

2013 ELECTRICAL

Hybrid/EV Cooling - Malibu

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Auxiliary Radiator Nut	9	80 lb in
Drive Motor Battery Cooling Blower Motor Bracket Fastener	9	80 lb in
Generator Control Module Coolant Pump Bracket Bolt	22	16 lb ft
Heater Outlet Hose Clip Bracket Bolt	22	16 lb ft

SCHEMATIC WIRING DIAGRAMS

HYBRID/EV COOLING WIRING SCHEMATICS

Starter/Generator Wiring Schematics

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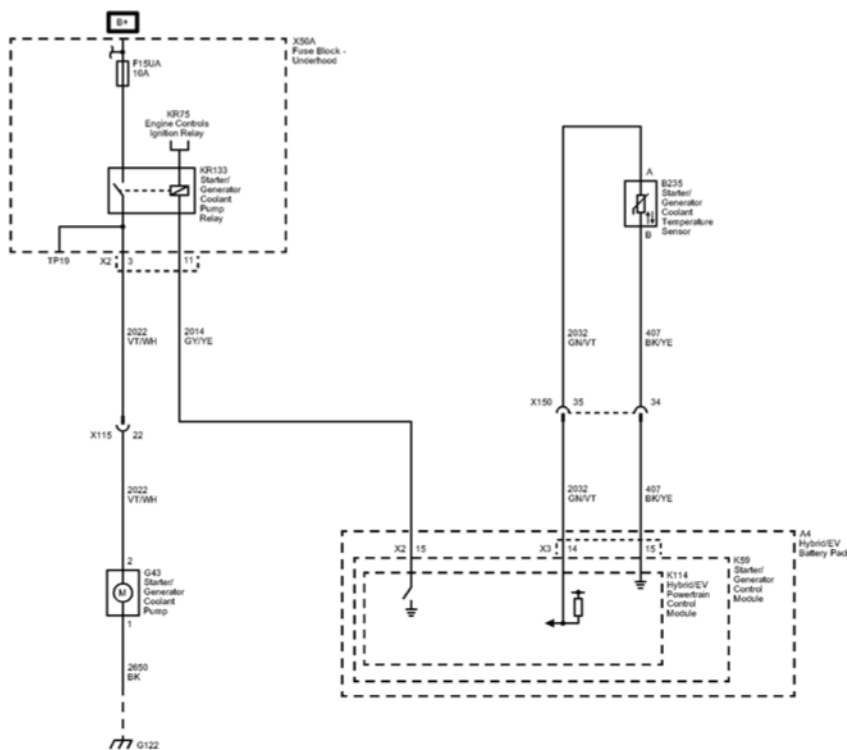


Fig. 1: Starter/Generator Wiring Schematics
 Courtesy of GENERAL MOTORS COMPANY

Battery Pack Wiring Schematics

Cardiagn.com

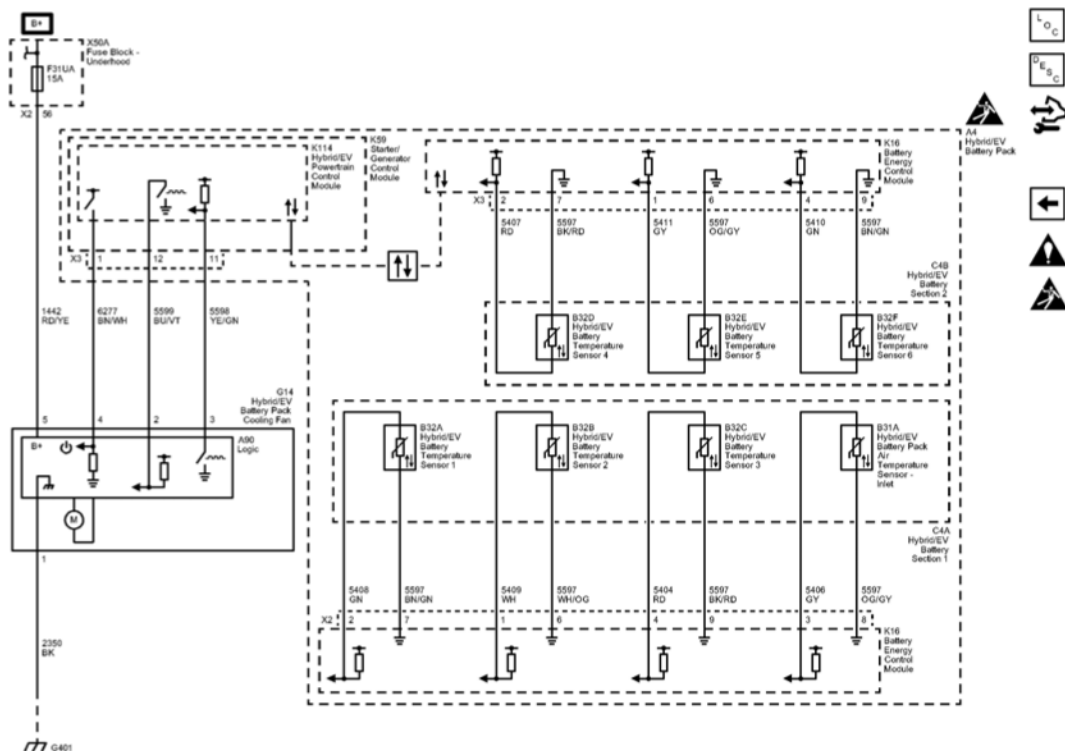


Fig. 2: Battery Pack Wiring Schematics
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC P0AAD-P0AAF</u>	DTC P0AAD Hybrid/EV Battery Pack Air Temperature Sensor 1 Performance DTC P0AAE Hybrid/EV Battery Pack Air Temperature Sensor 1 Circuit Low Voltage DTC P0AAF Hybrid/EV Battery Pack Air Temperature Sensor 1 Circuit High Voltage
<u>DTC P0A7E</u>	DTC P0A7E Hybrid/EV Battery Pack High Temperature
	DTC P0A9C Hybrid/EV Battery Temperature Sensor 1 Performance DTC P0A9D Hybrid/EV Battery Temperature Sensor 1 Circuit Low Voltage DTC P0A9E Hybrid/EV Battery Temperature Sensor 1 Circuit High Voltage

<u>DTC P0A9C-P0A9E, P0AC6-P0AC8, P0ACB-P0ACD, P0AE9-P0AEB, P0BC3-P0BC5, or P0C34-P0C36</u>	DTC P0AC6 Hybrid/EV Battery Temperature Sensor 2 Performance DTC P0AC7 Hybrid/EV Battery Temperature Sensor 2 Circuit Low Voltage DTC P0AC8 Hybrid/EV Battery Temperature Sensor 2 Circuit High Voltage DTC P0ACB Hybrid/EV Battery Temperature Sensor 3 Performance DTC P0ACC Hybrid/EV Battery Temperature Sensor 3 Circuit Low Voltage DTC P0ACD Hybrid/EV Battery Temperature Sensor 3 Circuit High Voltage DTC P0AE9 Hybrid/EV Battery Temperature Sensor 4 Performance DTC P0AEA Hybrid/EV Battery Temperature Sensor 4 Circuit Low Voltage DTC P0AEB Hybrid/EV Battery Temperature Sensor 4 Circuit High Voltage DTC P0BC3 Hybrid/EV Battery Temperature Sensor 5 Performance DTC P0BC4 Hybrid/EV Battery Temperature Sensor 5 Circuit Low Voltage DTC P0BC5 Hybrid/EV Battery Temperature Sensor 5 Circuit High Voltage DTC P0C34 Hybrid/EV Battery Temperature Sensor 6 Performance DTC P0C35 Hybrid/EV Battery Temperature Sensor 6 Circuit Low Voltage DTC P0C36 Hybrid/EV Battery Temperature Sensor 6 Circuit High Voltage
<u>DTC P0C32</u>	DTC P0C32 Hybrid/EV Battery Pack Cooling System Performance
<u>DTC P0CBD-P0CBF</u>	DTC P0CBD Drive Motor Coolant Temperature Sensor Performance DTC P0CBE Drive Motor Coolant Temperature Sensor Circuit Low Voltage DTC P0CBF Drive Motor Coolant Temperature Sensor Circuit High Voltage

DTC P0AAD-P0AAF

Diagnostic Instructions

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

DTC Descriptors

DTC P0AAD

Hybrid/EV Battery Pack Air Temperature Sensor 1 Performance

DTC P0AAE

Hybrid/EV Battery Pack Air Temperature Sensor 1 Circuit Low Voltage

DTC P0AAF

Hybrid/EV Battery Pack Air Temperature Sensor 1 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal - Terminal 3 X2	P0AAE	P0AAF	P0AAF	P0AAD
Low Reference - Terminal 8 X2	-	P0AAF	-	-

Circuit/System Description

The Battery Energy Control Module monitors an inlet air temperature sensor that is located at the inlet of the Hybrid/EV Battery Pack. This temperature sensor is a variable resistor that measures the air temperature of the incoming air which is used to heat and cool the Hybrid/EV Battery Sections and the internal electronics of the Starter/Generator Control Module. The Battery Energy Control Module supplies 5 V to the signal circuit and a ground for the low reference circuit. The inlet air temperature sensor resistance changes with temperature of the incoming inlet air. As the temperature decreases, the sensor resistance increases. As the temperature increases, the sensor resistance decreases. The Starter/Generator Control Module will control the Hybrid/EV Battery Pack Cooling Fan based on the inlet air temperature and hybrid/EV battery temperature sensors.

The Starter/Generator Control Module performs a rationality diagnostic that compares the air Inlet temperature sensor output signal to the average battery temperature of the six battery cell temperature sensors. This diagnostic gets one chance to run during a drive cycle after a specific vehicle off time.

Conditions for Running the DTC

P0AAD

- Ignition is RUN or CRANK
- Starter/generator control module off time is greater than six hours
- Starter/generator control module off time is not faulted (Starter/Generator Control Module internal clock diagnostic)
- None of the following DTCs are set: P0AAE, P0AAF, P0A9C, P0A9D, P0A9E, P0AC6, P0AC7, P0AC8, P0ACB, P0ACC, P0ACD, P0AEA, P0AEB, P0BC3, P0BC4, P0BC5, P0C34, P0C35, P0C36, P262B,

U0100, U182A

P0AAE and P0AAF

- Ignition OFF
- The 12 V battery voltage is greater than 8.8 V.
- DTC P1A5D is not set

Conditions for Setting the DTC

P0AAD

The air inlet temperature is more than 10°C (18°F) higher or lower than the average battery cell temperature

P0AAE

The air temperature sensor signal is greater than 87°C (188.6°F)

P0AAF

The air temperature sensor signal is less than -39°C (-38.2°F)

Action Taken When the DTC Sets

DTCs P0AAD, P0AAE, and P0AAF are type B DTCs

Conditions for Clearing the DTC

DTCs P0AAD, P0AAE, and P0AAF are type B DTCs

Reference Information

Schematic Reference

Hybrid/EV Cooling Schematics

Connector End View Reference

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Hybrid Cooling System Description and Operation

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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

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools .

Circuit/System Verification

1. Ignition ON
2. Verify the scan tool Battery Energy Control Module Hybrid Battery Inlet Air Temperature parameter is between -39° and 60°C (-38.2 and 140°F).
 - **If not between -39° and 60°C (-38.2 and 140°F)**

Refer to Circuit/System Testing below.
 - **If between -39° and 60°C (-38.2 and 140°F)**
3. Verify the scan tool Battery Energy Control Module Hybrid Battery Inlet Air Temperature parameter is within 10°C (18°F) of the average battery cell temperature.
 - **If not within 10°C (18°F) of the average battery cell temperature**

Refer to Circuit/System Testing below.
 - **If within 10°C (18°F) of the average battery cell temperature.**
4. 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.

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

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

1. Ignition OFF, disable the high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling .
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Disconnect the X2 harness connector at the K16 Battery Energy Control Module.
4. Test for 8-13k ohms at 19-24°C (66.2-75.2°F) between the signal circuit terminal 3 and the low reference circuit terminal 8.

- If not between 8-13k ohms

Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.

- If between 8-13k ohms

5. Replace the K16 Battery Energy Control Module.

Repair Instructions

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

- **Generator Battery Replacement**
- **Control Module References** for Battery Energy Control Module replacement, programming, and setup

DTC P0A7E

Diagnostic Instructions

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

DTC Descriptors

DTC P0A7E

Hybrid/EV Battery Pack High Temperature

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal - Terminal 2 X2	P0A9D	P0A9E	P0A9E	P0A9C
Low Reference - Terminal 7 X2	-	P0A9E	-	-
Signal - Terminal 1 X2	P0AC7	P0AC8	P0AC8	P0AC6
Low Reference - Terminal 6 X2	-	P0AC8	-	-
Signal - Terminal 4 X2	P0ACC	P0ACC	P0ACD	P0ACB
Low Reference - Terminal 9 X2	-	P0ACC	-	-
Signal - Terminal 2 X3	P0AEA	P0AEA	P0AEB	P0AE9
Low Reference - Terminal 7 X3	-	P0AEA	-	-
Signal - Terminal 1 X3	P0BC4	P0BC4	P0BC5	P0BC3
Low Reference - Terminal 6 X3	-	P0BC4	-	-
Signal - Terminal 4 X3	P0C35	P0C35	P0C36	P0C34
Low Reference - Terminal 9 X3	-	P0C35	-	-

Circuit/System Description

Six temperature sensors are used to monitor the battery temperature. The battery temperature sensors are located in the battery sections. Two of the temperature sensors are located on the top of the battery section and the remaining four are located on the bottom of the section. The temperature sensor is a variable resistor that measures the temperature of the battery cell group. The Battery Energy Control Module supplies 5 V to the signal circuit and a ground for the low reference circuit. The battery temperature sensor resistance changes with battery temperature. As the temperature decreases, the sensor resistance increases. As the temperature increases, the sensor resistance decreases.

