2014 Engine

Hybrid/EV Controls - Regal

SPECIFICATIONS

TEMPERATURE VERSUS RESISTANCE

Drive Motor Temperature Sensor

°C	°F	OHMS (±10%)
Temperature vs Resistance Values (Approximate)		
220	428	130
210	410	155
200	392	187
190	374	228
180	356	279
170	338	345
160	320	430
150	302	542
140	284	689
130	266	887
120	248	1155
110	230	1525
100	212	2036
90	194	2750
80	176	3775
70	158	5270
60	140	7500
50	122	10,800
40	104	16,050
30	86	24,270
20	68	37,300
10	50	59,100
0	32	96,200
-10	14	162,500
-20	-4	283,600
-30	-22	513,000
-40	-40	965,600

SCHEMATIC WIRING DIAGRAMS

HYBRID/EV CONTROLS WIRING SCHEMATICS

Drive Motor Monitoring

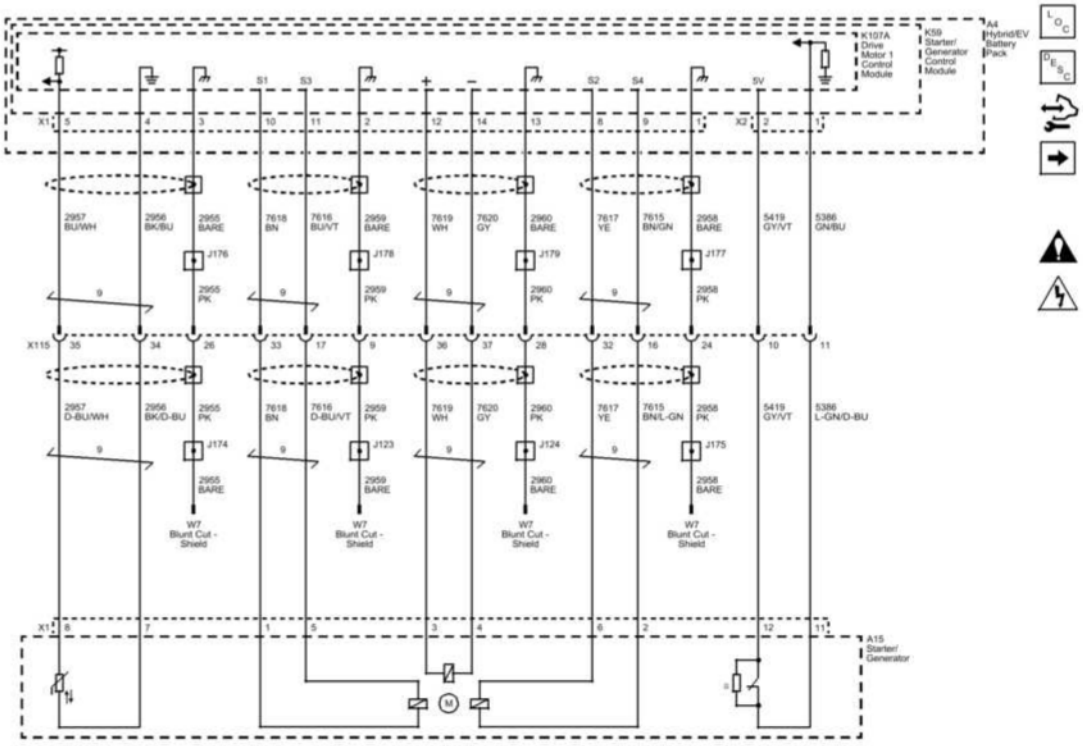


Fig. 1: Drive Motor Monitoring
Courtesy of GENERAL MOTORS COMPANY

Brake Apply and Drive Motor Control

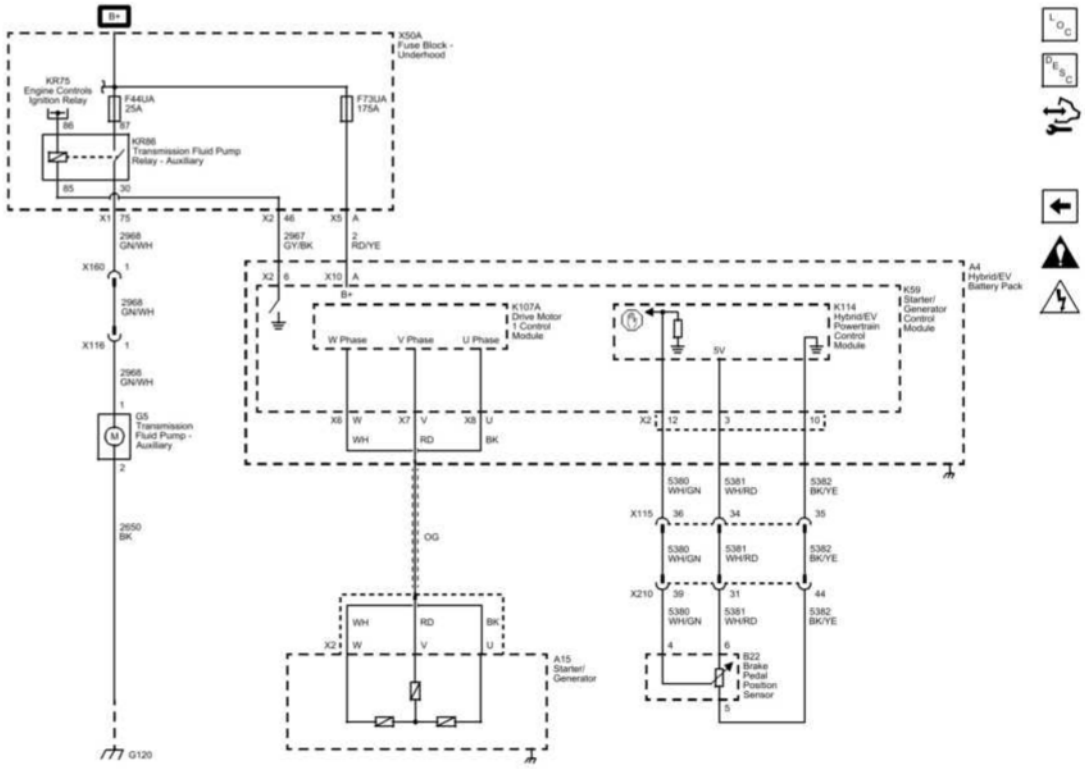


Fig. 2: Brake Apply and Drive Motor Control
Courtesy of GENERAL MOTORS COMPANY

COMPONENT LOCATOR

HYBRID CONTROLS COMPONENT VIEWS

Starter Generator, Drive Motor Tensioner, Drive Motor Battery Cable, and Components

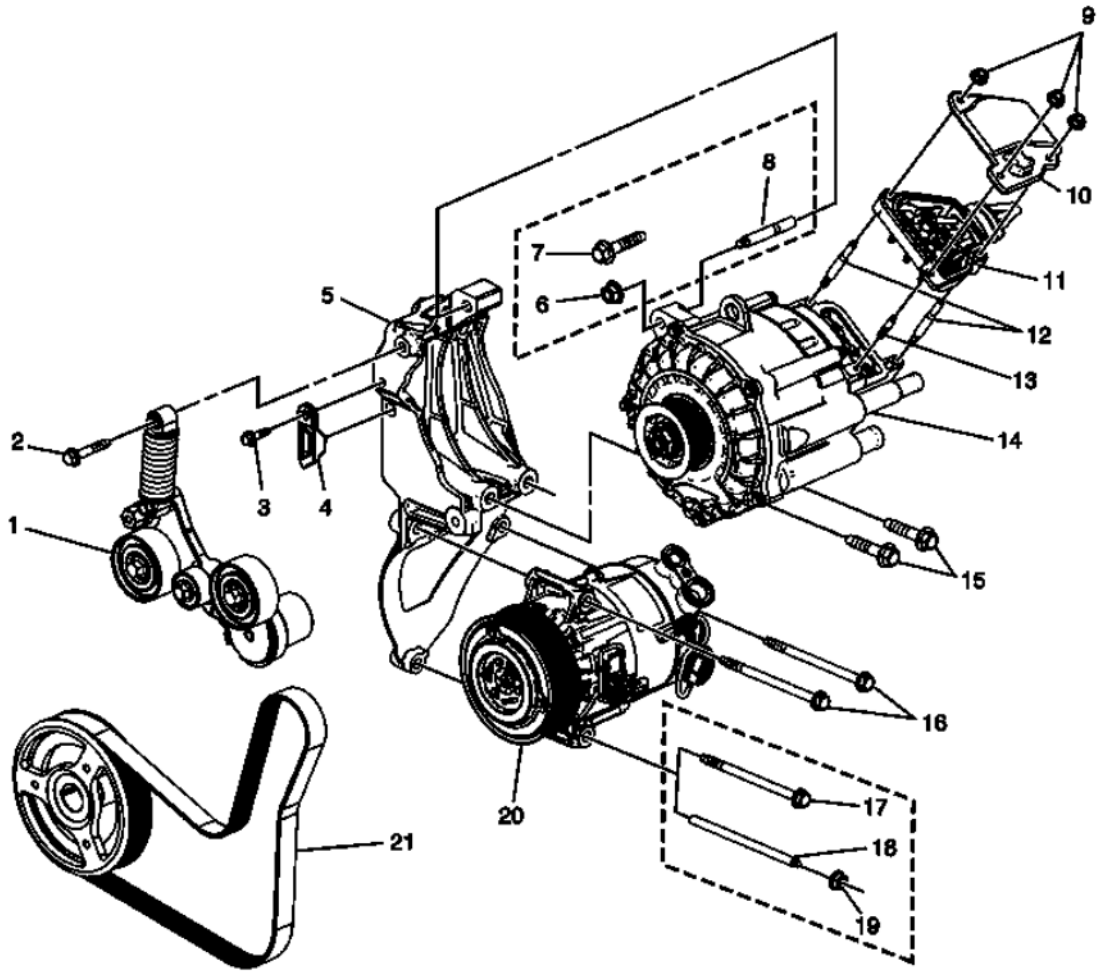


Fig. 3: Starter Generator, Drive Motor Tensioner, Drive Motor Battery Cable, and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Drive Belt Tensioner Assembly
2	Drive Belt Tensioner Bolt
3	Drive Belt Tensioner Stop Bolt
4	Tensioner Stop
5	Generator and A/C Compressor Bracket
6	Starter Generator Nut - Production
7	Starter Generator Bolt - Service
8	Starter Generator Stud - Production
9	Drive Motor Generator Battery Cable Cover Nuts
10	Drive Motor Generator Battery Cable Cover
11	Drive Motor Generator Battery Cable
12	Starter Generator Stud - Long
13	Starter Generator Stud - Short
14	Starter Generator
15	Starter Generator Bolt
16	A/C Compressor Bolts

17	A/C Compressor Bolt - Service
18	A/C Compressor Stud - Production
19	A/C Compressor Nut - Production
20	A/C Compressor
21	Generator and A/C Compressor Belt

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC P057B-P057E	DTC P057B Brake Pedal Position Sensor Performance DTC P057C Brake Pedal Position Sensor Circuit Low Voltage DTC P057D Brake Pedal Position Sensor Circuit High Voltage DTC P057E Brake Pedal Position Sensor Circuit Erratic
DTC P0601-P0604, P0606, P061B, P062F, or P262B (Hybrid Powertrain Control Module)	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 P061B Internal Control Module Torque Calculation Performance DTC P062F Control Module Long Term Memory Performance DTC P262B Control Module Power Off Timer Performance
DTC P0697	DTC P0697 5V Reference 3 Circuit
DTC P06AF	DTC P06AF Torque Management System Performance - Forced Engine Shutdown
DTC P06B1 or P06B2	DTC P06B1 Sensor Supply Positive Voltage Circuit Low Voltage DTC P06B2 Sensor Supply Positive Voltage Circuit High Voltage
DTC P0A1B, P1A50, P1A51, P1ADC, or P1EB6	DTC P0A1B Drive Motor Control Module Performance DTC P1A50 Drive Motor Control Module Random Access Memory DTC P1A51 Drive Motor Control Module Read Only Memory DTC P1ADC Drive Motor Control Module Long Term Memory Performance DTC P1EB6 Drive Motor Control Module Long Term Memory Reset
DTC P0A2B-P0A2D	DTC P0A2B Drive Motor Temperature Sensor Performance DTC P0A2C Drive Motor Temperature Sensor Circuit Low Voltage DTC P0A2D Drive Motor Temperature Sensor Circuit High Voltage
DTC P0A2F	DTC P0A2F Drive Motor High Temperature
DTC P0A3F, P0A40, P0C52, P0C53, P0C5C, P0C5D, or P1B03	DTC P0A3F Drive Motor Position Sensor Circuit DTC P0A40 Drive Motor Position Sensor Performance DTC P0C52 Drive Motor Position Sensor Circuit 1 Low Voltage DTC P0C53 Drive Motor Position Sensor Circuit 1 High Voltage DTC P0C5C Drive Motor Position Sensor Circuit 2 Low Voltage DTC P0C5D Drive Motor Position Sensor Circuit 2 High Voltage DTC P1B03 Drive Motor Position Sensor Circuit Tracking Lost
DTC P0A78	DTC P0A78 Drive Motor Inverter Performance
DTC P0A88 or P0A89	DTC P0A88 14V Power Module Input Current Sensor Circuit Low

	Current DTC P0A89 14V Power Module Input Current Sensor Circuit High Current
DTC P0A8D or P0A8E	DTC P0A8D 14V Power Module System Voltage Low Voltage DTC P0A8E 14V Power Module System Voltage High Voltage
DTC P0A8F	DTC P0A8F 14V Power Module System Voltage Performance
DTC P0A90	DTC P0A90 Drive Motor Performance
DTC P0AB9	DTC P0AB9 Hybrid/EV System Performance
DTC P0AEE, P0AEF, or P0AF0	DTC P0AEE Drive Motor Inverter Temperature Sensor Performance DTC P0AEF Drive Motor Inverter Temperature Sensor Circuit Low Voltage DTC P0AF0 Drive Motor Inverter Temperature Sensor Circuit High Voltage
DTC P0B09	DTC P0B09 Auxiliary Transmission Fluid Pump Supply Voltage Relay Control Circuit
DTC P0BE6-P0BE8, P0BEE, P0BEF, or P0BF0	DTC P0BE6 Drive Motor Phase U Current Sensor Performance DTC P0BE7 Drive Motor Phase U Current Sensor Circuit Low Voltage DTC P0BE8 Drive Motor Phase U Current Sensor Circuit High Voltage DTC P0BEE Drive Motor Phase W Current Sensor Performance DTC P0BEF Drive Motor Phase W Current Sensor Circuit Low Voltage DTC P0BF0 Drive Motor Phase W Current Sensor Circuit High Voltage
DTC P0BFD	DTC P0BFD Drive Motor Phase U-V-W Not Plausible
DTC P0C01	DTC P0C01 Drive Motor High Current
DTC P0C05	DTC P0C05 Drive Motor Phase U-V-W Circuits
DTC P0C0B	DTC P0C0B Drive Motor Inverter Supply Voltage Circuit
DTC P0C11	DTC P0C11 Drive Motor Inverter Phase U High Temperature
DTC P0C19	DTC P0C19 Drive Motor Torque Delivered Performance
DTC P0C76	DTC P0C76 Hybrid/EV Battery System High Voltage Present
DTC P0C9E or P0C9F	DTC P0C9E 14V Power Module Output Current Sensor Circuit Low Current DTC P0C9F 14V Power Module Output Current Sensor Circuit High Current
DTC P0CA2	DTC P0CA2 14V Power Module Step Down Voltage Performance
DTC P0CC5	DTC P0CC5 14V Power Module Input-Output Current Sensors Not Plausible
DTC P15F0	DTC P15F0 Engine Torque Delivered Signal Message Counter Incorrect
DTC P15F4	DTC P15F4 Drive Motor Torque Delivered Signal Message Counter Incorrect
DTC P15F5	DTC P15F5 Crankshaft Torque Command Signal Message Counter Incorrect
DTC P16F3	DTC P16F3 Control Module Redundant Memory Performance
DTC P1A56	DTC P1A56 Hybrid/EV System Voltage Discharge Circuit
DTC P1A6F	DTC P1A6F Drive Motor No Crank at Restart
DTC P1A71-P1A73	DTC P1A71 14V Power Module Temperature Sensor 2 Performance DTC P1A72 14V Power Module Temperature Sensor 2 Circuit Low Voltage DTC P1A73 14V Power Module Temperature Sensor 2 Circuit High

	Voltage
DTC P1A90-P1A92	DTC P1A90 14V Power Module Temperature Sensor 1 Performance DTC P1A91 14V Power Module Temperature Sensor 1 Circuit Low Voltage DTC P1A92 14V Power Module Temperature Sensor 1 Circuit High Voltage
DTC P1ADE or P1ADF	DTC P1ADE Drive Motor Control Module System Voltage Low Voltage DTC P1ADF Drive Motor Control Module System Voltage High Voltage
DTC P1AE8 or P1AE9	DTC P1AE8 Drive Motor Control Module Hybrid/EV Battery Voltage Sense Circuit Low Voltage DTC P1AE9 Drive Motor Control Module Hybrid/EV Battery Voltage Sense Circuit High Voltage
DTC P1AEC or P1AEE	DTC P1AEC Drive Motor Control Module Hybrid/EV Battery System Voltage DTC P1AEE Drive Motor Control Module Hybrid/EV Battery System Voltage High Voltage
DTC P1AF0	DTC P1AF0 Drive Motor Control Module Hybrid/EV Battery Voltage System Isolation Lost
DTC P1AF4 or P1AF5	DTC P1AF4 Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 Low Voltage DTC P1AF5 Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 High Voltage
DTC P1B0B or P1B0C	DTC P1B0B Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 Low Voltage DTC P1B0C Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 High Voltage
DTC P1B0D	DTC P1B0D Drive Motor Control Module Drive Motor Overspeed
DTC P1B41	DTC P1B41 Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Performance
DTC P1E0A	DTC P1E0A Drive Motor Control Module Torque Calculation Performance
DTC P1E3B	DTC P1E3B Drive Motor Rotor High Temperature
DTC P1E3C	DTC P1E3C Control Module Calculated Hybrid/EV Battery Performance
DTC P2534 or P2535	DTC P2534 Ignition On/Start Switch Circuit Low Voltage DTC P2535 Ignition On/Start Switch Circuit High Voltage
DTC P2537	DTC P2537 Ignition Accessory Switch Circuit Low Voltage
DTC P2797	DTC P2797 Auxiliary Transmission Fluid Pump Performance

DTC P057B-P057E: BRAKE PEDAL 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 P057B

Brake Pedal Position Sensor Performance

DTC P057C

Brake Pedal Position Sensor Circuit Low Voltage

DTC P057D

Brake Pedal Position Sensor Circuit High Voltage

DTC P057E

Brake Pedal Position Sensor Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Brake Pedal Position Sensor 5 V Reference	P057C, P0641, P1B3F	P057C	P057C, P0641	-
Brake Pedal Position Sensor Signal	P057C	P057C	P057D	P057E, P057B
Brake Pedal Position Sensor Low Reference	-	P057D	-	-

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The brake pedal position (BPP) sensor is used to sense the action of the driver application of the brake pedal. The BPP sensor provides an analog voltage signal that will increase as the brake pedal is applied. The BBP sensor contains two independent sensor assemblies. The hybrid powertrain control module located in the generator control module, and the body control module are connected to their respective sensor assembly. Each module provides a low reference signal and a 5-volt reference voltage to their respective BPP sensor. The hybrid powertrain control module also monitors the PRNDL state for inferred brake pedal application when transitioning in and out of the Park position.

Conditions for Running the DTC

- Ignition voltage must be greater than 10 V.
- Drive motor control and hybrid powertrain control module are awake.

P057B

- Vehicle speed is greater than 5 km/h (3 mph).

- Transmission is not in Park.
- Accelerator pedal position less than 5 percent.
- DTCs P0722, P0723, P077C, P077D, U0101, U0073, P182E, P1915, P2122, P2123, P2127, P2128 or P2138 not set.

Conditions for Setting the DTC

DTC P057B

The hybrid powertrain control module detects no change in brake pedal position after brake applied.

DTC P057C

- The hybrid powertrain control module detects a short to voltage in the BPP sensor 5 V reference circuit.
- The hybrid powertrain control module detects a short to ground or an open/high resistance in the BPP sensor 5 V reference circuit.
- The hybrid powertrain control module detects a short to ground or an open/high resistance in the BPP sensor signal circuit.

DTC P057D

- The hybrid powertrain control module detects a short to voltage in the BPP sensor signal circuit.
- The hybrid powertrain control module detects an open/high resistance in the BPP sensor low reference circuit.

DTC P057E

The hybrid powertrain control module detects the BPP sensor signal is changing faster than possible under normal operating conditions.

Actions Taken When the DTC Sets

- The hybrid powertrain control module disables the following functions: Autostop, Autostart, and Regenerative Braking.
- DTC P057B is a type A DTC.
- DTCs P057C-P057E are type B DTCs.

Conditions for Clearing the DTC

- DTC P057B is a type A DTC.
- DTCs P057C-P057E are type B DTCs.

