AF0, P0AF5, P0BD4, P0BD9, P0BDE and P0BE3

The inverter phase temperature sensor is less than -50°C (-72°F) for 7 s.

Actions Taken When the DTC Sets

DTCs P0AEE, P0AEF, P0AF0, P0AF3, P0AF4, P0AF5, P0BD2, P0BD3, P0BD4, P0BD7, P0BD8, P0BD9, P0BDC, P0BDD, P0BDE, P0BE1, P0BE2 and P0BE3 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0AEE, P0AEF, P0AF0, P0AF3, P0AF4, P0AF5, P0BD2, P0BD3, P0BD4, P0BD7, P0BD8, P0BD9, P0BDC, P0BDD, P0BDE, P0BE1, P0BE2 and P0BE3 are Type B DTCs.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P0AEE, P0AEF, P0AF0, P0AF3, P0AF4, P0AF5, P0BD2, P0BD3, P0BD4, P0BD7, P0BD8, P0BD9, P0BDC, P0BDD, P0BDE, P0BE1, P0BE2 or P0BE3 is not set.
 - **If any of the DTCs are set**
 1. Program the T6 Power Inverter Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
 3. All OK.
 - **If none of the DTCs are set**
3. All OK.

Repair Instructions

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

Control Module References for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module replacement, programming and setup.

DTC P0BE6-P0BE8, P0BEA-P0BEC, P0BEE, P0BEF, P0BF0, P0BF2-P0BF4, P0BF6-P0BF8 OR P0BFA-P0BFC: DRIVE MOTOR PHASE CURRENT SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC P0BE6

Drive Motor 1 Phase U Current Sensor Performance

DTC P0BE7

Drive Motor 1 Phase U Current Sensor Circuit Low Voltage

DTC P0BE8

Drive Motor 1 Phase U Current Sensor Circuit High Voltage

DTC P0BEA

Drive Motor 1 Phase V Current Sensor Performance

DTC P0BEB

Drive Motor 1 Phase V Current Sensor Circuit Low Voltage

DTC P0BEC

Drive Motor 1 Phase V Current Sensor Circuit High Voltage

DTC P0BEE

Drive Motor 1 Phase W Current Sensor Performance

DTC P0BEF

Drive Motor 1 Phase W Current Sensor Circuit Low Voltage

DTC P0BF0

Drive Motor 1 Phase W Current Sensor Circuit High Voltage

DTC P0BF2

Drive Motor 2 Phase U Current Sensor Performance

DTC P0BF3

Drive Motor 2 Phase U Current Sensor Circuit Low Voltage

DTC P0BF4

Drive Motor 2 Phase U Current Sensor Circuit High Voltage

DTC P0BF6

Drive Motor 2 Phase V Current Sensor Performance

DTC P0BF7

Drive Motor 2 Phase V Current Sensor Circuit Low Voltage

DTC P0BF8

Drive Motor 2 Phase V Current Sensor Circuit High Voltage

DTC P0BFA

Drive Motor 2 Phase W Current Sensor Performance

DTC P0BFB

Drive Motor 2 Phase W Current Sensor Circuit Low Voltage

DTC P0BFC

Drive Motor 2 Phase W Current Sensor Circuit High Voltage

Circuit/System Description

This is an internal fault detection of the power inverter module, often referred to as the drive motor generator power inverter module. This fault is handled inside the drive motor generator power inverter module and no external circuits are involved.

Conditions for Running the DTC

The control module runs the program to detect an internal fault when the Hybrid wake-up circuit is active.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

Action Taken When the DTC Sets

DTCs P0BE6, P0BE7, P0BE8, P0BEA, P0BEB, P0BEC, P0BEE, P0BEF, P0BF0, P0BF2, P0BF3, P0BF4, P0BF6, P0BF7, P0BF8, P0BFA, P0BFB and P0BFC are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0BE6, P0BE7, P0BE8, P0BEA, P0BEB, P0BEC, P0BEE, P0BEF, P0BF0, P0BF2, P0BF3, P0BF4, P0BF6, P0BF7, P0BF8, P0BFA, P0BFB and P0BFC are Type A DTCs.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P0BE6, P0BE7, P0BE8, P0BEA, P0BEB, P0BEC, P0BEE, P0BEF, P0BF0, P0BF2, P0BF3, P0BF4, P0BF6, P0BF7, P0BF8, P0BFA, P0BFB or P0BFC is not set.
 - **If any of the DTCs are set**
 1. Program the T6 Power Inverter Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
 - 3. All OK
 - **If none of the DTCs are set**
3. All OK

Repair Instructions

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

Control Module References for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P0BFD OR P0BFE: DRIVE MOTOR PHASES U-V-W NOT PLAUSIBLE

Diagnostic Instructions

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

DTC Descriptor

DTC P0BFD

Drive Motor 1 Phases U-V-W Not Plausible

DTC P0BFE

Drive Motor 2 Phases U-V-W Not Plausible

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains the motor control modules and the hybrid/EV powertrain control module 1. Each motor control module operates its respective drive motor based upon hybrid/EV powertrain control module 1 commands. Each motor control module controls the speed, direction and output torque of its respective drive motor through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. Each drive motor operates utilizing 3-phase alternating current (AC) electricity. Each insulated gate bipolar transistor operates a single phase of the drive motor. Each phase is individually identified as U, V and W. Each motor control module monitors the current of each phase in order to detect power inverter module over current conditions.

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

Conditions for Running the DTC

The vehicle is ON.

Conditions for Setting the DTC

The sum of the 3 phase current sensors is 179 A or greater.

Actions Taken When the DTC Sets

DTCs P0BFD and P0BFE are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0BFD and P0BFE are Type A DTCs.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P0BFD or P0BFE is not set.
 - **If any of the DTCs are set**

1. Program the T6 Power Inverter Module.
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
3. Verify the DTC does not set.
 - If the DTC sets, continue to Circuit/System Testing.
 - If the DTC does not set.
4. All OK.
 - **If none of the DTCs are set**
3. All OK.

Circuit/System Testing

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

1. Perform the High Voltage Disabling procedure for servicing the T6 Power Inverter Module cable connections.

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.

2. Remove the T6 Power Inverter Module. Refer to Drive Motor Power Inverter Module Replacement.
3. Test for infinite resistance between each of the AC circuit terminals listed below and ground for each phase of the appropriate M15 Drive Motor:

Drive Motor 1

- X3 Terminal 1 phase U
- X3 Terminal 2 phase V
- X3 Terminal 3 phase W

Drive Motor 2

- X4 Terminal 1 phase U
- X4 Terminal 2 phase V
- X4 Terminal 3 phase W
- **If less than infinite resistance**

Replace the M15 Drive Motor.

- **If infinite resistance for all AC circuits**

4. Perform each of the operations listed below one at a time until the fault is corrected.
 1. Replace the T6 Power Inverter Module.
 2. Replace the M15 Drive Motor.

Repair Instructions

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

- [Drive Motor Removal - 1st Position](#) for Drive Motor 1 replacement
- [Drive Motor Removal - 2nd Position](#) for Drive Motor 2 replacement
- [Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P0C01 OR P0C04: DRIVE MOTOR HIGH CURRENT

Diagnostic Instructions

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

DTC Descriptor

DTC P0C01

Drive Motor 1 High Current

DTC P0C04

Drive Motor 2 High Current

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains the motor control modules and the hybrid/EV powertrain control module 1. Each motor control module operates its respective drive motor based upon hybrid/EV powertrain control module 1 commands. Each motor control module controls the speed, direction and output torque of its respective drive motor through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. Each drive motor operates utilizing 3-phase alternating current (AC) electricity. Each insulated gate bipolar transistor operates a single phase of the drive motor. Each phase is individually identified as U, V and W. Each motor control module monitors the current of each phase in order to detect power inverter module over current conditions.

Conditions for Running the DTC

The hybrid wakeup circuit is active.

Conditions for Setting the DTC

One or more phase currents are greater than 750 A.

Actions Taken When the DTC Sets

- DTCs P0C01 and P0C04 are Type A DTCs.
- The power inverter module requests the hybrid/EV powertrain control module 2 to open the high voltage contactor relays.

Conditions for Clearing the DTC

DTCs P0C01 and P0C04 are Type A DTCs.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Electrical Information Reference

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

DTC Type Reference

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

[Circuit/System Verification](#)

1. Vehicle ON.
2. Verify DTC P0C01 or P0C04 is not set.
 - **If any of the DTCs are set**
 1. Clear the DTC, vehicle OFF for 2 minutes to allow all control modules to shut down.
 2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 3. Verify the DTC does not set.
 - If the DTC sets, continue to Circuit/System Testing.
 - If the DTC does not set.
 - 4. All OK
 - **If none of the DTCs are set**
3. All OK

[Circuit/System Testing](#)

1. Perform the [High Voltage Disabling](#) procedure for servicing the T6 Power Inverter Module or T12 Transmission.

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.

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

2. Remove the T6 Power Inverter Module. Refer to [Drive Motor Power Inverter Module Replacement](#).
3. Test for infinite resistance between each of the AC circuit terminals listed below and ground for each phase of the appropriate M15 Drive Motor:

Drive Motor 1

- X4 Terminal 1 phase U
- X4 Terminal 2 phase V
- X4 Terminal 3 phase W

Drive Motor 2

- X3 Terminal 1 phase U
- X3 Terminal 2 phase V
- X3 Terminal 3 phase W
- **If less than infinite resistance**

Replace the M15 Drive Motor.

- **If infinite resistance for all AC circuits**

4. Verify the DTC does not set.

- **If the DTC sets**

1. Perform each of the operations listed below one at a time until the fault is corrected.

1. Program the T6 Power Inverter Module.
2. Replace the T6 Power Inverter Module.
3. Replace the M15 Drive Motor.

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

3. Repeat the DTC check.

- **If the DTC does not set**

5. All OK.

Repair Instructions

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

- [Drive Motor Removal - 1st Position](#) for Drive Motor 1 replacement
- [Drive Motor Removal - 2nd Position](#) for Drive Motor 2 replacement
- [Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P0C0B OR P0C0E: DRIVE MOTOR 1 INVERTER SUPPLY VOLTAGE 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 P0C0B

Drive Motor 1 Inverter Supply Voltage Circuit

DTC P0C0E

Drive Motor 2 Inverter Supply Voltage Circuit

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains the motor control modules and the hybrid/EV powertrain control module 1. Each motor control module operates its respective drive motor based upon hybrid/EV powertrain control module 1 commands. Each motor control module controls the speed, direction and output torque of its respective drive motor through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. Each drive motor operates utilizing 3-phase alternating current (AC) electricity. Each insulated gate bipolar transistor operates a single phase of the drive motor. Each phase is individually identified as U, V and W. Each motor control module monitors the current of each phase in order to detect power inverter module over current conditions.

Conditions for Running the DTC

Vehicle is ON or Charge Mode is active.

Conditions for Setting the DTC

Phase U-V-W power supply voltage below 7.2 V.

Actions Taken When the DTC Sets

- DTCs P0C0B and P0C0E are Type A DTCs.
- Propulsion will be disabled.

Conditions for Clearing the DTC

DTCs P0C0B and P0C0E are Type A DTCs.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P0C0B or P0C0E is not set.
 - **If any of the DTCs are set**
 1. Clear the DTC, vehicle OFF for 2 minutes to allow all control modules to shut down.
 2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 3. Verify the DTC does not set.
 - If the DTC sets, continue to Circuit/System Testing.
 - If the DTC does not set.
 4. All OK
 - **If none of the DTCs are set**
3. All OK

Circuit/System Testing

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

1. Perform the [High Voltage Disabling](#) procedure for servicing the T6 Power Inverter Module cable connections.

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.

2. Remove the T6 Power Inverter Module. Refer to [Drive Motor Power Inverter Module Replacement](#).
3. Test for infinite resistance between each of the AC circuit terminals listed below and ground for each phase of the appropriate M15 Drive Motor:

Drive Motor 1

- X4 Terminal 1 phase U
- X4 Terminal 2 phase V
- X4 Terminal 3 phase W

Drive Motor 2

- X3 Terminal 1 phase U
- X3 Terminal 2 phase V
- X3 Terminal 3 phase W
- **If less than infinite resistance**

Replace the M15 Drive Motor.

- **If infinite resistance for all AC circuits**

4. Verify the DTC does not set.

- **If the DTC sets**

1. Perform each of the operations listed below one at a time until the fault is corrected.

1. Program the T6 Power Inverter Module.
2. Replace the T6 Power Inverter Module.
3. Replace the applicable M15 Drive Motor.

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

3. Repeat the DTC check.

- **If the DTC does not set**

5. All OK.

Repair Instructions

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

- [Drive Motor Removal - 1st Position](#) for M15A Drive Motor 1 replacement
- [Drive Motor Removal - 2nd Position](#) for M15B Drive Motor 2 replacement
- [Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P0C11-P0C16: DRIVE MOTOR INVERTER PHASE HIGH TEMPERATURE

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 P0C11

Drive Motor 1 Inverter Phase U High Temperature

DTC P0C12

Drive Motor 1 Inverter Phase V High Temperature

DTC P0C13

Drive Motor 1 Inverter Phase W High Temperature

DTC P0C14

Drive Motor 2 Inverter Phase U High Temperature

DTC P0C15

Drive Motor 2 Inverter Phase V High Temperature

DTC P0C16

Drive Motor 2 Inverter Phase W High Temperature

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains two drive motor control modules and the hybrid/EV powertrain control module 1. Each motor control module operates its respective drive motor based upon hybrid/EV powertrain control module 1 commands. Each motor control module controls the speed, direction and output torque of its respective drive motor through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. Each drive motor operates utilizing 3 phase AC. Each insulated gate bipolar transistor operates a single phase of the drive motor. Each phase is individually identified as U, V and W. Each motor control module monitors the temperature of each phase in order to detect power inverter module over-temperature conditions.

Conditions for Running the DTC

- Vehicle ON.
- Inverter temperature is normal at vehicle start up.

Conditions for Setting the DTC

The phase temperature has exceeded 119°C (235.4°F) for 2 seconds.

Action Taken When the DTC Sets

DTCs P0C11, P0C12, P0C13, P0C14, P0C15 and P0C16 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0C11, P0C12, P0C13, P0C14, P0C15 and P0C16 are Type A DTCs.

Reference Information

Description and Operation

- [Drive Motor Power Inverter Module Description and Operation](#)
- [Hybrid/EV Cooling System Description and Operation](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON, observe the scan tool ECM Engine Coolant Temperature (ECT) parameter in freeze frame data.
2. Verify the Engine Coolant Temperature parameter was below 125Â°C (257Â°F) when the DTC set.
 - **If the ECT was 125Â°C (257Â°F) or greater when the DTC set**
Refer to [Symptoms - Engine Cooling](#) and correct that concern first.
 - **If the ECT was below 125Â°C (257Â°F) when the DTC set**
3. Inspect for proper coolant level in the hybrid cooling system reservoir.
 - **If coolant level is low**
Refer to [Power Electronics and Auxiliary Radiator Cooling System Loss of Coolant](#).
 - **If coolant level is OK**
4. Inspect the hybrid/EV cooling system radiator for debris or obstruction.
 - **If a concern is found**
Repair or replace the restricted or damaged components as necessary.
 - **If no concern is found**
5. Inspect for proper operation of all hybrid/EV system coolant pumps. Refer to [Hybrid/EV Electronics Coolant Pump Malfunction](#).
 - **If a concern is found**
Repair or replace the coolant pumps as necessary.
 - **If no concern is found**
6. Perform the [Power Electronics and Auxiliary Radiator Cooling System Diagnostic](#).
 - **If a concern is found**
Repair or replace the restricted or damaged components as necessary.
 - **If no concern is found**
7. All OK.

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P0C18 OR P1B10: DRIVE MOTOR 2 POSITION

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 P0C18

Drive Motor 2 Position Not Learned

DTC P1B10

Drive Motor 2 Position Learn Incorrect

Circuit/System Description

The drive motor 2 position sensor is monitored by the drive motor 2 control module. The motor control module 2 monitors the angular position, speed and direction of the drive motor rotor based upon the signals of the resolver-type position sensor. The position sensor contains a drive coil, two driven coils and an irregular shaped metallic rotor. The metallic rotor is mechanically attached to the shaft of the drive motor generator. At vehicle ON, the motor control module outputs a 7 V AC, 10 kHz excitation signal to the drive coil. The drive coil excitation signal creates a magnetic field surrounding the two driven coils and the irregular shaped rotor. The motor control module then monitors the two driven coil circuits for a return signal. The position of the irregular metallic rotor causes the magnetically-induced return signals of the driven coils to vary in size and shape. A comparison of the two driven coils signals allows the motor control module to determine the exact position, speed and direction of the drive motor rotor.

A measurement called offset is needed for accurate determination of the motor position. Offset is the relationship between the position sensor and the drive motor generator output shaft. Whenever the vehicle is cycled to OFF, the motor control module attempts to learn the offset of the drive motor position sensor by rapidly oscillating the motor and observing the position sensor signals.

The motor control module 2 will attempt to learn the position at vehicle OFF. The non-learned condition would normally occur only after a motor control module reprogramming event. The control modules listed below are part of the power inverter module, often referred to as the drive motor generator power inverter module and are not serviced separately:

- Auxiliary transmission fluid pump control module
- Drive motor 1 control module
- Drive motor 2 control module
- Hybrid/EV powertrain control module 1

Conditions for Running the DTC

P0C18

- Vehicle is cycled from ON to OFF.
- The motor control module has no valid drive motor position sensor offset value in memory.

P1B10

- Vehicle is cycled from ON to OFF.
- The motor control module has learned a valid drive motor position sensor offset value at least once.

Conditions for Setting the DTC

Condition 1

Position sensor offset value not learned because drive motor speed is greater than 50 RPM.

Condition 2

Position sensor offset value not learned because hybrid battery voltage as observed at the motor control module is less than 200 V.

Condition 3

- Position sensor offset value not learned because drive motor phase to phase current difference is less than 20 A.
- P1B10 failed to learn for 1.4 s.

Actions Taken When the DTC Sets

P0C18

DTC P0C18 is a Type A DTC.

P1B10

- DTC P1B10 is a Type B DTC.
- The motor control module operates the drive motor generator using the last valid learned offset.

Conditions for Clearing the DTC

- DTC P0C18 is a Type A DTC.
- DTC P1B10 is a Type B DTC.

Diagnostic Aids

- If the vehicle is powered off while driving, DTC P1B10 may set.
- The drive motor position sensor circuits operate at very low current. These circuits are susceptible to moisture intrusion, corrosion and terminal damage. Extreme care must be taken when probing terminals and manipulating harnesses. Poor terminal connections can result in intermittent operation.
- Intermittent appearance of DTC P0A3F, P0A40, P0C52, P0C53, P0C5C, P0C5D or P1B03 for drive motor 1 or DTC P0A45, P0A46, P0C57, P0C58, P0C61, P0C62 or P1B04 for drive motor 2 suggests intermittent position sensor circuit or connector problems.

Reference Information

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Vehicle ON.
2. Verify that DTCs P0A3F, P0A40, P0A45, P0A46, P0A78, P0A79, P0C01, P0C04, P0C0B, P0C0E, P0C4E, P0C4F, P0C52, P0C53, P0C57, P0C58, P0C5C, P0C5D, P0C61, P0C62, P1B03, P1B04, P1B0D or P1B0E 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. Cycle vehicle power 4 times, using a scan tool to monitor the state of the appropriate Drive Motor Position Sensor Offset Learn Status.

NOTE: When turning vehicle OFF, open and close the driver door and wait 2 minutes to allow all modules to shut down.

- **If Drive Motor Position Sensor Offset Learn Status showed Motor Current Incorrect all 4 cycles**
Refer to Circuit/System Testing.
 - **If Drive Motor Position Sensor Offset Learn Status did not show Motor Current Incorrect all 4 cycles**
4. Vehicle ON.
 5. Verify DTC P0C18 or P1B10 is not set.
 - **If any of the DTCs are set**
 1. Program the T6 Power Inverter Module.
 2. Cycle vehicle power 4 times, using a scan tool to monitor the state of the appropriate Drive Motor Position Sensor Offset Learn Status.

3. Verify the DTC does not set.

- If the DTC sets, replace the T6 Power Inverter Module.
- If the DTC does not set

4. All OK.

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

6. All OK.

Circuit/System Testing

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

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

The High Voltage Disabling procedure will perform the following tasks:

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

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

1. Perform the **High Voltage Disabling** procedure for servicing the T6 Power Inverter Module or T12 Transmission.
2. Remove the T6 Power Inverter Module. Refer to **Drive Motor Power Inverter Module Replacement**.
3. Test for infinite resistance between each of the AC circuit terminals listed below and ground for each phase of the appropriate M15 Drive Motor:

Drive Motor 2

- Terminal X3 phase U
- Terminal X3 phase V
- Terminal X3 phase W
- **If less than infinite resistance**

Replace the M15 Drive Motor.

- **If infinite resistance for all AC circuits**

4. Verify the DTC does not set.

- **If the DTC sets**

1. Perform each of the operations listed below one at a time until the fault is corrected.

1. Replace the T6 Power Inverter Module.
2. Replace the appropriate M15 Drive Motor.

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

3. Repeat the DTC check.

- **If the DTC does not set**

5. All OK.

Repair Instructions

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

- [Drive Motor Removal - 2nd Position](#) for K107B Drive Motor 2 replacement.
- [Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P0C19: DRIVE MOTOR 1 TORQUE DELIVERED PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P0C19

Drive Motor 1 Torque Delivered Performance

Circuit/System Description

Each drive motor is controlled by a motor control module. The motor control module constantly monitors the requested torque and the delivered torque of its respective drive motor. The motor control module is part of the power inverter module, often referred to as the drive motor generator power inverter module and is not serviced separately.

Conditions for Running the DTC

- DTCs P0A3F, P0A40, P1AF5, P0BFD, P1B03, P1B0C, P1B41 or P16EB is not set.
- Vehicle ON.
- Drive motor 1 is commanded to develop torque.

OR

- There is a current high voltage hazard fault and there are no motor temperature or faults present.

Conditions for Setting the DTC

The motor control module has detected that difference between drive motor delivered and commanded torque is greater than 72 N.m (53.1 lb ft).

Actions Taken When the DTC Sets

- DTC P0C19 is a Type A DTC.
- Available motor torque will be reduced.

Conditions for Clearing the DTC

DTC P0C19 is a Type A DTC.

Diagnostic Aids

Because the engine and drive motor 1 are mechanically connected through a planetary gear set, an engine condition that requires drive motor 1 to consume excessive current while trying to rotate the engine may cause this DTC to set such as:

- Extreme braking during regeneration may cause this DTC to be set in history.
- Seized or binding engine
- Seized or binding clutch 5
- Seized or binding accessory drive belt

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON. Operate the hood release to open the hood. Depress and hold the accelerator pedal for more than 5 seconds. The engine should start and run.
2. Verify the engine or clutch 5 is not seized or binding.
 - **If the engine or clutch 5 is seized or binding**
Refer to [Symptoms - Engine Mechanical](#).
 - **If the engine or clutch 5 is not seized or binding**
3. Verify DTC P0C19 is not set.
 - **If the DTC is set**
 1. Program the T6 Power Inverter Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
 3. All OK
 - **If the DTC is not set**
4. All OK

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P0C1A: DRIVE MOTOR 2 TORQUE DELIVERED PERFORMANCE

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 P0C1A

Drive Motor 2 Torque Delivered Performance

Circuit/System Description

Each drive motor is controlled by a motor control module. The motor control module constantly monitors the requested torque and the delivered torque of its respective drive motor. The motor control module is part of the power inverter module, often referred to as the drive motor generator power inverter module and is not serviced separately.

Conditions for Running the DTC

- Vehicle ON.
- DTCs P0A3F, P0A40, P1AF5, P0BFD, P1B03, P1B0C, P1B41 or P16EB is not set.
- Drive motor 2 is commanded to develop torque.

Conditions for Setting the DTC

The motor control module has detected that difference between drive motor delivered and commanded torque is greater than 132 N.m (97 lb ft).

Actions Taken When the DTC Sets

- DTC P0C1A is a Type A DTC.
- Available motor torque will be reduced.

Conditions for Clearing the DTC

DTC P0C1A is a Type A DTC.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P0C1A is not set.
 - **If the DTC is set**
 1. Program the T6 Power Inverter Module.
 2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 3. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
 4. All OK
 - **If the DTC is not set**
3. All OK

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P0C28: AUXILIARY TRANSMISSION FLUID PUMP HIGH CURRENT

Diagnostic Instructions

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

DTC Descriptor

DTC P0C28

Auxiliary Transmission Fluid Pump High Current

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains two motor control modules and the hybrid/EV powertrain control module 1. The motor control modules operate their respective drive motor based upon power inverter module commands. The hybrid/EV

powertrain control module 1 controls the auxiliary transmission fluid pump. The motors utilize 3 phase AC electricity. The motor stator coil is comprised of three phase circuits. The phase circuits are identified as phase U, phase V and phase W. The U-V-W phase circuits are connected in a wye configuration. This means each phase is connected at a single, central point. The motor control modules monitor a current sensor connected to each motor phase. The current sensor is part of the motor assembly and is not serviced separately. The hybrid/EV powertrain control module 1 is part of the power inverter module and are not serviced separately.

Conditions for Running the DTC

Vehicle is ON.

Conditions for Setting the DTC

One or more phase currents are greater than 35 A.

Actions Taken When the DTC Sets

- DTC P0C28 is a Type A DTC.
- Vehicle propulsion will be disabled.

Conditions for Clearing the DTC

DTC P0C28 is a Type A DTC.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Testing

1. Perform the [High Voltage Disabling](#) procedure for servicing the T6 Power Inverter Module or T12 Transmission.

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.

2. Disconnect the X8 harness connector at the T6 Power Inverter Module.

3. Test for infinite resistance between each of the AC circuit terminals listed below and ground for each phase of the G5 Transmission Fluid Pump - Electric/Auxiliary:

- X5 Terminal 1 phase U
- X5 Terminal 2 phase V
- X5 Terminal 3 phase W
- **If less than infinite resistance**

Replace the G5 Transmission Fluid Pump - Electric/Auxiliary.

- **If infinite resistance**

4. Replace the T6 Power Inverter Module.

Repair Instructions

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

- [Transmission Fluid Pump Removal](#) for G5 Transmission Fluid Pump - Electric/Auxiliary replacement.
- [Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P0C4F: DRIVE MOTOR 2 POSITION EXCEEDED LEARNING LIMIT

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 P0C4F

Drive Motor 2 Position Exceeded Learning Limit

Circuit/System Description

The drive motor position sensor is monitored by the drive motor control module. The motor control module monitors the angular position, speed and direction of the drive motor rotor based upon the signals of the resolver-type position sensor. The position sensor contains a drive coil, two driven coils and an irregular shaped metallic rotor. The metallic rotor is mechanically attached to the shaft of the drive motor generator. At vehicle ON, the motor control module outputs a 7 V AC, 10 kHz excitation signal to the drive coil. The drive coil excitation signal creates a magnetic field surrounding the two driven coils and the irregular shaped rotor. The motor control module then monitors the two driven coil circuits for a return signal. The position of the irregular metallic rotor causes the magnetically-induced return signals of the driven coils to vary in size and shape. A comparison of the two driven coils signals allows the motor control module to determine the exact position, speed and direction of the drive motor rotor.

A measurement called offset is needed for accurate determination of the motor position. Offset is the relationship between the position sensor and the drive motor generator output shaft. Whenever the vehicle is cycled to OFF, the motor control module attempts to learn the offset of the drive motor position sensor by rapidly oscillating the motor and observing the position sensor signals.

The control modules listed below are part of the power inverter module, often referred to as the drive motor generator power inverter module and are not serviced separately:

- Auxiliary transmission fluid pump control module
- Drive motor 1 control module
- Drive motor 2 control module
- Hybrid/EV powertrain control module 1

Conditions for Running the DTC

- The vehicle is cycled OFF.
- Offset learn has completed.

Conditions for Setting the DTC

- The position sensor offset total exceeds 30 degrees during the learning process.

OR

- The current learned value differs from the previous learned value by greater than 10 degrees.

Actions Taken When the DTC Sets

- DTC P0C4F is a Type A DTC.
- Propulsion is disabled.

Conditions for Clearing the DTC

DTC P0C4F is a Type A DTC.

Diagnostic Aids

This DTC sets when the drive motor control module is unable to learn the position of the drive motor. When this DTC sets or after replacement of a drive motor position sensor, drive motor or power inverter module, it is possible that a special wide angle learn needs to occur. This wide angle learn occurs when the drive motor control module sees a programming event on the High Speed GMLAN bus.

For intermittent appearance of DTCs:

- The drive motor position sensor circuits operate at very low current. These circuits are susceptible to moisture intrusion, corrosion and terminal damage. Extreme care must be taken when probing terminals and manipulating harnesses. Poor terminal connections can result in intermittent operation.
- If the customer comments that the problem occurs only during moist environmental conditions: rain, snow, vehicle wash, etc., inspect the sensor wiring for signs of water intrusion.
- Intermittent appearance of DTC P0A45, P0A46, P0C57, P0C58, P0C61, P0C62 or P1B04 suggests intermittent position sensor circuit or connector problems.
- Drive motor control modules 1 and 2 monitor and report their respective Drive Motor Position Sensor Offset Learn Status. This information can be observed using a scan tool. Status is updated during the transition from vehicle ON to vehicle OFF during normal conditions. Alternating or intermittent display of "Not Run," "Learn Failed Motor Speed Not Zero," and "Motor Current Incorrect" suggests intermittent position sensor circuit or connector problems.

Drive Motor 1/2 Position Sensor Offset Learn Status Parameter Descriptions

Drive Motor Position Sensor Offset Learn Status	Description	May Be Caused By
Not Run	Not run yet, waiting for key off	NA
	Aborted run due to detecting high voltage too low or motor speed too high	Key off while rolling, drive motor position sensor circuit problems or high voltage system problems
	Ran but failed due to out of range values	Resolver or drive motor problems
Learn Successful	Position offset learned and stored successfully	NA
Learn Failed Motor Speed Not Zero	Speed high during offset learn but not before	Drive motor position sensor circuit problems
Learn Failed - High Voltage Too Low	High voltage contactors opened during offset learn	High voltage system problems

Drive Motor Position Sensor Offset Learn Status	Description	May Be Caused By
Motor Current Incorrect	Low current on 3-phase circuits between power inverter module and drive motor	Drive motor or power inverter module

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

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

Electrical Information Reference

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

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P0A45, P0A46, P0C57, P0C58, P0C61, P0C62 or P1B04 is not set.
 - **If any of the DTCs are set**

Refer to [**DTC P0A45, P0A46, P0C57, P0C58, P0C61, P0C62 or P1B04.**](#)

- **If none of the DTCs are set**
3. Verify DTC P0C4F is not set.

- **If the DTC sets**

1. Perform each of the operations listed below one at a time until the fault is corrected.

NOTE:

A current DTC indicates that the Motor Control Module cannot learn the motor position. Programming any module on the High Speed GMLAN bus will initiate a Motor Control Module wide angle learn. If current T6 Power Inverter Module software is already up-to-date, then programming will not take place and the wide angle learn will not be initiated. Program a different module, such as the ECM, to initiate the wide angle learn. If necessary, the majority of modules can be forced to reprogram using the SPS Replace and Program option.

1. Program the T6 Power Inverter Module or another High Speed GMLAN module if software is already up-to-date.
2. Replace the B228B Drive Motor 2 Position Sensor and if the DTC still sets, program a module to initiate wide angle learn.

NOTE:

Check for physical damage on the position sensor and drive motor rotor and replace any damaged component first.

3. Replace the M15B Drive Motor 2 and if the DTC still sets, program a module to initiate wide angle learn.
4. Replace and program the T6 Power Inverter Module.

2. Repeat the DTC check in step 3.

- **If the DTC does not set**

4. All OK.

Repair Instructions

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

- [Drive Motor Removal - 2nd Position](#) for B228B Drive Motor 2 Position Sensor replacement or Drive Motor 2 replacement.
- [Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P0C76: HYBRID/EV BATTERY SYSTEM HIGH VOLTAGE PRESENT

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 P0C76

Hybrid/EV Battery System High Voltage Present

Circuit/System Description

The hybrid/EV battery pack contains 4 high voltage contactors and 1 solid state relay (transistor). The high voltage contactors allow the high voltage DC to be connected to the vehicle or safely contained within the hybrid/EV battery pack. The 4 high voltage contactors are 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.

Conditions for Running the DTC

High voltage contactors are commanded open.

Conditions for Setting the DTC

- The high voltage bus voltage is greater than 200 V 3.5 seconds after the contactors have been commanded open for 2 cycles.
- This diagnostic must run and fail 2 times before the fault will set.

Action Taken When the DTC Sets

DTC P0C76 is a Type A DTC.

Conditions for Clearing the DTC

- DTC P0C76 is a Type A DTC.
- The [Clear Secured High Voltage DTCs](#) reset function must be performed to prevent resetting the DTC.

Reference Information

Schematic Reference

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

Circuit/System Verification

1. Verify the contactors are operating normally.

- **If the contactors are not operating properly**

Repair as necessary.

- **If the contactors are operating properly**

2. Vehicle ON.

3. With a scan tool, perform the [Clear Secured High Voltage DTCs](#) reset function.

4. Verify DTC P0C76 is not set.

- **If the DTC is set**

Replace the T6 Power Inverter Module.

- **If the DTC is not set**

5. All OK

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P150D OR P150E: SUPPLY VOLTAGE CIRCUIT LOW VOLTAGE

Diagnostic Instructions

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

DTC Descriptor

DTC P150D

Supply Voltage Circuit 2 Low Voltage

DTC P150E

Supply Voltage Circuit 1 Low Voltage

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains three motor control modules and the hybrid/EV powertrain control module 1. Two of the motor control modules operate their respective drive motor based upon power inverter module commands. The third motor control module controls the auxiliary transmission fluid pump. The hybrid/EV powertrain control module 1 and the motor control modules share the power inverter module ignition voltage circuit, battery voltage circuits and chassis ground.

Conditions for Running the DTC

The vehicle is ON.

Conditions for Setting the DTC

P150D

Battery voltage on circuit 2 is less than 8.0 V for more than 2.5 s.

P150E

Battery voltage on circuit 1 is less than 8.0 V for more than 2.5 s.

Action Taken When the DTC Sets

DTC P150D and P150E are Type C DTCs.

Conditions for Clearing the DTC

DTC P150D and P150E are Type C DTCs.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

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

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Testing

1. Vehicle ON.
2. Verify DTC P0562 or P0563 is not set.

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

Refer to [DTC B1325, B1330, B1517, C0800, C0899, C0900, C12E1, C12E2, P0561-P0563, P1A0C, P1A0D or P1EFC](#) .

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

3. Verify DTC P150D or P150E is not set.

- **If DTC P150D is set**

1. Vehicle OFF, disconnect the X1 harness connector at the T6 Power Inverter Module.
2. Verify a test lamp illuminates between the B+ circuit terminal 41 and ground.

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

1. Remove the test lamp.
2. Test for less than 2 Ω in the B+ circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.

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

1. Remove the test lamp.
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 T6 Power Inverter Module.

- **If the test lamp illuminates**

3. Program the T6 Power Inverter Module.

4. Verify the DTC does not set.

- If the DTC sets, replace the T6 Power Inverter Module.
- If the DTC does not set

5. All OK.

• **If DTC P150E is set**

1. Vehicle OFF, disconnect the X1 harness connector at the T6 Power Inverter Module.

2. Verify a test lamp illuminates between the B+ circuit terminal 56 and ground.

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

1. Remove the test lamp.

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

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

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

1. Remove the test lamp.

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 T6 Power Inverter Module.

