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IMPORTANT: Always use ServiceLink when attempting to diagnose problems with the AGS (Automated Gear Shift) transmission.

## How To Start

To gain a baseline for troubleshooting when there is no definite problem, when the malfunction is erratic or intermittent, or to determine the general health of the electrical system, start with the electrical pre-test in **Subject 301**.

In a few cases there will be a definite problem and no J1587 fault code will be sent (engine will not crank, no information on gear display, fluid level fault). For these problems, see the appropriate table in **Subject 301**.

But in most cases, the J1587 fault code is the starting point for the troubleshooting procedures. See **Table 1** to find information for SID fault codes. See **Table 2** to find information for PID fault codes.

Before starting any procedures, use ServiceLink to depressurize the AGS hydraulic system. For detailed procedures, see **Subject 160**.

## Fault Code Guide

To troubleshoot a given fault code, look up the subject number in **Table 1** (for SIDs) and **Table 2** (for PIDs). Follow the procedures for that fault code until the fault is corrected.

| Fault Code Guide (MID 130 SIDs) | | | | |
|---|---|---|---|---|
| **SID** | **FMI** | **Text Message** | **Failure Reason** | **Procedure** |
| 18 | 02 | Prim Selector Erratic | The shift lever does not shift gears. | See **Subject 302**. |
| 33 | 03 | MultiPress Ind Short Hi | The hydraulic pressure sensor circuit is shorted to power. | See **Subject 303**. |
| 33 | 04 | MultiPress Ind Short Lo | The hydraulic pressure sensor circuit is shorted to ground. | See **Subject 303**. |
| 33 | 05 | MultiPress Ind OPEN | The hydraulic pressure sensor circuit is open. | See **Subject 303**. |
| 52 | 05 | Hydraulic Sys OPEN | The hydraulic pump circuit is open. | See **Subject 304**. |
| 52 | 07 | Hydraulic Sys NoRESPONSE | The hydraulic pressure does not increase even though the hydraulic pump is activated. | See **Subject 304**. |
| 52 | 11 | Clutch Act Not Known | The hydraulic pump temperature is too high. | See **Subject 304**. |
| 55 | 00 | Clutch Act HIGH | The clutch is too hot. | See **Subject 305**. |
| 55 | 07 | Clutch Act NoRESPONSE | The clutch does not operate properly. | See **Subject 305**. |
| 55 | 13 | Clutch Act Calibrate | The clutch needs to be calibrated. | See **Subject 305**. |
| 231 | 02 | SAE J1939 Datalink Erratic | The J1939 datalink is not communicating properly. | See **Subject 306**. |
| 231 | 09 | SAE J1939 Datalink UPDATE | The J1939 datalink has timed out. | See **Subject 306**. |
| 231 | 12 | SAE J1939 Datalink Bad | The J1939 datalink is not communicating with the transmission. | See **Subject 306**. |
| 251 | 00 | POWER SUPPLY HIGH | The power supply voltage is too high. | See **Subject 307**. |
| 251 | 01 | POWER SUPPLY Low | The power supply voltage is too low. | See **Subject 307**. |
| 251 | 05 | POWER SUPPLY OPEN | There is no power to the transmission with the engine running. | See **Subject 307**. |
| 251 | 14 | POWER SUPPLY RSRVD | The power supply is not properly grounded. | See **Subject 307**. |
| 253 | 02 | Calibration Memory Erratic | The transmission needs to be recalibrated. | See **Subject 308**. |
| 253 | 12 | Calibration Memory Bad | The transmission needs to be recalibrated. | See **Subject 308**. |
| 253 | 13 | Calibration Memory Calibrate | The transmission needs to be recalibrated. | See **Subject 308**. |
| 253 | 14 | Calibration Memory RSRVD | The transmission needs to be recalibrated. | See **Subject 308**. |

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## General Troubleshooting

| Fault Code Guide (MID 130 SIDs) | | | | |
|---|---|---|---|---|
| **SID** | **FMI** | **Text Message** | **Failure Reason** | **Procedure** |
| 254 | 04 | Controller Short Lo | The TCU is shorted to ground. | See **Subject 309**. |
| 254 | 05 | Controller OPEN | The TCU has an open circuit. | See **Subject 309**. |
| 254 | 11 | Controller Not Known | The TCU AUTO mode software module has an error. | See **Subject 309**. |
| 254 | 12 | Controller Bad | The TCU has a hardware problem. | See **Subject 309**. |
| 254 | 13 | Controller Calibrate | The TCU has a software memory problem. | See **Subject 309**. |

