ACCESSORIES & EQUIPMENT

Displays and Gauges - Escalade, Suburban, Tahoe, Yukon

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Head-Up Display Bolt	9 N.m	80 lb in
Head-Up Display Nut	9 N.m	80 lb in
Instrument Cluster Bolt	2.5 N.m	22 lb in
Instrument Panel Multi Function Switch	.75 N.m	7 lb in

SCHEMATIC WIRING DIAGRAMS

INSTRUMENT CLUSTER WIRING SCHEMATICS

Power, Ground and Serial Data

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Esc...

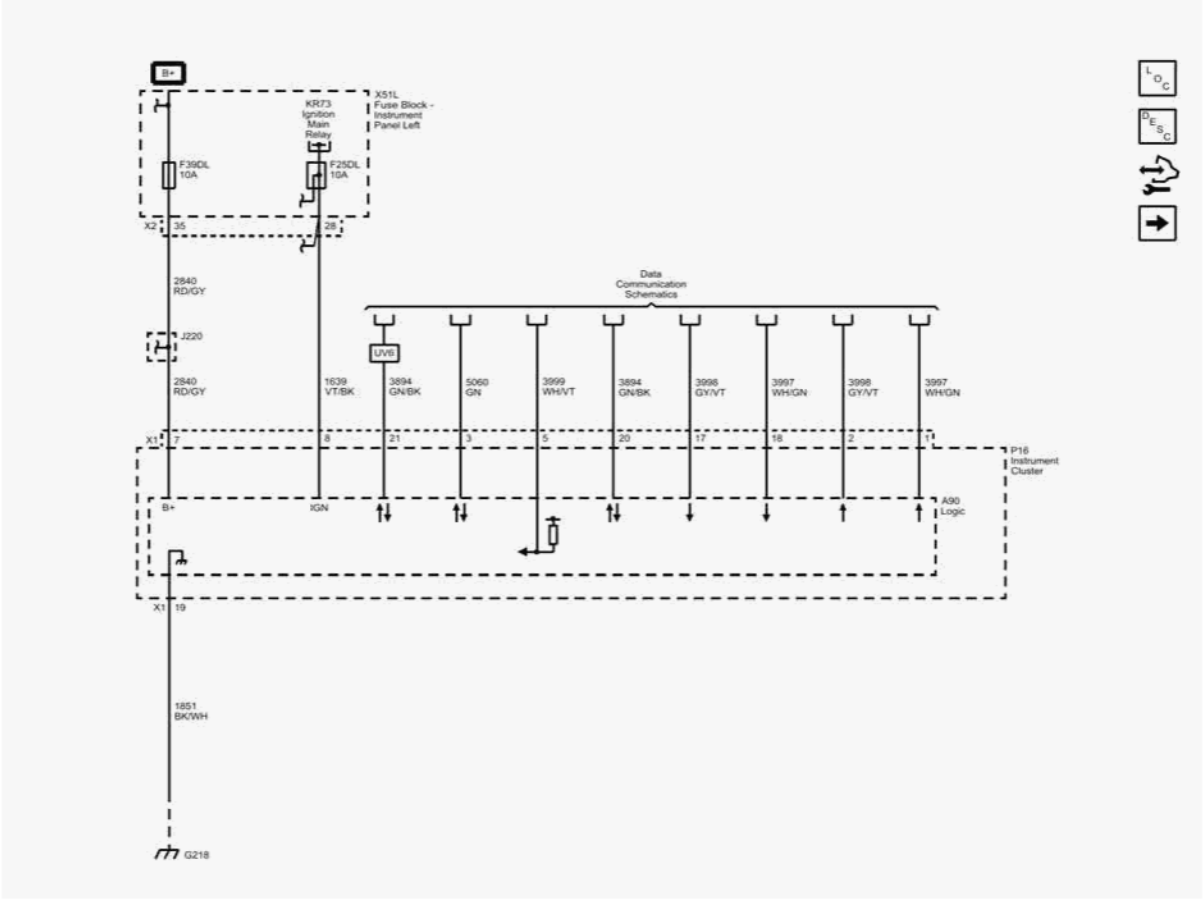


Fig. 1: Power, Ground and Serial Data
Courtesy of GENERAL MOTORS COMPANY

Gages (L83 or L86)

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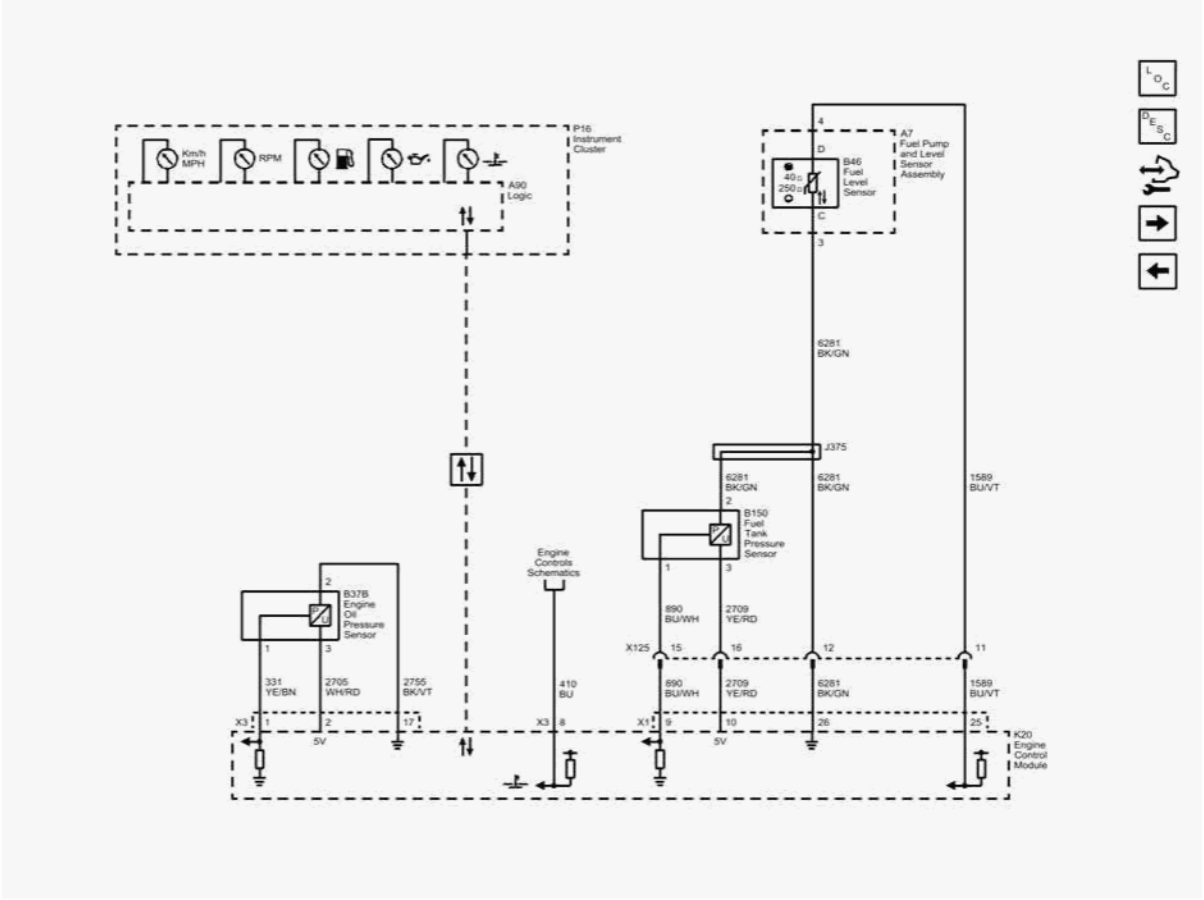


Fig. 2: Gages (L83 or L86)

Courtesy of GENERAL MOTORS COMPANY

Gages (L96)

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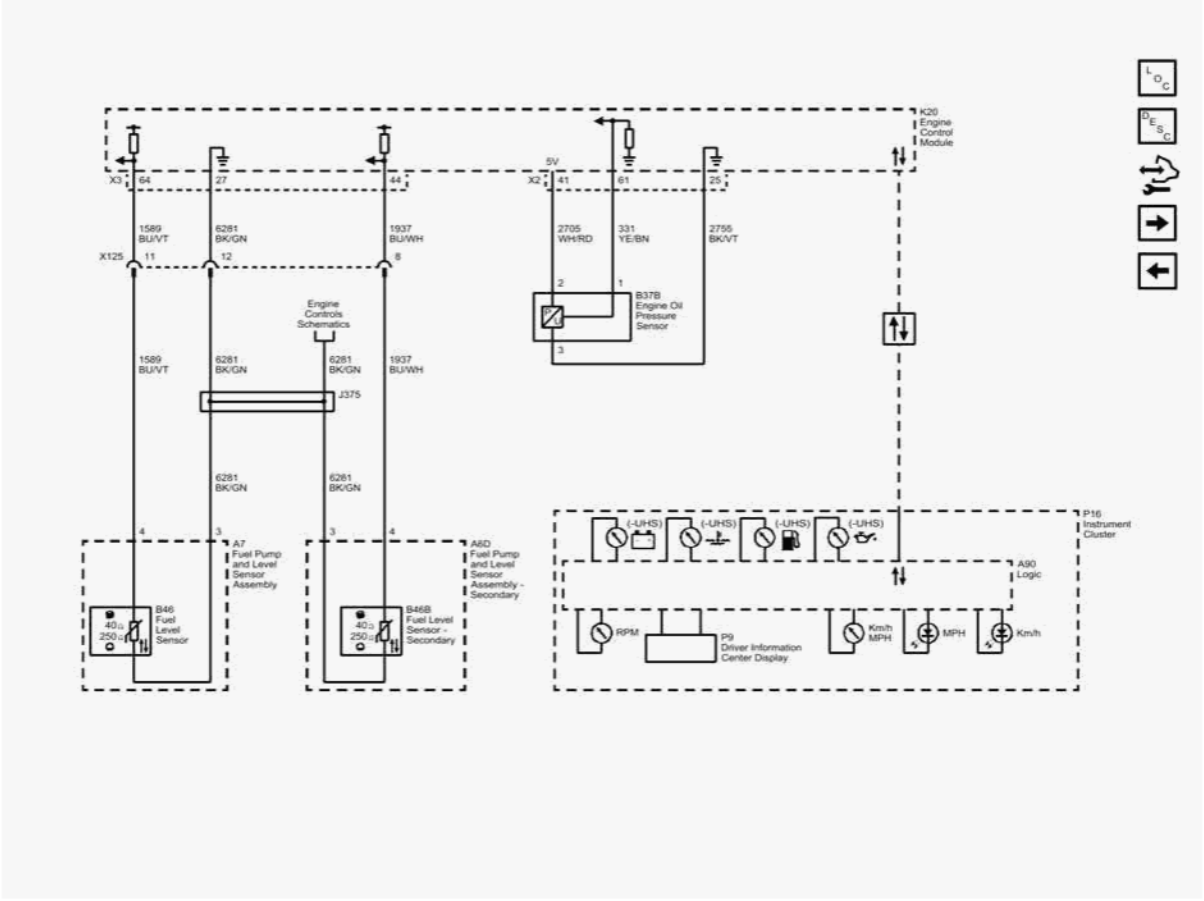


Fig. 3: Gages (L96)

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Indicators

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Esc...

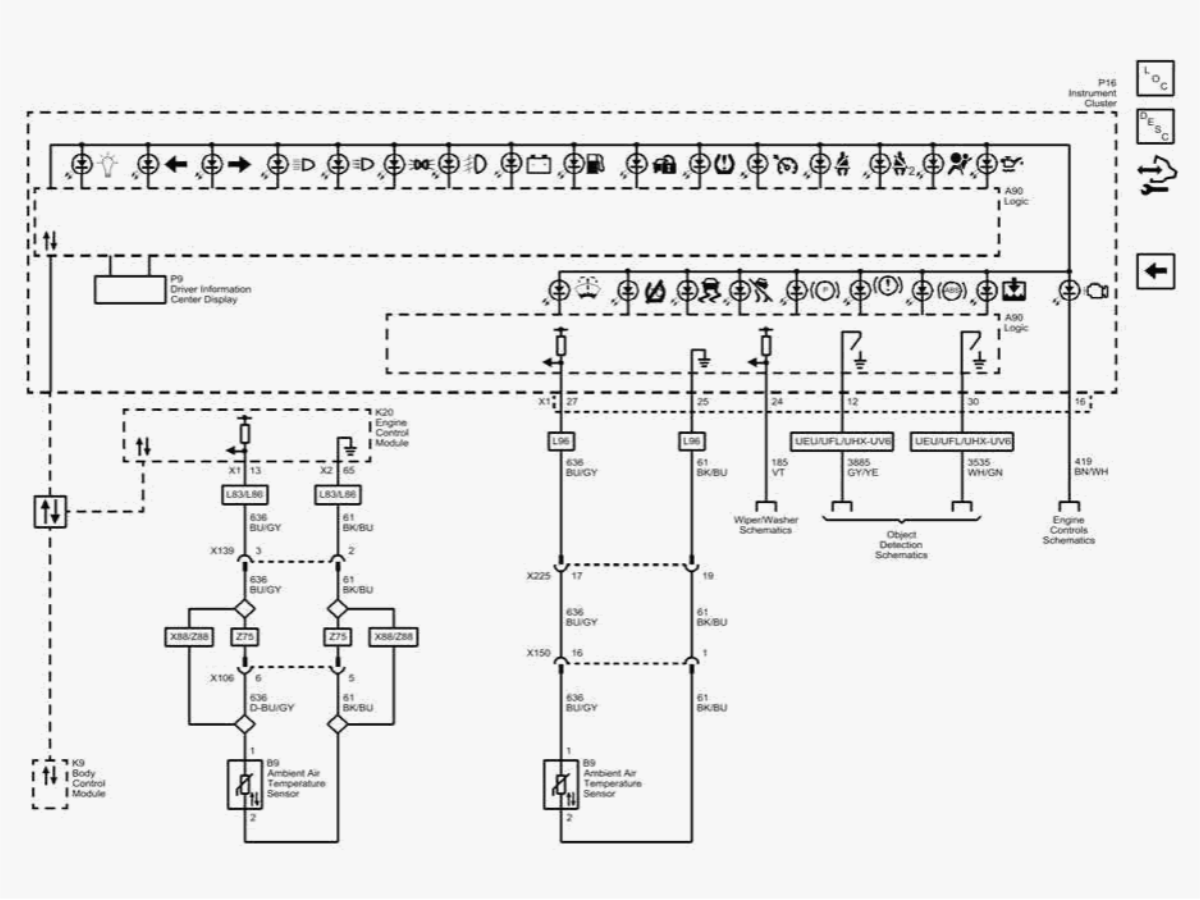


Fig. 4: Indicators

Courtesy of GENERAL MOTORS COMPANY

HEAD-UP DISPLAY WIRING SCHEMATICS

Head-Up Display Schematics

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Esc...

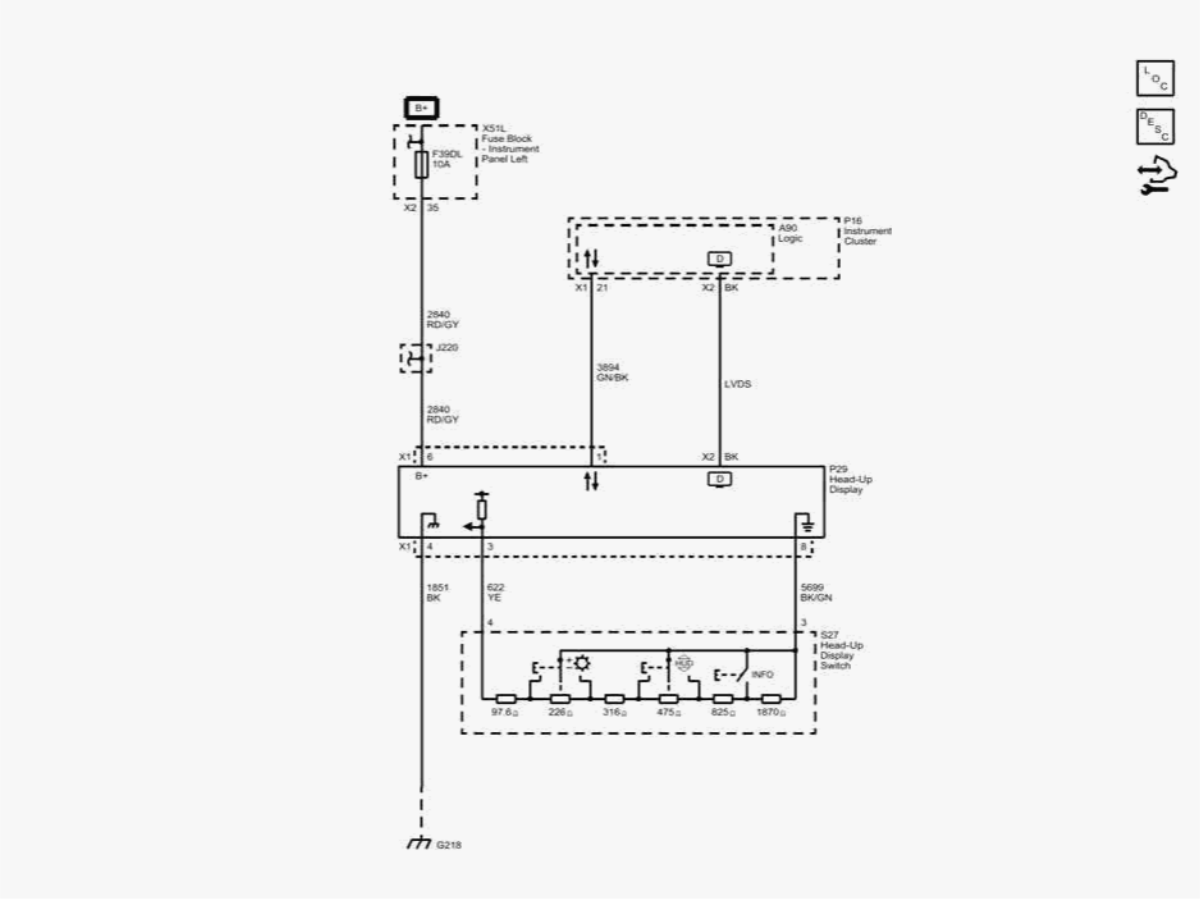


Fig. 5: Head-Up Display Schematics
Courtesy of GENERAL MOTORS COMPANY

AUDIBLE WARNINGS WIRING SCHEMATICS

Audible Warnings

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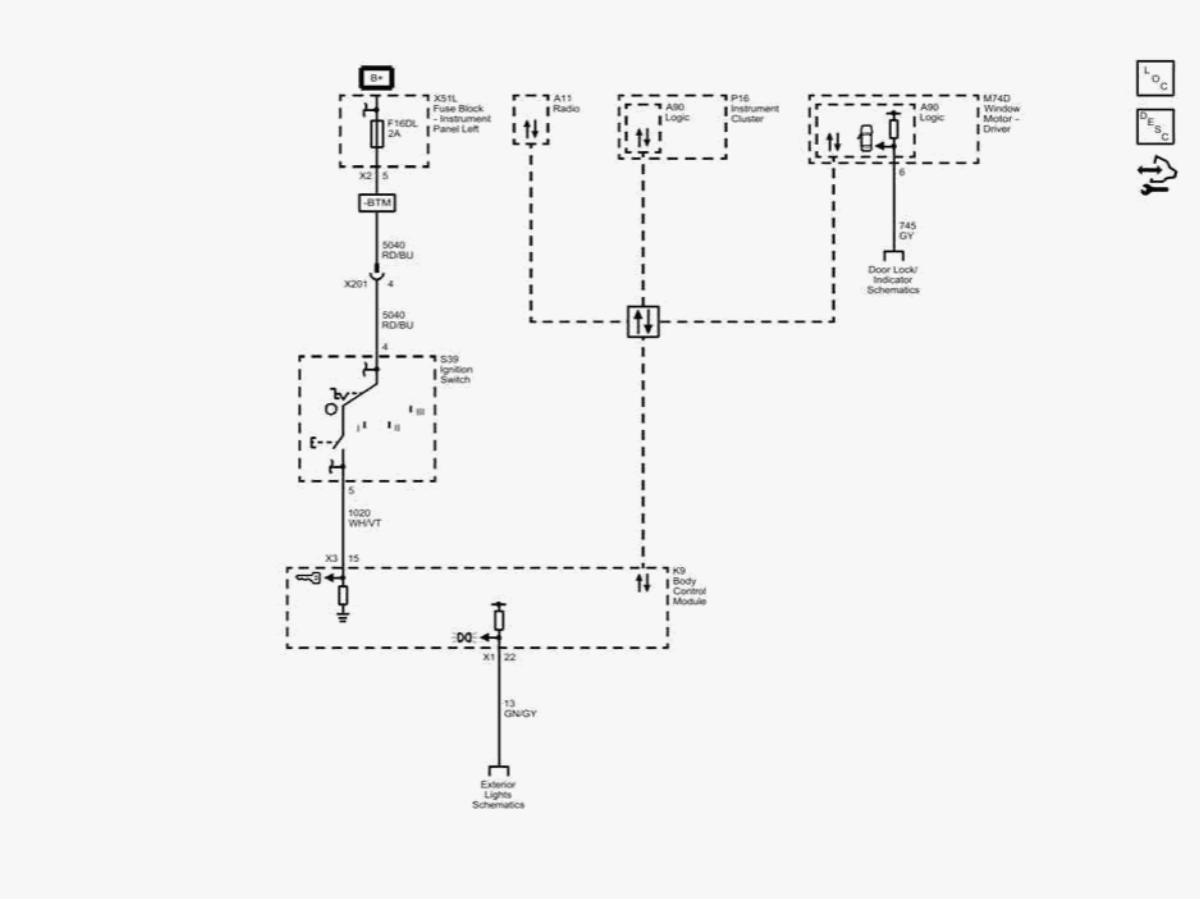


Fig. 6: Audible Warnings
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DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B0158: AMBIENT AIR TEMPERATURE SENSOR

Diagnostic Instructions

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

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DTC Descriptors

DTC B0158 02

Ambient Air Temperature Sensor Circuit Short to Ground

DTC B0158 05

Ambient Air Temperature Sensor Circuit High Voltage/Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	B0158 02	1 or B0158 05	B0158 05	1
Low Reference	-	B0158 05	-	-
1. Outside Air Temperature Display Malfunction				

Circuit/System Description

The B9 Ambient Air Temperature Sensor is located behind the grille. The instrument cluster monitors the ambient air temperature sensor with a low reference circuit and signal circuit. The instrument cluster monitors the voltage drop across the sensor, which is inversely proportional to temperature. When the ambient air temperature is cold, the resistance of the sensor is high. When the ambient air temperature is warm, the resistance of the sensors is low. The instrument cluster converts the voltage value to a temperature value and displays the temperature.

