High Voltage Contactor/Relay Malfunction

Diagnostic Instructions

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

Circuit/System Description

The drive motor generator battery control module is also referred to as the battery energy control module (BECM). The drive motor generator battery control module will diagnose its own systems and determine when a fault condition is present. Diagnostics and system status is communicated from the drive motor generator battery control module to the hybrid powertrain control module (HPCM) through serial data. The hybrid powertrain control module is the host controller for diagnostic trouble code (DTC) information.

The hybrid drive motor generator battery contains 3 high voltage contactor/relays also referred to as high voltage relays. The high voltage contactor/relays allow the high voltage DC batteries to be connected to the vehicle or safely contain the high voltage DC within the drive motor generator battery assembly. The 3 high voltage contactor/relays are a positive high voltage contactor, negative high voltage contactor, and current limit relay. These contactor/relays close and open in sequence and are controlled by the drive motor generator battery control module. The drive motor generator battery control module supplies voltage to the control circuit for the high voltage relays. Ground is provided through the case ground.

Diagnostic Aids

Note: If the high voltage contactor/relays opened while under high current load, replace BOTH high voltage contactor/relays. The following conditions could cause the high voltage contactor/relays to open while under high current load:

- A collision resulting in supplemental inflatable restraint (SIR) deployment.
- A collision that activates the high voltage circuit impact detection (HVCID) sensor.
- A high voltage circuit impact detection sensor circuit fault that occurs while the vehicle is moving.
- A loss of power or ground to the drive motor generator battery control module while the vehicle is moving.

DTC P0C76 can only be cleared in the hybrid powertrain control module with a scan tool. After the repair is complete, select the scan tool HPCM special functions, then select Clear 300V Present DTC.

Reference Information

Schematic Reference

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

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- *EL-48569* Terminal Covers
- *EL-48900* HEV Safety Kit

Circuit/System Verification

1. Ignition OFF, disable the high voltage at the drive motor generator battery. Refer to High Voltage Disabling.
2. Ignition ON, command the negative contactor ON and OFF with a scan tool while listening for the contactor to turn ON and OFF. The negative contactor should be heard turning ON and OFF.

   ⇒ If the negative contactor does not turn ON and OFF, refer to Negative Contactor Diagnosis.
3. Command the positive contactor ON and OFF with a scan tool while listening for the contactor to turn ON and OFF. The positive contactor should be heard turning ON and OFF.

   ⇒ If the positive contactor does not turn ON and OFF, refer to Positive Contactor and Current Limit Relay Diagnosis.
4. Command the current limit relay ON and OFF with a scan tool while listening for the relay to turn ON and OFF. The current limit relay should be heard turning ON and OFF.

   ⇒ If the current limit relay does not turn ON and OFF, refer to Positive Contactor and Current Limit Relay Diagnosis.

Circuit/System Testing

Negative Contactor Diagnosis

Danger: 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 these procedures may result in serious injury or death.

1. Ignition OFF, disable the high voltage at the drive motor generator battery. Refer to High Voltage Disabling.

   Note: The following tests require wearing personal protection equipment (PPE) gloves.
2. Ignition OFF, disconnect the inline X1 harness connector at the negative contactor.
3. Test for less than 5 Ω between the ground circuit terminal 2 and ground.

   ⇒ If greater than the specified range, test the ground circuit for an open/high resistance.
4. Connect a test lamp between the control circuit terminal 1 and ground.
5. Connect the 12 V battery.
6. Ignition ON, command the negative contactor open and closed with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   ⇒ If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the drive motor generator battery control module.

   ⇒ If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the drive motor generator battery control module.
7. Ignition OFF, disconnect the X2 harness connector at the negative contactor.
8. Ignition ON, command the negative contactor closed with a scan tool. Test for less than 2 Ω between terminals X2 and X3 of the negative contactor.

   ⇒ If greater than the specified range, replace the high voltage negative contactor.
9. Ignition OFF, test for infinite resistance between terminals X2 and X3 at the negative contactor.

   ⇒ If less than the specified value, replace the high voltage negative contactor.
10. DTC P0ADB, P0ADC, P0ADF, P0AE0, P0AE7, P0C76, P0C77, or P1A20 should not be set.

    ⇒ If DTC P0C76 is set, replace the hybrid powertrain control module.

    ⇒ If DTC P0ADB, P0ADC, P0ADF, P0AE0, P0C77 or P1A20 is set, replace the drive motor generator battery control module.

Positive Contactor and Current Limit Relay Diagnosis

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

The High Voltage Disabling procedure includes the following steps:
- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

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

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

1. Ignition OFF, disable the high voltage at the drive motor generator battery. Refer to High Voltage Disabling.

Note: The following tests require wearing personal protection equipment (PPE) gloves.