Conditions for Running the DTC

- The Starter/Generator Control Module and Battery Energy Control Module are awake and communicating
- None of the following DTCs are set: P0A9C, P0A9D, P0A9E, P0AC6, P0AC7, P0AC8, P0ACB, P0ACC, P0ACD, P0AE9, P0AEA, P0AEB, P0B45, P0B46, P0B47, P0B48, P0B4F, P0B50, P0B51, P0B52, P0B63, P0B64, P0B65, P0B66, P0B95, P0B96, P0B97, P0B98, P0B9F, P0BA0, P0BA1, P0BA2, P0BC3, P0BC4, P0BC5, P0C34, P0C35, P0C36, or P1A5D

Conditions for Setting the DTC

The battery temperature as measured by the temperature sensors is greater than 72.3°C (162.1°F)

Action Taken When the DTC Sets

DTC P0A7E is a type B DTC

Conditions for Clearing the DTC

DTC P0A7E is a type B DTC

Reference Information

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Hybrid/EV Cooling Schematics

Connector End View 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

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Verification

1. Visually inspect the inlet and outlet of the Hybrid/EV Battery Pack Cooling Fan ducts.
2. Verify the inlet and outlet are free of any debris or obstructions that will limit airflow through the duct.
 - **If any debris or obstructions are found**

Remove the obstruction to allow proper airflow and allow the Hybrid/EV Battery Pack to cool before retesting.

- **If no debris or obstructions are found**

3. Verify the Hybrid/EV Battery Pack Cooling Fan ducts are properly secured and are not crimped, crushed, or deformed in a manner that will limit airflow through the duct.

- **If the ducts are unsecured or damaged**

Repair or replace as necessary and allow the Hybrid/EV Battery Pack to cool before retesting.

- **If the ducts are properly secured and undamaged**

4. Ignition ON.
5. Verify the scan tool Battery Energy Control Module Battery Temperature parameters are all be between -39° and 60°C (-38.2 and 140°F).
 - **If not between -39° and 60°C (-38.2 and 140°F)**

Refer to Circuit/System Testing below.

- **If between -39° and 60°C (-38.2 and 140°F)**

6. 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.

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

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

1. Ignition OFF, disable the high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling .
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Determine which battery temperature sensor is not between -39° and 60°C (-38.2 and 140°F) by

observing the scan tool Battery Energy Control Module Battery Temperature parameters.

4. Disconnect the X2 and X3 harness connectors at the K16 Battery Energy Control Module.
 5. Test for 8-13k ohms at 19-24°C (66.2-75.2°F) between the appropriate temperature sensor signal circuit terminal and the low reference circuit terminal listed below:
 - Temperature sensor 1 - Signal circuit terminal 2 X2 and low reference circuit terminal 7 X2
 - Temperature sensor 2 - Signal circuit terminal 1 X2 and low reference circuit terminal 6 X2
 - Temperature sensor 3 - Signal circuit terminal 4 X2 and low reference circuit terminal 9 X2
 - Temperature sensor 4 - Signal circuit terminal 2 X3 and low reference circuit terminal 7 X3
 - Temperature sensor 5 - Signal circuit terminal 1 X3 and low reference circuit terminal 6 X3
 - Temperature sensor 6 - Signal circuit terminal 4 X3 and low reference circuit terminal 9 X3
- **If not between 8-13k ohms**

Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.

- **If between 8-13k ohms**

6. Replace the K16 Battery Energy Control Module.

Repair Instructions

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

- **Generator Battery Replacement**
- **Control Module References** for Battery Energy Control Module replacement, programming, and setup

DRIVE MOTOR BATTERY COOLING BLOWER MALFUNCTION - DTC P0A81-P0A85, P0BC8-P0BCA, OR P0D64-P0D66

Diagnostic Instructions

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

DTC Descriptors

DTC P0A81

Hybrid/EV Battery Pack Cooling Fan Control Circuit

DTC P0A84

Hybrid/EV Battery Pack Cooling Fan Control Circuit Low Voltage

DTC P0A85

Hybrid/EV Battery Pack Cooling Fan Control Circuit High Voltage

DTC P0BC8

Hybrid/EV Battery Pack Cooling Fan Performance

DTC P0BC9

Hybrid/EV Battery Pack Cooling Fan Feedback Circuit Low Voltage

DTC P0BCA

Hybrid/EV Battery Pack Cooling Fan Feedback Circuit High Voltage

DTC P0D64

Hybrid/EV Battery Pack Cooling Fan Enable Circuit

DTC P0D65

Hybrid/EV Battery Pack Cooling Fan Enable Circuit Low Voltage

DTC P0D66

Hybrid/EV Battery Pack Cooling Fan Enable Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	P0A84	P0A84	-	-
Control	P0D65	P0D66	P0D66	P0D64
Signal Terminal 2	P0BC9	P0BC9	P0BCA	P0BC8
Signal Terminal 3	P0A84	P0A84	P0A85	P0A81
Ground	-	P0A84	-	-

Circuit/System Description

The hybrid/EV battery pack cooling fan draws air through the hybrid/EV battery pack to control the temperature of the hybrid/EV battery pack. To operate, the cooling fan receives an enable signal from the starter/generator control module. The enable control is controlled by a discrete high side driver in the starter/generator control module. When the enable control circuit is high, the fan will be enabled. The fan speed is controlled by a fan control circuit from the starter/generator control module, by changing the duty cycle. Maximum fan speed is 3900 RPM. Hybrid/EV battery pack cooling fan enable circuit open and short to voltage diagnostics run continuously until hybrid/EV battery pack cooling fan is enabled to run while short to ground runs after it is enabled to run. These diagnostics detect and report a failure of the fan enable circuits.

Conditions for Running the DTC

P0A81, P0A84, or P0A85

- Ignition is RUN or CRANK
- The hybrid/EV battery pack cooling fan is enabled

P0BC8

- Ignition is RUN or CRANK
- The hybrid/EV battery pack cooling fan is enabled
- 12 V battery voltage is greater than 10 V
- The hybrid/EV battery pack cooling fan is commanded between 11-90%
- The hybrid/EV battery pack cooling fan enable delay timer is greater than 9 s
- DTC P0A84, P0A85, P0BC9, P0BCA, P0C32, P0D65, or P0D66 is not set

P0BC9 or P0BCA

- Ignition is RUN or CRANK
- The hybrid/EV battery pack cooling fan is enabled
- 12 V battery voltage is greater than 10 V
- The hybrid/EV battery pack cooling fan is commanded between 11-90%
- The hybrid/EV battery pack cooling fan enable delay timer is greater than 9 s

P0D64 or P0D66

- Ignition is RUN or CRANK
- The hybrid/EV battery pack cooling fan is not enabled

P0D65

- Ignition is RUN or CRANK
- The hybrid/EV battery pack cooling fan is enabled

Conditions for Setting the DTC

P0A81

An open is detected on the hybrid/EV battery pack cooling fan speed control circuit

P0A84

A short to ground is detected on the hybrid/EV battery pack cooling fan speed control circuit

P0A85

A short to voltage is detected on the hybrid/EV battery pack cooling fan speed control circuit

P0BC8

There is a excessive difference between the commanded hybrid/EV battery pack cooling fan speed and the hybrid/EV battery pack cooling fan speed feedback signal

P0BC9

The hybrid/EV battery pack cooling fan speed feedback signal is less than 8 Hz

P0BCA

The hybrid/EV battery pack cooling fan speed feedback signal is greater than 280 Hz

P0D64

An open is detected on the hybrid/EV battery pack cooling fan enable control circuit

P0D65

A short to ground is detected on the hybrid/EV battery pack cooling fan enable control circuit

P0D66

A short to voltage is detected on the hybrid/EV battery pack cooling fan enable control circuit

Action Taken When the DTC Sets

DTCs P0A81, P0A84, P0A85, P0BC8, P0BC9, P0BCA, P0D64, P0D65, and P0D66 are type B DTCs

Conditions for Clearing the DTC

DTCs P0A81, P0A84, P0A85, P0BC8, P0BC9, P0BCA, P0D64, P0D65, and P0D66 are type B DTCs

Reference Information

Schematic Reference

Hybrid/EV Cooling 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

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Verification

1. Verify the actual G14 Hybrid/EV Battery Pack Cooling Fan speed increases and decreases when commanding the Hybrid/EV Battery Pack Cooling Fan with a scan tool.
 - **If the fan speed does not increase and decrease as commanded**

Refer to Circuit/System Testing below.
 - **If the fan speed increases and decreases as commanded**
2. Verify the scan tool Hybrid Powertrain Control Module 14V Power Module Fan Speed parameter increases and decreases when commanding the Hybrid/EV Battery Pack Cooling Fan with a scan tool.
 - **If the parameter does not increase and decrease as commanded**

Refer to Circuit/System Testing below.
 - **If the parameter increases and decreases as commanded**
3. 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.

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

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the G14 Hybrid/EV Battery Pack Cooling Fan. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms between the ground circuit terminal 1 and ground.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**

3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 5 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the G14 Hybrid/EV Battery Pack Cooling Fan.
 - **If the test lamp illuminates**
5. Connect a test lamp between the control circuit terminal 4 and ground.
6. Verify the test lamp turns ON when commanding the Hybrid/EV Battery Pack Cooling Fan with a scan tool and OFF when releasing the control.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, test the control circuit for a short to voltage.
 - If less than 1 V, replace the K59 Starter/Generator Control Module.
 - **If the test lamp turns ON and OFF**
7. Test for 4.8-5.2 V between the signal circuit terminal 2 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit

○ If less than 2 ohms, replace the K59 Starter/Generator Control Module.

○ **If greater than 5.2 V**

1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, test the signal circuit for a short to voltage.
 - If less than 1 V, replace the K59 Starter/Generator Control Module.

○ **If between 4.8-5.2 V**

8. Connect a 3 A fused jumper wire to the signal circuit terminal 2.
9. Verify the scan tool Hybrid Powertrain Control Module 14V Power Module Fan Speed parameter is greater than 0 RPM while rapidly tapping the jumper wire to ground.

○ **If 0 RPM**

Replace the K59 Starter/Generator Control Module

○ **If greater than 0 RPM**

10. Connect a test lamp between the signal circuit terminal 3 and B+.
11. Verify the test lamp becomes progressively dimmer as the fan speed is increased and progressively brighter as the fan speed is decreased when commanding the Hybrid/EV Battery Pack Cooling Fan with a scan tool.

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

1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, test the signal circuit for a short to voltage.
 - If less than 1 V
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.

○ **If the test lamp illuminates, but does not change in brightness**

1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K59 Starter/Generator Control Module.

○ **If the test lamp brightness changes as commanded**

12. Test or replace the G14 Hybrid/EV Battery Pack Cooling Fan.

Repair Instructions

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

- **Drive Motor Battery Cooling Blower Replacement**

- **Control Module References** for starter/generator control module replacement, programming, and setup.

DTC P0A9C-P0A9E, P0AC6-P0AC8, P0ACB-P0ACD, P0AE9-P0AEB, P0BC3-P0BC5, OR P0C34-P0C36

Diagnostic Instructions

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

DTC Descriptors

DTC P0A9C

Hybrid/EV Battery Temperature Sensor 1 Performance

DTC P0A9D

Hybrid/EV Battery Temperature Sensor 1 Circuit Low Voltage

DTC P0A9E

Hybrid/EV Battery Temperature Sensor 1 Circuit High Voltage

DTC P0AC6

Hybrid/EV Battery Temperature Sensor 2 Performance

DTC P0AC7

Hybrid/EV Battery Temperature Sensor 2 Circuit Low Voltage

DTC P0AC8

Hybrid/EV Battery Temperature Sensor 2 Circuit High Voltage

DTC P0ACB

Hybrid/EV Battery Temperature Sensor 3 Performance

DTC P0ACC

Hybrid/EV Battery Temperature Sensor 3 Circuit Low Voltage

DTC P0ACD

Hybrid/EV Battery Temperature Sensor 3 Circuit High Voltage

DTC P0AE9

Hybrid/EV Battery Temperature Sensor 4 Performance

DTC P0AEA

Hybrid/EV Battery Temperature Sensor 4 Circuit Low Voltage

DTC P0AEB

Hybrid/EV Battery Temperature Sensor 4 Circuit High Voltage

DTC P0BC3

Hybrid/EV Battery Temperature Sensor 5 Performance

DTC P0BC4

Hybrid/EV Battery Temperature Sensor 5 Circuit Low Voltage

DTC P0BC5

Hybrid/EV Battery Temperature Sensor 5 Circuit High Voltage

DTC P0C34

Hybrid/EV Battery Temperature Sensor 6 Performance

DTC P0C35

Hybrid/EV Battery Temperature Sensor 6 Circuit Low Voltage

DTC P0C36

Hybrid/EV Battery Temperature Sensor 6 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal - Terminal 2 X2	P0A9D	P0A9E	P0A9E	P0A9C
Low Reference - Terminal 7 X2	-	P0A9E	-	-
Signal - Terminal 1 X2	P0AC7	P0AC8	P0AC8	P0AC6

Low Reference - Terminal 6 X2	-	P0AC8	-	-
Signal - Terminal 4 X2	P0ACC	P0ACC	P0ACD	P0ACB
Low Reference - Terminal 9 X2	-	P0ACC	-	-
Signal - Terminal 2 X3	P0AEA	P0AEA	P0AEB	P0AE9
Low Reference - Terminal 7 X3	-	P0AEA	-	-
Signal - Terminal 1 X3	P0BC4	P0BC4	P0BC5	P0BC3
Low Reference - Terminal 6 X3	-	P0BC4	-	-
Signal - Terminal 4 X3	P0C35	P0C35	P0C36	P0C34
Low Reference - Terminal 9 X3	-	P0C35	-	-

Circuit/System Description

Six temperature sensors are used to monitor the battery temperature. The battery temperature sensors are located in the battery sections. Two of the temperature sensors are located on the top of the battery section and the remaining four are located on the bottom of the section. The temperature sensor is a variable resistor that measures the temperature of the battery cell group. The Battery Energy Control Module supplies 5 V to the signal circuit and a ground for the low reference circuit. The battery temperature sensor resistance changes with battery temperature. As the temperature decreases, the sensor resistance increases. As the temperature increases, the sensor resistance decreases.

