

2017 ELECTRICAL Plug-In Charging - CT6

SPECIFICATIONS

FASTENER SPECIFICATIONS

Reusable Threaded Fastener Tightening Specifications

NOTE:

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

Application	Specification
	Metric (English)
Drive Motor Battery Charger Receptacle Fastener	9 N.m (80 lb in)

SCHEMATIC WIRING DIAGRAMS

PLUG-IN CHARGING WIRING SCHEMATICS

Battery Charger Power, Ground, Battery Charging Input and Charging Port Door

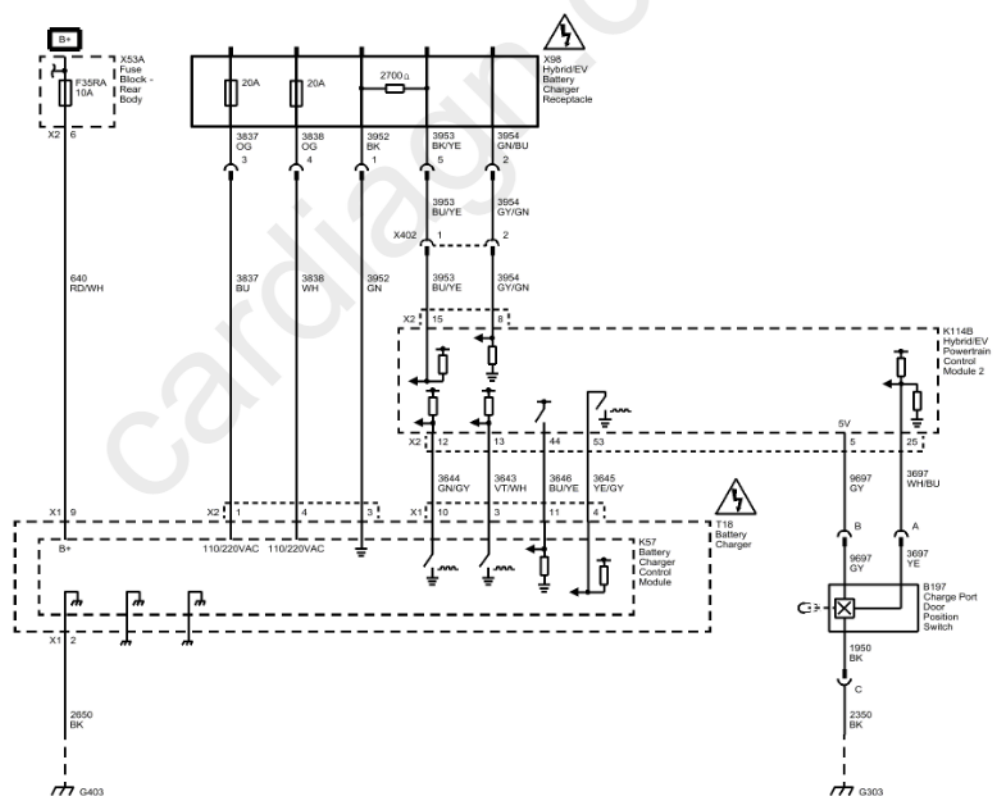


Fig. 1: Battery Charger Power, Ground, Battery Charging Input and Charging Port Door
Courtesy of GENERAL MOTORS COMPANY

Battery Charger Output

Diagnostic Instructions

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

DTC Descriptor

DTC P0CF4

Control Pilot Circuit Performance

DTC P0CF5

Control Pilot Circuit Low Voltage

DTC P0CF6

Control Pilot Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control Pilot Signal	P0CF4, P0CF5, P0CF6, P0CF9, P0D01, 1	P0CF4, P0CF5, P0CF6, 1	P0CF4, P0CF5, P0CF6, P0CF9, 1	P0CF4, P0CF5, P0CF6, 1
Proximity Status Signal	P0D58, 1	P0D59, 1	P0D59, 1	-
Voltage AC Line 1	1	P0D3F, P1EE6	1	-
Voltage AC Neutral Line 2	1	P1EE6	1	-
Voltage AC Ground	-	P0D59, 1	1	-
1. Plug In Charging Malfunction				

Circuit/System Description

The hybrid/EV powertrain control module 2 monitors a control pilot signal from the drive motor battery charger cable. The hybrid/EV powertrain control module 2 utilizes this signal to manage the charging process between the drive motor battery charger cable and the hybrid/EV powertrain control module 2.

Under normal charging conditions the control pilot signal is generated by the drive motor battery charger cable. This diagnostic runs with the drive motor battery charger cable disconnected to verify the vehicle side circuit integrity. The diagnostic signal is generated internally by the hybrid/EV powertrain control module 2.

Conditions for Running the DTC

DTC P0CF4

- The vehicle 12 V battery system voltage needs to be above 10.2 V.
- The drive motor battery charger cable is disconnected and the charge port door is closed.
- The vehicle needs to be driven above 8 km/h (5 mph).

DTC P0CF5

- The vehicle 12 V battery system voltage needs to be above 10.2 V.
- The drive motor battery charger cable is disconnected and the charge port door is closed.

DTC P0CF6

- The vehicle 12 V battery system voltage needs to be above 10.2 V.
- The drive motor battery charger cable is disconnected and the charge port door is closed.

- The vehicle needs to be driven above 8 km/h (5 mph).

Conditions for Setting the DTC

DTC P0CF4

The control pilot circuit is not meeting its internal range requirements for 5 seconds. This can only be set internal to the hybrid/EV powertrain control module 2. This is an internal circuit voltage in the hybrid/EV powertrain control module 2 and can not be measured.

DTC P0CF5

The control pilot circuit voltage divided by the system voltage is less than 0.03 V for 5 seconds. This is an internal circuit voltage in the hybrid/EV powertrain control module 2 and can not be measured.

DTC P0CF6

The control pilot circuit voltage divided by the system voltage is greater than 0.55 V for 5 seconds. This is an internal circuit voltage in the hybrid/EV powertrain control module 2 and can not be measured.

Actions Taken When the DTC Sets

- DTC P0CF4-P0CF6 are type A DTCs.
- Disables high voltage battery charging.

Conditions for Clearing the DTC

DTC P0CF4-P0CF6 are type A DTCs.

Reference Information

Schematic Reference

Plug-In Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Plug-In Charging System Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Testing

WARNING:

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

The High Voltage Disabling procedure includes the following steps:

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

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

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

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

1. Vehicle OFF, disable the high voltage at the T18 Battery Charger. Refer to [High Voltage Disabling](#) . Disconnect the X2 harness connector at the K114B Hybrid/EV Powertrain Control Module 2.
2. Test for infinite resistance between the control pilot signal circuit terminal 2 of the X98 Hybrid/EV Battery Charger Receptacle and the terminals listed below:

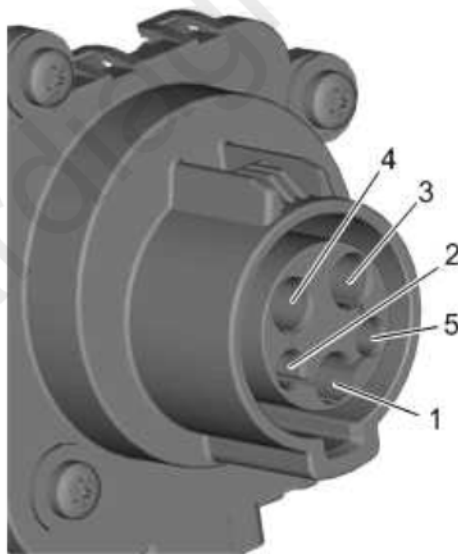


Fig. 4: Hybrid/EV Battery Charger Receptacle And Terminals

Courtesy of GENERAL MOTORS COMPANY

NOTE: The following tests are performed at the X98 Hybrid/EV Battery Charger Receptacle and not at the harness connector to the X98 Hybrid/EV Battery Charger Receptacle.

- Terminal 4
- Terminal 1
- Terminal 5
- Terminal 3
- **If less than infinite resistance**

1. Disconnect the harness connector from the X98 Hybrid/EV Battery Charger Receptacle.

2. Test for infinite resistance between the harness connector control pilot signal circuit terminal 2 and the terminals listed below:

NOTE: This test is performed on the vehicle side of the harness connector.

- Terminal 4
- Terminal 1
- Terminal 5
- Terminal 3
 - If less than infinite resistance, repair the short between the circuits.
 - If infinite resistance, replace the X98 Hybrid/EV Battery Charger Receptacle.
- **If infinite resistance**

3. Replace the K114B Hybrid/EV Powertrain Control Module 2.

Repair Instructions

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

- [Drive Motor Battery Charger Receptacle Replacement](#)
- [Control Module References](#) for hybrid/EV powertrain control module 2 replacement, programming and setup.

DTC P0CF9 OR P0D01: CONTROL PILOT CHARGING

Diagnostic Instructions

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

DTC Descriptor

DTC P0CF9

Control Pilot Charging Switch Performance

DTC P0D01

Control Pilot Charging Ventilation Switch Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control Pilot Signal	P0CF4, P0CF5, P0CF6, P0CF9, P0D01, 1	P0CF4, P0CF5, P0CF6, 1	P0CF4, P0CF5, P0CF6, P0CF9, 1	P0CF4, P0CF5, P0CF6, 1
Proximity Signal	P0D58, 1	P0D59, 1	P0D59, 1	-
Voltage AC Line 1	1	P0D3F, P1EE6	1	-
Voltage AC Neutral Line 2	1	P1EE6	1	-
Voltage AC Ground	-	P0D59, 1	1	-
1. Plug In Charging Malfunction				

Circuit/System Description

The hybrid/EV powertrain control module 2 has two internal switches used to modify the control pilot signal. The first internal switch modifies the control pilot signal to indicate to the drive motor battery charger cable that the vehicle is either ready or not ready to accept energy. The second internal switch modifies the control pilot signal to indicate to some drive motor battery charger cables (currently not used) if indoor ventilation is required.

Conditions for Running the DTC

P0CF9

- The 12 V battery voltage is greater than 10.2 V.
- The drive motor battery charger cable is disconnected and the charge port door is closed.
- The diagnostics for DTC P0CF4-P0CF6 must have passed.

P0D01

- The 12 V battery voltage is greater than 10.2 V.
- The drive motor battery charger cable is disconnected and the charge port door is closed.
- The diagnostics for DTC P0CF4-P0CF6 must have passed.

Conditions for Setting the DTC

The hybrid/EV powertrain control module 2 measures the control pilot signal voltage out of range for 5 seconds. This is an internal circuit voltage in the hybrid/EV powertrain control module 2 and can not be measured.

Actions Taken When the DTC Sets

- DTC P0CF9 and P0D01 are type A DTCs
- Disables the high voltage battery charging.

Conditions for Clearing the DTC

DTC P0CF9 and P0D01 are type A DTCs.

Reference Information

Schematic Reference

Plug-In Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Plug-In Charging System Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Verification

1. Vehicle ON.

2. Verify that DTC P0CF9 or P0D01 is not set.

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

Replace the K114B Hybrid/EV Powertrain Control Module 2.

- **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 hybrid/EV powertrain control module 2 replacement, programming and setup

DTC P0D1F: CONTROL MODULE DATE/TIME SYNCHRONIZATION PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P0D1F

Control Module Date/Time Synchronization Performance

Circuit/System Description

The hybrid/EV powertrain control module 2 monitors the date and time data it receives from the radio. This time information is used to ensure the module's internal clock is synchronized to the customer's local time. The Time of Day Charging feature utilizes this internal clock to keep track of time and alarms for delayed charging modes. If this radio time data is received during a drive cycle, the system is considered synchronized.

Conditions for Running the DTC

Vehicle in Service Mode.

Conditions for Setting the DTC

The vehicle is driven for more than 5 consecutive drive cycles where trip distance exceeds 15 Km (9.3 mi) and the date and time were unavailable from the radio.

Actions Taken When the DTC Sets

- DTC P0D1F is a type C DTC.
- On the Navigation screen "Default Charge Mode: Immediately" is displayed.
- The battery charger Time Of Day charging option is disabled and charging mode is set to IMMEDIATE.

Conditions for Clearing the DTC

DTC P0D1F is a type C DTCs.