2. Ignition OFF, test for 11–13 Ω between terminal X2 at the positive contactor and terminal X3 connectors at the current limit relay.
   ⇒ If less than the specified range, replace the current limit resistor.
3. Ignition OFF, disconnect the X2 harness connector at the current limit relay.
4. Test for less than 5 Ω between the ground circuit terminal 6 and ground.
   ⇒ If greater than the specified range, test the ground circuit for an open/high resistance.
5. Disconnect the X1 harness connector at the current limit relay.
6. Connect a test lamp between the control circuit terminal 5 X1 and ground.
7. Connect the 12 V battery.
8. Ignition ON, command the current limit relay open and closed with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
   ⇒ If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the drive motor generator battery control module.
   ⇒ If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the drive motor generator battery control module.
9. Ignition OFF, disconnect the X3 harness connector at the current limit relay.
10. Ignition ON, command the current limit relay closed with a scan tool. Test for less than 2 Ω between terminals X3 and X4 of the current limit relay.
    ⇒ If greater than the specified range, replace the high voltage current limit relay.
11. Ignition OFF, test for infinite resistance between the high voltage current limit relay terminals X3 and X4.
    ⇒ If not the specified value, replace the high voltage current limit relay.
12. Ignition OFF, disconnect the X1 harness connector at the positive contactor.
13. Test for less than 5 Ω between the ground circuit terminal 2 and ground.
    ⇒ If greater than the specified range, test the ground circuit for an open/high resistance.
14. Connect a test lamp between the control circuit terminal 1 and ground.
15. Ignition ON, command the positive contactor open and closed with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    ⇒ If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the drive motor generator battery control module.
    ⇒ If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the drive motor generator battery control module.
16. Ignition OFF, disconnect the X2 harness connector at the positive contactor.
17. Ignition ON, command the positive contactor closed with a scan tool. Test for less than 2 Ω between terminals X2 and X3 of the positive contactor.
    ⇒ If greater than the specified range, replace the high voltage positive contactor.
18. Ignition OFF, test for infinite resistance between the high voltage positive contactor terminals X2 and X3.
    ⇒ If not the specified range, replace high voltage positive contactor.
19. DTC P0ADB, P0ADC, P0ADF, P0AE0, P0AE7, P0C76, P0C77, or P1A20 should not be set.
    ⇒ If DTC P0C76 is set, replace the hybrid powertrain control module.
    ⇒ If DTC P0ADB, P0ADC, P0ADF, P0AE0, P0AE7, P0C77 or P1A20 is set, replace the drive motor generator battery control module.

Component Testing

Negative and Positive Contactor Test

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

The High Voltage Disabling procedure includes the following steps:
- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

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

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

1. Ignition OFF, perform the high voltage disable procedure. Refer to High Voltage Disabling.
2. Remove the appropriate high voltage contactor.
3. Test for 20–35 Ω between the control terminal 1 and the ground terminal 2.

   ⇒ If not within the specified range, replace the high voltage contactor.
4. Test for infinite resistance between the following terminals:
   - X2 and 1 X1
   - X2 and X3
   - X2 and 2 X1
   - 2 X1 and X3

   ⇒ If not within the specified value, replace the high voltage contactor.
5. Install a 20 A fused jumper wire between the relay terminal 1 X1 and 12 V. Install a jumper wire between terminal 2 X1 and ground. Test for less than 2 Ω between terminals X2 and X3.

   ⇒ If not within the specified range, replace the high voltage contactor.

Current Limit Relay

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

The High Voltage Disabling procedure includes the following steps:
- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:
- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.

- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
  - – Visually and functionally inspect the gloves before use.
  - – Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

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

1. Ignition OFF, perform the high voltage disable procedure. Refer to High Voltage Disabling.
2. Remove the current limit relay.
3. Test for 55–75 Ω between the control terminal 1 and the ground terminal 2.

   ⇒ If not within the specified range, replace the high voltage current limit relay.
4. Test for infinite resistance between the following terminals:
   - 1 X3 and 5 X1
   - 1 X3 and 2 X4
   - 1 X3 and 6 X2
   - 6 X2 and 2 X4

   ⇒ If not within the specified value, replace the high voltage current limit relay.
5. Install a 20 A fused jumper wire between relay terminal 5 X1 and 12 V. Install a jumper wire between relay terminal 6 X2 and ground. Test for less than 2 Ω between terminals 1 X3 and 2 X4.

   ⇒ If not within the specified range, replace the high voltage current limit relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Drive Motor Battery Positive High Voltage Contactor Relay Replacement
- Drive Motor Battery Negative High Voltage Contactor Relay Replacement
- Drive Motor Power Inverter Current Limit Relay Replacement
- Drive Motor Battery Replacement and Shipping Preparation
- Control Module References drive motor generator battery control module or hybrid powertrain control module replacement, setup and programming