Conditions for Running the DTC

P0A9C, P0AC6, P0ACB, P0AE9, P0BC3, and P0C34

- Starter/generator control module off time is greater than six hours
- Starter/generator control module off time is not faulted (Starter/Generator Control Module internal clock diagnostic)
- None of the following DTCs are set: P0A9D, P0A9E, P0AC7, P0AC8, P0ACC, P0ACD, P0AEA, P0AEB, P0B45, P0B46, P0B47, P0B48, P0B4F, P0BC4, P0BC5, P0C35, P0C63, or P1A5D

P0A9D, P0A9E, P0AC7, P0AC8, P0ACC, P0ACD, P0AEA, P0AEB, P0BC4, P0BC5, P0C35, and P0C36

- The 12 V battery voltage is greater than 8.8 V
- Battery energy control module is awake and communicating
- DTC P1A5D is not set

Conditions for Setting the DTC

P0A9C, P0AC6, P0ACB, P0AE9, P0BC3, and P0C34

The difference between a single battery temperature sensor and an average of the other battery temperature sensors is greater than 8.6°C (47.5°F)

P0A9D, P0AC7, P0ACC, P0AEA, P0BC4, and P0C35

The hybrid battery temperature sensor is greater than 87°C (188.2°F)

P0A9E, P0AC8, P0ACD, P0AEB, P0BC5, and P0C36

The hybrid battery temperature sensor is less than -39°C (-38.2°F)

Action Taken When the DTC Sets

DTCs P0A9C, P0A9D, P0A9E, P0AC6, P0AC7, P0AC8, P0ACB, P0ACC, P0ACD, P0AE9, P0AEA, P0AEB, P0BC3, P0BC4, P0BC5, P0C34, P0C35, and P0C36 are type B DTCs

Conditions for Clearing the DTC

DTCs P0A9C, P0A9D, P0A9E, P0AC6, P0AC7, P0AC8, P0ACB, P0ACC, P0ACD, P0AE9, P0AEA, P0AEB, P0BC3, P0BC4, P0BC5, P0C34, P0C35, and P0C36 are type B DTCs

Reference Information

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Hybrid/EV Cooling Schematics

Connector End View 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

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Battery Energy Control Module Battery Temperature parameters are all be between -39° and 60°C (-38.2 and 140°F).
 - If not between -39° and 60°C (-38.2 and 140°F)

Refer to Circuit/System Testing below.

- If between -39° and 60°C (-38.2 and 140°F)
3. 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.

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

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

1. Ignition OFF, disable the high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Determine which battery temperature sensor is not between -39° and 60°C (-38.2 and 140°F) by observing the scan tool Battery Energy Control Module Battery Temperature parameters.
4. Disconnect the X2 and X3 harness connectors at the K16 Battery Energy Control Module.
5. Test for 8-13k ohms at 19-24°C (66.2-75.2°F) between the appropriate temperature sensor signal circuit terminal and the low reference circuit terminal listed below:
 - Temperature sensor 1 - Signal circuit terminal 2 X2 and low reference circuit terminal 7 X2
 - Temperature sensor 2 - Signal circuit terminal 1 X2 and low reference circuit terminal 6 X2
 - Temperature sensor 3 - Signal circuit terminal 4 X2 and low reference circuit terminal 9 X2
 - Temperature sensor 4 - Signal circuit terminal 2 X3 and low reference circuit terminal 7 X3
 - Temperature sensor 5 - Signal circuit terminal 1 X3 and low reference circuit terminal 6 X3
 - Temperature sensor 6 - Signal circuit terminal 4 X3 and low reference circuit terminal 9 X3
 - **If not between 8-13k ohms**

Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.

- **If between 8-13k ohms**

6. Replace the K16 Battery Energy Control Module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Generator Battery Replacement
- Control Module References for Battery Energy Control Module replacement, programming, and setup

DTC P0C32

Diagnostic Instructions

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

DTC Descriptor

DTC P0C32

Hybrid/EV Battery Pack Cooling System Performance

Circuit/System Description

The Hybrid/EV Battery Pack Cooling Fan draws air through the Hybrid/EV Battery Pack to control the temperature of the Hybrid/EV Battery Pack. To operate, the cooling fan receives an enable signal from the Starter/Generator Control Module. The enable control is controlled by a discrete high side driver in the Starter/Generator Control Module. When the enable control circuit is high, the fan will be enabled. The fan speed is controlled by a fan control circuit in the Starter/Generator Control Module, by changing the duty cycle. Maximum fan speed is 3900 RPM.

The Hybrid/EV Battery Pack cooling system consists of the Hybrid/EV Battery Pack Cooling Fan pulling air through a set of porous ducts within the Hybrid/EV Battery Pack. These ducts direct air through the Hybrid/EV Battery Sections and under the Starter/Generator Control Module, where the air passes by various heat sinks and cavities to cool the internal electronic components. The performance diagnostic for the hybrid battery pack cooling fan is a functional check for the fan. The fan control feature uses the outcome of this diagnostic to take emissions related remedial actions. The Hybrid/EV Battery Pack cooling system performance diagnostic determines if the cooling system is providing the expected amount of conditioning. The Hybrid/EV Battery Pack Cooling Fan not spinning at the commanded speed or a blocked duct are examples of conditions of reduced performance.

The Starter/Generator Control Module uses a temperature model to predict the temperature of the 14 volt power module, an internal electronic component of the Starter/Generator Control Module. The Starter/Generator Control Module compares this predicted temperature to the 14 volt power module temperature sensor 1. With the Hybrid/EV Battery Pack Cooling Fan operating, the predicted 14 volt power module temperature and the 14 volt power module temperature sensor 1 should be nearly the same.

Conditions for Running the DTC

- Ignition is RUN or CRANK
- No power mode DTCs are set
- None of the following DTCs are set: P0A81, P0A84, P0A85, P0A88, P0A89, P0AAD, P0AAE, P0AAF, P0D64, P0D65, P0D66, P1A90, P1A92, P1AE8, P1AE9, P1AEC, U182A
- Hybrid battery pack temperature is greater than -10°C (14°F)

- The battery pack inlet temperature sensor is greater than -10°C (14°F)
- The battery pack cooling fan speed is greater than 29%
- 14 volt power module power is greater than 0.1 Kwatt
- The number of non-faulted battery cell temperature sensors is greater than 4
- Propulsion system is active for a minimum of 150 seconds
- Within the past 180 seconds, the 14 volt power module power has not changed more than 0.6 Kwatts over a time of 30 seconds

Conditions for Setting the DTC

The predicted temperature of the Hybrid/EV Battery Pack is more than 15°C (27°F) higher or lower than the actual measured 14 volt power module temperature sensor 1

Action Taken When the DTC Sets

DTC P0C32 is a type B DTC

Conditions for Clearing the DTC

DTC P0C32 is a type B DTC

Reference Information

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Hybrid/EV Cooling Schematics

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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.

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

1. Visually inspect the inlet and outlet of the Hybrid/EV Battery Pack Cooling Fan ducts.
2. Verify the inlet and outlet are free of any debris or obstructions that will limit airflow through the duct.
 - **If any debris or obstructions are found**

Remove the obstruction to allow proper airflow and allow the Hybrid/EV Battery Pack to cool before retesting.

- **If no debris or obstructions are found**

3. Verify the Hybrid/EV Battery Pack Cooling Fan ducts are properly secured and are not crimped, crushed, or deformed in a manner that will limit airflow through the duct.
 - **If the ducts are unsecured or damaged**

Repair or replace as necessary and allow the Hybrid/EV Battery Pack to cool before retesting.

- **If the ducts are properly secured and undamaged**

4. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the G14 Hybrid/EV Battery Pack Cooling Fan. It may take up to 2 minutes for all vehicle systems to power down.
5. Test for less than 10 ohms between the ground circuit terminal 1 and ground.

- **If 10 ohms or greater**

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

- **If less than 10 ohms**

6. Ignition ON.
7. Verify a test lamp illuminates between the B+ circuit terminal 5 and ground.

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

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

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

1. Ignition OFF.
2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the G14 Hybrid/EV Battery Pack Cooling Fan.

- **If the test lamp illuminates**

8. Verify that the Hybrid/EV Battery Pack Cooling Fan speed increases and decreases as the Hybrid Battery Fan Speed is commanded from 10%-90% with a scan tool.
 - **If the fan speed does not change**

Replace the G14 Hybrid/EV Battery Pack Cooling Fan.

- **If the fan speed changes**

9. Monitor the airflow at the intake duct and outlet duct while commanding the Hybrid Battery Fan Speed from 10%-90% with a scan tool. The actual airflow should increase as the fan speed is increased.

- **If the airflow does not increase**

1. Ignition OFF, disable the high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.
2. Remove any debris or obstructions that may limit airflow in the cooling ducts through the A4 Hybrid/EV Battery Pack and the heat sink under the K59 Starter/Generator Control Module.

- **If the airflow increases**

10. Verify the scan tool Battery Energy Control Module Battery Temperature parameters are all between -39° and 60°C (-38.2 and 140°F).

- **If not between -39° and 60°C (-38.2 and 140°F)**

Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.

- **If between -39° and 60°C (-38.2 and 140°F)**

11. All OK.

Repair Instructions

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

- **Generator Battery Replacement**
- **Drive Motor Battery Cooling Blower Outlet Duct Replacement**
- **Drive Motor Battery Cooling Air Outlet Duct Replacement**
- **Drive Motor Battery Cooling Air Inlet Upper Duct Replacement**
- **Drive Motor Battery Cooling Blower Replacement**
- **Control Module References** for Starter/Generator Control Module replacement, programming, and setup

DTC P0CBD-P0CBF

Diagnostic Instructions

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

DTC Descriptors

DTC P0CBD

Drive Motor Coolant Temperature Sensor Performance

DTC P0CBE

Drive Motor Coolant Temperature Sensor Circuit Low Voltage

DTC P0CBF

Drive Motor Coolant Temperature Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0CBE	P0CBF	P0CBF	P0CBD
Low Reference	-	P0CBF	-	-

Circuit/System Description

The hybrid electronics coolant temperature sensor is a variable resistor that measures the temperature of the starter/generator coolant. The Starter/Generator Control Module supplies 5 V to the signal circuit and a ground for the low reference circuit. The hybrid electronics coolant temperature sensor resistance changes with starter/generator coolant temperature. As the temperature decreases, the sensor resistance increases. As the temperature increases, the sensor resistance decreases. The Starter/Generator Control Module monitors the hybrid electronics coolant temperature sensor to determine the temperature of the starter/generator coolant. As the coolant temperature changes, the Starter/Generator Control Module will turn the Starter/Generator Control Module coolant pump ON or OFF to accommodate the starter/generator cooling requirements.

The Starter/Generator Control Module performs a rationality diagnostic that compares the hybrid electronics coolant temperature sensor signal to the average temperature of the starter/generator stator, engine intake air temperature, and transmission fluid temperature. This diagnostic gets one chance to run during a drive cycle after a specific vehicle OFF time.

Conditions for Running the DTC

P0CBD

- Ignition is RUN or CRANK
- Engine off time is greater than six hours
- Starter/generator control module internal clock diagnostic is not faulted
- None of the following DTCs are set: P0111, P0112, P0113, P0114, P0711, P0712, P0713, P0A2B, P0A2C, P0A2D, P0CBF, POCBE, P262B, U0100, U0101

P0CBE or P0CBF

- Ignition is RUN or CRANK
- Starter/generator control module internal coolant temperature monitoring and diagnostics are enabled

Conditions for Setting the DTC

P0CBD

The hybrid electronics coolant temperature sensor is more than 25°C (45°F) higher or lower than the average temperature of the starter/generator stator, engine intake air temperature, and transmission fluid temperature.

P0CBE

The drive motor coolant temperature sensor resistance is less than 100.7 ohms.

P0CBF

The drive motor coolant temperature sensor resistance is greater than 176, 962 ohms.

Action Taken When the DTC Sets

DTC P0CBD-P0CBF are type B DTCs

Conditions for Clearing the DTC

DTC P0CBD-P0CBF are type B DTCs

Reference Information

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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. Verify the coolant level of the starter/generator cooling system is normal.
 - o **If the coolant level is low**

Inspect the starter/generator cooling system for any leaks.
 - o **If the coolant level is normal**
2. Verify the starter/generator cooling system auxiliary radiator is clear of any debris, bent fins, or other damage which may inhibit airflow.
 - o **If debris are found**

Clean the auxiliary radiator.
 - o **If damage is found**

Replace the auxiliary radiator.
 - o **If no damage or debris are found**
3. Verify the starter/generator cooling system hoses are properly routed and are not kinked.
 - o **If any hoses are improperly routed or kinked**

Removed and properly route the hose.
 - o **If all hoses are routed properly and are not kinked**
4. Ignition ON.
5. Verify the scan tool Motor A Coolant Temperature Sensor parameter is between -40°C and 85°C.
 - o **If not between -40°C and 85°C**

Refer to Circuit/System Testing below.
 - o **If between -40°C and 85°C**
6. 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.

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

1. Ignition OFF, disconnect the harness connector at the B235 Starter/Generator Coolant Temperature Sensor.
2. Test for less than 10 ohms between the low reference circuit terminal B and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
 2. Test for less than 2 ohms between the low reference circuit terminal B and ground.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If less than 10 ohms**

3. Ignition ON.
4. Test for 4.8-5.2 V between the signal circuit terminal A and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, test the signal circuit for a short to voltage.
 - If less than 1 V, replace the K59 Starter/Generator Control Module.
 - **If between 4.8-5.2 V**
5. Test or replace the B235 Starter/Generator Coolant Temperature Sensor.