Reference Information

Schematic Reference

Plug-In Charging Schematics

Connector End View Reference

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

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Verification

1. Vehicle in Service Mode, verify no radio DTC's are set.
 - **If any radio DTC's are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
 - **If no radio DTC's are set**
2. Replace the K114B Hybrid/EV Powertrain Control Module 2.

Repair Instructions

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

[Control Module References](#) for hybrid/EV powertrain control module 2 replacement, programming and setup.

DTC P0D26: BATTERY CHARGER SYSTEM PRECHARGE TIME TOO LONG

Diagnostic Instructions

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

DTC Descriptor

DTC P0D26

Battery Charger System Precharge Time Too Long

Circuit/System Description

Before connecting the battery charger to the hybrid/EV battery pack, it is necessary to raise the voltage level of the battery charger output to match the hybrid/EV battery pack voltage. This is called the precharge of the battery charger. During precharge, the charging positive contactor is closed. Also the drive motor battery charger cable needs to be plugged into the hybrid/EV battery charger receptacle and utility power needs to be enabled to the vehicle. The hybrid/EV powertrain control module 2 monitors the amount of time it takes to achieve the proper pre-charge voltage.

Conditions for Running the DTC

- Battery charger must go from disconnected to connected.
- Drive motor battery charger cable must be connected and vehicle receiving power.

Conditions for Setting the DTC

The hybrid/EV powertrain control module 2 determines the battery charger does not reach its pre-charge voltage within 1 second.

Actions Taken When the DTC Sets

- DTC P0D26 is a Type A DTC.
- Disables the high voltage battery charging.
- The hybrid/EV powertrain control module 2 opens the high voltage contactors.

Conditions for Clearing the DTC

DTC P0D26 is a Type A DTC.

Diagnostic Aids

- The control pilot and proximity status circuits are susceptible to moisture intrusion, corrosion and terminal damage. Extreme care must be taken when probing terminals and manipulating harnesses. Poor terminal connections can result in intermittent operation. Terminal damage or moisture intrusion may cause intermittent appearance of DTC P0D26.
- If corrosion, moisture or damage is detected on one connector, always be sure to inspect the mating connector as well.
- If signs of moisture intrusion are observed in the hybrid/EV battery charger receptacle harness connector, such as moisture or corrosion, the hybrid/EV battery charger receptacle should be replaced to avoid repeated failure.

Reference Information

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Plug-In Charging Schematics

Connector End View Reference

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- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System Testing

1. Verify DTC P0AA1, P0AA4, P0AD9, P0ADD, P0AE4, P0AFA, P0D09, P0D0A, P0D58, P0D59, P0CF4, P0CF5, P0CF6, P1EBD, P1EC0, P1EC3 or any other battery charger DTC is not set.

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.

- If any of the DTCs are set

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

- If none of the DTCs are set

2. Verify DTC P0D26 is not set.

- If the DTC is set

1. Vehicle OFF. Disable the high voltage system for servicing the T18 Battery Charger and X98 Hybrid/EV Battery Charger Receptacle. Refer to [High Voltage Disabling](#).
2. Disconnect the vehicle wiring harness connector at the X98 Hybrid/EV Battery Charger Receptacle.
3. Verify that the X98 Hybrid/EV Battery Charger Receptacle harness connector and the mating vehicle wiring harness connector terminals are free from moisture, corrosion and damage.
 - If any terminals show signs of moisture damage or intrusion, such as corrosion or moisture, replace the X98 Hybrid/EV Battery Charger Receptacle and repair the vehicle wiring harness as necessary.
 - If any terminals or connectors show signs of physical damage, without signs of moisture intrusion, repair or replace as necessary.
 - If no damage, moisture or corrosion is found
4. Connect the vehicle wiring harness connector at the X98 Hybrid/EV Battery Charger Receptacle.
5. Enable the high voltage system. Refer to [High Voltage Enabling](#).
6. Verify DTC P0D26 sets.
 - If the DTC does not set, all OK.
 - If the DTC sets
7. Replace the X98 Hybrid/EV Battery Charger Receptacle.
8. Verify DTC P0D26 does not set.
 - If the DTC sets, replace the T18 Battery Charger.
 - If the DTC does not set

9. All OK.

- If the DTC is not set

3. All OK.

Repair Instructions

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

- [Drive Motor Battery Charger Receptacle Replacement](#) for X98 Hybrid/EV Battery Charger Receptacle replacement.
- [Control Module References](#) T18 Battery Charger, often referred to as the Drive Motor Battery Charger, replacement, programming and setup.

DTC P0D2B OR P0D2C: INDICATOR CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptor

DTC P0D2B

Control Pilot Indicator Control Circuit

DTC P0D2C

Charge Status Indicator Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Charge Pilot Indicator Control	P0D2B	P0D2B	P0D2B	-
Charge Status Indicator Control	P0D2C	P0D2C, 1	P0D2C	-
Charge Complete Indicator Control	1	1	1	-
Low Reference	-	P0D2C, P0D2B	-	-
1. Plug In Charging Indicator Malfunction				

Circuit/System Description

The status of charging events (including delays) is communicated to the user through a charge status indicator and audio tones. The vehicle charge status indicator, located on the top middle of the instrument panel, contains a green LED (charge status indicator) and yellow LED (charge pilot indicator) controlled by the Hybrid Powertrain Control Module 2 and a second green LED (charge complete indicator) controlled by the BCM. The indicator will have a short flash green when the vehicle is charging under automatic control. The flash rate increases from one to four as the battery charges. It will have a long flash green if the charging is delayed and will begin later. It will be illuminated solid green when charging is complete. A solid lit yellow indicator means the vehicle is not able to accept a charge. And if there is no indicator lit it means the electronic vehicle supply equipment is not working properly or connected.

Conditions for Running the DTC

Both conditions need to run for diagnostic to pass.

Condition 1

- The 12 V battery voltage is greater than 10.2 V.
- The drive motor battery charger cable is disconnected (charge status indicator commanded OFF).

Condition 2

- The 12 V battery voltage is greater than 10.2 V.
- The vehicle is connected to an AC supply and the battery charger is charging the vehicle (charge status indicator commanded ON).

Conditions for Setting the DTC

- Charge status indicator Commanded OFF, The hybrid/EV powertrain control module 2 detects a short to battery for about 4 s.
- Charge status indicator Commanded ON, The hybrid/EV powertrain control module 2 detects a short to ground or an open/high resistance for 4 s.

Actions Taken When the DTC Sets

DTC P0D2B and P0D2C are type C DTCs.

Conditions for Clearing the DTC

DTC P0D2B and P0D2C are type C DTCs.

Reference Information

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Plug-In Charging Schematics

Connector End View Reference

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- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System Testing

1. Vehicle OFF, disconnect the X1 harness connector at the B305 Ambient Light/Sunload Sensor and Battery State of Charge Indicator.
2. Test for less than 10 Ω between the low reference terminal 1 and ground.
 - **If 10 Ω or greater**
Repair the open/high resistance in the circuit.
 - **If less than 10 Ω**
3. Connect a test lamp between the control circuit terminal 4 and ground.

NOTE: If the drive motor battery charger cable is connected. The drive motor battery charger cable must be disconnected for more than 10 seconds before performing the next step.

4. Verify the test lamp does not illuminate.
 - **If the test lamp does illuminate**
 1. Disconnect the X2 harness connector at the K114B Hybrid/EV Powertrain Control Module 2.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V, replace the K114B Hybrid/EV Powertrain Control Module 2.
 - **If the test lamp does not illuminate**
5. Connect the drive motor battery charger cable.
6. Verify that the test lamp illuminates within the first 5 seconds of connecting the drive motor battery charger cable.
 - **If the test lamp does not illuminate**

1. Disconnect the drive motor battery charger cable. Disconnect the X2 harness connector at the K114B Hybrid/EV Powertrain Control Module 2.
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
3. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K114B Hybrid/EV Powertrain Control Module 2.
- **If the test lamp does illuminate**
7. Disconnect the drive motor battery charger cable for at least 10 seconds. Connect a test lamp between the control circuit terminal 3 and ground.
8. Verify the test lamp does not illuminate.
 - **If the test lamp does illuminate**
 1. Disconnect the X2 harness connector at the K114B Hybrid/EV Powertrain Control Module 2.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V, replace the K114B Hybrid/EV Powertrain Control Module 2.
 - **If the test lamp does not illuminate**
9. Connect the drive motor battery charger cable.
10. Verify that the test lamp illuminates within 25 seconds of connecting the drive motor battery charger cable.
 - **If the test lamp does not illuminate**
 1. Disconnect the drive motor battery charger cable. Disconnect the X2 harness connector at the K114B Hybrid/EV Powertrain Control Module 2.
 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
 3. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K114B Hybrid/EV Powertrain Control Module 2.
 - **If the test lamp does illuminate**
11. Replace the B305 Ambient Light/Sunload Sensor and Battery State of Charge Indicator.

Repair Instructions

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

- [Sun Load, Ambient Light and Charge Indicator Sensor Replacement](#) for B305 Ambient Light/Sunload Sensor and Battery State of Charge Indicator replacement.
- [Control Module References](#) for K114B hybrid/EV powertrain control module 2 replacement, programming and setup.

DTC P0D3E-P0D40: BATTERY CHARGER INPUT VOLTAGE SENSOR

Diagnostic Instructions

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

DTC Descriptor

DTC P0D3E

Battery Charger Input Voltage Sensor Performance

DTC P0D3F

Battery Charger Input Voltage Sensor Circuit Low Voltage

DTC P0D40

Battery Charger Input Voltage Sensor Circuit High Voltage

Circuit/System Description

The hybrid/EV powertrain control module 2 monitors the AC voltage sensor inside the battery charger. The signal is pulse-width modulated and the duty cycle increases as the AC voltage increases. The duty cycle equals 10% when the AC voltage sensor reports less than 60 V. The duty cycle equals 90% when the AC voltage sensor reports more than 280 V. Therefore, during normal operation the duty cycle is between 10% and 90%.

Conditions for Running the DTC

P0D3E

- The 12 V battery voltage is greater than 10.2 V.
- The vehicle is driven above 16 km/h (10 mph).

P0D3F and P0D40

- The 12 V battery voltage is greater than 10.2 V.
- The vehicle is connected to an AC supply and the battery charger is charging the vehicle.

Conditions for Setting the DTC

DTC P0D3E

The battery charger AC input duty cycle is greater than 12% or less than 8%.

DTC P0D3F

The battery charger AC input duty cycle is between 1% and 8%.

OR

The battery charger AC input duty cycle equals 100%.

DTC P0D40

The battery charger AC input duty cycle is between 92% and 99%.

OR

The battery charger AC input duty cycle equals 0%.

Actions Taken When the DTC Sets

- DTC P0D3E, P0D3F and P0D40 are type B DTCs.
- Disables high voltage battery charging.

Conditions for Clearing the DTC

DTC P0D3E, P0D3F and P0D40 are type B DTCs.

Reference Information

Schematic Reference

Plug-In Charging Schematics

Connector End View Reference

Description and Operation

Plug-In Charging System Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System Verification

1. Drive the vehicle above 16 km/h (10 mph).
2. Vehicle OFF. Connect the vehicle to an AC supply to begin charging.
3. Vehicle in Service Mode.
4. Verify that P0D3E, P0D3F or P0D40 is not set.

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

Refer to Circuit/System Testing.

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

5. All OK.

Circuit/System Testing

1. Vehicle OFF, disconnect the X1 harness connector at the T18 Battery Charger. Vehicle in Service Mode.
2. Verify the scan tool Battery Charger AC Input Status Duty Cycle parameter is less than 10%.
 - **If 10% or greater**
 1. Vehicle OFF, disconnect the X2 harness connector at the K114B Hybrid/EV Powertrain Control Module
 2. Test for infinite resistance between the AC voltage sensor circuit terminal 10 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K114B Hybrid/EV Powertrain Control Module 2.
 - **If less than 10%**
3. Install a 3 A fused jumper wire between the AC voltage sensor circuit terminal 10 and the ground circuit terminal 2.
4. Verify the scan tool Battery Charger AC Input Status Duty Cycle parameter is greater than 90%.
 - **If 90% or less**
 1. Vehicle OFF, disconnect the X2 harness connector at the K114B Hybrid/EV Powertrain Control Module
 2. Vehicle in Service Mode.
 2. Test for less than 1 V between the AC voltage sensor circuit terminal 10 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Vehicle OFF.
 4. Test for less than 2 Ω in the AC voltage sensor circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K114B Hybrid/EV Powertrain Control Module 2.