• **If the test lamp illuminates**

3. Program the T6 Power Inverter Module.

4. Verify the DTC does not set.

- If the DTC sets, replace the T6 Power Inverter Module.
- If the DTC does not set

5. All OK.

• **If none of the DTCs are set**

4. All OK.

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P15F0: ENGINE TORQUE DELIVERED SIGNAL MESSAGE COUNTER INCORRECT

Diagnostic Instructions

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

DTC Descriptor

DTC P15F0

Engine Torque Delivered Signal Message Counter Incorrect

Circuit/System Description

This diagnostic applies to internal microprocessor integrity conditions within the hybrid/EV powertrain control module 1. The hybrid/EV powertrain control module 1 is internal to the power inverter module, often referred to as the drive motor generator power inverter module and is not serviced separately. The hybrid/EV powertrain control module 1 monitors its ability to read and write to the memory. The hybrid/EV powertrain control module 1 processor monitors the data to verify that the indicated engine torque delivered calculation is correct.

Conditions for Running the DTC

- Vehicle is ON.
- Run/Crank is 9.5V or greater.

OR

Ignition Run/Crank is 11V or greater.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

Action Taken When the DTC Sets

- DTC P15F0 is a Type A DTC.
- The hybrid/EV powertrain control module 1 requests the hybrid powertrain control module 2 to open the high voltage contactor relays.

Conditions for Clearing the DTC

DTC P15F0 is a Type A DTC.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P15F0 is not set.
 - **If the DTC is set**
 1. Program the T6 Power Inverter Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
 3. All OK
 - **If the DTC is not set**
3. All OK

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Control Module References for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P15F1: AXLE TORQUE REQUEST SIGNAL MESSAGE COUNTER INCORRECT

Diagnostic Instructions

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

DTC Descriptor

DTC P15F1

Axle Torque Request Signal Message Counter Incorrect

Circuit/System Description

This diagnostic applies to internal microprocessor integrity conditions within the hybrid/EV powertrain control module 1. The hybrid/EV powertrain control module 1 is internal to the power inverter module, often referred to as the drive motor generator power inverter module and is not serviced separately. The hybrid/EV powertrain control module 1 monitors its ability to read and write to the memory. The hybrid/EV powertrain control module 1 processor monitors the data to verify that the indicated axle torque requested calculation is correct.

Conditions for Running the DTC

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

OR

The ignition run/crank voltage is 11V or greater.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

Action Taken When the DTC Sets

- DTC P15F1 is a Type A DTC.
- The hybrid/EV powertrain control module 1 requests the hybrid powertrain control module 2 to open the high voltage contactor relays.

Conditions for Clearing the DTC

DTC P15F1 is a Type A DTC.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P15F1 is not set.
 - **If the DTC is set**
 1. Program the T6 Power Inverter Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
 - 3. All OK
 - **If the DTC is not set**
3. All OK

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Control Module References for T6 Power Inverter Module, often referred to as Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P15FC: HYBRID/EV BATTERY CONTACTOR STATUS MESSAGE COUNTER INCORRECT

Diagnostic Instructions

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

DTC Descriptor

DTC P15FC

Hybrid/EV Battery Contactor Status Message Counter Incorrect

Circuit/System Description

This diagnostic applies to internal microprocessor integrity conditions within the hybrid/EV powertrain control module 1. The hybrid/EV powertrain control module 1 is internal to the power inverter module, often referred to as the drive motor generator power inverter module and is not serviced separately. The hybrid/EV powertrain control module 1 monitors its ability to read and write to the memory. The hybrid/EV powertrain control module 1 processor monitors the data to verify that the indicated contactor closure status is correct.

Conditions for Running the DTC

The vehicle is ON for 1 second.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

Actions Taken When the DTC Sets

- DTC P15FC is a Type A DTC.
- The hybrid/EV powertrain control module 1 requests the hybrid/EV powertrain control module 2 to open the high voltage contactor relays.

Conditions for Clearing the DTC

DTC P15FC is a Type A DTC.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P15FC is not set.
 - **If the DTC is set**
 1. Program the T6 Power Inverter Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
 3. All OK
 - **If the DTC is not set**
3. All OK

Repair Instructions

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

Control Module References for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P16E0: ENGINE PERFORMANCE - NO TORQUE DETECTED

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 P16E0

Engine Performance - No Torque Detected

Circuit/System Description

This vehicle does not use a 12V starter motor to crank the internal combustion engine. A much more powerful 360V motor located within the transmission is utilized to crank the engine. This motor, drive motor 1, can rotate the engine to operating speed within just a few hundred milliseconds. The hybrid/EV powertrain control module 1 can detect a condition where the engine is cranking but does not start or has stalled.

Conditions for Running the DTC

- The vehicle is ON.
- DTC U0100 is not set.
- Engine running.
- Fuel Level is NOT Low.
- No Fuel Level sensor DTCs set.
- Commanded engine torque is 10 N.m or greater.

Conditions for Setting the DTC

The difference between commanded engine torque and delivered engine torque is 50 N.m or greater for 3.5 seconds out of a 4 second window.

Action Taken When the DTC Sets

DTC P16E0 is a Type A DTC.

Conditions for Clearing the DTC

DTC P16E0 is a Type A DTC.

Diagnostic Aids

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

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

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

Reference Information

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

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

DTC Type Reference

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

[Circuit/System Verification](#)

1. Vehicle ON. Operate the hood release to open the hood. Depress and hold the accelerator pedal for more than 5 seconds. The engine should start and run.
2. Verify the engine starts.
 - **If the engine fails to start**
 Diagnose the engine system. Refer to [Engine Cranks But Does Not Run](#).
 - **If the engine starts**
3. All OK

[Repair Instructions](#)

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

DTC P16F3: CONTROL MODULE REDUNDANT MEMORY PERFORMANCE (HYBRID/EV POWERTRAIN CONTROL MODULE 1)

[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 P16F3

Control Module Redundant Memory Performance

[Circuit/System Description](#)

This diagnostic applies to internal microprocessor integrity conditions within the hybrid/EV powertrain control module 1. The hybrid/EV powertrain control module 1 is internal to the power inverter module, often referred to as the drive motor generator power inverter module and is not serviced separately. The hybrid/EV powertrain control module 1 monitors its ability to read and write to the memory. The hybrid/EV powertrain control module 1 processor stores identical data in two locations and compares the data to verify that the stored data is correct.

[Conditions for Running the DTC](#)

The system voltage is 11V or greater.

[Conditions for Setting the DTC](#)

The control module has detected that data identical when stored is not the same when retrieved.

[Action Taken When the DTC Sets](#)

- DTC P16F3 is a Type A DTC.
- The hybrid/EV powertrain control module 1 requests the hybrid/EV powertrain control module 2 to open the high voltage contactor relays.

[Conditions for Clearing the DTC](#)

DTC P16F3 is a Type A DTC.

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P0335 or any communication U-code DTC 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 P16F3 is not set.

- **If the DTC is set**

1. Program the T6 Power Inverter Module.
2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.

3. All OK

- **If the DTC is not set**

4. All OK

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P16F4: CONTROL MODULE TRANSMISSION RANGE SWITCH INPUT CIRCUITRY PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P16F4

Control Module Transmission Range Switch Input Circuitry Performance

Circuit/System Description

The Transmission Internal Mode Switch contains 9 separate switches in one assembly. The other 4 electronic switches are called the transmission range switches and are used to indicate the gear position the vehicle operator has selected. The Transmission Internal Mode Switch is mounted on the interior left side of the transmission case. The internal mode switch assembly is a dual sliding Hall Effect switch. The nine outputs from the switch indicate which position is selected by the transmission manual shaft. Four outputs (A, B, C, P), are range selection inputs to the transmission control module (TCM). Five outputs (R1, R2, D1, D2 and S) are direction selection inputs to the Hybrid/EV Powertrain Control Module 1, through the transmission X175 connector. The input voltage at the modules is high when the switch is open and low when the switch is closed to ground. The state of each input is displayed on the scan tool as Internal Mode Switch Range and Internal Mode Switch Direction. The Internal Mode Switch Range input parameters represented are transmission range signal A, signal B, signal C and signal P. The Internal Mode Switch Direction input parameters represented are transmission direction signal R1, signal R2, signal D1, signal

D2 and signal Start. The Transmission Internal Mode Switch indicates to the TCM which Range position the vehicle operator has selected. The Transmission Internal Mode Switch consists of 9 separate Hall Effect switches. Each Hall Effect switch is supplied a 9 V signal circuit from the TCM. Each signal circuit for each gear selector position will have either a voltage reading of 0.70-0.96 V indicting ON or 1.68-2.38 V indicating OFF. The voltage values on each Transmission Internal Mode Switch circuit will change and are dependent on the position of the gear selector. The state of each Transmission Internal Mode Switch A/B/C/P/S circuit is displayed on the scan tool.

Conditions for Running the DTC

- The vehicle is ON.
- Ignition voltage is greater than 9.5 V.

Conditions for Setting the DTC

The control module has detected the commanded transmission range state is not correct based upon internal calculations or by a comparison to input or output torque conditions.

Action Taken When the DTC Sets

- DTC P16F4 is a Type A DTC.
- Vehicle propulsion will be disabled. The hybrid/EV powertrain control module 1 requests the hybrid/EV powertrain control module 2 to open the high voltage contactor relays.

Conditions for Clearing the DTC

DTC P16F4 is a Type A DTC.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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. Verify DTC P1824, P182A-P182F, P1838-P1841, P18B5-P18BA, P18BC, P18BF, P18C0, P18C2 or P18C3 is not set.
 - **If any of the DTCs are set**
Refer to [DTC P1824, P182A-P182F, P1838 or P1839](#) .
 - **If none of the DTCs are set**
2. Verify that DTC P16F4 is not set.

- **If the DTC is set**

1. Program the T6 Power Inverter Module.
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
3. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set
4. All OK
 - **If the DTC is not set**

3. All OK

Repair Instructions

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

Control Module References for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P16F6: CONTROL MODULE TRANSMISSION RANGE CALCULATION PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P16F6

Control Module Transmission Range Calculation Performance

Circuit/System Description

This diagnostic applies to internal microprocessor integrity conditions within the hybrid/EV powertrain control module 1. The hybrid/EV powertrain control module 1 is internal to the power inverter module, often referred to as the drive motor generator power inverter module and is not serviced separately. The hybrid/EV powertrain control module 1 monitors its ability to read and write to the memory. The hybrid/EV powertrain control module 1 processor monitors the data to verify that the commanded range state calculation is correct.

Conditions for Running the DTC

- The vehicle is ON.
- The system voltage is greater than or equal to 9.5V.

OR

- Run/Crank voltage is greater than or equal to 11 V.

Conditions for Setting the DTC

The control module has detected the commanded transmission range state is not correct based upon internal calculations or by a comparison to input or output torque conditions.

Action Taken When the DTC Sets

- DTC P16F6 is a Type A DTC.
- The hybrid/EV powertrain control module 1 requests the hybrid powertrain control module 2 to open the high voltage contactor relays.

Conditions for Clearing the DTC

DTC P16F6 is a Type A DTC.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P16F6 is not set.
 - **If the DTC is set**
 1. Program the T6 Power Inverter Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
 3. All OK
 - **If the DTC is not set**
3. All OK

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Control Module References for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, setup and programming.

DTC P179A: AUXILIARY TRANSMISSION FLUID PUMP OVERSPEED

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 P179A

Auxiliary Transmission Fluid Pump Overspeed

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains two motor control modules and the hybrid/EV powertrain control module 1. The motor control modules operate their respective drive motor generator based upon drive motor generator power inverter module commands. The hybrid/EV powertrain control module 1 controls the auxiliary transmission fluid pump motor. The hybrid powertrain control module and the motor control modules share the power inverter module ignition voltage circuit, battery voltage circuits and chassis ground.

Conditions for Running the DTC

The vehicle is ON or the power inverter module is awake.

Conditions for Setting the DTC

An auxiliary transmission fluid pump motor speed of greater than 6500 RPM has been detected.

Action Taken When the DTC Sets

- DTC P179A is a Type A DTC.
- Propulsion is disabled.

Conditions for Clearing the DTC

DTC P179A is a Type A DTC.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify the transmission fluid level is correct, refer to [Transmission Fluid Level and Condition Check](#).
2. Vehicle ON.
3. Verify DTC P179A is not set.
 - **If the DTC is set**
 1. Program the T6 Power Inverter Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
 3. All OK
 - **If the DTC is not set**
4. All OK

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P181C-P181F, P183A-P183F, P184A OR P184B: INTERNAL MODE SWITCH CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P181C

Internal Mode Switch 2 R1 Circuit Low Voltage

DTC P181D

Internal Mode Switch 2 R1 Circuit High Voltage

DTC P181E

Internal Mode Switch 2 R2 Circuit Low Voltage

DTC P181F

Internal Mode Switch 2 R2 Circuit High Voltage

DTC P183A

Internal Mode Switch 2 D1 Circuit Low Voltage

DTC P183B

Internal Mode Switch 2 D1 Circuit High Voltage

DTC P183C

Internal Mode Switch 2 D2 Circuit Low Voltage

DTC P183D

Internal Mode Switch 2 D2 Circuit High Voltage

DTC P183E

Internal Mode Switch 2 Invalid Range

DTC P183F

Internal Mode Switch 1-2 Correlation

DTC P184A

Internal Mode Switch 2 S Circuit Low Voltage

DTC P184B

Internal Mode Switch 2 S Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal R1	P181C	P181D	P181D	-
Signal R2	P181E	P181F	P181F	-
Signal D1	P183A	P183B	P183B	-
Signal D2	P183C	P183D	P183D	-
Signal S	P184A	P184B	P184B	-
Low Reference	-	P183E	-	-

Circuit/System Description

The transmission internal mode switch, often referred to as the automatic transmission manual shift shaft position switch, contains two sliding hall-effect switch assemblies attached to the control valve body within the transmission. The 9 outputs from the switches indicate which position is selected by the transmission manual shaft. Four outputs (A, B, C, P) are range selection inputs to the transmission control module (TCM). Five outputs (R1, R2, D1, D2, S) are direction selection inputs to the hybrid/EV powertrain control module 1. The Range input signals are represented as TCM scan tool parameter Internal Mode Switch A/B/C/P. The Direction input signals are represented as hybrid powertrain control module scan tool parameters Internal Mode Switch 2 - R1, R2, D1, D2 and S. The input voltage at the modules is high when a switch is open and low when a switch is closed to ground. Each control module independently supplies power and ground to its respective switch assembly.

The hybrid/EV powertrain control module 1 is internal to the power inverter module, often referred to as the drive motor generator power inverter module and is not serviced separately.

Conditions for Running the DTC

- The vehicle is ON for at least 5 seconds.
- The ignition voltage is greater than 9.0 V.

Conditions for Setting the DTC

DTCs P181C, P181D, P181E, P181F, P183A, P183B, P183C, P183D, P183E, P184A and P184B

The transmission internal mode switch direction switch state does not match a selected gear for 3 seconds.

DTC P183F

The direction states for internal mode switches 1 and 2 do not match for 1.25 seconds.

Action Taken When the DTC Sets

- DTCs P181C, P181D, P181E, P181F, P183A, P183B, P183C, P183D, P183E, P184A and P184B are Type B DTCs.
- DTC P183F is a Type A DTC.
- Propulsion is disabled.

Conditions for Clearing the DTC

- DTCs P181C, P181D, P181E, P181F, P183A, P183B, P183C, P183D, P183E, P184A and P184B are Type B DTCs.
- DTC P183F is a Type A DTC.

Diagnostic Aids

The transmission internal mode switch can be damaged by electric current exceeding 25 mA. Test the transmission internal mode switch for an open condition whenever a short to voltage condition is observed.

Reference Information

Schematic Reference

- [Hybrid/EV Controls Schematics](#)
- [Automatic Transmission Controls Schematics](#)

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System Verification

1. Vehicle ON.
2. Verify the scan tool hybrid powertrain control module Internal Mode Switch 2 - D1, D2, R1, R2 and S parameters match those in the Internal Mode Switch 2 Parameters table below for each gear selector position. Record any discrepancies.
 - **If any parameter shows an incorrect state**

Refer to Circuit/System Testing.
 - **If all parameters show correct states**

Internal Mode Switch 2 Parameters

Parameter	Selector Position				
	Park	Reverse	Neutral	Drive	Manual
Internal Mode Switch 2 - D1	HIGH	HIGH	LOW	LOW	LOW
Internal Mode Switch 2 - D2	LOW	LOW	HIGH	HIGH	HIGH
Internal Mode Switch 2 - R1	HIGH	LOW	LOW	HIGH	HIGH
Internal Mode Switch 2 - R2	LOW	HIGH	HIGH	LOW	LOW
Internal Mode Switch 2 - S	LOW	HIGH	LOW	HIGH	HIGH

Circuit/System Testing

- Vehicle OFF, disconnect the X175 20-way harness connector at the transmission. Additional DTCs may set.
- Test for less than 2 Ω between the low reference circuit terminal 14 and ground.
 - If 2 Ω or greater**
 - Disconnect the X1 harness connector at the T6 Power Inverter Module.
 - Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the T6 Power Inverter Module.
 - If less than 2 Ω**
- Vehicle ON.
- Verify each scan tool hybrid powertrain control module parameter, Internal Mode Switch 2 - D1/D2/R1/R2/S, displays HIGH.
 - If any parameter displays LOW**
 - Vehicle OFF.
 - Disconnect the X1 harness connector at the T6 Power Inverter Module.
 - Test for infinite resistance between the appropriate signal circuit terminal listed below and ground:
 - Parameter D1 - terminal 40
 - Parameter D2 - terminal 53
 - Parameter R1 - terminal 38
 - Parameter R2 - terminal 39
 - Parameter S - terminal 54
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the T6 Power Inverter Module.
 - If all parameters display HIGH**
- Vehicle ON.
- Install a 3 A fused jumper wire between the low reference circuit terminal 52 and each signal terminal listed below one at a time:
 - Parameter D1 - terminal 40
 - Parameter D2 - terminal 53
 - Parameter R1 - terminal 38
 - Parameter R2 - terminal 39
 - Parameter S - terminal 54
- Verify each scan tool hybrid powertrain control module parameter, Internal Mode Switch 2 - D1/D2/R1/R2/S, displays LOW when grounded.
 - If any parameter displays HIGH when grounded**

1. Vehicle OFF.
2. Disconnect the X1 harness connector at the T6 Power Inverter Module.
3. Test for less than 2 Ω in the appropriate signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω
4. Vehicle ON.
5. 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 T6 Power Inverter Module.
- **If all parameters display LOW when grounded**
8. Refer to [Component Testing](#).

Component Testing

1. Vehicle OFF, disconnect the X175 20-way harness connector at the transmission. Additional DTCs may set.
2. Parking brake applied, transmission in PARK.
3. Test for less than 2 Ω between the low reference circuit terminal 52 and each signal circuit terminal listed below:
 - Signal D2 - Terminal 53
 - Signal R2 - Terminal 39
 - Signal S - Terminal 54
 - **If 2 Ω or greater**
 1. Disconnect the X1 harness connector at the B15 Transmission Internal Mode Switch.
 2. Test for less than 2 Ω in the low reference circuit and the appropriate signal circuit end to end.
 - If 2 Ω or greater, replace the a/trans wiring harness.
 - If less than 2 Ω , replace the B15 Transmission Internal Mode Switch.
 - **If less than 2 Ω**
4. Test for infinite resistance between the low reference circuit terminal 52 and each signal circuit terminal listed below:
 - Signal D1 - Terminal 40
 - Signal R1 - Terminal 38
 - **If less than infinite resistance**
 1. Disconnect the X1 harness connector at the B15 Transmission Internal Mode Switch.
 2. Test for infinite resistance between the low reference circuit and the signal circuit.
 - If less than infinite resistance, replace the a/trans wiring harness.
 - If infinite resistance, replace the B15 Transmission Internal Mode Switch.
 - **If infinite resistance**
5. Transmission in NEUTRAL.
6. Test for less than 2 Ω between the low reference circuit terminal 52 and each signal circuit terminal listed below:
 - Signal D1 - Terminal 40
 - Signal R1 - Terminal 38
 - **If 2 Ω or greater**
 1. Disconnect the X1 harness connector at the B15 Transmission Internal Mode Switch.
 2. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, replace the a/trans wiring harness.
 - If less than 2 Ω , replace the B15 Transmission Internal Mode Switch.
 - **If less than 2 Ω**
7. Test for infinite resistance between the low reference circuit terminal 52 and each signal circuit terminal listed below:

- Signal D2 - Terminal 53

- Signal R2 - Terminal 39

- **If less than infinite resistance**

1. Disconnect the X1 harness connector at the B15 Transmission Internal Mode Switch.
2. Test for infinite resistance between the low reference circuit and the signal circuit.
 - If less than infinite resistance, replace the a/trans wiring harness.
 - If infinite resistance, replace the B15 Transmission Internal Mode Switch.

- **If infinite resistance**

8. Transmission in REVERSE.

9. Test for infinite resistance between the low reference circuit terminal 52 and the signal S circuit terminal 54.

- **If less than infinite resistance**

1. Disconnect the X1 harness connector at the B15 Transmission Internal Mode Switch.
2. Test for infinite resistance between the low reference circuit and the signal circuit.
 - If less than infinite resistance, replace the a/trans wiring harness.
 - If infinite resistance, replace the B15 Transmission Internal Mode Switch.

- **If infinite resistance**

10. All OK.

Repair Instructions

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

- [Automatic Transmission Manual Shift Shaft Position Switch Replacement](#) for B15 Transmission Internal Mode Switch, often referred to as the manual shift shaft position switch, replacement.
- [Automatic Transmission Control Wiring Harness Replacement](#) for Automatic Transmission Wiring Harness - Shift Shaft Position Switch replacement.
- [Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P1904-P1907: DRIVE MOTOR 1 POSITION SENSOR SENSE CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P1904

Drive Motor 1 Position Sensor Sense Circuit 1 High Voltage

DTC P1905

Drive Motor 1 Position Sensor Sense Circuit 2 High Voltage

DTC P1906

Drive Motor 1 Position Sensor Sense Circuit 1 Low Voltage

DTC P1907

Drive Motor 1 Position Sensor Sense Circuit 2 Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Position Speed Direction Sensor Sense Circuit 1	P1904	-	P1905	-
Position Speed Direction Sensor Sense Circuit 2	P1906	-	P1907	-

Circuit/System Description

The drive motor 1 position sensor has 2 internal hall-effect type sensors and two signal-processing channels and is capable of sensing both speed and direction. The drive motor 1 position sensor is internal to the transmission.

The drive motor 1 position sensor receives 8.2 V on the supply voltage circuit from the hybrid control module 1. As the rotor rotates, the sensor produces a signal pulse based on the machined surface of the rotor. The electronics in the sensor combine the two channels and send a signal with a different pulse width. Motor direction and speed can be calculated by determining the order and frequency of the pulses.

The drive motor 1 position sensor is monitored by the motor 1 control module. The motor 1 control module is part of the T6 power inverter module and is not serviced separately. The drive motor 1 position sensor is part of the drive motor assembly and is not serviced separately.

Conditions for Running the DTC

P1904, P1905

Vehicle is On, Sensor circuit low side output is commanded ON.

P1906, P1907

The vehicle is ON.

Conditions for Setting the DTC

P1904, P1905

Position speed direction sensor circuit 1 is greater than 7.8 V.

P1906, P1907

Position speed direction sensor circuit 1 is less than 0.4 V.

Action Taken When the DTC Sets

- DTCs P1904, P1905, P1906 and P1907 are Type A DTCs.
- Propulsion is disabled.

Conditions for Clearing the DTC

DTCs P1904, P1905, P1906 and P1907 are Type A DTCs.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

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

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

DTC Type Reference

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

Scan Tool Reference

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

[Circuit/System Testing](#)

1. Vehicle OFF, disconnect the X175 harness connector at the transmission.

NOTE: If the a/trans wiring harness assembly circuits fail the circuit tests, replace the harness; do not repair.

2. Vehicle ON.

3. Test for 7.8-8.6 V between the circuit terminals listed below:

- Terminal 31 and 36
- Terminal 34 and 35
- **If less than 7.8 V**

1. Vehicle OFF, disconnect the X1 harness connector at the T6 Power Inverter Module.

2. Test for infinite resistance between the 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 circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the T6 Power Inverter Module.

- **If greater than 8.6 V**

1. Vehicle OFF, disconnect the X1 harness connector at the T6 Power Inverter Module, Vehicle ON.

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

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the T6 Power Inverter Module.

- **If between 7.8-8.6 V**

4. Vehicle OFF, disconnect the harness connector at the B228A Drive Motor 1 Position Sensor. Connect the X175 harness connector at the transmission. Vehicle ON.

5. Test for 7.8-8.6 V between the circuit terminals listed below:

- Terminal A and B
- Terminal C and D
 - If not between 7.8-8.6 V, replace the a/trans wiring harness assembly.
 - If between 7.8-8.6 V, replace the B228A Drive Motor 1 Position Sensor.

6. Verify DTC P0A3F, P0C52, P0C53, P0C5C or P0C5D is not set.

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

1. Program the T6 Power Inverter Module.

2. Verify the DTC does not set.

- If the DTC sets, replace the T6 Power Inverter Module.
- If the DTC does not set

3. All OK.

- If none of the DTCs are set

7. All OK.

Repair Instructions

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

- [Drive Motor Removal - 1st Position](#) for B228A Drive Motor 1 Position Sensor replacement.
- [Transmission Control Wiring Harness Removal](#) for A/Trans Wiring Harness Assembly replacement.
- [Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P190A-P190F: DRIVE MOTOR INVERTER PHASE TEMPERATURE ERRATIC

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 P190A

Drive Motor 1 Inverter Phase U Temperature Erratic

DTC P190B

Drive Motor 1 Inverter Phase V Temperature Erratic

DTC P190C

Drive Motor 1 Inverter Phase W Temperature Erratic

DTC P190D

Drive Motor 2 Inverter Phase U Temperature Erratic

DTC P190E

Drive Motor 2 Inverter Phase V Temperature Erratic

DTC P190F

Drive Motor 2 Inverter Phase W Temperature Erratic

Circuit/System Description

This is an internal fault detection of the power inverter module, often referred to as the drive motor generator power inverter module. This fault is handled inside the power inverter module and no external circuits are involved.

Conditions for Running the DTC

The vehicle is ON.

Conditions for Setting the DTC

The inverter phase temperature is intermittent.

Actions Taken When the DTC Sets

DTCs P190A-P190F are Type B DTCs.

Conditions for Clearing the DTC

DTCs P190A-P190F are Type B DTCs.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTCs P190A-P190F are not set.
 - **If any of the DTCs are set**
 1. Program the T6 Power Inverter Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set
 3. All OK.
 - **If none of the DTCs are set**
3. All OK.

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module replacement, programming and setup.

DTC P1A4F, P1A50-P1A54, P1ADC OR P1ADD: DRIVE MOTOR CONTROL MODULE MEMORY

Diagnostic Instructions

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

DTC Descriptor

DTC P1A4F

Drive Motor 1 Control Module Not Programmed

DTC P1A50

Drive Motor 1 Control Module Random Access Memory

DTC P1A51

Drive Motor 1 Control Module Read Only Memory

DTC P1A52

Drive Motor 2 Control Module Not Programmed

DTC P1A53

DTC P1A54

Drive Motor 2 Control Module Read Only Memory

DTC P1ADC

Drive Motor 1 Control Module Long Term Memory Performance

DTC P1ADD

Drive Motor 2 Control Module Long Term Memory Performance

Circuit/System Description

The drive motor control modules are internal to the power inverter module, often referred to as the drive motor generator power inverter module and are not serviced separately. This fault is handled inside the drive motor control modules and no external circuits are involved.

Conditions for Running the DTC

- The vehicle is ON.
- Ignition voltage is 8-18 V.

Conditions for Setting the DTC

The control module has detected an internal malfunction or a service module has been installed but not yet programmed.

Actions Taken When the DTC Sets

P1A4F, P1A50, P1A51, P1A52, P1A53 and P1A54

- DTCs P1A4F, P1A50, P1A51, P1A52, P1A53 and P1A54 are Type A DTCs.
- The power inverter module requests the hybrid powertrain control module 2 to open the high voltage contactor relays for any Type A DTC.

P1ADC and P1ADD

DTCs P1ADC and P1ADD are Type B DTCs.

Conditions for Clearing the DTC

- DTCs P1A4F, P1A50, P1A51, P1A52, P1A53 and P1A54 are Type A DTCs.
- DTCs P1ADC and P1ADD are Type B DTCs.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P1A4F, P1A50, P1A51, P1A52, P1A53, P1A54, P1ADC and P1ADD is not set.

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

1. Program the T6 Power Inverter Module.
2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.

3. All OK

- If none of the DTCs are set

3. All OK

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P1ADE, P1ADF, P1AE0 OR P1AE1: DRIVE MOTOR CONTROL MODULE SYSTEM VOLTAGE

Diagnostic Instructions

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

DTC Descriptor

DTC P1ADE

Drive Motor 1 Control Module System Voltage Low Voltage

DTC P1ADF

Drive Motor 1 Control Module System Voltage High Voltage

DTC P1AE0

Drive Motor 2 Control Module System Voltage Low Voltage

DTC P1AE1

Drive Motor 2 Control Module System Voltage High Voltage

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains two motor control modules and the hybrid/EV powertrain control module 1. The two motor control modules operate their respective drive motor based upon power inverter module commands. The hybrid/EV powertrain control module 1 controls the auxiliary transmission fluid pump. The hybrid/EV powertrain control module 1 and the motor control modules share the power inverter module ignition voltage circuit, battery voltage circuits and chassis ground.

Conditions for Running the DTC

The Vehicle is ON.

Conditions for Setting the DTC

DTCs P1ADE and P1AE0

Motor control module ignition-voltage is less than or equal to 10 V for 5 s.

DTCs P1ADF and P1AE1

Motor control module ignition voltage is greater than 16 V for 5 s.

Actions Taken When the DTC Sets

DTCs P1ADE, P1ADF, P1AE0 and P1AE1 are Type C DTCs.

Conditions for Clearing the DTC

DTCs P1ADE, P1ADF, P1AE0 and P1AE1 are Type C DTCs.

Diagnostic Aids

A battery charger or vehicle jump start may have set DTCs P1ADF or P1AE1.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P0562 or P0563 is not set.

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

Refer to [DTC B1325, B1330, B1517, C0800, C0899, C0900, C12E1, C12E2, P0561-P0563, P1A0C, P1A0D or P1EFC](#) .

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

3. Verify DTC P1ADE, P1ADF, P1AE0 or P1AE1 is not set.

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

1. Program the T6 Power Inverter Module.
2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.

3. All OK

- **If the DTC is not set**

4. All OK

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P1AE8, P1AE9, P1AEA OR P1AEB: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY VOLTAGE SENSE CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P1AE8

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

DTC P1AE9

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

DTC P1AEA

DTC P1AEB

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

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains two drive motor control modules. Each drive motor control module monitors its internal high voltage sensor for correct operation, no external circuits are involved. The modules listed below are part of the power inverter module and are not serviced separately.

- Hybrid/EV powertrain control module 1
- Motor control module 1
- Motor control module 2

Conditions for Running the DTC

- The vehicle is ON.
- The system voltage is 8-18 V.
- The high voltage contactor relays are closed.

Conditions for Setting the DTC**P1AE8 and P1AEA**

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

P1AE9 and P1AEB

The drive motor control module detects high voltage sensor voltage greater than 575 V.

Action Taken When the DTC Sets

DTCs P1AE8, P1AE9, P1AEA and P1AEB are Type A DTCs.

Conditions for Clearing the DTC

DTCs P1AE8, P1AE9, P1AEA and P1AEB are Type A DTCs.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions**Circuit/System Verification**

1. Vehicle ON.
2. Verify DTC P1AE8, P1AE9, P1AEA or P1AEB is not set.
 - **If any of the DTCs are set**
 1. Program the T6 Power Inverter Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
 3. All OK
 - **If none of the DTCs are set**
3. All OK

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, setup and programming.

DTC P1AEC-P1AEF: DRIVE MOTOR CONTROL MODULE 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 Descriptors

DTC P1AEC

Drive Motor 1 Control Module Hybrid/EV Battery System Voltage

DTC P1AED

Drive Motor 2 Control Module Hybrid/EV Battery System Voltage

DTC P1AEE

Drive Motor 1 Control Module Hybrid/EV Battery System Voltage High Voltage

DTC P1AEF

Drive Motor 2 Control Module Hybrid/EV Battery System Voltage High Voltage

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module contains two drive motor control modules. Each motor control module measures hybrid battery high voltage with several internal sensors. The hybrid/EV powertrain control module 2 also monitors high voltage with several internal sensors. The hybrid/EV powertrain control module 2 high voltage measurement is broadcast over serial data.

P1AEC and P1AED

The motor control modules compare the values in order to verify the hybrid battery high voltage measurement is accurate.

P1AEE and P1AEF

The motor control modules monitors for high voltage that is greater than the system allows during normal operation.

Conditions for Running the DTC

The hybrid/EV battery system contactor relays are closed.

P1AEC

DTCs P1AE8 or P1AE9 are not set.

P1AED

DTCs P1AEA or P1AEB are not set.

Conditions for Setting the DTC

P1AEC and P1AED

A difference of more than 40 V on the high voltage circuit is detected between the hybrid/EV powertrain control module 1 and the hybrid/EV powertrain control module 2 high voltage sensor.

OR

A difference of more than 50 V on the high voltage circuit is detected between the motor control module and the hybrid/EV powertrain control module 2 sum of the battery pack voltages.

P1AEE and P1AEF

Greater than 445 V on the high voltage circuit is detected by the motor control module.

Action Taken When the DTC Sets

DTCs P1AEC-P1AEF are Type A DTCs.

Conditions for Clearing the DTC

DTCs P1AEC-P1AEF are Type A DTCs.

Diagnostic Aids

Conditions such as loss of battery energy control module power or ground or removal of the high voltage manual disconnect while the vehicle was driving could create a voltage surge that may set DTCs P1AEE and P1AEF. History DTCs P1AEE and P1AEF may indicate that the high voltage contactor relays opened while large current flow was present.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P0ABB, P0ABC or P0ABD 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 P1AEC, P1AED, P1AEE or P1AEF is not set.
 - **If any of the DTCs are set**
Replace the T6 Power Inverter Module.
 - **If none of the DTCs are set**
4. All OK

Repair Instructions

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

Control Module References for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P1AEE OR P1AEF: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY SYSTEM VOLTAGE

Diagnostic Instructions

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

- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC P1AEE

Drive Motor 1 Control Module Hybrid/EV Battery System Voltage High Voltage

DTC P1AEF

Drive Motor 2 Control Module Hybrid/EV Battery System Voltage High Voltage

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module contains two drive motor control modules. Each motor control module measures hybrid battery high voltage with several internal sensors. The hybrid/EV powertrain control module 2 also monitors high voltage with several internal sensors. The hybrid/EV powertrain control module 2 high voltage measurement is broadcast over serial data.

The motor control modules monitors for high voltage that is greater than the system allows during normal operation.

Conditions for Running the DTC

- The hybrid/EV battery system contactor relays are closed.
- Ignition voltage is 8 V and no more than 18 V.

Conditions for Setting the DTC

Greater than 445 V on the high voltage circuit is detected by the motor control module.

Actions Taken When the DTC Sets

- DTCs P1AEE and P1AEF are Type A DTCs.
- Propulsion is disabled.

Conditions for Clearing the DTC

DTCs P1AEE and P1AEF are Type A DTCs.

Diagnostic Aids

Conditions such as loss of battery energy control module power or ground or removal of the high voltage manual disconnect while the vehicle was driving could create a voltage surge that may set DTCs P1AEE and P1AEF. History DTCs P1AEE and P1AEF may indicate that the high voltage contactor relays opened while large current flow was present.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P0ABB, P0ABC or P0ABD 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 P1AEE or P1AEF is not set.

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

1. Program the T6 Power Inverter Module.

2. Verify the DTC does not set.

- If the DTC sets, replace the T6 Power Inverter Module.
- If the DTC does not set.