**Table 1, Fault Code Guide (SIDs)**

| Fault Code Guide (MID 130 PIDs) | | | | |
|---|---|---|---|---|
| **PID** | **FMI** | **Text Message** | **Failure Reason** | **Procedure** |
| 33 | 02 | Erratic | The clutch position sensor gives invalid data. | See **Subject 310**. |
| 33 | 03 | Short Hi | The clutch position sensor circuit is shorted to power. | See **Subject 310**. |
| 33 | 04 | Short Lo | The clutch position sensor circuit is shorted to ground. | See **Subject 310**. |
| 33 | 05 | OPEN | The clutch position sensor circuit is open. | See **Subject 310**. |
| 33 | 14 | RSRVD | The clutch position sensor gives incorrect resistance readings. | See **Subject 310**. |
| 59 | 02 | Shift FNGR Gear Erratic | The shift rod position sensor gives invalid data. | See **Subject 311**. |
| 59 | 03 | Shift FNGR Gear Short Hi | The gear position sensor circuit is shorted to power. | See **Subject 311**. |
| 59 | 04 | Shift FNGR Gear Short Lo | The gear position sensor circuit is shorted to ground. | See **Subject 311**. |
| 59 | 05 | Shift FNGR Gear OPEN | The gear position sensor circuit is open. | See **Subject 311**. |
| 59 | 14 | Shift FNGR Gear RSRVD | The gear position sensor gives incorrect resistance readings. | See **Subject 311**. |
| 60 | 02 | Shift FNGR Rail Erratic | The rail position sensor circuit gives invalid data. | See **Subject 312**. |
| 60 | 03 | Shift FNGR Rail Short Hi | The rail position sensor circuit is shorted to power. | See **Subject 312**. |
| 60 | 04 | Shift FNGR Rail Short Lo | The rail position sensor circuit is shorted to ground. | See **Subject 312**. |
| 60 | 05 | Shift FNGR Rail OPEN | The rail position sensor circuit is open. | See **Subject 312**. |
| 60 | 14 | Shift FNGR Rail RSRVD | The rail position sensor gives incorrect resistance readings. | See **Subject 312**. |
| 64 | 09 | Dir Switch Update | The output shaft speed sensor is not providing accurate directional information. | See **Subject 313**. |
| 64 | 11 | Dir Switch Not Known | The output shaft speed sensor is not providing accurate directional information. | See **Subject 313**. |
| 158 | 00 | Volts (BattSw) HIGH | The voltage in the ignition power circuit is too high. | See **Subject 314**. |
| 158 | 01 | Volts (BattSw) Low | The voltage in the ignition power circuit is too low. | See **Subject 314**. |
| 161 | 02 | In shaft SPEED Erratic | The input shaft speed sensor circuit gives invalid data. | See **Subject 315**. |
| 161 | 03 | In shaft SPEED Short Hi | The input shaft speed sensor circuit is shorted to power. | See **Subject 315**. |
| 161 | 04 | In shaft SPEED Short Lo | The input shaft speed sensor circuit is shorted to ground. | See **Subject 315**. |
| 161 | 05 | In shaft SPEED OPEN | The input shaft speed sensor circuit is open. | See **Subject 315**. |
| 161 | 08 | In shaft SPEED Update | The input shaft speed sensor circuit is broadcasting an abnormal frequency. | See **Subject 315**. |

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| Fault Code Guide (MID 130 PIDs) | | | | |
|---|---|---|---|---|
| **PID** | **FMI** | **Text Message** | **Failure Reason** | **Procedure** |
| 162 | 02 | RANGE Selected Erratic | The transmission is not properly calibrated. | See **Subject 316**. |
| 163 | 02 | RANGE Attained Erratic | The gears do not shift properly. | See **Subject 316**. |
| 191 | 02 | OUTPUT SPEED Erratic | One or both of the output shaft speed sensor circuits give invalid data. | See **Subject 317**. |
| 191 | 05 | OUTPUT SPEED OPEN | One or both of the output shaft speed sensor circuits are open. | See **Subject 317**. |
| 191 | 08 | OUTPUT SPEED SIGNAL | There is no signal coming from one or both output shaft speed sensors. | See **Subject 317**. |
| 191 | 14 | OUTPUT SPEED RSRVD | The output shaft speed sensor is providing invalid data. | See **Subject 317**. |

**Table 2, Fault Code Guide (PIDs)**

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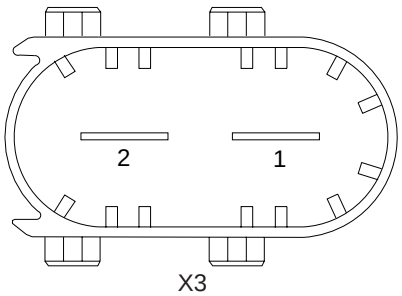
IMPORTANT: Always use ServiceLink when attempting to diagnose problems with the automated gear shift (AGS) transmission.

In most cases, the J1587 fault code is the starting point for the troubleshooting procedures. See **Subject 300** for a list of fault codes and the location of troubleshooting procedures for each code.

Use the electrical pre-test instructions given in **Table 1** as a baseline for troubleshooting when there is no definite problem, the malfunction is erratic or intermittent, or as an informational step to determine the general health of the electrical system. To record your findings, a result sheet is provided at the end of this subject. For locations of serial numbers, see **Fig. 1** and **Fig. 2**.

