

DTC P1AF0 or P1AF2

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 P1AF0 Drive Motor 1 Control Module Hybrid Battery Voltage System Isolation Lost

DTC P1AF2 Drive Motor 2 Control Module Hybrid Battery Voltage System Isolation Lost

Circuit/System Description

The drive motor generator power inverter control module contains two motor control modules. Each motor control module measures hybrid battery high voltage with several internal sensors. The motor control modules test for loss of isolation between either the high voltage positive circuit or high voltage negative circuit and vehicle chassis. The motor control modules test for isolation when the high voltage contactor relays are closed. The battery energy control module only tests the hybrid battery assembly for high voltage loss of isolation when the high voltage contactor relays are open.

Motor control modules loss of isolation is detected through the use of two high-impedance resistors and voltage measuring circuitry. The two resistors are connected in series between the high voltage positive and high voltage negative circuits. The center connection of the two resistors is also connected to vehicle chassis. The motor control module then measures the voltage drop across one of the resistors. Without a loss of isolation, the motor control module should measure about half of the high voltage potential. This is referred to as mid-pack voltage. The Mid-pack voltage value is then doubled by the software and displayed on a scan tool as Motor 1 Isolation Voltage or Motor 2 Isolation Voltage. When a loss of isolation is present, the motor isolation voltage display will indicate voltage that is more or less than actual hybrid battery high voltage.

Conditions for Running the DTC

- The high voltage contactor relays are closed.
- High voltage is greater than 50 V.
- Ignition voltage is 8–18 V.
- DTCs P1AEE, P1AF4, and P1AF5 are not set.

Conditions for Setting the DTC

The ratio between Mid-Pack Voltage and hybrid battery high voltage is less than 0.27 or greater than 1.80.

OR

- Mid-Pack Voltage is less than 35 V or greater than 975 V.
- Either above condition exists for 5 seconds.

Action Taken When the DTC Sets

DTCs P1AF0 and P1AF2 are Type C DTCs.

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Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

Component Connector End Views

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-48458* Pre-Charge Test Tool
- *EL-48569* Terminal Covers

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

1. Verify that DTC P1AE7 is not set.
⇒ If the DTC is set, refer to DTC P1AE6 or P1AE7.
2. Verify that DTCs 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.
3. Ignition ON, engine OFF, observe the scan tool battery energy control module contactor system status parameter. The status should display closed.
⇒ If not the specified value, refer to Symptoms - Hybrid Controls.
4. Hood closed, transmission in park, and Ignition OFF for at least 2 minutes.
5. Ignition ON, engine OFF, within 5 seconds of ignition ON, observe the hybrid powertrain control module 300V Circuit parameter and compare it to both data parameters listed below. Each motor parameter should be within 20 V of the hybrid powertrain control module 300 V circuit parameter.
 - Motor 1 Isolation Voltage
 - Motor 2 Isolation Voltage⇒ If only one Motor Isolation Voltage value is not within the specified range, replace the drive motor generator power inverter control module.
⇒ If both Motor Isolation Voltage values are not within the specified range, refer to DC Circuit Testing in Circuit/System Testing.

6. If both Motor Isolation Voltage values are within the indicated range, a loss of isolation

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Circuit/System Testing

DC Circuit Testing

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 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 at the drive motor generator control module cable connections.
2. Remove the air conditioning control module high voltage cable connector from the drive motor generator power inverter module. Protect the terminal ends immediately with the *EL-48569* terminal covers and UL® Listed or equivalent insulation tape rated at a minimum of 600 volts.
3. Temporarily install the drive motor generator control module high voltage distribution cover.
4. Install the drive motor generator control module sight shield.
5. Install the high voltage manual disconnect lever.
6. Connect the 12 volt battery. Refer to Battery Negative Cable Disconnection and Connection.
7. Ignition ON, engine OFF, within 5 seconds of ignition ON, observe the hybrid powertrain control module 300V Circuit parameter and compare it to both data parameters listed below. Both motor parameters should be at least 20 V less than the hybrid powertrain control module 300V circuit parameter.
 - Motor 1 Isolation Voltage
 - Motor 2 Isolation Voltage

⇒ If both motor parameters pass, replace the air conditioning control module.

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 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.

8. Perform the High Voltage Disabling procedure for servicing at the drive motor generator control module cable connections.
9. Disconnect the 300 V Battery Positive and Negative Cable Assembly connector at the drive motor generator power inverter module.
10. Remove and retain the cable mounting block O-ring. Re-install the O-ring after testing is complete.
11. Disconnect the X1 harness connector at the drive motor generator power inverter module.
12. Connect the *EL-48458* test tool at the 300 V Battery Positive and Negative Cable Assembly and the drive motor generator power inverter module X1 harness connector. Refer to High Voltage System Diagnosis for Installation Procedure, set-up, and usage instructions.

13. Using the *EL-48458* test tool move the high voltage contactor switch to the CLOSED position. The greater than 60V lamp should be illuminated.