3. All OK

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

4. All OK

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P1AF0 OR P1AF2: DRIVE MOTOR CONTROL MODULE 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 P1AF0

Drive Motor 1 Control Module Hybrid/EV Battery Voltage System Isolation Lost

DTC P1AF2

Drive Motor 2 Control Module Hybrid/EV Battery Voltage System Isolation Lost

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains two motor control modules and the hybrid/EV powertrain control module 1. The two motor control modules operate their respective drive motor based upon power inverter module commands. The hybrid/EV powertrain control module 1 controls the auxiliary transmission fluid pump. The motor control modules test for isolation between each high voltage bus and vehicle chassis whenever high voltage is present at the power inverter module.

If the motor control modules detect an isolation loss on either the positive or negative high voltage bus, the hybrid/EV powertrain control module 1 reports a fault. The isolation loss may be caused by any component in the high voltage system.

Conditions for Running the DTC

- DTCs P1AE8, P1AE9, P1AEC or are not set.
- The high voltage contactor relays are closed.
- High voltage is greater than 50 V.
- Ignition voltage is 8-18 V.

Conditions for Setting the DTC

The ratio between Negative Supply Isolation Voltage and Positive Supply Isolation Voltage is greater than 4.53 or less than 0.21 for greater than 2.5 s in a 5 s window.

Actions Taken When the DTC Sets

DTCs P1AF0 and P1AF2 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P1AF0 and P1AF2 are Type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 ON.
2. Verify DTC P0AA6 or P1AE6 is not set.
 - **If any of the DTCs are set**
Refer to **DTC P0AA6 or P1AE6** .
 - **If none of the DTCs are set**
3. Verify DTC P0A78, P0A79, P0BFD, P0BFE, P0C01 or P0C04 is not set.
 - **If any of the DTCs are set**
Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
 - **If none of the DTCs are set**
4. Verify DTC P1AF0 or P1AF2 is not set.
 - **If any of the DTCs are set**
Refer to **Loss of Isolation on the High Voltage Main Bus** .
 - **If none of the DTCs are set**
5. All OK

Repair Instructions

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

DTC P1AF4-P1AF7: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY VOLTAGE ISOLATION SENSING 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 P1AF4

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

DTC P1AF5

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

DTC P1AF6

Drive Motor 2 Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 Low Voltage

DTC P1AF7

Drive Motor 2 Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 High Voltage

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains two motor control modules and the hybrid/EV powertrain control module 1. Two of the motor control modules operate their respective drive motor based upon power inverter module commands. The hybrid/EV powertrain control module 1 controls the auxiliary transmission fluid pump. The motor control modules and the hybrid/EV powertrain control module 1 are part of the power inverter module and are not serviced separately.

The motor control modules test for isolation between each high voltage bus and vehicle chassis whenever high voltage is present at the power inverter module.

Conditions for Running the DTC

P1AF4 and P1AF6

- The Vehicle is ON.
- The hybrid/EV contactors are closed.

P1AF5 and P1AF7

The Vehicle is ON.

Conditions for Setting the DTC

P1AF4 and P1AF6

The motor control module detects Positive Supply Isolation sensor voltage less than 20 V.

P1AF5 and P1AF7

The motor control module detects the value of the Positive Supply Isolation voltage subtracted from the pack voltage is greater than 40 V.

Actions Taken When the DTC Sets

DTCs P1AF4, P1AF5, P1AF6 and P1AF7 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P1AF4, P1AF5, P1AF6 and P1AF7 are Type B DTCs.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P0AA6 is not set.
 - **If the DTC is set**
Refer to [DTC P0AA6 or P1AE6](#).
 - **If the DTC is not set**
3. Verify DTC P1AF4, P1AF5, P1AF6 or P1AF7 is not set.
 - **If any of the DTCs are set**
Refer to [Loss of Isolation on the High Voltage Main Bus](#).
 - **If none of the DTCs are set**
4. All OK

Repair Instructions

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

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

Drive Motor 1 Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 Low Voltage

DTC P1B0C

Drive Motor 1 Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 High Voltage

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains two motor control modules and the hybrid/EV powertrain control module 1. The two motor control modules operate their respective drive motor based upon power inverter module commands. The hybrid/EV powertrain control module 1 controls the auxiliary transmission fluid pump. The motor control modules and the hybrid/EV powertrain control module 1 are part of the power inverter module and are not serviced separately.

The motor control modules test for isolation between each high voltage bus and vehicle chassis whenever high voltage is present at the power inverter module.

Conditions for Running the DTC

- The vehicle is ON.
- Contactors are closed.

Conditions for Setting the DTC

P1B0B

The motor control module detects Negative Supply Isolation sensor voltage less than 20 V.

P1B0C

The motor control module detects Negative Supply Isolation sensor voltage greater than 40 V.

Actions Taken When the DTC Sets

DTCs P1B0B and P1B0C are Type B DTCs.

Conditions for Clearing the DTC

DTCs P1B0B and P1B0C are Type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 ON.
2. Verify DTC P1BOB or P1B0C is not set.

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

Refer to [Loss of Isolation on the High Voltage Main Bus](#) .

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

3. All OK

Repair Instructions

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

DTC P1B0D OR P1B0E: DRIVE MOTOR 1 CONTROL MODULE DRIVE MOTOR OVERSPEED

Diagnostic Instructions

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

DTC Descriptor

DTC P1B0D

Drive Motor 1 Control Module Drive Motor 1 Overspeed

DTC P1B0E

Drive Motor 2 Control Module Drive Motor 2 Overspeed

Circuit/System Description

The drive motor position sensor is monitored by the drive motor control module. The drive motor control module monitors the angular position, speed and direction of the drive motor based upon the signals of the resolver-type position sensor. The position sensor allows the drive motor control module to determine the exact position, speed and direction of the drive motor. The motor control modules are part of the power inverter module, often referred to as the drive motor generator power inverter module and are not serviced separately.

Conditions for Running the DTC

Vehicle is ON.

Conditions for Setting the DTC

P1B0D

Drive motor speed is greater than 12, 000 RPM.

P1B0E

Drive motor speed is greater than 13, 700 RPM.

Actions Taken When the DTC Sets

- DTCs P1B0D and P1B0E are Type A DTCs.
- The hybrid/EV powertrain control module 2 disables propulsion.

Conditions for Clearing the DTC

DTCs P1B0D and P1B0E are Type A DTCs.

Diagnostic Aids

- A transmission mechanical failure that occurs during high drive motor generator torque may cause these DTCs to set.
- Repeated drive motor operation at speeds in excess of the DTC limits may cause deterioration of the drive motor rotor magnets.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify no other Hybrid Transmission DTCs are set.

- If other Hybrid Transmission DTCs are set

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

- If no other Hybrid Transmission DTCs are set

3. Verify DTC P1B0D or P1B0E is not set.

- If any of the DTCs are set

1. Program the T6 Power Inverter Module.
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
3. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.

4. All OK

- If none of the DTCs are set

4. All OK

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P1B15: REGENERATIVE BRAKING TORQUE REQUEST SIGNAL MESSAGE COUNTER INCORRECT

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 P1B15

Regenerative Braking Torque Request Signal Message Counter Incorrect

Circuit/System Description

This diagnostic applies to internal microprocessor integrity conditions within the hybrid/EV powertrain control module 1. The hybrid/EV powertrain control module 1 is internal to the power inverter module, often referred to as the drive motor generator power inverter module and is not serviced separately. The hybrid/EV powertrain control module 1 monitors its ability to read and write to the memory. The hybrid/EV powertrain control module 1 processor monitors the data to verify that the indicated brake torque request calculation is correct.

Conditions for Running the DTC

- The vehicle is ON for 1 second.
- The Run/Crank system voltage is 9.5 V or greater

OR

The ignition/Run/Crank voltage is 11 V or greater.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

Actions Taken When the DTC Sets

- DTC P1B15 is a Type A DTC.
- The hybrid/EV powertrain control module 1 requests the hybrid/EV powertrain control module 2 to open the high voltage contactor relays.

Conditions for Clearing the DTC

DTC P1B15 is a Type A DTC.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P1B15 is not set.
 - **If the DTC is set**
 1. Program the T6 Power Inverter Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
 3. All OK
 - **If the DTC is not set**
3. All OK

Repair Instructions

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

Control Module References for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P1B41 OR P1B42: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY VOLTAGE ISOLATION SENSING PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P1B41

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

DTC P1B42

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

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains two motor control modules and the hybrid/EV powertrain control module 1. The two motor control modules operate their respective drive motor based upon power inverter module commands. The hybrid/EV powertrain control module 1 controls the auxiliary transmission fluid pump. The motor control

modules and the hybrid/EV powertrain control module 1 are part of the power inverter module and are not serviced separately.

The motor control modules test for isolation between each high voltage bus and vehicle chassis whenever high voltage is present at the power inverter module.

Conditions for Running the DTC

- The vehicle is ON.
- The high voltage contactor relays are closed.

P1B41

DTC P1AE8, P1AE9, P1B0B or P1B0C is not set.

P1B42

DTC P1AEA, P1AEB, P1B43 or P1B44 is not set.

Conditions for Setting the DTC

The difference between the Isolation Supply voltage sensed and hybrid battery voltage is greater than 50 V.

And

The difference between the Isolation Supply voltage sensed and the high voltage measured is greater than 50 V.

Actions Taken When the DTC Sets

DTCs P1B41 and P1B42 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P1B41 and P1B42 are Type B DTCs.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P1B41 or P1B42 is not set.
 - **If any of the DTCs are set**
Refer to [Loss of Isolation on the High Voltage Main Bus](#) .
 - **If none of the DTCs are set**
3. All OK

Repair Instructions

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

DTC P1B43 OR P1B44: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY VOLTAGE ISOLATION SENSING 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 P1B43

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

DTC P1B44

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

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains two motor control modules and the hybrid/EV powertrain control module 1. The two motor control modules operate their respective drive motor based upon power inverter module commands. The hybrid/EV powertrain control module 1 controls the auxiliary transmission fluid pump. The motor control modules and the hybrid/EV powertrain control module 1 are part of the power inverter module and are not serviced separately.

The motor control modules test for isolation between each high voltage bus and vehicle chassis whenever high voltage is present at the power inverter module.

Conditions for Running the DTC

- The vehicle is ON.
- The high voltage contactor relays are closed.

Conditions for Setting the DTC

P1B43

The drive motor control module detects Negative Supply Isolation sensor voltage less than 20 V for 1.5 s.

P1B44

The drive motor control module detects Negative Supply Isolation sensor voltage greater than 40 V for 1.5 s.

Actions Taken When the DTC Sets

DTCs P1B43 and P1B44 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P1B43 and P1B44 are Type B DTCs.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P1B43 or P1B44 is not set.

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

Refer to [Loss of Isolation on the High Voltage Main Bus](#) .

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

Repair Instructions

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

DTC P1E0A OR P1E0B: DRIVE MOTOR CONTROL MODULE TORQUE CALCULATION PERFORMANCE

Diagnostic Instructions

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

DTC Descriptors

DTC P1E0A

Drive Motor 1 Control Module Torque Calculation Performance

DTC P1E0B

Drive Motor 2 Control Module Torque Calculation Performance

Circuit/System Description

The motor control modules perform redundant calculations of desired and achieved torque values. These values are continuously compared and should always be the same.

Conditions for Running the DTC

Ignition voltage is 8-18V.

Conditions for Setting the DTC

The redundant torque calculation does not match the primary calculation.

Action Taken When the DTC Sets

- DTCs P1E0A and P1E0B are Type A DTCs.
- The hybrid/EV powertrain control module 1 requests the hybrid/EV powertrain control module 2 to open the high voltage contactor relays.

Conditions for Clearing the DTC

DTCs P1E0A and P1E0B are Type A DTCs.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify no transmission or motor control module DTCs are set.

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

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

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

3. Verify DTC P1E0A or P1E0B is not set.

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

1. Program the T6 Power Inverter Module.
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
3. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
4. All OK
 - **If none of the DTCs are set**

4. All OK

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P1E1B-P1E1F: AUXILIARY TRANSMISSION FLUID PUMP CONTROL MODULE HYBRID/EV BATTERY VOLTAGE ISOLATION SENSING CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P1E1B

Auxiliary Transmission Fluid Pump Control Module Hybrid/EV Battery Voltage Isolation Sensing Performance

DTC P1E1C

Auxiliary Transmission Fluid Pump Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 Low Voltage

DTC P1E1D

Auxiliary Transmission Fluid Pump Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 High Voltage

DTC P1E1E

Auxiliary Transmission Fluid Pump Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 Low Voltage

DTC P1E1F

Auxiliary Transmission Fluid Pump Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 High Voltage

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains three motor control modules and the hybrid/EV powertrain control module 1. Two of the motor control modules operate their respective drive motor based upon power inverter module commands. The third motor control module controls the auxiliary transmission fluid pump. The motor control modules and the hybrid/EV powertrain control module 1 are part of the power inverter module and are not serviced separately.

The motor control modules test for isolation between each high voltage bus and vehicle chassis whenever high voltage is present at the power inverter module.

Conditions for Running the DTC

- The vehicle is ON.
- The system voltage is at least 9 V.

Conditions for Setting the DTC

P1E1B

The motor control module detects a correlation difference between the Isolation Supply sensor and overall pack voltage.

P1E1C and P1E1E

The motor control module detects Isolation Supply sensor voltage less than 20 V.

P1E1D and P1E1F

The motor control module detects Isolation Supply sensor voltage greater than 40 V.

Action Taken When the DTC Sets

DTCs P1E1B, P1E15C, P1E1D, P1E1E and P1E1F are Type B DTCs.

Conditions for Clearing the DTC

DTCs P1E1B, P1E15C, P1E1D, P1E1E and P1E1F are Type B DTCs.

Reference Information

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P1E1B, P1E1C, P1E1D, P1E1E or P1E1F is not set.
 - **If any of the DTCs are set**

Refer to [Loss of Isolation on the High Voltage Main Bus](#) .

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

Repair Instructions

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

DTC P1E20-P1E22: AUXILIARY TRANSMISSION FLUID PUMP CONTROL MODULE HYBRID/EV BATTERY VOLTAGE SENSE CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P1E20

Auxiliary Transmission Fluid Pump Control Module Hybrid/EV Battery Voltage Sense Circuit Low Voltage

DTC P1E21

Auxiliary Transmission Fluid Pump Control Module Hybrid/EV Battery Voltage Sense Circuit High Voltage

DTC P1E22

Auxiliary Transmission Fluid Pump Control Module Hybrid/EV Battery Voltage System Isolation Lost

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains three motor control modules and the hybrid/EV powertrain control module 1. Two of the motor control modules operate their respective drive motor based upon power inverter module commands. The third motor control module controls the transmission fluid pump. Each drive motor control module monitors its internal high voltage sensor for correct operation; no external circuits are involved. The motor control modules and the hybrid/EV powertrain control module 1 are part of the power inverter module and are not serviced separately.

Conditions for Running the DTC

P1E20 or P1E21

- The vehicle is ON.
- The high voltage contactor relays are closed.

P1E22

- The controller is awake.
- DTC P1AE8, P1AE9, P1AEC is not set.

Conditions for Setting the DTC

P1E20

The drive motor control module detects high voltage sensor voltage less than 30 V.

P1E21

The drive motor control module detects high voltage sensor voltage greater than 575 V.

P1E22

The drive motor control module detects an isolation fault between the battery pack and chassis ground.

Action Taken When the DTC Sets

- DTCs P1E20 and P1E21 are Type A DTCs.
- DTC P1E22 is a Type B DTC.

Conditions for Clearing the DTC

- DTCs P1E20 and P1E21 are Type A DTCs.
- DTC P1E22 is a Type B DTC.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

P1E20 or P1E21

1. Vehicle ON.
2. Verify DTC P1E20 or P1E21 is not set.
 - **If any of the DTCs are set**
 1. Program the T6 Power Inverter Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
 3. All OK
 - **If none of the DTCs are set**
3. All OK

P1E22

1. Vehicle ON.
2. Verify DTC P1E22 is not set.
 - **If the DTC is set**

Refer to [Loss of Isolation on the High Voltage Main Bus](#) .
 - **If the DTC is not set**
3. All OK

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, also called the power inverter module, replacement, programming and setup.

DTC P1E22: AUXILIARY TRANSMISSION FLUID PUMP CONTROL MODULE HYBRID/EV BATTERY VOLTAGE SYSTEM ISOLATION LOST

Diagnostic Instructions

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

DTC Descriptors

DTC P1E22

Auxiliary Transmission Fluid Pump Control Module Hybrid/EV Battery Voltage System Isolation Lost

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains three motor control modules and the hybrid/EV powertrain control module 1. Two of the motor control modules operate their respective drive motor based upon power inverter module commands. The hybrid/EV powertrain control module 1 controls the auxiliary transmission fluid pump. Each drive motor control module monitors its internal high voltage sensor for correct operation; no external circuits are involved. The motor control modules and the hybrid/EV powertrain control module 1 are part of the power inverter module and are not serviced separately.

The motor control modules test for isolation between each high voltage bus and vehicle chassis whenever high voltage is present at the power inverter module.

Conditions for Running the DTC

- The vehicle is ON.
- The high voltage contactor relays are closed.
- DTCs P1AE8, P1AE9 or P1AEC are not set.

Conditions for Setting the DTC

The drive motor control module detects an isolation fault between the battery pack and chassis ground.

Action Taken When the DTC Sets

DTC P1E22 is a Type B DTC.

Conditions for Clearing the DTC

DTC P1E22 is a Type B DTC.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P1E22 is not set.

- **If the DTC is set**

Refer to [Loss of Isolation on the High Voltage Main Bus](#) .

- **If the DTC is not set**

3. All OK

DTC P1E27 OR P1E28: AUXILIARY TRANSMISSION FLUID PUMP CONTROL MODULE 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 Descriptors

DTC P1E27

Auxiliary Transmission Fluid Pump Control Module Hybrid/EV Battery System Voltage High Voltage

DTC P1E28

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains three motor control modules and the hybrid/EV powertrain control module 1. Two of the motor control modules operate their respective drive motor based upon power inverter module commands. The third motor control module controls the auxiliary transmission fluid pump. Each drive motor control module monitors its internal high voltage sensor for correct operation; no external circuits are involved. The motor control modules and the hybrid/EV powertrain control module 1 are part of the power inverter module and are not serviced separately.

Conditions for Running the DTC**DTC P1E27**

- The vehicle is ON.
- High voltage contactors are closed.

DTC P1E28

- The vehicle is ON.
- High voltage contactors are closed.
- DTC P1E20 or P1E21 is not set.

Conditions for Setting the DTC**DTC P1E27**

The motor control module detects High Voltage greater than 445 V.

DTC P1E28

The motor control module detects a correlation fault while comparing the mid pack and overall pack voltage during 2 different run cycles.

Action Taken When the DTC Sets

- DTC P1E27 is a Type A DTC.
- DTC P1E28 is a Type B DTC.

Conditions for Clearing the DTC

- DTC P1E27 is a Type A DTC.
- DTC P1E28 is a Type B DTC.

Diagnostic Aids

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

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions**Circuit/System Verification**

1. Vehicle ON.
2. Verify DTC P0562 is not set.
 - **If the DTC is set**

- **If the DTC is not set**
- 3. Verify DTC P1E27 or P1E28 is not set.
 - **If any of the DTCs are set**
 1. Program the T6 Power Inverter Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
 3. All OK
 - **If the DTC is not set**
- 4. All OK

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P1E29: AUXILIARY TRANSMISSION FLUID PUMP CONTROL MODULE CALCULATED MOTOR POSITION PERFORMANCE

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 P1E29

Auxiliary Transmission Fluid Pump Control Module Calculated Motor Position Performance

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains two motor control modules and the hybrid/EV powertrain control module 1. The two motor control modules operate their respective drive motor based upon power inverter module commands. The hybrid/EV powertrain control module 1 controls the auxiliary transmission fluid pump. The hybrid/EV powertrain control module 1 and the motor control modules share the power inverter module ignition voltage circuit, battery voltage circuits and chassis ground. The motor control modules and the hybrid/EV powertrain control module 1 are part of the power inverter module and are not serviced separately.

The control module uses sensorless control to estimate motor speed and position from the phase current sensors.

Conditions for Running the DTC

The vehicle is ON.

Conditions for Setting the DTC

The control module detects a fault.

Actions Taken When the DTC Sets

DTC P1E29 is a Type A DTC.

Conditions for Clearing the DTC

DTC P1E29 is a Type A DTC.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P179A, P1E20, P1E21, P1E22, P1E27, P1E28, P1E1C, P1E1D, P1E1E, P1E1F, P1E1B, P1E29, P1E34, P1E35 or P1E36 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 P1E29 is not set.
 - **If the DTC is set**
 1. Program the T6 Power Inverter Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
 3. All OK
 - **If the DTC is not set**
4. All OK

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P1E2A-P1E2F: AUXILIARY TRANSMISSION FLUID PUMP PHASE CURRENT SENSOR 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 P1E2A

Auxiliary Transmission Fluid Pump Phase U Current Sensor Circuit Low Voltage

DTC P1E2B

Auxiliary Transmission Fluid Pump Phase U Current Sensor Circuit High Voltage

DTC P1E2C

Auxiliary Transmission Fluid Pump Phase U Current Sensor Performance

DTC P1E2D

Auxiliary Transmission Fluid Pump Phase V Current Sensor Circuit Low Voltage

DTC P1E2E

Auxiliary Transmission Fluid Pump Phase V Current Sensor Circuit High Voltage

DTC P1E2F

Auxiliary Transmission Fluid Pump Phase V Current Sensor Performance

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains two motor control modules and the hybrid/EV powertrain control module 1. The two motor control modules operate their respective drive motor generator based upon power inverter module commands. The hybrid/EV powertrain control module 1 controls the auxiliary transmission fluid pump. This is an internal fault detection of the power inverter module. This fault is handled inside the power inverter module and no external circuits are involved.

Each motor control module operates its respective drive motor based upon hybrid/EV powertrain control module 1 commands. Each motor control module controls its respective motor through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. Each motor operates utilizing 3-phase alternating current AC electricity. Each insulated gate bipolar transistor operates a single phase of the drive motor generator. Each phase is individually identified as U, V and W. Each motor control module monitors the current of each phase in order to detect out of range current conditions.

Because each individual motor's phase circuits are electrically joined together, the phases normally flow about the same amount of current. The motor control module performs a mathematical calculation to verify that the phase current sensors are accurate. If the U-V-W phase current sensors indicate about the same amount of phase current, the sum of the calculation should be near zero. If the U-V-W phase currents are not similar, this DTC will set.

Conditions for Running the DTC

The vehicle is ON or the module is awake.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

Actions Taken When the DTC Sets

- DTCs P1E2A, P1E2B, P1E2C, P1E2D, P1E2E, P1E2F, are Type A DTCs.
- The power inverter module requests the hybrid/EV powertrain control module 2 to open the high voltage contactor relays.

Conditions for Clearing the DTC

DTCs P1E2A, P1E2B, P1E2C, P1E2D, P1E2E, P1E2F, are Type A DTCs.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P1E2A, P1E2B, P1E2C, P1E2D, P1E2E, P1E2F is not set.
 - **If any of the DTCs are set**
 1. Program the T6 Power Inverter Module.

2. Verify the DTC does not set.

- If the DTC sets, replace the T6 Power Inverter Module.
- If the DTC does not set.

3. All OK

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

3. All OK

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P1E34-P1E36: AUXILIARY TRANSMISSION FLUID PUMP INVERTER TEMPERATURE SENSOR 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 P1E34

Auxiliary Transmission Fluid Pump Inverter Temperature Sensor Circuit High Voltage

DTC P1E35

Auxiliary Transmission Fluid Pump Inverter Temperature Sensor Circuit Low Voltage

DTC P1E36

Auxiliary Transmission Fluid Pump Inverter Temperature Sensor Performance

Circuit/System Description

This is an internal fault detection of the power inverter module, often referred to as the drive motor generator power inverter module. This fault is handled inside the power inverter module and no external circuits are involved.

Conditions for Running the DTC

P1E34

- The vehicle is ON or the module is awake for more than 10 minutes.
- The drive motor(s) have been operating.

P1E35

The vehicle is ON or the module is awake.

P1E36

- The vehicle is ON or the module is awake after having been OFF for 9.17 hours or more.
- The inverter temperature is greater than -20°C (-4°F).
- P0AF0 and P0AEF are not present.

Conditions for Setting the DTC

P1E34

The inverter phase temperature sensor is less than -58°C (-72°F) for 3 seconds. If the fault is detected at the start of a drive cycle the DTC will set after 600 s.

P1E35

The inverter phase temperature sensor is greater than 144°C (291°F) for 6 s.

P1E36

A 10°C (18°F) difference is observed between the individual inverter phase temperature sensor and the average of the Hybrid Electronics Coolant Temperature and the Transmission Fluid Temperature.

Actions Taken When the DTC Sets

DTCs P1E34, P1E35 and P1E36 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P1E34, P1E35 and P1E36 are Type B DTCs.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P1E34, P1E35 or P1E36 is not set.
 - **If any of the DTCs are set**
 1. Program the T6 Power Inverter Module.
 2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 3. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
 - 4. All OK
 - **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 T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P1E37: AUXILIARY TRANSMISSION FLUID PUMP INVERTER HIGH TEMPERATURE

Diagnostic Instructions

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

DTC Descriptor

DTC P1E37

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains two motor control modules and the hybrid/EV powertrain control module 1. The two motor control modules operate their respective drive motor based upon power inverter module commands. The hybrid/EV powertrain control module 1 controls the auxiliary transmission fluid pump. The inverter temperature sensor is part of the power inverter module and is not serviced separately.

Conditions for Setting the DTC

The pump inverter temperature sensor is greater than 100°C (212°F).

Actions Taken When the DTC Sets

DTC P1E37 is a Type A DTC.

Conditions for Clearing the DTC

DTC P1E37 is a Type A DTC.

Diagnostic Aids

- Ask about the customer's driving habits, trailer towing, etc.
- Ensure the engine cooling system is functioning normally.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P1E36 is not set.
 - **If the DTC is set**
Refer to **DTC P1E34-P1E36**.
 - **If the DTC is not set**
3. Verify that DTC P0C11, P0C12, P0C13, P0C14, P0C15 or P0C16 is not set.
 - **If any of the DTCs are set**
Refer to **DTC P0C11-P0C16**.
 - **If none of the DTCs are set**
4. Verify DTC P1E37 is not set.
 - **If the DTC is set**
 1. Program the T6 Power Inverter Module.
 2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 3. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set.
 - **If the DTC does not set**
4. All OK

- If the DTC is not set

5. All OK

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P1E38: AUXILIARY TRANSMISSION FLUID PUMP INVERTER SUPPLY VOLTAGE 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 P1E38

Auxiliary Transmission Fluid Pump Inverter Supply Voltage Circuit

Circuit/System Description

The power inverter motor, often referred to as the drive motor generator power inverter module, contains two motor control modules and the hybrid/EV powertrain control module 1. The two motor control modules operate their respective drive motor based upon power inverter module commands. The hybrid/EV powertrain control module 1 controls the auxiliary transmission fluid pump. The hybrid/EV powertrain control module 1 and the motor control modules share the power inverter module ignition voltage circuit, battery voltage circuits and chassis ground.

Conditions for Running the DTC

Vehicle is ON or module is awake.

Conditions for Setting the DTC

The auxiliary transmission fluid pump inverter supply voltage circuit is less than 7.2 V.

Actions Taken When the DTC Sets

- DTC P1E38 is a Type A DTC.
- Propulsion is disabled.

Conditions for Clearing the DTC

DTC P1E38 is a Type A DTC.

Diagnostic Aids

To assist in troubleshooting and duplicating intermittent failure conditions, observe the Freeze Frame/Failure Records data. This is especially important to do before programming or replacing the power inverter module.

Reference Information

Schematic Reference

[Hybrid/EV Controls Schematics](#)

Connector End View Reference

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

Electrical Information Reference

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

DTC Type Reference

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

[Circuit/System Verification](#)

1. Perform the [High Voltage Disabling](#) procedure for servicing the T6 Power Inverter Module or the T12 Transmission.

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.

2. Disconnect the X5 harness connector at the T6 Power Inverter Module.
3. Test for infinite resistance between each of the AC circuit terminals listed below and ground for each phase of the G5 Transmission Fluid Pump - Electric/Auxiliary:
 - X5 terminal 1 phase U
 - X5 terminal 2 phase V
 - X5 terminal 3 phase W
 - **If less than infinite resistance**
 1. Disconnect the harness connector at the G5 Transmission Fluid Pump - Electric/Auxiliary.
 2. Test for infinite resistance between each of the AC circuit terminals listed below and ground for each phase of the G5 Transmission Fluid Pump - Electric/Auxiliary:
 - X5 terminal 1 phase U
 - X5 terminal 2 phase V
 - X5 terminal 3 phase W
 - If less than infinite resistance

Replace the Drive Motor Power Inverter Module 3-Phase Cable.
 - If infinite resistance
 - 3. Replace the G5 Transmission Fluid Pump - Electric/Auxiliary.
 - **If infinite resistance**
4. Verify DTC P1E38 does not set.
 - **If the DTC sets**
 1. Perform each of the operations listed below one at a time until the fault is corrected.

1. Program the T6 Power Inverter Module.
 2. Replace the T6 Power Inverter Module.
 3. Replace the G5 Transmission Fluid Pump - Electric/Auxiliary.
2. Repeat the DTC check.
 - **If the DTC does not set**
5. All OK.

Repair Instructions

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

- [Drive Motor Power Inverter Module 3 Phase Cable Replacement](#)
- [Transmission Fluid Pump Removal](#) for G5 Transmission Fluid Pump - Electric/Auxiliary replacement.
- [Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P1E39: AUXILIARY TRANSMISSION FLUID PUMP INVERTER PERFORMANCE

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 P1E39

Auxiliary Transmission Fluid Pump Inverter Performance

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains two motor control modules and the hybrid/EV powertrain control module 1. The two motor control modules operate their respective drive motor based upon power inverter module commands. The hybrid/EV powertrain control module 1 controls the auxiliary transmission fluid pump. Each motor control module controls its respective motor through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. Each insulated gate bipolar transistor assembly is monitored for fault conditions.

Conditions for Running the DTC

Vehicle is ON or Charge Mode is active.

Conditions for Setting the DTC

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

Actions Taken When the DTC Sets

- DTC P1E39 is a Type A DTC.
- Propulsion is disabled.

Conditions for Clearing the DTC

DTC P1E39 is a Type A DTC.

Diagnostic Aids

To assist in troubleshooting and duplicating intermittent failure conditions, observe the Freeze Frame/Failure Records data. This is especially important to do before programming or replacing the power inverter module.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

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

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Perform the [High Voltage Disabling](#) procedure for servicing the T6 Power Inverter Module or the T12 Transmission.

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.

2. Disconnect the X5 harness connector at the T6 Power Inverter Module.
3. Test for infinite resistance between each of the AC circuit terminals listed below and ground for each phase of the G5 Transmission Fluid Pump - Electric/Auxiliary:
 - Terminal 1 phase U
 - Terminal 2 phase V
 - Terminal 3 phase W
 - **If less than infinite resistance**
 1. Disconnect the harness connector at the G5 Transmission Fluid Pump - Electric/Auxiliary.
 2. Test for infinite resistance between each of the AC circuit terminals listed below and ground for each phase of the G5 Transmission Fluid Pump - Electric/Auxiliary:
 - X5 terminal 1 phase U
 - X5 terminal 2 phase V
 - X5 terminal 3 phase W

- If less than infinite resistance

Replace the Drive Motor Power Inverter Module 3-Phase Cable.

- If infinite resistance
3. Replace the G5 Transmission Fluid Pump - Electric/Auxiliary.
 - **If infinite resistance**
 4. Verify DTC P1E39 does not set.
 - **If the DTC sets**
 1. Perform each of the operations listed below one at a time until the fault is corrected.
 1. Program the T6 Power Inverter Module.
 2. Replace the T6 Power Inverter Module.
 3. Replace the G5 Transmission Fluid Pump - Electric/Auxiliary.
 2. Repeat the DTC check.
 - **If the DTC does not set**
 5. All OK

Repair Instructions

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

- [Drive Motor Power Inverter Module 3 Phase Cable Replacement](#)
- [Transmission Fluid Pump Removal](#) for G5 Transmission Fluid Pump - Electric/Auxiliary replacement.
- [Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P1E3A: AUXILIARY TRANSMISSION FLUID PUMP MOTOR TORQUE DELIVERED PERFORMANCE

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 P1E3A

Auxiliary Transmission Fluid Pump Motor Torque Delivered Performance

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains two motor control modules and the hybrid/EV powertrain control module 1. The two motor control modules operate their respective drive motor based upon power inverter module commands. The hybrid/EV powertrain control module 1 controls the auxiliary transmission fluid pump. The hybrid/EV powertrain control module 1 and the motor control modules share the power inverter module ignition voltage circuit, battery voltage circuits and chassis ground.

Conditions for Running the DTC

- The vehicle is ON.
- The system voltage is between 11.0-16.0 V.
- Auxiliary transmission fluid pump torque command is greater than 6.8 N.m (60 lb in).

Conditions for Setting the DTC

The actual auxiliary transmission fluid pump speed is more than 200 RPM different from the commanded speed.

Actions Taken When the DTC Sets

- DTC P1E3A is a Type A DTC.
- Propulsion is disabled.

Conditions for Clearing the DTC

DTC P1E3A is a Type A DTC.

Diagnostic Aids

There should always be other hybrid/EV powertrain or motor control module DTCs set along with DTC P1E3A. Always diagnose other DTCs before addressing this DTC.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify that no other hybrid/EV powertrain or motor control module DTC is set.
 - **If any of the DTCs are set**
Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
 - **If none of the DTCs are set**
 2. Verify DTC P1E3A is not set.
 - **If the DTC is set**
 1. Program the T6 Power Inverter Module.
 2. Verify the DTC does not set.
 - If the DTC sets.
 1. Replace the G5 Automatic Transmission Fluid Pump and the 3 phase cable.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the T6 Power Inverter Module.
 - If the DTC does not set
 - 3. All OK
 - If the DTC is not set.
 - 3. All OK
- **If the DTC is not set**
3. All OK

Repair Instructions

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

- **Transmission Fluid Pump Replacement** for G5 Automatic Transmission Fluid Pump, often referred to as the A/Trans Fluid Pump Motor, replacement
- **Control Module References** for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P1E4B: CONTROL MODULE REDUNDANT DRIVE MOTOR 2 SPEED SENSING 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 P1E4B

Control Module Redundant Drive Motor 2 Speed Sensing Circuit

Circuit/System Description

The drive motor position sensor is monitored by the motor control module. The motor control module monitors the angular position, speed and direction of the drive motor based upon the signals of the resolver-type position sensor. The position sensor allows the motor control module to determine the exact position, speed and direction of the drive motor. The hybrid/EV powertrain control module 1 also calculates motor speed. This fault is handled inside the power inverter module, often referred to as the drive motor generator power inverter module and no external circuits are involved.

Conditions for Running the DTC

- This diagnostic runs one time at vehicle ON.
- System voltage is greater than 11 V.
- No serial data communication faults.

Conditions for Setting the DTC

The calculated motor speed is greater than 400 RPM different from the measured speed for 3 s within a 5 s window.

Actions Taken When the DTC Sets

- DTC P1E4B is a Type A DTC.
- Propulsion will be disabled.

Conditions for Clearing the DTC

DTC P1E4B is a Type A DTC.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle ON.
2. Verify DTC P0562 or P0563 is not set.

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

Refer to [DTC B1325, B1330, B1517, C0800, C0899, C0900, C12E1, C12E2, P0561-P0563, P1A0C, P1A0D or P1EFC](#) .

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

3. Verify DTC P1E4B is not set.

- **If the DTC is set**

1. Program the T6 Power Inverter Module.

2. Verify the DTC does not set.

- If the DTC sets, replace the T6 Power Inverter Module.

- If the DTC does not set
3. All OK.
 - **If the DTC is not set**
 4. All OK.