Conditions for Running the DTC

The system voltage is between 9-16 V.

Conditions for Setting the DTC

B0158 02

The instrument cluster detects the sensor signal is more than 88Â°C (190Â°F).

B0158 05

The instrument cluster detects the sensor signal is less than -40Â°C (-40Â°F).

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Action Taken When the DTC Sets

The instrument cluster uses a default air temperature value for further calculations. The instrument cluster will display -Â°C (-Â°F). A/C compressor engagement may be disabled.

Conditions for Clearing the DTC

The DTC will become history if the instrument cluster no longer detects a malfunction.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **For vehicles with RPO AVF, ensure that the Body Control Module and Instrument Cluster have been programmed with the latest calibrations before proceeding with Circuit/System Verification and Circuit/System**

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Testing.

1. Ignition ON.

NOTE: **The scan tool Instrument Cluster Ambient Air Temperature parameter is a buffered value when the measured temperature is increasing. Performing the Ambient Air Temperature Instant Update with the scan tool may be necessary to force the Ambient Air Temperature parameter to update to the current measured temperature.**

2. Verify the scan tool Instrument Cluster Ambient Air Temperature parameter is between -40Â°C (-40Â°F) and +88Â°C (+190Â°F) and changes with air temperature changes.
   - **If not between -40Â°C (-40Â°F) and +88Â°C (+190Â°F) or changes with air temperature changes**

     Refer to Circuit/System Testing.

   - **If between -40Â°C (-40Â°F) and +88Â°C (+190Â°F) and changes with air temperature changes**
3. All OK.

Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before proceeding with Circuit/System Testing.**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B9 Ambient Air Temperature Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal B (or 2) and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the P16 Instrument Cluster.
   - **If less than 10 Ω**
3. Ignition ON.
4. Verify the scan tool Ambient Air Temperature parameter is greater than 98%.
   - **If 98% or less**

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1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster.
2. Test for infinite resistance between the signal circuit terminal A (or 1) and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the P16 Instrument Cluster.

- **If greater than 98%**

5. Install a 3 A fused jumper wire between the signal circuit terminal A (or 1) and the low reference circuit terminal B (or 2).
6. Verify the scan tool Ambient Air Temperature parameter is less than 8%.

- **If 8% or greater**

1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V
3. Ignition OFF
4. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the P16 Instrument Cluster.

- **If less than 8%**

7. Test or replace the B9 Ambient Air Temperature Sensor.

Repair Instructions

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

- **Displays and Gauges Component Replacement Reference**
- **Control Module References** for instrument cluster replacement, programming and setup

DTC B0550: ODOMETER CIRCUIT GENERAL MEMORY MALFUNCTION

Diagnostic Instructions

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

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

DTC Descriptor

DTC B0550 32

Odometer Circuit General Memory Malfunction

Circuit/System Description

The instrument cluster is equipped with an odometer that indicate the distance traveled by the vehicle. This information is also stored in the body control module. In addition to storing the odometer value for the vehicle, the instrument cluster and the body control module both store the vehicle VIN. Software checks are performed to ensure these modules, and their stored odometer information, can not be moved or transferred between different vehicles.

Conditions for Running the DTC

Ignition ON/Vehicle in Service Mode.

Conditions for Setting the DTC

The body control module has detected an internal memory malfunction.

Action Taken When the DTC Sets

The DTC is stored in the body control module memory.

Conditions for Clearing the DTC

The body control module no longer detects a malfunction.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON/Vehicle in Service Mode/Vehicle in Service Mode.
2. Verify DTC B0550 is not set.
    - **If the DTC is set**
    1. Program the K9 Body Control Module.
    2. Verify the DTC is not set.
        - If the DTC is set, replace the K9 Body Control Module.
        - If the DTC is not set
    3. All OK.
    - **If the DTC is not set**
3. All OK

Repair Instructions

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

Control Module References for body control module replacement, programming and setup

DTC B124F: UNIVERSAL SERIAL BUS (USB) PROGRAMMING

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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 B124F 41

Universal Serial Bus (USB) Programming Files Not Available

DTC B124F 42

Universal Serial Bus (USB) Programming Not Programmed

DTC B124F 44

Universal Serial Bus (USB) Programming Security Access Not Activated

DTC B124F 4A

Universal Serial Bus (USB) Programming Security Checksum Error

Circuit/System Description

The instrument cluster can communicate with other devices on a Media Oriented Systems Transport (MOST) bus. Some of the other devices may be connected to a USB port. This allows programming of the instrument cluster using a USB device via the MOST bus. Software checks are performed to ensure the internal MOST circuitry is operating properly.

Conditions for Running the DTC

Ignition ON/Vehicle in Service Mode.

Conditions for Setting the DTC

The instrument cluster has detected an internal memory malfunction or the programming event was incomplete, or completed with errors.

Action Taken When the DTC Sets

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The DTC is stored in the instrument cluster memory and may have limited or no functionality.

Conditions for Clearing the DTC

The instrument cluster no longer detects a malfunction.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON/Vehicle in Service Mode.
2. Verify DTC B124F is not set.
    - **If the DTC is set**
    1. Program the P16 Instrument Cluster.

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2. Verify the DTC is not set.
    - If the DTC is set, replace the P16 Instrument Cluster.
    - If the DTC is not set
3. All OK.

- **If the DTC is not set**

3. All OK

Repair Instructions

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

Control Module References for instrument cluster replacement, programming and setup

DTC B361A: HEAD-UP DISPLAY MODULE

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 B361A 39

Head-Up Display Module Internal Malfunction

DTC B361A 4B

Head-Up Display Module Calibration Not Learned

Circuit/System Description

Internal fault detection and calibration of the head-up display is handled within the instrument cluster. No external circuit diagnosis is involved.

Conditions for Running the DTC

Ignition ON/Vehicle in Service Mode.

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Conditions for Setting the DTC

B361A 39

An internal electrical malfunction has been detected in the head-up display.

B361A 4B

The instrument cluster has not leaned a valid calibration for the head-up display.

Action Taken When the DTC Sets

Head-up display function is disabled.

Conditions for Clearing the DTC

The DTC will clear when the conditions for setting the DTC are no longer present.

Reference Information

Schematic Reference

Head-Up Display Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

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

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON/Vehicle in Service Mode.
2. Verify DTC B361A 4B is not set.
    - **If DTC B361A 4B is set**
    1. Program the P16 Instrument Cluster.
    2. Verify the DTC does not set.
        - If the DTC sets, replace the P29 Head-Up Display.
        - If the DTC does not set
    3. All OK.
    - **If DTC B361A 4B is not set**
3. Verify DTC B361A 39 is not set.
    - **If DTC B361A 39 is set**

      Replace the P29 Head-Up Display.

    - **If DTC B361A 39 is not set**
4. All OK

Repair Instructions

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

Displays and Gauges Component Replacement Reference

DTC B361B: HEAD-UP DISPLAY SWITCH

Diagnostic Instructions

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

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

DTC Descriptor

DTC B361B 02

Head-Up Display Switch Short to Ground

DTC B361B 05

Head-Up Display Switch High Voltage/Open

DTC B361B 59

Head-Up Display Switch Protection Time-Out

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	B361B 02	B361B 05	B361B 05	B361B 59
Low Reference	-	B361B 05	-	-

Circuit/System Description

The head-up display switch is a multiplexed switch that controls the head-up display based on driver inputs. The head-up display provides the switch with a low reference and monitors a signal circuit. The head-up display switch is made up of a resistor ladder and three switches: Dim +/-, Up/Down, and Page. When a switch is pressed, the signal voltage is pulled low through the resistor ladder. When pressed, each of the switches will result in a different signal voltage seen by the head-up display, depending on the switch's location on the resistor ladder.

Conditions for Running the DTC

Ignition ON/Vehicle in Service Mode.

Conditions for Setting the DTC

B361B 02

The head-up display switch signal voltage is less than 1 V

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B361B 05

The head-up display switch signal voltage is greater than 11.5 V

B361B 59

The head-up display switch is stuck

Action Taken When the DTC Sets

The head-up display ignores the head-up display switch inputs

Conditions for Clearing the DTC

The DTC will become history if the head-up display no longer detects a malfunction

Reference Information

Schematic Reference

Head-Up Display Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

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

Scan Tool Reference

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Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON/Vehicle in Service Mode.
2. While holding each switch listed below, verify the scan tool Heads Up Display Switch State parameter is as follows:
   - DIM + Switch - HUD Dimming Up/Down Pressed
   - DIM - Switch - HUD Dimming Up/Down Pressed
   - UP Switch - HUD Movement
   - DOWN Switch- HUD Movement
   - PAGE Switch- HUD Page Switch
   - **If the scan tool parameter does not equal the expected result with the switch in the appropriate state**

     Refer to Circuit/System Testing.

   - **If the scan tool parameter equals the expected result with the switch in the appropriate state**
3. All OK.

Circuit/System Testing

NOTE: Circuit/System Verification must be performed before proceeding with Circuit/System Testing.

1. Ignition OFF/Vehicle OFF and all vehicle systems OFF, disconnect the harness connector at the S27 Head-Up Display Switch. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 3 and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the P29 Head-Up Display.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the P29 Head-Up Display.
   - **If less than 10 Ω**
3. Test for 4.8-5.2 V between the signal circuit terminal 4 and ground.
   - **If less than 4.8 V**

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1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the P29 Head-Up Displaye.
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 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the P29 Head-Up Display.

- **If greater than 5.2 V**

1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the P29 Head-Up Display.

- **If between 4.8-5.2 V**

4. Test or replace the S27 Head-Up Display switch.

Component Testing

1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the S27 Head-Up Display Switch.
2. Test for 3.4K - 4.2K Ω between the signal terminal 4 and the low reference terminal 3.
    - **If not between 3.4K - 4.2K Ω**

      Replace the S27 Head-Up Display Switch.

    - **If between 3.4K - 4.2K Ω**
3. Test for 87 - 107 Ω between the signal terminal 4 and the low reference terminal 3 with the DIM + Switch pressed.
    - **If not between 87 - 107 Ω**

      Replace the S27 Head-Up Display switch.

    - **If between 87 - 107 Ω**
4. Test for 291 - 356 Ω between the signal terminal 4 and the low reference terminal 3 with the DIM - Switch pressed.
    - **If not between 291 - 356 Ω**

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Replace the S27 Head-Up Display switch.

- **If between 291 - 356 Ω**

5. Test for 575 - 704 Ω between the signal terminal 4 and the low reference terminal 3 with the UP Switch pressed.
   - **If not between 575 - 704 Ω**

     Replace the S27 Head-Up Display Switch.

   - **If between 575 - 704 Ω**
6. Test for 1K - 1.2K Ω between the signal terminal 4 and the low reference terminal 3 with the DOWN Switch pressed.
   - **If not between 1K - 1.2K Ω**

     Replace the S27 Head-Up Display Switch.

   - **If between 1K - 1.2K Ω**
7. Test for 1.7K - 2.1K Ω between the signal terminal 4 and the low reference terminal 3 with the PAGE (or INFO) Switch pressed.
   - **If not between 1.7K - 2.1K Ω**

     Replace the S27 Head-Up Display Switch.

   - **If between 1.7K - 2.1K Ω**
8. All OK.

Repair Instructions

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

- **Displays and Gauges Component Replacement Reference**
- **Control Module References** for control module replacement, programming and setup

DTC P0071-P0074: AMBIENT AIR TEMPERATURE SENSOR

Diagnostic Instructions

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

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

DTC Descriptors

DTC P0071

Ambient Air Temperature Sensor Performance

DTC P0072

Ambient Air Temperature Sensor Circuit Low Voltage

DTC P0073

Ambient Air Temperature Sensor Circuit High Voltage

DTC P0074

Ambient Air Temperature Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0072	P0073	P0073	P0071 or P0074
Low Reference	-	P0073	-	P0071

Circuit/System Description

The ambient air temperature sensor is located behind the grille. The engine control module (ECM) monitors the ambient air temperature sensor utilizing a low reference circuit and signal circuit. The ECM monitors the voltage drop across the sensor, which is inversely proportional to temperature. When the ambient air temperature is cold, the resistance of the sensor is high. When the ambient air temperature is warm, the resistance of the sensor is low. The ECM converts the voltage value to a temperature value. The ECM also sends the temperature value to other control modules via serial data.

Conditions for Running the DTC

- Ignition ON/Vehicle in Service Mode

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- The 12 V battery voltage is greater than or equal to 10.2 V.

Conditions for Setting the DTC

P0071

During the first 20 s of run time after the 1 hour soaking period, the difference between the outside air temperature and the engine intake air temperature is greater than 30Â°C(86Â°F).

P0072

The ECM detects the sensor signal is more than 88Â°C (190Â°F).

P0073

The ECM detects the sensor signal is less than -40Â°C (-40Â°F).

P0074

The ECM detects an unrealistic signal variance.

Action Taken When the DTC Sets

- DTC P0071-P0074 are type B DTCs.
- The DIC will display SERVICE A/C SYSTEM.
- The system operates using a default value.

Conditions for Clearing the DTC

The DTC will become history if the ECM no longer detects a malfunction.

Diagnostic Aids

Following a Ambient Air Temperature Sensor disconnect or circuit fault, the temperature displayed in the vehicle can take several ignition cycles to update to the current temperature. Driving the vehicle may also be necessary.

Reference Information

Schematic Reference

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Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON/Vehicle in Service Mode.
2. Verify the scan tool ECM Ambient Air Temperature parameter is between -40Â°C (-40Â°F) and +88Â°C (+190Â°F) and changes with air temperature changes.
   - **If not between -40Â°C (-40Â°F) and +88Â°C (+190Â°F) or changes with air temperature changes**

     Refer to Circuit/System Testing.

   - **If between -40Â°C (-40Â°F) and +88Â°C (+190Â°F) and changes with air temperature changes**
3. All OK.

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Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before proceeding with Circuit/System Testing.**

1. Ignition OFF/Vehicle OFF and all vehicle systems OFF, disconnect the harness connector at the B9 Ambient Air Temperature Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal B (or 2) and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF/Vehicle OFF, disconnect the harness connectors at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If less than 10 Ω**
3. Ignition ON/Vehicle in Service Mode.
4. Verify the scan tool Ambient Air Temperature parameter is less than-39Â°C (-38Â°F).
    - **If -39Â°C (-38Â°F) or greater**
    1. Ignition OFF/Vehicle OFF, disconnect the harness connectors at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal A (or 1) and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **If less than -39Â°C (-38Â°F)**
5. Install a 3 A fused jumper wire between the signal circuit terminal A (or 1) and the low reference circuit terminal B (or 2).
6. Verify the scan tool Ambient Air Temperature parameter is greater than 88Â°C (190Â°F).
    - **If 88Â°C (190Â°F) or less**
    1. Ignition OFF/Vehicle OFF, remove the jumper wire and disconnect the harness connectors at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF/Vehicle OFF.

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4. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.
- **If warmer than 88Â°C (190Â°F)**

7. Test or replace the B9 Ambient Air Temperature Sensor.

Repair Instructions

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

- **Displays and Gauges Component Replacement Reference**
- **Control Module References** for control module replacement, programming and setup

DTC P0461-P0464: FUEL LEVEL SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC P0461

Fuel Level Sensor Performance

DTC P0462

Fuel Level Sensor Circuit Low Voltage

DTC P0463

Fuel Level Sensor Circuit High Voltage

DTC P0464

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Fuel Level Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Level Sensor 1 Signal	P0462	P0463	P0463	P0461
Low Reference	-	1	P0463, P0464	P0461
1. Fuel Gauge Malfunction				

Circuit/System Description

The fuel level sensor changes resistance based on fuel level. The engine control module (ECM) monitors the signal circuit of the fuel level sensor in order to determine the fuel level. When the fuel tank is full, the resistance of the fuel level sensor is low and the ECM senses a low signal voltage on the signal circuit of the fuel level sensor. When the fuel tank is empty, the resistance of the fuel level sensor is high and the ECM senses a high signal voltage. The ECM uses the signal circuit of the fuel level sensor in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via High Speed CAN-Bus to the body control module (BCM). The BCM then sends the fuel level percentage via Low Speed CAN-Bus to the instrument cluster in order to control the fuel gauge.

Conditions for Running the DTC

- Ignition ON/Vehicle in Service Mode
- Battery voltage is between 11-32 V

Conditions for Setting the DTC

P0461

- The ECM detects a change in fuel level of less than a specified amount (typically 3-10 L or 0.8-2.6 gal) over a specified driving distance (typically 240-320 km or 150-200 miles).

P0462

- The signal voltage is less than 0.25 V.
- The above conditions must be met for 5 s.

P0463

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- The signal voltage is greater than 4.7 V.
- The above conditions must be met for 5 s.

P0464

- The fuel level change is greater than 10% for a duration lasting less than 30 seconds.
- DTC P0464 runs and fails 2 out of 3 test cycles.