Repair Instructions

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

- **Auxiliary Radiator Replacement** - Hybrid/EV battery pack coolant temperature sensor 1 replacement
- **Control Module References** for Starter/Generator Control Module replacement, programming, and setup

GENERATOR CONTROL MODULE COOLANT PUMP MALFUNCTION - DTC P0CC1-P0CC4

Diagnostic Instructions

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

DTC Descriptors

DTC P0CC1

Drive Motor Coolant Pump Control Circuit

DTC P0CC2

Drive Motor Coolant Pump Performance

DTC P0CC3

Drive Motor Coolant Pump Control Circuit Low Voltage

DTC P0CC4

Drive Motor Coolant Pump Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Switch B+	1	1	-	-
Relay Coil Ignition	1	1	-	-
Relay Coil Control	P0CC3	P0CC1	P0CC4	-
Relay Switch Control	2	1	1	-
Component Ground	-	1	-	-
1. Starter/generator control module coolant pump inoperative 2. Starter/generator control module coolant pump always on				

Circuit/System Description

The Starter/Generator Control Module coolant pump is a single speed ON/OFF pump that circulates coolant through the auxiliary radiator and the starter/generator to control the temperature of the starter/generator. The starter/generator cooling system is separate from the engine cooling system and does not share any coolant or components. The Starter/Generator Control Module coolant pump is controlled by the starter/generator coolant pump relay. This relay is a printed circuit board relay and integrated as part of the underhood fuse block. The relay switch and coil both receive B+. The Starter/Generator Control Module controls the relay coil by applying ground to the coil control circuit. With the coil grounded, the relay switch is closed and voltage is sent to the Starter/Generator Control Module coolant pump, which will begin circulating coolant.

The Starter/Generator Control Module uses the exponentially weighted moving average to calculate temperature fluctuations in the starter/generator cooling system. In addition, this diagnostic compares the temperature rate of change by a slope calculation within a set time when the Starter/Generator Control Module coolant pump turns ON. This diagnostic runs once after pump turns ON. If the temperature changes over time too quickly, the Starter/Generator Control Module will indicate a fault.

Conditions for Running the DTC

P0CC1 or P0CC3

- Ignition is RUN or CRANK
- Starter/generator control module coolant pump control is inactive

P0CC2

- Ignition is RUN or CRANK
- 12 V battery voltage is greater than 10 V
- Starter/generator control module coolant pump control is active
- DTC P0A2B, P0A2C, P0A2D, P0CC1, P0CC3, P0CC4, P0CBD, P0CBE, or P0CBF is not set
- The predicted difference between the coolant temperature in the starter/generator and the coolant temperature as measured by the hybrid electronics coolant temperature sensor is greater than 17°C (31°F)

P0CC4

- Ignition is RUN or CRANK
- Starter/generator control module coolant pump control is active

Conditions for Setting the DTC

P0CC1

An open is detected on the starter/generator coolant pump relay control circuit.

P0CC2

The coolant temperature is 0.25°C/s greater than the maximum cooling system performance temperature.

P0CC3

A short to ground is detected on the starter/generator coolant pump relay control circuit.

P0CC4

A short to voltage is detected on the starter/generator coolant pump relay control circuit.

Action Taken When the DTC Sets

DTCs P0CC1, P0CC2, P0CC3, and P0CC4 are type B DTCs

Conditions for Clearing the DTC

DTCs P0CC1, P0CC2, P0CC3, and P0CC4 are type B DTCs

Reference Information

Schematic Reference

Hybrid/EV Cooling Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Hybrid Cooling 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. Verify the coolant level of the starter/generator cooling system is normal.
 - **If the coolant level is low**

Inspect the starter/generator cooling system for any leaks.
 - **If the coolant level is normal**
2. Verify the starter/generator cooling system auxiliary radiator is clear of any debris, bent fins, or other damage which may inhibit airflow.
 - **If debris are found**

Clean the auxiliary radiator.
 - **If damage is found**

Replace the auxiliary radiator.
 - **If the coolant level is normal**

3. Verify the starter/generator cooling system hoses are properly routed and are not kinked.

- **If any hoses are improperly routed or kinked**

Remove and properly route the hose.

- **If all hoses are routed properly and are not kinked**

4. Ignition ON.

5. Verify the G43 Starter/Generator Coolant Pump turns ON and OFF when commanding the Motor Coolant Pump Relay Enable ON and OFF with a scan tool. The G22 Starter/Generator Control Module coolant pump will make an audible noise during operation.

- **If the G43 Starter/Generator Coolant Pump does not turn ON and OFF**

Refer to Circuit/System Testing below.

- **If the G43 Starter/Generator Coolant Pump turns ON and OFF**

6. 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.

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

1. Ignition OFF, disconnect the X2 harness connector at the K50A Fuse Block - Underhood.
2. Connect a test lamp between the control circuit terminal 11 and B+, ignition ON.
3. Verify the test lamp turns ON and OFF when commanding the Motor Coolant Pump Relay Enable ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K59 Starter/Generator Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF.
 4. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K59 Starter/Generator Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K59 Starter/Generator Control Module.
 - **If the test lamp turns ON and OFF**
 - 4. Ignition OFF and all vehicle systems OFF, connect the X2 harness connector at the K50A Fuse Block - Underhood. Disconnect the harness connector at the G43 Starter/Generator Coolant Pump. It may take up to 2 minutes for all vehicle systems to power down.
 - 5. Test for less than 10 ohms between the ground circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
 - 6. Connect a test lamp between the control circuit terminal 1 and ground.
 - 7. Verify the test lamp turns ON and OFF when commanding the Motor Coolant Pump Relay Enable ON

and OFF with a scan tool.

- **If the test lamp is always OFF and the circuit fuse is good**

1. Ignition OFF, disconnect the X2 harness connector at the X50A Fuse Block - Underhood.
2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the X50A Fuse Block - Underhood.

- **If the test lamp is always OFF and the circuit fuse is open**

1. Ignition OFF.
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, test or replace the G43 Starter/Generator Coolant Pump.

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

1. Ignition OFF, disconnect the X2 harness connector at the X50A Fuse Block - Underhood, ignition ON.
2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the X50A Fuse Block - Underhood.

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

8. Test or replace the G43 Starter/Generator Coolant Pump.

Repair Instructions

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

- **Generator Control Module Coolant Pump Replacement**
- **Control Module References** for Starter/Generator Control Module replacement, programming, and setup

REPAIR INSTRUCTIONS

COOLANT RECOVERY RESERVOIR BRACKET REPLACEMENT

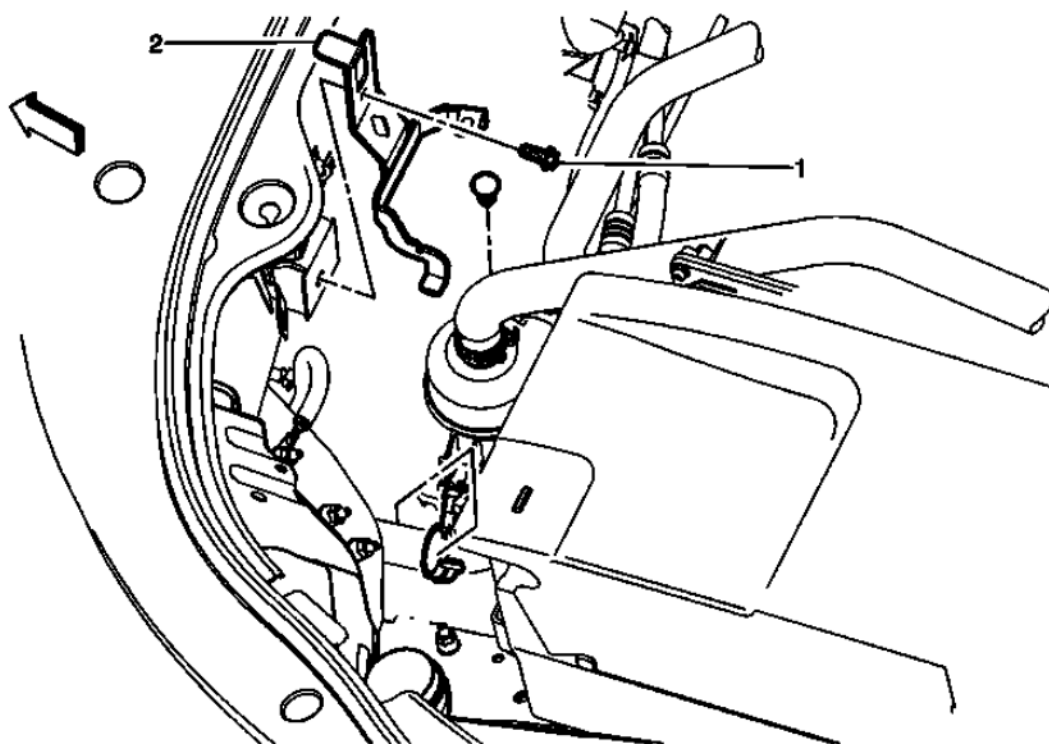


Fig. 3: Coolant Recovery Reservoir Bracket
 Courtesy of GENERAL MOTORS COMPANY

Coolant Recovery Reservoir Bracket Replacement

Callout	Component Name
Preliminary Procedure Remove the drive motor battery cool air separator from the bracket without disconnecting any hoses. Refer to <u>Drive Motor Battery Coolant/Air Separator Replacement</u> .	
1	Coolant Recovery Reservoir Fastener CAUTION: Refer to <u>Fastener Caution</u> .
2	Coolant Recovery Reservoir Bracket

AUXILIARY RADIATOR REPLACEMENT

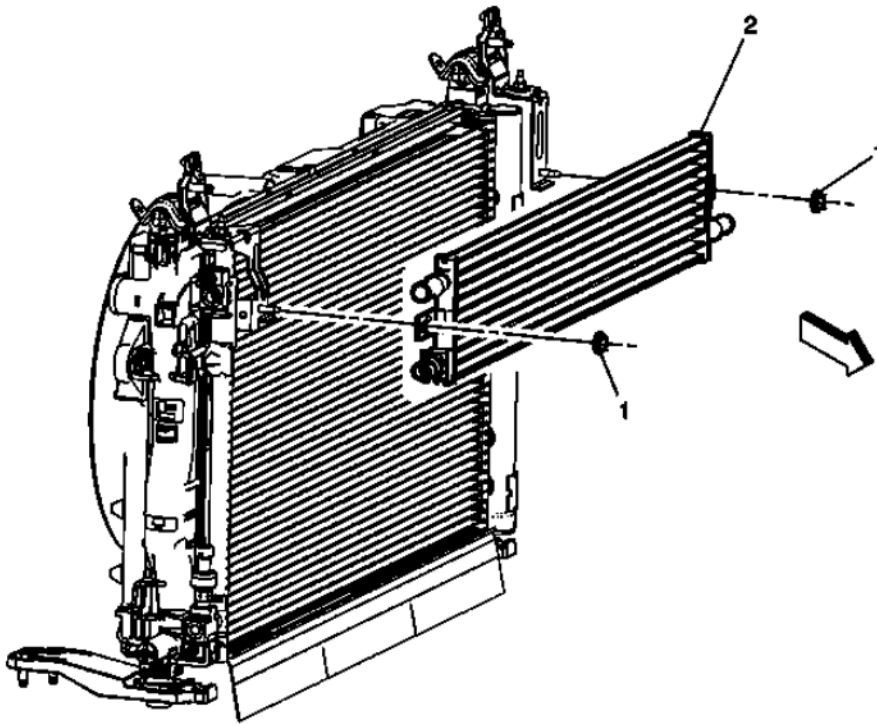


Fig. 4: Auxiliary Radiator & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Auxiliary Radiator Replacement

Callout	Component Name
Preliminary Procedures 1. Drain the engine cooling system. Refer to Cooling System Draining and Filling (GE 47716) , Cooling System Draining and Filling (Static Fill) . 2. Remove the front intake air duct deflector. Refer to Front Intake Air Duct Deflector Replacement . 3. Remove the auxiliary radiator inlet hose from the auxiliary cooler. Refer to Auxiliary Radiator Inlet Hose Replacement. 4. Remove the auxiliary radiator outlet hose from the auxiliary cooler. Refer to Auxiliary Radiator Outlet Hose Replacement.	
1	Auxiliary Radiator Nut (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 9 (80 lb in)
	Auxiliary Radiator Assembly

Procedures

2

1. Level the engine coolant to the proper level. Refer to Cooling System Draining and Filling (GE 47716) , Cooling System Draining and Filling (Static Fill) .
2. Inspect for engine coolant leaks.