Repair Instructions

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

[Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

DTC P2797: AUXILIARY TRANSMISSION FLUID PUMP PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P2797

Auxiliary Transmission Fluid Pump Performance

Circuit/System Description

The power inverter module, often referred to as the drive motor generator power inverter module, contains two motor control modules and the hybrid/EV powertrain control module 1. Two of the motor control modules operate their respective drive motor based upon power inverter module commands. The hybrid/EV powertrain control module 1 controls the auxiliary transmission fluid pump. The hybrid/EV powertrain control module 1 and the motor control modules share the power inverter module ignition voltage circuit, battery voltage circuits and chassis ground.

Conditions for Running the DTC

- The vehicle is ON.
- Run/crank voltage is greater than 6 V.
- Auxiliary transmission fluid pump speed is greater than 10 RPM.

Conditions for Setting the DTC

The actual auxiliary transmission fluid pump speed is not within a calibrated threshold of the commanded speed.

Action Taken When the DTC Sets

- DTC P2797 is a Type A DTC.
- The power inverter module requests the hybrid powertrain control module 2 to open the high voltage contactor relays.

Conditions for Clearing the DTC

DTC P2797 is a Type A DTC.

Diagnostic Aids

- There should always be other hybrid/EV powertrain or motor control module DTCs set along with DTC P2797. Always diagnose other DTCs before addressing this DTC.
- This DTC may set if the vehicle is run out of fuel while driving.
- This DTC may be set if the high voltage contactors open while the Auxiliary Transmission Fluid Pump has been commanded on using the Scan Tool.

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify that no other hybrid/EV powertrain or motor control module DTC is set.

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

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

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

2. Verify DTC P2797 is not set.

- **If the DTC is set**

1. Program the T6 Power Inverter Module.

2. Verify the DTC does not set.

- If the DTC sets.

1. Replace the G5 Transmission Fluid Pump - Electric/Auxiliary and the 3 phase cable.

2. Verify the DTC does not set.

- If the DTC sets, replace the T6 Power Inverter Module.

- **If the DTC is not set**

3. All OK.

Repair Instructions

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

- [Transmission Fluid Pump Replacement](#) G5 Transmission Fluid Pump - Electric/Auxiliary, often referred to as the A/Trans Aux Fluid Pump Motor, replacement
- [Control Module References](#) for T6 Power Inverter Module, often referred to as the Drive Motor Generator Power Inverter Module, replacement, programming and setup.

SYMPTOMS - HYBRID CONTROLS

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

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

Refer to the following procedures:

- [Drive Motor Power Inverter Module Description and Operation](#)
- [High Voltage Monitoring Systems Description](#)
- [Hybrid Modes of Operation Description](#)
- [Drive Motor Battery System Description](#)
- [Transmission General Description](#)

Visual/Physical Inspection

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

Intermittent

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

Symptom List

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

- [DC Power Conversion Test](#)
- [Drive Mode Select Switch Malfunction](#)

DRIVE MODE SELECT SWITCH MALFUNCTION

Diagnostic Instructions

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	Stuck in Normal Mode	Stuck in Normal Mode	-	-
Ground	-	Stuck in Normal Mode	-	-

Circuit/System Description

The body control module (BCM) monitors the state of the drive mode select switch. The BCM sends the drive mode select switch signal message to the ECM over the serial data circuits. The ECM uses this message to determine the following driver selected mode of operation:

- Tour
- Sport
- Hold

Diagnostic Aids

- Under normal operation, when the DRIVE MODE button is pressed, the drive mode select switch closes and the scan tool BCM Drive Mode Select Switch parameter displays Active. When the DRIVE MODE button is released, the switch opens, the parameter displays Inactive and the driver information center display is updated.
- When attempting to run or set ECM serial data DTCs, run the vehicle in propulsion system active mode for at least 1 minute and then shut the vehicle off for 30 seconds. Following this procedure will allow for a complete ECM shutdown.

Reference Information

Schematic Reference

[Automatic Transmission Controls Schematics](#)

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX](#)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)

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

Scan Tool Reference

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

Circuit/System Verification

1. Vehicle On.
2. Verify the scan tool BCM Drive Mode Select Switch parameter displays Inactive when DRIVE MODE button is not pressed and Active when pressed and held.
 - **If the BCM Drive Mode Select Switch parameter does not indicate the correct status**
Refer to Circuit/System Testing.
 - **If the BCM Drive Mode Select Switch parameter indicates the correct status**
3. All OK.

Circuit/System Testing

1. Vehicle OFF and all vehicle systems OFF, disconnect the harness connector at the S48E Multifunction Switch-Instrument Panel. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 2 and ground
 - **If 10 Ω or greater**
 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**
3. Vehicle ON.
4. Verify the scan tool BCM Drive Mode Select Switch parameter displays Inactive.
 - **If the parameter does not display Inactive**
 1. Vehicle in Service Mode.
 2. Test for 4.8-5.2 V between the 5 V reference circuit terminal 6 and ground.
 - If less than 4.8 V
 1. Vehicle OFF, disconnect the harness connector at the K20 engine control module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 engine control module.
 - If greater than 5.2 V
 1. Vehicle OFF, disconnect the harness connector at the K20 engine control module, vehicle in Service Mode.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 engine control module.
 - If between 4.8-5.2 V
5. Verify the scan tool BCM Drive Mode Select Switch parameter displays Inactive.
 - **If the parameter does not display Inactive**
 1. Vehicle in Service Mode. Disconnect the harness connector at the K20 engine control module.

2. Test for less than 1 V between the signal circuit terminal 66 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 engine control module.
- **If less than 0.2 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 66 and the 5 V reference circuit terminal 46.
7. Verify the scan tool BCM Drive Mode Select Switch parameter displays Active.
 - **If the parameter displays Inactive**
 1. Vehicle OFF, disconnect the harness connector at the K20 engine control module.
 2. Test for infinite resistance between the signal circuit terminal and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 engine control module.
 - **If greater than 4.8 V**
8. Replace the S48E Multifunction Switch-Instrument Panel.

Component Testing

1. Vehicle OFF, disconnect the harness connector at the S48E Multifunction Switch.
2. Test for infinite resistance between the signal terminal 5 and the ground terminal 2 with the switch in the open position.
 - **If less than infinite resistance**

Replace the S48E Multifunction Switch.
 - **If infinite resistance**
3. Test for less than 2 Ω between the signal terminal 5 and the ground terminal 2 with the switch in the closed position.
 - **If 2 Ω or greater**

Replace the S48E Multifunction Switch.
 - **If less than 2 Ω**
4. All OK.

Repair Instructions

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

- [Front Floor Console Trim Plate Replacement](#) for S48E Multifunction Switch replacement.
- [Control Module References](#) for K9 Body Control Module replacement, programming and setup.

DC POWER CONVERSION TEST

Diagnostic Instructions

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

Circuit/System Description

The 14 V power module, often referred to as the accessory DC power control module, supplies the energy that flows between the high voltage (360 V) direct current (DC) and low voltage (14 V) DC to charge the 12 V battery and to operate the power accessories. The ECM controls the 14 V power module by supplying

5 V pulse width modulated (PWM) signal through a control circuit. The 14 V power module sends 5 V PWM feedback signal to the ECM through the feedback circuit. The 14 V power module generates more power as the commanded duty cycle increases.

Diagnostic Aids

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

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Accessory DC Power Control Module Description and Operation

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Vehicle OFF.
2. Measure and record the C1 battery voltage at the C1 battery terminals. The C1 battery voltage should stabilize between 12.4 and 12.8 V within a few minutes of turning the vehicle OFF.
 - **If not within the specified range**
Refer to Battery Inspection/Test.
 - **If within the specified range**
3. Vehicle ON, accessories OFF.
4. Measure and record the C1 battery voltage at the C1 battery terminals. The voltage should be at least 1 V greater than the voltage measured in step 1 but less than 15.6 V.
 - **If not within the specified range**
Refer to Circuit/System Testing.
 - **If within the specified range**
5. All OK.

Circuit/System Testing

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

With Carbon Pile Tester

1. Vehicle ON.

2. Verify that no K1 14 V Power Module or B18 Battery Current Sensor DTCs are set that would cause a charging system concern.

- **If an applicable DTC is set**

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

- **If no applicable DTCs are set**

3. Vehicle OFF.

4. Test for 12.4 V or greater at room temperature across the C1 Battery terminals.

- **If not within the specified range**

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

- **If within the specified range**

5. Connect a carbon pile tester to the C1 Battery.

6. Vehicle ON, turn all accessories off. Observe the voltage reading on the tester. The voltage should read between 12.6-15.5 V.

7. Adjust the carbon pile tester so that the Low - Voltage Battery Current parameter on the 14 V Power Module data list of the Engine Control Module is reading 160 amps.

8. Verify the voltage reading remains between 12.6-15.5 V.

- **If not within the specified range**

Replace the K1 14 V Power Module.

- **If within the specified range**

9. All OK.

Without Carbon Pile Tester

1. Vehicle ON.

2. Verify that no K1 14 V Power Module or B18 Battery Current Sensor DTCs are set that would cause a charging system concern.

- **If an applicable DTC is set**

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

- **If no applicable DTCs are set**

3. Vehicle OFF.

4. Test for 12.4 V or greater at room temperature across the C1 Battery terminals.

- **If not within the specified range**

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

- **If within the specified range**

5. Vehicle ON.

6. Verify the scan tool Engine Control Module Ignition 1 Signal parameter continually increases when controlling the Engine Control Module 14 V Power Module Setpoint from 10-80% with a scan tool. It may take up to 10 s for the battery voltage to stabilize between each setpoint change.

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

Replace the K1 14 V Power Module.

- **If the battery voltage continually increases**

7. All OK.

Repair Instructions

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

REPAIR INSTRUCTIONS

DRIVE MOTOR POWER INVERTER MODULE 3 PHASE 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. Air Inlet Grille Panel (2) Remove - [Air Inlet Grille Panel Replacement](#)

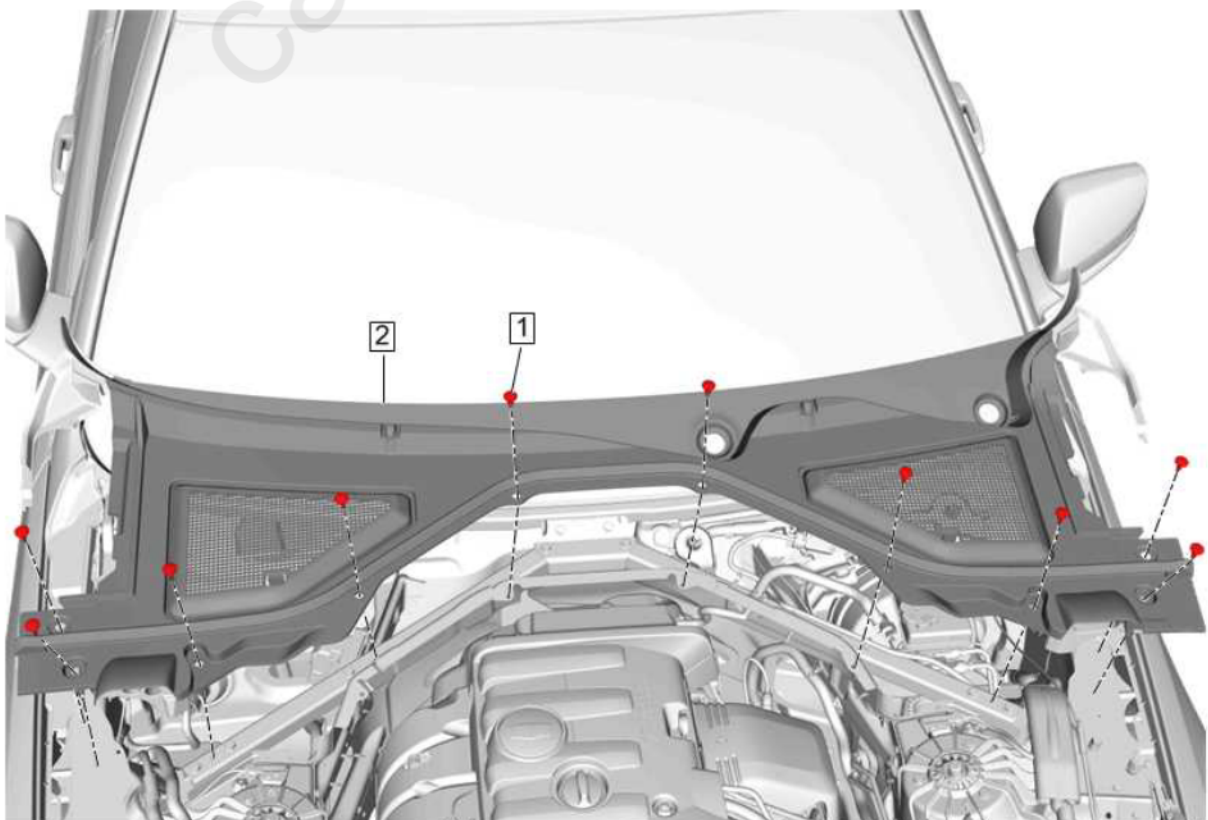


Fig. 6: Air Inlet Grille Panel

Courtesy of GENERAL MOTORS COMPANY

3. High Voltage Cable Connector Cover Bolt (1)» Remove [4x]

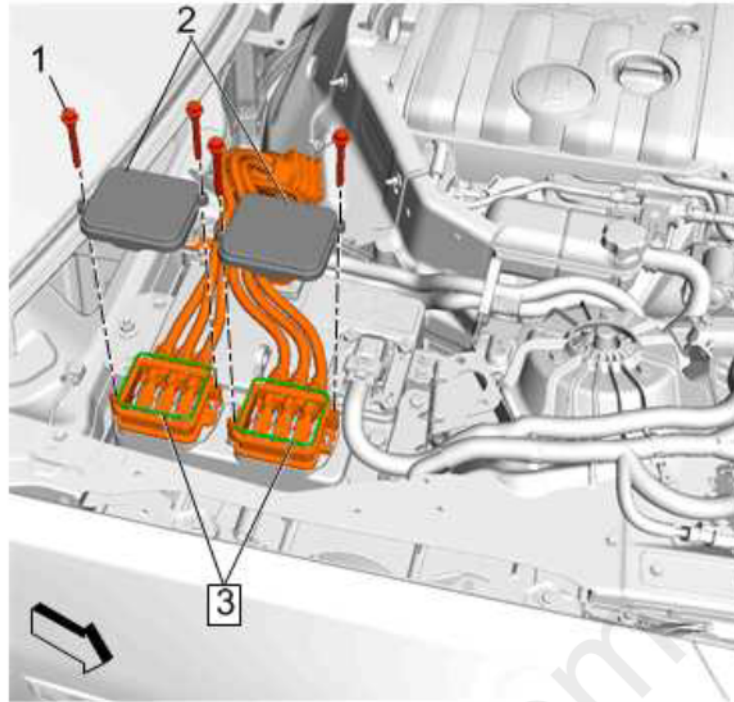


Fig. 7: High Voltage Cable Connector Cover, Bolts And Seals

Courtesy of GENERAL MOTORS COMPANY

4. High Voltage Cable Connector Cover (2)» Remove [2x]
5. High Voltage Cable Connector Cover Seal (3)» DISCARD the seal. [2x]
6. High Voltage Terminal Bolt (1)» Remove [6x]

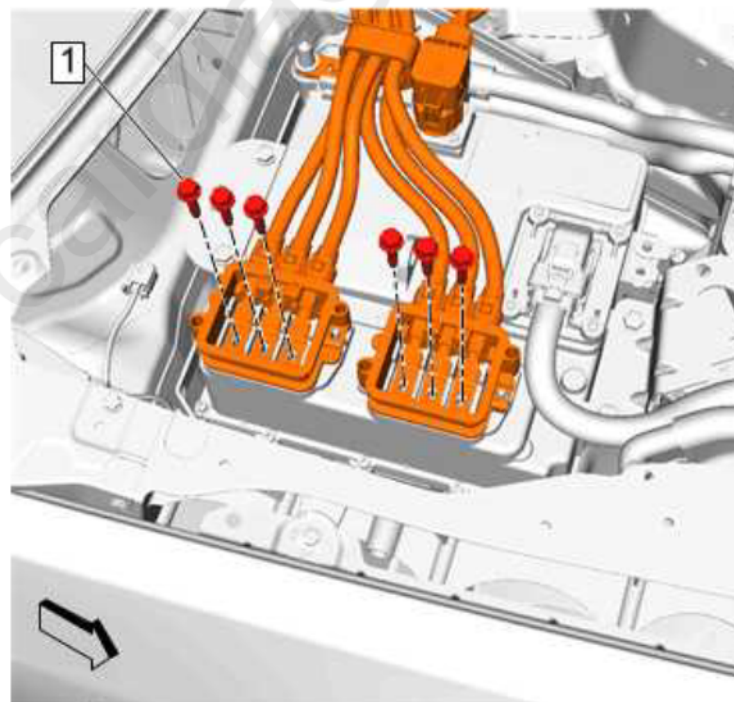


Fig. 8: High Voltage Terminal Bolts

Courtesy of GENERAL MOTORS COMPANY

7. Protective Terminal Cover (2)» Remove

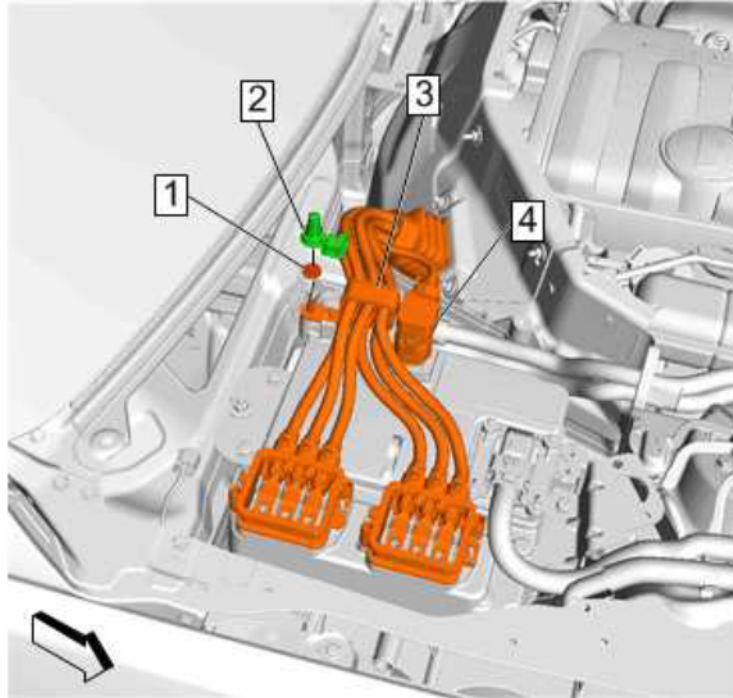


Fig. 9: Protective Terminal Cover

Courtesy of GENERAL MOTORS COMPANY

8. Cable Retainer Nut (1)» Remove
9. Drive Motor Power Inverter Module Connector (4)» Disconnect
10. Drive Motor Power Inverter Module 3-Phase Cable (3)» Remove
11. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#)
12. Support the transmission with a suitable jack.
13. Transmission Support Crossmember» Remove - [Transmission Support Crossmember Replacement \(LTG\)](#)
14. Lower the transmission 40mm to access the high voltage cable covers.
15. Drive Motor Power Inverter Module 3-Phase Cable (4, 5)» Remove - [Transmission Replacement](#)

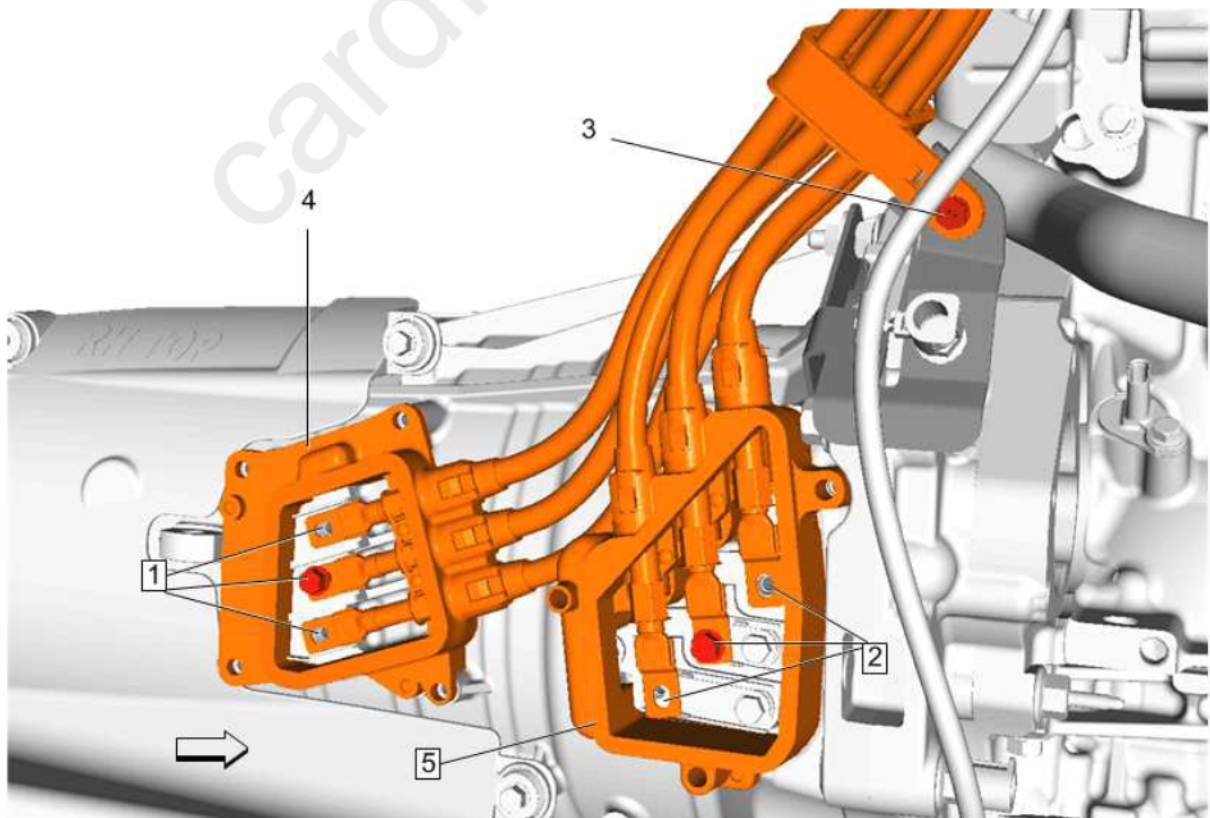


Fig. 10: High Voltage Cable Connector Bolts

Courtesy of GENERAL MOTORS COMPANY

16. Cable Retainer Fastener (1)» Remove

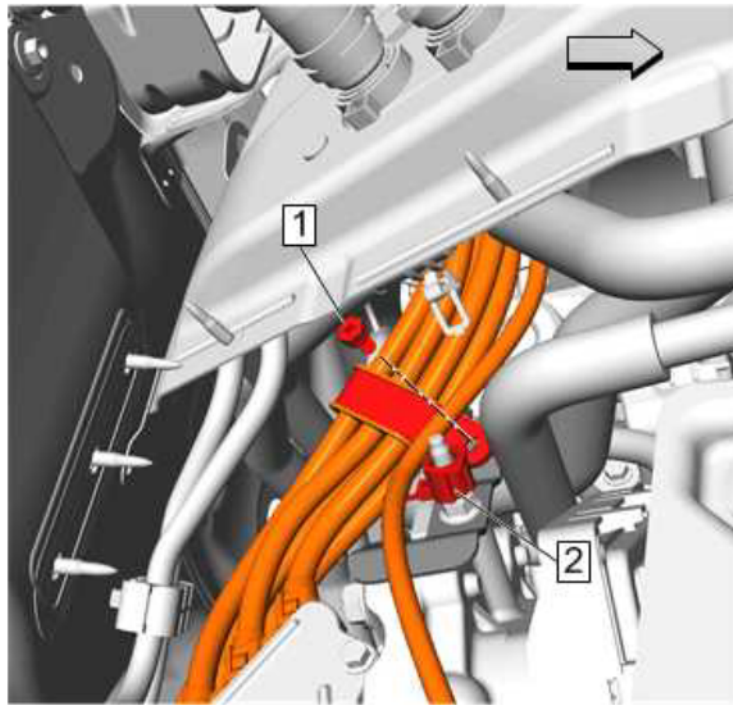


Fig. 11: Cable Retainer Fastener

Courtesy of GENERAL MOTORS COMPANY

17. Retainer (2)» Disengage

18. Electrical Connector (1)» Disconnect

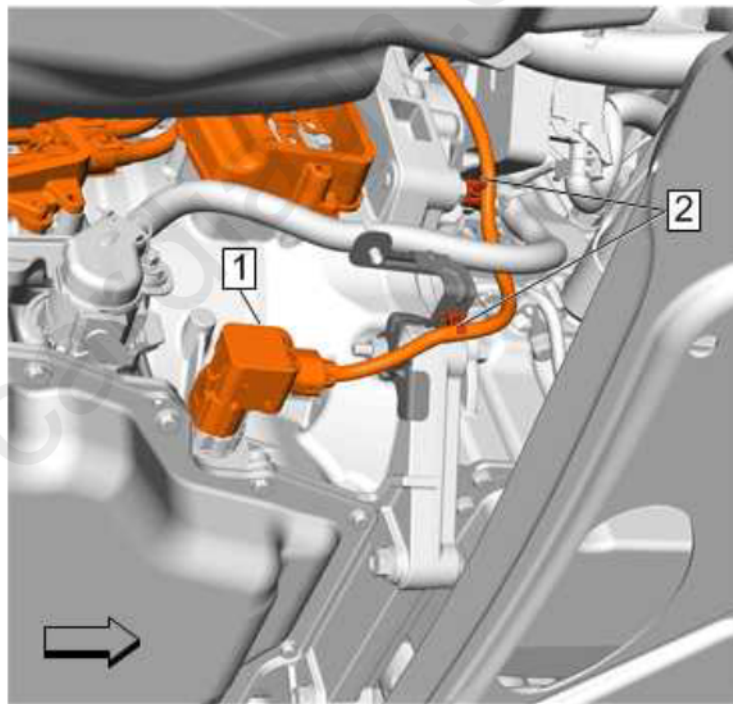


Fig. 12: Electrical Connector and Retainers

Courtesy of GENERAL MOTORS COMPANY

19. Retainer (2)» Disengage [2x]

20. Lower the vehicle.

21. Front Wheelhouse Panel Brace Nut (1)» Remove [4x]

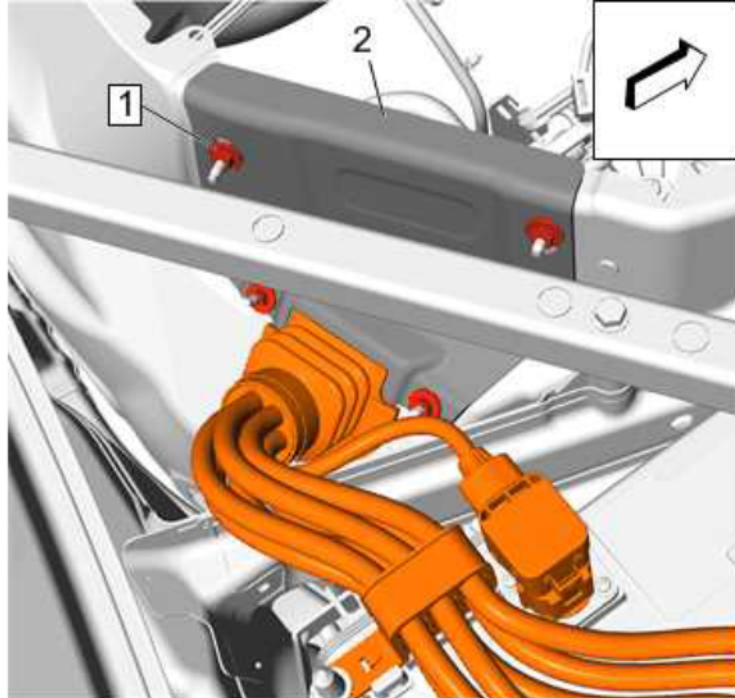


Fig. 13: Front Wheelhouse Panel Brace Nuts

Courtesy of GENERAL MOTORS COMPANY

22. Front Wheelhouse Panel Brace (2)» Remove
23. Drive Motor Power Inverter Module 3-Phase Cable (1)» Remove

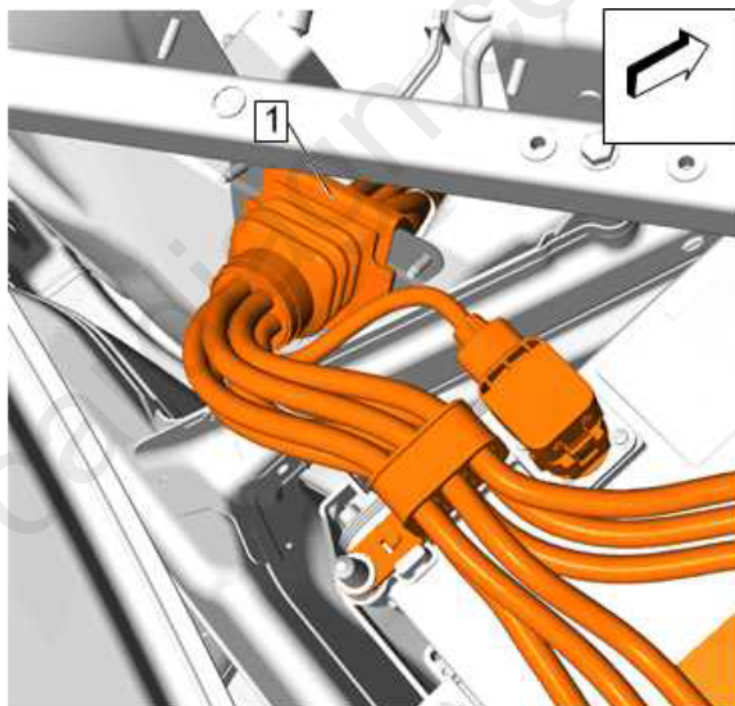


Fig. 14: Drive Motor Power Inverter Module 3-Phase Cable

Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

1. Drive Motor Power Inverter Module 3-Phase Cable (1)» Install

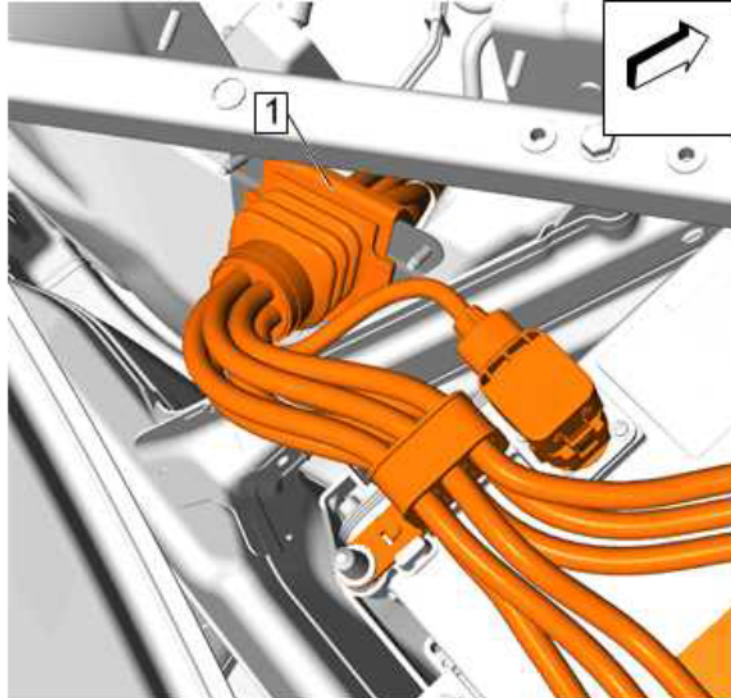


Fig. 15: Drive Motor Power Inverter Module 3-Phase Cable
 Courtesy of GENERAL MOTORS COMPANY

2. Front Wheelhouse Panel Brace (2)» Install

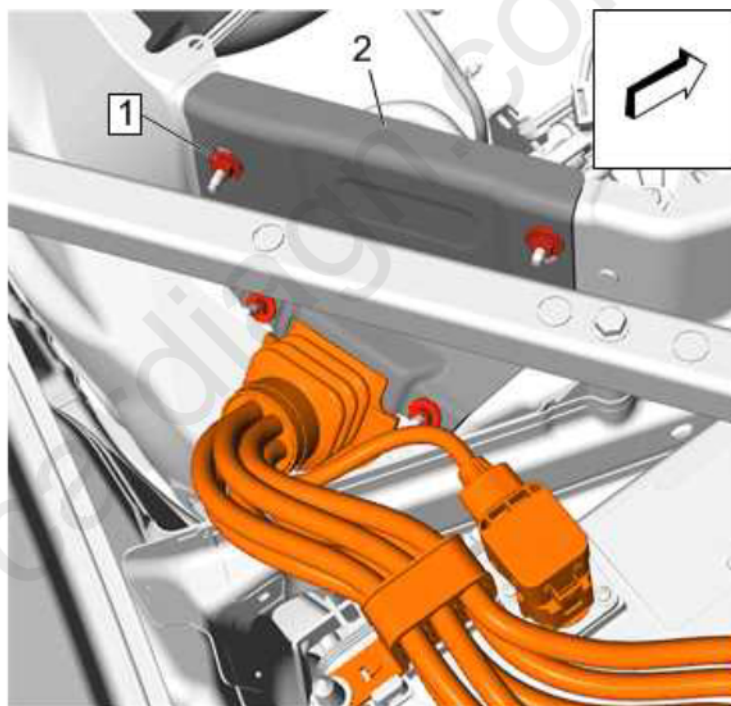


Fig. 16: Front Wheelhouse Panel Brace Nuts
 Courtesy of GENERAL MOTORS COMPANY

3. Front Wheelhouse Panel Brace Nut (1)» Install and tighten [4x] 9 N.m (80 lb in)

CAUTION: Refer to **Fastener Caution**

4. Drive Motor Power Inverter Module 3-Phase Cable (3)» Install

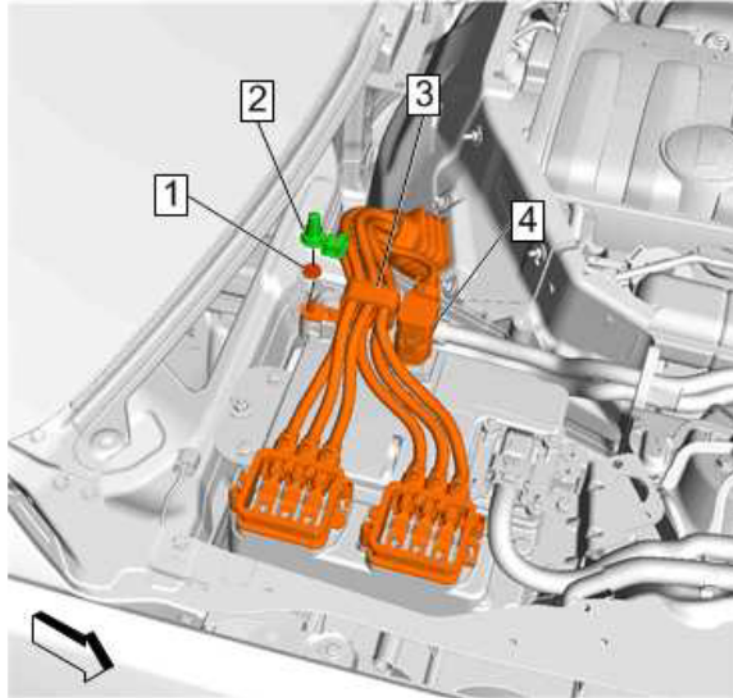


Fig. 17: Protective Terminal Cover

Courtesy of GENERAL MOTORS COMPANY

5. Cable Retainer Nut (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)

6. Protective Terminal Cover (2) » Install

7. Drive Motor Power Inverter Module Connector (4) » Connect

8. High Voltage Terminal Bolt (1) » Hand tighten [6x]

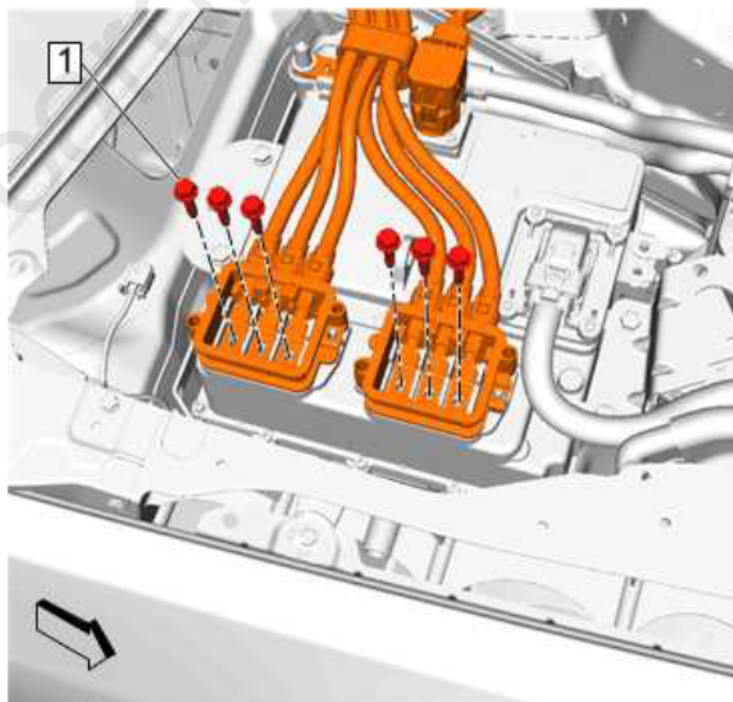


Fig. 18: High Voltage Terminal Bolts

Courtesy of GENERAL MOTORS COMPANY

NOTE: Critical high voltage fastener. Perform second torque verification check following re-assembly.