Diagnostic Aids

P057B

Inspect the connector at the Brake Pedal Position sensor for a high resistance connection.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Exterior Lighting Systems Description and Operation**
- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

DTC P057C and P057D

1. Verify that DTC P0562 or P0563 is not set.
    - If DTC P0562 or P0563 is set, refer to **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, C12E1, C12E2, P0560, P0562, or P0563** for Hybrid (HP6).
2. Ignition OFF, disconnect the harness connector at the B22 brake pedal position sensor.
3. Ignition ON, verify that a test lamp illuminates between B+ and the low reference circuit terminal 5.
    - If the test lamp does not illuminate, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K59 starter generator control module.
4. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 6 and ground.
    - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K59 starter generator control module.
    - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K59 starter generator control module.
5. Test for less than 0.3 V between the signal circuit terminal 4 and ground.

- If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K59 starter generator control module.

6. Test for 4.8-5.2 V between the 5 V reference circuit terminal 6 and the signal circuit terminal 4.
   - If less than the specified range, test the signal circuit for an open/high resistance. If the circuit tests normal, replace the K59 starter generator control module.
7. Ignition OFF, disconnect the X2 harness connector at the K59 starter generator control module.
8. Test for infinite resistance between the signal circuit terminal 4 and ground.
   - If less than the specified range, test the signal circuit for a short to ground.
9. If all circuits test normal, replace the B22 brake pedal position sensor.

DTC P057B

Operate the vehicle within the Conditions for Running and Setting the DTC and verify the DTC does not reset.

- If DTC P057B resets as current, replace the B22 brake pedal position sensor.

DTC P057E

1. Replace the brake pedal position sensor.
2. Perform the brake pedal position sensor calibration procedure. Refer to **Brake Pedal Position Sensor Calibration** .
3. Operate the vehicle within the Conditions for Running and Setting the DTC and verify the DTC does not reset.
   - If DTC P057E resets as current, replace the K59 starter generator control module.

Repair Instructions

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

- **Brake Pedal Position Sensor Calibration**
- **Brake Pedal Position Sensor Replacement**
- **Control Module References** for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup

DTC P0601-P0604, P0606, P061B, P062F, OR P262B (HYBRID POWERTRAIN CONTROL MODULE): 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 Descriptor

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 P061B

Internal Control Module Torque Calculation Performance

DTC P062F

Control Module Long Term Memory Performance

DTC P262B

Control Module Power Off Timer Performance

Circuit/System Description

The starter/generator control module, often referred to as the generator control module, is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non-serviceable parts of the starter/generator control module. This is an internal fault detection of the starter/generator control module and no external circuits are involved.

Conditions for Running the DTC

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

Conditions for Setting the DTC

The control module has detected an internal malfunction.

P0602

A service module has been installed but not yet programmed.

Action Taken When the DTC Sets

- DTCs P0601-P0604, P0606, P061B, and P062F are Type A DTCs.
- DTC P262B is a Type B DTC.

P0601, P0602, P0604, P0606, P061B, and P262B

The hybrid powertrain control module requests the high voltage contactor relay open.

Conditions for Clearing the DTC

- DTCs P0601-P0604, P0606, P061B, and P062F are Type A DTCs.
- DTC P262B is a Type B DTC.

Diagnostic Aids

DTC P0606 may cause DTCs U0073, U0074, U0293, U1817 to set.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify DTC P0562 is not set.
   - **If DTC is set**

     Refer to **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, C12E1, C12E2, P0560, P0562, or P0563** .

   - **If the DTC does not set**
2. Verify P0601-P0604, P0606, P061B, P062F, or P262B is not set.
   - **If any of the DTCs are set**
     1. Program the K59 Starter/Generator Control Module.
     2. Verify the DTC does not set.
        - If the DTC sets, replace the K59 Starter/Generator Control 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 K59 Starter/Generator Control Module, often referred to as the Generator Control Module, replacement, programming and setup.

DTC P0697: 5V REFERENCE 3 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 P0697

5V Reference 3 Circuit

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The hybrid powertrain control module has three internal 5 V reference circuits. Each internal reference circuit provides a 5 V reference for one or more sensors. A short to ground or short to voltage on one external 5 V reference circuit can affect all components connected to the same internal 5 V reference circuit.

Conditions for Running the DTC

- Ignition is on.
- Ignition voltage is greater than 10 V.

Conditions for Setting the DTC

The hybrid powertrain control module detects a voltage out of range on the 5 V reference 3 circuit for greater than 5 seconds.

Action Taken When the DTC Sets

DTC P0697 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0697 is a Type B DTC.

Diagnostic Aids

The 5 V reference 3 circuit provides 5 V to internal circuitry contained in the generator control module.

Reference Information

Schematic Reference

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

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **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

Circuit/System Verification

If the DTC is set, replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called Starter Generator Control 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 generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The hybrid powertrain control module monitors a state of health message that the ECM transmits to verify the ECM is functioning properly.

Conditions for Running the DTC

- Ignition is On.
- The system voltage is greater than 9.5 V.

Conditions for Setting the DTC

The hybrid powertrain control module 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.

Conditions for Clearing the DTC

DTC P06AF is a Type A DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Testing

1. Verify that ECM DTC P0606 is not set.
    - If the DTC is set, Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition OFF, disconnect the K59 starter generator control module X3 connector and the K20 ECM X1 connector.
3. Test for less than 1 ohms between the serial data circuits listed below:
    - K59 starter generator control module X3 connector terminal 16 and K20 ECM X1 connector terminal 36
    - K59 starter generator control module X3 connector terminal 17 and K20 ECM X1 connector terminal 37
    - If greater than the specified range, test the serial data circuit for an open/high resistance condition. If the circuit tests normal, replace the K20 ECM.
4. If the DTC resets, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for ECM or Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P06B1 OR P06B2: SENSOR SUPPLY POSITIVE 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 P06B1

Sensor Supply Positive Voltage Circuit Low Voltage

DTC P06B2

Sensor Supply Positive Voltage Circuit High Voltage

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The motor control modules are part of the generator control module. The drive motor control module uses an internal 15 V reference power supply in order to operate the drive motor sensors and processor. This fault is handled inside the generator control module and no external circuits are involved.

Conditions for Running the DTC

The drive motor control module is awake.

Conditions for Setting the DTC

P06B1

The reference voltage is less than 9.7 V for 1 second.

P06B2

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

Action Taken When the DTC Sets

DTCs P06B1 and P06B2 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P06B1 and P06B2 are Type B DTCs.

Diagnostic Aids

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

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

Verify P0562 or P0563 is not set.

- If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
- If DTC P06B1 or P06B2 is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup

DTC P0A1B, P1A50, P1A51, P1ADC, OR P1EB6: DRIVE MOTOR 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 Descriptor

DTC P0A1B

Drive Motor Control Module Performance

DTC P1A50

Drive Motor Control Module Random Access Memory

DTC P1A51

Drive Motor Control Module Read Only Memory

DTC P1ADC

Drive Motor Control Module Long Term Memory Performance

DTC P1EB6

Drive Motor Control Module Long Term Memory Reset

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This fault is handled inside the drive motor control module and no external circuits are involved.

Conditions for Running the DTC

- The ignition is ON.
- Ignition 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, P1A50, P1A51, P1ADC and P1EB6 are Type A DTCs.

P0A1B, P1A50, and P1A51

The hybrid powertrain control module opens the high voltage contactor relay.

Conditions for Clearing the DTC

DTCs P0A1B, P1A50, P1A51, P1ADC and P1EB6 are Type A DTCs.

Diagnostic Aids

DTC P0A1B may cause DTCs U0073, U0074, U0293, U1817 to set.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P0A2B-P0A2D: DRIVE MOTOR TEMPERATURE 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 P0A2B

Drive Motor Temperature Sensor Performance

DTC P0A2C

Drive Motor Temperature Sensor Circuit Low Voltage

DTC P0A2D

Drive Motor Temperature Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Motor Temperature Sensor Signal	P0A2C	P0A2D	P0A2D	P0A2B
Motor Temperature Sensor Low Reference	-	P0A2D	-	P0A2B

Typical Scan Tool Data

Drive Motor Temperature

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON **Parameter Normal Range:** -39°C (-38°F) to 214°C (417°F)			
Motor Temperature Signal	215°C (419°F)	-40°C (-40°F)	Sensor Damage Possible
Motor Temperature Sensor Low Reference	-	-40°C (-40°F)	-

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The motor temperature sensor is a non-serviceable part of the starter generator assembly, often referred to as the drive motor assembly. The motor temperature sensor is a thermistor, or a resistor that changes value when the temperature changes. The motor temperature sensor is located in the stator. The sensor has a negative-temperature coefficient. This means that as the temperature increases, the resistance decreases, and as the temperature decreases, the resistance increases. The motor control module supplies a 5 V reference signal to the sensor and measures the voltage drop in the circuit. When the motor is cold, the sensor resistance is high. As the motor temperature increases, the resistance of the sensor decreases, which lowers the signal voltage.

Conditions for Running the DTC

P0A2B

- DTC P0A2B, P0A2C, P0A2D, P0A2F, P0AEE, P0AEF, P0AF0, P1A71, P1A72, P1A73, P1A90, P1A91, P1A92, P0C11, or P262B is not set.
- The Engine off time is greater than 8 hours.
- The Ignition is ON.
- Ignition voltage is between 9-16V.

P0A2C

The drive motor control module and the hybrid powertrain control module are awake.

P0A2D

Vehicle has been driven with starter generator torque greater than 10 N.m (89 lb in) for at least 90 seconds.

Conditions for Setting the DTC

P0A2B

The Motor temperature is more than 25°C (45°F) greater than the average of the 14 volt power module temperature sensors and the power inverter module temperature.

P0A2C

Motor temperature sensor signal is greater than 215°C (419°F) for 1 second.

P0A2D

Motor temperature sensor signal is less than -40°C (-40°F) for 1 second after a warm up condition when drive motor generator torque is greater than 10 N.m (89 lb in) for 90 seconds.

Action Taken When the DTC Sets

DTCs P0A2B-P0A2D are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0A2B-P0A2D are Type B DTCs.

Diagnostic Aids

The motor temperature sensor can be damaged by excessive electric current. Test the sensor for an open condition whenever a short to voltage condition is observed.

Reference Information

Schematic Reference

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

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **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

Circuit/System Verification

P0A2B-P0A2D

1. Allow the vehicle to cool to ambient temperature by leaving the ignition OFF for at least 8 hours.
2. Ignition ON, observe the motor temperature scan tool parameters.

   The temperature parameter should be within 25°C (45°F) of ambient temperature.

Circuit/System Testing

1. Ignition OFF, disconnect the starter generator X1 harness connector from the A15 starter generator.
2. Ignition ON, test the harness side for less than 12 ohms between the low reference circuit terminal 7 and ground.
   - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K59 starter generator control module.
3. Ignition ON, verify the scan tool motor temperature sensor parameter is -40°C (-40°F).
   - If more than the specified value, test the motor temperature sensor signal circuit for a short to ground. If the circuit tests normal, replace the K59 starter generator control module.
4. Install a 3-amp fused jumper wire between the signal circuit X1 terminal 8 and the low reference circuit X1 terminal 7 at the A15 starter generator. Verify the scan tool motor temperature sensor parameter is greater than 214°C (417°F):

   NOTE: If a short to voltage is found, test the motor temperature sensor for an open circuit or physical damage.

   - If less than the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K59 starter generator control module.
5. Ignition OFF, measure and record the resistance between the sensor signal and low reference terminals. Compare the actual sensor and circuit resistance to the expected sensor resistance. Refer to **Temperature Versus Resistance**.
   - If the resistance is not near the expected value, replace the A15 starter generator.

Repair Instructions

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

- **Starter Generator Replacement** for Drive Motor replacement
- **Control Module References** for Generator Control Module, also called Starter Generator Control Module, replacement, programming and setup.

DTC P0A2F: DRIVE MOTOR 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 P0A2F

Drive Motor High Temperature

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The starter generator is also referred to as the drive motor. The drive motor temperature sensor is a variable resistor that measures the temperature of the drive motor stator windings. The hybrid powertrain control module supplies 5 V to the signal circuit and a ground for the low reference circuit. The drive motor temperature sensor resistance changes with drive motor coolant temperature. As the temperature decreases, the sensor resistance increases. As the temperature increases, the sensor resistance decreases. The hybrid powertrain control module monitors the drive motor temperature sensor to determine the temperature of the drive motor.

Conditions for Running the DTC

- DTC P0A2B, P0A2C, and P0A2D is not set.
- The drive motor control module and hybrid powertrain control module are awake.

Conditions for Setting the DTC

The motor temperature sensor is greater than 165°C (329°F) for 5 seconds.

Action Taken When the DTC Sets

- DTC P0A2F is a Type B DTC.
- The hybrid powertrain control module system starts to reduce the maximum torque beginning at 155° C (311°F) down to 0 N.m as the drive motor stator temperature approaches 165°C (329°F).

Conditions for Clearing the DTC

DTC P0A2F is a Type B DTC.

Diagnostic Aids

- Ask about the customer's driving habits, trailer towing, etc.
- Ensure the engine cooling system is functioning normally.
- Ensure the starter generator cooling system is functioning normally.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Check the cooling system for the correct amount of coolant. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
2. Verify that DTC P0A2C is not set.
   - If DTC P0A2C is set, Refer to **DTC P0A2B-P0A2D**.
3. Ignition ON, observe the scan tool motor temperature parameter. The reading should be less than 165° C (329°F). If greater than the specified value, replace the starter generator assembly.

Repair Instructions

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

Starter Generator Replacement for Drive Motor replacement

DTC P0A3F, P0A40, P0C52, P0C53, P0C5C, P0C5D, OR P1B03: DRIVE MOTOR 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 P0A3F

Drive Motor Position Sensor Circuit

DTC P0A40

Drive Motor Position Sensor Performance

DTC P0C52

Drive Motor Position Sensor Circuit 1 Low Voltage

DTC P0C53

Drive Motor Position Sensor Circuit 1 High Voltage

DTC P0C5C

Drive Motor Position Sensor Circuit 2 Low Voltage

DTC P0C5D

Drive Motor Position Sensor Circuit 2 High Voltage

DTC P1B03

Drive Motor Position Sensor Circuit Tracking Lost

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal* S1/S3	P0C5C, P0A3F, P0A40, P1B03	P1B03, P0A3F	P0C53, P0A3F	P1B03, P0A40
Signal* S2/S4	P0C52, P0A3F, P0A40, P1B03	P1B03, P0A3F	P0C5D, P0A3F	P1B03, P0A40
Reference* +/-	P0A3F, P0A40, P1B03	P0A3F	P0A3F	P1B03, P0A40
* Represents a differential circuit consisting of a pair of wires. See Circuit/System Description and schematic for detailed description.				

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The generator control module monitors the angular position, speed and direction of the starter generator rotor based upon the signals of the resolver-type motor 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 starter generator.

At ignition ON, an AC voltage, 10 kHz excitation signal is output to the drive coil. The drive coil excitation signal creates a magnetic field surrounding the two driven coils and the irregular shaped rotor. The generator 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 generator control module to determine the exact

position, speed and direction of the starter generator rotor. The position sensor is a non-serviceable part of the starter generator.

Conditions for Running the DTC

- Ignition voltage is greater than 9.5V.
- The drive motor control module and hybrid powertrain control module are awake.

Conditions for Setting the DTC

P0A3F

Sin or Cos signal is less than 2.3V.

P0A40

Sin or Cos signal is greater than 4V.

P0C52

Drive Motor Position Sensor Circuit 1 reference voltage is less than 0.5 V.

P0C53

Drive Motor Position Sensor Circuit 1 reference voltage is greater than 4.5 V.

P0C5C

Drive Motor Position Sensor Circuit 2 reference voltage is less than 0.5 V.

P0C5D

Drive Motor Position Sensor Circuit 2 reference voltage is greater than 4.5 V.

P1B03

The generator control module tracking error is greater than 5 degrees.

Action Taken When the DTC Sets

- DTCs P0A3F, P0A40, P0C52, P0C53, P0C5C, P0C5D, and P1B03 are Type B DTCs.
- Starter generator operation is disabled.
- Autostop operation is disabled.
- Autostart operation is disabled.
- 14 volt power module remains active until hybrid battery power is depleted, or 14 volt power module power limits are exceeded, after which the high voltage contactor's relay is opened.

Conditions for Clearing the DTC

DTCs P0A3F, P0A40, P0C52, P0C53, P0C5C, P0C5D, and P1B03 are Type B DTCs.

Diagnostic Aids

- The starter generator position sensor circuits operate at very low current. These circuits are susceptible to moisture intrusion, coolant contamination, corrosion, and terminal damage. Extreme care must be taken when removing the starter generator, 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 and seals for signs of water intrusion.
- The sensor and reference circuit loops are a twisted pair with each pair covered in a grounded foil shield.
- The shield circuits are grounded inside the drive motor control module. Improperly grounded shield circuits may cause inaccurate sensor signals.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

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

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **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

Circuit/System Testing

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

1. Ignition OFF, disconnect the X1 harness connector at the A15 Starter Generator.
2. Ignition ON.
3. Test for 1.7-3.2 V between the signal circuit terminals listed below and ground:
   - Signal (S1) circuit terminal 1
   - Signal (S3) circuit terminal 5
   - Signal (S2) circuit terminal 6
   - Signal (S4) circuit terminal 2
   - **If less than 1.7 V**
   1. Vehicle OFF, disconnect the X1 harness connector at the K59 Starter Generator Control Module.

      NOTE: The following test must be performed at the K59 Starter Generator Control Module end of the wiring harness.

   2. Test for infinite resistance between the appropriate signal circuit and the ground circuit listed below:
      - Signal (S1) circuit terminal 10 and ground circuit terminal 2
      - Signal (S3) circuit terminal 11 and ground circuit terminal 2
      - Signal (S2) circuit terminal 8 and ground circuit terminal 1
      - Signal (S4) circuit terminal 9 and ground circuit terminal 1
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for infinite resistance between the signal circuit and chassis ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   4. Test for less than 2 ohms in the signal circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K59 Starter Generator Control Module.
   - **If greater than 3.2 V**
   1. Ignition OFF, disconnect the X1 harness connector at the K59 Starter Generator Control Module, Ignition 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 K59 Starter Generator Control Module.
   - **If between 1.7-3.2 V**
4. Test for 6.5-8.5 V between the reference circuit terminals listed below and ground:
   - Reference terminal 3
   - Reference terminal 4
   - **If less than 6.5 V**

1. Ignition OFF, disconnect the X1 harness connector at the K59 Starter Generator Control Module.

NOTE: The following test must be performed at the K59 Starter Generator Control Module end of the wiring harness.

2. Test for infinite resistance between the reference circuit and the following ground paths:
   - Chassis ground
   - Ground circuit terminal 13
   - If less than infinite resistance, repair the short to ground on the circuit.
   - If infinite resistance
3. Test for less than 2 ohms in the reference circuit end to end.
   - If 2 ohms or greater, repair the open/high resistance in the circuit.
   - If less than 2 ohms, replace the K59 Starter Generator Control Module.

- **If greater than 8.5 V**

1. Ignition OFF, disconnect the X1 harness connector at the K59 Starter Generator Control Module, Ignition 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 K59 Starter Generator Control Module.

- **If between 6.5-8.5 V**

5. Verify DTC P0A3F, P0A40, P0C52, P0C53, P0C5C, P0C5D, or P1B03 is not set.
   - **If any of the DTCs are set**
   1. Program the K59 Starter Generator Control Module.
   2. Verify the DTC does not set.
      - If the DTC sets, replace the K59 Starter Generator Control Module.
      - If the DTC does not set
   3. All OK.
   - **If none of the DTCs are set**
6. All OK.

Component Testing

NOTE: If moist environmental conditions: rain, snow, vehicle wash, etc. are present please refer to the appropriate Diagnostic Aids section above before doing component tests.

1. Ignition OFF, disconnect the X1 harness connector at the A15 Starter Generator.
2. Test for 10-35 ohms between the reference terminal 3 and the reference terminal 4.
   - **If not within the specified range**

   Replace the A15 Starter Generator.

- **If within the specified range**

3. Test for 30-60 ohms between the signal (S1) terminal 1 and the signal (S3) terminal 5.
   - **If not within the specified range**

     Replace the A15 Starter Generator.

   - **If within the specified range**
4. Test for 30-60 ohms between the signal (S4) terminal 2 and the signal (S2) terminal 6.
   - **If not within the specified range**

     Replace the A15 Starter Generator.

   - **If within the specified range**
5. Test for greater than 10,000 ohms between the terminals listed below and A15 Starter Generator case:
   - Signal (S1) terminal 1
   - Signal (S4) terminal 2
   - Reference terminal 3
   - Reference terminal 4
   - Signal (S3) terminal 5
   - Signal (S2) terminal 6
   - **If less than 10,000 ohms**

     Replace the A15 Starter Generator.

   - **If 10,000 ohms or greater**
6. Test for infinite resistance between the terminals listed below:
   - Terminals 1 and 3
   - Terminals 1 and 2
   - Terminals 2 and 3
   - **If less than infinite resistance**

     Replace the A15 Starter Generator.