- If greater than 90%

5. Replace the T18 Battery Charger.

Repair Instructions

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

[Control Module References](#) for K114B Hybrid/EV Powertrain Control Module 2 or T18 Battery Charger replacement, programming and setup.

DTC P0D4D-P0D4F: BATTERY CHARGER HYBRID/EV BATTERY OUTPUT VOLTAGE SENSOR

Diagnostic Instructions

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

DTC Descriptor

DTC P0D4D

Battery Charger Hybrid/EV Battery Output Voltage Sensor Performance

DTC P0D4E

Battery Charger Hybrid/EV Battery Output Voltage Sensor Circuit Low Voltage

DTC P0D4F

Battery Charger Hybrid/EV Battery Output Voltage Sensor Circuit High Voltage

Circuit/System Description

The hybrid/EV powertrain control module 2 monitors the DC voltage sensor inside the battery charger. The signal is pulse-width modulated and the duty cycle increases as the DC voltage increases. The duty cycle equals 10% when the DC voltage sensor reports less than 0 V. The duty cycle equals 90% when the DC voltage sensor reports more than 500 V. Therefore, during normal operation the duty cycle is between 10% and 90%.

Conditions for Running the DTC

- The 12 V battery voltage is greater than 10.2 V.
- The vehicle is connected to an AC supply and the battery charger is charging the vehicle.

Conditions for Setting the DTC

DTC P0D4D

The difference between the battery charger DC output voltage and hybrid/EV battery DC input voltage is greater than 30 V.

DTC P0D4E

The battery charger DC output duty cycle is between 1% and 8%.

OR

The battery charger DC output duty cycle equals 100%.

DTC P0D4F

The battery charger DC output duty cycle is between 92% and 99%.

OR

The battery charger DC output duty cycle equals 0%.

Actions Taken When the DTC Sets

- DTC P0D4D, P0D4E and P0D4F are type B DTCs.
- Disables high voltage battery charging.

Conditions for Clearing the DTC

DTC P0D4D, P0D4E and P0D4F are type B DTCs.

Reference Information

Schematic Reference

Plug-In Charging Schematics

Connector End View Reference

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Description and Operation

Plug-In Charging System Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Connect the vehicle to an AC supply to begin charging. Vehicle in Service Mode.
2. Verify that P0D4D, P0D4E or P0D4F is not set.

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

Refer to Circuit/System Testing.

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

3. All OK.

Circuit/System Testing

1. Vehicle OFF, disconnect the X1 harness connector at the T18 Battery Charger. Vehicle in Service Mode.
2. Verify the scan tool Battery Charger DC Output Status Duty Cycle parameter is less than 10%.

- **If 10% or greater**

1. Vehicle OFF, disconnect the X2 harness connector at the K114B Hybrid/EV Powertrain Control Module 2.

2. Test for infinite resistance between the DC voltage sensor circuit terminal 3 and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the K114B Hybrid/EV Powertrain Control Module 2.

- **If less than 10%**

3. Install a 3 A fused jumper wire between the DC voltage sensor circuit terminal 3 and the ground circuit terminal 2.
4. Verify the scan tool Battery Charger DC Output Status Duty Cycle parameter is greater than 90%.
 - **If 90% or less**
 1. Vehicle OFF, disconnect the X2 harness connector at the K114B Hybrid/EV Powertrain Control Module
 2. Vehicle in Service Mode.
 2. Test for less than 1 V between the DC voltage sensor circuit terminal 3 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Vehicle OFF.
 4. Test for less than 2 Ω in the DC voltage sensor circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K114B Hybrid/EV Powertrain Control Module 2.
 - **If greater than 90%**
5. Replace the T18 Battery Charger.

Repair Instructions

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

[Control Module References](#) for K114B Hybrid/EV Powertrain Control Module 2 or T18 Battery Charger replacement, programming and setup.

DTC P0D58 OR P0D59: PROXIMITY DETECTION CIRCUIT

Diagnostic Instructions

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

DTC Descriptor

DTC P0D58

Proximity Detection Circuit Low Voltage

DTC P0D59

Proximity Detection Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
AC Voltage Line 1	P1EE6	P1EE6	-	-
AC Voltage Line 2	P1EE6	P1EE6	-	-
AC Voltage Ground	1	P1EE6	1	-
Control Pilot Signal	1	1	1	-
Proximity Signal	P0D58	P0D59	P0D59	-
1. Plug In Charging Malfunction				

Circuit/System Description

The proximity detection circuit prevents movement of the vehicle while the drive motor battery charger cable is connected. This diagnostic runs with the drive motor battery charger cable disconnected to verify the vehicle side circuit integrity.

Conditions for Running the DTC

- The 12 V battery voltage is greater than 10.2 V.
- The vehicle speed is greater than 20 km/h (15 mph) for more than 5 seconds.
- No vehicle speed DTCs are set.

Conditions for Setting the DTC

DTC P0D58

The hybrid/EV powertrain control module 2 measures a voltage less than 4.2 V for 5 seconds.

DTC P0D59

The hybrid/EV powertrain control module 2 measures a voltage greater than 4.8 V for 5 seconds.

Actions Taken When the DTC Sets

- DTC P0D58 and P0D59 are Type A DTCs.
- Disable the high voltage battery charging.

Conditions for Clearing the DTC

DTC P0D58 and P0D59 are Type A DTCs.

Reference Information

Schematic Reference

Plug-In Charging Schematics

Connector End View Reference

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Description and Operation

Plug-In Charging System Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Testing

WARNING:

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

The High Voltage Disabling procedure includes the following steps:

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

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

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

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

1. Vehicle OFF, disable the high voltage at the T18 Battery Charger. Refer to [High Voltage Disabling](#) . Reconnect the X2 harness connector at the T18 Battery Charger.
2. Test for less than 10 Ω between the low reference circuit terminal 1 and ground.

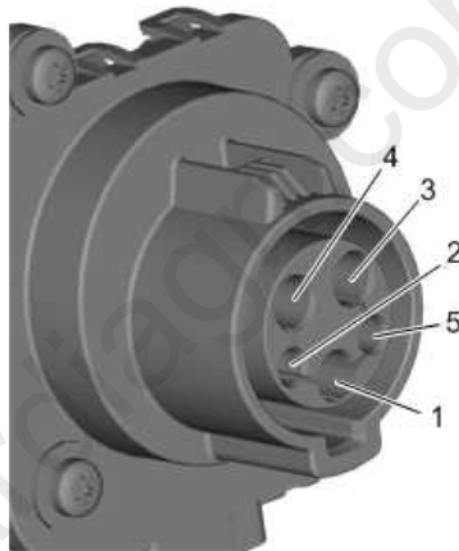


Fig. 5: Hybrid/EV Battery Charger Receptacle And Terminals

Courtesy of GENERAL MOTORS COMPANY

NOTE: The following tests are performed at the X98 Hybrid/EV Battery Charger Receptacle and not at the harness connector to the X98 Hybrid/EV Battery Charger Receptacle.

- **If 10 Ω or greater**
 1. Disconnect the X2 harness connector at the T18 Battery Charger.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the T18 Battery Charger.
- **If less than 10 Ω**
 3. Connect the 12 V battery. Vehicle in Service Mode.
 4. Test for 4.2-4.8 V between the signal circuit terminal 5 and ground.

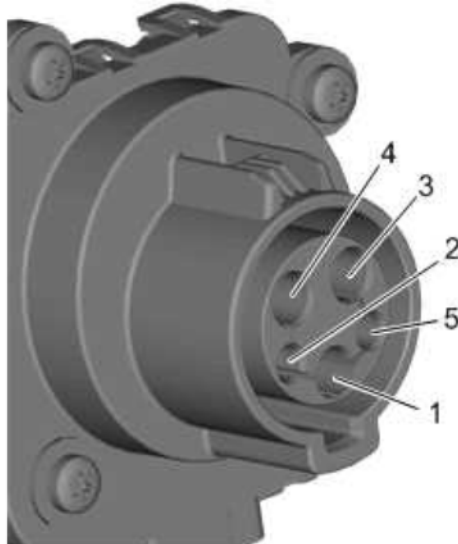


Fig. 6: Hybrid/EV Battery Charger Receptacle And Terminals

Courtesy of GENERAL MOTORS COMPANY

- **If less than 4.2 V**

1. Vehicle OFF, disconnect the harness connector to the X98 Hybrid/EV Battery Charger Receptacle. Vehicle in Service Mode.
2. Test for 4.2-4.8 V between the signal circuit terminal 5 and ground.

NOTE:

The following tests are performed at the harness connector to the X98 Hybrid/EV Battery Charger Receptacle.

- If less than 4.2 V
3. Disconnect the X2 harness connector at the K114B Hybrid/EV Powertrain Control Module 2.
 4. Test for infinite resistance between the signal circuit terminal 5 and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance
 5. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K114B Hybrid/EV Powertrain Control Module 2.
- **If greater than 4.8 V**
1. Vehicle OFF, disconnect the X2 harness connector at the T18 Battery Charger. Disconnect the harness connector to the X98 Hybrid/EV Battery Charger Receptacle. Vehicle in Service Mode.
 2. Test for 4.2-4.8 V between the signal circuit terminal 5 and ground.

NOTE:

The following tests are performed at the harness connector to the X98 Hybrid/EV Battery Charger Receptacle.

- If greater than 4.8 V
3. Disconnect the X2 harness connector at the K114B Hybrid/EV Powertrain Control Module 2.
 4. Test for less than 1 V between the signal circuit terminal 5 and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V
 5. Test for 2.565-2.835 K Ω between the signal circuit terminal 5 and the low reference circuit terminal 1.
 - If not within the specified range, replace the X98 Hybrid/EV Battery Charger Receptacle.
 - If within the specified range, replace the K114B Hybrid/EV Powertrain Control Module 2.
- **If within 4.2-4.8 V**
5. Replace the K114B Hybrid/EV Powertrain Control Module 2.

Repair Instructions

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

- [Drive Motor Battery Charger Receptacle Replacement](#)
- [Control Module References](#) for battery charger or hybrid/EV powertrain control module 2 replacement, programming and setup.

DTC P0D5A: PROXIMITY DETECTION CIRCUIT ERRATIC

Diagnostic Instructions

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

DTC Descriptor

DTC P0D5A

Proximity Detection Circuit Erratic

Circuit/System Description

This diagnostic runs with the drive motor battery charger cable connected. The hybrid/EV powertrain control module 2 uses a 5 V regulated signal through a 2700 Ω resistor to a low reference circuit in the battery charger to detect if the drive motor battery charger cable is attached.

Conditions for Running the DTC

The drive motor battery charger cable is connected.

Conditions for Setting the DTC

The hybrid/EV powertrain control module 2 determines the proximity signal voltage is erratic for 40 seconds.

Actions Taken When the DTC Sets

DTC P0D5A is a Type C DTC.

Conditions for Clearing the DTC

DTC P0D5A is a Type C DTC.

Diagnostic Aids

The proximity status circuit is susceptible to moisture intrusion. If signs of moisture intrusion are observed in the hybrid/EV battery charger receptacle harness connector, the hybrid/EV battery charger receptacle should be replaced. If moisture is detected on one connector, always be sure to inspect the mating connector as well.

Reference Information

Schematic Reference

Plug-In Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Plug-In Charging System Description and Operation

Electrical Information Reference

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

- [Wiring Repairs](#)

DTC Type Reference

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

Scan Tool Reference

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

[Circuit/System Verification](#)

1. Connect the drive motor battery charger cable.
2. Verify DTC P0D5A is not set.
 - **If the DTC is set**

Replace the X98 Hybrid/EV Battery Charger Receptacle.
 - **If the DTC is not set**
3. All OK.

[Repair Instructions](#)

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

[Drive Motor Battery Charger Receptacle Replacement](#)

DTC P0D5E: BATTERY CHARGER SYSTEM HIGH VOLTAGE PRESENT

[Diagnostic Instructions](#)

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

[DTC Descriptor](#)

DTC P0D5E

Battery Charger System High Voltage Present

[Circuit/System Description](#)

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

[Conditions for Running the DTC](#)

- All contactors are commanded open.
- Runs once per charger contacts discharge event.
- None of the following DTCs are set: P0D4D, P0D4E or P0D4F.