⇒ If the Greater than 60V When Lit lamp does not illuminate inspect Drive Motor Generator Battery Control Module Scan Tool Information for the contactor open reasons such as an open high voltage interlock circuit condition. Repair the reason for the open contactor condition, turn the ignition OFF and repeat this step.

Note: The scan tool isolation test output control could cause a loss of communication condition with the battery energy control module if utilized incorrectly. If the loss of communication condition occurs, you must remove the battery energy control module fuse from the auxiliary fuse block in order for the battery energy control module to re-initialize. To avoid causing this battery energy control module condition, ensure the following conditions are met prior to activating the scan tool output control:

- External 12 V battery chargers are disconnected from the vehicle.
- The output control limits are not violated when this output control is initiated.

14. Ensure the output control limits are not violated when this output control is initiated. Refer to Drive Motor Generator Battery Control Module Scan Tool Information for the control limits.

15. Activate the battery energy control module 300V Isolation Test output control with the scan tool. The Isolation Test should complete within 1 minute. Observe the 300V Isolation Test Status scan tool parameter. The test status should display FAIL when the test is completed.

⇒ If the 300V Isolation Test displays PASS, replace the drive motor generator power inverter module and the accessory DC power control module.

16. Verify high voltage is not present before disconnecting the *EL-48458* test tool from the vehicle. Refer to High Voltage System Diagnosis for Removal Procedure.

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 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.

17. Perform the High Voltage Disabling procedure for servicing at the drive motor generator battery.

18. Disconnect the 300V Battery Positive and Negative Cable Assembly connector at the drive motor generator battery assembly. Protect the terminal ends immediately with the *EL-48569* terminal covers and UL® Listed or equivalent insulation tape rated at a minimum of 600 volts.

19. Using the extension harness connect the *EL-48458* test tool at the hybrid battery 300 V positive and negative terminals.

20. Connect the *EL-48458* test tool the drive motor generator power inverter module X1 harness connector. Refer to High Voltage System Diagnosis for Installation Procedure, set-up, and usage instructions.

Note: The drive motor generator control module sight shield and the drive motor generator battery terminal cover must be reinstalled in order to complete the HVIC current loop. The battery energy control module will not close the high voltage contactor relays if an open high voltage interlock circuit condition is detected.

21. Using the *EL-48458* test tool move the high voltage contactor switch to the CLOSED position. The greater than 60V lamp should be illuminated.

⇒ If the Greater than 60V When Lit lamp does not illuminate inspect Drive Motor Generator Battery Control Module Scan Tool Information for the contactor open reasons such as an open high voltage interlock circuit condition. Repair the reason for the open contactor

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Note: The scan tool isolation test output control could cause a loss of communication condition with the battery energy control module if utilized incorrectly. If the loss of communication condition occurs, you must remove the battery energy control module fuse from the auxiliary fuse block in order for the battery energy control module to re-initialize. To avoid causing this battery energy control module condition, ensure the following conditions are met prior to activating the scan tool output control:

- External 12 V battery chargers are disconnected from the vehicle.
- The output control limits are not violated when this output control is initiated.

22. Verify the output control limits are not violated when this output control is initiated. Refer to Drive Motor Generator Battery Control Module Scan Tool Information for the control limits.
23. Activate the battery energy control module 300V Isolation Test output control with the scan tool. The Isolation Test should complete within 1 minute. Observe the 300V Isolation Test Status scan tool parameter. The test status should display FAIL when the test is completed.
⇒ If the 300V Isolation Test displays PASS, replace the 300 V Battery Positive and Negative Cable Assembly.
24. If the Isolation Test Status displays FAIL the loss of isolation has occurred within the hybrid battery between the switched side of the high voltage contactors and the hybrid battery high voltage terminal assembly. Replace or repair the drive motor generator battery.

AC Circuit Testing

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 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 at the drive motor generator control module cable connections.
2. Remove the 3-phase cable assembly from the T6 drive motor generator control module distribution box. Refer to Generator Control Module 3-Phase Cable Assembly Replacement.
3. Test for infinite resistance between each of the AC circuit terminals listed below and ground:
 - Drive motor 1st position phase U terminal
 - Drive motor 1st position phase V terminal
 - Drive motor 1st position phase W terminal
 - Drive motor 2nd position phase U terminal
 - Drive motor 2nd position phase V terminal
 - Drive motor 2nd position phase W terminal

⇒ If not the specified value, test the AC circuit for a short to ground or a short between the AC circuit terminals and the aluminum cable mounting block. If the circuit tests normal replace the appropriate M15 drive motor with generator assembly.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Drive Motor Battery Positive and Negative Cable Replacement
- Air Conditioning Compressor Replacement

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- Generator Control Module 3-Phase Cable Assembly Replacement
- Drive Motor with Generator Assembly Removal - 1st Position
- Drive Motor with Generator Assembly Removal - 2nd Position
- Control Module References for Drive Motor Generator Power Inverter Module and Accessory DC Power Control Module replacement, setup, and programming.