   - **If infinite resistance**
7. Refer to Circuit/System Testing.

Repair Instructions

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

- **Starter Generator Replacement**
- **Control Module References** for K59 Starter Generator Control Module, often referred to as Generator Control Module, replacement, programming and setup

DTC P0A78: DRIVE MOTOR INVERTER 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 P0A78

Drive Motor Inverter Performance

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter generator, also referred to as the drive motor, based upon hybrid powertrain control module commands. The drive motor control module controls the speed and output torque of the starter generator 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. The motor control module is part of the generator control module and is not serviced separately.

Conditions for Running the DTC

The high voltage contactor relay is closed.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

- DTC P0A78 is a Type B DTC.
- The hybrid powertrain control module opens the high voltage contactor relay.

Conditions for Clearing the DTC

DTC P0A78 is a Type B DTC.

Reference Information

Schematic Reference

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

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **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

Circuit/System Verification

If the DTC is set, clear DTC; Turn the ignition OFF for 2 minutes. Turn the ignition ON, Operate vehicle within conditions for running and setting DTC. If the DTC resets, go to Circuit/System Testing.

Circuit/System Testing

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

The High Voltage Disabling procedure 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.
2. Remove the 3-phase cables from the K59 starter generator control module.
3. Test for infinite resistance between the 3-Phase cable terminals listed below and ground for each

phase of the drive motor generator battery cable:

- X8 phase U terminal
- X7 phase V terminal
- X6 phase W terminal
    - If less than infinite resistance, test each phase of the drive motor generator battery cable for a short to ground. If the cables test normal, replace the A15 starter generator.

4. Disconnect the 3-phase cables from the A15 starter generator.
5. Test for infinite resistance between the 3-Phase circuits listed below for each phase of the Drive Motor Generator Battery Cable:
    - Phase U and phase V
    - Phase V and phase W
    - Phase W and phase U
        - If less than infinite resistance, replace the Drive Motor Generator Battery Cable.
6. Replace the A15 starter generator and retest for the DTC. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

- **Starter Generator Replacement** for starter generator replacement.
- **Drive Motor Generator Battery Cable Replacement** for 3-Phase Cable Assembly replacement.
- **Control Module References** for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P0A88 OR P0A89: POWER MODULE INPUT CURRENT SENSOR: 14V POWER MODULE INPUT 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 Descriptor

DTC P0A88

14V Power Module Input Current Sensor Circuit Low Current

DTC P0A89

14V Power Module Input Current Sensor Circuit High Current

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following

three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14V power module has 2 current sensors, one for input and one for output current measurements. This diagnostic checks the input current sensor. These current sensors are internal to the 14V power module and are not serviced separately from the generator control module.

Conditions for Running the DTC

- The ignition is ON.
- 14V Power Module Status is Normal.
- Ignition voltage is between 9-16V.

Conditions for Setting the DTC

P0A88

14 volt power module input current is Less than 0.5 amp for greater than 2 seconds.

P0A89

14 volt power module input current is greater than 22.5 amps for greater than 2 seconds.

Action Taken When the DTC Sets

- DTCs P0A88 and P0A89 are Type B DTCs.
- Autostop disabled.
- Autostart disabled.
- Power regeneration disabled.

Conditions for Clearing the DTC

DTCs P0A88 and P0A89 are Type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, replace the K59 starter generator control module.

Repair Instructions

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

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

DTC P0A8D OR P0A8E: 14V POWER MODULE SYSTEM VOLTAGE

Diagnostic Instructions

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

DTC Descriptor

DTC P0A8D

14V Power Module System Voltage Low Voltage

DTC P0A8E

14V Power Module System Voltage High Voltage

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14V power module has a voltage sensor that constantly monitors system output voltage. This diagnostic is intended to check the output voltage sensor's signal voltage, not the 12V system voltage. This sensor is internal to the 14V power module and is not serviced separately from the generator control module.

Conditions for Running the DTC

- The ignition is ON.
- 14V Power Module Status parameter is Normal.
- Ignition voltage is between 9-16V.

Conditions for Setting the DTC

P0A8D

14V Power Module output voltage sensor value is less than 1 volt for greater than 2 seconds.

P0A8E

14V Power Module output voltage sensor value is greater than 20 volts for greater than 2 seconds.

Action Taken When the DTC Sets

DTCs P0A8D and P0A8E are Type B DTCs.

P0A8E

The charging system light will illuminate, and Service Battery Charging System will display on the Driver Information Center.

Conditions for Clearing the DTC

DTCs P0A8D and P0A8E are Type B DTCs.

P0A8D

14V Power Module output voltage sensor value is greater than 1.5 volts.

P0A8E

14V Power Module output voltage sensor value is less than 19.5 volts.

Diagnostic Aids

This DTC may set due to an open 175 amp fuse in the X50A fuse block-underhood.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

P0A8E

If the DTC is set, replace the K59 starter generator control module.

P0A8D

1. Ignition OFF, measure and record the battery voltage at the C1 12V battery terminals. The battery voltage should stabilize between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
    - If not within the specified range, refer to **Battery Inspection/Test** for Hybrid (HP6).
2. Ignition ON, observe the scan tool Ignition 1 Signal parameter in the 14V Power Module data list. The parameter should be within 4.5 volts of the Low Voltage Circuit Voltage measured at the C1 12V battery.
    - If the voltage is not within the specified range, check the ignition circuit to the K59 starter generator control module for high resistance.
3. Remove the B+ terminal at the K59 starter generator control module.
4. Connect a test lamp between C1 12-volt positive battery post and the K59 starter generator control module terminal at the module.
5. Ignition ON, observe the scan tool parameter Low-Voltage Circuit Voltage in the 14V Power Module data list. The parameter should be within 0.5 volt of the actual 12-volt battery voltage.
    - If the voltage is not within the specified range, replace the K59 starter generator control module.
6. Ignition OFF, remove the positive connection at the C1 12-volt battery.
7. Measure the resistance of the 14 V Power Module positive harness between the X10 connector at the K59 starter generator control module and the X50A Fuse block-Underhood connection.
    - If the resistance is greater than 1.0 ohms, repair the open/high resistance condition in the 12-volt circuit.
    - If the resistance is less than 1.0 ohms, Test the 175 amp fuse in the X50A fuse block-underhood. If the fuse tests good, replace the K59 starter generator control module.

Repair Instructions

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

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

DTC P0A8F: 14V POWER MODULE SYSTEM VOLTAGE 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 P0A8F

14V Power Module System Voltage Performance

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14V power module has a voltage sensor that constantly monitors system output voltage. This diagnostic is designed to test the performance of the voltage sensor. This sensor is internal to the 14V power module and is not serviced separately from the generator control module.

Conditions for Running the DTC

- The ignition is ON.
- 14V Power Module Status parameter is Normal.
- Ignition voltage is between 9-16V.

Conditions for Setting the DTC

P0A8F

The difference between the Low Voltage Circuit Voltage and the ignition voltage value is greater than 4.5 volts for greater than 4 seconds.

Action Taken When the DTC Sets

- The charging system light will illuminate, and Service Battery Charging System will display on the Driver Information Center.
- DTC P0A8F is a Type B DTC.

Conditions for Clearing the DTC

DTC P0A8F is a Type B DTC.

Diagnostic Aids

- This DTC may set due to low 12 V system voltage.
- This DTC may set due to voltage stress to the underhood 175A fuse and junction block.

Reference Information

Schematic Reference

Power Distribution Schematics

Description and Operation

- **Starter Generator Description and Operation**

- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Ignition OFF, measure and record the battery voltage at the C1 12V battery terminals. The battery voltage should stabilize between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
    - If not within the specified range, refer to **Battery Inspection/Test** for Hybrid (HP6).
2. Ignition ON, observe the scan tool Ignition 1 Signal parameter in the 14V Power Module data list. The parameter should be within 4.5 volts of the Low Voltage Circuit Voltage measured at the C1 12V battery.
    - If the voltage is not within the specified range, check the ignition circuit to the K59 starter generator control module for high resistance.

Circuit/System Testing

1. Remove the generator control module cable cover. Refer to **Generator Control Module Cable Cover Replacement** .
2. Remove the X10 B+ cable at the K59 starter generator control module, and tape the cable ring terminal.
3. Connect a 3A fused jumper wire between C1 12-volt positive battery post and the K59 starter generator control module X10 B+ terminal.
4. Connect C1 12V battery negative terminal.
5. Ignition ON, observe the scan tool parameter Low-Voltage Circuit Voltage in the 14V Power Module data list. The parameter should be within 0.5 volt of the actual 12-volt battery voltage.
    - If the voltage is not within the specified range, replace the K59 starter generator control module.
6. Ignition OFF, remove the 3A fused jumper wire at the C1 12-volt battery.
7. Disconnect the C1 12V battery positive terminal and measure the resistance of the 14 V Power Module positive harness between the X10 connector at the K59 starter generator control module and the C1 12V battery positive terminal.
    - If the resistance is greater than 1.0 ohms, repair the high resistance condition in the 12-volt circuit.
    - If the resistance is less than 1.0 ohms, replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P0A90: DRIVE MOTOR 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 P0A90

Drive Motor Performance

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The eAssist hybrid system has a starter generator also called a drive motor. The starter generator is mounted to the front of the engine and is mechanically connected to the crankshaft pulley by a serpentine belt.

The hybrid powertrain control module receives an engine RPM signal over serial data and compares that value to the starter generator rpm received from the drive motor control module. The hybrid powertrain control module uses a ratio of these two speeds to determine if the drive belt is missing or slipping.

Conditions for Running the DTC

- Engine is running.
- The system voltage is at least 9.5 V.
- DTCs P0A3F, P0A40, P0B03, P0B0D, P0335, P0336, P0C19 or P1E0A are not set.

Conditions for Setting the DTC

The hybrid powertrain control module detects a speed difference between the engine and the starter generator of greater than 1000 rpm.

OR

The hybrid powertrain control module detects a speed difference between the engine and the starter generator of greater than 500 rpm multiple times on two consecutive ignition cycles with a Engine Off time of 30 minutes between key cycles.

Action Taken When the DTC Sets

DTC P0A90 is a Type A DTC.

Conditions for Clearing the DTC

- DTC P0A90 is a Type A DTC.

- The hybrid powertrain control module detects a speed difference between the engine and the starter generator of less than 500 rpm.

Diagnostic Aids

- The ratio between the crankshaft and the drive motor speeds is 2.3 to 1. When using a scan tool to determine belt slip the engine (crankshaft) RPM value must be multiplied by 2.3 to approximate the starter generator speed.
- Inspect the drive belt for cracks and oil contamination.
- Test drive the vehicle through the different modes of operation, performing Autostop and Autostart cycles. Accelerate up to 50 mph and brake moderately, and listen for any audible belt squeal. If drive belt noise is noticed check the drive belt tensioner assembly for proper operation and installation.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Testing

1. If drive belt noise was noticed on an AutoStart, refer to **Drive Belt Tensioner Diagnosis** .
2. Inspect the drive belt for cracks, wear and contamination.
    - If the belt is not OK, replace the drive belt.
3. If the DTC resets, replace the A15 starter generator.

Repair Instructions

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

- **Starter Generator Replacement**
- **Drive Belt Replacement (LEA)** , **Drive Belt Replacement (LUK)**
- **Drive Belt Tensioner Replacement (LUK)** , **Drive Belt Tensioner Replacement (LEA)**

DTC P0AB9: HYBRID/EV SYSTEM 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 P0AB9

Hybrid/EV System Performance

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The eAssist hybrid system has the ability to crank and start the engine using two different methods. The first method is a conventional 12 volt system. On every initial start up the conventional 12 volt starter and 12 volt battery are used to crank and start the engine.

The second starting method uses both the 115 Volt generator control and battery assembly, also called the hybrid EV battery pack, and the starter generator, also called the drive motor. The drive motor is a 3 phase AC induction machine. This device not only serves as a 115-volt AC generator, it is also used to provide engine power assist and to start the engine when in auto-stop mode. If the system is in the auto-stop mode and fails to restart with the drive motor, the 12 volt conventional starter will automatically be engaged to start the engine.

The drive motor can quickly rotate the engine to operating speed (800 RPM). The hybrid powertrain control module can detect a condition where the engine is stalling and command the drive motor to rotate the engine to prevent a stall.

Conditions for Running the DTC

Engine Running.

Conditions for Setting the DTC

The hybrid powertrain control module detects that engine speed has fallen below a specific minimum speed indicating the engine has stalled.

Action Taken When the DTC Sets

DTC P0AB9 is a Type C DTC.

Conditions for Clearing the DTC

- DTC P0AB9 is a Type C DTC.
- Engine restarts with key cycle.

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.

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.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

Circuit/System Verification

1. Verify that no other DTCs are set.
    - If other DTCs are set, diagnose them first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Start the engine. The engine should start and run.
    - If the engine fails to start, or stalls, diagnose the engine system. Refer to **Engine Cranks But Does Not Run** .
3. If the DTC is set, and the engine is running smoothly, program the K59 starter generator control module.
    - If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

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

DTC P0AEE, P0AEF, OR P0AF0: DRIVE MOTOR INVERTER TEMPERATURE 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 Descriptor

DTC P0AEE

Drive Motor Inverter Temperature Sensor Performance

DTC P0AEF

Drive Motor Inverter Temperature Sensor Circuit Low Voltage

DTC P0AF0

Drive Motor Inverter Temperature Sensor Circuit High Voltage

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This is an internal fault detection of the generator control module. This fault is handled inside the generator control module and no external circuits are involved.

Conditions for Running the DTC

- DTCs P1A90, P1A91, P1A92, P1A71, P1A72, P1A73, P0A2B, P0A2C, P0A2D, P0A2F, P0AEE, P0AEF, P0AF0, P0C11 and P262B are not set.
- Ignition voltage is between 9-16V.
- The drive motor control module and the hybrid powertrain control module are awake.

P0AEE

The engine OFF time is greater than 8 hours.

Conditions for Setting the DTC

P0AEE

The temperature average of the drive motor temperature sensor and 14V power module temperature sensors 1 and 2 are 20°C (36°F) different from the Phase U DC/AC Inverter Temperature value.

P0AEF

The inverter phase temperature sensor 1 is greater than 150°C (302°F) for 3 seconds.

P0AF0

The inverter phase temperature sensor 1 is less than -70°C (-94°F) for 3 seconds.

Action Taken When the DTC Sets

- DTCs P0AEE, P0AEF, and P0AF0 are Type B DTCs.
- The power inverter module limits the maximum torque of the starter generator to 10.8 N.m (95.6 lb in).
- Autostop will be disabled.

Conditions for Clearing the DTC

DTCs P0AEE, P0AEF, and P0AF0 are Type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Allow the vehicle to cool to ambient temperature by leaving the ignition OFF for at least 8 hours.
2. Ignition ON, if the DTC is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

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

DTC P0B09: AUXILIARY TRANSMISSION FLUID PUMP SUPPLY VOLTAGE RELAY CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptor

DTC P0B09

Auxiliary Transmission Fluid Pump Supply Voltage Relay Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Relay Switch B+	P2797 **	P2797	-
Relay Coil Ignition	P0B09 **	P0B09	-
Relay Coil Control	P0B09 *	P0B09	P0B09
Relay Switch Control	P2797 **	P2797	P2797 *
Component Ground	-	***	-
* Auxiliary Transmission Fluid Pump - always On ** Will open the fuse *** Auxiliary Transmission Fluid Pump - inoperative			

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The transmission fluid pump - auxiliary is used to maintain transmission fluid line pressure to the transmission during Autostop mode. The transmission fluid pump - auxiliary is externally mounted to the transmission case assembly. The hybrid powertrain control module controls the auxiliary pump by providing the ground path to the transmission pump relay - auxiliary coil control circuit.

Conditions for Running the DTC

Ignition voltage is greater than 9 V.

Conditions for Setting the DTC

The generator control module detects an invalid voltage on the auxiliary transmission fluid pump relay control circuit for greater than 1 second.

Action Taken When the DTC Sets

- DTC P0B09 is a type B DTC.
- Autostop is disabled.

Conditions for Clearing the DTC

DTC P0B09 is a type B DTC.

Diagnostic Aids

Transmission Fluid Pump Relay Underhood Electrical Center Terminal Identification

Front of Vehicle			
Left Side of Vehicle	Control	Load	Right Side of Vehicle
	B+	Ignition	

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Description and Operation

- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**
- **Starter Generator Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Electrical Center Identification Views**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the auxiliary transmission fluid pump relay turns on and off/clicks when commanding the auxiliary transmission fluid pump relay ON and OFF with a scan tool.
    - **If the relay does not click**

      Refer to Circuit/System Testing.

    - **If the relay clicks**

      All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the KR86 Transmission Fluid Pump Relay - Auxiliary, Ignition ON.
2. Verify a test lamp illuminates between the ignition circuit terminal 86 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.

2. Test for less than 2 ohms in the ignition circuit end to end.
    - If 2 ohms or greater, repair the open/high resistance in the circuit.
    - If less than 2 ohms, 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. Ignition OFF.
2. Test for infinite resistance between the ignition circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, test or replace the KR86 Transmission Fluid Pump Relay - Auxiliary.

- **If the test lamp illuminates**

3. Connect a test lamp between the ignition circuit terminal 86 and the control circuit terminal 85.
4. Verify the test lamp turns ON and OFF when commanding the Auxiliary Transmission Pump Relay ON and OFF with a scan tool.

- **If the test lamp is always OFF**

1. Ignition OFF, disconnect the X2 harness connector at the K59 starter generator control module, ignition ON.
2. Test for less than 1 V between the control circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V
3. Ignition OFF.
4. Test for less than 2 ohms in the control circuit end to end.
    - If 2 ohms or greater, repair the open/high resistance in the circuit.
    - If less than 2 ohms, replace the K59 starter generator control module.

- **If the test lamp is always ON**

1. Ignition OFF, disconnect the harness connector at the K59 starter generator control module.
2. Test for infinite resistance between the control circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the K59 starter generator control module.

- **If the test lamp turns ON and OFF**

5. Replace the K59 starter generator control module.

Component Testing

1. Ignition OFF, disconnect the KR86 Transmission Fluid Pump Relay - Auxiliary.
2. Test for 85-130 ohms between terminals 85 and 86.
    - **If less than 85 ohms or greater than 130 ohms**

      Replace the relay.

    - **If between 85-130 ohms**
3. Test for infinite resistance between the terminals listed below:
    - 30 and 86

- 30 and 87
- 30 and 85
- 85 and 87
- **If less than infinite resistance**

  Replace the relay.

- **If infinite resistance**

4. Install a 3 A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground.
5. Test for less than 2 ohms between terminals 30 and 87.
   - **If 2 ohms or greater**

     Replace the relay.

   - **If less than 2 ohms**
6. All OK.

Repair Instructions

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

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)** for Transmission Fluid Pump Relay - Auxiliary replacement, Within an Electrical Center
- **Control Module References** for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P0BE6-P0BE8, P0BEE, P0BEF, OR P0BF0: DRIVE MOTOR PHASE U/W 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 Descriptor

DTC P0BE6

Drive Motor Phase U Current Sensor Performance

DTC P0BE7

Drive Motor Phase U Current Sensor Circuit Low Voltage

DTC P0BE8

Drive Motor Phase U Current Sensor Circuit High Voltage

DTC P0BEE

Drive Motor Phase W Current Sensor Performance

DTC P0BEF

Drive Motor Phase W Current Sensor Circuit Low Voltage

DTC P0BF0

Drive Motor Phase W Current Sensor Circuit High Voltage

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This is an internal fault detection of the generator control module. This fault is handled inside the generator control 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 drive motor control module is awake and the engine is off.

Conditions for Setting the DTC

- The control module has detected an internal malfunction.
- The motor phase U current is greater than 440 amps or less than -440 amps.
- The motor phase W current is greater than 440 amps or less than -440 amps.

Action Taken When the DTC Sets

- DTCs P0BE6, P0BE7, P0BE8, P0BEE, P0BEF, and P0BF0 are Type B DTCs.
- The generator control module operates in a reduced power mode.
- Regenerative breaking torque is reduced.
- Autostop and electric power assist are disabled.

Conditions for Clearing the DTC

DTCs P0BE6, P0BE7, P0BE8, P0BEE, P0BEF, and P0BF0 are Type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P0BFD: DRIVE MOTOR PHASE U-V-W NOT PLAUSIBLE

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 P0BFD

Drive Motor Phase U-V-W Not Plausible

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter generator, also referred to as the drive motor, based upon hybrid powertrain control module commands. The drive motor control module controls the speed and output torque of the starter generator through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. The starter generator operates utilizing 3-phase alternating current (AC) electricity. Each insulated gate bipolar transistors operates a single phase of the starter generator. Each

phase is individually identified as U, V and W. The drive motor control module monitors the current of phase U and W. The drive motor control module uses logic to calculate phase V current values. This information is used in order to detect over current conditions.

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

Conditions for Running the DTC

- The ignition is ON.
- The high voltage contactor relay is closed.
- DTCs P0BE6, POBE7, POBE8, P0BEE, POBEF, or P0BF0 are not set.