[Conditions for Setting the DTC](#)

High voltage bus does not discharge to below 60 V within 4 seconds of the charger contactors being commanded open.

[Actions Taken When the DTC Sets](#)

- DTC P0D5E is a type A DTC.
- The hybrid/EV powertrain control module 2 opens the high voltage contactors.

Conditions for Clearing the DTC

- DTC P0D5E is a type A DTC.
- The [Clear Secured High Voltage DTCs](#) reset function must be performed with a scan tool before clear codes.

Reference Information

Schematic Reference

[Hybrid/EV Energy Storage Schematics](#)

Connector End View Reference

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

Description and Operation

[Drive Motor Battery System Description](#)

Electrical Information Reference

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

DTC Type Reference

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

Scan Tool Reference

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

Circuit/System Verification

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

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

2. OPEN the driver door using outside door handle. Leave driver door OPEN.
3. PRESS and HOLD the brake pedal.

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

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

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

5. Disconnect the S15 Manual Service Disconnect.
6. Command the Battery Charging System Positive Contactor CLOSED and ALL OPEN with a scan tool while listening for the contactor to close and open. The KR116B Battery Charging System Positive Contactor should be heard closing and opening.

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

- If the Battery Charging System Positive Contactor does not open and close

Refer to Circuit/System Testing.

- If the Battery Charging System Positive Contactor does open and close

7. Replace the T18 Battery Charger.

Circuit/System Testing

WARNING:

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

The High Voltage Disabling procedure includes the following steps:

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

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

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

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

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

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

- If 10 Ω or greater

1. Vehicle OFF.

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

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , repair the open/high resistance in the ground connection.

- If less than 10 Ω

3. Verify that a test lamp illuminates between the A4 Hybrid/EV Battery Pack harness B+ circuit terminal 1 X358 and ground.

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

1. Vehicle OFF.

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

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

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

1. Vehicle OFF.

2. Test for infinite resistance between the B+ circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the A28 Hybrid/EV Battery Contactor Assembly and K16 Battery Energy Control Module ensuring you reconnect the connectors in the sequence provided in Repair Instructions. Refer to [Battery Energy Control Module Replacement](#).

- If the test lamp illuminates

4. Vehicle OFF, disconnect the X357 harness connector at the A4 Hybrid/EV Battery Pack. Vehicle in Service Mode.
5. Verify that a test lamp does not illuminate between the A4 Hybrid/EV Battery Pack harness control circuit terminal 7 X357 and ground.
 - **If the test lamp illuminates**
 1. Vehicle OFF, disconnect the X1 harness connector at the K114B Hybrid Powertrain Control Module 2. Vehicle in Service Mode.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K114B Hybrid Powertrain Control Module 2.
 - **If the test lamp does not illuminate**
6. Vehicle OFF, disconnect the X1 harness connector at the K114B Hybrid Powertrain Control Module 2.
7. Test for infinite resistance between the A4 Hybrid/EV Battery Pack harness control circuit terminal 7 X357 and ground.
 - **If less than infinite resistance**

Repair the short to ground on the circuit.
 - **If infinite resistance**
8. Test for less than 2 Ω in the control circuit end to end.
 - **If 2 Ω or greater**

Repair the open/high resistance in the circuit.
 - **If less than 2 Ω**
9. Replace the K114B Hybrid Powertrain Control Module 2.
10. Verify that DTC P0D5E does not set while operating the vehicle within the Conditions for Running the DTC.
 - **If DTC P0D5E is set**

Replace the A28 Hybrid/EV Battery Contactor Assembly.
 - **If DTC P0D5E is not set**
11. All OK.

Repair Instructions

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

- [High Voltage Battery Disconnect Relay Replacement](#) for A28 Hybrid/EV Battery Contactor Assembly.
- [Control Module References](#) for battery charger, battery energy control module or hybrid/EV powertrain control module 2 replacement, programming and setup.

DTC P0E61 OR P0E65: BATTERY CHARGER ENABLE/CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptor

DTC P0E61

Battery Charger Enable Circuit

DTC P0E65

Battery Charger Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Battery Charger Enable	P0E61	P0E61	P0E61	-
Battery Charger Control	P0E65	P0E65	P0E65	-

Circuit/System Description

The battery charger is controlled with a charger enable signal and a pulse width modulated (PWM) charger control circuit from the hybrid/EV powertrain control module 2. The charger enable signal is set to 12 V when the hybrid/EV powertrain control module 2 is awake. This allows the battery charger to operate while driving to allow DC voltage sensor operation.

Conditions for Running the DTC

DTC P0E61

The 12 V battery voltage is greater than 10.2 V.

DTC P0E65

- The 12 V battery voltage is greater than 10.2 V.
- Vehicle in Service Mode or the drive motor battery charger cable is connected.

Conditions for Setting the DTC

DTC P0E61

The hybrid/EV powertrain control module 2 detects an open, short to ground or short to voltage on battery charger enable circuit for 1 second.

DTC P0E65

The hybrid/EV powertrain control module 2 detects an open, short to ground or short to voltage on battery charger control circuit for 1 second.

Actions Taken When the DTC Sets

- DTC P0E61 and P0E65 are type B DTCs.
- Disables high voltage battery charging.

Conditions for Clearing the DTC

DTC P0E61 and P0E65 are type B DTCs.

Reference Information

Schematic Reference

Plug-In Charging Schematics

Connector End View Reference

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Description and Operation

Plug-In Charging System Description and Operation

Electrical Information Reference

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

DTC Type Reference

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

Scan Tool Reference

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

[Circuit/System Testing](#)

1. Vehicle OFF. Disconnect the X2 harness connector at the K114B Hybrid/EV Powertrain Control Module 2. Disconnect the X1 harness connector at the T18 Battery Charger.
2. Test for infinite resistance between the terminals listed below at the T18 Battery Charger X1 harness connector:
 - Battery charger enable terminal 11 and B+ terminal 9
 - Battery charger enable terminal 11 and ground terminal 2
 - Battery charger control terminal 4 and B+ terminal 9
 - Battery charger control terminal 4 and ground terminal 2
 - **If less than infinite resistance**
Repair the short between the circuits.
 - **If infinite resistance**
3. Test for less than 2 Ω between the terminals listed below end to end:
 - T18 Battery Charger terminal 11 X1 and K114B Hybrid/EV Powertrain Control Module 2 terminal 44 X2
 - T18 Battery Charger terminal 4 X1 and K114B Hybrid/EV Powertrain Control Module 2 terminal 53 X2
 - **If 2 Ω or greater**
Repair the open/high resistance in the circuit.
 - **If less than 2 Ω**
4. Replace the K114B Hybrid/EV Powertrain Control Module 2.
5. Verify P0E61 or P0E65 is not set.
 - **If any of the DTCs are set**
Replace the T18 Battery Charger.
 - **If none of the DTCs are set**
6. All OK.

[Repair Instructions](#)

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

[Control Module References](#) for battery charger or hybrid/EV powertrain control module 2 replacement, programming and setup.

DTC P1ECE: BATTERY CHARGER TOTAL OUTPUT POWER PERFORMANCE

[Diagnostic Instructions](#)

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

DTC Descriptor

DTC P1ECE

Battery Charger Total Output Power Performance

Circuit/System Description

The hybrid/EV powertrain control module 2 monitors the hybrid/EV battery pack voltage and current sensors to determine battery charger output power efficiency.

Conditions for Running the DTC

- The vehicle 12 V battery system voltage needs to be 10.2 V or greater.
- There cannot be any high voltage or current sensor faults present.
- Drive motor battery charger cable must be connected and vehicle receiving power.

Conditions for Setting the DTC

- Battery charger output power efficiency is less than 62% or greater than 167% for 80 minutes.
- Hybrid/EV electronics coolant temperature is between -12°C (10°F) and 65°C (149°F).

Actions Taken When the DTC Sets

- DTC P1ECE is a type A DTC.
- Disables the high voltage battery charging.

Conditions for Clearing the DTC

DTC P1ECE is a type A DTC.

Diagnostic Aids

The diagnostic consists of a passive efficiency test and active efficiency test. The passive test runs first, which takes a minimum of 80 minutes to mature. If the passive test fails, the active test is then run, which is intrusive. The DTC sets upon failure of the active test. The scan tool control function allows the active test to be run directly, eliminating the need to wait for the failure of the passive test.

The efficiency value is calculated by dividing the battery charger's output power by input power. A value less than 100% indicates power loss. A value more than 100% indicates an overcurrent condition and is less likely to occur.

Reference Information

Schematic Reference

Plug-In Charging Schematics

Connector End View Reference

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Description and Operation

Plug-In Charging System Description and Operation

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

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

Circuit/System Verification

1. Connect the drive motor battery charger cable. Vehicle in Service Mode.
2. Perform the scan tool control function: Battery Charging System Efficiency Test (Active Test) @ K114B Hybrid/EV Powertrain Control Module 2 $\tilde{\Delta}$, $\tilde{\Delta}$ »On. Wait for test to complete.
3. Verify DTC P1EE6 is not set.
 - **If the DTC is set**
Replace the T18 Battery Charger.
 - **If the DTC is not set**
4. All OK.

Repair Instructions

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

[Control Module References](#) for T18 Battery Charger, often referred to as the Drive Motor Battery Charger, replacement, programming and setup.

DTC P1EE6: BATTERY CHARGER AC VOLTAGE NOT PRESENT

Diagnostic Instructions

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

DTC Descriptor

DTC P1EE6

Battery Charger AC Voltage Not Present

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Voltage AC Line 1	P1EE6	P1EE6	-	-
Voltage AC Neutral Line 2	P1EE6	P1EE6	-	-
Voltage AC Ground	-	P1EE6	1	-
1. Plug In Charging Malfunction				

Circuit/System Description

The hybrid battery charger receptacle is connected to the battery charger through two AC circuits and one ground circuit. When the battery charger has been enabled by the hybrid/EV powertrain control module 2, the battery charger will provide an AC voltage measurement to the hybrid/EV powertrain control module 2. The hybrid/EV powertrain control module 2 allows charging to occur if proper AC voltage is present.

Conditions for Running the DTC

- The 12 V battery voltage is greater than 10.2 V.
- The drive motor battery charger cable is connected.
- DTCs P0D3E, P0D3F, P0D40 or P0D5C is not set.

Conditions for Setting the DTC

The battery charger AC input voltage is below 5 V.

Actions Taken When the DTC Sets

- DTC P1EE6 is a type C DTC.
- Disables the vehicle high voltage battery charging.

Conditions for Clearing the DTC

DTC P1EE6 is a type C DTC.

Diagnostic Aids

The hybrid/EV battery charger receptacle contains internal fuses on Voltage AC Line 1 and Voltage AC Neutral Line 2 circuits. A battery charger internal failure may cause these fuses to blow. If an open circuit is found in the hybrid/EV battery charger receptacle, the battery charger may also need to be replaced.

Reference Information

Schematic Reference

Plug-In Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Plug-In Charging System Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Testing

WARNING:

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

The High Voltage Disabling procedure includes the following steps:

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

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

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

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

1. Clear DTC, connect a known good drive motor battery charger cable to vehicle and household supply voltage.
2. Verify DTC P1EE6 is set.

- **If DTC P1EE6 is not set**

Replace customer's drive motor battery charger cable.