9. High Voltage Terminal Bolt (1)» Tighten [6x]
- First Pass: 9 N.m (80 lb in)
 - Final Pass: 9 N.m (80 lb in)
10. High Voltage Cable Connector Cover Seal (3)» Install NEW Seal [2x]

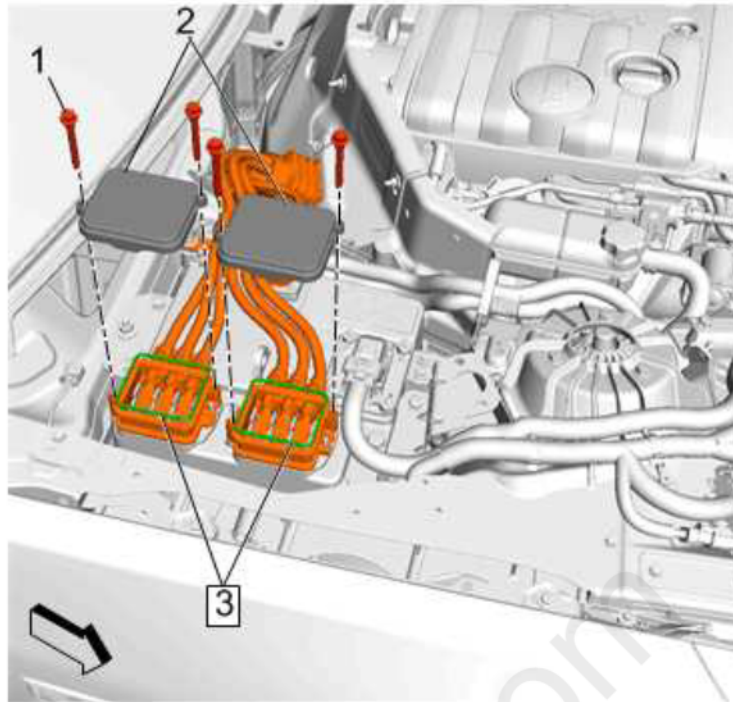


Fig. 19: High Voltage Cable Connector Cover, Bolts And Seals
Courtesy of GENERAL MOTORS COMPANY

NOTE: Make sure the seal does not roll out of channel when installing NEW seal.

11. High Voltage Cable Connector Cover (2)» Install [2x]
12. High Voltage Cable Connector Cover Bolt (1)» Install and tighten [4x]

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)

13. Air Inlet Grille Panel (2)» Install - [Air Inlet Grille Panel Replacement](#)

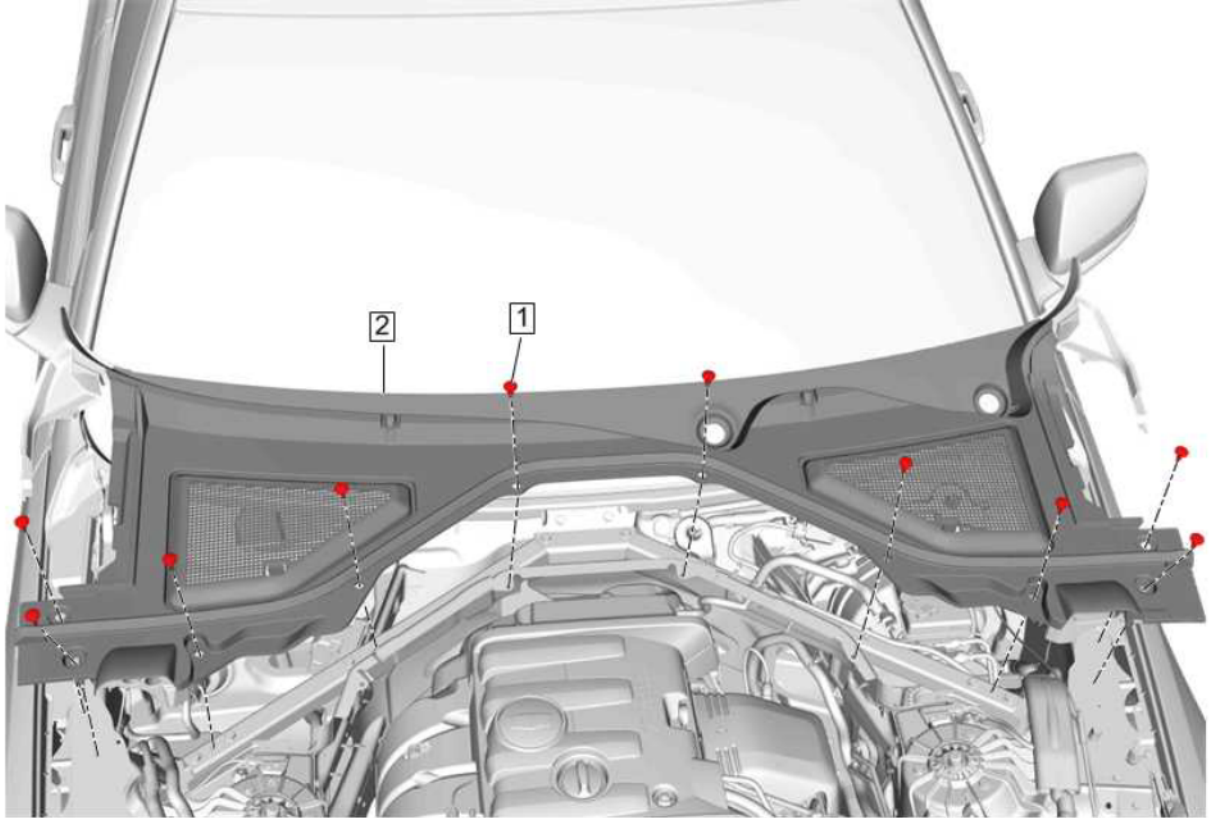


Fig. 20: Air Inlet Grille Panel

Courtesy of GENERAL MOTORS COMPANY

14. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#)
15. Drive Motor Power Inverter Module 3-Phase Cable (4, 5)» Install - [Transmission Replacement](#)

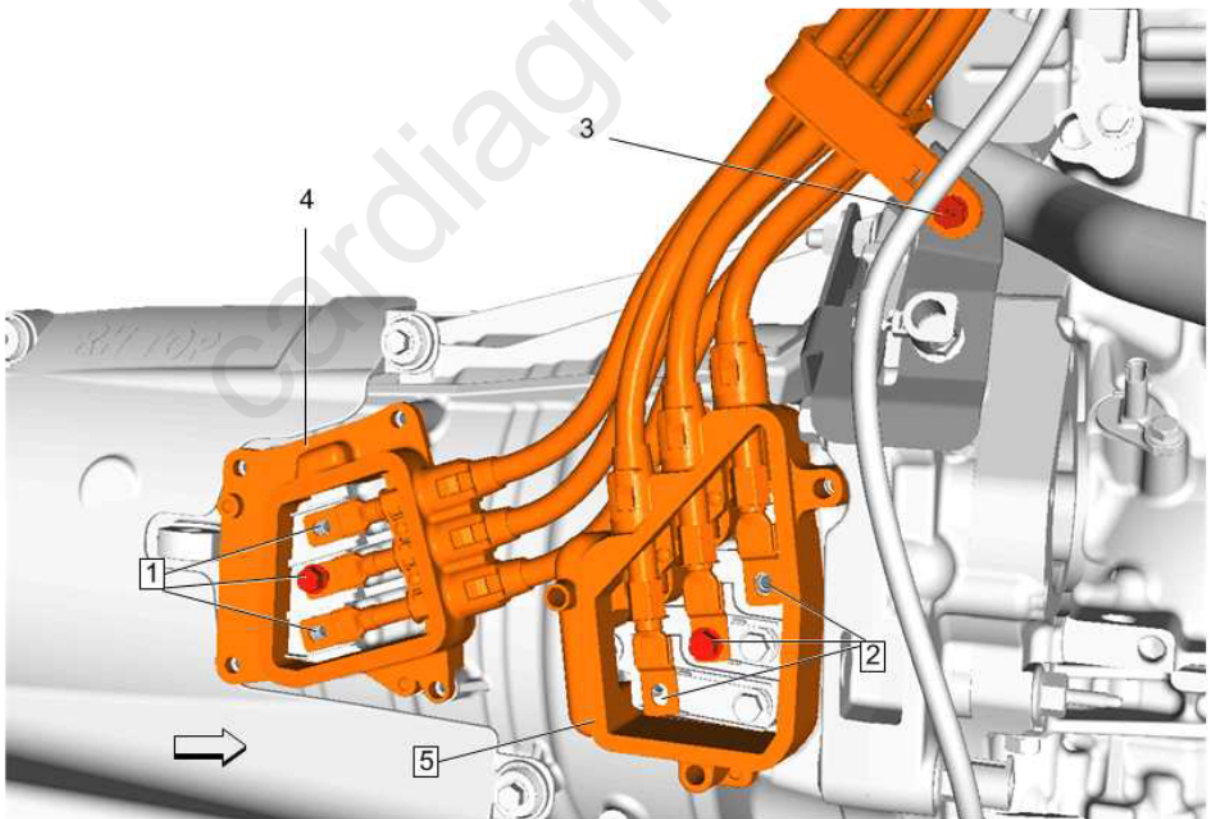


Fig. 21: High Voltage Cable Connector Bolts

Courtesy of GENERAL MOTORS COMPANY

16. Transmission Support Crossmember» Install - [Transmission Support Crossmember Replacement \(LTG\)](#)
17. Electrical Connector (1)» Connect

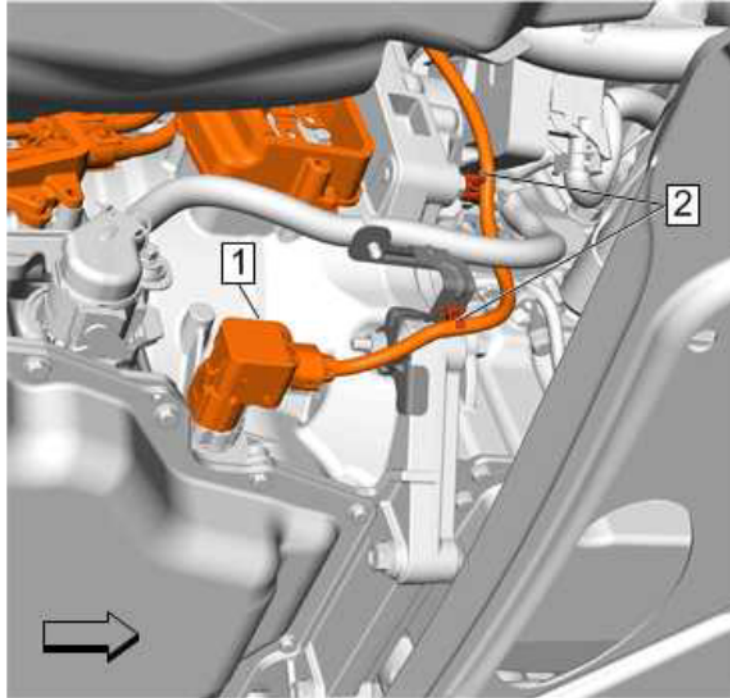


Fig. 22: Electrical Connector and Retainers

Courtesy of GENERAL MOTORS COMPANY

- 18. Retainer (2) » Engage [2x]
- 19. Cable Retainer Fastener (1) » Install and tighten 9 N.m (80 lb in)

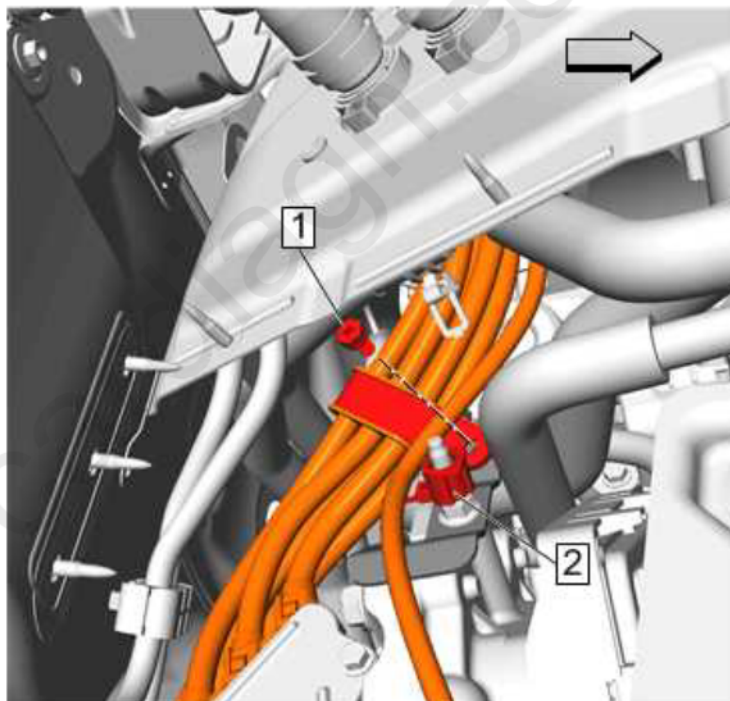


Fig. 23: Cable Retainer Fastener

Courtesy of GENERAL MOTORS COMPANY

- 20. Retainer (2) » Engage
- 21. Lower the vehicle.
- 22. Enable the high voltage system. Refer to [High Voltage Enabling](#)

DRIVE MOTOR POWER INVERTER MODULE 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. Front End Sheet Metal Cross Brace (1)» Remove - [Front End Sheet Metal Cross Brace Replacement](#)

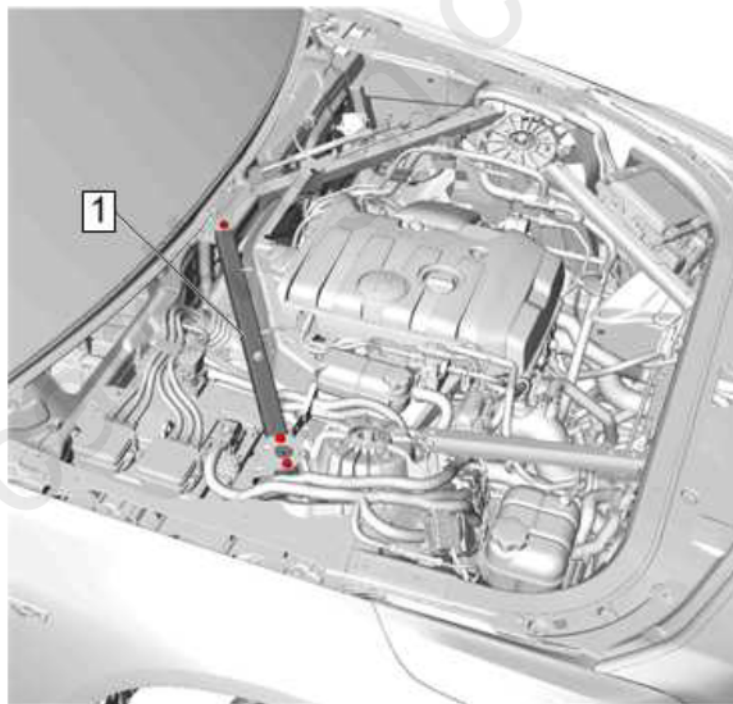


Fig. 24: Front End Sheet Metal Cross Brace
Courtesy of GENERAL MOTORS COMPANY

3. Drive Motor Power Inverter Module Cooling Inlet Hose (3)» 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 \(Heater Inlet Pipe Connector Auxiliary Air Conditioning Evaporator Intermediate Tube to Heater Inlet Pipe Connector\)](#)

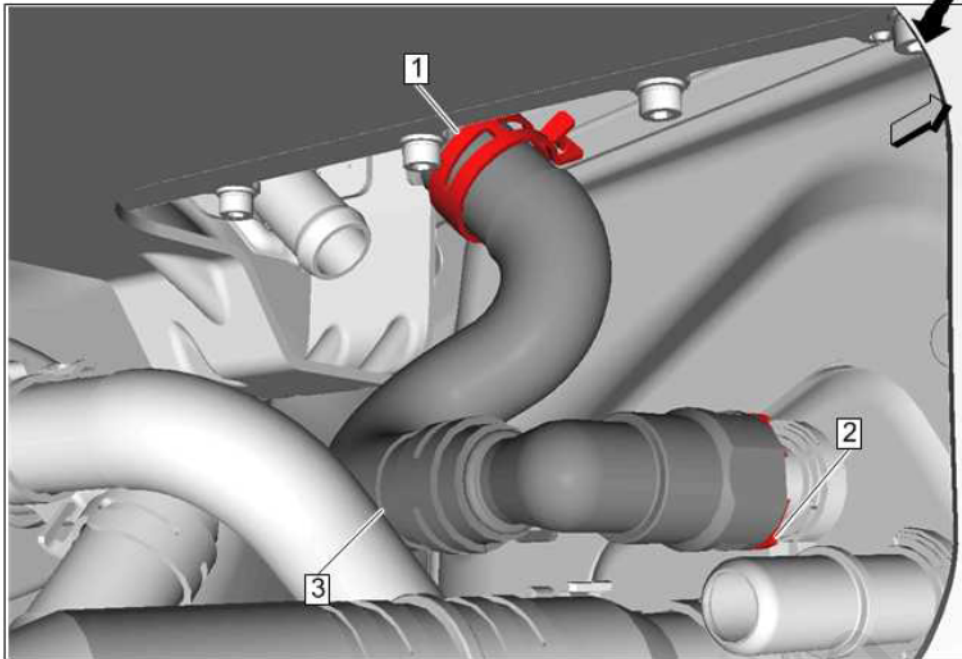


Fig. 25: Drive Motor Power Inverter Module Cooling Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

4. Drive Motor Generator Control Module Cooling Outlet Hose (3) » Remove - **Drive Motor Generator Control Module Cooling Outlet Hose Replacement**

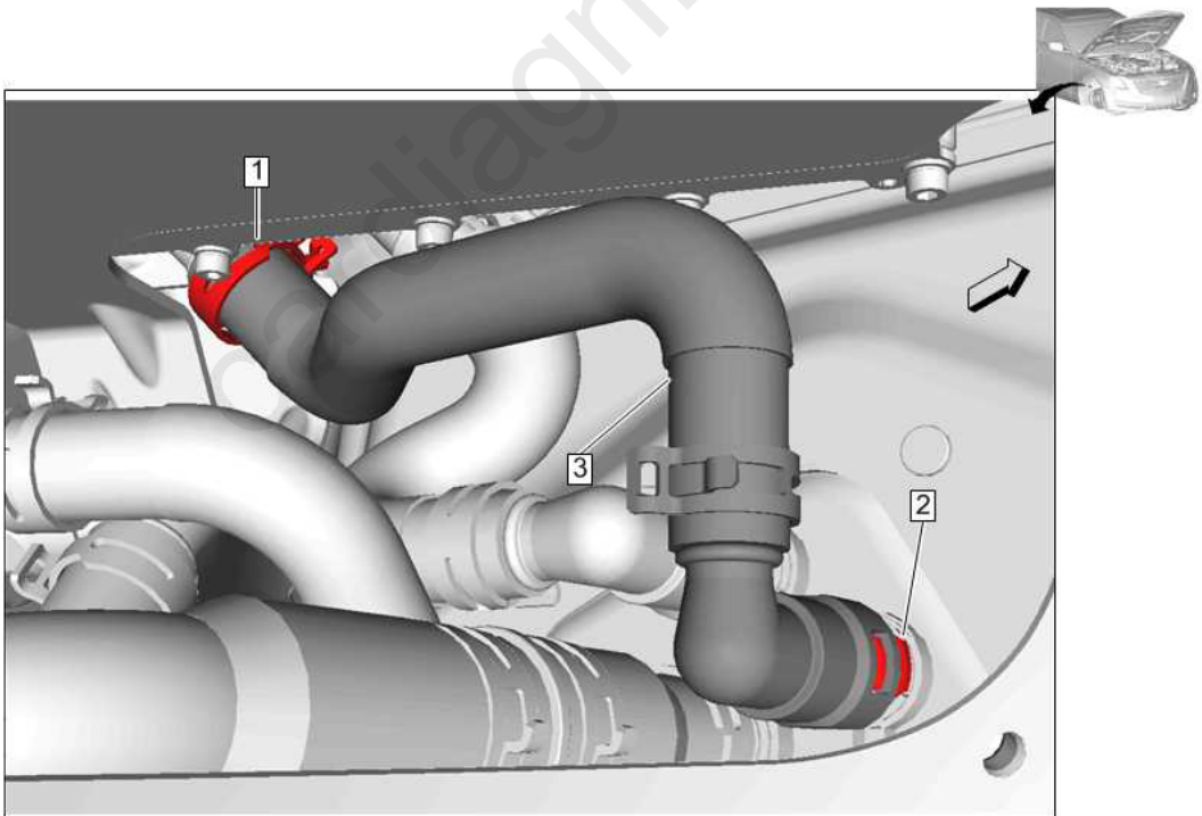


Fig. 26: Drive Motor Generator Control Module Cooling Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

5. High Voltage Cable Connector Cover Bolt (1) » Remove [4x]

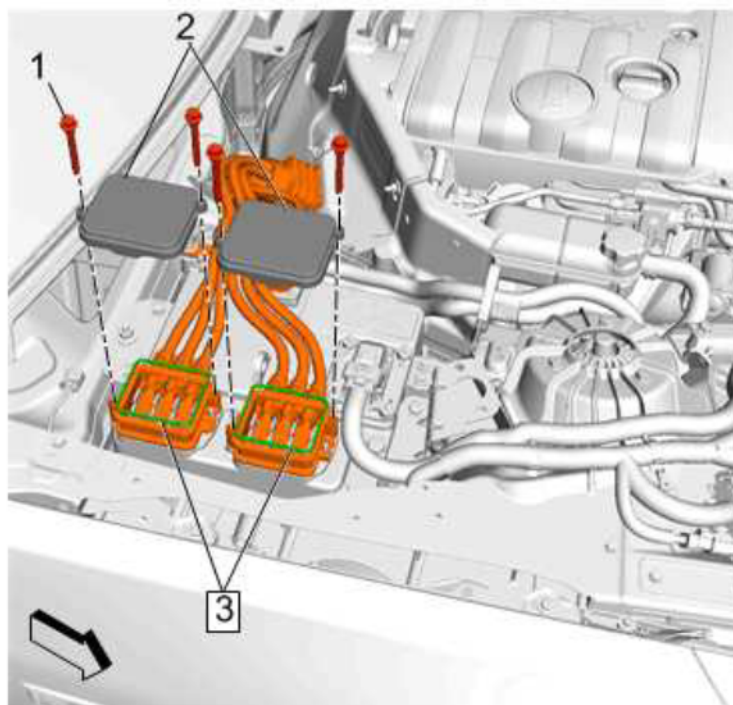


Fig. 27: High Voltage Cable Connector Cover, Bolts And Seals
 Courtesy of GENERAL MOTORS COMPANY

- 6. High Voltage Cable Connector Cover (2)» Remove [2x]
- 7. High Voltage Cable Connector Cover Seal (3)» Visual Inspection [2x]
- 8. High Voltage Terminal Bolt (1)» Remove [6x]

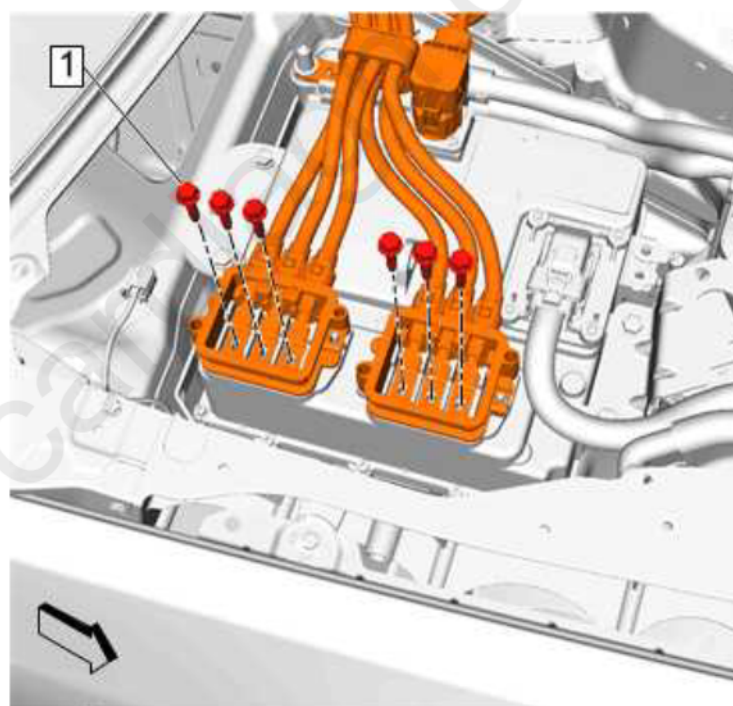


Fig. 28: High Voltage Terminal Bolts
 Courtesy of GENERAL MOTORS COMPANY

- 9. Protective Terminal Cover (2)» Remove

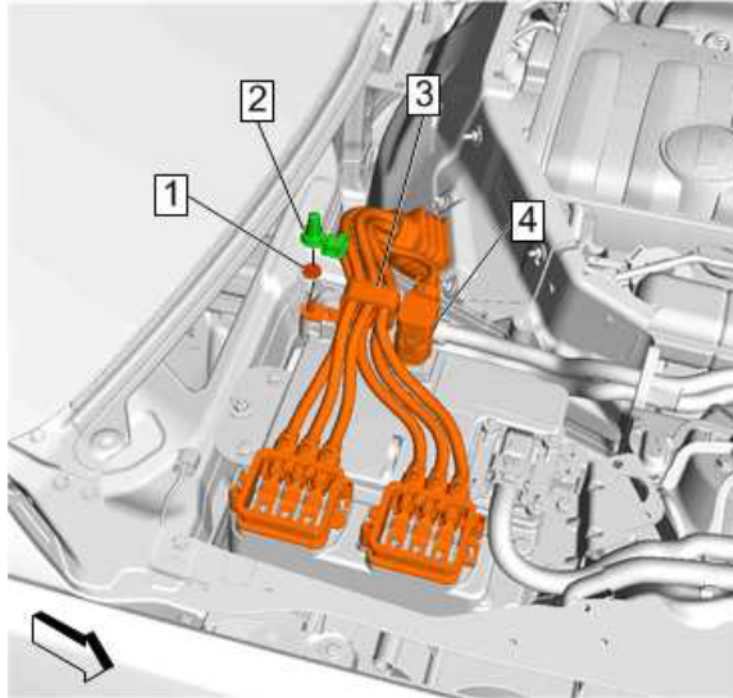


Fig. 29: Protective Terminal Cover

Courtesy of GENERAL MOTORS COMPANY

10. Cable Retainer Nut (1) » Remove
11. Drive Motor Power Inverter Module Connector (4) » Disconnect
12. Drive Motor Power Inverter Module 3-Phase Cable (3) » Reposition away
13. Drive Motor Power Inverter Module Connector (1) » Disconnect

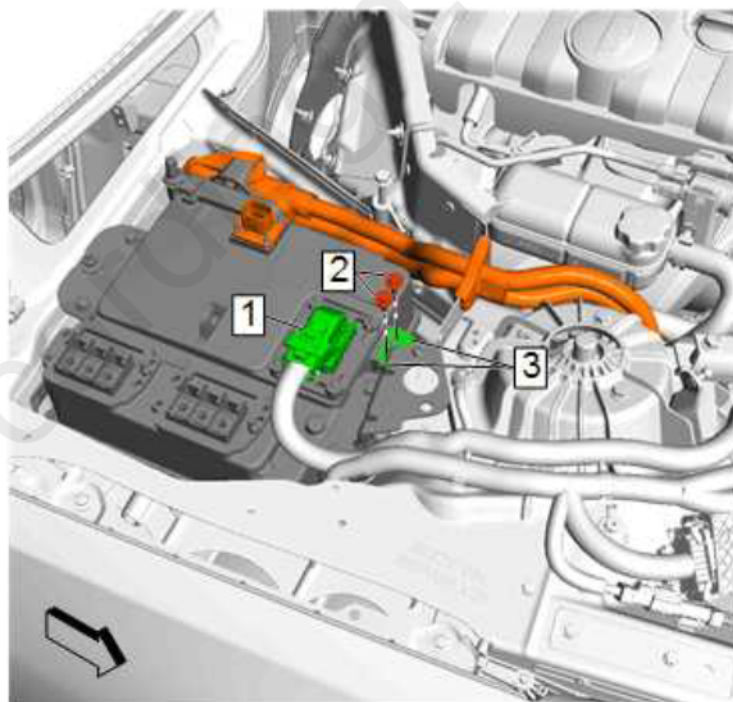


Fig. 30: Drive Motor Power Inverter Module Connectors, Ground Terminals And Bolts

Courtesy of GENERAL MOTORS COMPANY

14. Drive Motor Power Inverter Module Connector (2) » Disconnect
15. Ground Terminal Bolt (3) » Remove [2x]
16. Ground terminal (4) » Reposition away [2x]
17. Drive Motor Power Inverter Module Bracket Bolt (1) » Remove [2x]

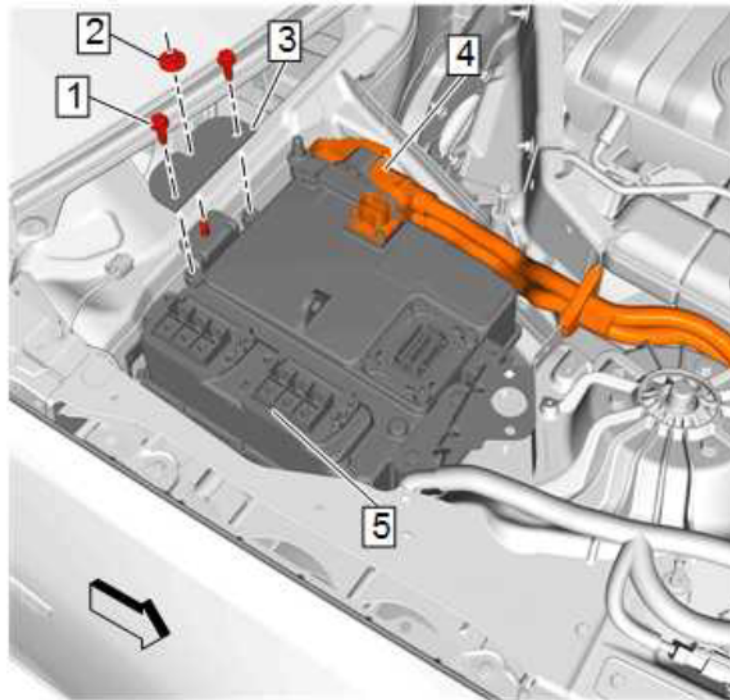


Fig. 31: Drive Motor Power Inverter Module, Bracket, Bolts And Nut
Courtesy of GENERAL MOTORS COMPANY

18. Drive Motor Power Inverter Module Bracket Nut (2)» Remove
19. Drive Motor Power Inverter Module Bracket (3)» Remove
20. Drive Motor Power Inverter Module (4)» Remove

Installation Procedure

1. Drive Motor Power Inverter Module (4)» Install

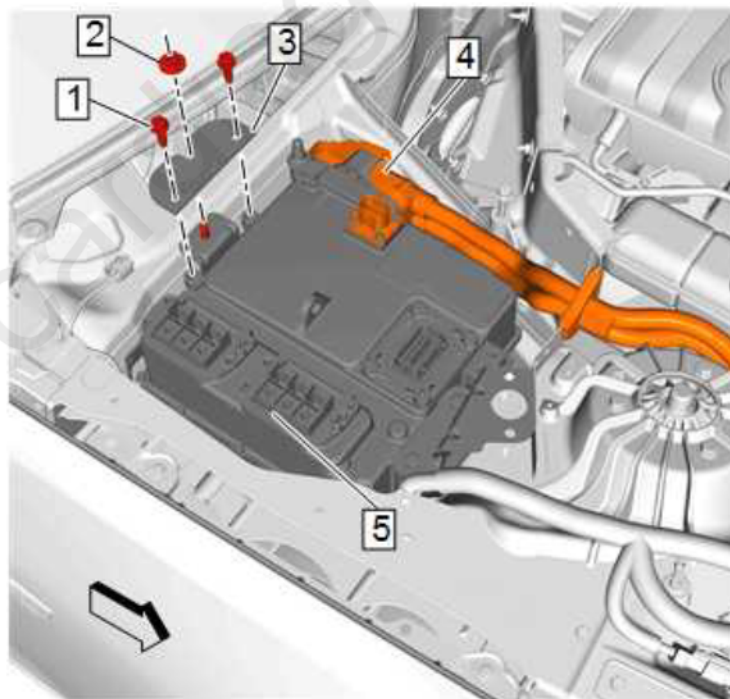


Fig. 32: Drive Motor Power Inverter Module, Bracket, Bolts And Nut
Courtesy of GENERAL MOTORS COMPANY

2. Drive Motor Power Inverter Module Bracket (3)» Install
3. Drive Motor Power Inverter Module Bracket Nut (2)» Install and tighten 22 N.m (16 lb ft)

CAUTION: Refer to **Fastener Caution**

4. Drive Motor Power Inverter Module Bracket Bolt» Install and tighten [2x] 22 N.m (16 lb ft)
5. Drive Motor Power Inverter Module Connector (1)» Connect

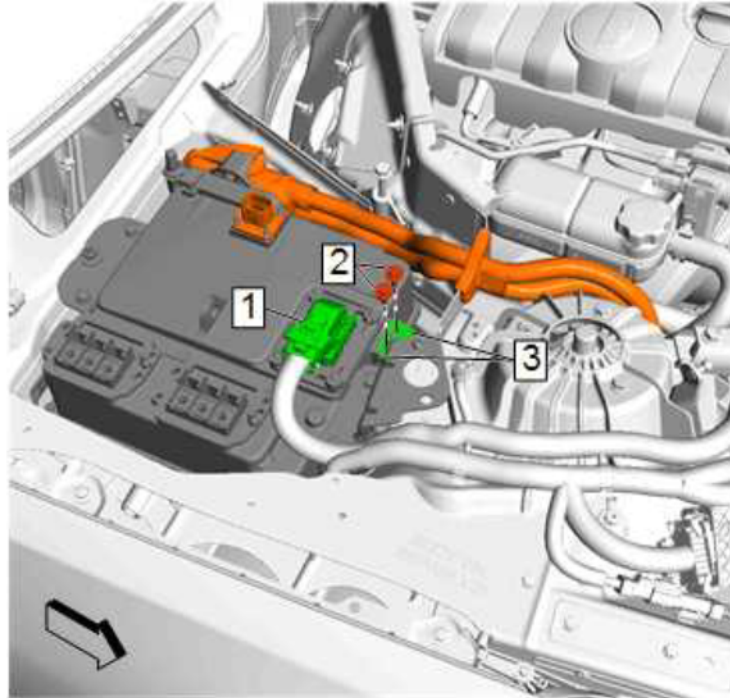


Fig. 33: Drive Motor Power Inverter Module Connectors, Ground Terminals And Bolts
 Courtesy of GENERAL MOTORS COMPANY

6. Drive Motor Power Inverter Module Connector (2)» Connect
7. Ground terminal (4)» Install [2x]
8. Ground Terminal Bolt (3)» Install and tighten [2x] 9 N.m (80 lb in)
9. Drive Motor Power Inverter Module 3-Phase Cable (3)» Install

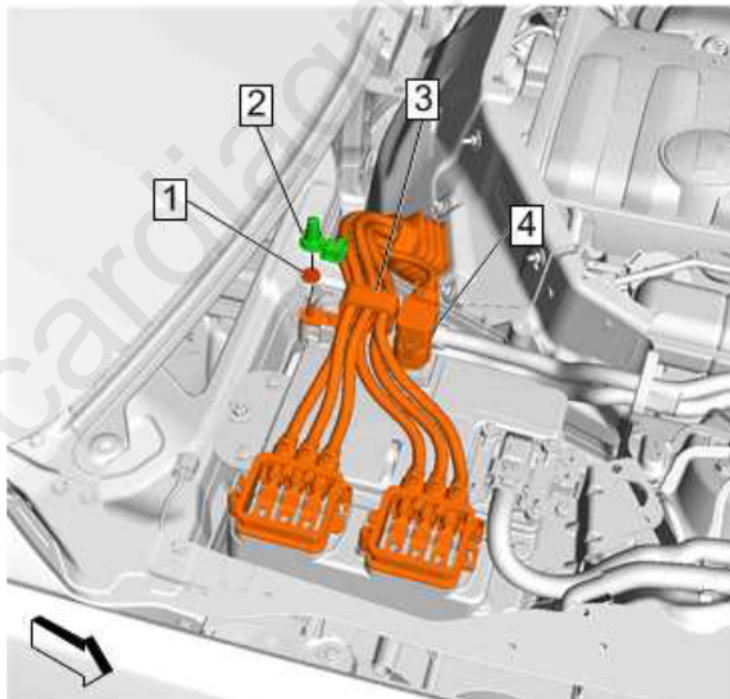


Fig. 34: Protective Terminal Cover
 Courtesy of GENERAL MOTORS COMPANY

10. Cable Retainer Nut (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)

11. Protective Terminal Cover (2)» Install
12. Drive Motor Power Inverter Module Connector (4)» Connect

13. High Voltage Terminal Bolt (1)» Hand tighten [6x]

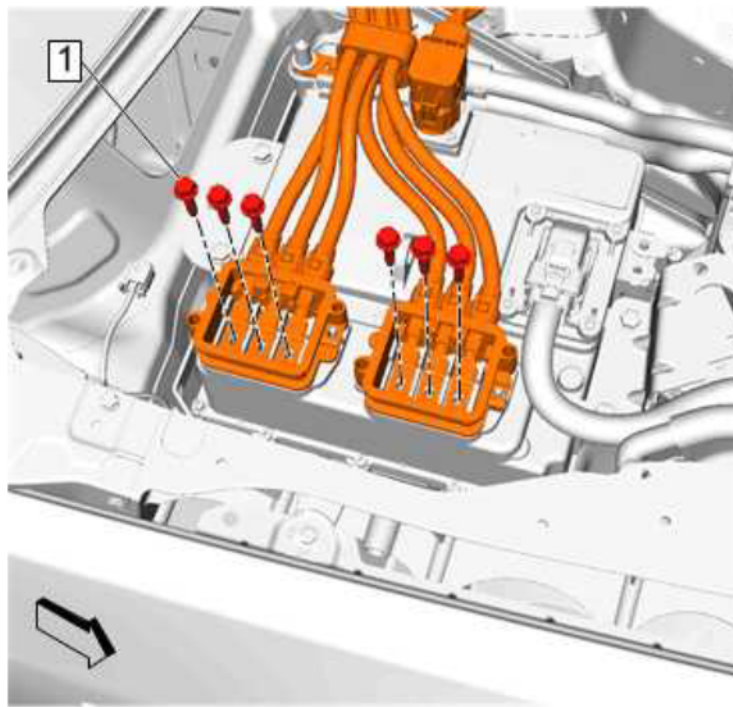


Fig. 35: High Voltage Terminal Bolts

Courtesy of GENERAL MOTORS COMPANY

NOTE: Critical high voltage fastener. Perform second torque verification check following re-assembly.