Conditions for Setting the DTC

The sum of the 3 phase current calculations is greater than 40 A.

Action Taken When the DTC Sets

- DTC P0BFD is a Type B DTC.
- The generator control module operates in a reduced power mode.
- Regeneration is limited.
- Autostop and electric assist is disabled.

Conditions for Clearing the DTC

DTC P0BFD is a Type B DTC.

Diagnostic Aids

The 14V power module remains active.

Reference Information

Schematic Reference

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

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **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

Circuit/System Verification

If the DTC is set, clear DTC; Turn the ignition OFF for 2 minutes. Turn the ignition ON, Operate vehicle within conditions for running and setting DTC. If the DTC resets, go to Circuit/System Testing.

Circuit/System Testing

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

The High Voltage Disabling procedure 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.
2. Remove the 3-phase cables from the K59 generator control module.
3. Test for infinite resistance between each of the 3-phase circuit terminals listed below and ground:
   - X8 phase U terminal
   - X7 phase V terminal
   - X6 phase W terminal
   - If not the specified value, disconnect the 3-phase cables from the A15 starter generator, and test the AC circuits for a short to ground. If the circuit tests normal, replace the A15 starter generator.
   - Replace the K59 starter generator control module. If the DTC resets replace the A15 starter generator.

Repair Instructions

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

- **Starter Generator Replacement**
- **Drive Motor Generator Battery Cable Replacement** for 3-Phase Cable Assembly replacement
- **Control Module References** for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P0C01: DRIVE MOTOR HIGH 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 Descriptor

DTC P0C01

Drive Motor High Current

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter generator, also referred to as the drive motor based upon hybrid powertrain control module commands. The drive motor control module controls the speed and output torque of the starter generator through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. Each insulated gate bipolar transistor assembly is monitored for overcurrent conditions.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

One or more phase currents are greater than ±396 A.

Action Taken When the DTC Sets

- DTC P0C01 is a Type B DTC.
- The starter generator regeneration and power assist functions are disabled.

Conditions for Clearing the DTC

DTC P0C01 is a Type B DTC.

Diagnostic Aids

The 14 V power module will still be active.

Reference Information

Schematic Reference

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

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **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

Circuit/System Verification

1. Verify DTCs P0BE6, P0BE7, P0BE8, P0BEE, P0BEF, and P0BF0 are not set.
2. If the DTC is set, clear DTC; Turn the ignition OFF for 2 minutes. Turn the ignition ON, Operate vehicle within conditions for running and setting DTC. If the DTC resets, go to Circuit/System Testing.

Circuit/System Testing

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

The High Voltage Disabling procedure 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** .
2. Ignition OFF, disconnect the 3-phase cables from the K59 starter generator control module.
3. Test for infinite resistance to 3-phase circuit terminals listed below and ground:
   - X8 phase U terminal
   - X7 phase V terminal
   - X6 phase W terminal
   - If not the specified value, disconnect the 3-phase cables from the A15 starter generator, and test the 3-phase circuit for a short to ground. If the circuit tests normal, replace the A15 starter generator motor.
4. Replace the K59 starter generator control module. If the DTC resets replace the A15 starter generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Starter Generator Replacement**
- **Drive Motor Generator Battery Cable Replacement** for 3-Phase Cable Assembly replacement
- **Control Module References** for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup

DTC P0C05: DRIVE MOTOR PHASE U-V-W CIRCUITS

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 P0C05

Drive Motor Phase U-V-W Circuits

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter generator, also referred to as the drive motor. The drive motor control module controls the speed and output torque of the starter generator through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. Each insulated gate bipolar transistor assembly is monitored for overcurrent conditions.

Conditions for Running the DTC

- The ignition is ON.
- The high voltage input to the generator control module is above 50 volts.
- DTCs P0BE6, POBE7, POBE8, P0BEE, POBEF, P0BF0, or P0BFD are not set.
- The drive motor control module has applied greater than or equal to 25A to the drive motor.

Conditions for Setting the DTC

The drive motor control module detects at least one U-V-W phase current values is less than 9A.

Action Taken When the DTC Sets

- DTC P0C05 is a Type B DTC.
- The starter generator regeneration and power assist functions are disabled.

Conditions for Clearing the DTC

DTC P0C05 is a Type B DTC.

Diagnostic Aids

The 14v power module remains active.

Reference Information

Schematic Reference

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

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **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

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.
2. Remove the 3-phase cable assembly from the K59 starter generator control module.
3. Test for less than 0.5 ohms at each phase by measuring between the following circuits at the cable with a DMM:
   - Phase U and phase V
   - Phase U and phase W
   - Phase V and phase W
   - **If within the specified value**
4. Inspect the 3-phase drive motor generator battery cable terminal fasteners at the K59 starter generator control module.
   - **If any fasteners were loose and no arc-flash damage is present**

     Torque the fasteners and re-assembly the vehicle. Retest for the DTC.

   - **If any fasteners were loose and arc-flash damage is present**

     Replace the K59 starter generator control module assembly and the 3-phase drive motor generator battery cable assembly.

   - **If not within the specified value**
5. Disconnect the 3-phase drive motor generator battery cable assembly from the A15 starter generator. Test each cable for continuity from the starter generator connection terminal to the K59 starter generator control module connection terminal.
   - **If you measure greater than 0.5 ohms**

Replace the 3-phase drive motor generator battery cable assembly.

6. Replace the A15 starter generator and retest for the DTC. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

- **Starter Generator Replacement** for starter generator replacement.
- **Drive Motor Generator Battery Cable Replacement** for 3-Phase Cable Assembly replacement.
- **Control Module References** for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup

DTC P0C0B: DRIVE MOTOR INVERTER SUPPLY VOLTAGE CIRCUIT

Diagnostic Instructions

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

DTC Descriptor

DTC P0C0B

Drive Motor Inverter Supply Voltage Circuit

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The inverter supply voltage circuit detects the loss of the bias power supply to the insulated gateway bi-polar transistors. This is an internal fault detection of the generator control module. This fault is handled inside the generator control module and no external circuits are involved.

Conditions for Running the DTC

- The ignition is on and greater than 7 volts.
- The drive motor control module is awake.

Conditions for Setting the DTC

The generator control module does not detect voltage at the insulated gate bi-polar transistor bias supply.

Action Taken When the DTC Sets

- DTC P0C0B is a Type A DTC.
- The drive motor will be disabled.

Conditions for Clearing the DTC

DTC P0C0B is a Type A DTC.

Diagnostic Aids

The 14V power module remains active.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify DTC P0562 is not set.
   - If the DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. If DTC P0C0B is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P0C11: DRIVE MOTOR INVERTER PHASE U 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 Inverter Phase U High Temperature

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter generator, also referred to as the drive motor, based upon hybrid powertrain control module commands. The drive motor control module controls the speed and output torque of the drive motor through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. The 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. The drive motor control module monitors the temperature of the switching transistors in order to detect inverter module overtemperature conditions. The generator control module is air cooled.

Conditions for Running the DTC

- The drive motor control module and hybrid powertrain control module are awake.
- DTC P0AEE, P0AF0, and P0AEF are not set.

Conditions for Setting the DTC

The Phase U DC/AC Inverter Temperature 1 is greater than 118°C (245°F) for 5 seconds.

Action Taken When the DTC Sets

- DTC P0C11 is a Type B DTC.
- The hybrid powertrain control module system starts to reduce the maximum torque beginning at 110° C (230°F) linearly down to 0 N.m(0 lb in) as the drive motor stator temperature approaches 120°C (248°F).

Conditions for Clearing the DTC

DTC P0C11 is a Type B DTC.

Diagnostic Aids

Ask about the customer's driving habits, trailer towing, etc.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify P0C32, P0A81, P0A84, P0A85 or P0A7E are not set.
2. Ignition On, verify with a scan tool that the Phase U DC/AC Inverter Temperature 1 is less than 118° C (245°F).
    - If greater than 118°C (245°F), inspect for proper operation of the hybrid battery cooling fan and ducts.
    - If the hybrid cooling system tests normal, Reprogram K59 starter generator control module. If the DTC resets replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the starter generator control module, replacement, programming and setup.

DTC P0C19: DRIVE MOTOR TORQUE DELIVERED 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 P0C19

Drive Motor Torque Delivered Performance

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The starter generator also called the drive motor is controlled by the drive motor control module. The drive

motor control module constantly monitors the requested torque and the delivered torque of the drive motor.

Conditions for Running the DTC

- DTCs P0BFD, P0BE6, P0BE7, P0BE8, P0BEE, P0BEF, P0BF0, P1AE8, P1AE9, P1AEC, P1B0D, P0C52, P0C53, P0C5C, P0C5D, P0A3F, P1B03 and P0A40 are not set
- Drive motor is commanded to develop torque.

Conditions for Setting the DTC

The drive motor control module has detected that the difference between drive motor torque commanded and delivered is greater than 36 N.m (27 lb ft).

Action Taken When the DTC Sets

- DTC P0C19 is a Type B DTC.
- Commanded motor torque is limited to below 36 N.m (27 lb ft).

Conditions for Clearing the DTC

DTC P0C19 is a Type B DTC.

Diagnostic Aids

- Seized or binding engine
- Seized or binding accessory drive belt
- Seized or binding starter generator

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Start the engine. DTC P0C19 should not be set.
2. Verify DTC P0A90 is not set.
    - If the DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

3. Verify the engine or AC compressor is not seized or binding.
    - If the engine is seized or binding, refer to **Symptoms - Engine Mechanical** .
    - If the AC Compressor is seized or binding, refer to **Noise Diagnosis - Air Conditioning (A/C) System** .
4. Verify the A15 starter generator is not seized or binding.
5. If DTC P0C19 is set, replace the A15 starter generator.

Repair Instructions

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

Starter Generator Replacement for starter generator replacement.

DTC P0C76: HYBRID/EV BATTERY SYSTEM HIGH VOLTAGE PRESENT

Diagnostic Instructions

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

DTC Descriptor

DTC P0C76

Hybrid/EV Battery System High Voltage Present

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The generator control and battery module assembly contains a high voltage contactor. The high voltage contactor allows the high voltage DC batteries to be connected to the vehicle and safely contain the high voltage DC within the generator control and battery module assembly. The high voltage contactor is connected in series with the positive side of the DC voltage potential of the high voltage battery. The hybrid powertrain control module supplies ground to the control circuit of the high voltage contactor to close.

Conditions for Running the DTC

High Voltage Contactor Relay is commanded open.

Conditions for Setting the DTC

The high voltage circuit is greater than 65 V for 6.5 seconds after the contactor has been commanded open.

Action Taken When the DTC Sets

- DTC P0C76 is a Type A DTC.
- A clear DTC command will not clear this DTC or the Action Taken.

Conditions for Clearing the DTC

DTC P0C76 is a Type A DTC.

Diagnostic Aids

- A clear DTC command will not clear this DTC or the Action Taken.
- The DTC may set due to a low 12V battery condition.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Connect charger to 12V Battery.
2. Ignition ON, perform the hybrid powertrain control module scan tool Clear DTC output control. Cycle the ignition twice.
3. Refer to **Hybrid\EV Battery Voltage Present** . If the contactors test normal, replace the K59 starter generator control module.

Repair Instructions

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

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

DTC P0C9E OR P0C9F: POWER MODULE OUTPUT 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 Descriptor

DTC P0C9E

14V Power Module Output Current Sensor Circuit Low Current

DTC P0C9F

14V Power Module Output Current Sensor Circuit High Current

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14V power module has 2 current sensors, one for input and one for output current measurements. This diagnostic checks the output current sensor. These current sensors are internal to the 14V power module and are not serviced separately from the generator control module.

Conditions for Running the DTC

- Ignition is ON.
- 14V Power Module Status parameter is Normal.
- Ignition voltage is between 9-16V.

Conditions for Setting the DTC

P0C9E

Low Voltage Circuit Current is less than 2 amps for greater than 2 seconds.

P0C9F

Low Voltage Circuit Current is greater than 123 amps for greater than 2 seconds.

Action Taken When the DTC Sets

DTCs P0C9E and P0C9F are Type B DTCs.

P0C9F

- The 14V power module stops supplying power to the 12V system.
- The charge indicator will illuminate.

Conditions for Clearing the DTC

DTCs P0C9E and P0C9F are Type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P0CA2: 14V POWER MODULE STEP DOWN VOLTAGE 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 P0CA2

14V Power Module Step Down Voltage Performance

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14V power module has switching transistors that allows it to convert high voltage from the Hybrid Battery to 12 volts. This diagnostic is designed to test for an electrical short in the MOSFET transistors. The transistors are internal to the 14V power module and cannot be serviced separately from the generator control module.

Conditions for Running the DTC

The ignition is ON and the 14V Power Module is enabled.

Conditions for Setting the DTC

The 14 V Power Module has detected a transistor failure for 25 mS.

Action Taken When the DTC Sets

- The 14V power module stops supplying power to the 12V system.
- The charging system light will illuminate, and Service Battery Charging System will display on the Driver Information Center.
- DTC P0CA2 is a Type A DTC.

Conditions for Clearing the DTC

- DTC P0CA2 is a Type A DTC.
- 14 V Power Module detects no transistor failures for 5 seconds.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, program the K59 Starter Generator Control Module. If the DTC resets, go to Circuit/System Testing.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to

servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure 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.
2. Remove the 3-phase cables from the K59 starter generator control module.
3. Test for infinite resistance between the 3-Phase cable terminals listed below and ground for each phase of the drive motor generator battery cable:
   - X8 Phase U terminal
   - X7 Phase V terminal
   - X6 Phase W terminal
   - If less than infinite resistance, test each phase of the drive motor generator battery cable for a short to ground. If the cables test normal, replace the A15 starter generator.
4. Retest for the DTC. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

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

DTC P0CC5: 14V POWER MODULE INPUT-OUTPUT CURRENT SENSORS NOT PLAUSIBLE

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 P0CC5

14V Power Module Input-Output Current Sensors Not Plausible

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14V power module has 2 internal current sensors, one for input and one for output current measurements. The 14 volt power module monitors both input and output current, and then makes a correlation between them. This diagnostic will check range performance malfunctions of one or both of the current sensors. These current sensors are internal to the 14V power module and are not serviced separately from the generator control module.

Conditions for Running the DTC

- Ignition is ON.
- Ignition voltage is between 9-16V.

Conditions for Setting the DTC

The difference between the calculated input power and calculated output power of the two current sensors is greater than 0.4 kW for greater than 4 seconds.

Action Taken When the DTC Sets

DTC P0CC5 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0CC5 is a Type B DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called Starter Generator Control 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

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This diagnostic applies to internal microprocessor integrity conditions within the hybrid powertrain control module. This is an internal fault detection of the hybrid powertrain control module and no external circuits are involved.

Conditions for Running the DTC

- Ignition 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

- DTC P15F0 is a Type A DTC.
- The hybrid powertrain control module opens the high voltage contactor relay.

Conditions for Clearing the DTC

DTC P15F0 is a Type A DTC.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P15F4: DRIVE MOTOR 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 P15F4

Drive Motor Torque Delivered Signal Message Counter Incorrect

Circuit/System Description

The generator control module, also called the starter generator control module, is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This is an internal fault detection of the hybrid powertrain control module and no external circuits are involved.

Conditions for Running the DTC

- Ignition is ON.
- The system voltage is greater than 9.5 V.
- DTC U1817 is not set.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

Action Taken When the DTC Sets

- DTC P15F4 is a Type A DTC.
- The HPCM commands the battery energy control module (BECM) to open the high voltage contactor relays.

Conditions for Clearing the DTC

DTC P15F4 is a Type A DTC.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Testing

NOTE: Diagnose and repair any communication DTCs prior to performing this testing.

1. Ignition ON.
2. Verify DTC P15F4 is not set.
    - **If the DTC is set**
    1. Program the K59 Starter Generator Control Module.
    2. Verify the DTC does not set.
        - If the DTC sets, replace the K59 Starter Generator Control 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 K59 Starter Generator Control Module replacement, programming and setup

DTC P15F5: CRANKSHAFT TORQUE COMMAND 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 P15F5

Crankshaft Torque Command Signal Message Counter Incorrect

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This is an internal fault detection of the hybrid powertrain control module and no external circuits are involved.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

Action Taken When the DTC Sets

- DTC P15F5 is a Type A DTC.
- The hybrid powertrain control module opens the high voltage contactor relay.

Conditions for Clearing the DTC

DTC P15F5 is a Type A DTC.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify that DTC P0562 is not set.
   - If DTC is set, refer to **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, C12E1, C12E2, P0560, P0562, or P0563** for Hybrid (HP6).

NOTE: Diagnose and repair any communication DTCs prior to performing this testing.

2. If the DTC is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for generator control module, also called Starter Generator Control Module, replacement, programming and setup.

DTC P16F3: CONTROL MODULE REDUNDANT MEMORY 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 P16F3

Control Module Redundant Memory Performance

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This is an internal fault detection of the hybrid powertrain control module and no external circuits are

involved.

Conditions for Running the DTC

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

Conditions for Setting the DTC

The control module has detected that the redundant data does not match the primary data.

Action Taken When the DTC Sets

- DTC P16F3 is a Type A DTC.
- The hybrid powertrain control module opens the high voltage contactor relay.

Conditions for Clearing the DTC

DTC P16F3 is a Type A DTC.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

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

DTC P1A56: HYBRID/EV SYSTEM VOLTAGE DISCHARGE CIRCUIT

Diagnostic Instructions

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

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

DTC Descriptor

DTC P1A56

Hybrid/EV System Voltage Discharge Circuit

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The generator control module contains DC high voltage capacitors and a resistor circuit intended to discharge the electrical energy stored within those capacitors. Whenever the high voltage contactors are opened, the hybrid powertrain control module connects the internal resistor circuit across the capacitor circuit. The level of the high voltage is monitored by the hybrid powertrain control module before and after the resistor circuit has been connected. If the voltage level remains high for too long, the hybrid powertrain control module sets this DTC and then commands the motor control module to connect the drive motor generator 3 phase circuits across the DC high voltage positive and negative circuits thereby discharging the capacitors.

Conditions for Running the DTC

High Voltage Contactors are commanded Open.

Conditions for Setting the DTC

Within 300 milliseconds after commanding contactors open, the high voltage bus voltage fails to decrease by at least 18 V.

Or

Within 300 milliseconds after commanding contactors open, the high voltage bus voltage is greater than 60 V.

Or

The active bus discharge circuit status is disabled.

Action Taken When the DTC Sets

- DTC P1A56 is a Type B DTC.
- The drive motor control module is commanded to discharge the capacitor through the drive motor generator 3 phase stator circuits.

Conditions for Clearing the DTC

DTC P1A56 is a Type B DTC.

Diagnostic Aids

A high-pitched whine may emanate from the drive motor whenever the HV DC capacitance is discharged through the drive motor stator circuits.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify other DTCs are not set.
    - If other DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. If the DTC is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

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

DTC P1A6F: DRIVE MOTOR NO CRANK AT RESTART

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 P1A6F

Drive Motor No Crank at Restart

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The eAssist hybrid system has the ability to crank and start the engine using two different methods. The first method is a conventional 12 volt system. On every initial start up the conventional 12 volt starter and 12 volt battery are used to crank and start the engine.

The second starting method uses the 115 Volt generator control and battery assembly also called the hybrid battery and the starter generator also called the drive motor. The drive motor is a 3 phase AC induction machine. This device not only serves as a 115-volt AC generator, it is also used to provide engine power assist and to start the engine when in auto-stop mode. If the system is in the auto-stop mode and fails to restart with the drive motor, the 12 volt conventional starter will automatically be engaged to start the engine.

Conditions for Running the DTC

Ignition is ON and the vehicle is in autostop.

Conditions for Setting the DTC

The hybrid powertrain control module detects that an autostart failed to take place successfully.

Action Taken When the DTC Sets

- DTC P1A6F is a Type B DTC.
- The 12 V starter will be engaged to start the engine and autostop will be disabled.

Conditions for Clearing the DTC

DTC P1A6F is a Type B DTC.

Diagnostic Aids

A slipping drive motor belt can cause belt noise on an AutoStart, inspect the drive belt tensioner assembly for proper operation and installation.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**

- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

Circuit/System Verification

1. If drive belt noise was noticed on an AutoStart, refer to **Drive Belt Tensioner Diagnosis** .
2. Verify that no other hybrid control module or engine control modules DTCs are set.
   - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
3. If the DTC is set, program the K59 starter generator control module.
   - If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

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

DTC P1A71-P1A73: POWER MODULE TEMPERATURE SENSOR 2

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 P1A71

14V Power Module Temperature Sensor 2 Performance

DTC P1A72

14V Power Module Temperature Sensor 2 Circuit Low Voltage

DTC P1A73

14V Power Module Temperature Sensor 2 Circuit High Voltage

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14V power module constantly monitors its temperature to protect against overheat conditions. The module also monitors the performance of the temperature sensors to assure they are working properly. These

sensors are internal to the 14V power module and are not serviced separately from the generator control module.

Conditions for Running the DTC

- The Ignition is ON.
- Ignition voltage is between 9-16V.