- **If DTC P1EE6 is set**

3. Vehicle OFF, disable the high voltage at the T18 Battery Charger. Refer to [**High Voltage Disabling**](#)
4. Disconnect the X2 harness connector at the T18 Battery Charger.
5. Test into the harness for infinite resistance between the AC circuit terminals listed below and ground:
 - T18 Battery Charger terminal 1 X2
 - T18 Battery Charger terminal 4 X2
 - **If less than infinite resistance**
 1. Disconnect the harness connector to the X98 Hybrid/EV Battery Charger Receptacle.
 2. Test into the harness for infinite resistance between the appropriate AC circuit terminal and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance, replace the X98 Hybrid/EV Battery Charger Receptacle.
 - **If infinite resistance**
6. Test into the harness for infinite resistance between all the AC circuit terminals listed below:
 - T18 Battery Charger terminal 1 X2
 - T18 Battery Charger terminal 3 X2
 - T18 Battery Charger terminal 4 X2
 - **If less than infinite resistance**
 1. Disconnect the harness connector to the X98 Hybrid/EV Battery Charger Receptacle.
 2. Test into the harness for infinite resistance between the three AC circuit terminals.
 - If less than infinite resistance, repair the short between the circuits.
 - If infinite resistance, replace the X98 Hybrid/EV Battery Charger Receptacle.
 - **If infinite resistance**
7. Test for less than 10 Ω between the AC circuit terminals listed below:

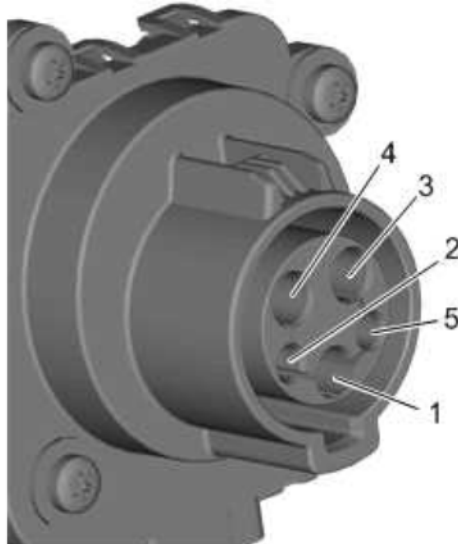


Fig. 7: Hybrid/EV Battery Charger Receptacle And Terminals

Courtesy of GENERAL MOTORS COMPANY

- T18 Battery Charger terminal 1 X2 and X98 Hybrid/EV Battery Charger Receptacle 3
- T18 Battery Charger terminal 3 X2 and X98 Hybrid/EV Battery Charger Receptacle 1
- T18 Battery Charger terminal 4 X2 and X98 Hybrid/EV Battery Charger Receptacle 4
- **If 10 Ω or greater**
 1. Disconnect the harness connector to the X98 Hybrid/EV Battery Charger Receptacle.
 2. Test for less than 2 Ω in the AC circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω
 3. Replace the X98 Hybrid/EV Battery Charger Receptacle.
 4. Verify the DTC does not set.
 - If the DTC sets, replace the T18 Battery Charger and X98 Hybrid/EV Battery Charger Receptacle.
 - If the DTC does not set
 5. All OK.
- **If less than 10 Ω**
 8. Replace the T18 Battery Charger.

Repair Instructions

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

- [Drive Motor Battery Charger Receptacle Replacement](#)
- [Control Module References](#) for battery charger replacement, programming and setup.

PLUG-IN CHARGING MALFUNCTION

Diagnostic Instructions

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control Pilot Signal	P0CF4, P0CF5, P0CF6, P0CF9, P0D01, 1	P0CF4, P0CF5, P0CF6, 1	P0CF4, P0CF5, P0CF6, P0CF9, 1	P0CF4, P0CF5, P0CF6, 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Proximity Status Signal	P0D58, 1	P0D59, 1	P0D59, 1	-
Voltage AC Line 1	1	P0D3F, P1EE6	1	-
Voltage AC Neutral Line 2	1	P1EE6	1	-
Voltage AC Ground	-	P0D59, 1	1	-
1. Plug In Charging Malfunction				

Circuit/System Description

The drive motor battery charger cable allows the vehicle to be charged using a common household power outlet. The drive motor battery charger cable contains LEDs that indicate the status of the drive motor battery charger cable. The drive motor battery charger cable automatically prohibits voltage transfer to the hybrid/EV battery charger receptacle and the Fault Indicator is illuminated red if it senses internal faults or inadequate household voltage. If the drive motor battery charger cable senses no faults the AC Present Indicator is illuminated solid green.

When the hybrid/EV powertrain control module 2 senses the drive motor battery charger cable is connected to the vehicle charge receptacle, it will communicate with the off-vehicle charge equipment to ensure compatibility and proper function. The hybrid/EV powertrain control module 2 will then indicate the status of charging events (including user-programmable delays) to the user via instrument panel mounted plug-in charging status indicator LEDs and audio tones.

Diagnostic Aids

If the drive motor battery charger cable Fault Indicator is illuminated solid red or flashing red before plugging into the vehicle, the charger cable will need to be diagnosed first.

Reference Information

Schematic Reference

Plug-In Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Plug-In Charging System Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Verification

1. Vehicle ON, verify no DTCs are set.

- If DTCs are set

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

- If no DTCs are set

2. With the charge cord NOT connected to the vehicle battery charger receptacle, verify the vehicle plug-in charging status indicators are OFF.

- If the vehicle plug-in charging status indicators are not OFF with the charge cord disconnected from the vehicle

Refer to [Plug-In Charging Indicator Malfunction](#).

- If the vehicle plug-in charging status indicators are OFF

3. Vehicle OFF and connect the charge cord to the vehicle battery charger receptacle.

4. Verify the vehicle charge status indicators are operating properly.

- If the vehicle charge status indicator is solid yellow

Refer to Circuit/System Testing.

- If the vehicle charge status indicator is not illuminated

1. Vehicle ON.

2. Verify the Charge Cord Connected message is displayed in the instrument panel/message center.

NOTE: Vehicle must be ON and not in Service Mode for message operation.

- If the Charge Cord Connected message is displayed, refer to [Plug-In Charging Indicator Malfunction](#).
- If the Charge Cord Connected message is NOT displayed, refer to Circuit/System Testing.

- If the vehicle charge status indicator is operating properly

5. All OK.

Circuit/System Testing

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

The High Voltage Disabling procedure includes the following steps:

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

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

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

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

1. Connect the customer's drive motor battery charger cable to household power outlet, but not the vehicle battery charger receptacle.
2. After 25 seconds, verify drive motor battery charger cable AC Present Indicator illuminates solid green.
 - **If drive motor battery charger cable AC Present Indicator does not illuminate solid green**
 1. Connect a known good drive motor battery charger cable to the same household power outlet.
 - If known good drive motor battery charger cable AC Present Indicator illuminates solid green, replace the customer's drive motor battery charger cable.
 - If known good drive motor battery charger cable AC Present Indicator does not illuminate solid green, have the service provider inspect the household power outlet for insufficient voltage, high frequency noise or open/high resistance.
 - **If drive motor battery charger cable AC Present Indicator does illuminate solid green**
3. Test for greater than 1 V between the low voltage circuits listed below on drive motor battery charger cable.

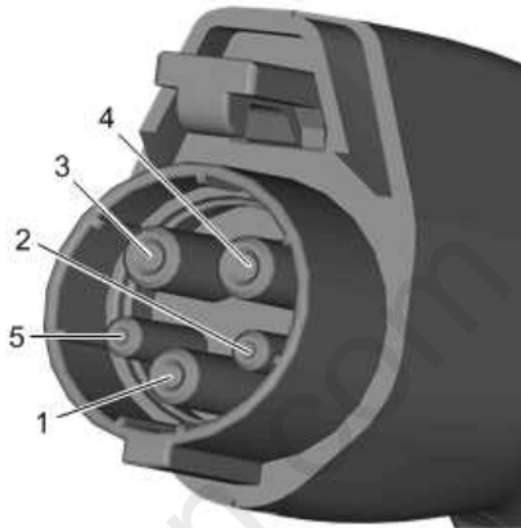


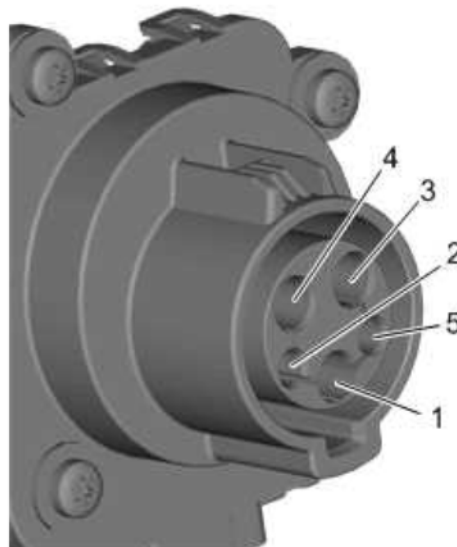
Fig. 8: Drive Motor Battery Charger Cable Terminals
Courtesy of GENERAL MOTORS COMPANY

- Proximity status signal circuit terminal 5
- Control pilot signal circuit terminal 2
- **If less than 1 V**

Replace drive motor battery charger cable.

- **If greater than 1 V**

4. Vehicle OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Test for 100 k Ω -4 M Ω between the control pilot signal terminal 2 at the X98 Hybrid/EV Battery Charger Receptacle and ground.



NOTE: The following tests are performed at the X98 Hybrid/EV Battery Charger Receptacle and not at the harness connector to the X98 Hybrid/EV Battery Charger Receptacle.

NOTE: When measuring resistance observe proper meter polarity by connecting the common/ground meter probe to ground/vehicle chassis.

NOTE: You must measure with a high-impedance Digital Multimeter (DMM) such as the EL-39200 or equivalent.

- **If 4 M Ω or greater**

1. Disconnect the X2 harness connector from K114B Hybrid/EV Powertrain Control Module 2
2. Test for 2 Ω in the control pilot signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K114B Hybrid/EV Powertrain Control Module 2.

- **If less than 100 k Ω**

1. Disconnect the X2 harness connector from K114B Hybrid/EV Powertrain Control Module 2
2. Test for infinite resistance between the control pilot signal circuit and ground.

- If less than infinite resistance, repair the short to ground in the circuit.
- If infinite resistance, replace the K114B Hybrid/EV Powertrain Control Module 2.

- **If within the specified range**

5. Test for less than 1 V between the control pilot signal terminal 2 at the X98 Hybrid/EV Battery Charger Receptacle and ground.

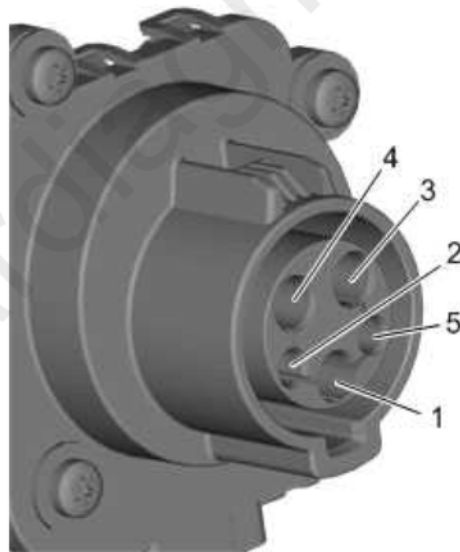


Fig. 10: Hybrid/Ev Battery Charger Receptacle And Terminals
Courtesy of GENERAL MOTORS COMPANY

- **If greater than 1 V**

1. Disconnect the X2 harness connector from K114B Hybrid/EV Powertrain Control Module 2
2. Test for less than 1 V between the control pilot signal circuit and ground.

- If greater than 1 V, repair the short to voltage in the circuit.
- If less than 1 V, replace the K114B Hybrid/EV Powertrain Control Module 2.

- **If less than 1 V**

6. Vehicle in Service Mode.
7. Test for 4.2-4.8 V between the proximity status signal terminal 5 at the X98 Hybrid/EV Battery Charger Receptacle and ground.

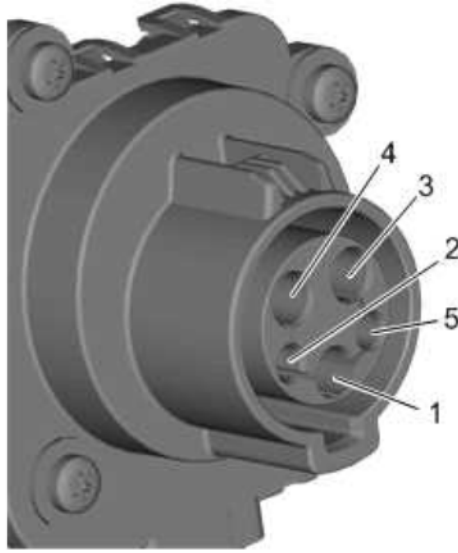


Fig. 11: Hybrid/EV Battery Charger Receptacle And Terminals

Courtesy of GENERAL MOTORS COMPANY

- **If less than 4.2 V**

1. Vehicle OFF, test for infinite resistance between the proximity status signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
2. Disconnect the X2 harness connector from K114B Hybrid/EV Powertrain Control Module 2.
3. Test for less than 2 Ω in the proximity status signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K114B Hybrid/EV Powertrain Control Module 2.