RADIATOR SIDE MOUNT BRACKET REPLACEMENT - LEFT SIDE

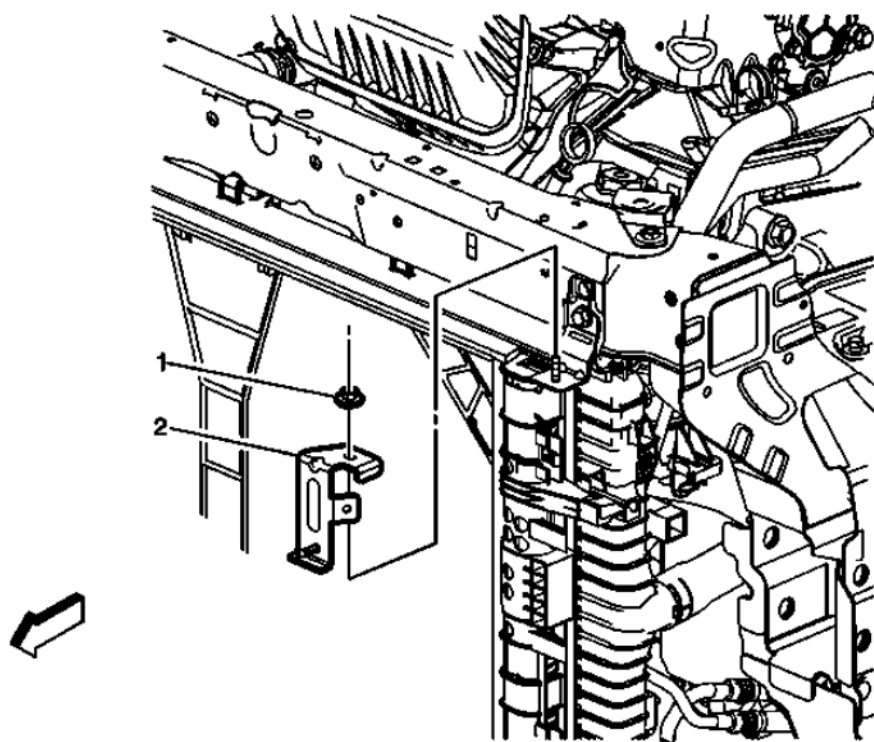


Fig. 5: Radiator Side Mount Bracket - Left Side
Courtesy of GENERAL MOTORS COMPANY

Radiator Side Mount Bracket Replacement - Left Side

Callout	Component Name
Preliminary Procedure Without disconnecting the cooler lines, remove the fasteners securing the auxiliary radiator to the brackets and reposition the auxiliary radiator out of the way. Refer to <u>Auxiliary Radiator Replacement</u> .	
1	Radiator Side Mount Bracket-Left Side Fastener (Qty: 1) CAUTION: Refer to <u>Fastener Caution</u> .
2	Radiator Side Mount Bracket

RADIATOR SIDE MOUNT BRACKET REPLACEMENT - RIGHT SIDE

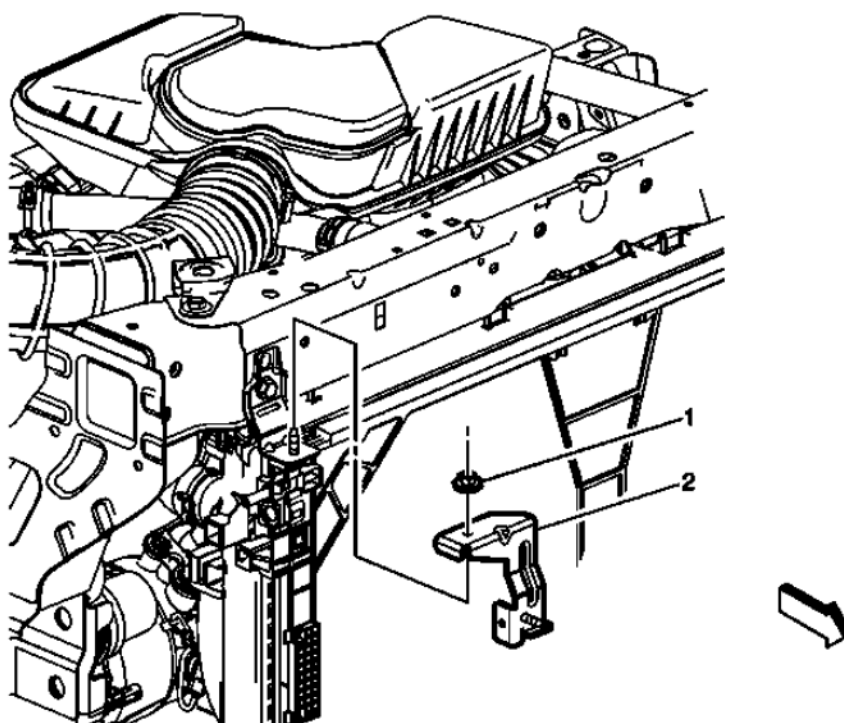


Fig. 6: Radiator Side Mount Bracket - Right Side
Courtesy of GENERAL MOTORS COMPANY

Radiator Side Mount Bracket Replacement - Right Side

Callout	Component Name
Preliminary Procedure Without disconnecting the cooler lines, remove the fasteners securing the auxiliary radiator to the brackets and reposition the auxiliary radiator out of the way. Refer to <u>Auxiliary Radiator Replacement</u> .	
1	Radiator Side Mount Bracket - Right Side Fastener CAUTION: Refer to <u>Fastener Caution</u> .
2	Radiator Side Mount Bracket

AUXILIARY RADIATOR INLET HOSE REPLACEMENT

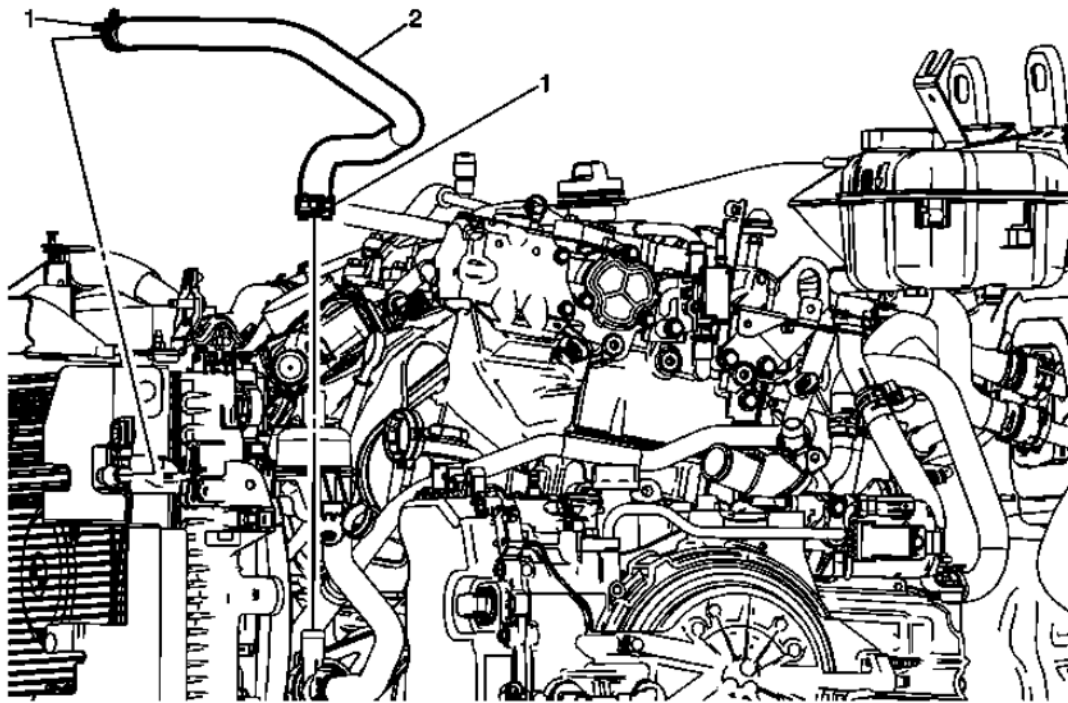


Fig. 7: Auxiliary Radiator Inlet Hose & Clamps
 Courtesy of GENERAL MOTORS COMPANY

Auxiliary Radiator Inlet Hose Replacement

Callout	Component Name
Preliminary Procedures 1. Drain the engine cooling system. Refer to <u>Cooling System Draining and Filling (GE 47716)</u> , <u>Cooling System Draining and Filling (Static Fill)</u> . 2. Remove the front intake air duct deflector. Refer to <u>Front Intake Air Duct Deflector Replacement</u> . 3. Remove the radiator air upper baffle and deflector. Refer to <u>Radiator Air Upper Baffle and Deflector Replacement (LUK)</u> , <u>Radiator Air Upper Baffle and Deflector Replacement (LCV, LTG)</u> .	
1	Auxiliary Radiator Inlet Hose Clamp (Qty: 2) Procedure Reposition the auxiliary radiator inlet hose clamp using the BO-38185 hose clamp pliers. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
	Auxiliary Radiator Inlet Hose Procedures

2

1. Level the engine coolant to the proper level. Refer to **Cooling System Draining and Filling (GE 47716)** , **Cooling System Draining and Filling (Static Fill)** .
2. Inspect for engine coolant leaks.

AUXILIARY RADIATOR OUTLET HOSE REPLACEMENT

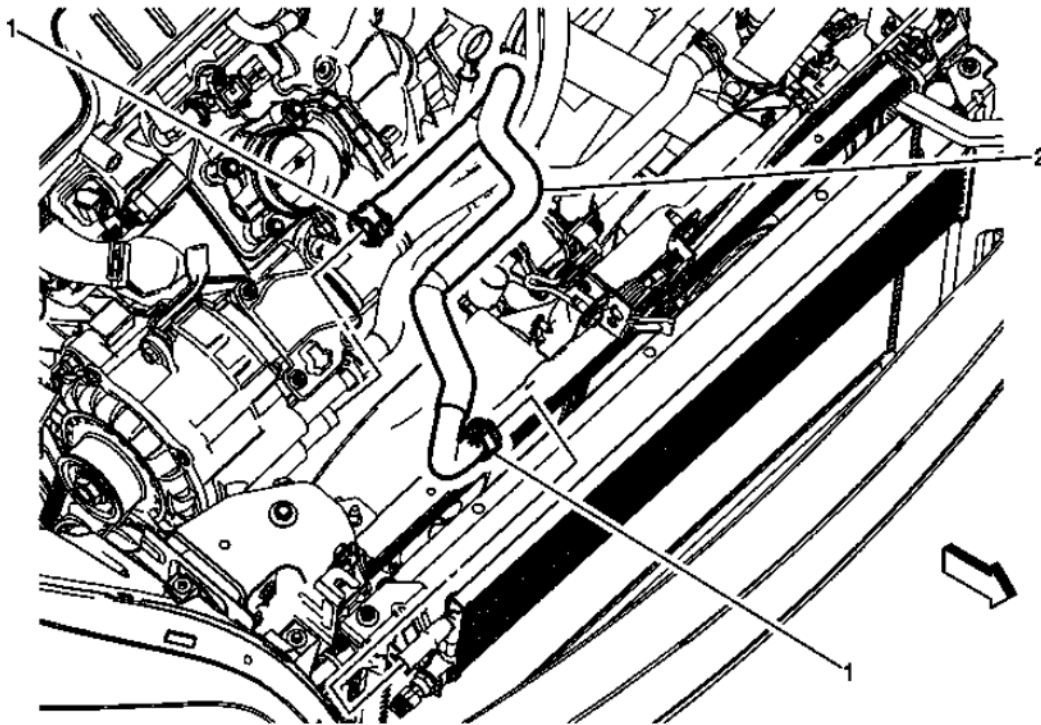


Fig. 8: Auxiliary Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

Auxiliary Radiator Outlet Hose Replacement

Callout	Component Name
Preliminary Procedures	
1. Drain the engine cooling system. Refer to Cooling System Draining and Filling (GE 47716) , Cooling System Draining and Filling (Static Fill) . 2. Remove the front intake air duct deflector. Refer to Front Intake Air Duct Deflector Replacement . 3. Remove the radiator air upper baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement (LUK) , Radiator Air Upper Baffle and Deflector Replacement (LCV, LTG) . 4. Remove the air cleaner outlet duct assembly. Refer to Air Cleaner Outlet Duct Replacement .	
	Auxiliary Radiator Outlet Hose Clamp (Qty: 2)
Procedure	

1	Reposition the auxiliary radiator outlet hose clamp using the BO-38185 hose clamp pliers. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Auxiliary Radiator Outlet Hose Procedures 1. Route the auxiliary radiator outlet hose out of between the front end upper tie bar and the radiator assembly. 2. Route the NEW auxiliary radiator outlet hose back between the front end upper tie bar and the radiator assembly. 3. Level the engine coolant to the proper level. Refer to Cooling System Draining and Filling (GE 47716) , Cooling System Draining and Filling (Static Fill) . 4. Inspect for engine coolant leaks.

DRIVE MOTOR GENERATOR CONTROL MODULE COOLANT PUMP HOSE REPLACEMENT

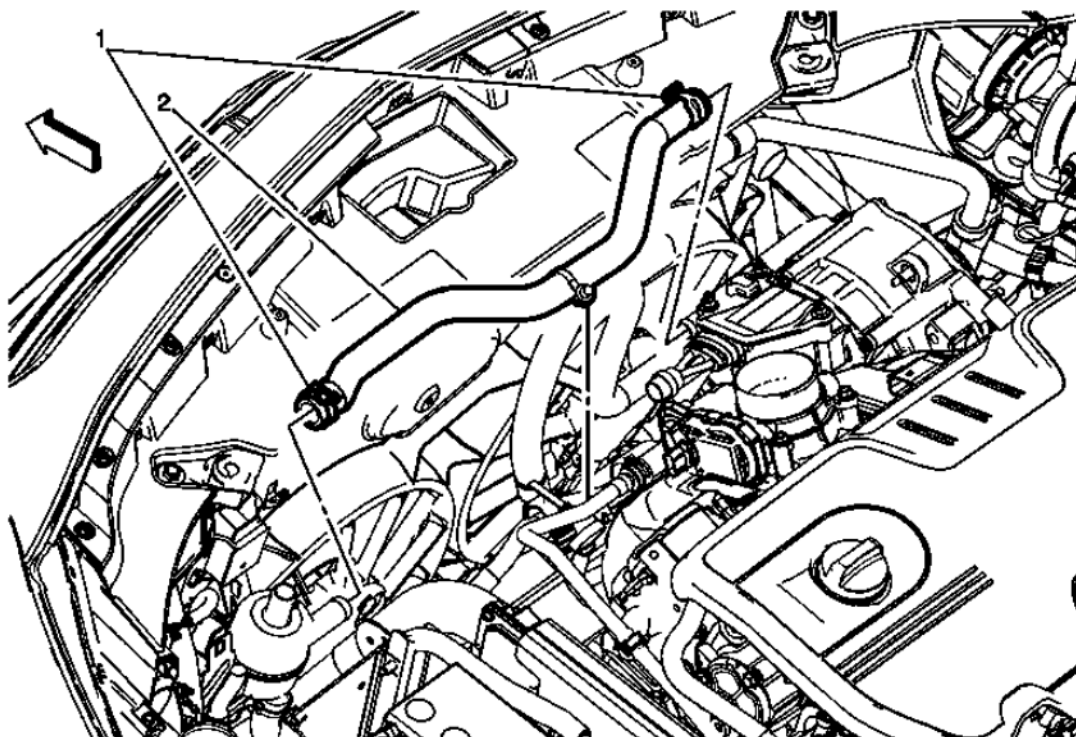


Fig. 9: Drive Motor Generator Control Module Coolant Pump Hose
Courtesy of GENERAL MOTORS COMPANY

Drive Motor Generator Control Module Coolant Pump Hose Replacement

Callout	Component Name
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Preliminary Procedures

1. Drain the engine cooling system. Refer to **Cooling System Draining and Filling (GE 47716)** , **Cooling System Draining and Filling (Static Fill)** .
2. Remove the air cleaner outlet duct assembly. Refer to **Air Cleaner Outlet Duct Replacement** .