P1A71

- DTCs P1A90, P1A91, P1A92, P1A71, P1A72, P1A73, P0A2B, P0A2C, P0A2D, P0A2F, P0AEE, P0AEF, P0AF0, P0C11, and P262B are not set.
- Ignition must be off for 8 hours or more.

Conditions for Setting the DTC

P1A71

14V Power Module Temperature Sensor 2 has a value of 20°C greater than the average value of 14V Power Module Temperature Sensor 1, Motor Generator Unit Temperature, and the Inverter Temperature for greater than 4 seconds.

P1A72

14V Power Module Temperature Sensor 2 is greater than 145°C (293°F) for greater than 4 seconds.

P1A73

14V Power Module Temperature Sensor 2 is less than -65°C (-85°F) for greater than 4 seconds.

Action Taken When the DTC Sets

- DTCs P1A71, P1A72, or P1A73 are Type B DTCs.
- The 14V power module stops supplying power to the 12V system.
- The charging system light will illuminate, and Service Battery Charging System will display on the Driver Information Center.

Conditions for Clearing the DTC

DTCs P1A71, P1A72, or P1A73 are Type B DTCs.

P1A72

14V Power Module Temperature Sensor 2 is less than 140°C (284°F).

P1A73

14V Power Module Temperature Sensor 2 is greater than -60°C (-76°F).

Diagnostic Aids

Verify 14V Power Module Temperature Sensor 2 reads between -59°C (-74°F) and +139°C (+282°F) and is within 20°C (36°F) of the average of 14V Power Module Temperature Sensor 1, Drive Motor Temperature, and 14V Power Module Temperature Sensor 2 after ignition has been off for 8 hours.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P1A90-P1A92: POWER MODULE TEMPERATURE SENSOR 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 P1A90

14V Power Module Temperature Sensor 1 Performance

DTC P1A91

14V Power Module Temperature Sensor 1 Circuit Low Voltage

DTC P1A92

14V Power Module Temperature Sensor 1 Circuit High Voltage

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14V power module constantly monitors its temperature to protect against overheat conditions. The module also monitors the performance of the temperature sensors to assure they are working properly. These sensors are internal to the 14V power module and are not serviced separately from the generator control module.

Conditions for Running the DTC

- The Ignition is ON.
- Ignition voltage is between 9-16V.

P1A90

- DTCs P1A90, P1A91, P1A92, P1A71, P1A72, P1A73, P0A2B, P0A2C, P0A2D, P0A2F, P0AEE, P0AEF, P0AF0, P0C11, and P262B are not set.
- The Ignition has been off for 8 hours.

Conditions for Setting the DTC

P1A90

14V Power Module Temperature Sensor 1 has a value of 20°C greater than the average value of 14V Power Module Temperature Sensor 2 and Drive Motor Temperature for greater than 4 seconds.

P1A91

14V Power Module Temperature Sensor 1 is greater than 145°C (293°F) for greater than 4 seconds.

P1A92

14V Power Module Temperature Sensor 1 is less than -65°C (-85°F) for greater than 4 seconds.

Action Taken When the DTC Sets

DTCs P1A90, P1A91, or P1A92 are Type B DTCs.

P1A91

- The 14V power module stops supplying power to the 12V system.
- The charging system light will illuminate, and Service Battery Charging System will display on the

Driver Information Center.

Conditions for Clearing the DTC

DTCs P1A90, P1A91, or P1A92 are Type B DTCs.

P1A91

14V Power Module Temperature Sensor 1 is less than 140°C (284°F).

P1A92

14V Power Module Temperature Sensor 1 is greater than -60°C (-76°F).

Diagnostic Aids

Under normal operation, the scan tool parameter 14V Power Module Temperature Sensor 1 should be between -59°C (-74°F) and +139°C (+282°F), and be within 20°C (36°F) of the average of 14V Power Module Temperature Sensor 2 and Drive Motor Temperature after ignition has been off for 8 hours.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P1ADE OR P1ADF: DRIVE MOTOR CONTROL MODULE SYSTEM VOLTAGE

Diagnostic Instructions

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

DTC Descriptor

DTC P1ADE

Drive Motor Control Module System Voltage Low Voltage

DTC P1ADF

Drive Motor Control Module System Voltage High Voltage

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter generator based upon hybrid powertrain control module information.

The vehicle control modules or sensors monitor the system voltage to verify the system voltage is within the normal operating range.

Conditions for Running the DTC

The Ignition is ON.

Conditions for Setting the DTC

P1ADE

Drive motor control module ignition voltage is less than or equal to 10 V for 6 seconds.

P1ADF

Drive motor control module ignition voltage is greater than 18 Volts for 5 seconds.

Action Taken When the DTC Sets

DTCs P1ADE and P1ADF are Type C DTCs.

P1ADE

The hybrid powertrain control module opens the high voltage contactor relay.

Conditions for Clearing the DTC

DTCs P1ADE and P1ADF are Type C DTCs.

Diagnostic Aids

- A high or low voltage DTC set

  Or

  Voltage value in multiple modules/sensors indicates a concern in the charging system.

- A battery charger or vehicle jump start may have set DTC P1ADF.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Ignition OFF, measure and record the battery voltage at the C1 12V battery terminals. The battery voltage should stabilize between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
   - If not within the specified range, refer to **Battery Inspection/Test** for Hybrid (HP6).
2. Engine running, accessories OFF, measure and record the battery voltage at the C1 12V battery terminals. The voltage should be at least 1 V greater than the voltage measured in step 1 but less than 15 V.
   - If not within the specified range, refer to **Charging System Test** for Hybrid (HP6).
3. Observe the drive motor control module ignition 1 signal voltage parameter with a scan tool. The voltage readings should be within 1 V of the 12V battery voltage.

Circuit/System Testing

NOTE: Use the schematic to identify the following:

- **Control modules the vehicle is equipped with**
- **The control modules ground, B+, and ignition circuit terminal IDs and connectors**

1. Ignition OFF, disconnect the harness connectors at the K59 starter generator control module.

NOTE: Some control module ground circuits may require up to 20 minutes to achieve a resistance reading of less than 10 ohms. In most cases the readings will drop below 20 ohms within 1 minute indicating the control modules are going to sleep.

2. Ignition OFF, scan tool disconnected, open and close the driver door and wait 1 minute. Test for less than 10 ohms between each ground circuit terminal at the K59 starter generator control module harness and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Test for 10-18V between each B+ circuit terminal at the K59 starter generator control module harness and ground.
   - If less than the specified range, test the B+ circuit for a short to ground or an open/high resistance.

NOTE: If less than the specified range, test the B+ circuit for a short to ground or an open/high resistance.

4. Ignition ON, test for 10-18 V between each ignition circuit terminal and ground.
   - If less than the specified range, test the ignition circuit for a short to ground or an open/high resistance.
5. If all circuits test normal, replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P1AE8 OR P1AE9: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY VOLTAGE

Diagnostic Instructions

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

DTC Descriptor

DTC P1AE8

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

DTC P1AE9

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

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter generator based upon generator control module commands. The hybrid powertrain control module is able to detect out of range low or out of range high conditions on the high voltage sensor circuit.

Conditions for Running the DTC

- The Ignition is ON.
- The high voltage contactor relay is closed.

Conditions for Setting the DTC

P1AE8

With the hybrid/EV battery system contactor closed, the starter generator control module detects high voltage sensor voltage less than 30V.

P1AE9

The drive motor control module detects high voltage sensor voltage greater than 190V.

Action Taken When the DTC Sets

- DTCs P1AE8 and P1AE9 are Type B DTCs.
- The hybrid powertrain control module opens the high voltage contactor relay.
- The battery indicator light will illuminate.

Conditions for Clearing the DTC

DTCs P1AE8 and P1AE9 are Type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**

- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P1AEC OR P1AEE: 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 Control Module Hybrid/EV Battery System Voltage

DTC P1AEE

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

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter generator based upon generator control module commands. The hybrid powertrain control module monitors the high voltage measurement and then will broadcast the high voltage measurement over serial data.

P1AEC

The drive motor control module compares the values in order to verify the hybrid battery high voltage measurement is accurate.

P1AEE

The hybrid powertrain control module monitors for high voltage that is greater than the system allows during normal operation.

Conditions for Running the DTC

P1AEC

DTC P1AE8 or P1AE9 is not set,

AND

High voltage is available and valid,

AND

Ignition is On,

AND

The high voltage contactor relays are closed.

P1AEE

Ignition voltage is greater than 7V.

Conditions for Setting the DTC

P1AEC

The difference between high voltage sensed and high voltage battery voltage measured is greater than 15V,

AND

The difference between high voltage sensed and the sum of the mid-pack voltages is greater than 10V.

P1AEE

The high voltage sensor voltage is greater than 150V,

OR

Hardware Overvoltage is detected.

Action Taken When the DTC Sets

- DTCs P1AEC and P1AEE are Type B DTCs.
- The hybrid powertrain control module opens the high voltage contactor relay.

Conditions for Clearing the DTC

DTCs P1AEC and P1AEE are Type B 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 DTC P1AEE. History DTC P1AEE may indicate that the high voltage contactor relays opened while large current flow was present.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify that DTCs P0ABB, P0ABC, or P0ABD is not set.
    - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. If the DTC is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P1AF0: DRIVE MOTOR 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 Descriptor

DTC P1AF0

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

Circuit/System Description

The vehicle is equipped with a high voltage isolation monitor feature. The purpose of the isolation monitor is to test the resistance between the high voltage positive and negative direct current (DC) bus and chassis ground. The isolation monitoring system measures the resistance between the high voltage system and chassis ground in the following way: The isolation monitoring system measures voltage potential difference between the positive battery mid pack voltage and chassis ground as well as the voltage difference between negative battery mid pack voltage and chassis ground. These voltage values are used by the Starter/Generator Control Module to calculate a resistance value between the high voltage bus and the chassis ground. If this resistance value is too low, a high voltage isolation fault has occurred.

Conditions for Running the DTC

- Internal battery voltage sensor value is greater than 100 V
- None of the following DTCs are set: P0AA8, P0AAA, P1AE8, P1AE9, P1AEC, P1E0D, P1E10, P1E11, P1E13, P1E14

Conditions for Setting the DTC

The calculated resistance between the high voltage DC systems and vehicle chassis ground less than 225.6K ohms

Action Taken When the DTC Sets

- DTC P1AF0 is a type B DTC.
- If the DTC sets while there is a loss of communication with the sensing and diagnostic module (SDM), the Starter/Generator Control Module will record the fault as a crash event and the DTC will become latched.

Conditions for Clearing the DTC

- DTC P1AF0 is a type B DTC.
- If the DTC is set as a latched DTC, the crash event must be cleared before the DTC will clear.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

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

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

Circuit/System Testing

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

The High Voltage Disabling procedure includes the following steps:

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

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

- **Safety glasses with appropriate side shields when within 15**

meters (50 feet) of the vehicle, either indoors or outdoors.

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

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

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

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

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

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

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

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

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

Repair Instructions

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

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

DTC P1AF4 OR P1AF5: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY VOLTAGE ISOLATION SENSING CIRCUIT 1

Diagnostic Instructions

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

DTC Descriptors

DTC P1AF4

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

DTC P1AF5

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

Circuit/System Description

The vehicle is equipped with a high voltage isolation monitor feature. The purpose of the isolation monitor is to test the resistance between the high voltage positive and negative direct current (DC) bus and chassis ground. The isolation monitoring system measures the resistance between the high voltage system and chassis ground in the following way. The Starter/Generator Control Module places an AC signal on the high voltage system and monitors its amplitude. A reduced amplitude return signal indicates a loss of resistance to chassis ground. This isolation monitor method is sometimes referred to as the active isolation monitor.

Conditions for Running the DTC

P1AF4

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

P1AF5

Power mode is RUN or CRANK.

Conditions for Setting the DTC

P1AF4

The positive mid-pack voltage is less than 5 V.

P1AF5

The positive mid-pack voltage minus the high voltage is greater than 10 V.

Action Taken When the DTC Sets

DTCs P1AF4 and P1AF5 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P1AF4 and P1AF5 are Type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Verification

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

The High Voltage Disabling procedure includes the following steps:

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

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

- **Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
  - **Visually and functionally inspect the gloves before use.**
  - **Wear the Insulation gloves with leather protectors at all**

times when working with the high voltage battery assembly, whether the system is energized or not.

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

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

1. Ignition ON.
2. Verify DTC P1AF4 or P1AF5 is not set.
   - **If DTC P1AF4 or P1AF5 is set**

     Replace the K59 Starter/Generator Control Module.

   - **If DTC P1AF4 and P1AF5 are not set**
3. All OK.

Repair Instructions

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

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

DTC P1B0B OR P1B0C: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY VOLTAGE ISOLATION SENSING CIRCUIT 2

Diagnostic Instructions

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

DTC Descriptors

DTC P1B0B

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

DTC P1B0C

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

Circuit/System Description

The vehicle is equipped with a high voltage isolation monitor feature. The purpose of the isolation monitor is to test the resistance between the high voltage positive and negative direct current (DC) bus and chassis ground. The isolation monitoring system measures the resistance between the high voltage system and chassis ground in the following way. The Starter/Generator Control Module places an AC signal on the high voltage system and monitors its amplitude. A reduced amplitude return signal indicates a loss of resistance to chassis ground. This isolation monitor method is sometimes referred to as the active isolation monitor.

Conditions for Running the DTC

P1B0B

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

P1B0C

Power mode is RUN or CRANK.

Conditions for Setting the DTC

P1B0B

The negative mid-pack voltage is less than 5 V.

P1B0OC

The negative mid-pack voltage minus the high voltage is greater than 10 V.

Action 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 Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Verification

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

The High Voltage Disabling procedure includes the following steps:

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

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

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

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

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

1. Ignition ON.
2. Verify P1B0B or P1B0C is not set.
   - **If P1B0B or P1B0C is set**

     Replace the K59 Starter/Generator Control Module.

   - **If P1B0B and P1B0C are not set**
3. All OK.

Repair Instructions

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

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

DTC P1B0D: DRIVE MOTOR CONTROL MODULE DRIVE MOTOR 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 P1B0D

Drive Motor Control Module Drive Motor Overspeed

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor position sensor is monitored by the generator control module. The generator control module monitors the angular position, speed and direction of the starter generator based upon the signals of the resolver-type position sensor. The position sensor allows the drive motor control module to determine the exact position and speed of the starter generator.

Conditions for Running the DTC

The drive motor control module and hybrid powertrain control module are awake.

Conditions for Setting the DTC

Starter generator speed is greater than 18,000 RPM.

Action Taken When the DTC Sets

- DTC P1B0D is a Type B DTC.
- The hybrid powertrain control module opens the high voltage contactor relay.
- The battery indicator light will illuminate.

Conditions for Clearing the DTC

DTC P1B0D is a Type B DTC.

Diagnostic Aids

Check for broken or missing drive belt.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify if DTC P0A3F, P0A40, P1B03, P0C52, P0C53, P0C5C, and P0C5D are not set.
   - If DTC P0A3F, P0A40, P1B03, P0C52, P0C53, P0C5C, and P0C5D is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. If the DTC is set, program the generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

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

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

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

Circuit/System Description

The vehicle is equipped with a high voltage isolation sensor rationality or performance fault detection. The purpose of the isolation voltage sensor monitor is to test the rationality between the sum of the high voltage positive and negative current sensed voltages against the high voltage sensed value and also against the high voltage value from the battery pack energy control module. This is part of the passive isolation monitor.

Conditions for Running the DTC

Main contactor is commanded closed.

Conditions for Setting the DTC

All the following conditions exist:

- The mid-pack positive voltage minus the mid-pack negative voltage minus the high voltage battery voltage is greater than 15 V and he mid-pack positive voltage minus the mid-pack negative voltage minus the high voltage is greater than 10 V
- The mid-pack positive voltage minus the mid-pack negative voltage minus the high voltage is greater than 10 V

Action Taken When the DTC Sets

DTC P1B41 is a type B DTC.

Conditions for Clearing the DTC

DTC P1B41 is a type B DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Verification

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

The High Voltage Disabling procedure includes the following steps:

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

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

- **Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.**

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

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

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

1. Ignition ON.
2. Verify P1B41 is not set.
   - **If P1B41 is set**

     Replace the K59 Starter/Generator Control Module.

   - **If P1B41 is not set**
3. All OK.

Repair Instructions

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

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

DTC P1E0A: 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 Descriptor

DTC P1E0A

Drive Motor Control Module Torque Calculation Performance

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This is an internal fault detection of generator control module and no external circuits are involved.

Conditions for Running the DTC

The ignition voltage is greater than 9.5 V.

Conditions for Setting the DTC

The difference between the redundant torque calculation and the primary calculation is greater than 36 N.m (27 lb ft).

Action Taken When the DTC Sets

- DTC P1E0A is a Type A DTC.
- The hybrid powertrain control module opens the high voltage contactor relay.

Conditions for Clearing the DTC

DTC P1E0A is a Type A DTC.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

Program the K59 starter generator control module. If the DTC resets replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P1E3B: DRIVE MOTOR ROTOR 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 P1E3B

Drive Motor Rotor High Temperature

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The starter generator is also referred to as the drive motor. The drive motor temperature sensor is a variable resistor that measures the temperature of the drive motor stator windings. The hybrid powertrain control module supplies 5 V to the signal circuit and a ground for the low reference circuit. The hybrid powertrain control module calculates a value to estimate the drive motor rotor temperature. The hybrid powertrain control module uses the stator temperature, drive motor current, and commanded motor torque in order to calculate the value for the drive motor rotor temperature.

Conditions for Running the DTC

The drive motor control module and hybrid powertrain control module are awake.

Conditions for Setting the DTC

- DTCs P0A3F, P1A40, P1B03, P1B0D, P0C52, P0C53, P0C5C, P0C5D, P1AE8, P1AE9, P1AEC, P0BFD, P0BE6, P0BE7, P0BE8, P0BEE, P0BEF, and P0BF0 are not set.
- The motor rotor temperature calculation is greater than 197°C (387°F) for 8 seconds and has not fallen below 194°C (381°F).

Action Taken When the DTC Sets

- DTC P1E3B is a Type B DTC.
- The hybrid powertrain control module system starts to reduce the maximum torque beginning at 180° C (356°F) down to 0 NM as the calculated drive motor rotor temperature approaches 200°C (392°F).

Conditions for Clearing the DTC

DTC P1E3B is a Type B DTC.

Diagnostic Aids

- Ask about the customer's driving habits, trailer towing, etc.
- Ensure the engine cooling system is functioning normally.
- The drive motor stator temperature should be within 60°C (140°F) of the motor calculated rotor temperature.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Check the cooling system for the correct amount of coolant. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
2. Verify that DTC P0A2C, P0CC1-P0CC4 is not set.
    - If DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
3. Start the engine and observe the scan tool motor A calculated rotor temperature parameter. The reading should be less than 180°C (356°F). If greater than the specified value, check the cooling system and pump for proper operation. If there is coolant and flow then monitor the calculated rotor temperature and verify that it drops below 180°C (356°F). If the temperature does not drop below 180°C (356°F) then reprogram the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P1E3C: DRIVE MOTOR ROTOR 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 P1E3C

Control Module Calculated Hybrid/EV Battery Performance

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The hybrid powertrain control module performs internal calculations multiple times and compares the results of these calculations to verify proper operation of the internal controller memory. The result of these calculations is a voltage value. This voltage value is an internal value and cannot be measured externally. This fault is handled inside the generator control module and no external circuits are involved.

Conditions for Running the DTC

- The 12 V battery voltage is greater than 9 V.
- The drive motor control module and the hybrid powertrain control module are awake.

Conditions for Setting the DTC

If the results of these calculations differ by more than one volt.

Action Taken When the DTC Sets

- DTC P1E3C is a type A DTC.
- The high voltage contactor relay will be opened.

Conditions for Clearing the DTC

DTC P1E3C is a type A DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**
- **Drive Motor Battery System Description**

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

If the DTC is set, replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P2534 OR P2535: IGNITION ON/START SWITCH

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 P2534

Ignition On/Start Switch Circuit Low Voltage

DTC P2535

Ignition On/Start Switch Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Ignition Voltage	P2534	P2534	P2535

Typical Scan Tool Data

Ignition 1 Signal

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Key ON **Parameter Normal Range:** 8-18 volts			
IGN	0 volts	0 volts	B+

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The hybrid powertrain control module monitors the system voltage on the ignition voltage circuit.

Conditions for Running the DTC

The generator control module is communicating on the serial data circuits.

P2534

Ignition is ON.

P2535

Ignition is OFF.

Conditions for Setting the DTC

P2535

The hybrid powertrain control module detects greater than 5 volts on the ignition voltage circuit at the generator control module when not enabled for greater than 10 seconds.

P2534

The hybrid powertrain control module detects less than 2 volts on the ignition voltage circuit at the generator control module for greater than 10 seconds.

Action Taken When the DTC Sets

DTCs P2534 and P2535 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P2534 and P2535 are Type A DTCs.