- **If greater than 4.8 V**

1. Disconnect the X2 harness connector from K114B Hybrid/EV Powertrain Control Module 2
2. Test for 0 V between the proximity status signal circuit and ground.
 - If greater than 0 V, repair the short to voltage in the circuit.
 - If 0 V, replace the K114B Hybrid/EV Powertrain Control Module 2.

- **If within the specified range**

8. Vehicle OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Disconnect the X2 harness connector from T18 Battery Charger and the X2 harness connector from the K114B Hybrid/EV Powertrain Control Module 2.
9. Test for infinite resistance between the terminals listed below at the X98 Hybrid/EV Battery Charger Receptacle:

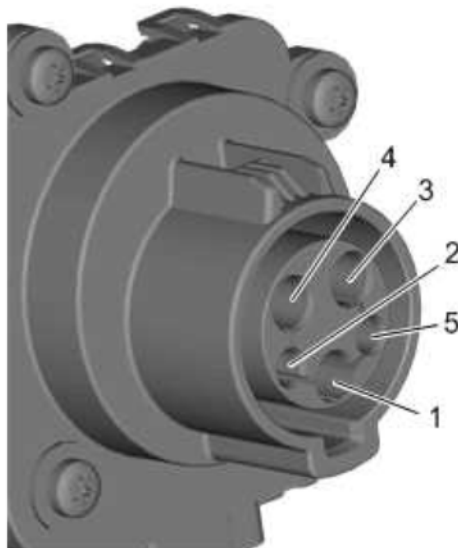


Fig. 12: Hybrid/ev Battery Charger Receptacle And Terminals

Courtesy of GENERAL MOTORS COMPANY

- Voltage AC Line 1 terminal 3 and Voltage AC Neutral Line 2 terminal 4
- Voltage AC Line 1 terminal 3 and Voltage AC Ground terminal 1
- Voltage AC Line 1 terminal 3 and Control pilot signal circuit terminal 2
- Voltage AC Line 1 terminal 3 and Proximity status signal circuit terminal 5
- Voltage AC Neutral Line 2 terminal 4 and Voltage AC Ground terminal 1
- Voltage AC Neutral Line 2 terminal 4 and Control pilot signal circuit terminal 2
- Voltage AC Neutral Line 2 terminal 4 and Proximity status signal circuit terminal 5
- Voltage AC Ground terminal 1 and Control pilot signal circuit terminal 2
- Control pilot signal circuit terminal 2 and Proximity status signal circuit terminal 5
- **If less than infinite resistance**

Repair the short between the circuits.

- **If infinite resistance**

10. Disconnect the harness connector from the X98 Hybrid/EV Battery Charger Receptacle.
11. Test for 2.56-2.84 k Ω between the Voltage AC Ground terminal 1 and Proximity status signal circuit terminal 5 at the X98 Hybrid/EV Battery Charger Receptacle.

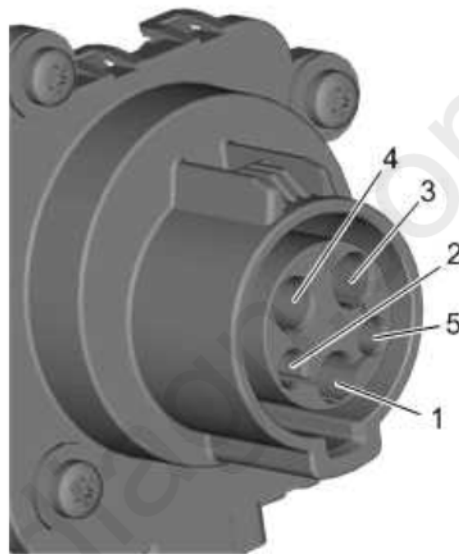


Fig. 13: Hybrid/Ev Battery Charger Receptacle And Terminals
Courtesy of GENERAL MOTORS COMPANY

- **If not within the specified range**

Replace the X98 Hybrid/EV Battery Charger Receptacle.

- **If within the specified range**

12. Test for infinite resistance between the Voltage AC Ground terminal 1 and Proximity status signal circuit terminal 5 of the harness connector.

NOTE: This test is performed on the vehicle side of the harness connector.

- **If less than infinite resistance**

Repair the short between the circuits.

- **If infinite resistance**

13. Replace and program the K114B Hybrid/EV Powertrain Control Module 2.
14. Repeat Circuit/System Verification and confirm vehicle is All OK.

- **If Circuit/System Verification was not All OK**

Replace the T18 Battery Charger.

- **If Circuit/System Verification was All OK**

15. All OK.

Repair Instructions

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

- [Drive Motor Battery Charger Receptacle Replacement](#)
- [Control Module References](#) for T18 battery charger or K114B hybrid/EV powertrain control module 2 replacement, programming and setup.

PLUG-IN CHARGING INDICATOR MALFUNCTION

Diagnostic Instructions

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Charge Pilot Indicator Control	P0D2B	P0D2B	P0D2B	-
Charge Status Indicator Control	P0D2C	P0D2C, 1	P0D2C	-
Charge Complete Indicator Control	1	1	1	-
Low Reference	-	P0D2C, P0D2B	-	-
1. Plug In Charging Indicator Malfunction				

Circuit/System Description

The status of charging events (including delays) is communicated to the user through a vehicle plug-in charge status indicator and audio tones. The vehicle plug-in charge status indicator, located on the top middle of the instrument panel, contains a green LED (charge status indicator) and yellow LED (charge pilot indicator) controlled by the Hybrid Powertrain Control Module 2 and a second green LED (charge complete indicator) controlled by the BCM. The indicator will have a short flash green when the vehicle is charging under automatic control. The flash rate increases from one to four as the battery charges. It will have a long flash green if the charging is delayed and will begin later. It will be illuminated solid green when charging is complete. A solid lit yellow indicator means the vehicle is not able to accept a charge.

Reference Information

Schematic Reference

[Plug-In Charging Schematics](#)

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX](#)

Description and Operation

[Plug-In Charging System Description and Operation](#)

Electrical Information Reference

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

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

1. Vehicle in Service Mode.
2. Verify that DTC U135B is not set.

- **If DTC U135B is set**

Refer to DTC U1340-U135F.

- **If DTC U135B is not set**

3. Verify no other hybrid/EV battery-related DTCs are set.

- **If any hybrid/EV battery-related DTCs are set**

Refer to Diagnostic Trouble Code (DTC) List - Vehicle

- **If no hybrid/EV battery-related DTCs are set**

4. Vehicle OFF. Ensure the charge cord is not connected to the vehicle.

5. Verify the vehicle charge indicator is OFF.

- **If the vehicle charge indicator is not OFF**

Refer to Circuit/System Testing.

- **If the vehicle charge indicator is OFF**

6. Connect the charge cord.

7. Verify the vehicle charge indicator is operating properly.

- **If the vehicle charge indicator is solid yellow**

Refer to Plug-In Charging Malfunction

- **If the vehicle charge indicator is OFF**

1. Vehicle ON.

2. Verify the Charge Cord Connected message is displayed in the instrument panel/message center.

NOTE: Vehicle must be ON and not in Service Mode for message operation.

- If the Charge Cord Connected message is displayed, refer to Circuit/System Testing.
- If the Charge Cord Connected message is NOT displayed, refer to Plug-In Charging Malfunction.

- **If the vehicle charge indicator is operating properly**

8. All OK.

Circuit/System Testing

WARNING:

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

The High Voltage Disabling procedure includes the following steps:

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

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

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

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

1. Vehicle OFF, disconnect the X1 harness connector at the B305 Ambient Light/Sunload Sensor and Battery State of Charge Indicator.
2. Test for less than 10 Ω between the low reference terminal 1 and ground.

- **If 10 Ω or greater**

Repair the open/high resistance in the circuit.

- **If less than 10 Ω**

3. Connect a test lamp between the yellow LED control circuit terminal 4 and ground.

NOTE: If the drive motor battery charger cable is connected. The drive motor battery charger cable must be disconnected for more than 10 s before performing the next step.

4. Verify the test lamp does not illuminate.

- **If the test lamp illuminates**

1. Disconnect the X2 harness connector at the K114B Hybrid/EV Powertrain Control Module 2.
2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V, replace the K114B Hybrid/EV Powertrain Control Module 2.

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

5. Connect the drive motor battery charger cable.

6. Verify that the test lamp illuminates or flashes in the first 5 s of connecting the drive motor battery charger cable.

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

1. Disconnect the X2 harness connector at the K114B Hybrid/EV Powertrain Control Module 2.
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
3. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K114B Hybrid/EV Powertrain Control Module 2.

- **If the test lamp illuminates**

7. Disconnect the drive motor battery charger cable for at least 10 s. Connect a test lamp between the green LED control circuit terminal 3 and ground.

8. Verify test lamp does not illuminate.

- **If the test lamp illuminates**

1. Disconnect the X2 harness connector at the K114B Hybrid/EV Powertrain Control Module 2.

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

- If 1 V or greater, repair the short to voltage in the circuit.
- If less than 1 V, replace the K114B Hybrid/EV Powertrain Control Module 2.

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

9. Connect the drive motor battery charger cable.

10. Verify that the test lamp illuminates or flashes within 25 s of connecting the drive motor battery charger cable.

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

1. Disconnect the X2 harness connector at the K114B Hybrid/EV Powertrain Control Module 2.

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

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

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K114B Hybrid/EV Powertrain Control Module 2.

• **If the test lamp illuminates**

11. Replace the B305 Ambient Light/Sunload Sensor and Battery State of Charge Indicator.

Repair Instructions

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

- [Sun Load, Ambient Light and Charge Indicator Sensor Replacement](#) for B305 Ambient Light/Sunload Sensor and Battery State of Charge Indicator replacement.
- [Control Module References](#) for T18 battery charger or K114B hybrid/EV powertrain control module 2 replacement, programming and setup.

REPAIR INSTRUCTIONS

CHARGE PORT DOOR REPLACEMENT

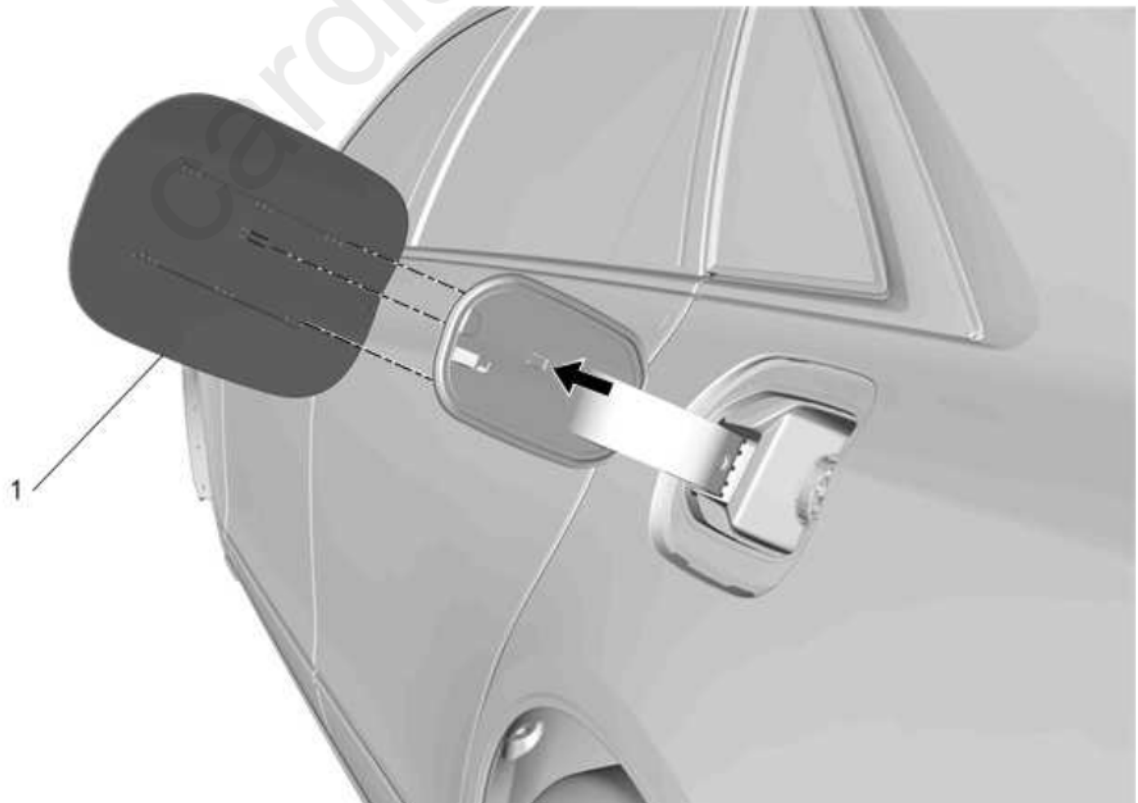


Fig. 14: Charge Port Door

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

Callout	Component Name
WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed. The High Voltage Disabling procedure includes the following steps: • Identify how to disable high voltage. • Identify how to test for the presence of high voltage. • Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed. Before working on any high voltage system, be sure to wear the following Personal Protection Equipment: • Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors. • Certified and up-to-date Class "0" Insulation gloves rated at 1000 V with leather protectors. • Visually and functionally inspect the gloves before use. • Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not. Failure to follow the procedures may result in serious injury or death. Preliminary Procedures 1. High Voltage Disabling 2. Left Rear Wheel House Panel» Remove - Rear Wheelhouse Liner Replacement (LTG) and/or Rear Wheelhouse Liner Replacement (LGX, LGW) 3. Charge Port Door Replacement 4. Disconnect the electrical connector.	
1	Charge Port Housing Procedure 1. From inside the rear wheel house, release the lower tabs to the charge port housing assembly. 2. Push outward on the assembly housing. 3. High Voltage Enabling