14. High Voltage Terminal Bolt (1)» Tighten [6x]

- First Pass: 9 N.m (80 lb in)
- Final Pass: 9 N.m (80 lb in)

15. High Voltage Cable Connector Cover Seal (3)» Install [2x]

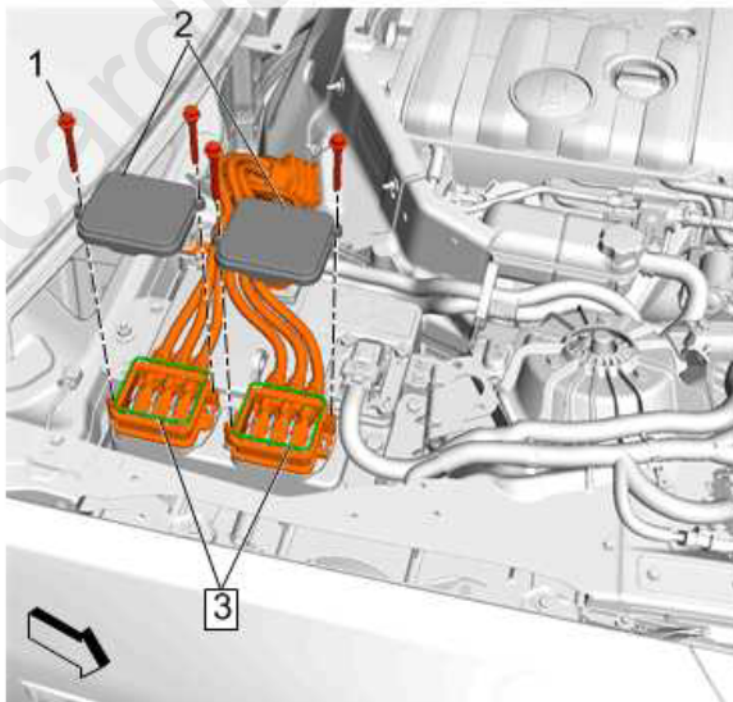


Fig. 36: High Voltage Cable Connector Cover, Bolts And Seals

Courtesy of GENERAL MOTORS COMPANY

16. High Voltage Cable Connector Cover (2)» Install [2x]

17. High Voltage Cable Connector Cover Bolt (1)» Install and tighten [4x]

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)

18. Drive Motor Power Inverter Module Cooling Inlet Hose (3)» 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)**

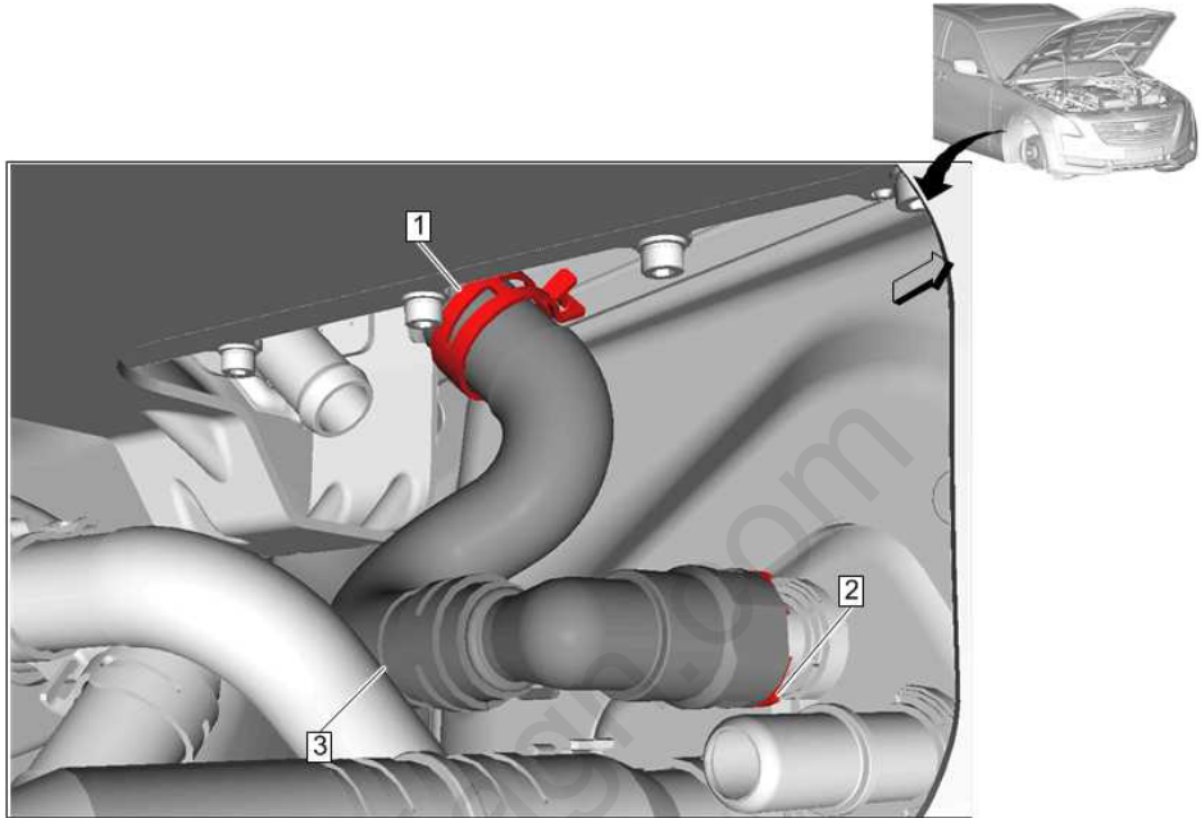


Fig. 37: Drive Motor Power Inverter Module Cooling Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

19. Drive Motor Generator Control Module Cooling Outlet Hose (3)» Install - **Drive Motor Generator Control Module Cooling Outlet Hose Replacement**

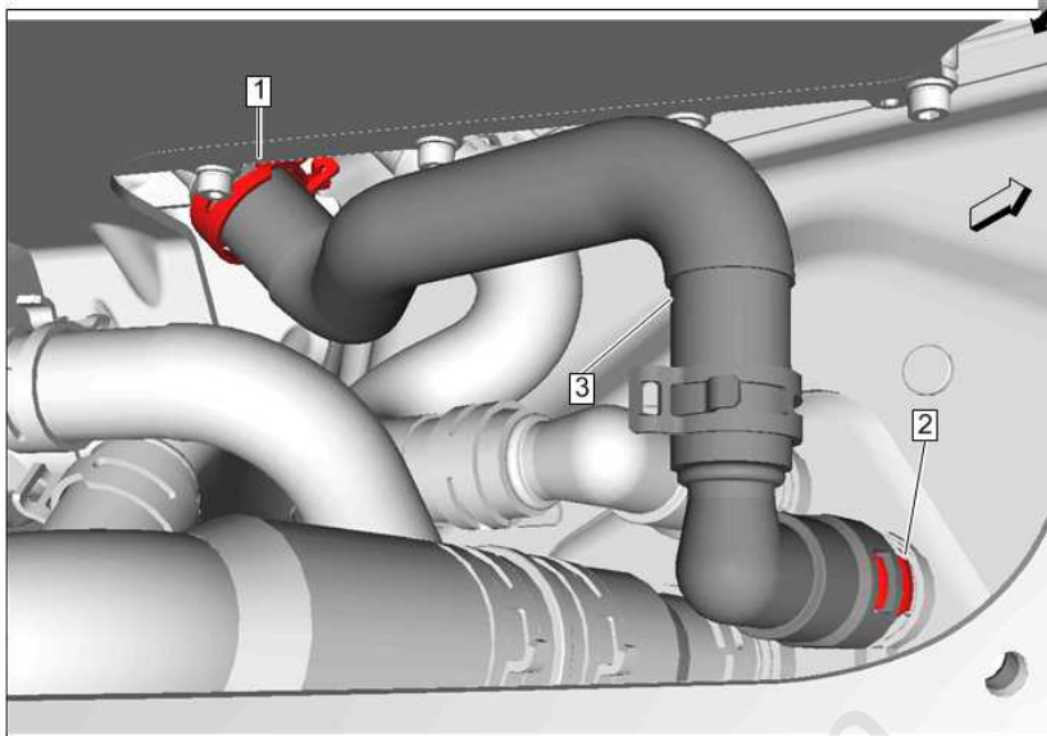


Fig. 38: Drive Motor Generator Control Module Cooling Outlet Hose
 Courtesy of GENERAL MOTORS COMPANY

20. Front End Sheet Metal Cross Brace (1) » Install - **Front End Sheet Metal Cross Brace Replacement**

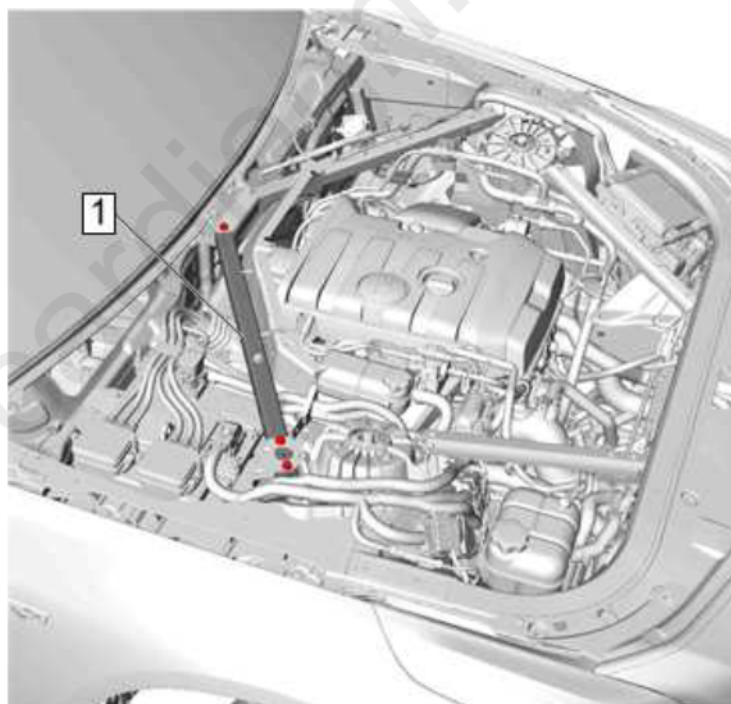


Fig. 39: Front End Sheet Metal Cross Brace
 Courtesy of GENERAL MOTORS COMPANY

21. Enable the high voltage system. Refer to **High Voltage Enabling**
 22. Reprogram the drive motor power inverter module, refer to **Control Module References**

ACCESSORY DC POWER CONTROL MODULE BRACKET REPLACEMENT

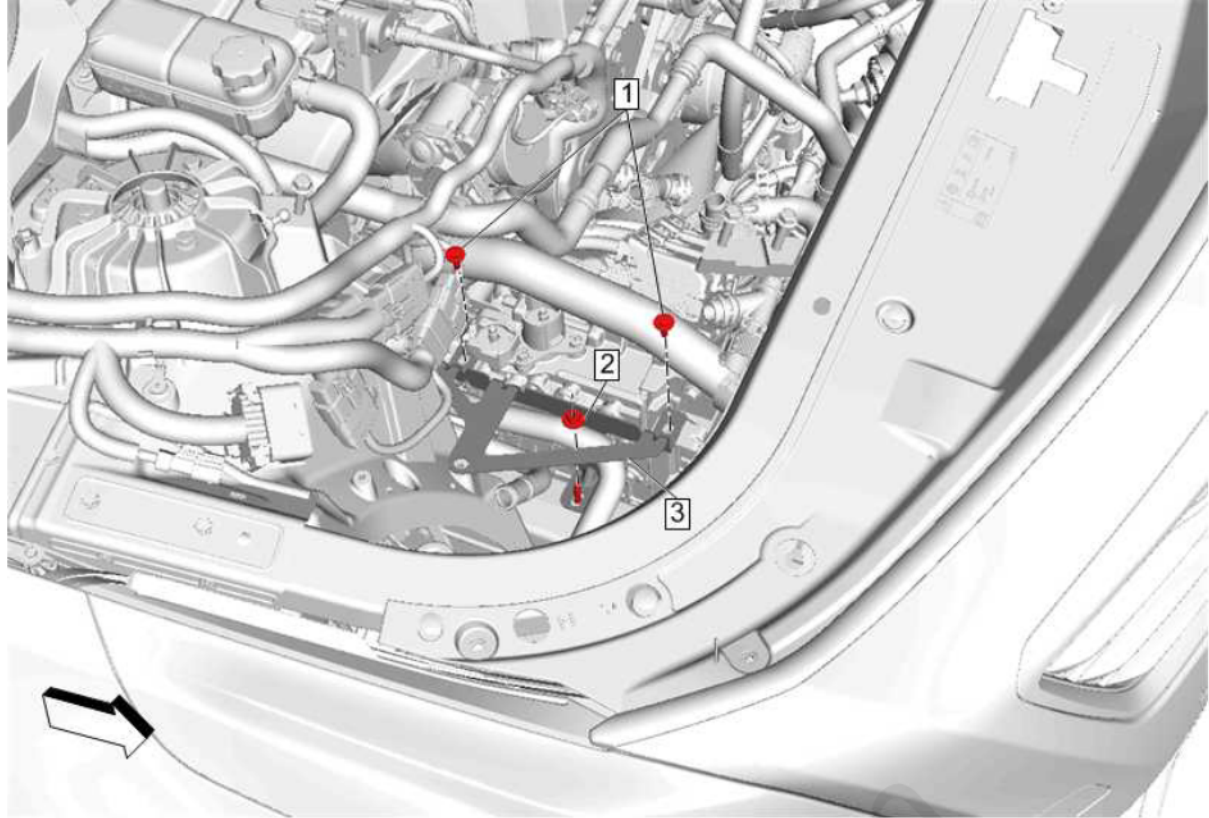


Fig. 40: Accessory DC Power Control Module Bracket
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure <u>Radiator Surge Tank Bracket Replacement (LGW LTG without HP9) Radiator Surge Tank Bracket Replacement (LTG with HP9)</u>	
cardiagr.com	

Callout	Component Name
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. Accessory DC Power Control Module Bracket Bolt [2x] CAUTION: Refer to Fastener Caution Tighten 9 N.m (80 lb in)
2	Accessory DC Power Control Module Bracket Nut Tighten 9 N.m (80 lb in)
3	Accessory DC Power Control Module Bracket

INTERFACE CONTROL MODULE BRACKET REPLACEMENT

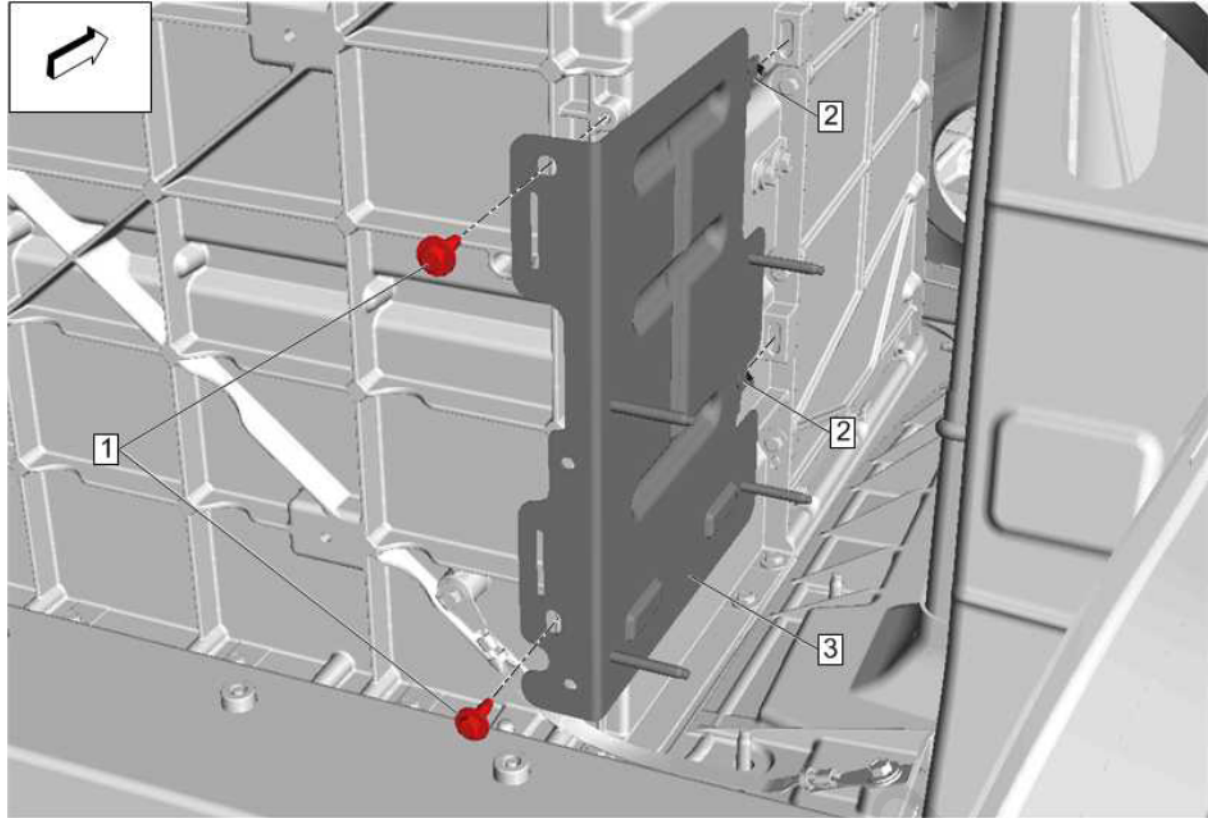


Fig. 41: Interface Control Module Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Hybrid Powertrain Control Module 2 Replacement	
1	Interface Control Module Bracket Bolt [2x] CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)
2	Retaining Tab [2x]
3	Interface Control Module Bracket

ACCESSORY DC POWER CONTROL MODULE 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. Generator Control Module Coolant Radiator Hose (2)» Remove - [Generator Control Module Coolant Radiator Hose Replacement](#)

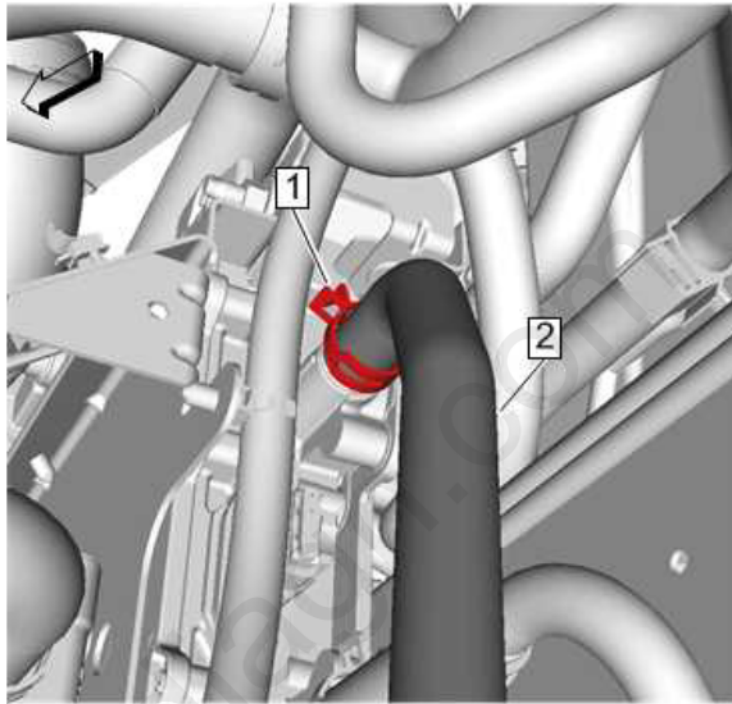


Fig. 42: Generator Control Module Coolant Radiator Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

3. Drive Motor Generator Control Module Radiator Outlet Hose (2)» Remove - [Drive Motor Generator Control Module Radiator Outlet Hose Replacement](#)

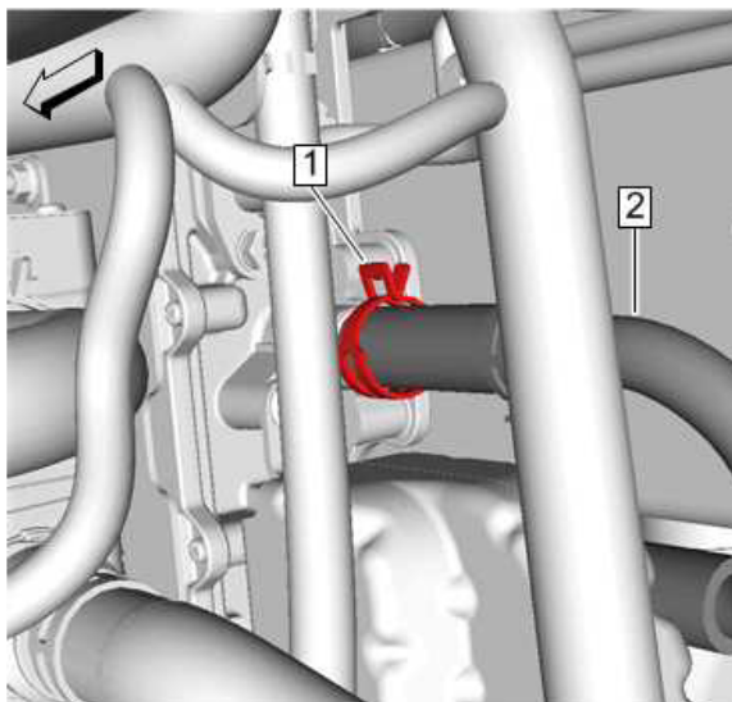


Fig. 43: Drive Motor Generator Control Module Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

4. Retainer (2) » Disengage [2x]

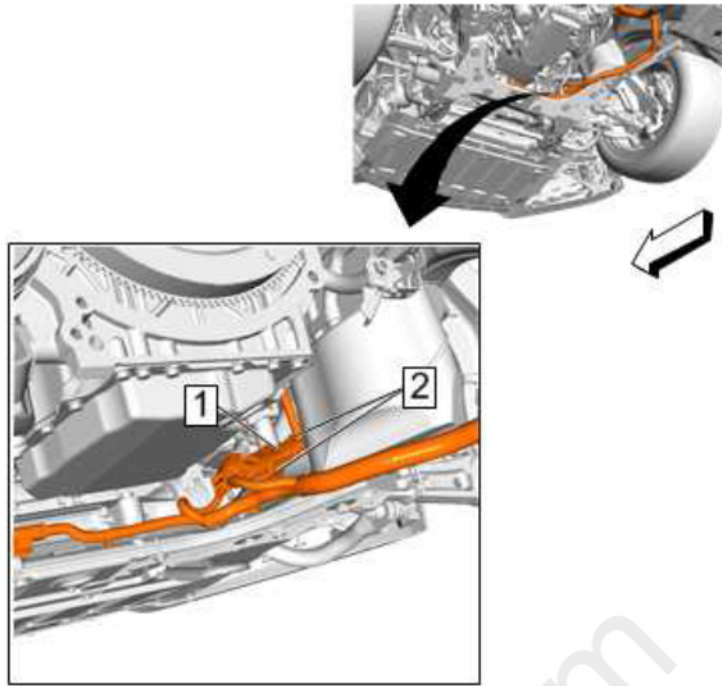


Fig. 44: Electrical Connector And Retainers
Courtesy of GENERAL MOTORS COMPANY

5. Electrical Connector (1) » Disconnect
6. Accessory DC Power Control Module High Voltage Connector Protector Bolt (1) » Remove

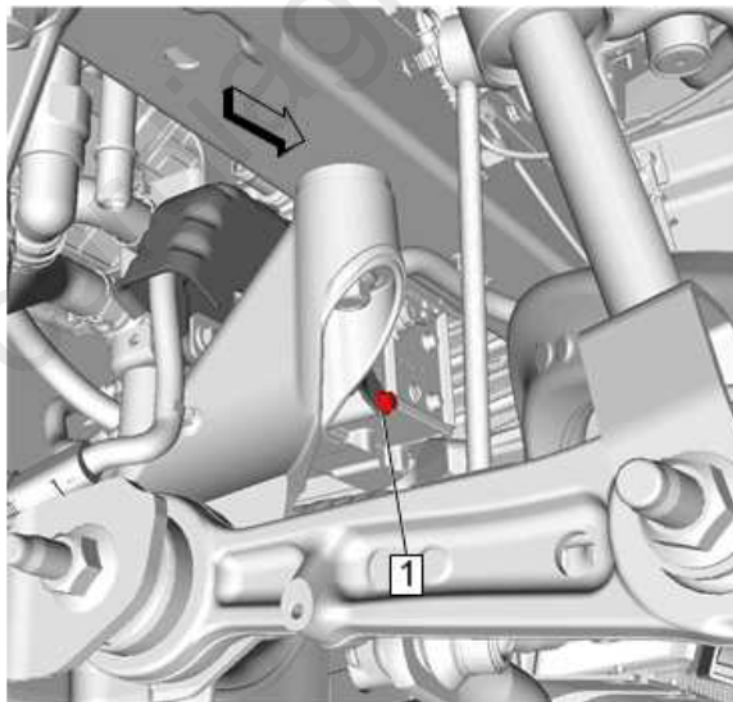


Fig. 45: Accessory DC Power Control Module High Voltage Connector Protector Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Accessory DC Power Control Module High Voltage Connector Protector Bolt (1) » Remove [2x]

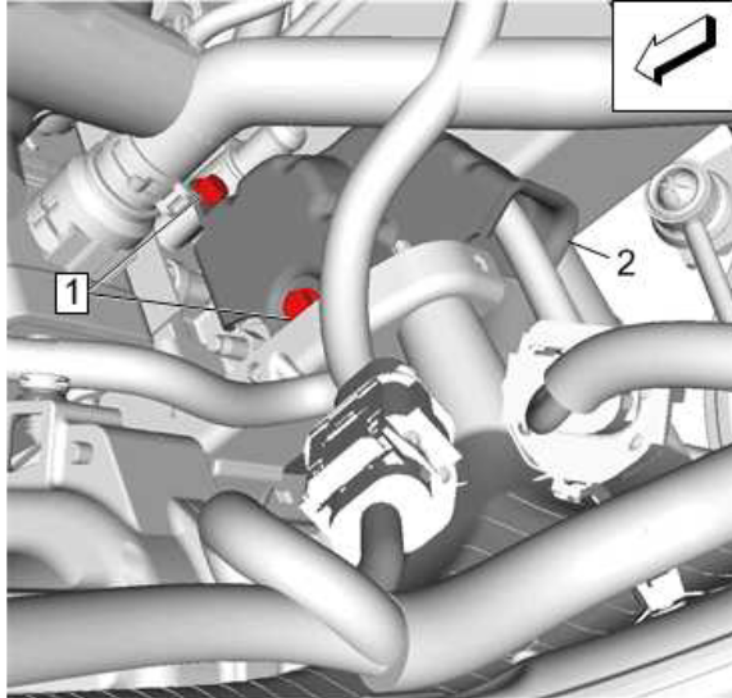


Fig. 46: Accessory DC Power Control Module High Voltage Connector Protector Bolts
 Courtesy of GENERAL MOTORS COMPANY

8. Accessory DC Power Control Module High Voltage Connector Protector (2)» Remove
9. Accessory DC Power Control Module Bolt (1)» Remove

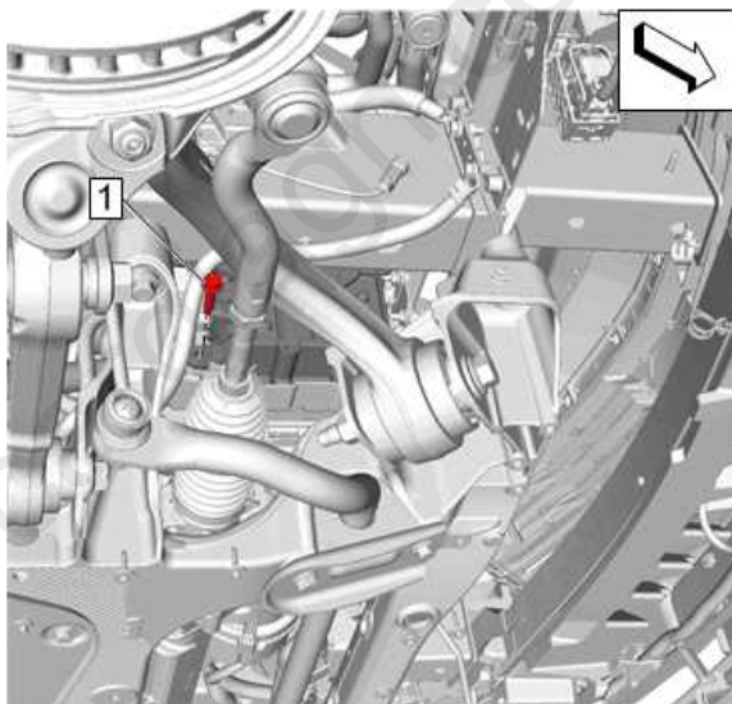


Fig. 47: Accessory DC Power Control Module Bolt
 Courtesy of GENERAL MOTORS COMPANY