Diagnostic Aids

- Verify the charging system is functioning correctly.
- If the run crank circuit is shorted to voltage, the engine will continue to run with the ignition in the OFF position.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **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

Circuit/System Testing

1. Ignition OFF, measure and record the battery voltage at the battery terminals. The battery voltage should stabilize between 12.4 and 12.8V within a few minutes of turning the ignition OFF.
    - If not within the specified range, refer to **Battery Inspection/Test** .
2. Ignition OFF, disconnect K59 starter generator control module X3 connector.
3. Ignition ON, test for 8-18V between the K59 starter generator control module X3 connector ignition

voltage circuit terminal 10 and ground.

- If not within the specified range, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Starter Generator Control Module, also called the Starter generator Control Module, replacement, programming and setup.

DTC P2537: IGNITION ACCESSORY SWITCH CIRCUIT LOW VOLTAGE

Diagnostic Instructions

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

DTC Descriptor

DTC P2537

Ignition Accessory Switch Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Accessory Voltage	P2537	P2537	-

Typical Scan Tool Data

Ignition Input Accessory

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Key ON **Parameter Normal Range:** Active			
Accessory	Inactive	Inactive	Active

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The hybrid powertrain control module monitors the system voltage on the accessory voltage circuit.

Conditions for Running the DTC

- The Ignition is ON.
- The generator control module is communicating on the serial data circuits.

Conditions for Setting the DTC

The generator control module detects less than 2 volts on the ignition voltage circuit at the generator control module for greater than 10 seconds.

Action Taken When the DTC Sets

P2537 is a Type C DTC.

Conditions for Clearing the DTC

P2537 is a Type C DTC.

Diagnostic Aids

Verify the charging system is functioning correctly.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **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

Circuit/System Testing

1. Ignition OFF, disconnect K59 starter generator control module X2 connector.
2. Ignition ON, test for 8-18V between the K59 starter generator control module X2 connector accessory voltage circuit terminal 8 and ground.
    - If not within the specified range, test the accessory voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal replace the K59 starter generator control module.

Repair Instructions

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

Control Module References for Starter Generator Control Module, also called the Starter Generator Control 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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Relay Switch B+	P2797 **	P2797	-
Relay Coil Ignition	P0B09 **	P0B09	-
Relay Coil Control	P0B09 *	P0B09	P0B09
Relay Switch Control	P2797 **	P2797	P2797 *
Component Ground	-	***	-
* Auxiliary Transmission Fluid Pump - always On ** The fuse opens *** Auxiliary Transmission Fluid Pump - inoperative			

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The transmission fluid pump - auxiliary is used to maintain transmission fluid line pressure to the transmission during Autostop mode. The transmission fluid pump - auxiliary is externally mounted to the transmission case assembly. The hybrid powertrain control module controls the auxiliary pump by providing the ground path to the transmission pump relay - auxiliary coil control circuit.

Conditions for Running the DTC

- The Ignition is ON.
- The system voltage is between 9.0 and 32.0 V.

Condition 1

The vehicle is in autostop mode.

Condition 2

- All conditions allowing an autostop have been met.
- A/C compressor ON.

Conditions for Setting the DTC

Condition 1

The calculated transmission slip speed is greater than 150 RPM during a vehicle launch from autostart mode, 7 consecutive times in the same key cycle.

Condition 2

The 14 volt power module output current does not increase by 100 watts or more when the auxiliary transmission fluid pump is commanded ON by the hybrid powertrain control module.

OR

The 14 volt power module output current does not decrease by greater than 250 watts when the auxiliary transmission fluid pump is commanded OFF by the hybrid powertrain control module.

Action Taken When the DTC Sets

- The hybrid powertrain control module disables the Autostop mode.
- DTC P2797 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2797 is a Type B DTC.

Diagnostic Aids

Driving a vehicle with an auxiliary transmission fluid pump failure that causes low or no pressure will cause a harsh transmission engagement on vehicle launch from an autostop.

Transmission Fluid Pump Relay Underhood Electrical Center Terminal Identification			
Front of Vehicle			
Left Side of Vehicle	Control	Load	Right Side of Vehicle
	B+	Ignition	

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Description and Operation

- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**
- **Starter Generator Description and Operation**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify that no other hybrid powertrain or transmission control module DTC is set.
   - **If any hybrid powertrain or transmission control module DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Perform the **Transmission Fluid Level and Condition Check** to verify correct fluid level and condition.
3. Ignition ON.
4. Verify the auxiliary transmission fluid pump turns ON and OFF when commanding the auxiliary transmission fluid pump relay ON and OFF with a scan tool.
   - **If the pump does not operate**

     Refer to Circuit/System Testing.

   - **If the pump operates**

     All OK. Refer to transmission **Line Pressure Check (Non Hybrid)** , **Line Pressure Check (Hybrid)** .

Circuit/System Testing

1. Ignition OFF, disconnect the KR86 transmission fluid pump relay - auxiliary, Ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF.
2. Test for less than 2 ohms in the B+ circuit end to end.
    - If 2 ohms or greater, repair the open/high resistance in the circuit.
    - If less than 2 ohms, 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. Ignition OFF.
2. Test for infinite resistance between the B+ circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Disconnect the X1 harness connector at the G5 Transmission Fluid Pump - Auxiliary, test for infinite resistance between the switched control circuit terminal 1 and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the G5 Transmission Fluid Pump - Auxiliary.

- **If the test lamp illuminates**

3. Ignition OFF and all vehicle systems OFF, disconnect the X1 harness connector at the G5 Transmission Fluid Pump - Auxiliary. It may take up to 2 minutes for all vehicle systems to power down.
4. Test for less than 10 ohms between the G5 Transmission Fluid Pump - Auxiliary ground circuit X1 terminal 2 and ground.
    - **If 10 ohms or greater**

    1. Ignition OFF.
    2. Test for less than 2 ohms in the ground circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, repair the open/high resistance in the ground connection.

    - **If less than 10 ohms**

5. Connect the harness connector at the G5 Transmission Fluid Pump - Auxiliary.
6. Connect a 30 A fused jumper wire between the B+ circuit terminal 30 and the switch control circuit terminal 87. Ignition ON.
7. Verify the G5 Transmission Fluid Pump - Auxiliary is ON.
    - **If the Pump is not ON**

    1. Ignition OFF.
    2. Test for less than 2 ohms in the switch control circuit terminal 87 end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, test or replace the G5 Transmission Fluid Pump - Auxiliary.

    - **If the Pump is ON**

8. Test or replace the KR86 Transmission Fluid Pump Relay - Auxiliary.
    - **If the DTC resets**
9. Refer to transmission **Line Pressure Check (Non Hybrid)** , **Line Pressure Check (Hybrid)** .

Component Testing

1. Ignition OFF, disconnect the KR86 Transmission Fluid Pump Relay - Auxiliary.

2. Test for 85-130 ohms between terminals 85 and 86.
    - **If less than 85 ohms or greater than 130 ohms**

      Replace the relay.

    - **If between 85-130 ohms**
3. Test for infinite resistance between the terminals listed below:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - **If less than infinite resistance**

      Replace the relay.

    - **If infinite resistance**
4. Install a 3 A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground.
5. Test for less than 2 ohms between terminals 30 and 87.
    - **If 2 ohms or greater**

      Replace the relay.

    - **If less than 2 ohms**
6. All OK.

Repair Instructions

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

- **Auxiliary Fluid Pump Removal (Hybrid)**
- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)** , Within an Electrical Center, for Transmission Fluid Pump Relay - Auxiliary replacement.

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:

- **Generator Control Module Description and Operation**
- **High Voltage Monitoring Systems Description**
- **Hybrid Modes of Operation Description**
- **Starter Generator Description and Operation**
- **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

DC POWER CONVERSION TEST

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 generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14 volt power module supplies the energy that flows between the high voltage (115V) direct current (DC) and low voltage (14V) DC to charge the 12V battery and power accessories. The 14V power module receives a wake-up signal from the hybrid powertrain control module when the ignition is switched to On. After a successful initialization, the 14V power module receives an enable command from the hybrid powertrain control module to begin power conversion.

Diagnostic Aids

A poor connection at the B+ terminal of the 14V power module or open 300 Amp Mega-Fuse in the engine compartment, will prevent the 14V power module from operating.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Generator 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. Ignition OFF, measure and record the battery voltage at the C1 12V battery terminals. The battery voltage should stabilize between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
    - If not within the specified range, refer to **Battery Inspection/Test**
2. Start and idle the engine, accessories OFF, measure and record the battery voltage at the battery terminals. The voltage should be at least 1 V greater than the voltage measured in step 1 but less than 15 V.
    - If not within the specified range, refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition ON, verify that no K1 14V power module or B18 battery current sensor DTCs are set that would cause a charging system concern.
    - If DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition OFF, measure the voltage across the battery terminals. The voltage should read 12.4 V or greater at room temperature.
    - If not within the specified range, refer to **Battery Inspection/Test**
3. Connect a carbon pile tester to the C1 battery.
4. Start and idle the engine, turn all accessories off. Observe the voltage reading on the tester. The voltage should read between 12.6-15.5V.
5. Adjust the carbon pile tester so that the 12V current on the 14V power module data list is reading 120 amps. The voltage reading should remain between 12.6-15.5V.
    - If not within the specified value, replace the K1 14V power module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for Generator Control Module replacement, programming, and setup for 14 Volt Power Module replacement.

REPAIR INSTRUCTIONS

STARTER GENERATOR REPLACEMENT

Special Tools

EN-48932 Hydraulic Belt Tensioner Compressor

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

Removal Procedure

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

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

The High Voltage Disabling procedure includes the following steps:

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

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

- **Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
  - **Visually and functionally inspect the gloves before use.**
  - **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery**

assembly, whether the system is energized or not.

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

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
2. Disable the high voltage system. Refer to **High Voltage Disabling** .
3. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
4. Reposition the secondary air injection pump inlet hose, if equipped. Refer to **Secondary Air Injection Pump Inlet Hose Replacement (LEA, LUK)** .

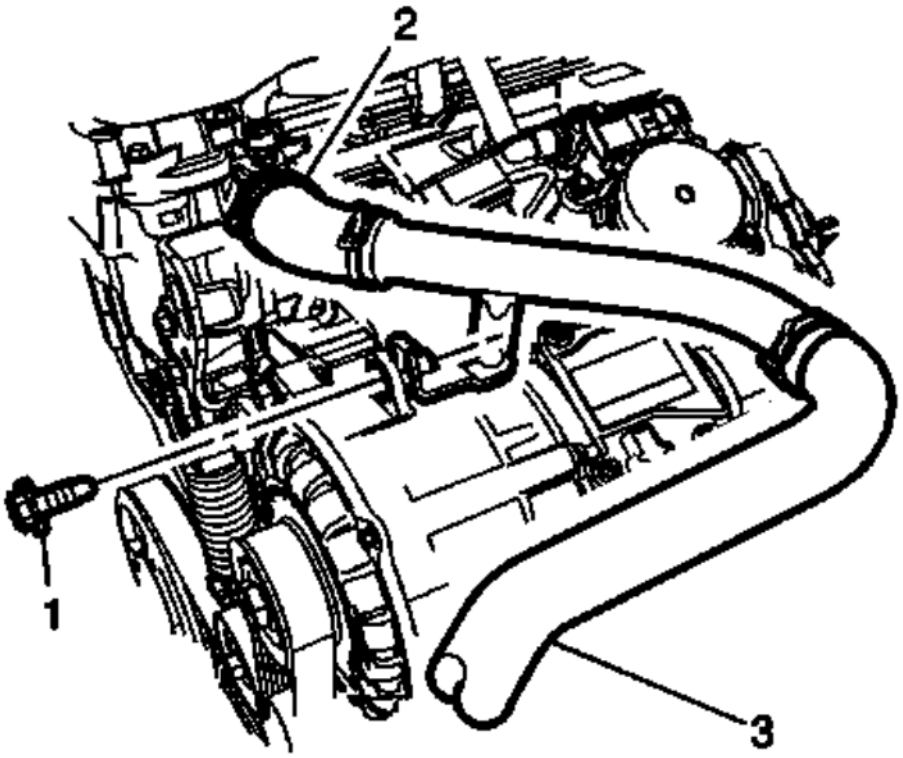


Fig. 4: Radiator Inlet Hose, Bracket & Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the radiator inlet hose bracket bolt (1) and the radiator inlet hose clamp (2).
6. Reposition the radiator inlet hose (3).

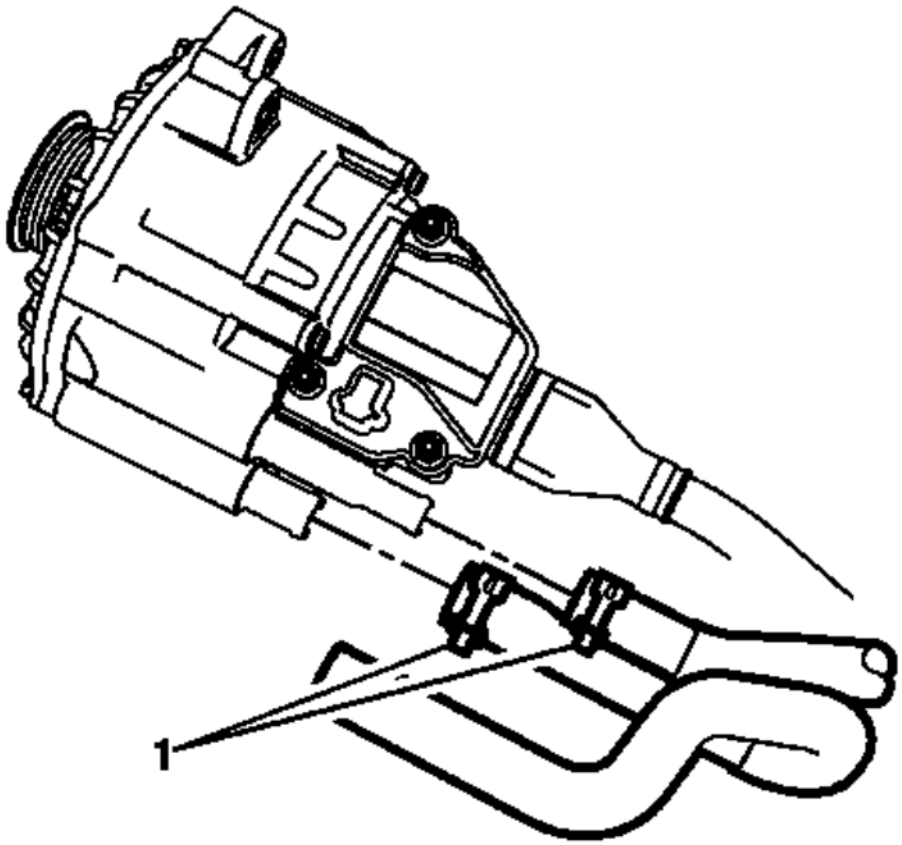


Fig. 5: Starter Generator Hoses
Courtesy of GENERAL MOTORS COMPANY

NOTE: Place a clean cloth in the starter generator coolant tubes to prevent coolant leakage.

7. Remove the starter generator hoses (1) and reposition hoses away from the Starter Generator.

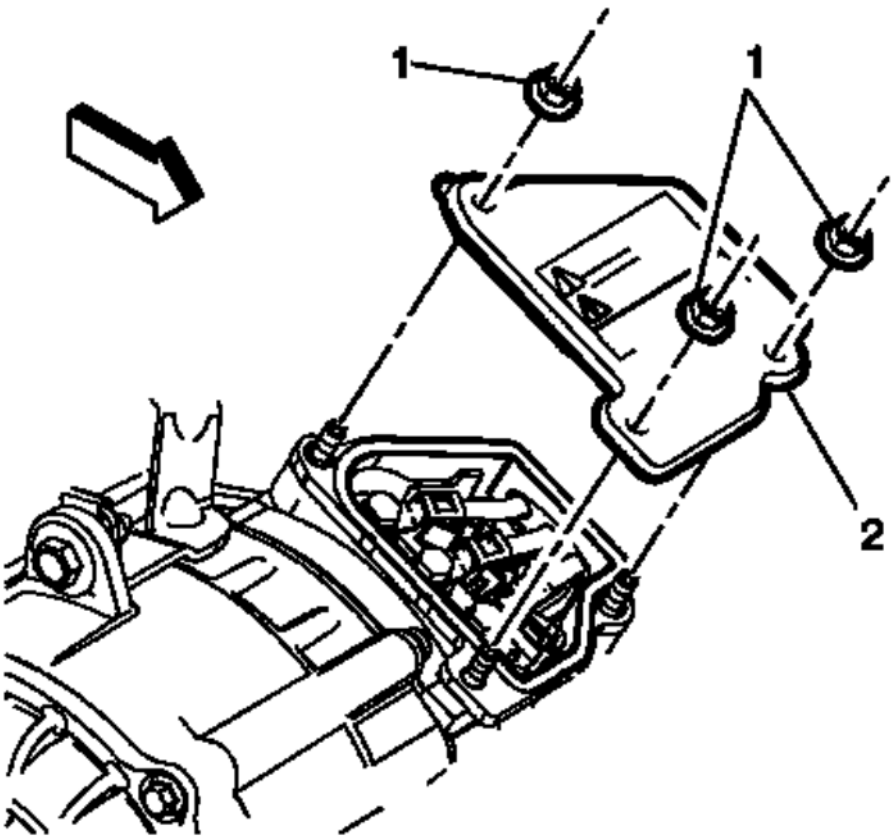


Fig. 6: Generator Starter Cover Nuts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the drive motor generator battery cable cover nuts (1) and the drive motor generator battery cable cover (2).

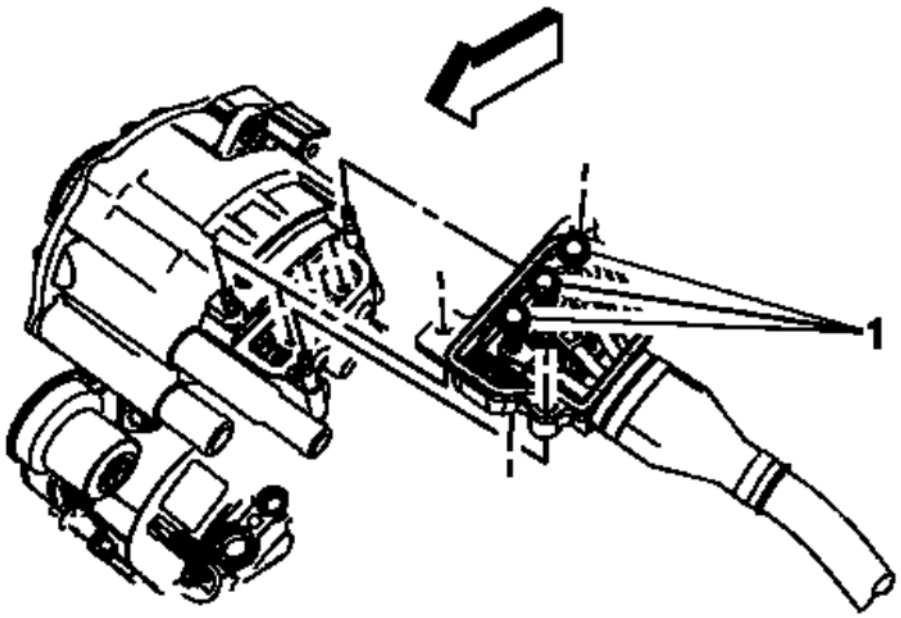


Fig. 7: Starter Generator
Courtesy of GENERAL MOTORS COMPANY

NOTE: The terminals are very sensitive to contamination. Be sure to protect the terminals from engine coolant or debris.

9. Remove the drive motor generator battery cable terminal bolts (1) and reposition the drive motor generator battery cable.