Action Taken When the DTC Sets

P0461, P0462, and P0463

- P0461, P0462, and P0463 are Type B DTCs
- The fuel gauge defaults to empty
- The low fuel indicator illuminates

P0464

- P0464 is a Type A DTC

Conditions for Clearing the DTC

- P0461, P0462, and P0463 are Type B DTCs
- P0464 is a Type A DTC

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

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Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Without UHS or UDV

1. Ignition ON/Vehicle in Service Mode.
2. Verify the fuel level gauge sweeps when performing the scan tool Instrument Cluster Gauge Sweep control function.
   - **If the fuel level gauge does not sweep**

     Replace the P16 Instrument Cluster

   - **If the fuel level gauge sweeps**
3. Verify the low fuel level indicator turns ON and OFF when commanding the scan tool All Indicators control function ON and OFF.
   - **If the low fuel level indicator does not turn ON and OFF**

     Replace the P16 Instrument Cluster

   - **If the low fuel level indicator turns ON and OFF**
4. Verify the scan tool Fuel Level Sensor parameter is between 0.5-3.5 V and varies with fuel level.
   - **If not between 0.5-3.5 V or does not vary with fuel level**

     Refer to Circuit/System Testing

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- **If between 0.5-3.5 V and varies with fuel level**

5. All OK.

With UHS or UDV

1. Ignition ON/Vehicle in Service Mode.
2. Verify the scan tool Fuel Level Sensor parameter is between 0.5-3.5 V and varies with fuel level.
   - **If not between 0.5-3.5 V or does not vary with fuel level**

     Refer to Circuit/System Testing

   - **If between 0.5-3.5 V and varies with fuel level**
3. All OK.

Circuit/System Testing

NOTE: Circuit/System Verification must be performed before proceeding with Circuit/System Testing.

1. Ignition OFF/Vehicle OFF and all vehicle systems OFF, disconnect the harness connector at the A7 Fuel Pump and Level Sensor assembly. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 3 and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If less than 10 Ω**
3. Ignition ON/Vehicle in Service Mode.
4. Verify the scan tool Fuel Level Sensor parameter is greater than 4.8 V.
   - **If 4.8 V or less**
   1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit terminal 4 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.

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- If infinite resistance, replace the K20 Engine Control Module.

- **If greater than 4.8 V**

5. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3.
6. Verify the scan tool Fuel Level Sensor parameter is less than 0.2 V.
   - **If 0.2 V or greater**
   1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the signal circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V
   3. Ignition OFF/Vehicle OFF
   4. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If less than 0.2 V**
7. Test or replace the fuel level sensor

Component Testing

1. Ignition OFF/Vehicle OFF, remove the fuel level sender.
2. Sweep the fuel level sensor through its full range of motion while measuring resistance between the signal terminal 4 and the low reference terminal 3.
3. Test for a minimum resistance value of 37-43 Ω and a maximum value of 245-255 Ω without any spikes or dropouts.
   - **If minimum resistance is not 37-43 Ω, maximum resistance is not 245-255 Ω, or if there are any spikes or dropouts**

     Replace the fuel level sensor.

   - **If minimum resistance is 37-43 Ω, maximum resistance is 245-255 Ω, and if there are no spikes or dropouts**
4. All OK.

Repair Instructions

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

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- **Displays and Gauges Component Replacement Reference**
- **Control Module References** for engine control module or instrument cluster replacement, programming, and setup

DTC P0521, P0522, OR P0523: ENGINE OIL PRESSURE SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC P0521

Engine Oil Pressure Sensor Performance

DTC P0522

Engine Oil Pressure Sensor Circuit Low Voltage.

DTC P0523

Engine Oil Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Engine Oil Pressure 5 V Reference	P0522	1	P0522	P0523	P0521
Engine Oil Pressure Sensor Signal	P0522	1	P0522	P0523	P0521
Low Reference	-	1	P0523	-	P0521
1. Engine Oil Pressure Gauge Inaccurate or Inoperative					

Circuit/System Description

The engine oil pressure sensor changes voltage based on the engine oil pressure. The engine oil pressure sensor is a 3-wire sensor comprising of the signal circuit, the low reference circuit and the 5 V reference circuit. The engine control module (ECM) supplies 5 V to the engine oil pressure sensor via the 5 V reference circuit and provides ground via the low reference circuit. The ECM monitors the signal circuit of the engine oil pressure sensor

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to determine if the engine oil pressure sensor voltage is within the normal operating range of approximately 1-4 V. When the engine oil pressure is high, the engine oil pressure sensor voltage is high and the ECM senses a high signal voltage. When the engine oil pressure is low, the engine oil pressure sensor voltage is low and the ECM senses a low signal voltage. The ECM sends the engine oil pressure information to the instrument cluster via serial data. The instrument cluster will illuminate or display the engine oil pressure indicator when the engine oil pressure is low.

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

P0521

- The ECM detects that measured oil pressure is at least 47 kPa (6.8 psi) less than or 50 kPa (7.3 psi) higher than the predicted oil pressure.
- The engine oil pressure is outside of a calculated working range determined by engine speed and temperature.
- One of the above conditions are present for greater than 4 s.

P0522

- The ECM detects that the engine oil pressure sensor signal circuit is less than 0.2 V.
- The above condition is present for greater than 10 s.

P0523

- The ECM detects that the engine oil pressure sensor signal circuit is greater than 4.8 V.
- The above condition is present for greater than 10 s.

Action Taken When the DTC Sets

- The ECM records the operating conditions at the time the diagnostics test fails. The ECM displays this information in the Failure Records on the scan tool.
- The instrument cluster illuminates the engine oil pressure indicator.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

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Diagnostic Aids

DTC P0521 can set if engine oil pressure is outside the calculated engine oil pressure model stored in the engine control module. This can be an indication of mechanical engine issues causing lower than expected engine oil pressure.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Indicator/Warning Message Description and Operation**
- **Instrument Cluster Description and Operation**

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON/Vehicle in Service Mode.
2. Verify the scan tool Engine Oil Pressure Sensor parameter is 0 psi (0 kPa).
    - **If not 0 psi (0 kPa)**

      Refer to Circuit/System Testing.

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- **If 0 psi (0 kPa)**

3. Engine running.
4. Verify actual engine oil pressure is within specified range. Refer to Oil Pressure Diagnosis and Testing in **Displays and Gauges Component Replacement Reference**.
5. Verify the scan tool Engine Oil Pressure parameter is within specified range.
   - **If not within specified range**

     Refer to Circuit/System Testing.

   - **If within specified range**
6. Verify the engine oil pressure displayed on the P16 Instrument Cluster is within specified range.
   - **If not within specified range**

     Test or replace the P16 Instrument Cluster.

   - **If within specified range**
7. All OK.

Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before proceeding with Circuit/System Testing.**

1. Ignition OFF/Vehicle OFF and all vehicle systems OFF, disconnect the harness connector at the B37B Engine Oil Pressure Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 2 and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If less than 10 Ω**
3. Ignition ON/Vehicle in Service Mode.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.

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- **If less than 4.8 V**

1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the 5 V reference circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the 5 V reference circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the 5 V reference circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

5. Verify the scan tool Engine Oil Pressure parameter is less than 14 kPa (2 psi).
    - **If 14 kPa (2 psi) or above**

    1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit terminal 1 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.

    - **If below 14 kPa (2 psi)**

6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3.
7. Engine running.
8. Verify the scan tool Engine Oil Pressure parameter is greater than 800kPa (116psi).
    - **If 800kPa (116psi) or less**

    1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 1 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance

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3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.
- **If greater than 800kPa (116psi)**

9. Test or replace the B37B Engine Oil Pressure Sensor.

Repair Instructions

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

- **Displays and Gauges Component Replacement Reference**
- **Control Module References** for control module replacement, programming and setup

DTC P2066: FUEL LEVEL SENSOR 2 PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P2066

Fuel Level Sensor 2 Performance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Level Sensor Signal Secondary	P2067	1	P2068	P2068	P2066
Fuel Level Sensor Low Reference	-	1	P2068	P2068	P2066
1. Fuel Gauge Inaccurate or Inoperative					

Circuit/System Description

The primary fuel level sensor and the secondary fuel level sensor change resistance in response to the fuel level. The engine control module (ECM)

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monitors the signal circuit of the primary fuel level sensor, the secondary fuel level sensor, and the type of fuel in order to determine the fuel level. For regular unleaded fuel the ECM monitors a constant signal. When the vehicle has approximately 20% or greater ethanol for E85 fuel applications, the ECM controls a pulse cycle signal where it monitors the signal and calculates the fuel level percentage only during the on pulse of approximately 100 ms.

When the fuel tanks are full, the sensor resistances of both fuel level sensors are low and the ECM senses a low signal voltage on both the signal circuits of the primary fuel level sensor and the secondary fuel level sensor. When the fuel tanks are empty, the resistances of the fuel level sensors are high and the ECM senses a high signal voltage. The ECM uses the signal circuit of the primary fuel level sensor and the secondary fuel level sensor in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via the serial data circuit to the instrument cluster in order to control the fuel gauge.

This diagnostic tests for a stuck fuel level sensor signal. The ECM sets this DTC if the fuel level sensor signal appears to be stuck based on a lack of signal variation expected during normal operation.

Conditions for Running the DTC

- The engine is running.
- Fuel level is greater than 32 liters (8.5 gallons).

Conditions for Setting the DTC

- The ECM detects a change in fuel level less than 3 liters (0.8 gallon) over a distance greater than 282 km (175 miles).
- The vehicle is at rest and the primary fuel tank increases by 3 liters (0.8 gallon) and the secondary fuel tank does not decrease by 3 liters (0.8 gallon) when the transfer pump is on greater than 500 seconds.

Action Taken When the DTC Sets

- The fuel gauge defaults to empty.
- The low fuel indicator illuminates.
- The ECM records the operating conditions at the time that the diagnostic test fails. The ECM displays the failure information in the Failure Records on the scan tool.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

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Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Component Testing

1. Ignition OFF, remove the fuel level sender.
2. Sweep the fuel level sensor through its full range of motion while measuring resistance between the signal terminal 4 and the low reference terminal 3.
3. Test for a minimum resistance value of 37-43 Ω and a maximum value of 245-255 Ω without any spikes or dropouts.
   - **If minimum resistance is not 37-43 Ω, maximum resistance is not 245-255 Ω, or if there are any spikes or dropouts**

     Replace the fuel level sensor.

   - **If minimum resistance is 37-43 Ω, maximum resistance is 245-255 Ω, and if there are no spikes or dropouts**
4. All OK.

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Repair Instructions

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

- **Displays and Gauges Component Replacement Reference**
- **Control Module References** for ECM replacement, programming and setup

DTC P2067: FUEL LEVEL SENSOR 2 LOW VOLTAGE

Diagnostic Instructions

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

DTC Descriptor

DTC P2067

Fuel Level Sensor 2 Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Level Sensor Signal Secondary	P2067	1	P2068	P2068	P2066
Fuel Level Sensor Low Reference	-	1	P2068	P2068	P2066
1. Fuel Gauge Inaccurate or Inoperative					

Circuit/System Description

The primary fuel level sensor and the secondary fuel level sensor change resistance in response to the fuel level. The engine control module (ECM) monitors the signal circuit of the primary fuel level sensor, the secondary fuel level sensor, and the type of fuel in order to determine the fuel level. For regular unleaded fuel the ECM monitors a constant signal. When the vehicle has approximately 20% or greater ethanol for E85 fuel applications, the ECM controls a pulse cycle signal where it monitors the signal and calculates the fuel level percentage only during the on pulse of approximately 100 ms.

When the fuel tanks are full, the sensor resistances of both fuel level sensors are low and the ECM senses a low signal voltage on both the signal circuits of the primary fuel level sensor and the secondary fuel level sensor. When the fuel tanks are empty, the resistances of the fuel level sensors

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are high and the ECM senses a high signal voltage. The ECM uses the signal circuit of the primary fuel level sensor and the secondary fuel level sensor in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via the serial data circuit to the instrument cluster in order to control the fuel gauge.

Conditions for Running the DTC

- The ignition is ON, with the engine running.
- The system voltage is between 11-18 V.

Conditions for Setting the DTC

- The secondary sender output is less than 0.5 V.
- The above condition is present for greater than 30 seconds.

Action Taken When the DTC Sets

- The fuel gauge defaults to empty.
- The low fuel indicator illuminates.
- The ECM records the operating conditions at the time that the diagnostic test fails. The ECM displays the failure information in the Failure Records on the scan tool.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

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Instrument Cluster Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, verify the scan tool Fuel Tank Level Remaining parameter is between 4-98 percent.

Circuit/System Testing

NOTE: Circuit/System Verification must be performed before proceeding with Circuit/System Testing.

1. Ignition OFF, disconnect the harness connector at the secondary fuel level sensor.
2. Ignition ON, verify that the scan tool Fuel Tank Level Remaining parameter display is less than 4 percent.
   - If greater than the specified value, test the secondary signal circuit terminal 4 for a short to ground. If the circuit tests normal, replace the ECM.
3. If all circuits test normal, test or replace the secondary fuel level sensor.

Component Testing

1. Ignition OFF, remove the fuel level sender.
2. Sweep the fuel level sensor through its full range of motion while measuring resistance between the signal terminal 4 and the low reference terminal 3.
3. Test for a minimum resistance value of 37-43 Ω and a maximum value of 245-255 Ω without any spikes or dropouts.
   - **If minimum resistance is not 37-43 Ω, maximum resistance is not 245-255 Ω, or if there are any spikes or dropouts**

     Replace the fuel level sensor.

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- **If minimum resistance is 37-43 Ω, maximum resistance is 245-255 Ω, and if there are no spikes or dropouts**

4. All OK.

Repair Instructions

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

- **Displays and Gauges Component Replacement Reference**
- **Control Module References** for ECM replacement, programming and setup

DTC P2068: FUEL LEVEL SENSOR 2 HIGH VOLTAGE

Diagnostic Instructions

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

DTC Descriptor

DTC P2068

Fuel Level Sensor 2 High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Level Sensor Signal Secondary	P2067	1	P2068	P2068	P2066
Fuel Level Sensor Low Reference	-	1	P2068	P2068	P2066
1. Fuel Gauge Inaccurate or Inoperative					

Circuit/System Description

The primary fuel level sensor and the secondary fuel level sensor change resistance in response to the fuel level. The engine control module (ECM) monitors the signal circuit of the primary fuel level sensor, the secondary fuel level sensor, and the type of fuel in order to determine the fuel level. For regular unleaded fuel the ECM monitors a constant signal. When the vehicle has approximately 20% or greater ethanol for E85 fuel applications, the ECM controls a pulse cycle signal where it monitors the signal and calculates the fuel level percentage only during the on pulse of approximately

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100 ms.

When the fuel tanks are full, the sensor resistances of both fuel level sensors are low and the ECM senses a low signal voltage on both the signal circuits of the primary fuel level sensor and the secondary fuel level sensor. When the fuel tanks are empty, the resistances of the fuel level sensors are high and the ECM senses a high signal voltage. The ECM uses the signal circuit of the primary fuel level sensor and the secondary fuel level sensor in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via the serial data circuit to the instrument cluster in order to control the fuel gauge.

Conditions for Running the DTC

- The ignition is ON, with the engine running.
- The system voltage is between 9-16 V.

Conditions for Setting the DTC

- The secondary sensor output is greater than 3.5 V.
- The above condition is present for greater than 30 seconds.

Action Taken When the DTC Sets

- The fuel gauge defaults to empty.
- The low fuel indicator illuminates.
- The ECM records the operating conditions at the time that the diagnostic test fails. The ECM displays the failure information in the Failure Records on the scan tool.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

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COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, verify the scan tool Fuel Tank Level Remaining parameter is between 4-98 percent.

Circuit/System Testing

NOTE: Circuit/System Verification must be performed before proceeding with Circuit/System Testing.

1. Ignition OFF, disconnect the harness connector at the secondary fuel level sensor.
2. Ignition OFF, test for less than 10 Ω between the low reference circuit terminal 3 and ground.
   - If greater than the specified range, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, install a 3 A fused jumper wire between the secondary signal circuit terminal 4 and the low reference circuit terminal 3. Verify the scan tool Fuel Tank Level Remaining parameter display is greater than 98 percent.
   - If less than the specified range, test the secondary signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
4. If all circuits test normal, test or replace the secondary fuel level sensor.

Component Testing

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1. Ignition OFF, remove the fuel level sender.
2. Sweep the fuel level sensor through its full range of motion while measuring resistance between the signal terminal 4 and the low reference terminal 3.
3. Test for a minimum resistance value of 37-43 Ω and a maximum value of 245-255 Ω without any spikes or dropouts.
    - **If minimum resistance is not 37-43 Ω, maximum resistance is not 245-255 Ω, or if there are any spikes or dropouts**

      Replace the fuel level sensor.

    - **If minimum resistance is 37-43 Ω, maximum resistance is 245-255 Ω, and if there are no spikes or dropouts**
4. All OK.

Repair Instructions

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

- **Displays and Gauges Component Replacement Reference**
- **Control Module References** for ECM replacement, programming and setup

DTC P250A: FUEL LEVEL SENSOR 2 HIGH VOLTAGE

Diagnostic Instructions

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

DTC Descriptor

DTC P250A

Fuel Level Sensor 2 High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Engine Oil Level Sensor Signal	2	P250A, 1	-
Engine Oil Level Sensor Ground	-	P250A, 1	-

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage
1. DIC message Engine Oil Level Low always ON 2. DIC message Engine Oil Level Low always OFF			

Typical Scan Tool Data

Engine Oil Level Switch

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON **Parameter Normal Range:** OK			
Engine Oil Level Sensor/Switch Signal	OK	Low	OK
Engine Oil Level Sensor/Switch Ground	-	Low	-

Circuit/System Description

The engine oil level sensor/switch is normally-closed with proper engine oil level. The switch opens when the engine oil level drops below a calibrated level. The engine control module (ECM) monitors the engine oil level signal circuit when the ignition is ON, and the engine is OFF. With the switch in the closed position, the ECM detects a low voltage on the signal circuit. With the switch in the open position, the ECM detects a high voltage on the signal circuit. When high voltage is detected on the signal circuit, the ECM will send a serial data message to the instrument panel cluster (IPC). The IPC will then display a message on the driver information center (DIC) or illuminate a low engine oil level lamp.

The following information determines the message sent from the ECM to the IPC:

- The Low Engine Oil Level message lamp is displayed only after the ECM detects a high voltage on the signal circuit for three consecutive ignition cycles, followed by an ignition OFF event from 15 minutes to greater than 50 minutes, depending on engine oil temperatures.
- The Low Engine Oil Level message is turned OFF when the ECM detects a low voltage on the signal circuit after an ignition OFF event for greater than 90 seconds, followed by an ignition ON event for less than 1 second.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

The ECM detects a high voltage on the signal circuit for three consecutive ignition cycles, followed by an ignition OFF event from 15 minutes to greater than 50 minutes, depending on engine oil temperatures.

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Action Taken When the DTC Sets

Engine Oil Level Low message activated.

Conditions for Clearing the DTC

The ECM detects a low voltage on the signal circuit after an ignition OFF event for greater than 90 seconds, followed by an ignition ON event for less than 1 second.

Reference Information

Schematic Reference

- **Engine Mechanical Schematics**
- **Instrument Cluster Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Instrument Cluster Description and Operation**
- **Indicator/Warning Message Description and Operation**

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

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1. Verify proper engine oil level.
    - **If not at proper level**

      Add oil as necessary.

    - **If at proper level**
2. Ignition ON, verify the scan tool Engine Oil Level parameter reads OK.
    - **If not OK**

      Refer to Circuit/System Testing.

    - **If OK**
3. All OK.

Circuit/System Testing

NOTE: **Verify proper engine oil level before continuing with diagnosis.**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B35 Engine Oil Level Switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the ground circuit terminal 1 and ground.
    - **If 5 Ω or greater**
    1. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **If less than 5 Ω**
3. Ignition ON.
4. Verify the scan tool Engine Oil Level Switch parameter reads Low.
    - **If the Engine Oil Level Switch parameter reads OK**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 2 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.

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- **If the Engine Oil Level Switch parameter reads Low**

NOTE: **If a short to voltage is found on the signal circuit, the fuse in the 3A jumper wire will open.**

5. Install a 3A fused jumper wire between the signal circuit terminal 2 and the ground circuit terminal 1.
6. Verify the scan tool Engine Oil Level Switch parameter reads OK.
    - **If the Engine Oil Level Switch parameter reads Low**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance on the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If the Engine Oil Level Switch parameter reads OK**
7. Test or replace the B35 Engine Oil Level Switch.