10. Accessory DC Power Control Module Bracket (3)» Remove - [Accessory DC Power Control Module Bracket Replacement](#)

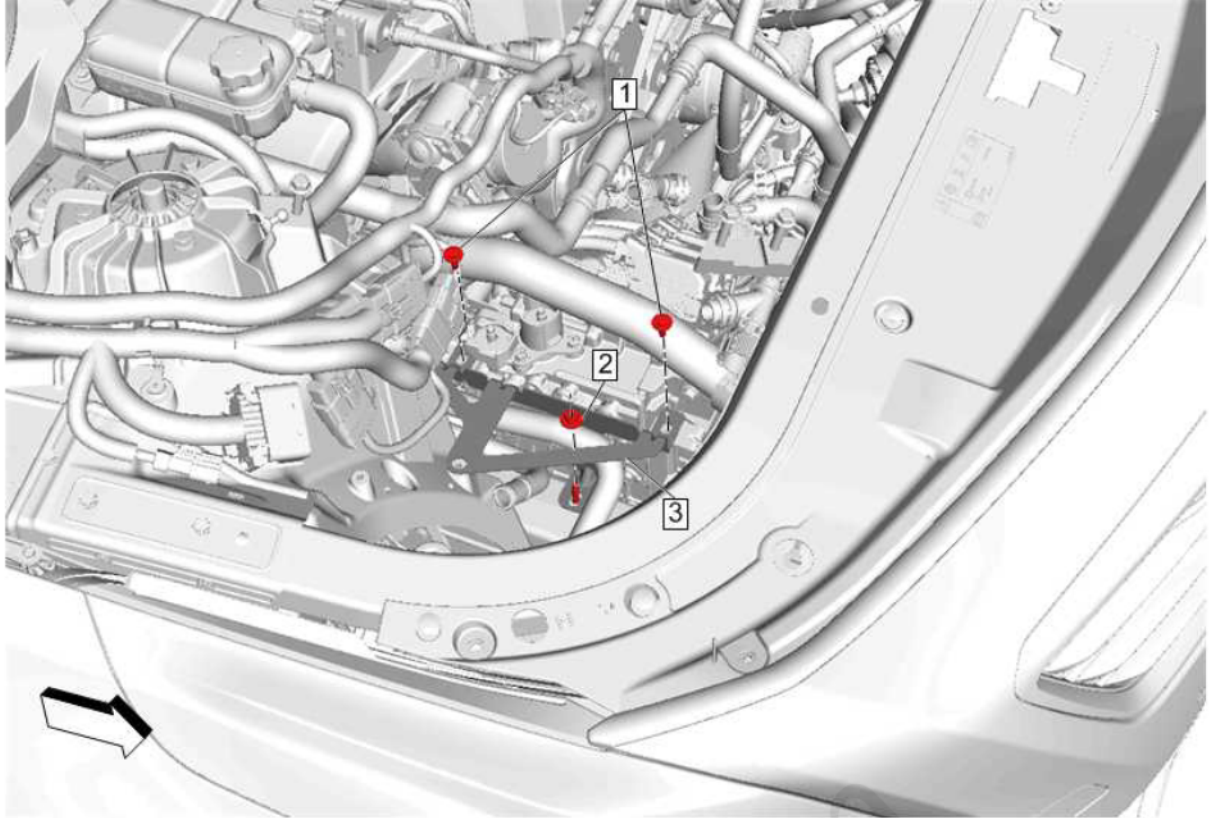


Fig. 48: Accessory DC Power Control Module Bracket
 Courtesy of GENERAL MOTORS COMPANY

11. Accessory DC Power Control Module Bolt (1)» Remove

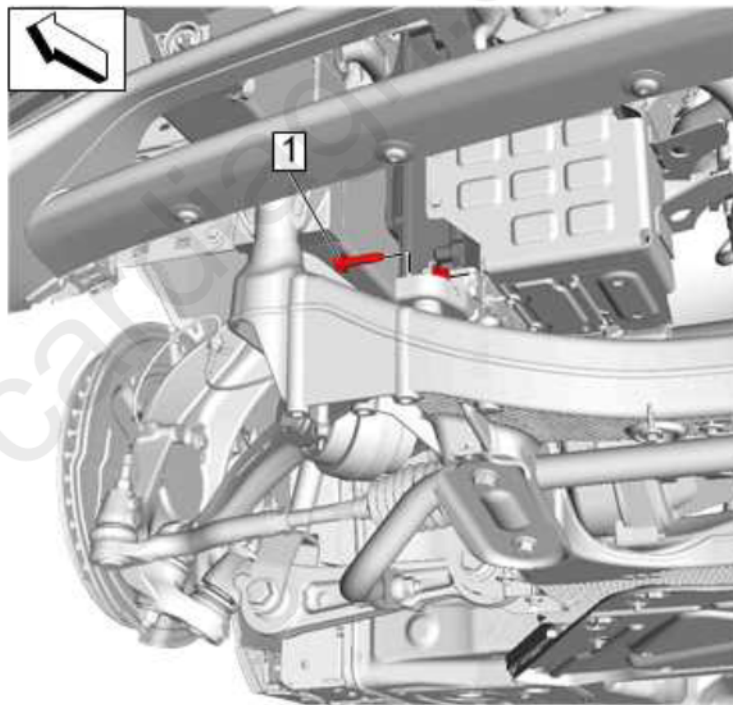


Fig. 49: Accessory DC Power Control Module Bolt
 Courtesy of GENERAL MOTORS COMPANY

12. Front Wheelhouse Panel Brace - Front (2)» Remove - **Front Wheelhouse Panel Brace Replacement (Front)**

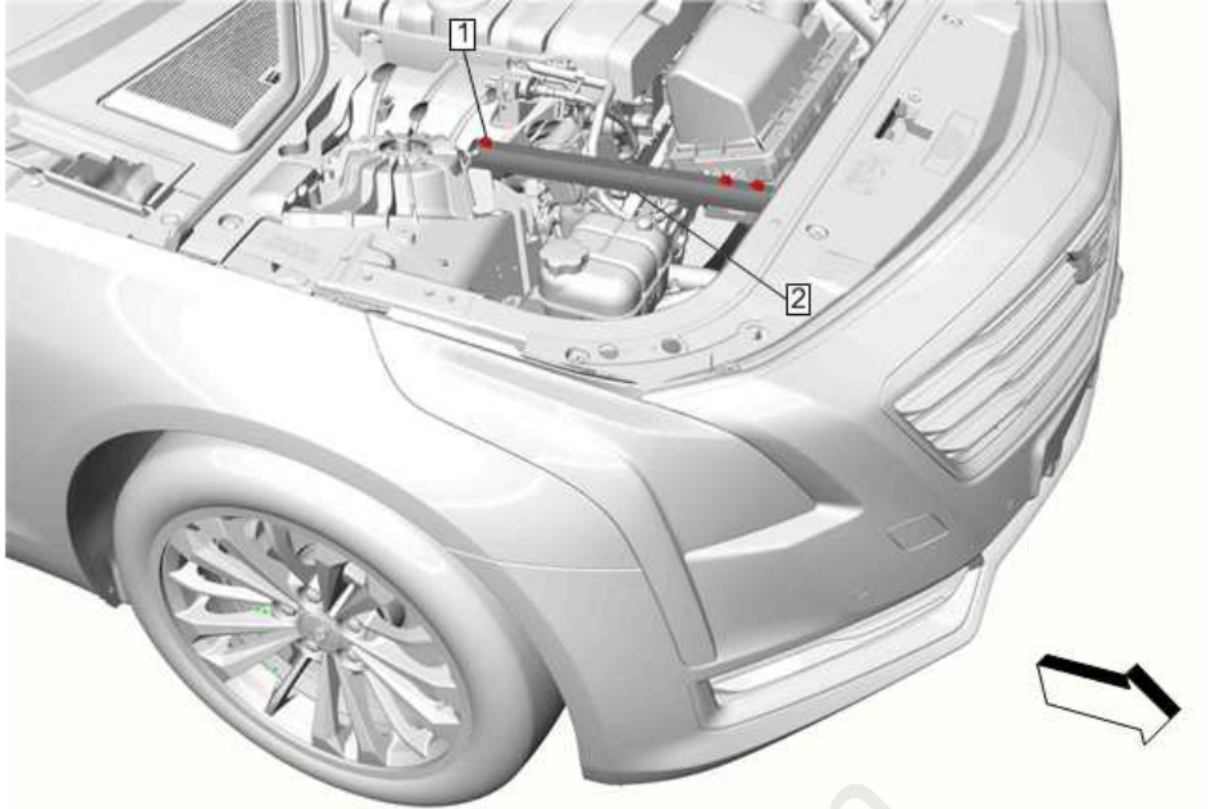


Fig. 50: Front Wheelhouse Panel Brace (Front)
 Courtesy of GENERAL MOTORS COMPANY

13. Radiator Inlet Hose (2)» Remove - **Radiator Inlet Hose Replacement (LTG without HP9)**, **Radiator Inlet Hose Replacement (LGW)**, **Radiator Inlet Hose Replacement (LGX)**, **Radiator Inlet Hose Replacement (LTG with HP9)**

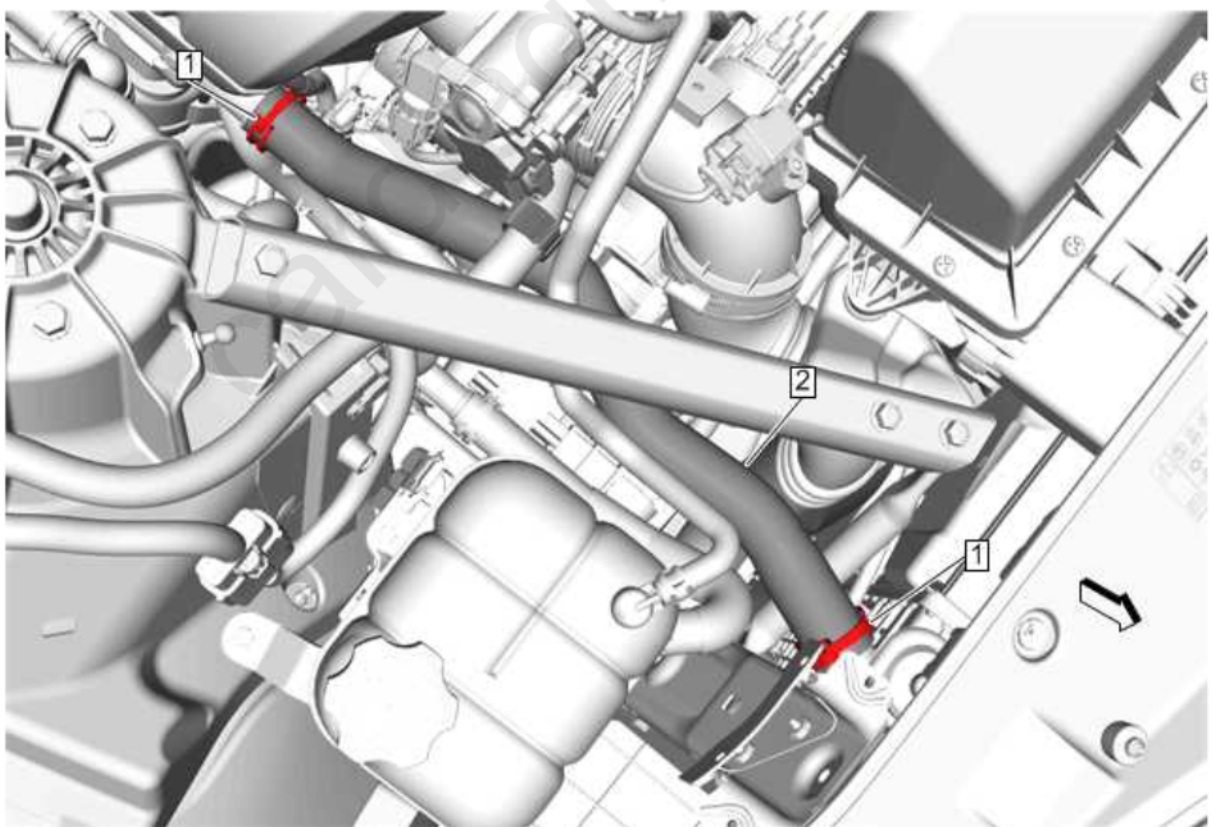


Fig. 51: Radiator Inlet Hose
 Courtesy of GENERAL MOTORS COMPANY

14. Retainer (1)» Disengage

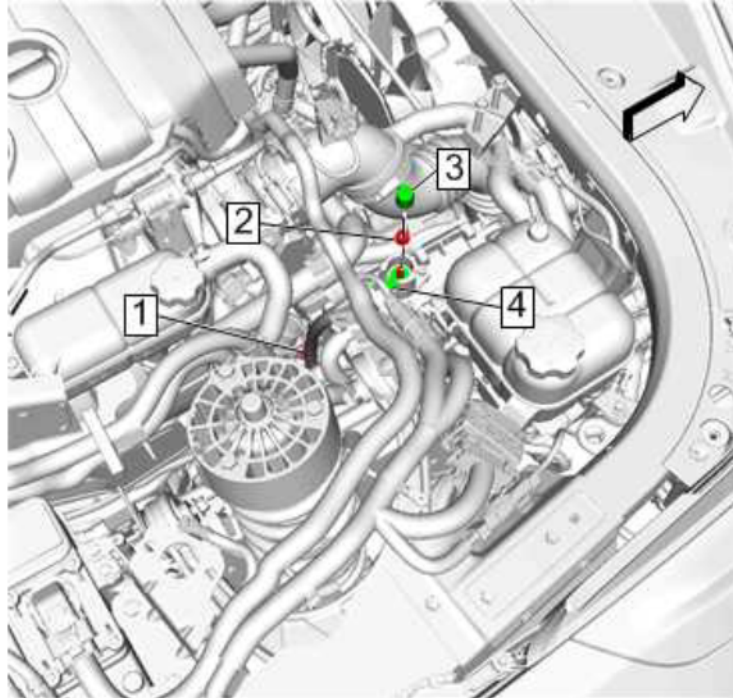


Fig. 52: Retainer, Protective Cap, Generator Cable And Fastener
Courtesy of GENERAL MOTORS COMPANY

- 15. Protective Cap (3) » Remove
- 16. Generator Cable Fastener (2) » Remove
- 17. Generator Cable (4) » Remove
- 18. Protective Cap (2) » Remove

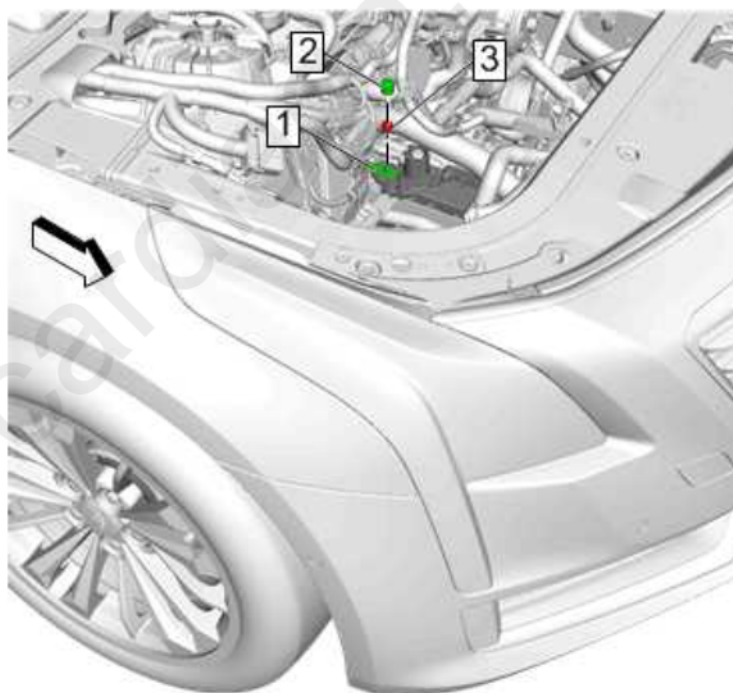


Fig. 53: Protective Cap, Ground Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

- 19. Ground Cable Nut (3) » Remove
- 20. Ground Cable (1) » Remove
- 21. Accessory DC Power Control Module Bolt (1) » Remove [2x]

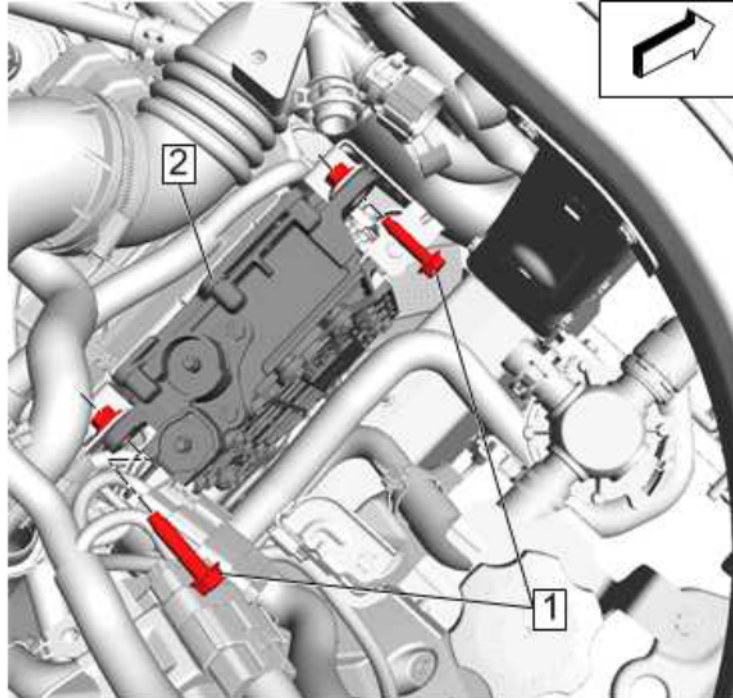


Fig. 54: Accessory DC Power Control Module Bolts

Courtesy of GENERAL MOTORS COMPANY

22. Raise the accessory DC power control module (2) to access the engine wiring harness connector.
23. Electrical Connector (1) » Disconnect

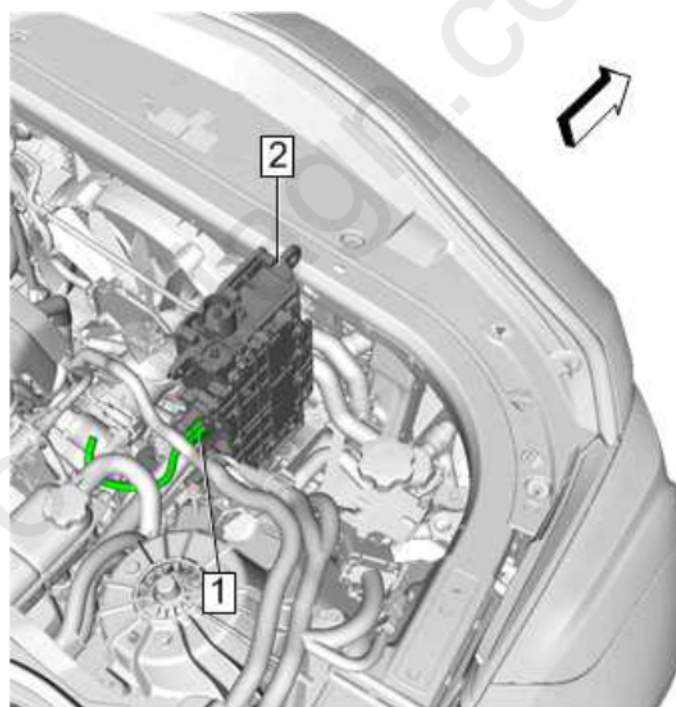


Fig. 55: Electrical Connector And Accessory DC Power Control Module

Courtesy of GENERAL MOTORS COMPANY

24. Accessory DC Power Control Module (2) » Remove
25. Disconnect and transfer the high voltage extension cable (1) to the NEW accessory DC power control module.

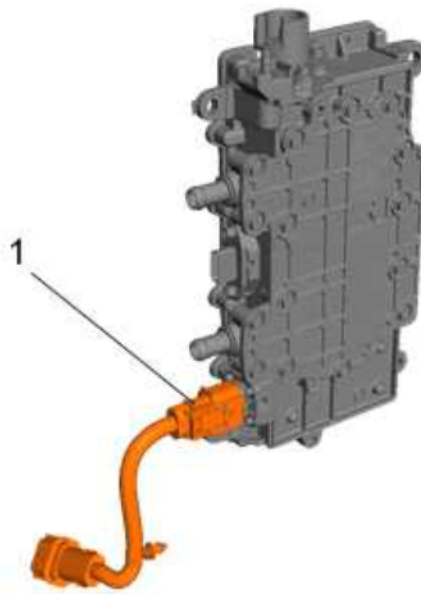


Fig. 56: High Voltage Extension Cable
 Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

1. Electrical Connector (1) » Connect
2. Accessory DC Power Control Module (2) » Install
3. Accessory DC Power Control Module Bolt (1) » Install and tighten [2x] 22 N.m (16 lb ft)

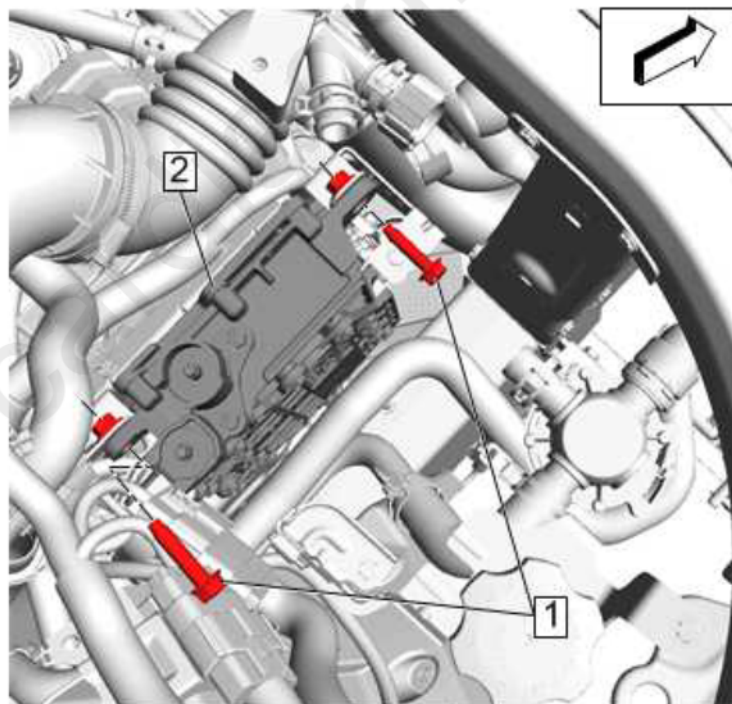


Fig. 57: Accessory DC Power Control Module Bolts
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution**

4. Ground Cable (1) » Install

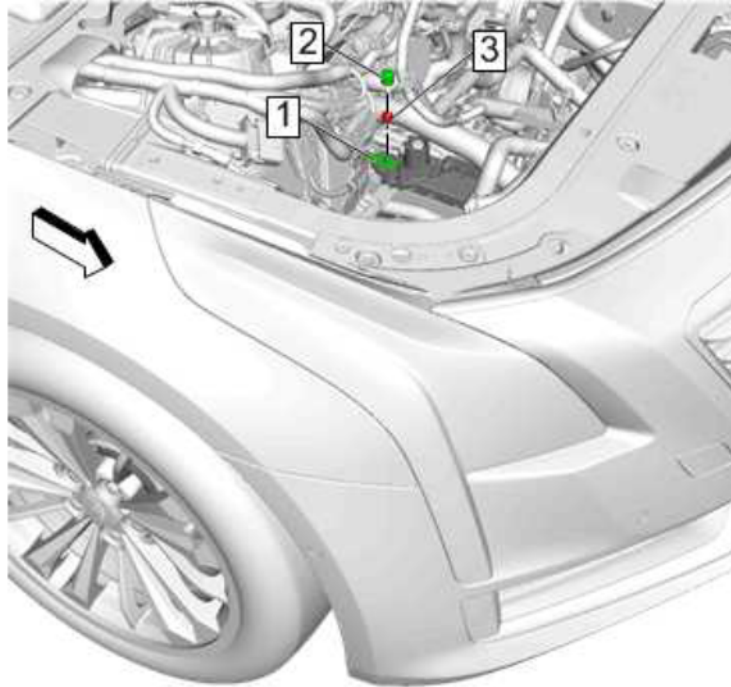


Fig. 58: Protective Cap, Ground Cable And Nut
 Courtesy of GENERAL MOTORS COMPANY

- 5. Ground Cable Nut (3)» Install and tighten 12 N.m (106 lb in)
- 6. Protective Cap (2)» Install
- 7. Generator Cable (4)» Install

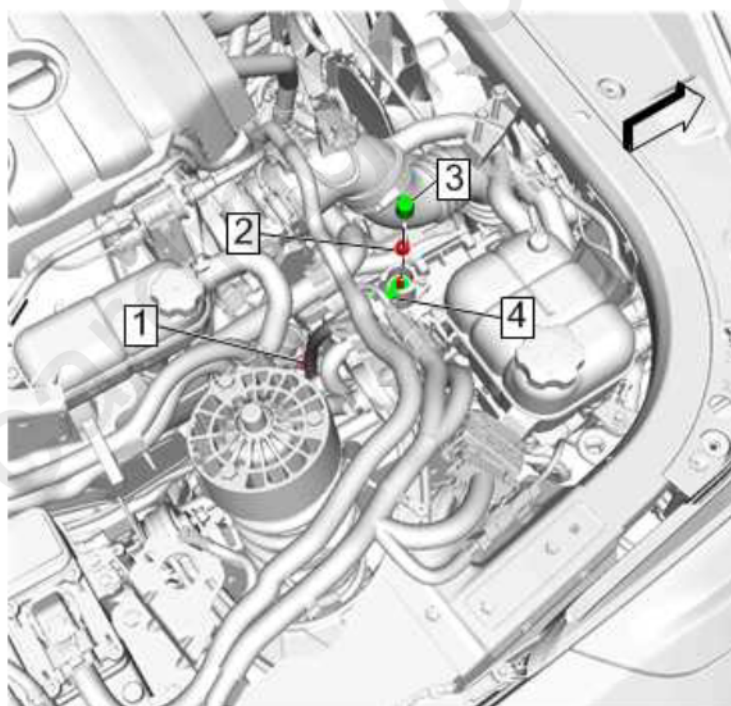


Fig. 59: Retainer, Protective Cap, Generator Cable And Fastener
 Courtesy of GENERAL MOTORS COMPANY

- 8. Generator Cable Fastener (2)» Install and tighten 12 N.m (106 lb in)
- 9. Protective Cap (3)» Install
- 10. Retainer (1)» Engage
- 11. Radiator Inlet Hose (2)» Install - **Radiator Inlet Hose Replacement (LTG without HP9)**
Radiator Inlet Hose Replacement (LGW) **Radiator Inlet Hose Replacement (LGX)** **Radiator Inlet Hose Replacement (LTG with HP9)**

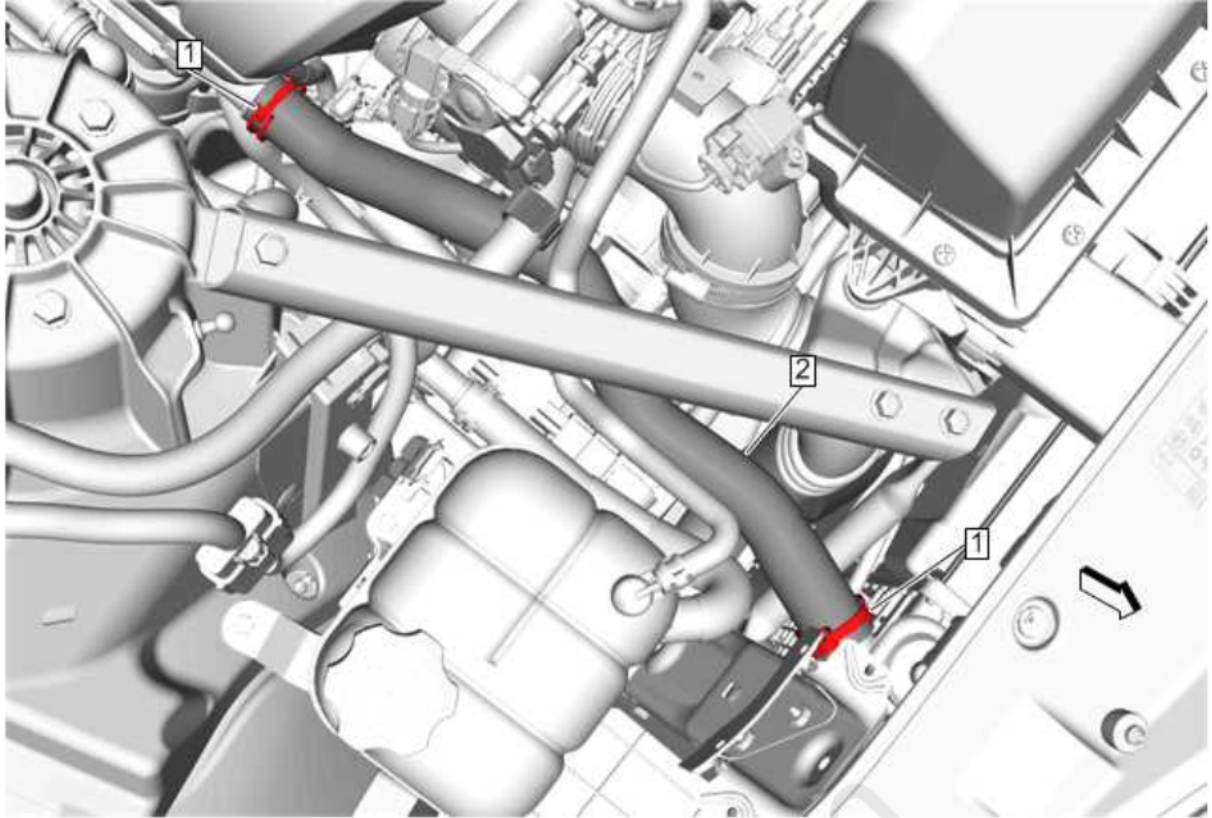


Fig. 60: Radiator Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

12. Front Wheelhouse Panel Brace - Front (2)» Install - **Front Wheelhouse Panel Brace Replacement (Front)**

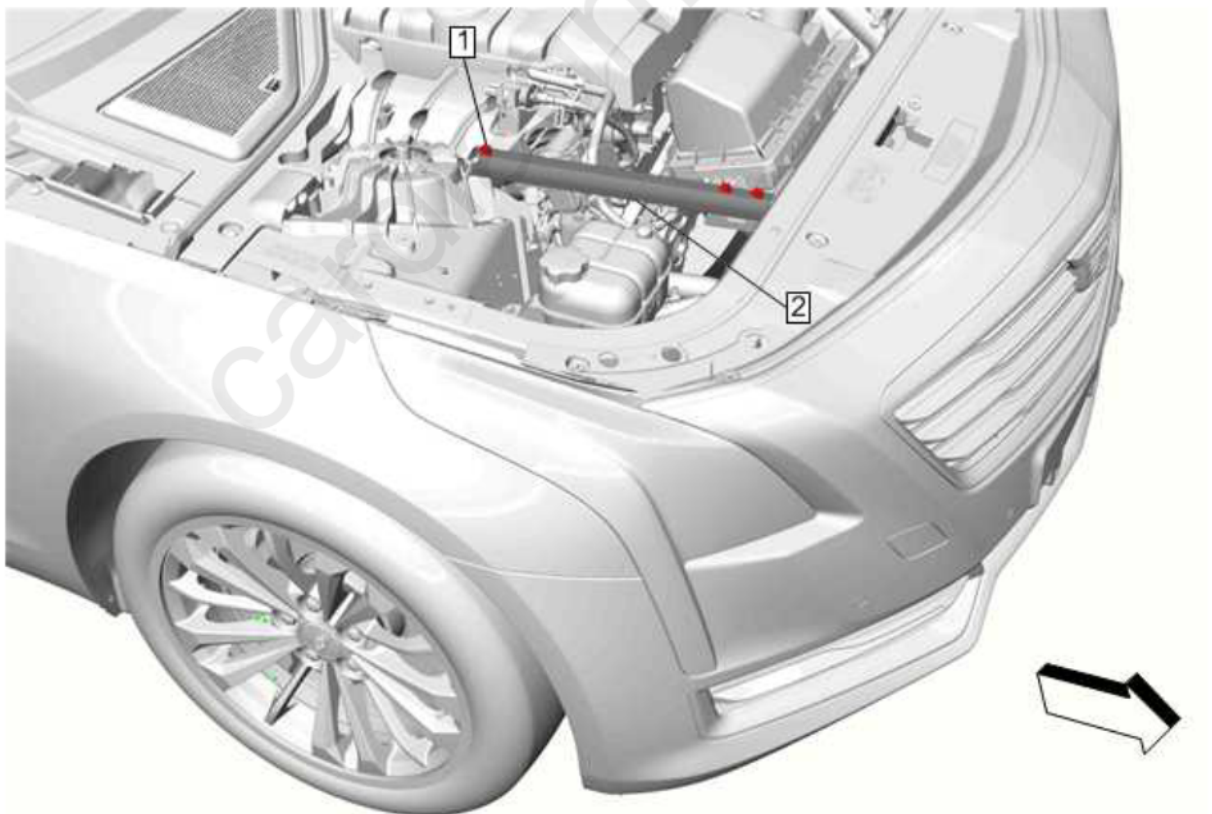


Fig. 61: Front Wheelhouse Panel Brace (Front)

Courtesy of GENERAL MOTORS COMPANY

13. Accessory DC Power Control Module Bolt (1)» Install and tighten 22 N.m (16 lb ft)

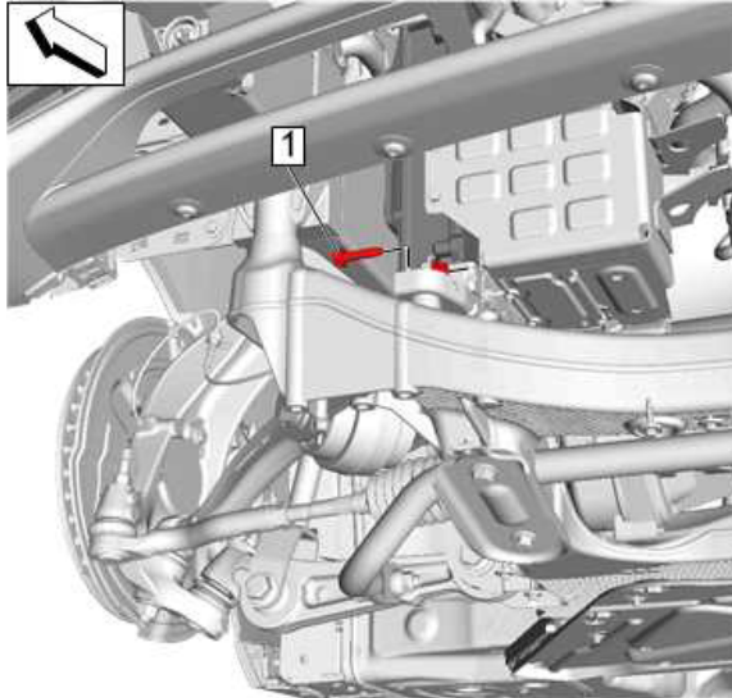


Fig. 62: Accessory DC Power Control Module Bolt
Courtesy of GENERAL MOTORS COMPANY

14. Accessory DC Power Control Module Bracket (3)» Install - [Accessory DC Power Control Module Bracket Replacement](#)

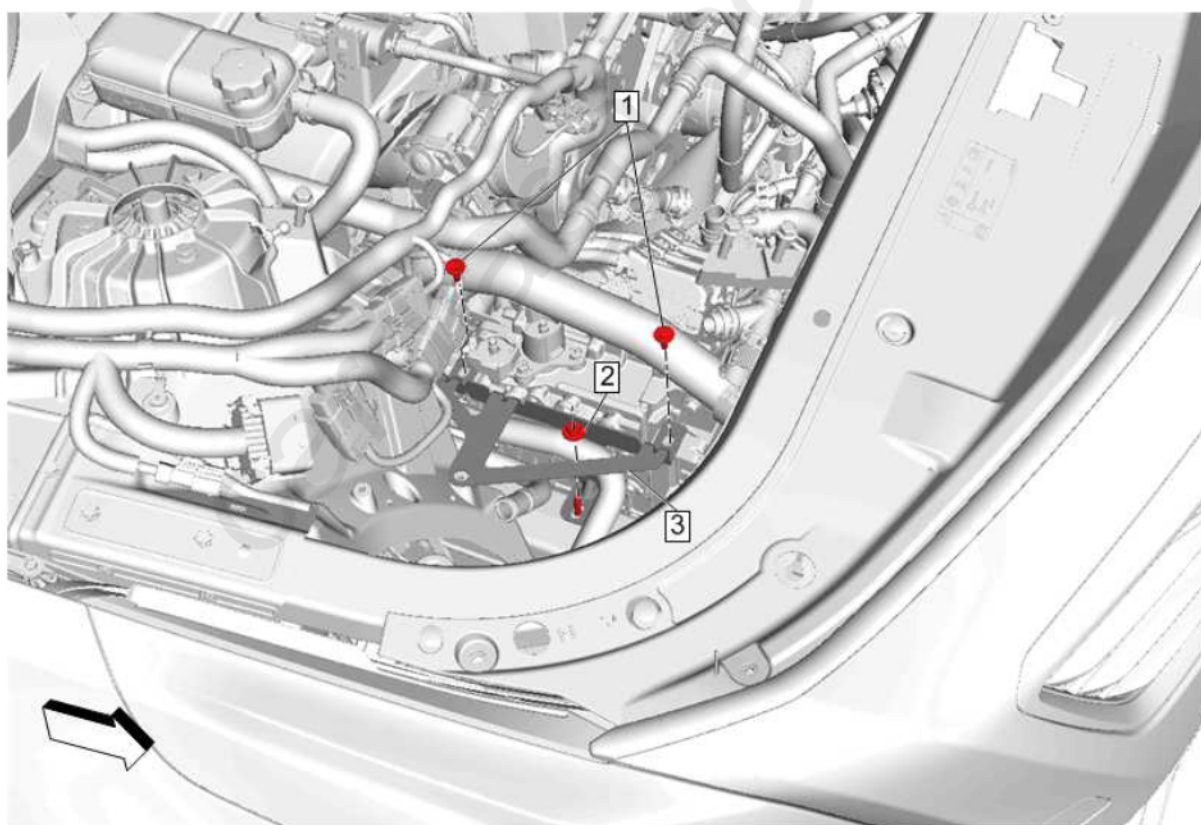


Fig. 63: Accessory DC Power Control Module Bracket
Courtesy of GENERAL MOTORS COMPANY