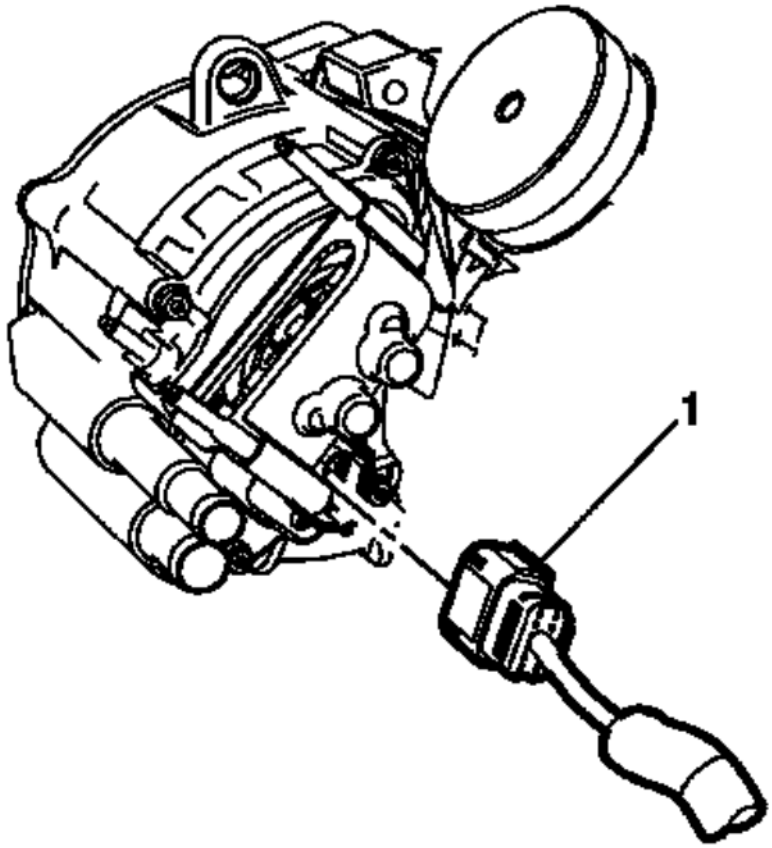


Fig. 8: Drive Motor Generator Battery Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The terminals are very sensitive to contamination. Be sure to protect the connector from debris or engine coolant.**

10. Remove and cover the drive motor generator battery connector (1).

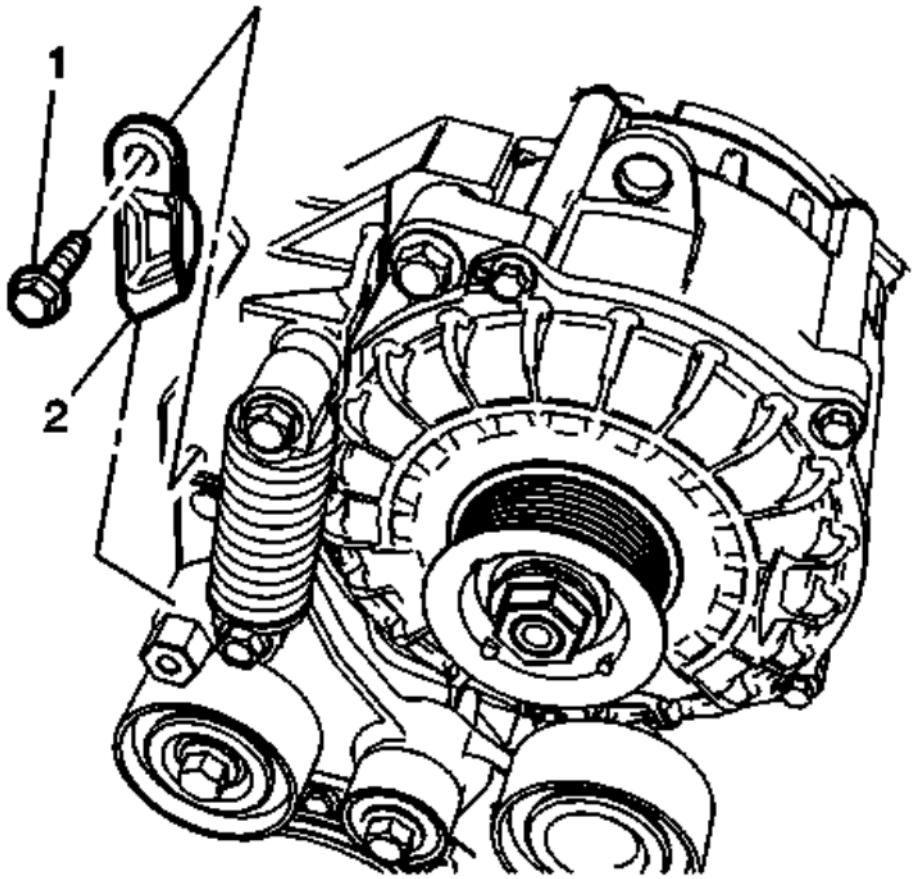


Fig. 9: Drive Belt Tensioner Stop Bolt
Courtesy of GENERAL MOTORS COMPANY

11. Remove the drive belt tensioner stop bolt (1) and the drive belt tensioner stop (2).

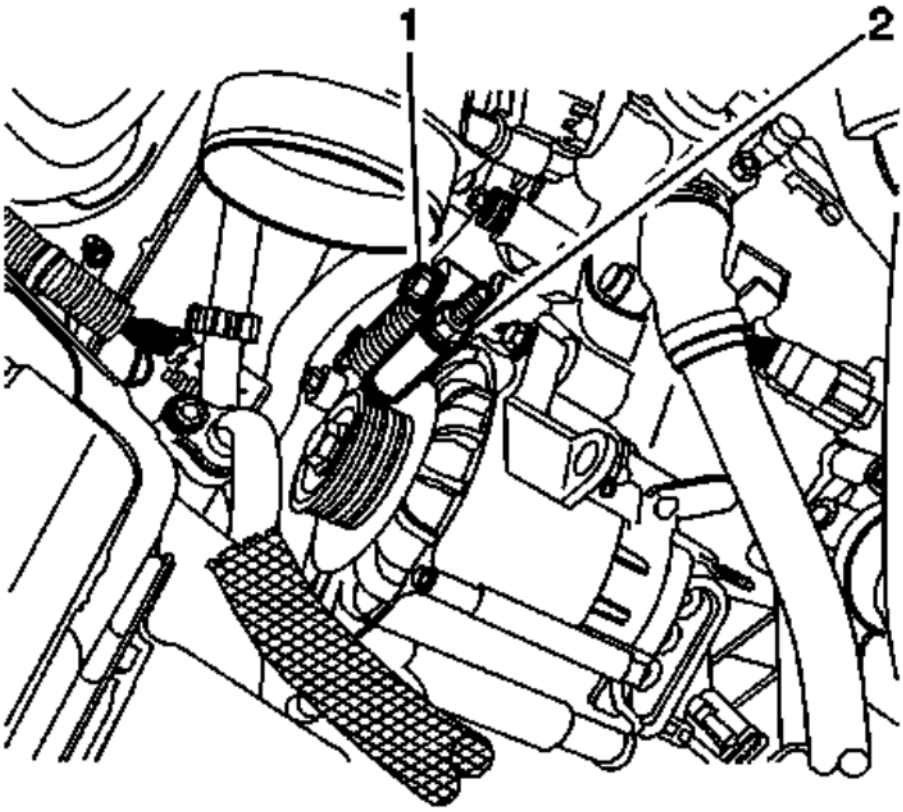


Fig. 10: Special Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: Make sure the EN-48932 compressor tool is not on the Generator bracket and A/C Compressor bracket.

12. Install the **EN-48932** compressor tool (2) to the drive belt tensioner spring.
13. Tighten the nut (1) on the **EN-48932** compressor tool (2) until the tensioner spring reaches its internal stop.

NOTE: Try not to remove the drive belt from the other pulleys.

14. Release the tension from the other drive belt tensioner and remove the drive belt from the starter generator pulley.

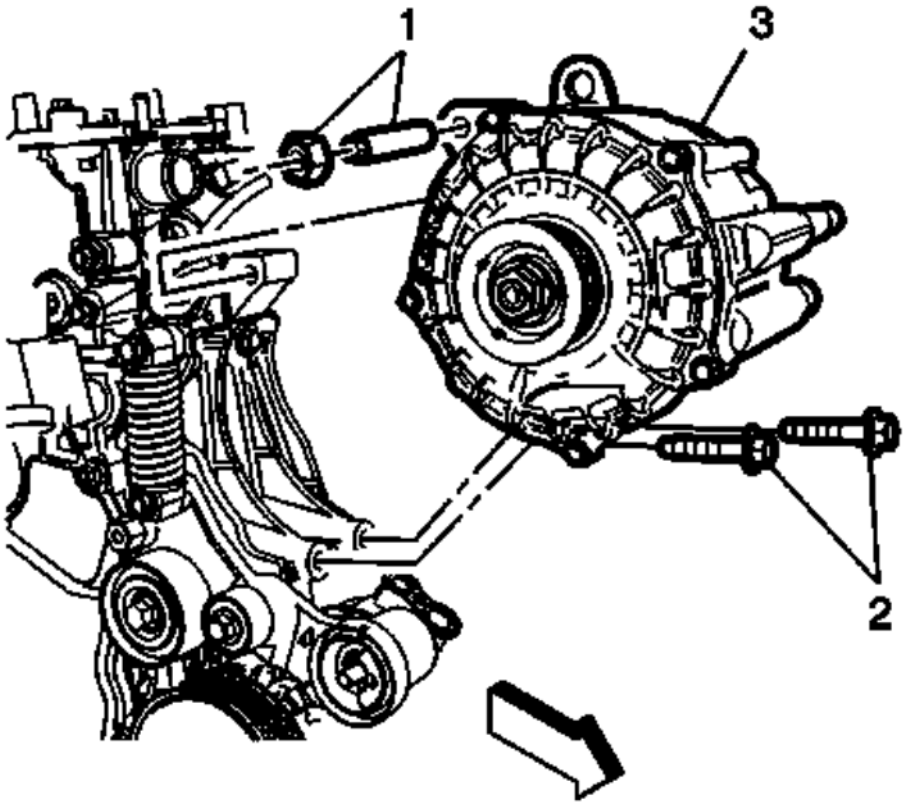


Fig. 11: Stud/Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If stud is seized, place 2 nuts on the end of the stud and remove with a socket.**

15. Remove the stud/nut (1) from the starter generator.
16. Raise the vehicle.
17. Remove the starter generator bolts (2).
18. Remove the starter generator (3).

Installation Procedure

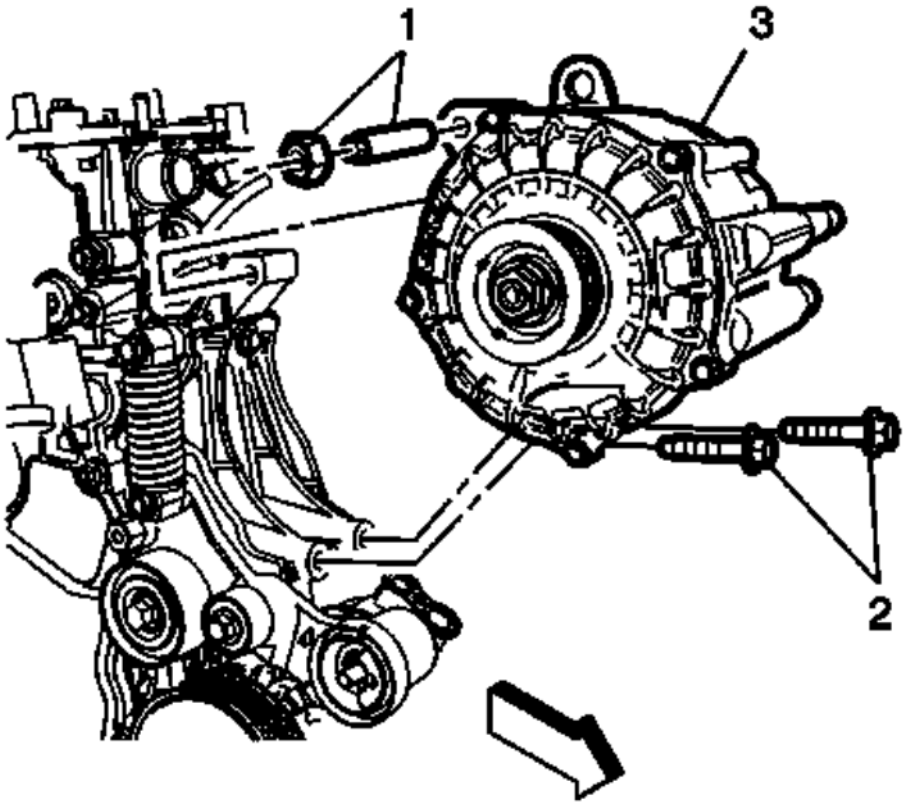


Fig. 12: Stud/Nut
Courtesy of GENERAL MOTORS COMPANY

1. Position the starter generator to the engine.

CAUTION: Refer to Fastener Caution .

2. For ease of service, replace the stud (1) with a new starter generator lower bolt (2) from the parts catalog and apply medium LOCTITE to the bolt. Tighten to 58 N.m (41 lb ft).
3. Install the starter generator lower bolts (2) and tighten to 58 N.m (41 lb ft).

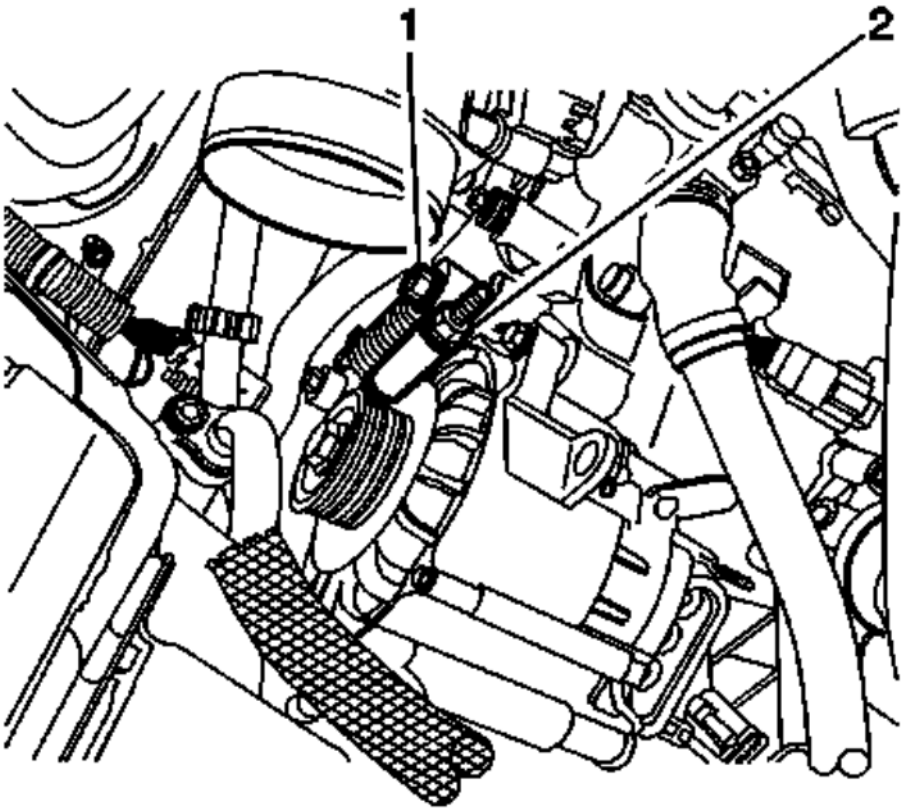


Fig. 13: Special Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

4. Remove the belt from the middle idler.
5. Install the drive belt onto the starter generator pulley.
6. Rotate the tensioner pulley clockwise and then install the belt around the middle idler.
7. Remove the **EN-48932** compressor tool (2) from the drive belt tensioner spring.

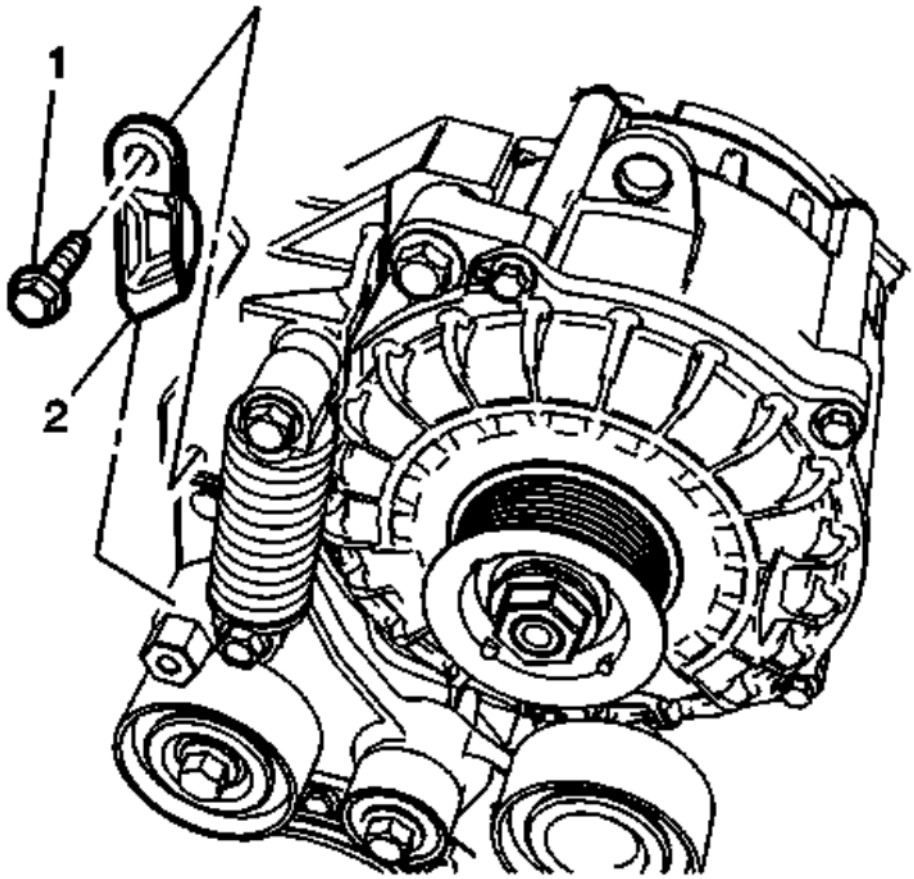


Fig. 14: Drive Belt Tensioner Stop Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Make sure the drive belt tensioner stop pin is aligned with the hole in the Generator and A/C Compressor bracket.

8. Install the drive belt tensioner stop bolt (1) and the drive belt tensioner stop. Tighten to 9 N.m (80 lb in).

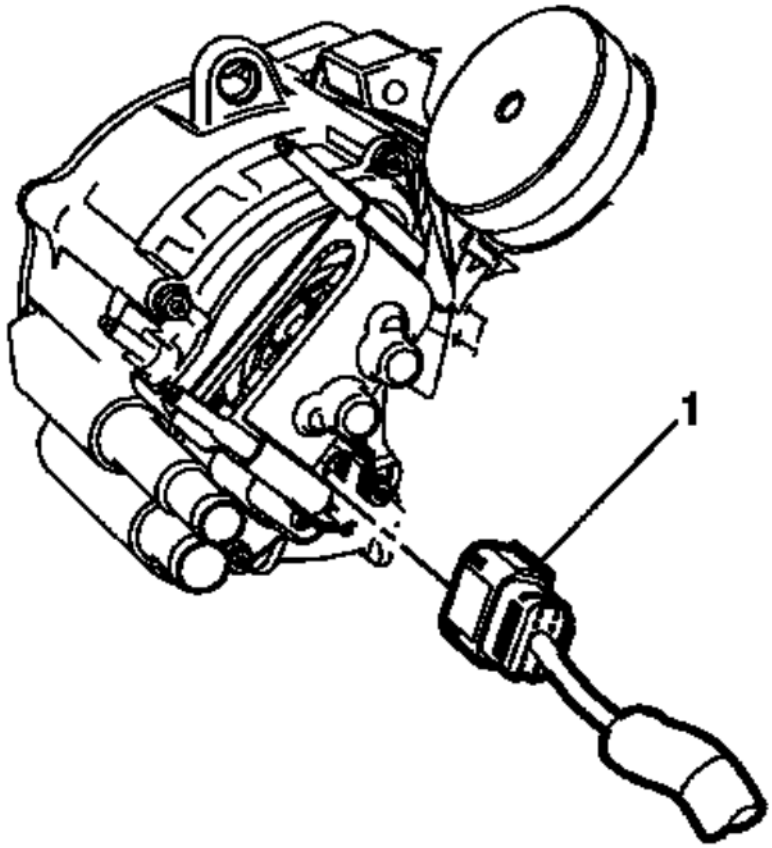


Fig. 15: Drive Motor Generator Battery Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE: Verify the connector is free of contamination prior to engagement.

9. Install the starter generator battery connector (1).

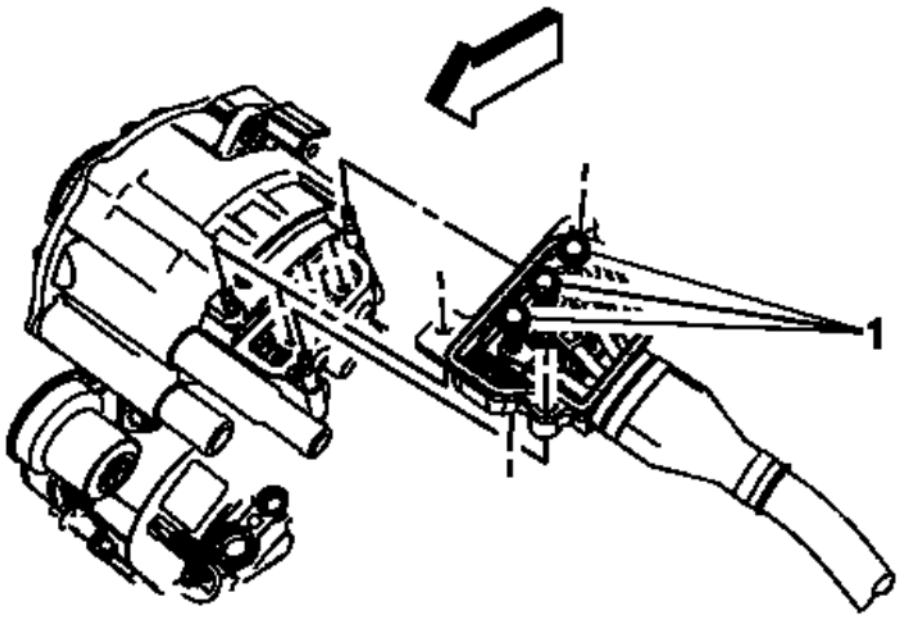


Fig. 16: Starter Generator
Courtesy of GENERAL MOTORS COMPANY

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

10. Install the drive motor generator battery cable to the starter generator assembly and tighten the nuts (1) to 9 N.m (80 lb in).