1	Drive Motor Generator Control Module Coolant Pump Hose Clamp (Qty: 2) Procedure Reposition the drive motor generator control module coolant pump hose clamp using the BO-38185 hose clamp pliers. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
2	Drive Motor Generator Control Module Coolant Pump Hose Procedure 1. Release the drive motor generator control module coolant pump hose from the retainer. 2. Level the engine coolant to the proper level. Refer to <u>Cooling System Draining and Filling (GE 47716)</u> , <u>Cooling System Draining and Filling (Static Fill)</u> 3. Inspect for engine coolant leaks.

DRIVE MOTOR GENERATOR CONTROL MODULE COOLING OUTLET HOSE REPLACEMENT

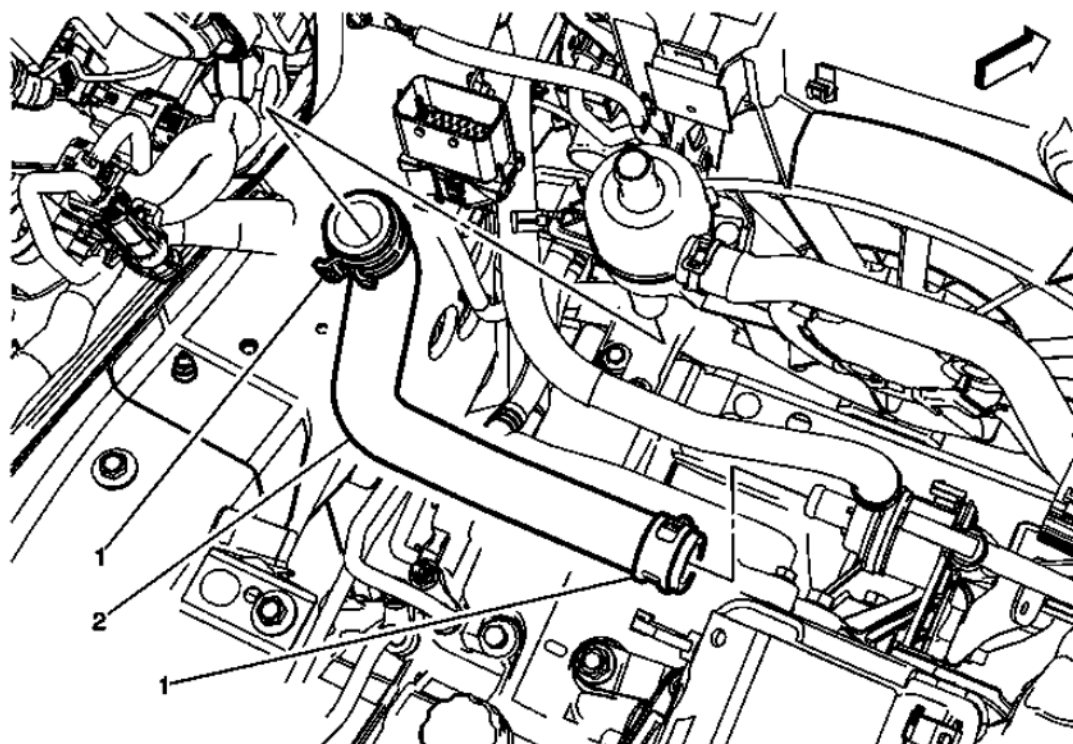


Fig. 10: Drive Motor Generator Control Module Cooling Outlet Hose
 Courtesy of GENERAL MOTORS COMPANY

Drive Motor Generator Control Module Cooling Outlet Hose Replacement

Callout	Component Name
Preliminary Procedures	
1. Drain the engine cooling system. Refer to <u>Cooling System Draining and Filling (GE 47716)</u> , <u>Cooling System Draining and Filling (Static Fill)</u> . 2. Remove the air cleaner outlet duct assembly. Refer to <u>Air Cleaner Outlet Duct Replacement</u> .	
1	Drive Motor Generator Control Module Coolant Outlet Hose Clamp (Qty: 2) Procedure Reposition the drive motor generator control module coolant outlet hose clamp using the BO-38185 hose clamp pliers. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
2	Drive Motor Generator Control Module Coolant Outlet Hose Procedure 1. Level the engine coolant to the proper level. Refer to <u>Cooling System Draining and Filling (GE 47716)</u> , <u>Cooling System Draining and Filling (Static Fill)</u>

2. Inspect for engine coolant leaks.

GENERATOR CONTROL MODULE COOLANT PUMP REPLACEMENT

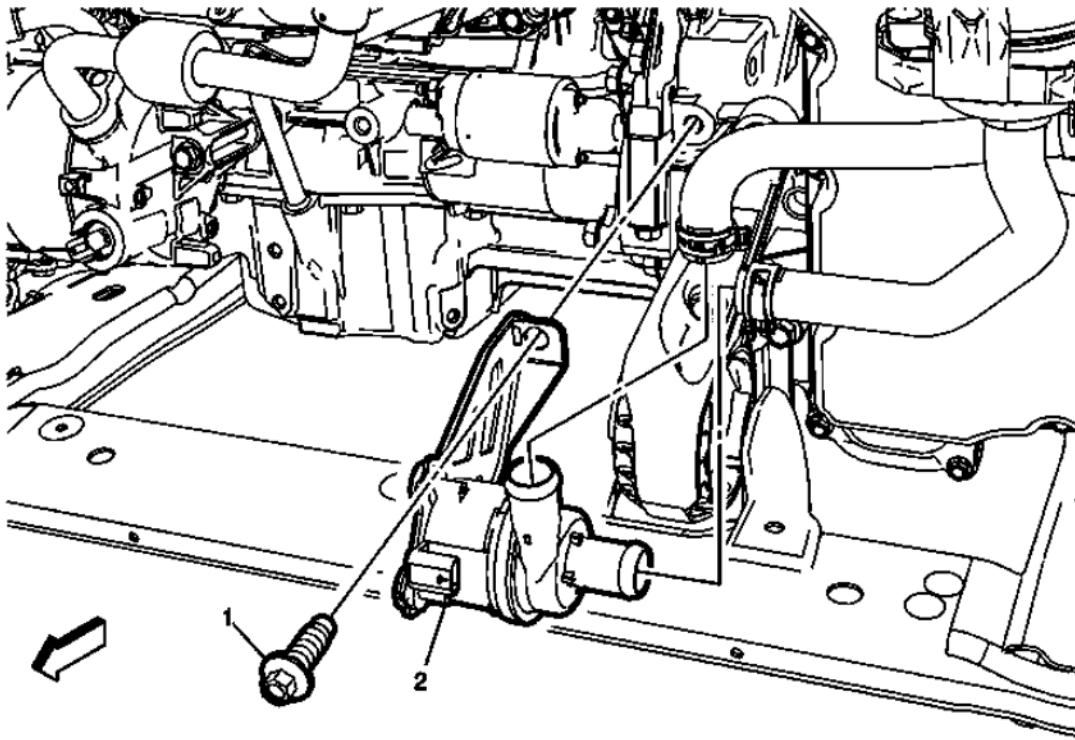


Fig. 11: Generator Control Module Coolant Pump
Courtesy of GENERAL MOTORS COMPANY

Generator Control Module Coolant Pump Replacement

Callout	Component Name
Preliminary Procedures	
1. Drain the engine cooling system. Refer to Cooling System Draining and Filling (GE 47716) , Cooling System Draining and Filling (Static Fill) . 2. Remove the air cleaner outlet duct assembly. Refer to Air Cleaner Outlet Duct Replacement . 3. Remove the auxiliary radiator inlet hose from the generator control module coolant pump. Refer to Auxiliary Radiator Inlet Hose Replacement . 4. Remove the generator control module coolant pump hose coming from the driver motor battery coolant air separator from the generator control module coolant pump assembly. Refer to Drive Motor Generator Control Module Coolant Pump Hose Replacement .	
1	Generator Control Module Coolant Pump Bracket Bolt CAUTION: Refer to Fastener Caution .

	Tighten to 22 (16 lb ft)
2	Generator Control Module Coolant Pump - (Auxiliary Water Pump) Procedure 1. Disconnect the generator control module coolant pump connector. 2. Level the engine coolant to the proper level. Refer to <u>Cooling System Draining and Filling (GE 47716)</u> , <u>Cooling System Draining and Filling (Static Fill)</u> . 3. Inspect for engine coolant leaks.

HEATER COOLANT PUMP HOSE REPLACEMENT

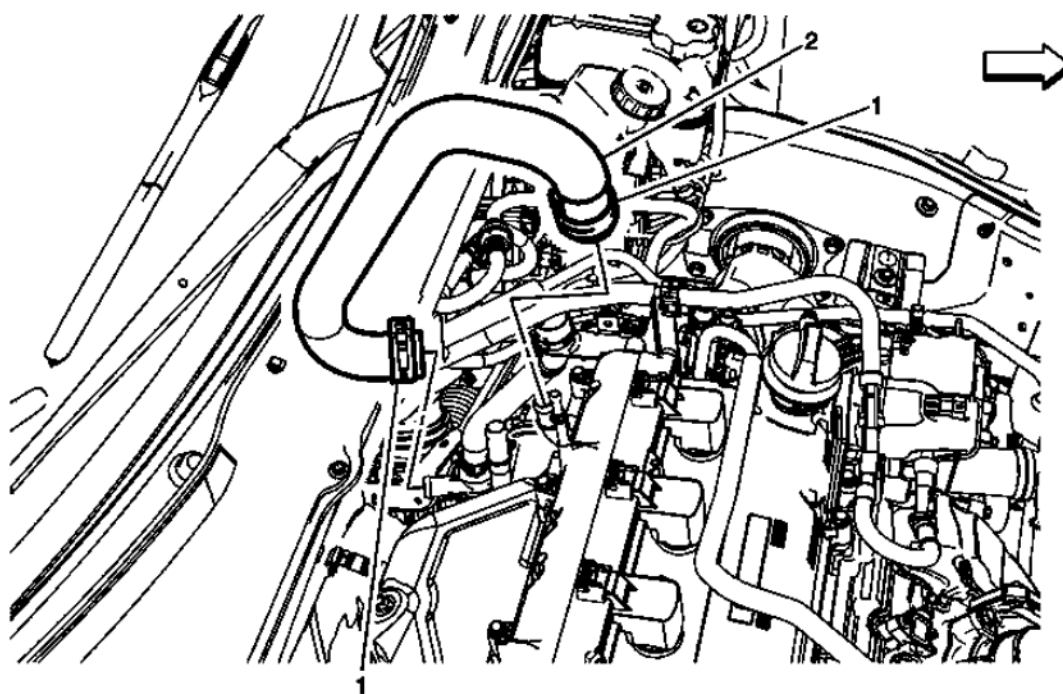


Fig. 12: Heater Coolant Pump Hose
Courtesy of GENERAL MOTORS COMPANY

Heater Coolant Pump Hose Replacement

Callout	Component Name
Preliminary Procedures	
1.	Drain the engine cooling system. Refer to <u>Cooling System Draining and Filling (GE 47716)</u> , <u>Cooling System Draining and Filling (Static Fill)</u> .

2. Remove intake manifold cover. Refer to. <u>Intake Manifold Cover Replacement</u> .	
1	Auxiliary Coolant Pump Hose Clamp (Qty: 2) Procedure Reposition the auxiliary coolant pump hose clamp using the BO-38185 hose clamp pliers. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
2	Auxiliary Coolant Pump Hose Procedure 1. Level the engine coolant to the proper level. Refer to <u>Cooling System Draining and Filling (GE 47716)</u> , <u>Cooling System Draining and Filling (Static Fill)</u> 2. Inspect for engine coolant leaks.