CHARGE PORT DOOR AJAR INDICATOR SWITCH REPLACEMENT

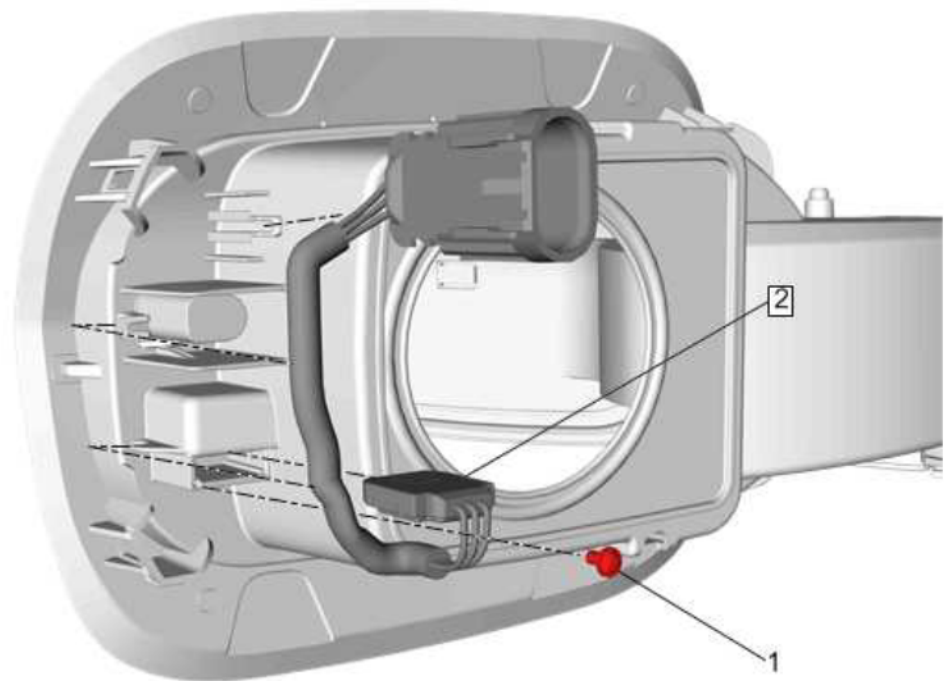


Fig. 16: Charge Port Door Ajar Indicator Switch

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
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. Preliminary Procedures 1. High Voltage Disabling 2. Charge Port Housing Replacement	

Callout	Component Name
1	Charge Port Door Ajar Switch Bolt CAUTION: Refer to Fastener Caution . Procedure Install and hand tighten
2	Charge Port Door Ajar Indicator Switch Procedure 1. Release the charge port door ajar indicator switch and connector from the charge port housing cavity. 2. High Voltage Enabling

DRIVE MOTOR BATTERY CHARGER REPLACEMENT

WARNING:

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

The High Voltage Disabling procedure includes the following steps:

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

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

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

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

Removal Procedure

1. Disable the high voltage system. Refer to [High Voltage Disabling](#)
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#)
3. Remove and plug the generator control module inlet and outlet hoses (2), refer to [Generator Control Module Coolant Outlet Hose Replacement \(Inlet\)](#) and/or [Generator Control Module Coolant Outlet Hose Replacement \(Outlet\)](#)

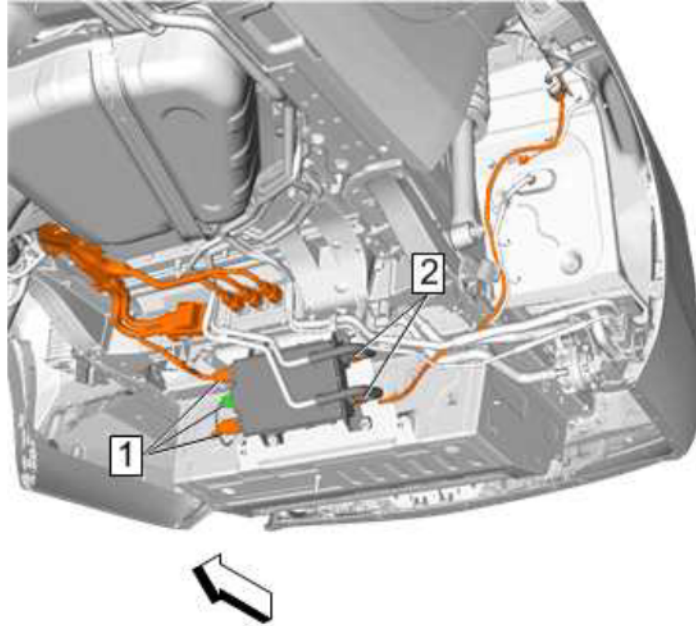


Fig. 17: Generator Control Module Inlet And Outlet Hoses With Electrical Connectors
 Courtesy of GENERAL MOTORS COMPANY

4. Electrical Connector (1) » Disconnect [3x]

NOTE: Do not contaminate electrical connectors with coolant.

5. Drive Motor Battery Charger Fastener (1) » Remove [2x]

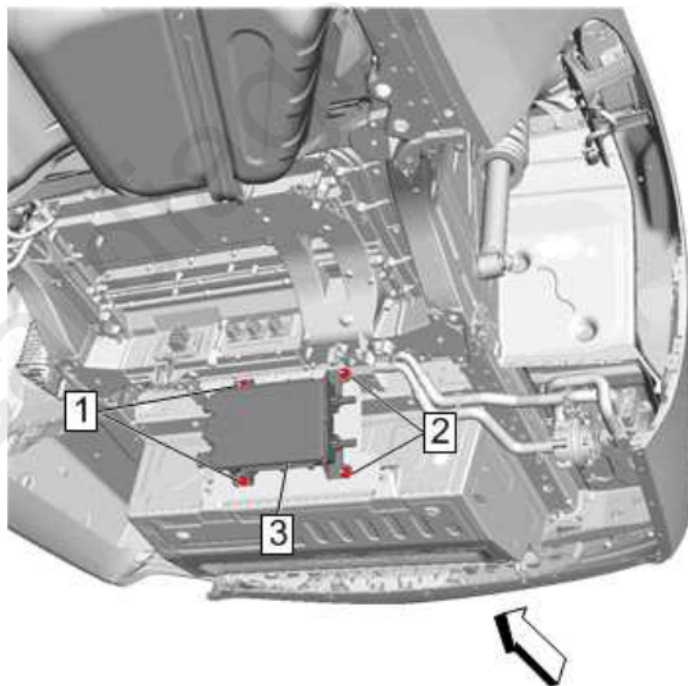


Fig. 18: Drive Motor Battery Charger And Fasteners
 Courtesy of GENERAL MOTORS COMPANY

6. Drive Motor Battery Charger Fastener (2) » Remove [2x]
7. Drive Motor Battery Charger (3) » Remove

Installation Procedure

1. Drive Motor Battery Charger (3) » Install

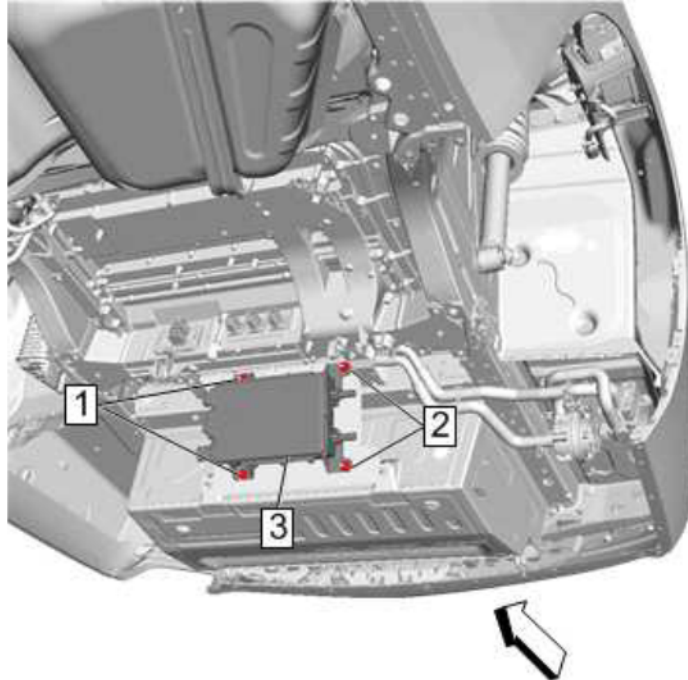


Fig. 19: Drive Motor Battery Charger And Fasteners

Courtesy of GENERAL MOTORS COMPANY

2. Drive Motor Battery Charger Fastener (2) » Install and tighten [2x] 22 N.m (16 lb ft)

CAUTION: Refer to **Fastener Caution**

3. Drive Motor Battery Charger Fastener (1) » Install and tighten [2x] 22 N.m (16 lb ft)
4. Electrical Connector (1) » Connect [3x]

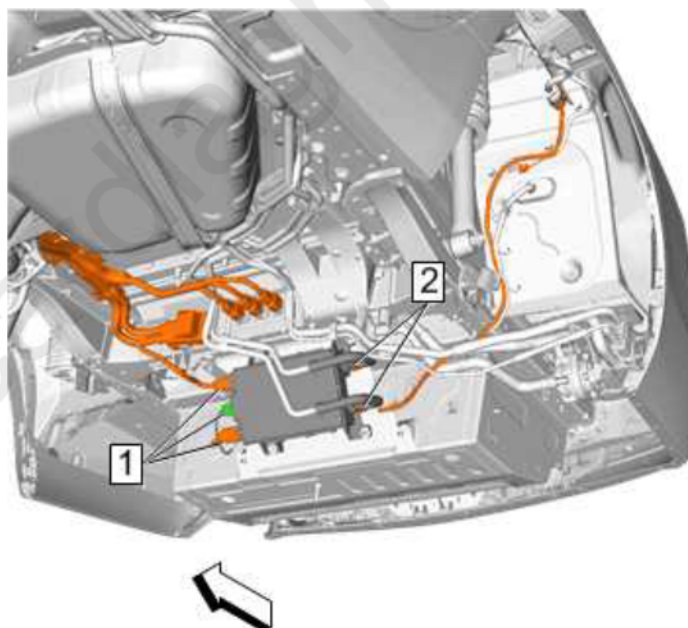


Fig. 20: Generator Control Module Inlet And Outlet Hoses With Electrical Connectors

Courtesy of GENERAL MOTORS COMPANY

5. Install the generator control module coolant inlet and outlet hoses (2), refer to **Generator Control Module Coolant Outlet Hose Replacement (Inlet)** and/or **Generator Control Module Coolant Outlet Hose Replacement (Outlet)**
6. Lower the vehicle.
7. Enable the high voltage system. Refer to **High Voltage Enabling**