Repair Instructions

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

- **Displays and Gauges Component Replacement Reference**
- **Control Module References** for control module replacement, programming, and setup

DISPLAYS AND GAUGES COMPONENT REPLACEMENT REFERENCE

Component	Repair Instruction
B9 Ambient Air Temperature Sensor	**Ambient Air Temperature Sensor Replacement (X88)Ambient Air Temperature Sensor Replacement (Z88)Ambient Air Temperature Sensor Replacement (Cadillac)**
B35 Engine Oil Level Switch	{5.3L or 6.2L engine} **Engine Oil Level Indicator Switch Replacement (L83)**
B37B Engine Oil Pressure Sensor	{5.3L or 6.2L engine} **Engine Oil Pressure Sensor Replacement**

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Component	Repair Instruction
B46 Fuel Level Sensor	{5.3L or 6.2L engine} Fuel Level Sensor Replacement
P29 Head-Up Display	Head-Up Display Replacement (Chevrolet / GMC)Head-Up Display Replacement (Cadillac)
S39 Ignition Switch	Ignition and Start Switch Replacement (Without BTM) Ignition and Start Switch Replacement (Chevrolet / GMC With BTM) Ignition and Start Switch Replacement (Cadillac With BTM)
Oil Pressure Diagnosis and Testing	{5.3L or 6.2L engine} Oil Pressure Diagnosis and Testing

SYMPTOMS - DISPLAYS AND GAUGES

NOTE: **The following steps must be completed before using the symptom diagnostic tables.**

1. Before using the symptom diagnostic tables, perform the Diagnostic System Check - Vehicle in order to determine that there are no DTCs set, and that the control modules can communicate via the serial data link.
2. Review the system operation in order to understand the system functions. Refer to the following description and operations:
   - Instrument Cluster Description and Operation
   - Indicator/Warning Message Description and Operation
   - Audible Warnings Description and Operation
   - Head-Up Display Description and Operation

Visual/Physical Inspection

- Inspect for aftermarket devices which can affect the operation of the instrument panel cluster or the audible warning systems. Refer to Checking Aftermarket Accessories .
- Inspect the accessible system components or the visible system components for obvious damage or for obvious conditions which can cause the symptom.
- Inspect for the proper fluid levels.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections

Symptom List

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Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Fuel Gauge Malfunction (with single fuel tank)Fuel Gauge Malfunction (with dual fuel tanks)**
- **Engine Oil Pressure Gauge Inaccurate or Inoperative**
- **Head-Up Display Malfunction**
- **Outside Air Temperature Display Malfunction (2500/3500 series)Outside Air Temperature Display Malfunction (1500 series)**

CHIME MALFUNCTION

Diagnostic Instructions

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	1	1	-	1
Signal	1	1	1	1
1. Chime Malfunction				

Circuit/System Description

The radio generates the audible warnings. The instrument cluster, the body control module, the inflatable restraint sensing and diagnostic module or the object alarm module request audible warnings via serial data.

Reference Information

Schematic Reference

Audible Warnings Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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Description and Operation

Audible Warnings Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify all the radio speakers operate by adjust the radio balance and fade to each speaker.
   - **If any speaker does not operate properly**

     Refer to **Speaker Malfunction (UQ3)** **Speaker Malfunction (with Front Bench Seat)** **Speaker Malfunction (with Front Bucket Seats)** **Speaker Malfunction (UQS)** **Speaker Malfunction (UQH)** .

   - **If the speakers operate properly**
3. Verify the scan tool Driver Seat Belt Status and Passenger Seat Belt Status parameters are Buckled when both front seat belts are buckled.
   - **If not Buckled**

     Refer to **Seat Belt Indicator Malfunction - Driver** .

   - **If buckled**
4. Verify the scan tool Headlamp On Switch parameter is Inactive when the headlamps are OFF.
   - **If not Inactive**

     Refer to **Headlamps Malfunction (Chevrolet, GMC)** **Headlamps Malfunction (Cadillac)**

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- **If Inactive**

5. Verify the scan tool Park Lamps Switch parameter is Inactive when the park lamp switch is OFF.
   - **If not Inactive**

     Refer to **Park, License, and/or Tail Lamps Malfunction**

   - **If Inactive**
6. Verify the scan tool Left Turn Signal Switch and Right Turn Signal Switch parameters are Inactive while the turn signal switch is OFF.
   - **If not Inactive**

     Refer to **Park, License, and/or Tail Lamps Malfunction**

   - **If Inactive**
7. Verify the scan tool Park Brake Switch parameter is Inactive when the park brake is OFF.
   - **If not Inactive**

     Refer to **Park Brake System Diagnosis**

   - **If Inactive**
8. Verify that all scan tool parameters listed below are Inactive when all the doors are closed.
   - Driver Door Ajar Switch
   - Passenger Door Ajar Switch
   - Left Rear Door Ajar Switch
   - Right Rear Door Ajar Switch
   - **If not Inactive**

     Refer to **Door Ajar Indicator Malfunction**

   - **If Inactive**
9. Verify the scan tool Key in Ignition Status parameter is Inactive when the key is out of the ignition.
   - **If not Inactive**

     Refer to Circuit/System Testing.

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- **If Active**

10. All OK

Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before proceeding with Circuit/System Testing.**

1. Ignition ON, disconnect the harness connector at the S39 Ignition Switch while the ignition is ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 4 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. 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
   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 K9 Body Control Module.
   - **If the test lamp illuminates**
3. Verify the scan tool Key in Ignition Status parameter is Inactive.
   - **If not Inactive**
   1. Disconnect the X3 harness connector at the K9 Body Control Module.
   2. Test for less than 1 V between the signal circuit terminal 5 and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K9 Body Control Module.
   - **If Inactive**
4. Install a 3 A fused jumper wire between the signal circuit terminal 5 and the B+ circuit terminal 4.
5. Verify the scan tool Key in Ignition Status parameter is Active.

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- **If not Active**

1. Ignition OFF, disconnect the X3 harness connector at the K9 Body Control Module.
2. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K9 Body Control Module.

- **If Active**

6. Test or replace the S39 Ignition Switch.

Repair Instructions

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

- **Displays and Gauges Component Replacement Reference**
- **Control Module References** for body control module or radio replacement, programming and setup.

ENGINE OIL PRESSURE GAUGE INACCURATE OR INOPERATIVE

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 P0521

Engine Oil Pressure Sensor Performance

DTC P0522

Engine Oil Pressure Sensor Circuit Low Voltage.

DTC P0523

Engine Oil Pressure Sensor Circuit High Voltage

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Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Engine Oil Pressure 5 V Reference	P0522	1	P0522	P0523	P0521
Engine Oil Pressure Sensor Signal	P0522	1	P0522	P0523	P0521
Low Reference	-	1	P0523	-	P0521
1. Engine Oil Pressure Gauge Inaccurate or Inoperative					

Circuit/System Description

The engine oil pressure sensor changes voltage based on the engine oil pressure. The engine oil pressure sensor is a 3-wire sensor comprising of the signal circuit, the low reference circuit and the 5 V reference circuit. The engine control module (ECM) supplies 5 V to the engine oil pressure sensor via the 5 V reference circuit and provides ground via the low reference circuit. The ECM monitors the signal circuit of the engine oil pressure sensor to determine if the engine oil pressure sensor voltage is within the normal operating range of approximately 1-4 V. When the engine oil pressure is high, the engine oil pressure sensor voltage is high and the ECM senses a high signal voltage. When the engine oil pressure is low, the engine oil pressure sensor voltage is low and the ECM senses a low signal voltage. The ECM sends the engine oil pressure information to the instrument cluster via serial data. The instrument cluster will illuminate or display the engine oil pressure indicator when the engine oil pressure is low.

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

P0521

- The ECM detects that measured oil pressure is at least 47 kPa (6.8 psi) less than or 50 kPa (7.3 psi) higher than the predicted oil pressure.
- The engine oil pressure is outside of a calculated working range determined by engine speed and temperature.
- One of the above conditions are present for greater than 4 s.

P0522

- The ECM detects that the engine oil pressure sensor signal circuit is less than 0.2 V.
- The above condition is present for greater than 10 s.

P0523

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- The ECM detects that the engine oil pressure sensor signal circuit is greater than 4.8 V.
- The above condition is present for greater than 10 s.

Action Taken When the DTC Sets

- The ECM records the operating conditions at the time the diagnostics test fails. The ECM displays this information in the Failure Records on the scan tool.
- The instrument cluster illuminates the engine oil pressure indicator.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Diagnostic Aids

DTC P0521 can set if engine oil pressure is outside the calculated engine oil pressure model stored in the engine control module. This can be an indication of mechanical engine issues causing lower than expected engine oil pressure.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Indicator/Warning Message Description and Operation**
- **Instrument Cluster Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON/Vehicle in Service Mode.
2. Verify the scan tool Engine Oil Pressure Sensor parameter is 0 psi (0 kPa).
   - **If not 0 psi (0 kPa)**

     Refer to Circuit/System Testing.

   - **If 0 psi (0 kPa)**
3. Engine running.
4. Verify actual engine oil pressure is within specified range. Refer to Oil Pressure Diagnosis and Testing in **Displays and Gauges Component Replacement Reference**.
5. Verify the scan tool Engine Oil Pressure parameter is within specified range.
   - **If not within specified range**

     Refer to Circuit/System Testing.

   - **If within specified range**
6. Verify the engine oil pressure displayed on the P16 Instrument Cluster is within specified range.
   - **If not within specified range**

     Test or replace the P16 Instrument Cluster.

   - **If within specified range**
7. All OK.

Circuit/System Testing

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NOTE: **Circuit/System Verification must be performed before proceeding with Circuit/System Testing.**

1. Ignition OFF/Vehicle OFF and all vehicle systems OFF, disconnect the harness connector at the B37B Engine Oil Pressure Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 2 and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If less than 10 Ω**
3. Ignition ON/Vehicle in Service Mode.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If between 4.8-5.2 V**
5. Verify the scan tool Engine Oil Pressure parameter is less than 14 kPa (2 psi).
    - **If 14 kPa (2 psi) or above**

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1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit terminal 1 and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **If below 14 kPa (2 psi)**

6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3.
7. Engine running.
8. Verify the scan tool Engine Oil Pressure parameter is greater than 800kPa (116psi).

- **If 800kPa (116psi) or less**

1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit terminal 1 and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If greater than 800kPa (116psi)**

9. Test or replace the B37B Engine Oil Pressure Sensor.

Repair Instructions

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

- **Displays and Gauges Component Replacement Reference**
- **Control Module References** for control module replacement, programming and setup

FUEL GAUGE MALFUNCTION (WITH SINGLE FUEL TANK)

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.

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

DTC Descriptors

DTC P0461

Fuel Level Sensor Performance

DTC P0462

Fuel Level Sensor Circuit Low Voltage

DTC P0463

Fuel Level Sensor Circuit High Voltage

DTC P0464

Fuel Level Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Level Sensor 1 Signal	P0462	P0463	P0463	P0461
Low Reference	-	1	P0463, P0464	P0461
1. Fuel Gauge Malfunction				

Circuit/System Description

The fuel level sensor changes resistance based on fuel level. The engine control module (ECM) monitors the signal circuit of the fuel level sensor in order to determine the fuel level. When the fuel tank is full, the resistance of the fuel level sensor is low and the ECM senses a low signal voltage on the signal circuit of the fuel level sensor. When the fuel tank is empty, the resistance of the fuel level sensor is high and the ECM senses a high signal voltage. The ECM uses the signal circuit of the fuel level sensor in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via High Speed CAN-Bus to the body control module (BCM). The BCM then sends the fuel level percentage via Low Speed CAN-Bus to the instrument cluster in order to control the fuel gauge.

Conditions for Running the DTC

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- Ignition ON/Vehicle in Service Mode
- Battery voltage is between 11-32 V

Conditions for Setting the DTC

P0461

- The ECM detects a change in fuel level of less than a specified amount (typically 3-10 L or 0.8-2.6 gal) over a specified driving distance (typically 240-320 km or 150-200 miles).

P0462

- The signal voltage is less than 0.25 V.
- The above conditions must be met for 5 s.

P0463

- The signal voltage is greater than 4.7 V.
- The above conditions must be met for 5 s.

P0464

- The fuel level change is greater than 10% for a duration lasting less than 30 seconds.
- DTC P0464 runs and fails 2 out of 3 test cycles.

Action Taken When the DTC Sets

P0461, P0462, and P0463

- P0461, P0462, and P0463 are Type B DTCs
- The fuel gauge defaults to empty
- The low fuel indicator illuminates

P0464

- P0464 is a Type A DTC

Conditions for Clearing the DTC

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- P0461, P0462, and P0463 are Type B DTCs
- P0464 is a Type A DTC

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Without UHS or UDV

1. Ignition ON/Vehicle in Service Mode.
2. Verify the fuel level gauge sweeps when performing the scan tool Instrument Cluster Gauge Sweep control function.

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- **If the fuel level gauge does not sweep**

  Replace the P16 Instrument Cluster

- **If the fuel level gauge sweeps**

3. Verify the low fuel level indicator turns ON and OFF when commanding the scan tool All Indicators control function ON and OFF.
   - **If the low fuel level indicator does not turn ON and OFF**

     Replace the P16 Instrument Cluster

   - **If the low fuel level indicator turns ON and OFF**
4. Verify the scan tool Fuel Level Sensor parameter is between 0.5-3.5 V and varies with fuel level.
   - **If not between 0.5-3.5 V or does not vary with fuel level**

     Refer to Circuit/System Testing

   - **If between 0.5-3.5 V and varies with fuel level**
5. All OK.

With UHS or UDV

1. Ignition ON/Vehicle in Service Mode.
2. Verify the scan tool Fuel Level Sensor parameter is between 0.5-3.5 V and varies with fuel level.
   - **If not between 0.5-3.5 V or does not vary with fuel level**

     Refer to Circuit/System Testing

   - **If between 0.5-3.5 V and varies with fuel level**
3. All OK.

Circuit/System Testing

NOTE: Circuit/System Verification must be performed before proceeding with Circuit/System Testing.

1. Ignition OFF/Vehicle OFF and all vehicle systems OFF, disconnect the harness connector at the A7 Fuel Pump and Level Sensor assembly. It may take up to 2 min for all vehicle systems to power down.

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2. Test for less than 10 Ω between the low reference circuit terminal 3 and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If less than 10 Ω**
3. Ignition ON/Vehicle in Service Mode.
4. Verify the scan tool Fuel Level Sensor parameter is greater than 4.8 V.
    - **If 4.8 V or less**
    1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 4 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **If greater than 4.8 V**
5. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3.
6. Verify the scan tool Fuel Level Sensor parameter is less than 0.2 V.
    - **If 0.2 V or greater**
    1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF/Vehicle OFF
    4. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If less than 0.2 V**
7. Test or replace the fuel level sensor

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Component Testing

1. Ignition OFF/Vehicle OFF, remove the fuel level sender.
2. Sweep the fuel level sensor through its full range of motion while measuring resistance between the signal terminal 4 and the low reference terminal 3.
3. Test for a minimum resistance value of 37-43 Ω and a maximum value of 245-255 Ω without any spikes or dropouts.
    - **If minimum resistance is not 37-43 Ω, maximum resistance is not 245-255 Ω, or if there are any spikes or dropouts**

      Replace the fuel level sensor.

    - **If minimum resistance is 37-43 Ω, maximum resistance is 245-255 Ω, and if there are no spikes or dropouts**
4. All OK.

Repair Instructions

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

- **Displays and Gauges Component Replacement Reference**
- **Control Module References** for engine control module or instrument cluster replacement, programming, and setup

FUEL GAUGE MALFUNCTION (WITH DUAL FUEL TANKS)

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 P0461

Fuel Level Sensor 1 Performance

DTC P0462

Fuel Level Sensor 1 Circuit Low Voltage

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DTC P0463

Fuel Level Sensor 1 Circuit High Voltage

DTC P0464

Fuel Level Sensor 1 Circuit Intermittent

DTC P2066

Fuel Level Sensor 2 Performance

DTC P2067

Fuel Level Sensor 2 Circuit Low Voltage

DTC P2068

Fuel Level Sensor 2 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Level Sensor 1/Primary Signal	P0462	P0463	P0463	P0461, 1
Fuel Level Sensor 2/Secondary Signal	P2067	P2068	P2068	P2066, 1
Low Reference	-	P0463, P2068	P0463, P2068	P0461, P2066, 1
1. Fuel Gauge Malfunction				

Circuit/System Description

The primary fuel level sensor and the secondary fuel level sensor change resistance based on fuel level. The engine control module (ECM) monitors the signal circuits of both sensor to determine the fuel level. When the fuel tank is full, the resistances of both fuel level sensors are low. When the fuel tank is empty, the resistances of the fuel level sensors are high. The ECM uses the signal voltages of the primary fuel level sensor and the secondary fuel level sensor to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via serial data to the body control module (BCM). The BCM then sends the fuel level percentage via serial data to the instrument cluster to control the fuel gauge.

Conditions for Running the DTC

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- The engine is running
- The system voltage is between 11-16 V

Conditions for Setting the DTC

P0461 or P2066

The ECM detects a change in fuel level of less than a specified amount (typically 3-10 L or 0.8-2.6 gal) over a specified driving distance (typically 240-320 km or 150-200 miles).

P0462 or P2067

- The signal voltage is less than 0.25 V.
- The above conditions must be met for 5 seconds.

P0463 or P2068

- The signal voltage is greater than 4.7 V.
- The above conditions must be met for 5 seconds.

P0464

- The fuel level change is greater than 10%.
- The above conditions must be met for 30 seconds.
- DTC P0464 runs and fails 2 out of 3 test cycles.

Action Taken When the DTC Sets

- P0461, P0462, P0463, P0464, P2066, P2067 and P2068 are Type B DTCs
- The fuel gauge defaults to empty

Conditions for Clearing the DTC

- P0461, P0462, P0463, P0464, P2066, P2067 and P2068 are Type B DTCs
- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

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Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Without UHS or UDV

1. Ignition ON.
2. Verify the fuel level gauge sweeps when performing the scan tool Instrument Cluster Gauge Sweep control function.
    - **If the fuel level gauge does not sweep**

      Replace the P16 Instrument Cluster

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- **If the fuel level gauge sweeps**

3. Verify the low fuel level indicator turns ON and OFF when commanding the scan tool All Indicators control function ON and OFF.
   - **If the low fuel level indicator does not turn ON and OFF**

     Replace the P16 Instrument Cluster

   - **If the low fuel level indicator turns ON and OFF**
4. Verify the scan tool Fuel Level Sensor Left Tank parameter is between 0.5-3.5 V and varies with fuel level.
   - **If not between 0.5-3.5 V or does not vary with fuel level**

     Refer to Primary Fuel Level Sensor Malfunction in Circuit/System Testing

   - **If between 0.5-3.5 V and varies with fuel level**
5. Verify the scan tool Fuel Level Sensor Right Tank parameter is between 0.5-3.5 V and varies with fuel level.
   - **If not between 0.5-3.5 V or does not vary with fuel level**

     Refer to Secondary Fuel Level Sensor Malfunction in Circuit/System Testing

   - **If between 0.5-3.5 V and varies with fuel level**
6. All OK.

With UHS or UDV

1. Ignition ON.
2. Verify the scan tool Fuel Level Sensor Left Tank parameter is between 0.5-3.5 V and varies with fuel level.
   - **If not between 0.5-3.5 V or does not vary with fuel level**

     Refer to Primary Fuel Level Sensor Malfunction in Circuit/System Testing

   - **If between 0.5-3.5 V and varies with fuel level**
3. Verify the scan tool Fuel Level Sensor Right Tank parameter is between 0.5-3.5 V and varies with fuel level.
   - **If not between 0.5-3.5 V or does not vary with fuel level**

     Refer to Secondary Fuel Level Sensor Malfunction in Circuit/System Testing

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- **If between 0.5-3.5 V and varies with fuel level**

4. All OK.

Circuit/System Testing

NOTE: Circuit/System Verification must be performed before proceeding with Circuit/System Testing.