HEATER OUTLET HOSE CLIP BRACKET REPLACEMENT

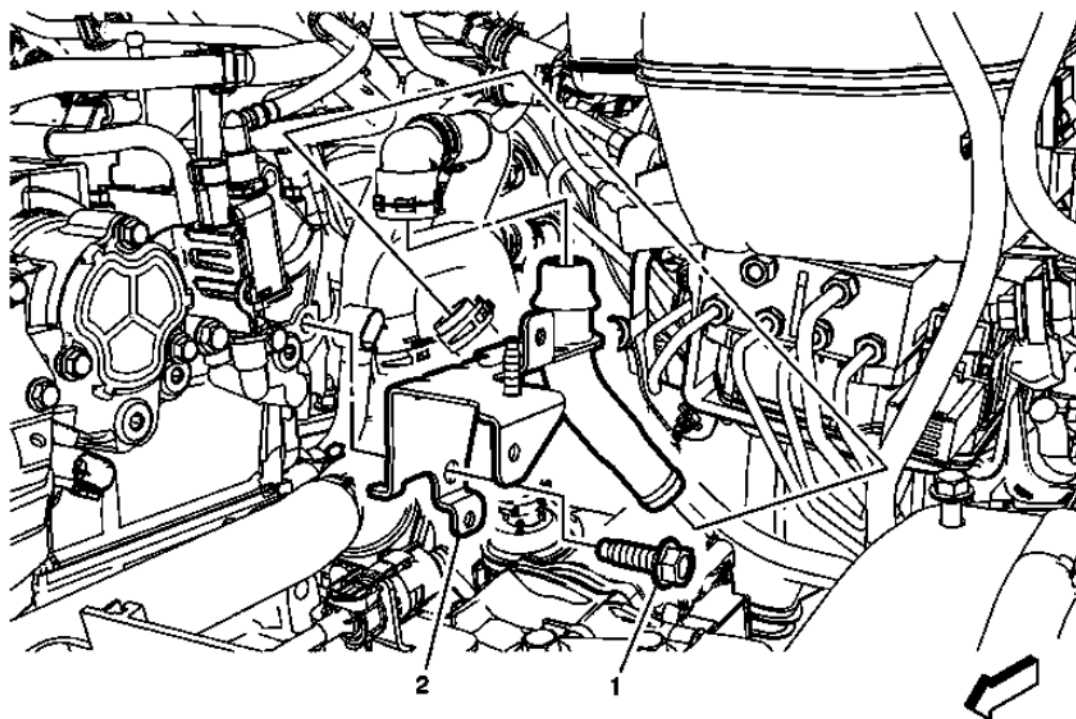


Fig. 13: Heater Outlet Hose Clip Bracket
 Courtesy of GENERAL MOTORS COMPANY

Heater Outlet Hose Clip Bracket Replacement

Callout	Component Name

Preliminary Procedures

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)** , **Cooling System Draining and Filling (Static Fill)** .
2. Remove the intake manifold cover assembly. Refer to **Intake Manifold Cover Replacement** .
3. Reposition the engine control module out of the way. Refer to **Engine Control Module Replacement** .
4. Remove the battery tray. Refer to **Battery Tray Replacement** .
5. Reposition the radiator surge tank outlet hose out of the way. Refer to **Radiator Surge Tank Outlet Hose Replacement** .
6. Remove the heater outlet hose from the heater outlet clip bracket. Refer to **Heater Outlet Hose Replacement (LUK)** , **Heater Outlet Hose Replacement (LCV)** , **Heater Outlet Hose Replacement (LTG)** .
7. Remove the auxiliary heater outlet hose from the heater outlet clip bracket. Refer to **Auxiliary Heater Outlet Hose Replacement (LUK)** .

1	Heater Outlet Hose Clip Bracket Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 (16 lb ft)
2	Heater Outlet Hose Clip Bracket Procedures 1. Disconnect the wiring harness retaining clips from the heater outlet hose clip bracket. 2. Disconnect the brake booster vacuum tube retaining clip from the heater outlet hose clip bracket.

DRIVE MOTOR BATTERY COOLING BLOWER REPLACEMENT

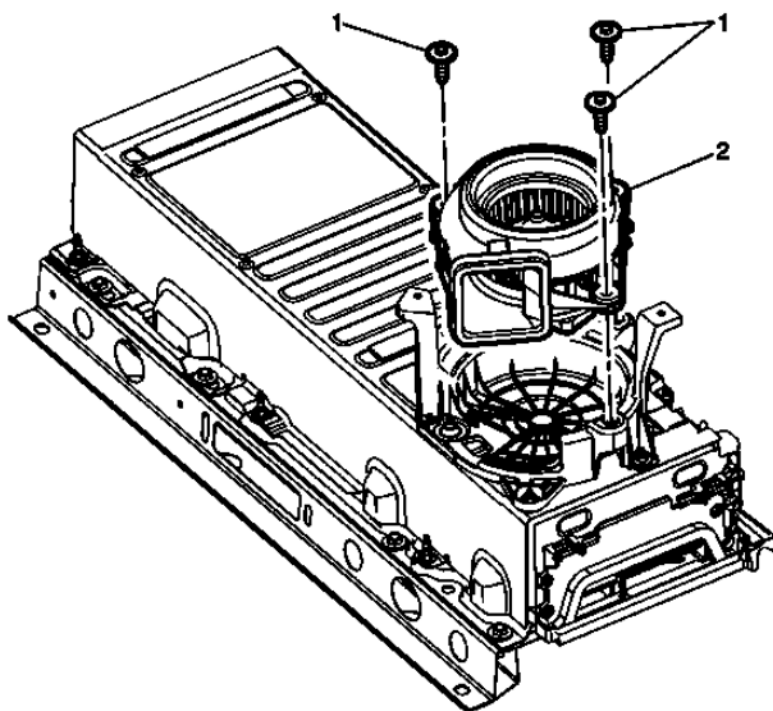


Fig. 14: Drive Motor Battery Cooling Blower Motor & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Drive Motor Battery Cooling Blower Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the drive motor battery cooling blower outlet duct. Refer to <u>Drive Motor Battery Cooling Blower Outlet Duct Replacement</u>. 2. Remove the drive motor battery cooling air outlet duct. Refer to <u>Drive Motor Battery Cooling Air Outlet Duct Replacement</u>.	
1	Drive Motor Battery Cooling Blower Motor Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> .
2	Drive Motor Battery Cooling Blower Motor Procedure Disconnect the electrical connector.

DRIVE MOTOR GENERATOR BATTERY BRACKET REPLACEMENT

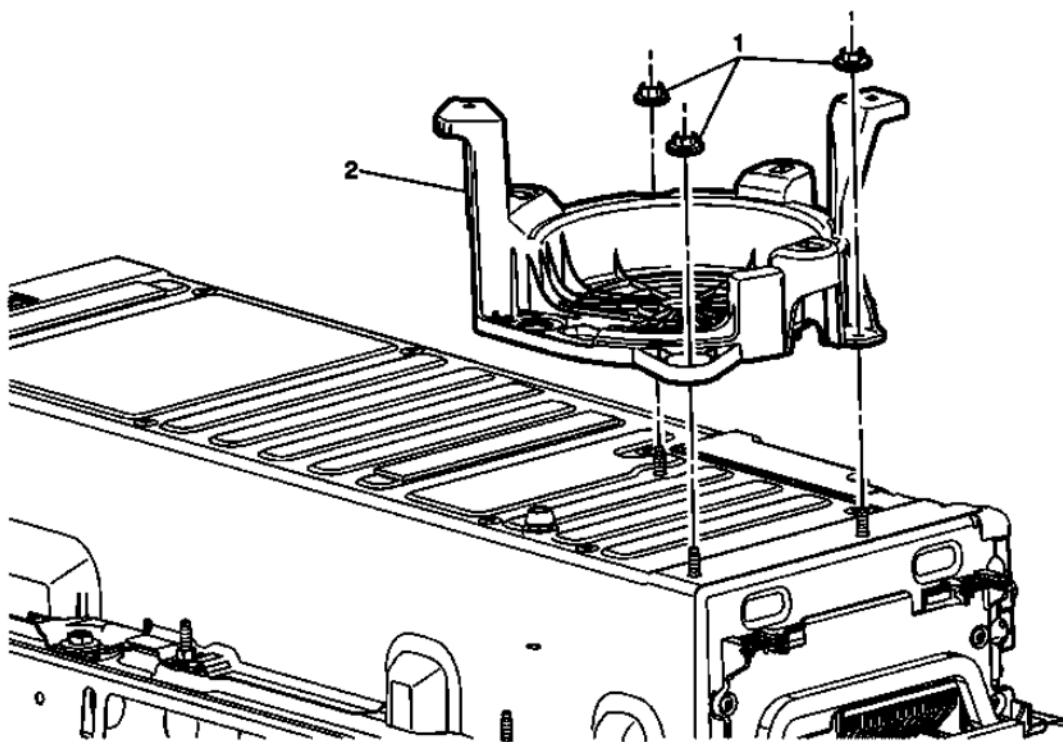


Fig. 15: Drive Motor Generator Battery Cooling Blower Motor Bracket & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Drive Motor Generator Battery Bracket Replacement

Callout	Component Name
Preliminary Procedures Remove the Drive Motor Battery Cooling Blower. Refer to <u>Drive Motor Battery Cooling Blower Replacement</u> .	
1	Drive Motor Battery Cooling Blower Motor Bracket Fasteners (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Drive Motor Battery Cooling Blower Motor Bracket.

DRIVE MOTOR BATTERY COOLING BLOWER OUTLET DUCT REPLACEMENT

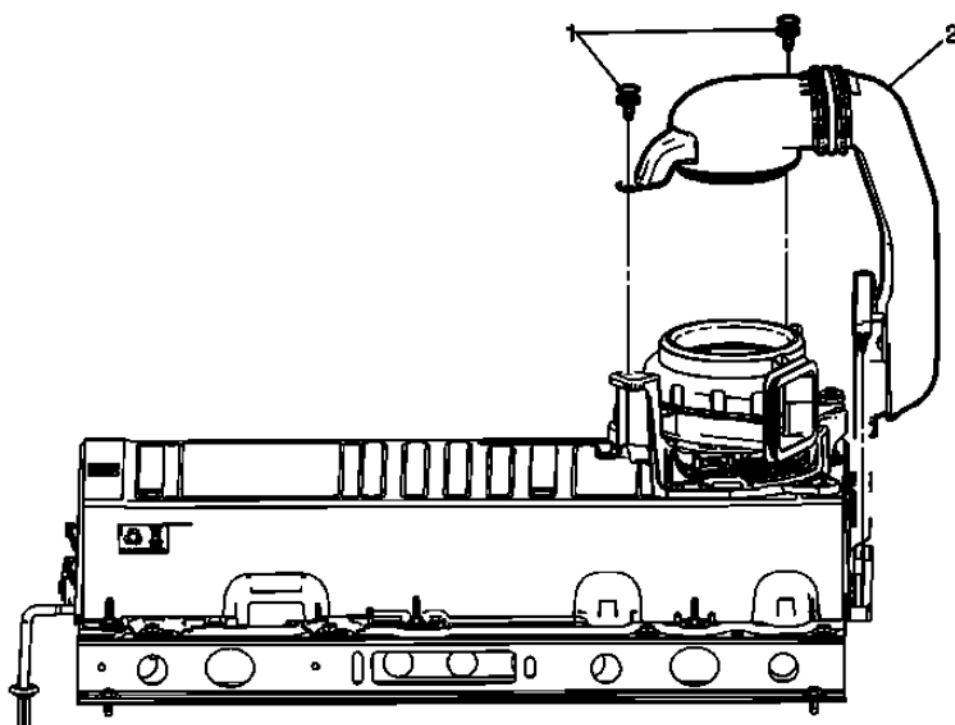


Fig. 16: Drive Motor Battery Cooling Blower Outlet Duct & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Drive Motor Battery Cooling Blower Outlet Duct Replacement

Callout	Component Name
Preliminary Procedure Remove the rear window panel storage compartment. Refer to <u>Rear Window Panel Stowage Compartment Cover Replacement (with HP6)</u> .	
1	Drive Motor Battery Cooling Blower Outlet Upper Duct Fastener (Qty: 2)
2	Drive Motor Battery Cooling Blower Outlet Upper Duct

DRIVE MOTOR BATTERY COOLING AIR OUTLET DUCT REPLACEMENT

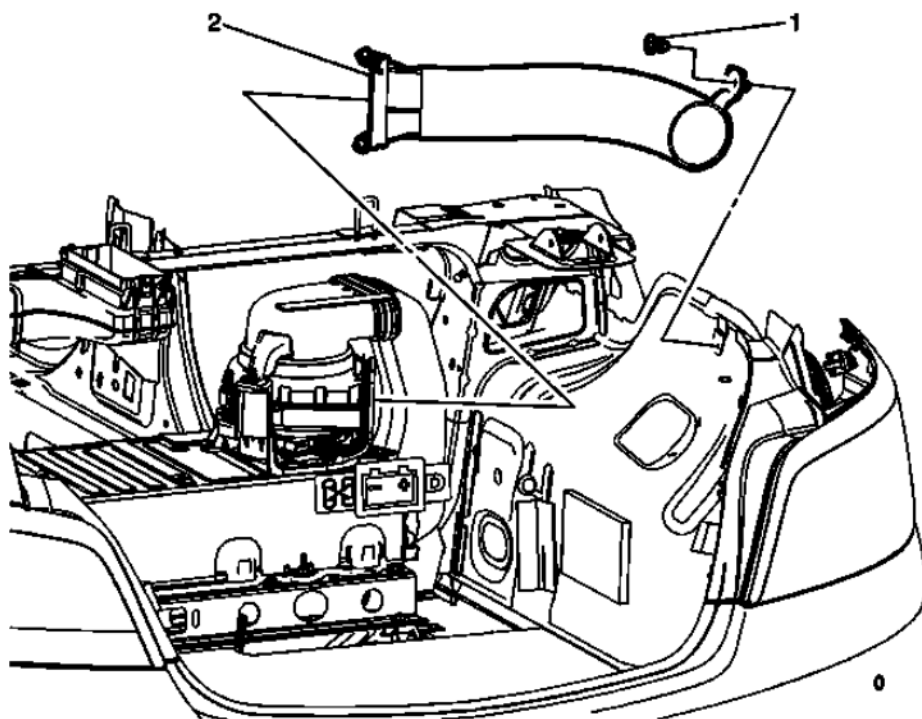


Fig. 17: Drive Motor Battery Cooling Air Outlet Duct & Fastener
 Courtesy of GENERAL MOTORS COMPANY

Drive Motor Battery Cooling Air Outlet Duct Replacement

Callout	Component Name
Preliminary Procedure Remove the right rear compartment side trim. Refer to <u>Rear Compartment Side Trim Panel Replacement (without HP6)</u> , <u>Rear Compartment Side Trim Panel Replacement (HP6, Left Side)</u> , <u>Rear Compartment Side Trim Panel Replacement (HP6, Right Side)</u> .	
1	Drive Motor Battery Cooling Outlet Duct Fastener
2	Drive Motor Battery Cooling Outlet Duct