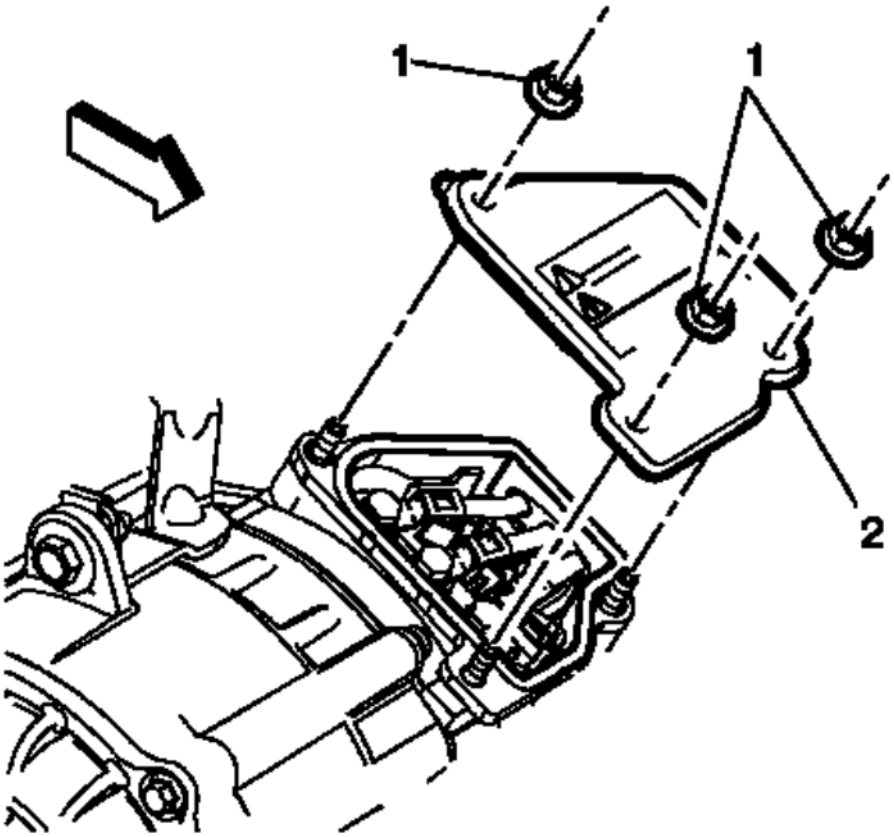


Fig. 17: Generator Starter Cover Nuts
Courtesy of GENERAL MOTORS COMPANY

11. Install the drive motor generator battery cable cover nuts (1) and the drive motor generator battery cable cover (2). Tighten to 9 N.m (80 lb in).

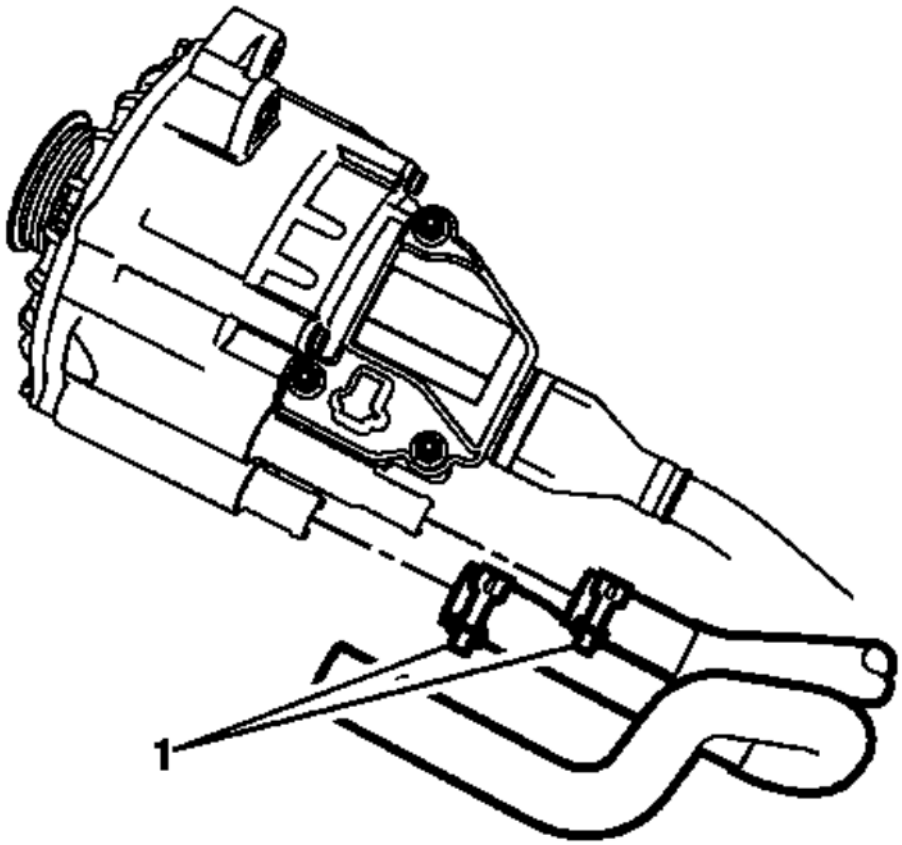


Fig. 18: Starter Generator Hoses
Courtesy of GENERAL MOTORS COMPANY

12. Install the starter generator hoses and clamps (1).

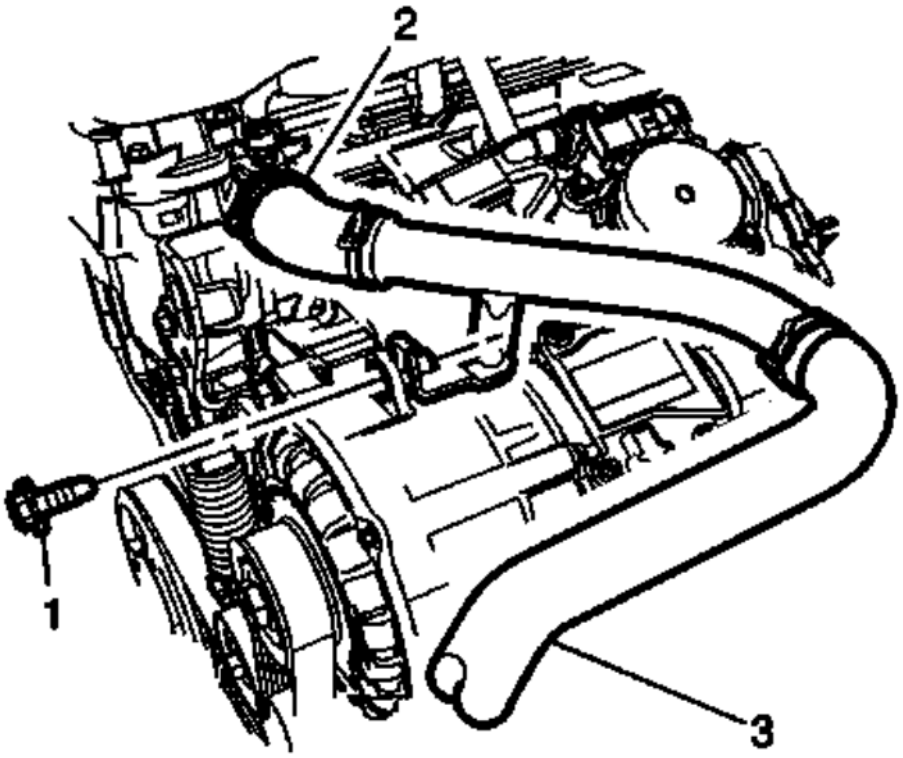


Fig. 19: Radiator Inlet Hose, Bracket & Bolt
Courtesy of GENERAL MOTORS COMPANY

13. Install the radiator inlet hose (3), the radiator inlet hose clamps (2) and tighten the bracket bolt (1) to 9 N.m (80 lb in).
14. Install the secondary air injection pump inlet PCV pipe, if equipped. Refer to **Secondary Air Injection Pump Inlet Hose Replacement (LEA, LUK)** .
15. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
16. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
17. Enable the high voltage system. Refer to **High Voltage Enabling** .

DESCRIPTION AND OPERATION

STARTER GENERATOR DESCRIPTION AND OPERATION

Location

The starter generator, also referred to as the drive motor, is located in the engine compartment. The drive motor is mounted to the front of the engine in place of the alternator, directly above the air conditioning compressor. The drive motor is connected to the crankshaft pulley using a specially designed serpentine belt and drive belt tensioner.

Operating Functions

The drive motor is a 3 phase AC induction machine. This device not only serves as a 115-volt AC generator, it is also used to provide engine power assist and to start the engine when in auto-stop mode. The 115-volt AC current flows between the drive motor and the generator control module, also referred to as the starter generator control module, through a three phase cable assembly.

As a generator, the drive motor provides up to 15 kW of AC power to the drive motor control module.

As a motor, the drive motor provides up to 11 kW of electric power assistance and engine starting. The motor receives three phase AC power from the drive motor control module which is internal and part of the generator control module.

The drive motor has 2 internal sensors that are not serviceable, the drive motor position sensor and the drive motor temperature sensor.

The ratio between the drive motor pulley and the crankshaft pulley is 2.38 to 1. The generator control module is capable of checking the integrity of the drive motor belt by receiving an engine RPM input from the ECM over serial data and comparing that against the drive motor speed input signal from the drive motor position sensor.

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 effecting their operation. EMI is generated whenever electrical current flows through a circuit. The amount of EMI generated is usually dependent upon the amount of current flow and the switching frequency of current flow through the circuit. 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 operates
- Shielding wires, cables and components

Circuit Design

The generator control module, often referred to as the drive motor control module, and the 14V power 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. Reducing voltage spikes reduces EMI. The switching frequency of the current is also closely regulated. Too high of 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 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

Drive Motor Generator Battery 3 Phase Cable Assembly

The high voltage cables utilize internal braid shielding. Typically, both ends of the internal braid shield are attached to chassis ground. All of the shielded high voltage cables are grounded at their cable end attachment points.

Low and Intermediate Voltage Wiring

The drive motor position sensor and temperature sensor circuits utilize internal foil shielding.

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 component's 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** .

GENERATOR CONTROL MODULE DESCRIPTION AND OPERATION

Overview

The generator control module is also referred to as the starter generator control module. The generator control module is located in the generator control and battery module assembly which is located in the trunk directly behind the rear seat.

The generator control module is comprised of the following control modules:

- Hybrid powertrain control module
- 14 volt power module
- Drive motor control module

The generator control module functions as an inverter, inverting high voltage direct current (DC) electrical energy to 3 phase alternating current (AC) electrical energy and vice versa. The generator control module also functions as a DC to DC converter, converting high voltage DC to 14 volts DC. The generator control module is located in the generator control and battery module assembly. The generator control and battery module assembly is air cooled.

High Voltage Circuits

Direct Current (DC)

The generator control module is connected to the positive and negative terminals of the high voltage, (DC) generator battery assembly. Both of the negative and positive high voltage DC battery poles are isolated from the vehicle chassis. The positive high voltage DC cable is switched ON or OFF by a high voltage, high current contactor relay contained within the generator control and battery module assembly. All high voltage DC negative and positive DC cables are orange in color to alert the technician to the potential presence of high voltage.

Three Phase Alternating Current (AC)

Three individual cables connect each phase of the drive motor to the generator control module. Each individually shielded cable is orange in color to alert the technician to the potential presence of high voltage. These three cables are routed from engine compartment to the rear of the vehicle in a single conduit.

Low Voltage Circuits

The 14V power module is an electronic device that converts high voltage (115V) DC to low voltage (14V) DC for operation of all low voltage modules and to charge the 12 volt accessory battery. The 14 volt power module is not serviced separately and is part of the generator control module.

Low Voltage (12V) Direct Current

Low voltage (12V) cables on the hybrid vehicle do not require unique coloring or servicing procedures.

Hybrid Powertrain Control Module

Location

The hybrid powertrain control module is a non-serviceable, flash-programmable micro-processor that is part of the generator control module.

Operating Functions

The hybrid powertrain control module is the main controller of powertrain operation. The hybrid powertrain control module determines when to perform normal operating modes such as auto stop, launch assist mode, and regenerative braking. The hybrid powertrain control module also operates in conjunction with the battery energy control module to determine when to enable and disable the DC high voltage circuits. The motor control module operates the drive motor based upon hybrid powertrain control module commands.

Communication and Hosted Diagnostics

The hybrid powertrain control module is the host controller for DTC and scan tool parameter information for the following control modules:

- 14V power module
- Drive motor control module
- Battery energy control module

These modules diagnose their own operation and determine when a fault condition is present. The 14V

power module communicates diagnostic status to the hybrid powertrain control module over serial data.

The drive motor control module and the hybrid powertrain control module exchange information and commands on a serial peripheral interface bus internal communication circuit as well as the hi-speed serial data communication circuit.

In the event the battery energy control module (BECM) communicates a fault condition, the hybrid powertrain control module 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 powertrain control module 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 powertrain control module.

Circuit Inputs

In addition to data parameters, the hybrid powertrain control module directly monitors the following signal circuits:

- Engine crankshaft position sensor signal (via serial data message from ECM - not direct)
- High voltage interlock circuit
- Brake Pedal Position
- Drive Motor Temperature (via motor control module)
- Drive Motor Position (via motor control module)
- Hood switch
- Various internal signals (temps, etc.)

Circuit Outputs

In addition to control through other controllers, the hybrid powertrain control module directly controls:

- Cooling Fan
- Auxiliary Transmission fluid pump
- Drive Motor
- Drive Motor Cooling pump

Drive Motor Control Module

Location

The drive motor control module is a flash-programmable micro-processor. The drive motor control module is non serviceable and is part of the generator control module.

Operating Functions

The drive motor control module's main function is to monitor the drive motor input/output circuits and to control the insulated gate bipolar transistors that control the drive motor by inverting the high voltage DC electrical energy to 3 phase AC electrical energy and vice versa.

Communication and Hosted Diagnostics

The hybrid powertrain control module communicates with the drive motor control module using an internal serial data circuit. The drive motor control module does not store its own diagnostic trouble code (DTC) information. The hybrid powertrain control module will store the drive motor control module associated DTC information for retrieval by a scan tool. The scan tool can communicate directly with the drive motor control module in order to retrieve data parameters only.

Circuit Inputs

In addition to data parameters, the drive motor control module monitors the drive motor for:

- Voltage
- Current
- Speed and direction
- Temperature

Additionally, the drive motor control module monitors the insulated gate bipolar transistor components for temperature and proper operation. Some of the drive motor control modules operation data is shared with the hybrid powertrain control module.

Circuit Outputs

The drive motor control module controls the insulated gate bipolar transistor driver board which is located in the drive motor control module, that in-turn controls the drive motor. The drive motor is controlled by the 3-phase alternating current (AC). Three cables connect the drive motor to the drive motor control module which is part of the generator control module.

14 Volt Power Module

Location

The 14 volt power module is a non-serviceable device that is part of the generator control module.

Operating Functions

The 14V power module is the device which converts high voltage (115V) DC to low voltage (12V) DC for accessory electrical operation and to charge the 12 volt accessory battery. The 14 volt power module will typically charge the 12 volt system at approximately 14.5 volts with a max power output of 1600 watts. The 14 volt power module is not programmable.

HIGH VOLTAGE MONITORING SYSTEMS DESCRIPTION

The hybrid 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 battery and the vehicle chassis. The drive motor control module monitors the hybrid system for access and loss of isolation detection.

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 system may react to the loss of high voltage interlock circuit continuity by opening the high voltage contactor relay and discharging the high voltage capacitors. The high voltage interlock circuit signal is generated by the drive motor control module. The high voltage interlock circuit status is monitored by the drive motor control module, the hybrid powertrain control module, and the drive motor control module.

High Voltage DC Chassis Isolation

The hybrid system monitors the electrical potential between high voltage and the vehicle chassis. High voltage should always be isolated from the vehicle chassis by a certain amount of resistance to avoid the potential for a life threatening current path. In the event that a high voltage leak path is detected to the vehicle chassis, the hybrid system will set a diagnostic trouble code (DTC). High voltage DC chassis isolation is monitored by the generator control module.

Testing for loss of isolation requires special tools and procedures. Because of the high voltages present in the hybrid system, a loss of isolation may occur due to insulation breakdown. Insulation breakdown typically occurs only when high voltages and/or current is present. Conditions such as insulation breakdown cannot be diagnosed with a typical DMM because high voltage is not used by the DMM when measuring resistance.

HYBRID MODES OF OPERATION DESCRIPTION

Automatic Engine Start/Stop

WARNING: Exiting the vehicle without first shifting into P (Park) may cause the vehicle to move. You or others may be injured. Because the vehicle has the automatic engine start/stop feature, the vehicle's engine might seem to be shut off; however, once the brake pedal is released, the engine will start up again.

Shift to P (Park) and turn the ignition to LOCK/OFF, before exiting the vehicle.

Vehicles with eAssist have an automatic (auto) engine start/stop feature. After the engine has started and reached operating temperature the auto stop feature may cause the engine to turn off when brakes are applied and the vehicle has come to a complete stop. When the brake is released or the accelerator pedal applied, the engine will start. The engine will continue to run until the next auto stop or until the ignition switch is turned OFF.

AUTO STOP on the tachometer signifies that the engine is in auto stop mode. When the vehicle is turned off, the tachometer will move to OFF. If the driver door is opened while in auto stop mode, a chime will sound.

To restart the engine during auto stop, release the brake pedal or press the accelerator pedal. The engine starts immediately. The engine continues to run until the next stop.

There are several conditions which may prevent an auto stop or cause an auto start.

The Engine Will Remain Running When:

- The engine, transmission, or hybrid battery is not warmed up.
- The outside temperature is less than -15°C (5°F).
- The air conditioning or defrost system requires the A/C compressor to maintain vehicle comfort.
- The shift lever is in any position other than DRIVE.
- The hybrid battery pack charge is low.
- The 12-volt vehicle battery charge is low, or loads are high.
- The hood is not fully closed.

The Engine Will Restart When:

- The brake pedal is released.
- The accelerator pedal is applied.
- Shifting out of D (Drive) to any other gear.
- If the eco air conditioning button is selected, the duration of the auto stop will mainly depend on the outside temperature along with some other factors. This economy mode improves fuel economy by limiting the effects of the air conditioning. The warmer it is outside, the shorter the time before the engine is restarted to provide cabin cooling.
- The climate control system is turned from off to normal air conditioning or defrost.
- The engine is required to run for either heater or climate control performance.
- The hybrid battery pack charge is low and requires recharging.
- Auto stop time is greater than two minutes.

Regenerative Braking

Regenerative braking takes some of the energy from the moving vehicle and turns it into electrical energy. This energy is then used to charge the vehicle's hybrid battery system, which increases fuel efficiency.

The torque converter stays locked allowing the drive motor to be coupled to the wheels (through engine and trans) to recharge the hybrid batteries via regenerative braking.

The system works whenever you take your foot off the accelerator pedal while the vehicle is moving in a forward gear. This causes the vehicle to slow down more quickly. It may feel like the brake pedal is being pressed, even when it is not. When the brake pedal is depressed the system will deliver a higher percent of regenerative energy to the hybrid battery system than when in coast down.

Electric Power Assist

Significant internal transmission changes to clutch controls and hardware provide reduced spin losses while improving shift quality. The added electric power provided by the eAssist system allows for higher gearing to improve steady state efficiency without impacting acceleration performance or driveability. The system's capability of providing up to 11 kW of electric power assist at cruising speeds allows the driver to accelerate lightly, ascend mild grades without the transmission downshifting and helps performance during wide open throttle maneuvers.

Torque Smoothing

While not unique to the eAssist hybrid vehicle, expanded operational range is possible because the drive motor can react quickly to smooth driveline disturbances that would otherwise be objectionable.

Deceleration Fuel Cut-Off

When the driver releases the accelerator pedal, air flow into the engine is reduced. The ECM monitors the corresponding changes in the throttle position, MAP, and MAF. The ECM shuts OFF fuel completely if the deceleration is very rapid, or for long periods, such as closed-throttle coast-down. The fuel shuts OFF in order to prevent damage to the catalytic converter and saves fuel by not running the engine. This mode is activated quickly and for a longer duration in the eAssist hybrid vehicle.

While in deceleration fuel cut-off mode, the torque converter stays locked allowing the drive motor to be coupled to the wheels (through engine and trans) to recharge the hybrid batteries via regenerative braking. The drive motor can also quickly react to help smooth driveline disturbances (downshifts), or provide assist for a smooth take off when the accelerator is depressed. If the vehicle is brought to a complete stop the drive motor spins the engine bringing it to a smooth stop and is properly positioned for a smooth restart.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description
	EN-48932 Hydraulic Belt Tensioner Compressor