Primary Fuel Level Sensor Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A7 Fuel Pump and Level Sensor Assembly. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 3 and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If less than 10 Ω**
3. Ignition ON.
4. Verify the scan tool Fuel Level Sensor Left Tank parameter is greater than 4.8 V.
   - **If 4.8 V or less**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit terminal 4 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.
   - **If greater than 4.8 V**
5. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3.
6. Verify the scan tool Fuel Level Sensor Left Tank parameter is less than 0.2 V.
   - **If 0.2 V or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the signal circuit and ground.

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- 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 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.
- **If less than 0.2 V**

7. Test or replace the B46 Fuel Level Sensor.

Secondary Fuel Level Sensor Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B46B Fuel Level Sensor - Secondary. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 3 and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If less than 10 Ω**
3. Ignition ON.
4. Verify the scan tool Fuel Level Sensor Right Tank parameter is greater than 4.8 V.
    - **If 4.8 V or less**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 4 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **If greater than 4.8 V**
5. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3.
6. Verify the scan tool Fuel Level Sensor Right Tank parameter is less than 0.2 V.

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- **If 0.2 V or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V
3. Ignition OFF
4. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If less than 0.2 V**

7. Test or replace the B46B Fuel Level Sensor - Secondary.

Component Testing

1. Ignition OFF, remove the appropriate Fuel Level Sender.
2. Sweep the Fuel Level Sensor through its full range of motion while measuring resistance between the signal terminal 4 and the low reference terminal 3.
3. Test for a minimum resistance value of 37-43 Ω and a maximum value of 245-255 Ω without any spikes or dropouts.
    - **If minimum resistance is not 37-43 Ω, maximum resistance is not 245-255 Ω, or if there are any spikes or dropouts**

      Replace the appropriate Fuel Level Sensor.

    - **If minimum resistance is 37-43 Ω, maximum resistance is 245-255 Ω, and if there are no spikes or dropouts**
4. All OK.

Repair Instructions

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

- **Displays and Gauges Component Replacement Reference**
- **Control Module References** for Engine Control Module or Instrument Cluster replacement, programming, and setup

HEAD-UP DISPLAY MALFUNCTION

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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.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U1518 00	U1518 00	-	-
Serial Data	1, U1518 00	U1518 00	1, U1518 00	-
Video Signal	1	1	1	1
Switch Signal	B361B 02	B361B 05	B361B 05	B361B 59
Switch Low Reference	-	B361B 05	-	-
Ground	-	U1518 00	-	-
1. Head-Up Display Malfunction				

Circuit/System Description

The head-up display projects a full color image onto the windshield and is only viewable from the driver seat. The image location and brightness is adjustable using the head-up display switch. The image information is received from the instrument cluster through a video cable.

The head-up display is a slave device to the instrument cluster. The head-up display is powered through ignition voltage and ground. It communicates directly with instrument cluster via serial data and only has limited self-diagnosis capacity. Head-up display DTCs are reported through the Instrument Cluster.

The head-up display switch is a multiplexed switch that controls the head-up display based on driver inputs. The head-up display provides the switch with a low reference and monitors a signal circuit. The head-up display switch is made up of a resistor ladder and three switches: Dim +/-, Up/Down, and Page. When a switch is pressed, the signal voltage is pulled low through the resistor ladder. When pressed, each of the switches will result in a different signal voltage seen by the head-up display, depending on the switch's location on the resistor ladder.

Reference Information

Schematic Reference

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Head-Up Display Schematics

Steering Wheel Secondary/Configurable Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON/Vehicle in Service Mode.
2. Verify a test pattern is displayed is displayed on the P29 Head-Up Display when performing the Head-Up Display Pattern Check on the scan tool.
    - **If the test pattern is not displayed**

      Refer to Inoperative Head-Up display Circuit/System Testing.

    - **If the test pattern is displayed**
3. While holding each switch listed below, verify the scan tool Head-Up Display Switch parameter is as follows:
    - DIM + Switch - HUD Dimming Up/Down Pressed
    - DIM - Switch - HUD Dimming Up/Down Pressed

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- UP Switch - HUD Movement
- DOWN Switch - HUD Movement
- PAGE Switch - HUD Page Switch
- **If the scan tool parameter does not equal the expected result with the switch in the appropriate state**

  Refer to Inoperative Head-Up Display Switch Circuit/System Testing.

- **If the scan tool parameter equals the expected result with the switch in the appropriate state**

4. Verify the P29 Head-Up Display performs the following function with the switch in the appropriate state:
   - DIM + Switch - Head-up display brightness increases
   - DIM - Switch - Head-up display brightness decreases
   - UP Switch - Head-up display image moves up
   - DOWN Switch - Head-up display image moves down
   - PAGE Switch - Head-up display image changes pages
   - **If the P29 Head-Up Display does not perform the expected function with the switch in the appropriate state**

     Replace the P29 Head-Up Display.

   - **If the P29 Head-Up Display performs the expected function with the switch in the appropriate state**
5. All OK.

Circuit/System Testing

NOTE: Circuit/System Verification must be performed before proceeding with Circuit/System Testing.

Inoperative Head-Up Display

1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the P16 Instrument Cluster and P29 Head-Up Display. Ignition ON/Vehicle in Service Mode.
2. Test for less than 1 V between the P16 Instrument Cluster harness connector X1 serial data circuit terminal 21 and ground.
   - **If greater than 1 V**

     Repair the short to voltage on the circuit.

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- **If less than 1 V**

3. Ignition OFF/Vehicle OFF.
4. Test for infinite resistance between the P16 Instrument Cluster harness connector X1 serial data circuit terminal 21 and ground.
   - If less than infinite resistance, repair the short to ground on the circuit.
   - If infinite resistance
5. Disconnect the harness connector at the S70R Steering Wheel Controls Switch - Right. Ignition ON/Vehicle in Service Mode.
6. Test for less than 1 V between the S70R Steering Wheel Controls Switch - Right serial data circuit terminal 3 and ground.
   - **If greater than 1 V**

     Repair the short to voltage on the circuit.

   - **If less than 1 V**
7. Ignition OFF/Vehicle OFF.
8. Test for infinite resistance between the serial data circuit terminal 3 and ground.
   - **If less than infinite resistance**

     Repair the short to ground on the circuit.

   - **If infinite resistance**
9. Replace the video cable between the P29 Head-Up Display and the P16 Instrument Cluster. Ignition ON/Vehicle in Service Mode.
10. Verify a test pattern is displayed is displayed on the P29 Head-Up Display when performing the Head-Up Display Pattern Check on the scan tool.
    - **If the test pattern is displayed**

      All OK.

    - **If the test pattern is not displayed**
11. Connect the harness connector at the P16 Instrument Cluster and S70R Steering Wheel Controls Switch - Right. Ignition ON/Vehicle in Service Mode.
12. Verify steering wheel controls function properly.
    - **If steering wheel controls function properly**

      Replace P29 Head-Up Display.

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- **If steering wheel controls do not function properly**

13. Ignition OFF/Vehicle OFF. Disconnect harness connector at the S70R Steering Wheel Controls Switch - Right. Connect the harness connector at the and P29 Head-Up Display. Ignition ON/Vehicle in Service Mode.
14. Verify head-up display functions properly.
    - **If head-up display functions properly**

      Replace S70R Steering Wheel Controls Switch - Right.

    - **If head-up display does not function properly**
15. Replace P16 Instrument Cluster.

Inoperative Head-Up Display Switch

1. Ignition OFF/Vehicle OFF and all vehicle systems OFF, disconnect the harness connector at the S27 Head-Up Display Switch. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 3 and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the P29 Head-Up Display.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the P29 Head-Up Display.
    - **If less than 10 Ω**
3. Ignition ON/Vehicle in Service Mode.
4. Test for 4.8-5.2 V between the signal circuit terminal 4 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the P29 Head-Up Display.
    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 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.

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- If less than 2 Ω, replace the P29 Head-Up Display.

- **If greater than 5.2 V**

1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the P29 Head-Up Display, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the P29 Head-Up Display.

- **If between 4.8-5.2 V**

5. Test or replace the S27 Head-Up Display Switch.

Component Testing

1. Ignition OFF/Vehicle OFF, disconnect the harness connector at the S27 Head-Up Display Switch.
2. Test for 3.4K - 4.2K Ω between the signal terminal 4 and the low reference terminal 3.
    - **If not between 3.4K - 4.2K Ω**

      Replace the S27 Head-Up Display Switch.

    - **If between 3.4K - 4.2K Ω**
3. Test for 87 - 107 Ω between the signal terminal 4 and the low reference terminal 3 with the Dim + switch pressed.
    - **If not between 87 - 107 Ω**

      Replace the S27 Head-Up Display Switch.

    - **If between 87 - 107 Ω**
4. Test for 291 - 356 Ω between the signal terminal 4 and the low reference terminal 3 with the Dim - switch pressed.
    - **If not between 291 - 356 Ω**

      Replace the S27 Head-Up Display Switch.

    - **If between 291 - 356 Ω**
5. Test for 575 - 704 Ω between the signal terminal 4 and the low reference terminal 3 with the Up switch pressed.
    - **If not between 575 - 704 Ω**

      Replace the S27 Head-Up Display Switch.

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- **If between 575 - 704 Ω**

6. Test for 1K - 1.2K Ω between the signal terminal 4 and the low reference terminal 3 with the Down switch pressed.
   - **If not between 1K - 1.2K Ω**

     Replace the S27 Head-Up Display Switch.

   - **If between 1K - 1.2K Ω**
7. Test for 1.7K - 2.1K Ω between the signal terminal 4 and the low reference terminal 3 with the Page switch pressed.
   - **If not between 1.7K - 2.1K Ω**

     Replace the S27 Head-Up Display Switch.

   - **If between 1.7K - 2.1K Ω**
8. All OK.

Repair Instructions

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

- **Displays and Gauges Component Replacement Reference**
- **Control Module References** for instrument cluster replacement, programming, and setup

ENGINE OIL LEVEL SENSOR DIAGNOSIS

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 P250A

Engine Oil Level Switch Circuit

Diagnostic Fault Information

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Engine Oil Level Sensor Signal	2	P250A, 1	-
Engine Oil Level Sensor Ground	-	P250A, 1	-
1. DIC message Engine Oil Level Low always ON 2. DIC message Engine Oil Level Low always OFF			

Typical Scan Tool Data

Engine Oil Level Switch

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON **Parameter Normal Range:** OK			
Engine Oil Level Sensor/Switch Signal	OK	Low	OK
Engine Oil Level Sensor/Switch Ground	-	Low	-

Circuit/System Description

The engine oil level sensor/switch is normally-closed with proper engine oil level. The switch opens when the engine oil level drops below a calibrated level. The engine control module (ECM) monitors the engine oil level signal circuit when the ignition is ON, and the engine is OFF. With the switch in the closed position, the ECM detects a low voltage on the signal circuit. With the switch in the open position, the ECM detects a high voltage on the signal circuit. When high voltage is detected on the signal circuit, the ECM will send a serial data message to the instrument panel cluster (IPC). The IPC will then display a message on the driver information center (DIC) or illuminate a low engine oil level lamp.

The following information determines the message sent from the ECM to the IPC:

- The Low Engine Oil Level message lamp is displayed only after the ECM detects a high voltage on the signal circuit for three consecutive ignition cycles, followed by an ignition OFF event from 15 minutes to greater than 50 minutes, depending on engine oil temperatures.
- The Low Engine Oil Level message is turned OFF when the ECM detects a low voltage on the signal circuit after an ignition OFF event for greater than 90 seconds, followed by an ignition ON event for less than 1 second.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

The ECM detects a high voltage on the signal circuit for three consecutive ignition cycles, followed by an ignition OFF event from 15 minutes to

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greater than 50 minutes, depending on engine oil temperatures.

Action Taken When the DTC Sets

Engine Oil Level Low message activated.

Conditions for Clearing the DTC

The ECM detects a low voltage on the signal circuit after an ignition OFF event for greater than 90 seconds, followed by an ignition ON event for less than 1 second.

Reference Information

Schematic Reference

- **Engine Mechanical Schematics**
- **Instrument Cluster Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Instrument Cluster Description and Operation**
- **Indicator/Warning Message Description and Operation**

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information.

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Circuit/System Verification

1. Verify proper engine oil level.
    - **If not at proper level**

      Add oil as necessary.

    - **If at proper level**
2. Ignition ON, verify the scan tool Engine Oil Level parameter reads OK.
    - **If not OK**

      Refer to Circuit/System Testing.

    - **If OK**
3. All OK.

Circuit/System Testing

NOTE: **Verify proper engine oil level before continuing with diagnosis.**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B35 Engine Oil Level Switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the ground circuit terminal 1 and ground.
    - **If 5 Ω or greater**
    1. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **If less than 5 Ω**
3. Ignition ON.
4. Verify the scan tool Engine Oil Level Switch parameter reads Low.
    - **If the Engine Oil Level Switch parameter reads OK**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 2 and ground.

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- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the K20 Engine Control Module.

- **If the Engine Oil Level Switch parameter reads Low**

NOTE: **If a short to voltage is found on the signal circuit, the fuse in the 3A jumper wire will open.**

5. Install a 3A fused jumper wire between the signal circuit terminal 2 and the ground circuit terminal 1.
6. Verify the scan tool Engine Oil Level Switch parameter reads OK.
   - **If the Engine Oil Level Switch parameter reads Low**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the signal circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance on the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If the Engine Oil Level Switch parameter reads OK**
7. Test or replace the B35 Engine Oil Level Switch.

Repair Instructions

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

- **Displays and Gauges Component Replacement Reference**
- **Control Module References** for control module replacement, programming, and setup

OUTSIDE AIR TEMPERATURE DISPLAY MALFUNCTION (2500/3500 SERIES)

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.

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DTC Descriptors

DTC B0158 02

Ambient Air Temperature Sensor Circuit Short to Ground

DTC B0158 05

Ambient Air Temperature Sensor Circuit High Voltage/Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	B0158 02	1 or B0158 05	B0158 05	1
Low Reference	-	B0158 05	-	-
1. Outside Air Temperature Display Malfunction				

Circuit/System Description

The B9 Ambient Air Temperature Sensor is located behind the grille. The instrument cluster monitors the ambient air temperature sensor with a low reference circuit and signal circuit. The instrument cluster monitors the voltage drop across the sensor, which is inversely proportional to temperature. When the ambient air temperature is cold, the resistance of the sensor is high. When the ambient air temperature is warm, the resistance of the sensors is low. The instrument cluster converts the voltage value to a temperature value and displays the temperature.

Conditions for Running the DTC

The system voltage is between 9-16 V.

Conditions for Setting the DTC

B0158 02

The instrument cluster detects the sensor signal is more than 88Â°C (190Â°F).

B0158 05

The instrument cluster detects the sensor signal is less than -40Â°C (-40Â°F).

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Action Taken When the DTC Sets

The instrument cluster uses a default air temperature value for further calculations. The instrument cluster will display -Â°C (-Â°F). A/C compressor engagement may be disabled.

Conditions for Clearing the DTC

The DTC will become history if the instrument cluster no longer detects a malfunction.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **For vehicles with RPO AVF, ensure that the Body Control Module and Instrument Cluster have been programmed with the latest calibrations before proceeding with Circuit/System Verification and Circuit/System**

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Testing.

1. Ignition ON.

NOTE: **The scan tool Instrument Cluster Ambient Air Temperature parameter is a buffered value when the measured temperature is increasing. Performing the Ambient Air Temperature Instant Update with the scan tool may be necessary to force the Ambient Air Temperature parameter to update to the current measured temperature.**

2. Verify the scan tool Instrument Cluster Ambient Air Temperature parameter is between -40Â°C (-40Â°F) and +88Â°C (+190Â°F) and changes with air temperature changes.
   - **If not between -40Â°C (-40Â°F) and +88Â°C (+190Â°F) or changes with air temperature changes**

     Refer to Circuit/System Testing.

   - **If between -40Â°C (-40Â°F) and +88Â°C (+190Â°F) and changes with air temperature changes**
3. All OK.

Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before proceeding with Circuit/System Testing.**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B9 Ambient Air Temperature Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal B (or 2) and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the P16 Instrument Cluster.
   - **If less than 10 Ω**
3. Ignition ON.
4. Verify the scan tool Ambient Air Temperature parameter is greater than 98%.
   - **If 98% or less**

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1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster.
2. Test for infinite resistance between the signal circuit terminal A (or 1) and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the P16 Instrument Cluster.

- **If greater than 98%**

5. Install a 3 A fused jumper wire between the signal circuit terminal A (or 1) and the low reference circuit terminal B (or 2).
6. Verify the scan tool Ambient Air Temperature parameter is less than 8%.

- **If 8% or greater**

1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V
3. Ignition OFF
4. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the P16 Instrument Cluster.

- **If less than 8%**

7. Test or replace the B9 Ambient Air Temperature Sensor.

Repair Instructions

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

- **Displays and Gauges Component Replacement Reference**
- **Control Module References** for instrument cluster replacement, programming and setup

OUTSIDE AIR TEMPERATURE DISPLAY MALFUNCTION (1500 SERIES)

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.

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

DTC Descriptors

DTC P0071

Ambient Air Temperature Sensor Performance

DTC P0072

Ambient Air Temperature Sensor Circuit Low Voltage

DTC P0073

Ambient Air Temperature Sensor Circuit High Voltage

DTC P0074

Ambient Air Temperature Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0072	P0073	P0073	P0071
Low Reference	-	P0073	-	P0071

Circuit/System Description

The B9 Ambient Air Temperature Sensor is located behind the grille. The engine control module monitors the ambient air temperature sensor with a low reference circuit and signal circuit. The engine control module monitors the voltage drop across the sensor, which is inversely proportional to temperature. When the ambient air temperature is cold, the resistance of the sensor is high. When the ambient air temperature is warm, the resistance of the sensors is low. The engine control module converts the voltage value to a temperature value and sends the value to the P17 Info Display Module via serial data. The P17 Info Display Module displays the temperature.

Reference Information

Schematic Reference

Instrument Cluster Schematics

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Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool ECM Ambient Air Temperature parameter is between -40Â°C (-40Â°F) and +88Â°C (+190Â°F) and changes with air temperature changes.
   - **If not between -40Â°C (-40Â°F) and +88Â°C (+190Â°F) or changes with air temperature changes**

     Refer to Circuit/System Testing.

   - **If between -40Â°C (-40Â°F) and +88Â°C (+190Â°F) and changes with air temperature changes**
3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B9 Ambient Air Temperature Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal B (or 2) and ground.

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- **If 10 Ω or greater**

1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
2. Test for less than 2 Ω in the low reference circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the P16 Instrument Cluster.

- **If less than 10 Ω**

3. Ignition ON.
4. Verify the ECM scan tool Ambient Air Temperature parameter reads colder than -30Â°F (-34Â°C).

- **If -30Â°F (-34Â°C) or warmer**

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit terminal A (or 1) and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the P16 Instrument Cluster.

- **If colder than -30Â°F (-34Â°C)**

5. Install a 3 A fused jumper wire between the signal circuit terminal A (or 1) and the low reference circuit terminal B (or 2).
6. Verify the scan tool Ambient Air Temperature parameter reads warmer than 180Â°F (82Â°C)

- **If 180Â°F (82Â°C) or colder**

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V
3. Ignition OFF
4. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If warmer than 180Â°F (82Â°C)**

7. Test or replace the B9 Ambient Air Temperature Sensor.

Repair Instructions

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

- **Displays and Gauges Component Replacement Reference**
- **Control Module References** for control module replacement, programming and setup

SPEEDOMETER AND/OR ODOMETER MALFUNCTION

Diagnostic Instructions

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

Circuit/System Description

The instrument cluster displays the engine coolant temperature, fuel level, vehicle speed and the engine speed based on the information from the engine control module (ECM). The ECM sends information via serial data to the body control module (BCM). The BCM then sends the information via serial data to the instrument cluster to display the engine coolant temperature, fuel level, the engine speed, the vehicle speed and the distance travelled, either in kilometers or miles, based on the vehicle requirements. The instrument cluster will display dashes when its VIN does not match the VIN received from the BCM.