15. Accessory DC Power Control Module Bolt (1)» Install and tighten [2x] 22 N.m (16 lb ft)

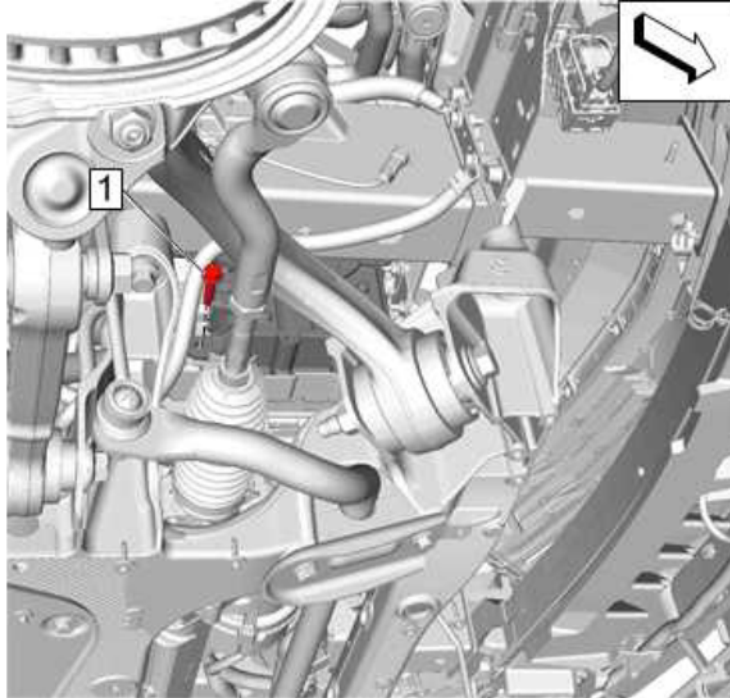


Fig. 64: Accessory DC Power Control Module Bolt
 Courtesy of GENERAL MOTORS COMPANY

16. Accessory DC Power Control Module High Voltage Connector Protector Bolt (1)» Install and tighten 9 N.m (80 lb in)

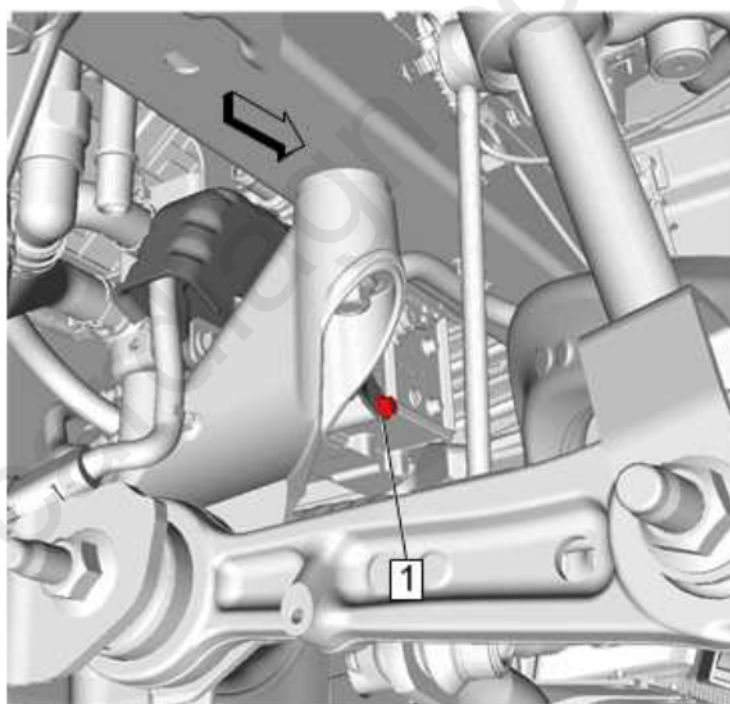


Fig. 65: Accessory DC Power Control Module High Voltage Connector Protector Bolt
 Courtesy of GENERAL MOTORS COMPANY

17. Accessory DC Power Control Module High Voltage Connector Protector (2)» Install

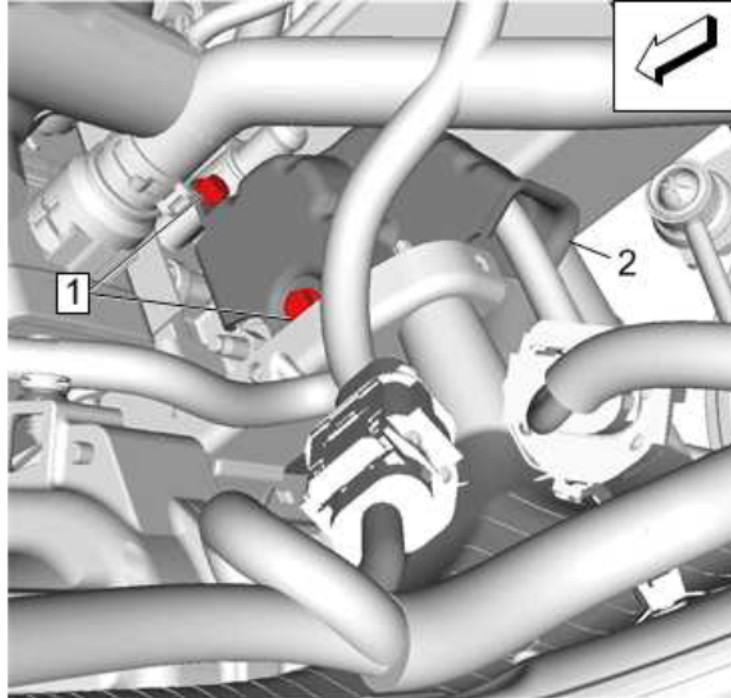


Fig. 66: Accessory DC Power Control Module High Voltage Connector Protector Bolts
 Courtesy of GENERAL MOTORS COMPANY

18. Accessory DC Power Control Module High Voltage Connector Protector Bolt (1)» Install and tighten [2x] 9 N.m (80 lb in)
19. Electrical Connector (1)» Connect

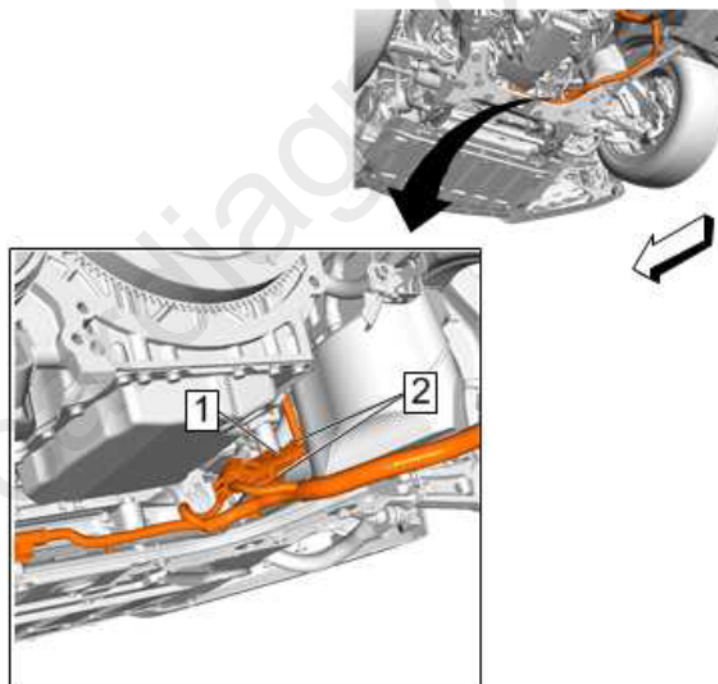


Fig. 67: Electrical Connector And Retainers
 Courtesy of GENERAL MOTORS COMPANY

20. Retainer (2)» Engage [2x]
21. Generator Control Module Coolant Radiator Hose (2)» Install - **Generator Control Module Coolant Radiator Hose Replacement**

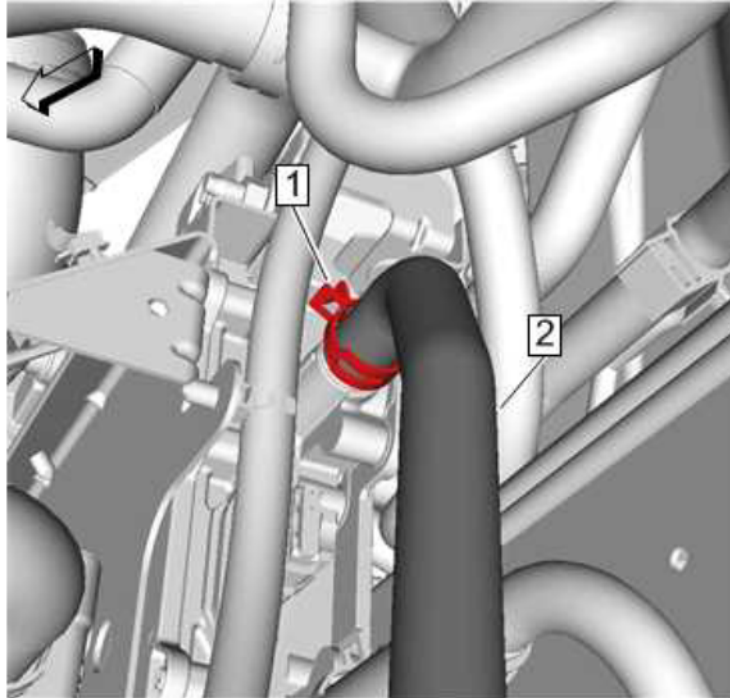


Fig. 68: Generator Control Module Coolant Radiator Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

22. Drive Motor Generator Control Module Radiator Outlet Hose (2)» Install - **Drive Motor Generator Control Module Radiator Outlet Hose Replacement**

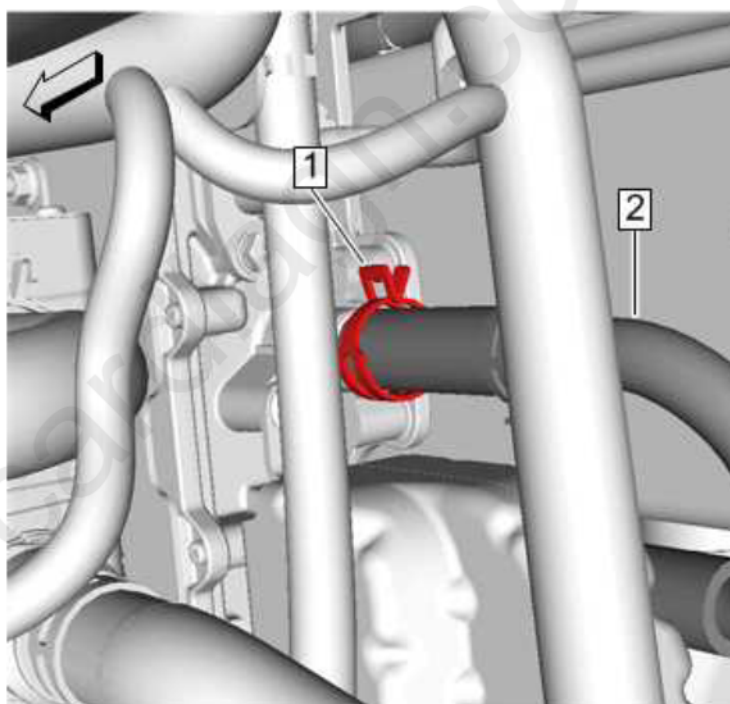


Fig. 69: Drive Motor Generator Control Module Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

23. Enable the high voltage system. Refer to **High Voltage Enabling**
24. Reprogram the accessory DC power control module, refer to **Control Module References**

DESCRIPTION AND OPERATION

ACCESSORY DC POWER CONTROL MODULE DESCRIPTION AND OPERATION

Location

The 14 V power module, also called the accessory DC power control module, is located in right front of the engine compartment. The 14 V power module is cooled with pre-mixed Dexcool® circulating through a cooling system that is separate from the engine cooling system.

The 14 V power module is an electronic device that takes the place of the generator on a traditional vehicle. On a hybrid or electric vehicle the 14 V power module converts high voltage (355 V) direct current (DC) to low voltage (12 V) DC for accessory electrical operation and to charge the 12 V battery. Under normal conditions, the 14 V power module supplies 12 V DC when the vehicle is On or in Accessory mode.

The 14 V power module is capable of supplying up to 150 Amps of 12 V DC.

12 V Battery Maintenance Mode

Battery Maintenance Mode is an automatic function that prevents deep discharge of the 12 V battery in specific circumstances. It is not dependent on the drive motor battery charger cable being plugged into the hybrid/EV battery charger receptacle. It functions either when the drive motor battery charger cable is plugged in or unplugged. Operation differs depending on whether the power mode is Vehicle Off or Vehicle in Service Mode.

With Vehicle Off, the 12 V battery is monitored at periodic intervals up to a maximum of 30 days. With Vehicle in Service Mode, the 12 V battery is monitored at periodic intervals up to a maximum of 60 hours. If voltage is low, the 12 V battery is charged by the 14 V power module using external power for up to four hours. This function is only intended to prevent a dead 12 V battery and does not provide a full charge. This is more efficient than continuously trickle charging, thus minimizing the usage of external power.

Under normal circumstances, with a 12 V battery that is charged when the vehicle is parked, Battery Maintenance Mode will simply monitor the voltage level and no charging will be necessary. With Vehicle Off, Battery Maintenance Mode will maintain the 12 V battery for up to 30 days. For longer periods, refer to Owner Manual for instructions.

Communication and Hosted Diagnostics

The 14 V power module has no internal diagnostic tests and does not communicate over serial data. The engine control module (ECM) monitors and controls the 14 V power module and will report DTCs if a fault is detected.

Circuit Inputs

Inputs to the 14 V power module include the high voltage and 12 V circuits. The 14 V power module also has a pulse width modulated set point input from the engine control module (ECM). This input enables conversion of voltage from high to the desired 12 V output level.

For more information on the 12 V Battery Charging System, refer to [**Charging System Description and Operation**](#).

Circuit Outputs

Outputs

The only outputs supported by the 14 V power module are the status feedback circuit to the engine control module (ECM) and 12 V DC which powers the 12 V components in the vehicle and charges the 12 V battery.

Low voltage 12 V cables on the hybrid/EV vehicle do not require unique coloring or servicing procedures.

DRIVE MOTOR POWER INVERTER MODULE DESCRIPTION AND OPERATION

Overview

The power inverter module, often referred to as the drive motor generator power inverter module, converts high voltage direct current (DC) electrical energy to 3-phase alternating current (AC) electrical energy. It is mounted under hood below the air inlet grill panel and is cooled with pre-mixed DEX-COOLÂ® circulating through a cooling system that is separate from the engine cooling system. The hybrid cooling system utilizes a heat exchanger at the front of the vehicle and electric pumps to circulate the coolant. Refer to [**Hybrid/EV Cooling System Description and Operation**](#).

High Voltage Circuits

Direct Current (DC)

The power inverter module is connected to the positive and negative terminals of the high voltage DC hybrid/EV battery pack. Both of the negative and positive high voltage DC battery poles are electrically isolated from the vehicle chassis by a specific amount of resistance. Each high voltage DC bus is switched ON or OFF by a high voltage, high current contactor relay contained within the hybrid/EV battery pack. All high voltage DC negative and positive DC cables are individually shielded and orange in color to alert the technician to the potential presence of high voltage.

Three Phase Alternating Current (AC)

There are two 3-phase motors in the transmission, connected directly to the power inverter module via ring terminals and A/C connector rods. A single shielded cable connects the electric auxiliary fluid pump motor assembly to the power inverter module. This cable contains 3 individual wires that are connected to the 3 phases of the auxiliary transmission fluid pump. The cable is orange in color to alert the technician to the potential presence of high voltage.

Drive Motor Generator Power Inverter Module

Overview

The power inverter module contains 2 motor control modules, the transmission fluid pump control and the hybrid/EV powertrain control module 1. Two of the motor control modules operate their respective drive motors based upon power inverter module commands. The third motor control module controls the electric auxiliary fluid pump motor assembly. The hybrid/EV powertrain control module 1 and the motor control modules share the power inverter module ignition voltage circuit, battery voltage circuits and chassis ground. All four modules are flash-programmable microprocessors.

Hybrid Powertrain Control Module

Location

The hybrid/EV powertrain control module 1 is a non-serviceable, flash-programmable microprocessor contained within the power inverter module.

Operating Functions

The hybrid/EV powertrain control module 1 is the main controller of powertrain operation. The hybrid/EV powertrain control module 1 determines when to perform normal operating modes such as electric mode, extended range mode and regenerative braking. The hybrid/EV powertrain control module 1 also operates in conjunction with the hybrid/EV powertrain control module 2 to determine when to enable and disable the DC high voltage circuits. Each motor control module operates the applicable motor based upon hybrid/EV powertrain control module 1 commands.

Communication and Hosted Diagnostics

The hybrid/EV powertrain control module 1 is the host controller for DTC information for the following control modules:

- Drive motor 1 control module
- Drive motor 2 control module
- Electric auxiliary fluid pump motor assembly

These modules diagnose their own operation and determine when a fault condition is present.

The motor control modules and the hybrid/EV powertrain control module 1 exchange information and commands on a serial peripheral interface bus internal communication circuit as well as the hi-speed GMLAN communication circuit.

In the event a hosted module communicates a fault condition, the hybrid/EV powertrain control module 1 will determine if one or more operating modes are affected and notify the vehicle operator by requesting the MIL illuminate and/or by displaying a message in the Driver Information Center. In addition, the hybrid/EV powertrain control module 1 will store the associated DTC information for retrieval by a scan

tool. Some hosted modules may require an ignition cycle to clear certain DTCs from the hybrid/EV powertrain control module 1.

Circuit Inputs

In addition to data parameters, the hybrid/EV powertrain control module 1 directly monitors the following signal circuits:

- Transmission internal mode switch direction and Park/Neutral switch signals
- Crankshaft position sensor signal

Motor Control Modules

Location

Both of the drive motors and the electric auxiliary fluid pump motor assembly are located within the transmission. They are each controlled by their own motor control module; each module is a flash-programmable micro-processor. Each motor control module is contained within the power inverter module. Also contained within the power inverter module is the hybrid/EV powertrain control module 1 micro-processor.

Operating Functions

The motor control modules operate their respective motors based upon hybrid/EV powertrain control module 1 commands. Each motor control module controls the speed, direction and output torque of its respective drive motor or the electric auxiliary fluid pump motor assembly through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors.

Communication and Hosted Diagnostics

In addition to the internal serial peripheral interface bus communication circuit that the hybrid/EV powertrain control module 1 and each motor control module control use to communicate, the motor control modules also communicate on the hi-speed and hybrid serial data circuits. The motor control modules do not store their own Diagnostic Trouble Code (DTC) information. The hybrid/EV powertrain control module 1 will store motor control module associated DTC information for retrieval by a scan tool. The scan tool can communicate directly with each motor control module in order to retrieve data parameters only.

Circuit Inputs

In addition to data parameters, each motor control module monitors its respective motor for voltage, current, speed, direction and temperature. Additionally, the motor control module monitors the insulated gate bipolar transistor components for temperature and proper operation. Some of the motor control module operation data is shared with the hybrid/EV powertrain control module 1.

Circuit Outputs

Each motor control module controls its respective insulated gate bipolar transistor driver board that in-turn controls each motor. The motors operate using 3-phase AC electricity and are connected directly to the power inverter module via ring terminals and A/C connector rods. A single shielded cable connects the electric auxiliary fluid pump motor assembly to the power inverter module. This cable contains 3 individual wires that are connected to the 3 phases of the electric auxiliary fluid pump motor assembly. The cable is orange in color to alert the technician to the potential presence of high voltage.

ELECTROMAGNETIC COMPATIBILITY DESCRIPTION

Overview

Vehicles are typically subject to certain legal requirements that limit the amount of electromagnetic interference (EMI) that can be generated by the vehicles electronic devices. Additionally, the electronic devices within the vehicle must be able to withstand a certain amount of EMI without affecting their operation. EMI is generated whenever electrical current flows through a circuit. The amount of EMI generated or amplitude, is usually dependent upon the amount of current flow, amperage and the on-off

pattern of current flow through the circuit, frequency. The EMI requirements are generally referred to as electromagnetic compatibility.

There are many ways of ensuring the vehicle meets electromagnetic compatibility requirements. These include:

- Adding capacitors and resistors to certain electrical circuits
- Regulating the frequency at which a component may operate
- Shielding the wires, cables and components

Circuit Design

The power inverter module, often referred to as the drive motor generator power inverter module and the 14 V power module, often referred to as the accessory DC power control module, each contain filter capacitors connected to the high voltage circuits. These capacitors are necessary to reduce the voltage spikes that occur as a result of the switching of current On and Off. Reducing voltage spikes reduces EMI. The frequency of current switching is also closely regulated. Too high a frequency can cause an increase in EMI generation.

Wiring/Cable Design

Different types of wire/cable shielding methods are utilized in the vehicle. Common types of circuit shielding include twisted-pair and internal braid or foil. Twisted pair is typically used in circuits such as serial data circuits. The wire pair is twisted together at a particular turns-per-length ratio. Shielded cable is utilized for all other circuits requiring either protection from external EMI or to reduce EMI radiation of the cable itself into other nearby components or circuits.

High Voltage Cable

- 300-Volt Battery Positive and Negative Cable
- Air Conditioning and Drive Motor Battery Cooling Compressor

The high voltage cables utilize internal braid shielding. Typically, both ends of the internal braid shield are attached to chassis ground. All of the high voltage, internally shielded cables are grounded at their cable end attachment points. Mounting blocks, where used, perform the shield to chassis ground connection. Connection points not serviced with a mounting block utilize a separate ring terminal.

Low and Intermediate Voltage Wiring

The signal circuits for the transmission sensors utilize shielding protection. The drive motor position sensor circuits utilize internal foil shielding. The wiring harness external of the transmission assembly is connected to chassis ground with ring terminals at the power inverter module. The internal transmission wiring harness is attached to chassis ground with a ring terminal at the valve body assembly.

The auxiliary transmission fluid pump 3 phase cables utilize internal foil shielding. The wiring harness shield is connected to chassis ground within the power inverter module.

Component Shielding

Certain components utilize their structure to effectively shield EMI. Metal covers, chassis grounded metal cases and electro-magnetically conductive gaskets may all be part of a components electromagnetic compatibility design.

Shielding Loss

A loss of proper shielding may result in poor AM band radio reception and/or incorrect sensor circuit readings depending upon the location of the shield loss. Damage that has penetrated to the insulated conductor of high voltage cables is not repairable. Certain Low and Intermediate voltage shielded wiring harnesses may be repairable. Refer to [Wiring Repairs](#) and [Splicing Twisted or Shielded Cable](#).

HIGH VOLTAGE MONITORING SYSTEMS DESCRIPTION

The hybrid/EV system monitors several high voltage components for attempted access. Additionally, a minimum amount of isolation resistance is maintained at all times between both negative and positive

poles of the hybrid/EV battery and the vehicle chassis. Microprocessors internal to the power inverter module, often referred to as the drive motor generator power inverter module and the hybrid/EV powertrain control module 2 monitor the hybrid/EV system for access and loss of isolation.

High Voltage Interlock Circuit

The high voltage interlock circuit is a wire loop that passes through certain high voltage components. The high voltage interlock circuit is used to determine if access to high voltage components is being attempted. The opening of these high voltage components causes the high voltage interlock circuit to open. The hybrid/EV system may react to the loss of high voltage interlock circuit continuity by opening the high voltage contactor relays and discharging the high voltage capacitors. The high voltage interlock circuit signal is generated by the hybrid/EV powertrain control module 2. The high voltage interlock circuit status is monitored by the hybrid/EV powertrain control module 2.

High Voltage DC Chassis Isolation

Vehicles equipped with high voltage storage and propulsion capability are designed with the high voltage circuits isolated from the vehicle chassis. If either the positive or negative high voltage Direct Current (DC) circuits or any of the high voltage Alternating Current (AC) phase circuits lose this isolation to the vehicle chassis, one or more diagnostic trouble codes (DTCs) may set. Additional information can be found in [Hybrid/EV System High Voltage Isolation Description](#).

HYBRID MODES OF OPERATION DESCRIPTION

Vehicle Operating Modes Description

Hybrid Operation

This vehicle combines gasoline and electric propulsion. The gasoline engine will automatically start to provide power and then shut off to save fuel.

The engine may remain running when:

- Accelerating aggressively or climbing hills.
- Vehicle speed is greater than 125 km/h (75 mph).
- Charging the high voltage battery.
- The heater is being used.

Auto Engine Stop/Start

When the brakes are applied and the vehicle is at a complete stop, the engine may turn off. When stopped, The Auto Stop light may come on in the instrument cluster. When the brake pedal is released or the accelerator pedal is pressed, the engine may restart.

Auto Stop may be deactivated if:

- A minimum vehicle speed is not reached.
- The engine or transmission is not at the required operating temperature.
- The outside temperature is not in the required operating range, typically between -10°C (14°F) and 50°C (122°F).
- The shift lever is in any gear other than D (Drive).
- The battery has been recently disconnected.
- The battery charge is low.
- The interior comfort level has not reached the required level for the climate control system or defog settings.
- The Auto Stop time is greater than two minutes.
- With the hood open, the engine will be in an Auto Stop. The driver may force the engine on when the hood is open, by completely pressing the accelerator pedal for at least two seconds.

Internal Combustion Engine (ICE) Starting

This vehicle does not use a 12 V starter motor to crank the ICE. A much more powerful 300 V motor, drive motor 1, located within the transmission is utilized to crank the ICE. Drive motor 1 can rotate the ICE to operating speed within just a few hundred milliseconds. This allows near-instant starting of the ICE.

The vehicle's on-board computers determine when the ICE needs to run. Some of the normal vehicle conditions that force the ICE to run are:

- The hybrid/EV battery pack has a low state of charge
- The ICE is needed to maintain the hybrid/EV battery pack temperature
- The ICE needs to run for maintenance
- Extremely low ambient temperatures

When the hood is open, the ICE will run without turning off. The hybrid/EV battery pack is neither charged nor discharged when this occurs.

Some hybrid/EV battery pack faults will cause the ICE to run without turning off.

Service Mode

Service Mode is available for service and diagnostics and to verify the proper operation of the MIL and may be required for emission inspection purposes. With vehicle OFF and the brake pedal not applied, pressing and holding the POWER button for more than 5 seconds will place the vehicle in Service Mode. The instruments and audio systems will operate as they do in ON, but the vehicle will not be able to be driven. The propulsion system will not start in Service Mode.

Engine Unavailable

If the vehicle runs out of fuel or the power inverter module has detected the ICE will not start due to a malfunction, the vehicle can continue to be driven in Electric Mode.

Propulsion Power is Reduced

This message comes on any time the battery is reporting less than 35 kW of power available for any reason. This message will NOT require service by a dealer unless the Propulsion Power Reduced message is accompanied by a Malfunction Indicator Lamp.

- This message may appear while severe highway grades, even in Mountain Mode.
- This message may appear on start up if the battery is at or below -15°C (5°F), possibly from the vehicle sitting outside unplugged in the winter.
- This message may appear in Normal or Sport mode in non-mountainous terrain, typically with aggressive driving. When this message appears with aggressive driving, the battery reserve has been depleted.

Maintenance Modes

Engine Maintenance Mode

Engine Maintenance Mode runs the engine to keep it in good working condition when the vehicle has been operated in Electric Mode only for a prolonged period. Engine Maintenance Mode will run the ICE, even if the hybrid/EV battery pack state of charge is sufficient to operate the vehicle in Electric Mode.

Fuel Maintenance Mode

When only Electric Mode is used for a prolonged period, Fuel Maintenance Mode will run the ICE to use up old fuel. The ICE will run until enough fresh fuel is added or a low fuel level is detected. During Fuel Maintenance Mode the ICE may cycle on and off.

Regenerative Braking

When the vehicle is coasting or braking the power inverter module may operate the drive motor as a generator in an Electrical Generation Mode. Operating as an electrical generator, the drive motor exerts a driveline load that helps to slow the vehicle. The electrical energy that the drive motor creates is transferred by the power inverter module to the hybrid/EV battery pack. Constant communication between the power

inverter module and the electronic brake control module allows the blending of regenerative braking force with hydraulic braking force.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

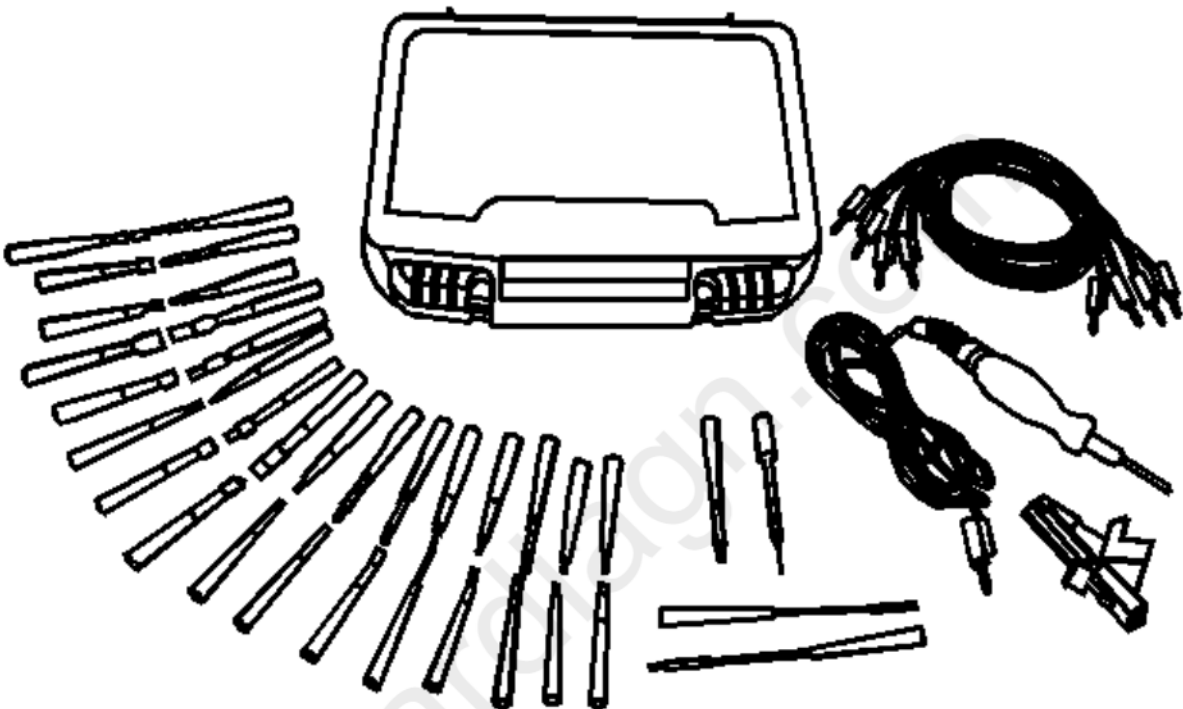
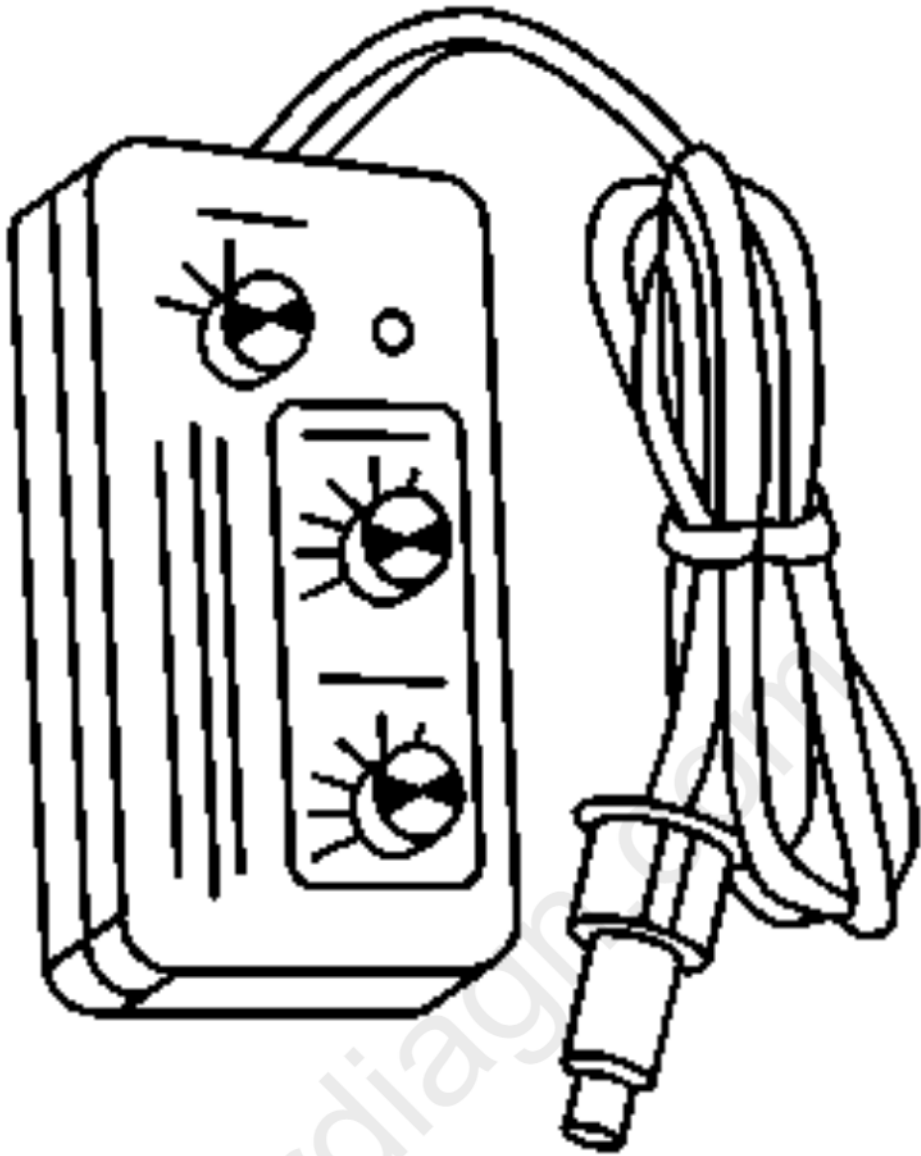
Illustration	Tool Number/ Description
	EL-35616 J-35616 GM- Approved Terminal Test Kit

Illustration	Tool Number/ Description
	EL-38522-A J-38522-A Variable Signal Generator