DRIVE MOTOR BATTERY COOLING AIR INLET UPPER DUCT REPLACEMENT

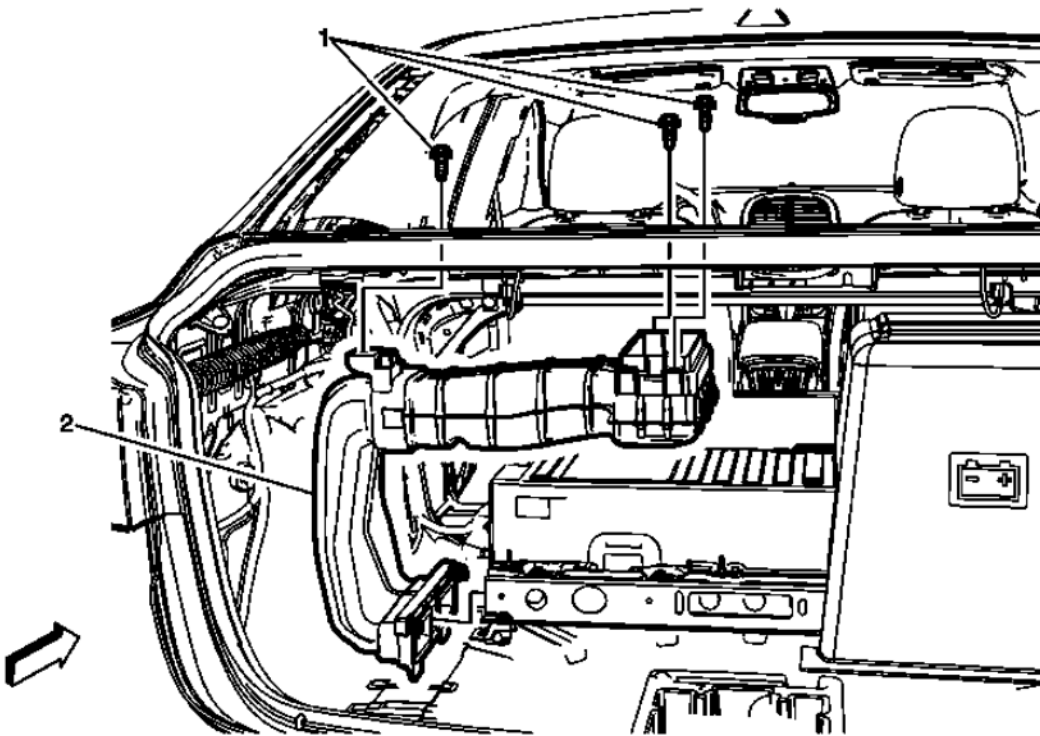


Fig. 18: Drive Motor Battery Cooling Air Inlet Upper Duct
 Courtesy of GENERAL MOTORS COMPANY

Drive Motor Battery Cooling Air Inlet Upper Duct Replacement

Callout	Component Name
Preliminary Procedures 1. Remove rear window panel storage compartment. Refer to <u>Rear Window Panel Stowage Compartment Cover Replacement (with HP6)</u>. 2. Remove the rear compartment floor panel trim. Refer to <u>Rear Compartment Floor Panel Trim Replacement (With Battery Cover, HP6)</u>, <u>Rear Compartment Floor Panel Trim Replacement (With Blower Cover, HP6)</u>.	
1	Drive Motor Battery Cooling Air Inlet Upper Duct Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Procedure Remove the drive motor battery cooling air inlet upper duct fasteners from inside the rear passenger compartment rear window panel.
2	Drive Motor Battery Cooling Air Inlet Upper Duct Procedure Unclip the drive motor battery cooling air inlet upper duct assembly from the generator control module cover assembly.

DRIVE MOTOR BATTERY COOLANT/AIR SEPARATOR REPLACEMENT

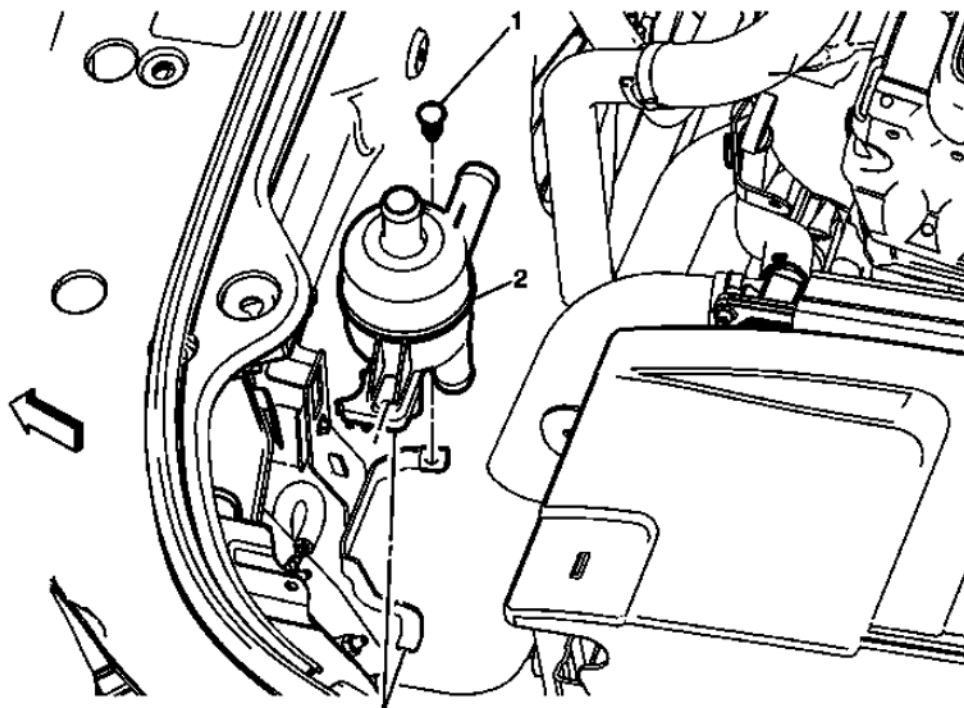


Fig. 19: Drive Motor Battery Coolant/Air Separator & Retainer
Courtesy of GENERAL MOTORS COMPANY

Drive Motor Battery Coolant/Air Separator Replacement

Callout	Component Name
Preliminary Procedures 1. Drain the engine cooling system. Refer to Cooling System Draining and Filling (GE 47716) , Cooling System Draining and Filling (Static Fill) 2. Remove the surge tank outlet hose from the drive motor battery coolant air separator. Refer to Radiator Surge Tank Outlet Hose Replacement . 3. Remove the drive motor generator control module coolant pump hose from the drive motor battery coolant air separator. Refer to Drive Motor Generator Control Module Coolant Pump Hose Replacement. 4. Remove drive motor generator control module coolant outlet hose from the drive motor battery coolant air separator. Refer to Drive Motor Generator Control Module Cooling Outlet Hose Replacement.	
1	Drive Motor Battery Coolant Air Separator Retainer
2	Drive Motor Battery Coolant Air Separator
	Procedure 1. Level the engine coolant to the proper level. Refer to Cooling

2. Inspect for engine coolant leaks.

DESCRIPTION AND OPERATION

HYBRID COOLING SYSTEM DESCRIPTION AND OPERATION

Hybrid/EV Battery Pack Cooling

Within the Hybrid/EV Battery Pack, the Hybrid/EV Battery Section 1, Hybrid/EV Battery Section 2, and Starter/Generator Control Module are air cooled. Air is drawn in by the Hybrid/EV Battery Pack Cooling Fan from the vehicle's passenger compartment. This air travels through a series of ducts into the Hybrid/EV Battery Pack. Once inside the Hybrid/EV Battery Pack, the air travels through the Hybrid/EV Battery Section 1 and Hybrid/EV Battery Section 2. The internal battery cells of the Hybrid/EV Battery Section 1 and Hybrid/EV Battery Section 2 are arranged in a staggered manner that allows maximum cooling as air travels through the battery sections. The air is then drawn under the Starter/Generator Control Module. The underside of the Starter/Generator Control Module have a series of heat sinks that allowing cooling of the internal electronics and capacitors. Air exits the Hybrid/EV Battery Pack through a duct and is drawn through the Hybrid/EV Battery Pack Cooling Fan. From the fan, air is exhausted into the vehicle's rear compartment through a series of ducts.

The cooling needs of the Hybrid/EV Battery Pack is determined through the use of a series of temperature sensors. Six temperature sensors are used to monitor the temperature of the Hybrid/EV Battery Section 1 and Hybrid/EV Battery Section 2 cell groups. The Starter/Generator Control Module commands the Hybrid/EV Battery Pack Cooling Fan to provide more or less air as the battery temperature increases or decreases. A single temperature sensor is used to monitor the air temperature of the incoming cooling air.

The Hybrid/EV Battery Pack cooling system contains the following serviceable components:

- Hybrid/EV Battery Pack Case
- Hybrid/EV Battery Section 1
- Hybrid/EV Battery Section 2
- Battery Energy Control Module
- Starter/Generator Control Module
- Hybrid/EV Battery Pack Cooling Fan

Hybrid/EV Battery Pack

The Hybrid/EV Battery Pack is integral to the Hybrid/EV Battery Pack cooling system. Foam gaskets are adhered to the metal battery pack tray. This seals the underside of the Starter/Generator Control Module to ensure proper airflow under the control module for cooling purposes. The Hybrid/EV Battery Pack case cover also provides a mounting surface for the Hybrid/EV Battery Pack Cooling Fan and has openings where the plastic vents are allowed to pass into the Hybrid/EV Battery Pack to direct air through components which require cooling.

Hybrid/EV Battery Section 1 and Hybrid/EV Battery Section 2

The hybrid battery sections are air cooled. Each battery case has an air inlet and an air outlet. Air is drawn through the battery case to cool the individual cells. Six temperature sensors are used to monitor the battery temperature. The battery temperature sensors are located in the battery sections. Two of the temperature sensors are located on the top of the battery section and the remaining four are located on the bottom of the section. The temperature sensor is a variable resistor that measures the temperature of the battery cell group.

Battery Energy Control Module

The battery energy control module measures critical temperatures within the two battery sections and at the Hybrid/EV Battery Section 1 air inlet. Six temperature sensors are used to monitor the battery temperature. The battery temperature sensors are located in the battery sections. Two of the temperature sensors are located on the top of the battery section and the remaining four are located on the bottom of the section. The temperature sensor is a variable resistor that measures the temperature of the battery cell group. The battery energy control module supplies 5 V to the signal circuit and a ground for the low reference circuit. The battery temperature sensor resistance changes with battery temperature. As the temperature decreases, the sensor resistance increases. As the temperature increases, the sensor resistance decreases. The air inlet temperature sensor operates in much the same way, except that it measures the temperature of the incoming air used to cool the Hybrid/EV Battery Pack at the Hybrid/EV Battery Section 1 air inlet. None of the temperature sensors or the temperature sensor harness is serviceable. They are all serviced as part of the battery sections.

Starter/Generator Control Module

The Starter/Generator Control Module uses temperature information from the battery energy control module to control the Hybrid/EV Battery Pack Cooling Fan and increase or decrease the cooling capacity. As battery cell temperature increases, the start/generator control module will command the Hybrid/EV Battery Pack Cooling Fan speed to increase, increasing the air flow through the Hybrid/EV Battery Pack. The Starter/Generator Control Module may also command the fan on in low ambient temperatures to aid in the warming of the battery cells. If the ambient temperature of the air in the passenger compartment, where the cooling air is drawn from, is warmer than the battery cell temperatures, it may be used to help warm the cells more quickly. The Starter/Generator Control Module will use the air inlet temperature sensor to determine the temperature of the incoming air.

Hybrid/EV Battery Pack Cooling Fan

The Hybrid/EV Battery Pack Cooling Fan draws air through the Hybrid/EV Battery Pack to control the temperature of the Hybrid/EV Battery Section 1, Hybrid/EV Battery Section 2, and Starter/Generator Control Module. To operate, the cooling fan receives an enable signal from the Starter/Generator Control Module. The enable control is controlled by a discrete high side driver in the Starter/Generator Control Module. When the enable control circuit is high, the fan will be enabled. The fan speed is controlled by a pulsed high side driver in the Starter/Generator Control Module. The greater the duty cycle on the fan speed signal circuit, the higher the fan speed. Maximum fan speed is 3900 RPM. The Hybrid/EV Battery Pack Cooling Fan provides a low-side drive, pulse-width modulated feedback signal to the Starter/Generator Control Module. During normal operation, this feedback signal provides fan speed information. The Hybrid/EV Battery Pack Cooling Fan has limited self-diagnostic capability. If the fan determines there is an internal fault, it will provide this information on the feedback circuit.

Starter/Generator Cooling

The starter/generator is liquid cooling using a stand-alone cooling system that is separate from the engine's cooling system.

The starter/generator cooling system contains the following serviceable components:

- Starter/Generator Control Module
- Starter/Generator Coolant Temperature Sensor
- Starter/Generator Coolant Pump

Starter/Generator Control Module

The Starter/Generator Control Module monitors the starter/generator coolant temperature sensor. When the coolant temperature indicates that starter/generator cooling is required, the Starter/Generator Control Module commands the starter/generator coolant pump on. The Starter/Generator Control Module provides ground to the starter/generator coolant pump relay coil through a dedicated low side driver. This will cause the starter/generator coolant pump relay switch to close, providing B+ to the starter/generator coolant pump.

Starter/Generator Coolant Temperature Sensor

The starter/generator coolant temperature sensor is a variable resistor that measures the temperature of the starter/generator coolant. The Starter/Generator Control Module supplies 5 V to the signal circuit and a ground for the low reference circuit. The starter/generator coolant temperature sensor resistance changes with starter/generator coolant temperature. As the temperature decreases, the sensor resistance increases. As the temperature increases, the sensor resistance decreases. The Starter/Generator Control Module monitors the starter/generator coolant temperature sensor to determine the temperature of the starter/generator coolant. As the coolant temperature changes, the Starter/Generator Control Module will turn the starter/generator coolant pump on or off to accommodate the starter/generator cooling requirements.

Starter/Generator Coolant Pump

The drive motor coolant pump is a single speed ON/OFF pump that circulates coolant through the starter/generator radiator and the starter/generator to control the temperature of the starter/generator.