Diagnostic Aids

If the VIN mismatch is corrected the odometer will once again be displayed in the instrument cluster. If the vehicle is driven for a calibrated distance with a VIN mismatch, it will cause the instrument cluster odometer to enter into an error mode and lock itself. When this occurs the dashes will remain on the display even after correcting the VIN mismatch. The vehicle odometer status data display on the scan tool can be used to identify a locked odometer. The only way to unlock the instrument cluster (clear the dashes from the display) is to perform an SPS programming event. Failure to follow the diagnostic and programming procedures may result in either an improper odometer value or a module replacement.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON/Vehicle in Service Mode.
2. Verify no DTC is set.
   - **If any DTC is set**

     Diagnose DTCs first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **If no DTCs are set**
3. If applicable, verify the speedometer sweeps from low to high position when performing the Instrument Cluster Gauge Sweep with the scan tool.
   - **If speedometer does not sweep**

     Replace the P16 Instrument Cluster.

   - **If speedometer sweeps properly**
4. Verify the speedometer gauge value matches the scan tool Vehicle Speed parameter while driving the vehicle.
   - **If the values do not match**

     Replace the P16 Instrument Cluster.

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- **If the speedometer value matches the scan tool parameter**

5. Verify the odometer display and the displayed distance counts up while driving the vehicle.
   - **If the odometer displays only "----" (dashes)**

     Refer to Circuit/System Testing.

   - **If the odometer display does not count up**

     Replace the P16 Instrument Cluster.

   - **If speedometer sweeps and displays the correct value, and the odometer display counts up**
6. All OK.

Circuit/System Testing

NOTE:

- **Circuit/System Verification must be performed before proceeding with Circuit/System Testing.**
- **If there are multiple modules not original to the vehicle and they are used or incorrectly configured service parts, SPS may not be able to proper read or recover the vehicle odometer value. Follow government rules and documentation (including vehicle identification) regarding inaccurate/unknown odometer values.**

Correcting VIN mismatch: Instrument Cluster is Showing "----" (Dashes), odometer is still unlocked

1. Ignition ON/Vehicle in Service Mode.
2. Verify the scan tool Odometer Status parameter is Unlocked.
   - **If the reading is Locked**

     Refer to correcting VIN mismatch - odometer locked.

   - **If the reading is Unlocked**
3. Verify the scan tool BCM VIN parameter matches the vehicle's VIN placard.
   - **If the VIN does not match**

     Reprogram the BCM, then proceed to Step 3.

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- **If the VIN matches**

4. Verify the scan tool Instrument Cluster Vehicle Identification Number (VIN) parameter matches the vehicle's VIN placard.
   - **If the VIN does not match**

     Reprogram the instrument cluster. Then proceed with step 4.

   - **If the VIN matches**
5. Verify the instrument cluster is displaying the correct value.
   - **If the instrument cluster is still displaying "----" (dashes)**

     Replace the P16 Instrument Cluster.

   - **If the instrument cluster is displaying the correct value**
6. All OK.

Correcting VIN mismatch: Instrument Cluster is Showing "----" (Dashes), odometer is locked

1. Ignition ON/Vehicle in Service Mode.
2. Verify the scan tool Odometer Status parameter is Locked.
   - **If the reading is Unlocked**

     Refer to Correcting VIN mismatch - odometer unlocked.

   - **If the reading is Locked**
3. Verify the scan tool Instrument Cluster Vehicle Identification Number (VIN) parameter matches the vehicle's VIN placard.
   - **If the VIN does not match**

     Reprogram the Instrument Cluster. Then proceed with step 3.

   - **If the VIN matches**
4. Perform the BCM setup procedure in SPS.
5. Verify the instrument cluster is displaying the correct value.
   - **If the instrument cluster is still displaying "----" (dashes)**

     Replace the P16 Instrument Cluster.

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- **If instrument cluster is displaying the correct value**

6. All OK.

Repair Instructions

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

Control Module References for instrument cluster, BCM or ECM replacement, programming, and setup.

REPAIR INSTRUCTIONS

AMBIENT AIR TEMPERATURE SENSOR REPLACEMENT (X88)

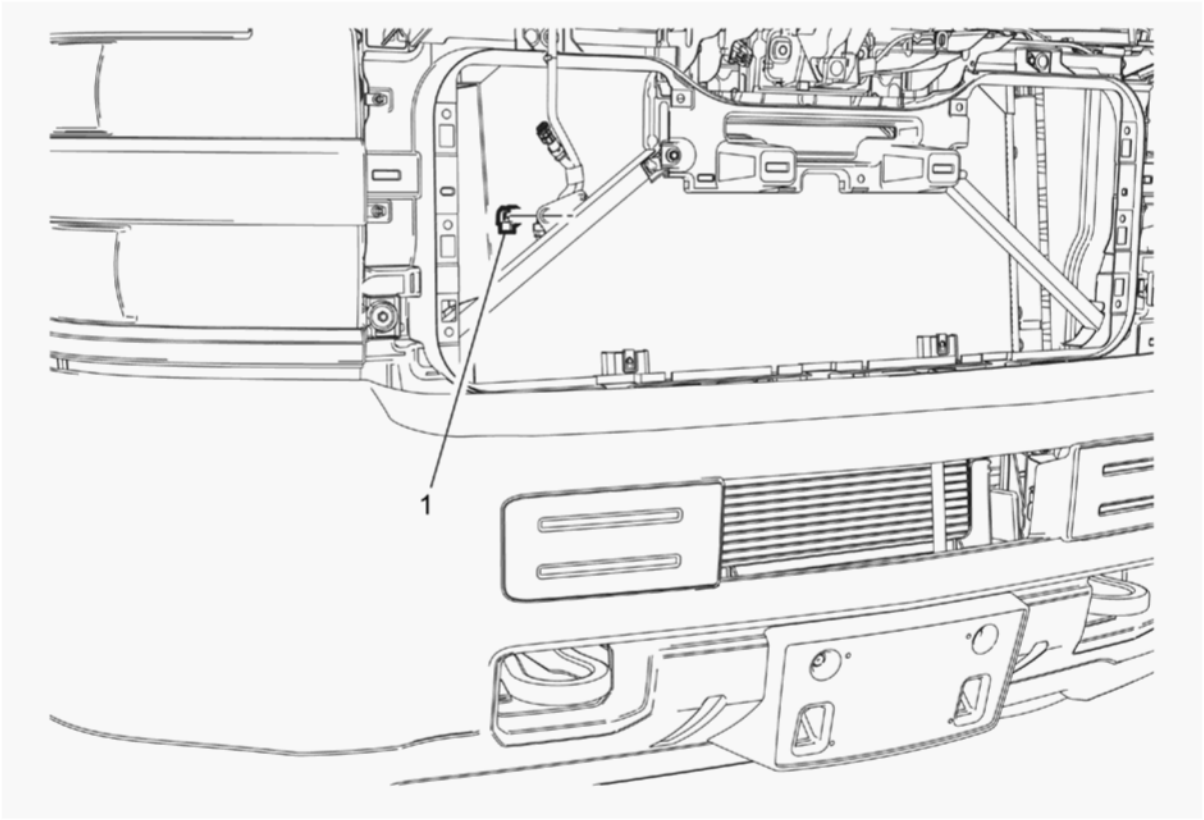
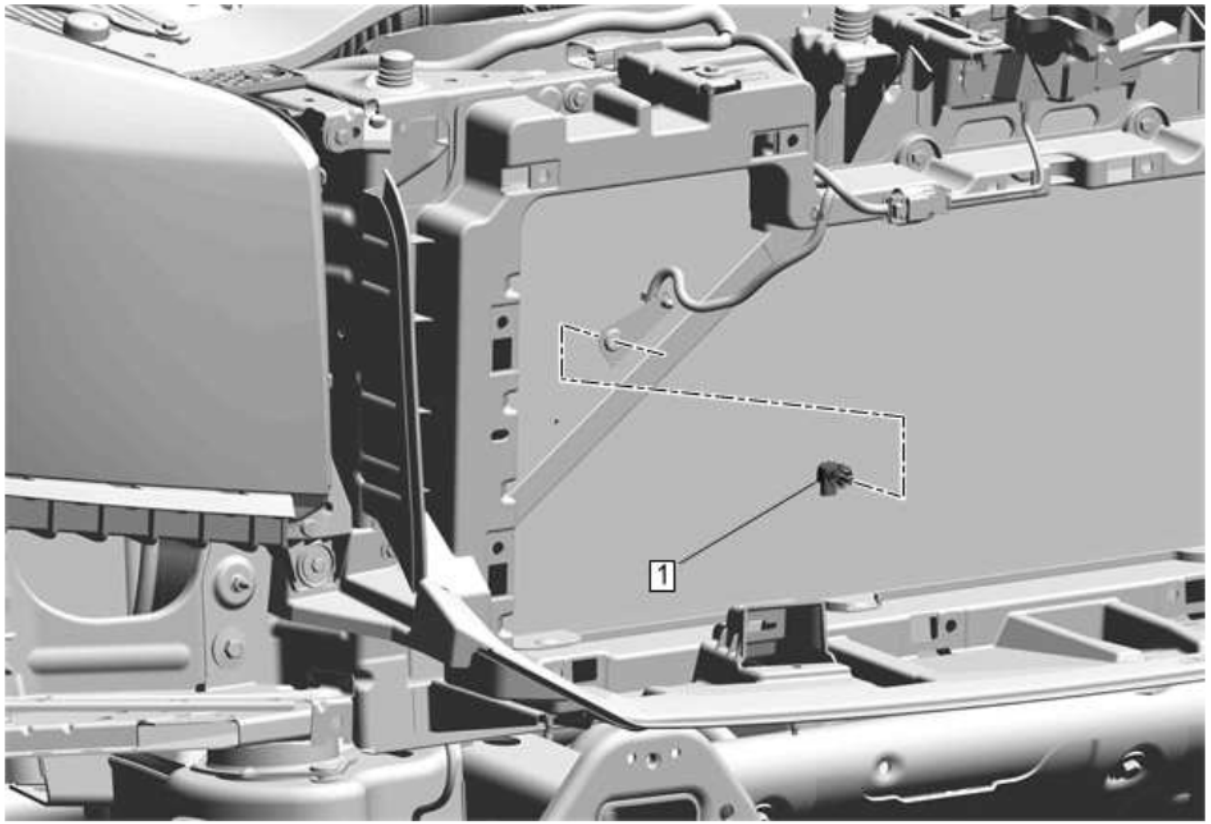


Fig. 7: Ambient Air Temperature Sensor
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Call out	Component Name
Preliminary Procedure Remove the front bumper fascia assembly. Refer to **Front Bumper Fascia Replacement (GMC)** **Front Bumper Fascia Replacement (Chevrolet)** **Front Bumper Fascia Replacement (Cadillac)** .	
1	Ambient Air Temperature Sensor **Procedures** 1. Squeeze the tabs on the ambient air temperature sensor, and push ambient air temperature sensor back out of the ambient air temperature sensor bracket. 2. Disconnect ambient air temperature sensor electrical connector.

AMBIENT AIR TEMPERATURE SENSOR REPLACEMENT (Z88)



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Fig. 8: Ambient Air Temperature Sensor (Z88)
Courtesy of GENERAL MOTORS COMPANY

Call out	Component Name
Preliminary Procedure Front Bumper Fascia Replacement (GMC) Front Bumper Fascia Replacement (Chevrolet) Front Bumper Fascia Replacement (Cadillac)	
1	Ambient Air Temperature Sensor **Procedures** 1. Squeeze the tabs on the ambient temperature sensor, and push ambient temperature sensor back out of the ambient air temperature sensor bracket. 2. Disconnect the electrical connector.

AMBIENT AIR TEMPERATURE SENSOR REPLACEMENT (CADILLAC)

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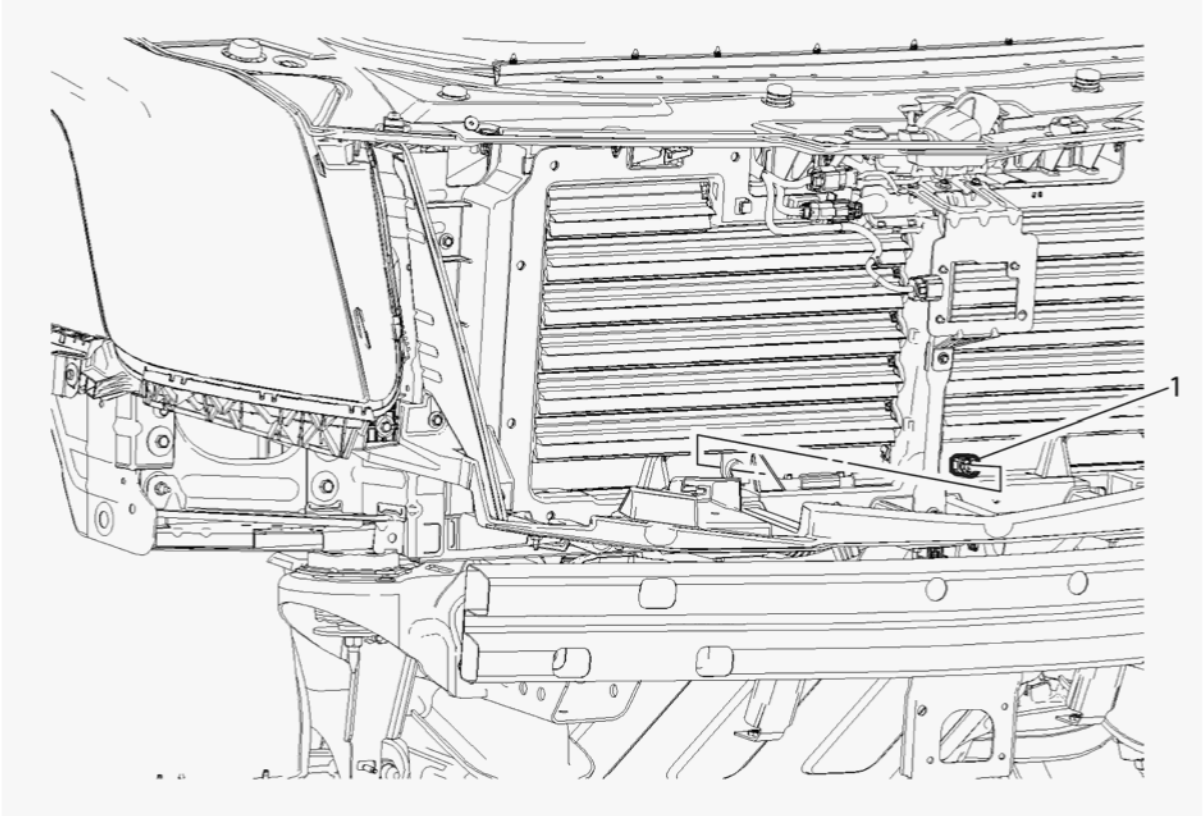


Fig. 9: Ambient Air Temperature Sensor (Cadillac)
Courtesy of GENERAL MOTORS COMPANY

Call out	Component Name
Preliminary Procedure Remove the front bumper fascia assembly. Refer to **Front Bumper Fascia Replacement (Cadillac)** .	
1	Ambient Air Temperature Sensor **Procedures** 1. Squeeze the tabs on the ambient air temperature sensor, and push ambient air temperature sensor back out of the ambient air temperature sensor bracket. 2. Disconnect ambient air temperature sensor electrical connector.

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HEAD-UP DISPLAY DIMMER SWITCH REPLACEMENT (CHEVROLET / GMC)

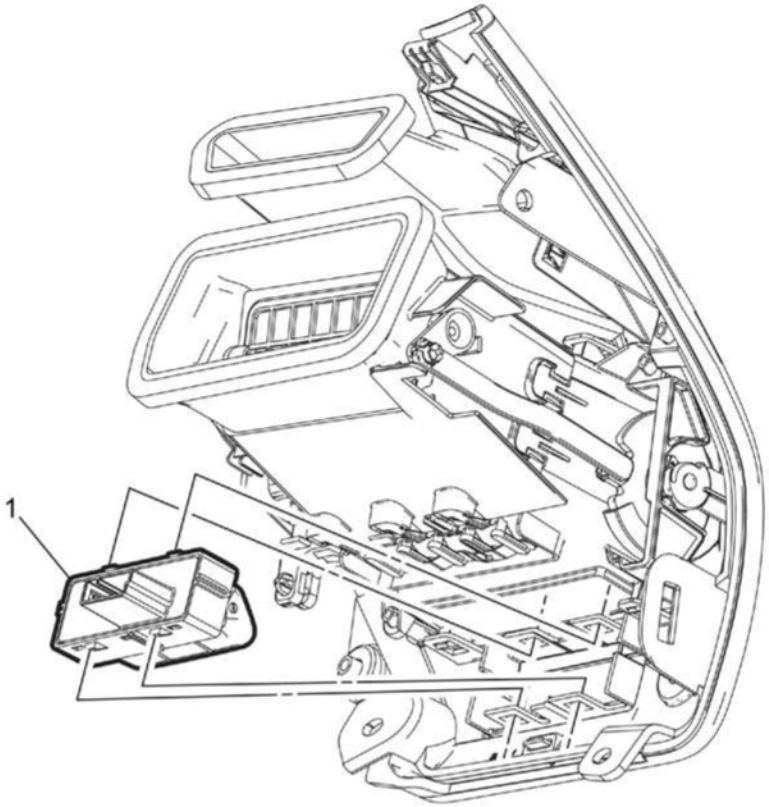


Fig. 10: Head-Up Display Dimmer Switch (Chevrolet / GMC)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the instrument panel outer air outlet - left side. Refer to **Instrument Panel Outer Air Outlet Replacement - Left Side (Chevrolet / GMC)** .	
1	Head Up Display Dimmer Switch **Procedure** Release tabs on switch to remove from the outlet.

HEAD-UP DISPLAY DIMMER SWITCH REPLACEMENT (CADILLAC)

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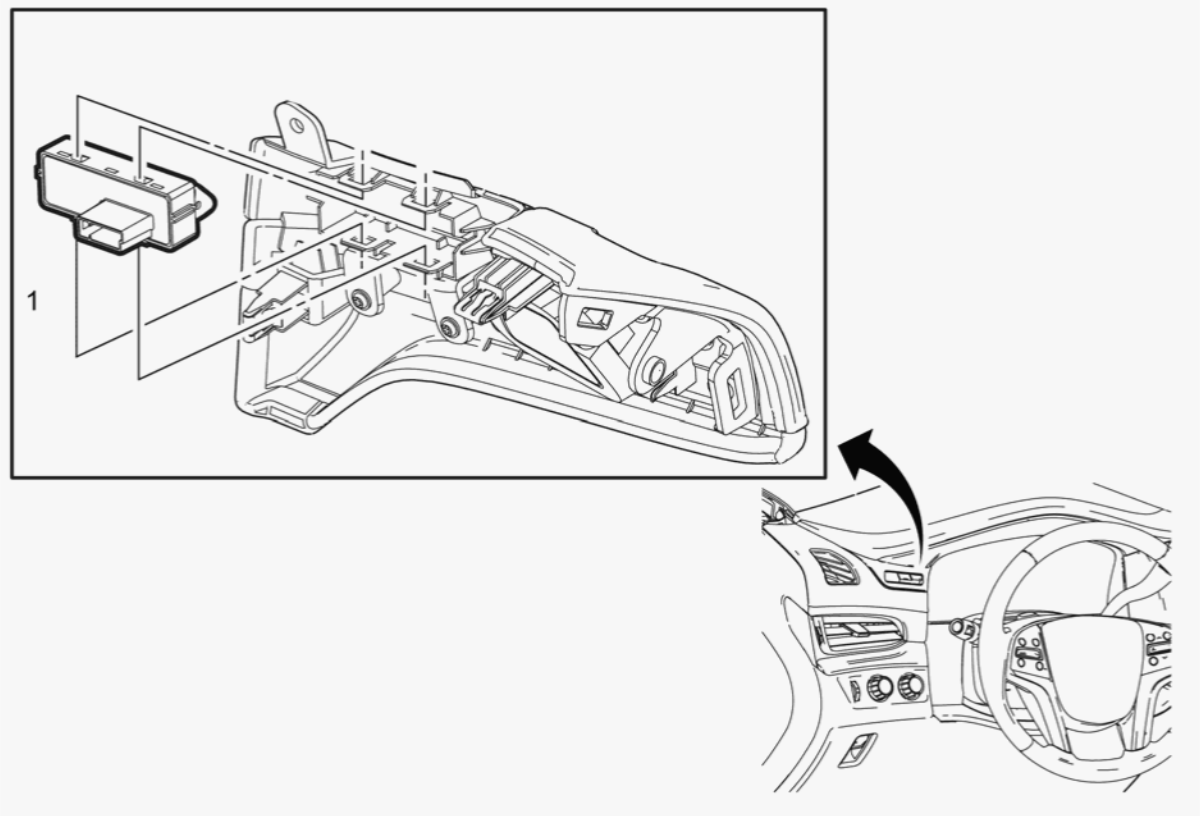


Fig. 11: Head-Up Display Dimmer Switch (Cadillac)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the instrument panel upper trim panel - left side. Refer to **Instrument Panel Upper Trim Panel Replacement - Left Side (Cadillac)** .	
1	Head Up Display Dimmer Switch **Procedure** Release tabs on switch to remove from the trim panel.