DRIVE MOTOR BATTERY CHARGER RECEPTACLE REPLACEMENT

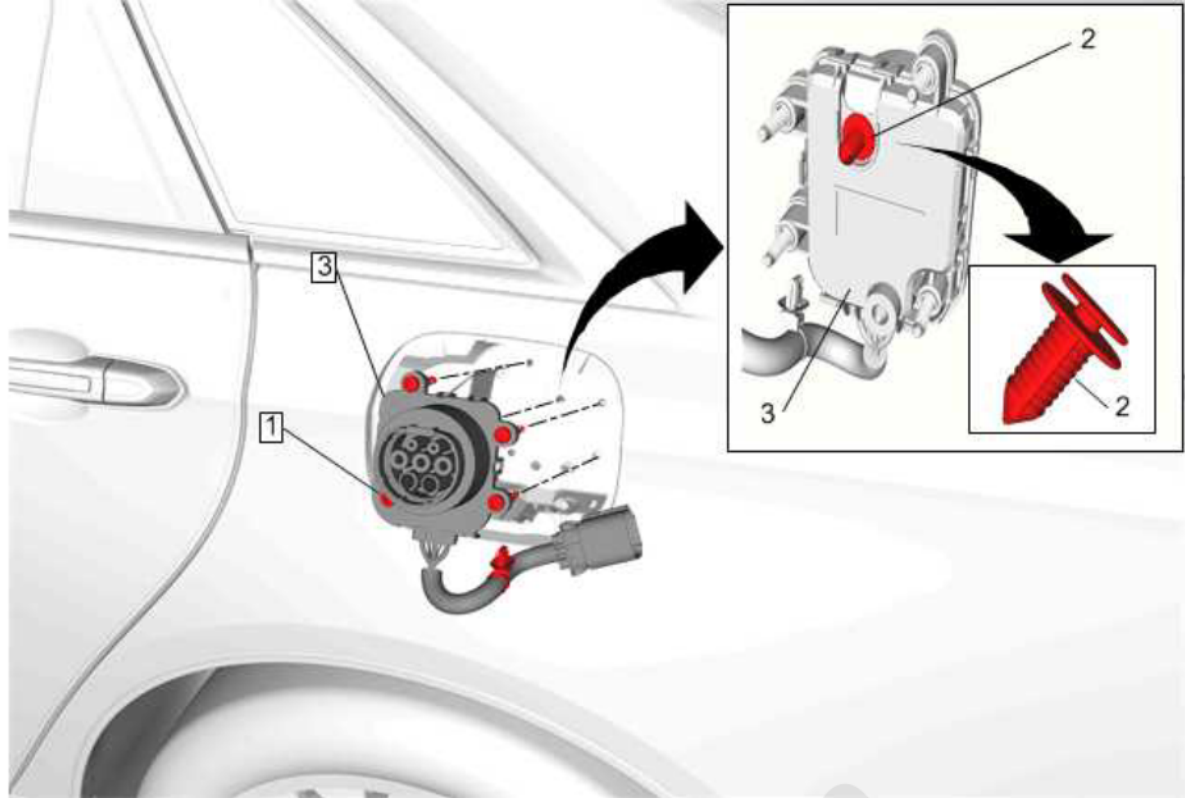


Fig. 21: Drive Motor Battery Charger Receptacle

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
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. Preliminary Procedures 1. Remove the electric vehicle supply equipment (EVSE) charge cord plug handle from the charger receptacle. 2. High Voltage Disabling 3. Charge Port Housing Replacement	

Callout	Component Name
1	Drive Motor Battery Charger Receptacle Fastener [4x] CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)
2	Drive Motor Battery Charger Receptacle Retainer Procedure Using a trim type tool, release the retainer.
3	Drive Motor Battery Charger Receptacle Procedure 1. Disconnect the electrical connector. 2. High Voltage Enabling

DESCRIPTION AND OPERATION

PLUG-IN CHARGING SYSTEM DESCRIPTION AND OPERATION

Plug-In Charging System Components

The high voltage battery charging system consists of four main components:

1. The off-vehicle charging equipment:
 - Drive motor battery charger cable, often referred to as the travel cord set
 - Optional, permanent 230/240 V charge station
2. The hybrid/EV battery charger receptacle, often referred to as the drive motor battery charger receptacle.
3. The battery charger, often referred to as the drive motor battery charger.
4. The hybrid/EV battery pack.

A variety of mechanical, visual and audio indicators/devices are used to communicate with the user of the charging equipment.

Drive Motor Battery Charger Cable/Charge Station

The drive motor battery charger cable provided with the vehicle features a standard household electrical plug on one end and a plug designed to interface with the vehicles hybrid/EV battery charger receptacle on the other end. The drive motor battery charger cable features a charge current interrupt device with AC power and fault indicators and it is stored in the vehicle's cargo area. An optional charge station is available for customers who want to reduce the amount of time needed to recharge. The optional charge station, if available, is hard-wired to a 230/240 V power supply and must be permanently mounted at the customer's location. The optional charge station features the same plug on the vehicle end as the drive motor battery charger cable.

The Drive Motor Battery Charger Cable Indicators and the Vehicle Indicators

The drive motor battery charger cable has two indicators, the AC Present Indicator and the Fault Indicator, which display its status.

- Solid green AC Present Indicator means AC voltage is present at the wall plug and there are no faults.
- Flashing green AC Present Indicator and solid red Fault Indicator means the electrical outlet or plug is faulty or overheated.
- Solid red Fault Indicator means the AC outlet does not have a proper ground and charging is not permitted for safety reasons.
- Flashing red Fault Indicator means there is a vehicle fault and the charger cable ground-fault circuit interrupter (GFCI) has tripped.

- Solid green AC Present Indicator and flashing red Fault Indicator means the charger cable has failed self-check.

The off-vehicle battery charging equipment is supervised and controlled by the hybrid/EV powertrain control module 2. The hybrid/EV powertrain control module 2 is the primary controller and all diagnostic trouble codes will set in that module even though some of the diagnostics are actually run within the battery charger. Charging events can be delayed at customer request to take advantage of lower rates during non-peak hours. The status of charging events, including delays, is communicated to the user through visual indications, instrument panel mounted charge status indicator and audio tones. The vehicle charge status indicator, located on the top middle of the instrument panel, will be short flashing green when the vehicle is charging under automatic control. The flash rate increases from one to four as the battery charges. It will be long flashing green if the charging is delayed and will begin later. It will be solid green when charging is complete. A solid yellow indicator means the vehicle is not able to accept a charge. If there is no indicator, the drive motor battery charger cable is not working properly or not connected.

Vehicle Receptacle

The vehicle receptacle or hybrid/EV battery charger receptacle, is located behind the charging port door on the driver's side rear quarter panel. The receptacle is accessed by depressing and opening the receptacle door.

Battery Charger

The battery charger is a serviceable assembly containing several micro-processors and two separate high voltage chargers. One of the high voltage chargers is used while charging with a 120 V charge source and both are used with a 230/240 V charge source. The battery charger is mounted beneath the vehicle under the hybrid/EV battery pack. DEX-COOL[®] coolant is used to ensure that the charger does not exceed its maximum designed operating temperature. The battery charger, along with the 14 V power module and the drive motor generator power inverter module, are cooled by a power electronics cooling loop, which is separate from other cooling systems.

12 V Battery Maintenance Mode

Battery Maintenance Mode is an automatic function that prevents deep discharge of the 12 V battery in specific circumstances. It is enabled when the drive motor battery charger cable is plugged into the hybrid/EV battery charger receptacle and the hybrid/EV battery pack is not being charged. Operation differs depending on whether the power mode is Vehicle Off or Vehicle in Service Mode.

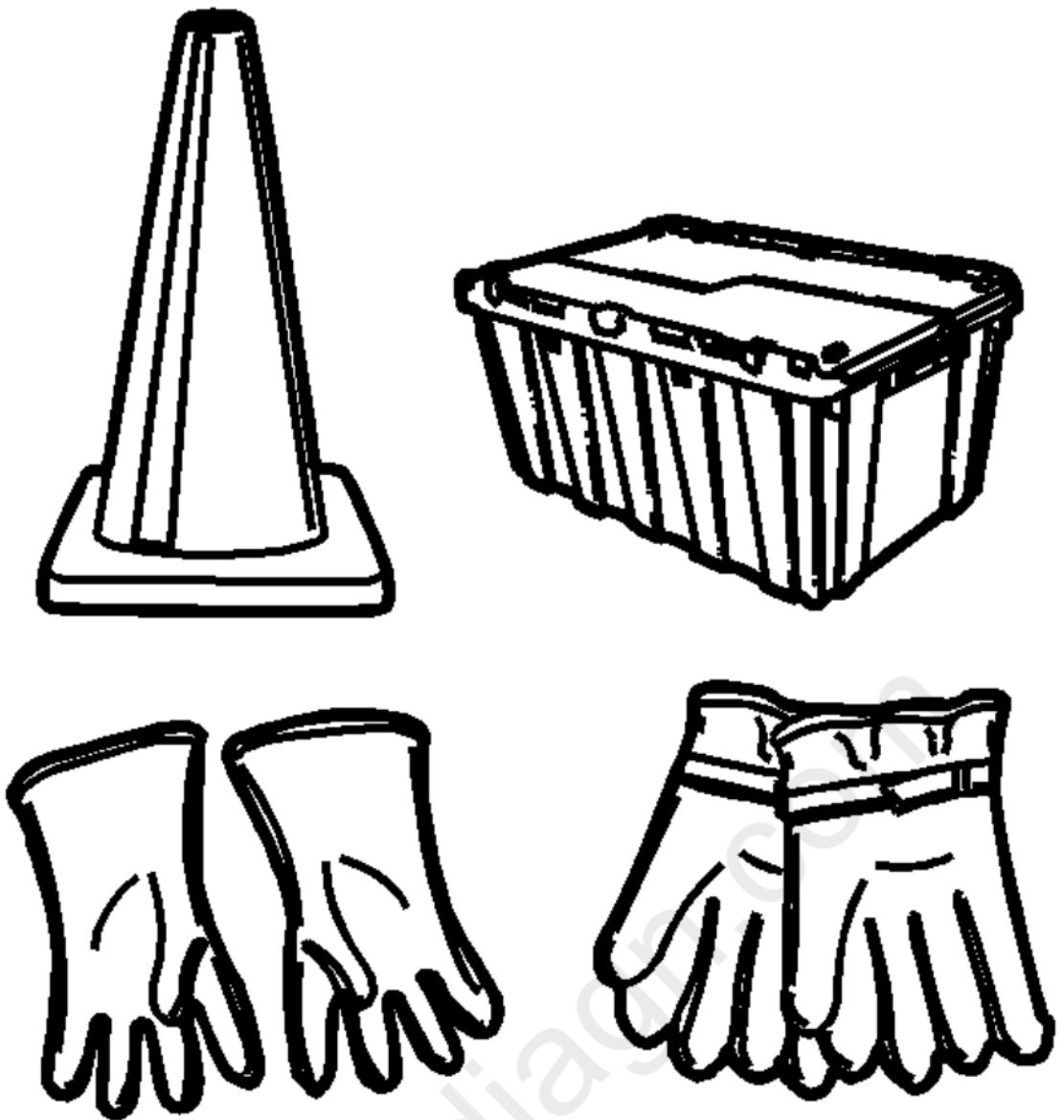
With Vehicle Off, the 12 V battery is monitored at periodic intervals up to a maximum of 30 days. With Vehicle in Service Mode, the 12 V battery is monitored at periodic intervals up to a maximum of 60 hours. If voltage is low, the 12 V battery is charged by the 14 V power module using external power for up to four hours. This function is only intended to prevent a dead 12 V battery and does not provide a full charge. This is more efficient than continuously trickle charging, thus minimizing the usage of external power.

Under normal circumstances, with a 12 V battery that is charged when the vehicle is parked, Battery Maintenance Mode will simply monitor the voltage level and no charging will be necessary. With Vehicle Off, Battery Maintenance Mode will maintain the 12 V battery for up to 30 days. For longer periods, refer to Owner Manual for instructions.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/Description

Illustration	Tool Number/Description
 The illustration shows three items: a traffic cone on the left, a rectangular plastic storage bin in the upper right, and two pairs of gloves at the bottom. One pair of gloves is short and has a textured, wavy pattern on the palms and fingers. The other pair is longer, reaching up to the forearm, and has a smooth surface.	EL-48900 HEV Safety Kit or equivalent Dealer Equipment