HEAD-UP DISPLAY REPLACEMENT (CHEVROLET / GMC)

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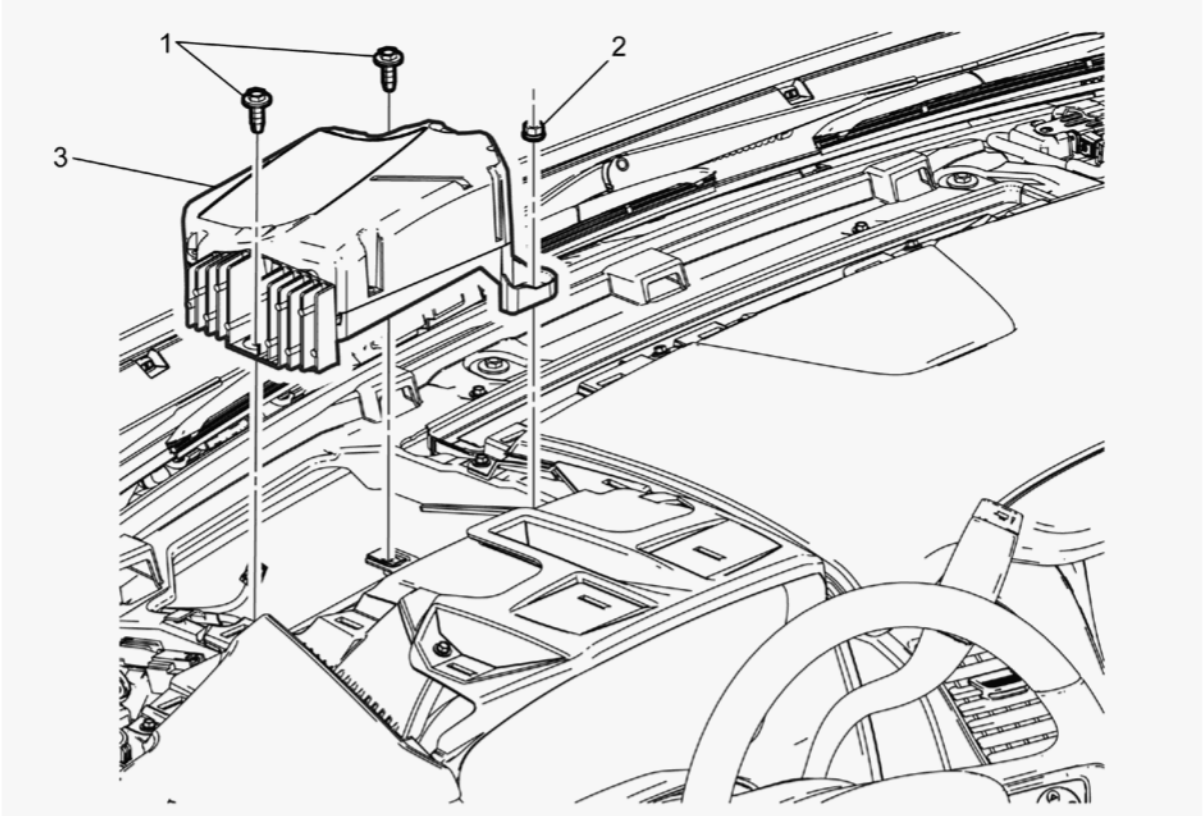


Fig. 12: Head-Up Display (Chevrolet / GMC)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the windshield defroster nozzle grille. Refer to **Windshield Defroster Nozzle Grille Replacement (Chevrolet / GMC)** .	
1	Head-Up Display Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .**

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Callout	Component Name
	Tighten 9 N.m (80 lb in)
2	Head-Up Display Nut **Tighten** 9 N.m (80 lb in)
3	Head-Up Display **Procedure** Disconnect the electrical connector.

HEAD-UP DISPLAY REPLACEMENT (CADILLAC)

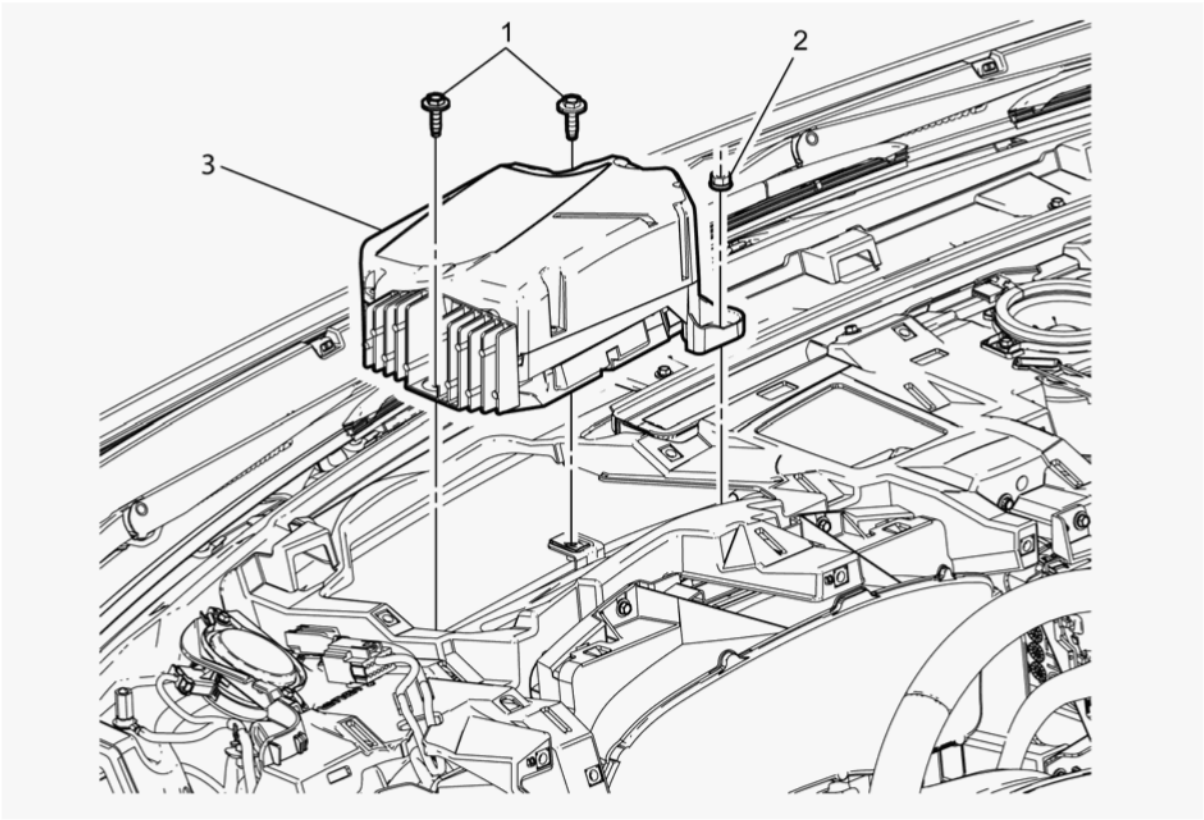


Fig. 13: Head-Up Display (Cadillac)
Courtesy of GENERAL MOTORS COMPANY

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Callout	Component Name
Preliminary Procedure Remove the instrument panel instrument cluster hood. Refer to **Instrument Panel Instrument Cluster Hood Replacement (Cadillac)** .	
1	Head-Up Display Bolt (Qty: 2) **CAUTION:** **Refer to** **Fastener** **Caution** . **Tighten** 9 N.m (80 lb in)
2	Head-Up Display Nut **Tighten** 9 N.m (80 lb in)
3	Head-Up Display **Procedure** 1. Disconnect the electrical connector. 2. Refer to **Control Module References** for programming and set up procedures, if required.

INSTRUMENT CLUSTER REPLACEMENT (CHEVROLET / GMC)

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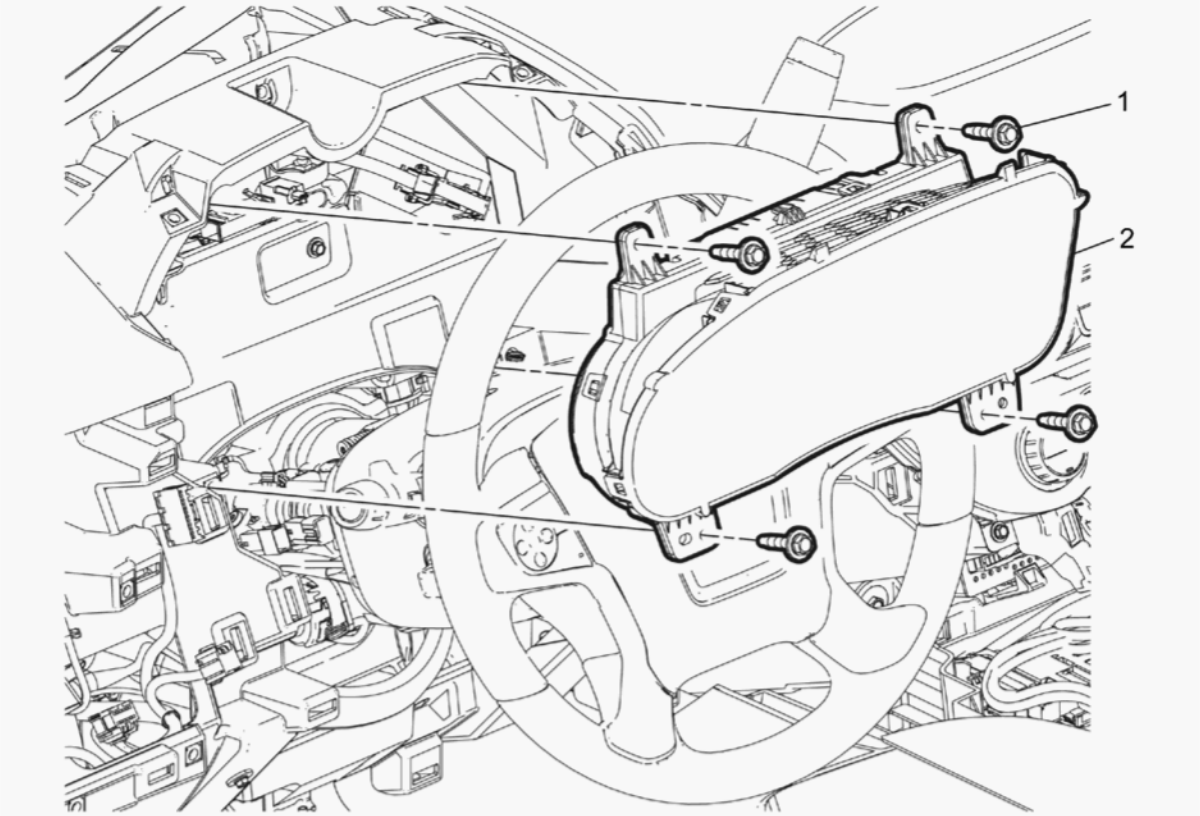


Fig. 14: Instrument Cluster
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the instrument panel cluster trim plate. Refer to **Instrument Panel Cluster Trim Plate Replacement (Chevrolet / GMC)** .	
1	Instrument Cluster Fasteners (Qty: 4) **CAUTION:** **Refer to Fastener Caution .**

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Callout	Component Name
	Tighten 2.5 N.m (22 lb in)
2	Instrument Cluster Assembly **Procedure** 1. Disconnect the electrical connector. 2. Refer to **Control Module References** for programming and set up information.

INSTRUMENT CLUSTER REPLACEMENT (CADILLAC)

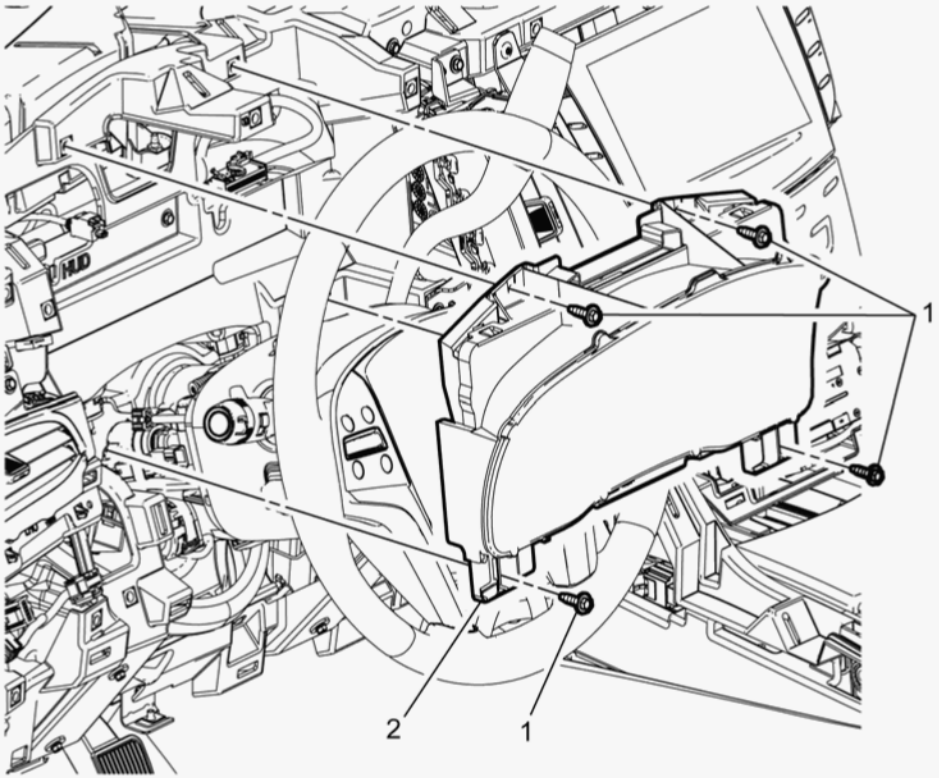


Fig. 15: Instrument Cluster
Courtesy of GENERAL MOTORS COMPANY

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Callout	Component Name
Preliminary Procedure Remove the instrument panel instrument cluster hood. Refer to **Instrument Panel Instrument Cluster Hood Replacement (Cadillac)** .	
1	Instrument Cluster Fasteners (Qty: 4) **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 2.5 N.m (22 lb in)
2	Instrument Cluster Assembly **Procedure** 1. Disconnect the electrical connector. 2. Refer to **Control Module References** for programming and set up procedures, if required.

INSTRUMENT PANEL MULTIFUNCTION SWITCH REPLACEMENT (CADILLAC)

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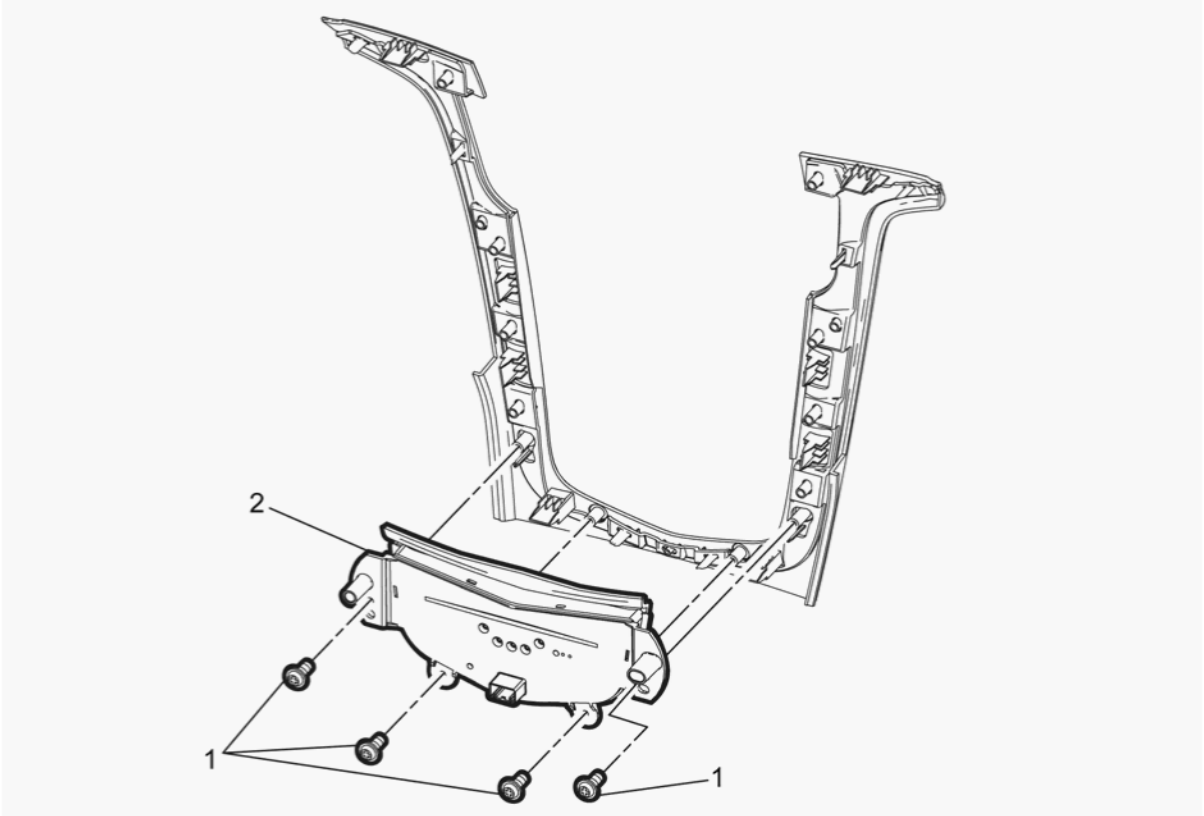


Fig. 16: Instrument Panel Multifunction Switch (Cadillac)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the instrument panel lower trim plate applique. Refer to **Instrument Panel Lower Trim Plate Applique Replacement (Cadillac)** .	
1	Instrument Panel Multifunction Switch Fastener (Qty: 4) **CAUTION:** **Refer to** **Fastener** **Caution** .

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Callout	Component Name
	Tighten .75 N.m (6.6 lb in)
2	Instrument Panel Multifunction Switch

DESCRIPTION AND OPERATION

AUDIBLE WARNINGS DESCRIPTION AND OPERATION

The audible warnings alert the driver of a system concern or a critical vehicle condition. If equipped with an serial data communicating audio amplifier, the audio amplifier generates the audible warnings through the speakers. If not equipped with an audio amplifier, the radio generates the audible warnings through the speakers. The radio or audio amplifier receives audible warning requests via serial data. If the radio or audio amplifier receives multiple audible warning requests, the warning with the highest priority sounds first. Different audible warnings may sound with a different frequency or a different chime pattern, depending on the system or module making the request. The chime volume may be selectable through vehicle personalization.

Audible Warnings or Chimes

The following is a list of common audible warnings or chimes. For additional chimes or complete system description, refer to the appropriate system's Description and Operation or the vehicle owner's manual.

- Driver Seat Belt Reminder - If the vehicle is started and the seat belt is unbuckled, the BCM requests the radio or audio amplifier sound a chime to indicated that the belt is unbuckled. This is accompanied by a flashing driver seat belt indicator on the instrument cluster. If the belt remains unbuckled, the chime cycle may continue multiple times if the vehicle is driven and the indicator will remain on solid.
- Passenger Seat Belt Reminder - If the passenger presence system determines that their is an occupant in the passenger seat and the vehicle is started with the passenger seat belt unbuckled, the BCM requests the radio or audio amplifier sound a chime to indicated that the belt is unbuckled. This is accompanied by a flashing passenger seat belt indicator. If the belt remains unbuckled, the chime cycle may continue multiple times if the vehicle is driven and the indicator will remain on solid. If an object is placed on the passenger seat, the passenger presence system may interpret this as a passenger occupying the seat. Because the passenger seat belt is unbuckled, the passenger seat belt reminder chime will sound. To correct this, remove the object from the passenger seat.
- Exterior Lamps On Warning - If the exterior lamps are left on after the ignition is turned off and the driver door is opened, the BCM will request the radio or audio amplifier sound a chime as an indicator that the exterior lamps are on.
- Electric Parking Brake (if equipped) - If the electric parking brake switch is pressed while the vehicle is in motion, the parking brake control module will request the radio or audio amplifier sound a chime. To release the parking brake, the brake pedal must be pressed when the electric parking brake switch is pressed. If the brake pedal is not pressed, the parking brake control module will request the radio or audio amplifier

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sound a chime. A message will also appear on the driver information center.

- Delayed Locking - If the keyless entry transmitter is not in the vehicle and the door lock switch is pressed with the driver door open, the BCM will request the radio or audio amplifier sound a chime three times to indicate that the vehicle has entered a delayed locking state. The doors will automatically lock five seconds after the last door is closed.
- Object Detection - The object detection system sends various chime requests to the radio or audio amplifier during normal operation.

Additional Warnings

The following warnings have an associated instrument cluster indicator or driver information center message:

- Turn Signal Indicators - The radio or audio amplifier activates the audible warning as requested by the BCM.
- Vehicle Overspeed Message - The radio or audio amplifier activates the audible warning as requested by the BCM.
- Fuel Level Low Message - The radio or audio amplifier activates the audible warning as requested by the BCM.
- Oil Pressure Indicator - The radio or audio amplifier activates the audible warning as requested by the BCM.
- Tire Pressure Low Indicator - The radio or audio amplifier activates the audible warning as requested by the BCM.
- Antilock Brake Indicator - The radio or audio amplifier activates the audible warning as requested by the electronic brake control module.
- Engine Cooling System Messages - The radio or audio amplifier activates the audible warning as requested by the engine control module.
- Transmission Messages - The radio or audio amplifier activates the audible warning as requested by the transmission control module.

Backup Alarm (with 8S3)

When transmission placed in reverse, the Body Control Module (BCM) activates the KR61 Trailer Backup Lamps Relay which supplies 12V to the reverse lamps and the Backup Alarm simultaneously.

HEAD-UP DISPLAY DESCRIPTION AND OPERATION

The head-up display projects an image on the windshield that is viewed from the driver seat. Information that is relevant to what the drive is currently doing is displayed, as well as any safety-critical information as it is happening.

The components of the head-up display are:

- Head-Up Display
- Instrument Cluster
- Head-Up Display Switch

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Head-Up Display

The head-up display is a slave device to the instrument cluster. The head-up display is powered through ignition voltage and ground. It communicates directly with instrument cluster via serial data and only has limited self-diagnosis capacity. Head-up display DTCs are reported through the instrument cluster.

The head-up display projects a full color image onto the windshield and is only viewable from the driver seat. The image location and brightness is adjustable using the head-up display switch. The image information is received from the instrument cluster through a video cable.

Instrument Cluster

The instrument cluster sends the image information to the head-up display via a discrete video cable. The image sent to the head-up display is closely related to the information currently being displayed on the instrument cluster or driver information center. For example, if an incoming phone call is displayed in the cluster, this information will be displayed on the head-up display. If a navigation alert is shown in the cluster, then a turn-by-turn alert will display on the head-up display. When the operator interacts with the instrument cluster using the steering wheel mounted driver information center switch, the head-up display also responds to the interaction. If the operator dismisses the navigation alert on the instrument cluster, it is also removed from the head-up display.

Head-Up Display Switch

The head-up display switch is a multiplexed switch that controls the head-up display based on driver inputs. The head-up display provides the switch with a low reference and monitors a signal circuit. The head-up display switch is made up of a resistor ladder and three switches: Dim +/-, Up/Down, and Page. When a switch is pressed, the signal voltage is pulled low through the resistor ladder. When pressed, each of the switches will result in a different signal voltage seen by the head-up display, depending on the switch's location on the resistor ladder.

Head-Up Display Operation

In normal operation, the operator may select from three different display configurations. These display configurations provide the operator with different information, with the vehicle speed being the primary item, along with the following standard indicators:

- Turn signal indicators
- High beam indicator
- Lane departure warning indicator (if equipped)
- Vehicle detected ahead indicator (if equipped)
- Adaptive cruise control on indicator (if equipped)

Standard/Speed Configuration

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The head-up display projects only the vehicle speed. Additionally, the outside air temperature, compass, and time may also be displayed.

Audio Configuration

The head-up display will project the current audio information when listening to the audio system and the active phone information if the operator is on a phone call.

Navigation Configuration

The head-up display will project navigation information. If a current route is being followed, turn by turn instructions and arrows will be displayed. If no route is programed, the compass heading is displayed.

Performance Configuration

The head-up display will project RPM and PRNDL information.

Adaptive Cruise Control Configuration (if equipped)

The head-up display will project the selected following distance when adaptive cruise control is active.

INDICATOR/WARNING MESSAGE DESCRIPTION AND OPERATION

INDICATOR LIGHT ON

Refer to the OWNER'S MANUAL for the descriptions and explanations of all indicator lights.

For diagnosis and repair information related to an indicator light refer to the System Diagnosis and the Description of Operation that the message relates to.

MESSAGE DISPLAYED

Refer to the OWNER'S MANUAL for descriptions and explanations of all messages displayed.

For diagnosis and repair information related to a displayed message refer to the System Diagnosis and the Description of Operation that the message relates to.

CHANGE TIMING BELT MESSAGE

The Instrument Cluster monitors the odometer mileage to determine when timing belt (if equipped) replacement may be necessary. After the vehicle has accumulated approximately 100, 000 miles (160, 000 kilometers), the Instrument Cluster may display the CHANGE TIMING BELT message.

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After the engine timing belt has been replaced, reset the CHANGE TIMING BELT message by locating and removing the fuses that supply power to the Instrument Cluster for two minutes.

BRAKES OVERHEATED

The Electronic Brake Control Module monitors brake usage and compares it to an internal thermal model to determine if the brakes could become overheated. If the Electronic Brake Control Module determines the brakes pads have exceeded a desirable temperature based on the thermal model, it sends a serial data message to the Instrument Cluster to display the BRAKES OVERHEATED message. The message remains displayed until the estimated temperature returns to a desirable range.

Transmission Shift Lever Position Indicator

The Transmission Shift Lever Position Indicator (if equipped) is located on the center console and indicates the current transmission shift lever position. The Transmission Shift Lever Position Indicator receives power and ground and is controlled by the Body Control Module (BCM) via serial data. The Transmission Control Module determines transmission shift lever position based on signals from the Transmission Internal Mode Switch and sends the shift lever position information to the BCM via serial data.

INSTRUMENT CLUSTER DESCRIPTION AND OPERATION

Instrument Cluster (with RPO UDC)

The instrument cluster is a multifunction module that provides the vehicle operator with information that is critical to vehicle operation, such as vehicle speed, engine RPM, oil pressure, battery voltage, fuel level, and coolant temperature, using analog gauges. The instrument cluster also provides the operator with operational warnings and message through various indicators and the driver information center. The driver information center is a one color multifunction display that is located in the instrument cluster. The driver information center has several screens that can be scrolled through by twisting the trip reset stem.

Instrument Cluster (with RPO UDD)

The instrument cluster is a multifunction module that provides the vehicle operator with information that is critical to vehicle operation, such as vehicle speed, engine RPM, oil pressure, battery voltage, fuel level, and coolant temperature, using analog gauges. The instrument cluster also provides the operator with operational warnings and message through various indicators and the driver information center. The driver information center is a full color multifunction display that is located in the instrument cluster. The driver information center is also tightly integrated with the vehicle's infotainment system and is highly reconfigurable.

Instrument Cluster (with RPO UHS)

The instrument cluster is a multifunction module that provides the vehicle operator with information such as vehicle speed and engine RPM using analog gauges. Oil pressure, battery voltage, fuel level, and coolant temperature can also be displayed using an interactive LCD display. The

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instrument cluster is highly reconfigurable, with four different themes available for selection. The instrument cluster also provides the operator with operational warnings and message through various indicators and the driver information center. Because the instrument cluster is an LCD display, driver information center elements are located in various zones of the display, depending on how the instrument panel is configured.

Instrument Cluster (with RPO UDV)

The instrument cluster is a multifunction module that provides the vehicle operator with information that is critical to vehicle operation, such as vehicle speed, engine RPM, and coolant temperature, using an interactive LCD display. The instrument cluster is highly reconfigurable, with four different themes available for selection. The instrument cluster also provides the operator with operational warnings and message through various indicators and the driver information center. Because the instrument cluster is an LCD display, driver information center elements are located in various zones of the display, depending on how the instrument panel is configured.

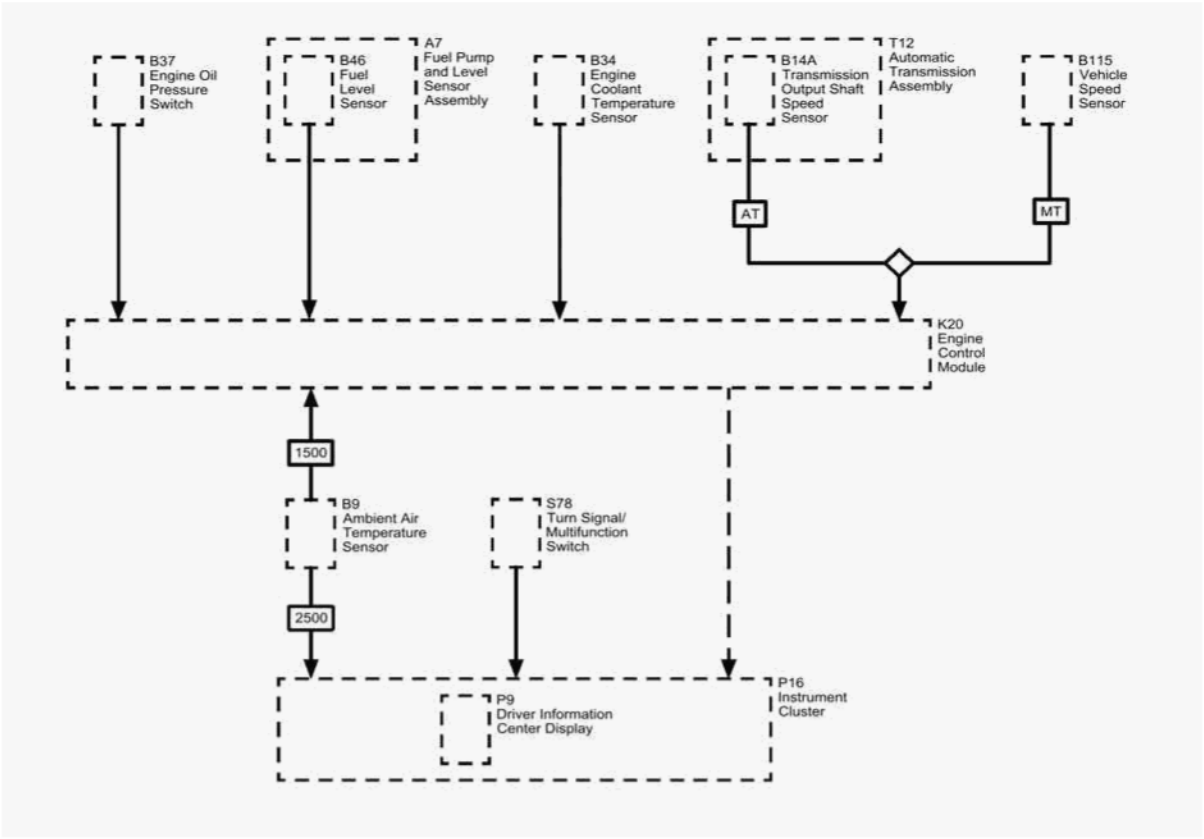


Fig. 17: Instrument Cluster Block Diagram
Courtesy of GENERAL MOTORS COMPANY

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Callout	Component Name
AT	Automatic Transmission
MT	Manual Transmission
P16	P16 Instrument Cluster
P9	P9 Driver Information Center Display
S78	S78 Turn Signal/Multifunction Switch
B9	B9 Ambient Air Temperature Sensor
B14A	B14A Transmission Output Shaft Speed Sensor
T12	T12 Automatic Transmission Assembly
B115	B115 Vehicle Speed Sensor
K20	K20 Engine Control Module
B46	B46 Fuel Level Sensor
A7	A7 Fuel Pump and Level Sensor Assembly
B37	B37 Engine Oil Pressure Switch
B34	B34 Engine Coolant Temperature Sensor

Indicators and Warning Messages

Refer to **Indicator/Warning Message Description and Operation**.

Engine Coolant Temperature Gauge

The instrument cluster displays the engine coolant temperature as determined by the engine control module (ECM). The ECM sends the engine coolant temperature information via serial data to the body control module (BCM). The BCM then sends the information via a serial data to the instrument cluster to display the engine coolant temperature.

Engine Oil Pressure Gauge (if equipped)

The IPC displays the engine oil pressure as determined by the ECM. The ECM monitors the engine oil pressure sensor. The IPC receives a serial data message from the ECM indicating the engine oil pressure. The engine oil pressure gauge defaults to 0 kPa (0 psi) or below if:

- The ECM detects a malfunction in the engine oil pressure sensor signal circuit.
- The IPC detects a loss of serial data communication with the ECM.

Fuel Level Gauge

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The instrument cluster displays the fuel level based on the information from the ECM. The ECM converts the data from the fuel level sensors to a fuel level signal. The ECM sends the fuel level signal via serial data to the BCM. The BCM then sends the information via serial data to the instrument cluster to display the fuel level. If the fuel level falls under 11% the instrument cluster will illuminate the low fuel level indicator. The fuel gauge defaults to empty if:

- The ECM detects a malfunction in the fuel level sensor circuit.
- The BCM detects a loss of serial data communications with the ECM.
- The instrument cluster detects a loss of serial data communications with the BCM.

Speedometer

The instrument cluster displays the vehicle speed based on the information from the ECM. The ECM sends the vehicle speed information via serial data to the BCM. The BCM then sends the vehicle speed information via serial data to the instrument cluster to display the vehicle speed.

Odometer

The instrument cluster displays the vehicle odometer in the driver information center. The ECM send a distance rolling count message via serial data to the body control module (BCM). The BCM uses this information to calculate the vehicle odometer. This odometer value is then sent to the instrument cluster. The instrument cluster does not calculate the odometer.

The odometer value is stored in multiple modules. The instrument cluster is a secondary storage module for the odometer, while the BCM is the primary storage and accumulator.

In addition to storing the odometer value for the vehicle, the instrument cluster and the BCM store the VIN. Software checks are performed to ensure these modules, and their stored odometer information, can not be move or transferred between different vehicles.

Tachometer

The instrument cluster displays the engine speed based on the information from the ECM. The ECM converts the data from the crankshaft position sensor to an engine revolution signal. The ECM sends the engine speed information via serial data to the BCM. The BCM then sends the information via serial data to the instrument cluster to display the engine speed.

Compass

The vehicle compass information is gather through the compass module or vehicle communication interface module (VCIM). The compass module or VCIM determines vehicle direction and communicates this with the BCM through serial data. The BCM sends the compass information to the instrument cluster via serial data, where it is displayed.

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Outside Air Temperature (1500 series)

The Ambient Air Temperature Sensor is located behind the grille and varies it's resistance with temperature. The Engine Control Module (ECM) reads the resistance value to determine temperature. The time of and rate of the temperature update is based on an algorithm in the ECM software. Factors such as, last reading, current reading, length of time vehicle is been off/on, power mode, vehicle speed, driven distance, and sensor location are all considered by the ECM to know when to update the displayed temperature. For example, if the sensor is located near the engine compartment, and the vehicle has been turned off for only 10 minutes then restarted, the ECM will wait until the vehicle is driven to get more accurate air flow across the sensor before it updates the display.

Outside Air Temperature (2500 series)

The Ambient Air Temperature Sensor is located behind the grille and varies it's resistance with temperature. The Instrument Cluster reads the resistance value to determine temperature. The time of and rate of the temperature update is based on an algorithm in the Instrument Cluster software. Factors such as, last reading, current reading, length of time vehicle is been off/on, power mode, vehicle speed, driven distance, and sensor location are all considered by the Instrument Cluster to know when to update the displayed temperature. For example, if the sensor is located near the engine compartment, and the vehicle has been turned off for only 10 minutes then restarted, the Instrument Cluster will wait until the vehicle is driven to get more accurate air flow across the sensor before it updates the display.

Driver Information Center Display (with RPO UDD)

The driver information center is located in the lower middle portion of the instrument cluster, between the speedometer and the tachometer. The driver information center displays information about the vehicle and allows the operator to access applications. It also displays warning messages if a system problem is detected.

The driver information center is made up of three zones. The left zone is a list of the applications that can be displayed. The right zone contains choices to customize what information is displayed for the respective application chosen. In the middle is the interactive application display zone. The application display zone allows access to the navigation application, audio application, phone application, or settings applications. The information display zone contains multiple pages that display vehicle information. The compass and PRNDL are displayed at all times in the lower portion of the display zone.

The driver information center can also be configured with several different themes. Changing the theme is accomplished using the infotainment system faceplate settings page. The chosen theme is used for both the faceplate and the driver information center displays.

Instrument Cluster Configuration (with RPO UHS, UDV)

The instrument cluster is highly interactive and reconfigurable. The operator can select from four different display configures and each of these configuration may contain one, two, or three separate display zones. Regardless of which configuration is selected, the vehicle odometer and PRNDL are always displayed in the lower left and lower right corners of the display.

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The different display configurations are:

- Simple - The most basic of the available configurations, the Simple configuration includes four static information display zones and one interactive information display zone. The infotainment display zone is located on the left side of the display and displays phone, turn-by-turn navigation, and audio information. The speedometer and compass are located in the upper middle of the display. On the right side of the display is a graphical representation of the fuel level and fuel range.

  Below the speedometer, in the lower middle of the display, is the interactive information display zone. The information display zone contains multiple pages that can be scrolled through and selected using the steering wheel mounted driver information center switch.

- Performance - The Performance configuration contains three static information zones, one interactive information display zone, and one interactive application display zone. The speedometer and tachometer/fuel level gauge are located on the left and right of the display. In between the speedometer and tachometer is a static information display zone that displays current information while the operator scrolls through other pages in the interactive application display zone.

  In the middle of the speedometer is an interactive information display zone. This display zone has a limited number of selection and will only display a digital speedometer, a navigation map, a settings page with sub-menus, or a blank page.

  Below the tachometer and extending into the lower middle of the display is an interactive application display zone. The application display zone allows access to the navigation application, audio application, phone application, settings application, or information application. Unlike the information display zone that is located within the speedometer, the information application is fully featured and allows access to all available information pages.

- Balanced - The Balanced configuration contains three static information zones, two interactive information display zones, and one interactive application display zone. The tachometer is located on the left side of the display, the speedometer in the middle, and the coolant temperature/fuel level gauge on the right.

  Located in the tachometer is an interactive information display zone.

  In the speedometer is an interactive information display zone. This display zone has a limited number of selection and will only display a digital speedometer, a navigation map, a settings page with sub-menus, or a blank page.

  An interactive application display zone is located in the coolant temperature/fuel level gauge. The application display zone allows access to the navigation application, audio application, phone application, or settings application.

- Enhanced - The Enhanced configuration contains four static information zones, two interactive information display zones, and one interactive application display zone. The speedometer in the upper middle of the display, a navigation map or compass in located on the upper left, and a fuel level gauge and fuel range display on the right.

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Located on the left and right lower portion of the display are interactive information display zones.

An interactive application display zone is located in the middle of the display. The application display zone allows access to the navigation application, audio application, phone application, or settings application.

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