## Electrical Pre-Test Instructions

Before starting any procedures, use ServiceLink to depressurize the AGS hydraulic system. For detailed procedures, see **Subject 160**.

| Electrical Pre-Test | | |
|---|---|---|
| **Procedure** | **Result** | **Action** |
| Make sure that the selector switch on the SmartShift lever is set to N. Turn on the ignition switch to power up the transmission. | The current gear indicator does not power up normally. No fault codes display. | Troubleshoot the current gear indicator. See **Table 4**. |
| NOTE: If the hydraulic pump starts up with its characteristic humming noise, this means the main power cables are OK (see the steps below to check the X3 connector). | The current gear indicator goes through its normal power-up sequence, ending by displaying "N." | Turn off the ignition switch and go to the next row in the table. |
| With the ignition switch off, check the voltage at the battery. | Voltage is less than 11 or greater than 13 volts. | Charge or replace the battery. For battery charging procedures, see **Section 54.12**, Subject 150. |
| | Voltage is between 11 and 13 volts. | Go to the next row in the table. |
| Remove the X3 (electric motor 2-pin) connector from the transmission control unit (TCU). Check the electric motor power circuit. |  06/01/2004 X3 f544485 | |
| Check for voltage between pin 1 (power circuit 232) of the X3 connector and the battery ground terminal. | Voltage drops more than 0.2 volts from the voltage measured at the battery. | Repair or replace the wiring as needed. See **Section 54.06**, Subject 100. |
| | Voltage is within 0.2 volts of the voltage measured at the battery. | Go to the next row in the table. |

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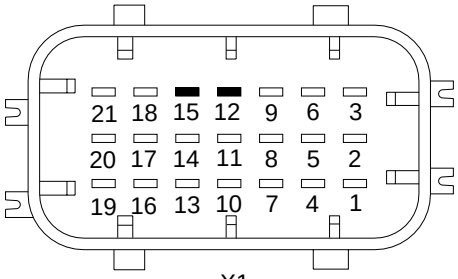
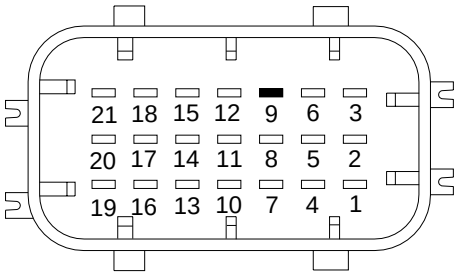
## Troubleshooting Without Fault Codes

| Electrical Pre-Test | | |
|---|---|---|
| **Procedure** | **Result** | **Action** |
| Check for resistance between pin 2 (ground) of the X3 connector and the battery ground terminal. | Resistance is greater than 0.3 ohms. | Repair or replace the wiring as needed. See **Section 54.06**, Subject 100. |
| | Resistance is 0.3 ohms or less. | Go to the next row in the table. |
| Remove the X1 (vehicle 21-pin) connector from the transmission control unit (TCU). Check the battery power circuit. |  07/16/2004 X1 f544483b | |
| Check for voltage from pins 12 and 15 (battery power circuit 232D) of the X1 connector to the battery ground terminal. | Voltage drops more than 0.2 volts from the voltage measured at the battery. | Repair or replace the wiring as needed. See **Section 54.06**, Subject 100. |
| | Voltage is within 0.2 volts of the voltage measured at the battery. | Go to the next row in the table. |
| Turn on the ignition switch. Check the ignition power circuit. |  07/16/2004 X1 f544483c | |
| Check for voltage from pin 9 (ignition power circuit 232E) of the X1 connector to the battery ground terminal. | Voltage drops more than 0.2 volts from the voltage measured at the battery. | Repair or replace the wiring as needed. See **Section 54.06**, Subject 100. |
| | Voltage is within 0.2 volts of the voltage measured at the battery. | Go to the next row in the table. |

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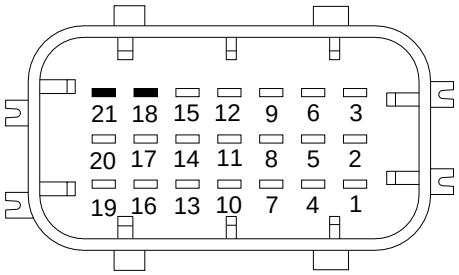
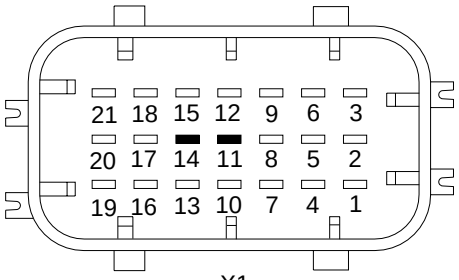
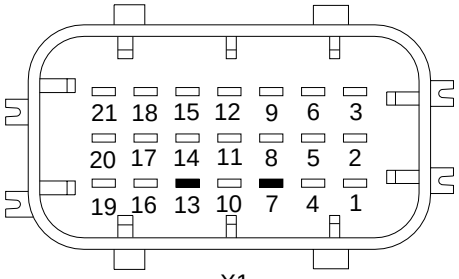
<table>
<tr><th colspan="3">Electrical Pre-Test</th></tr>
<tr><th>Procedure</th><th>Result</th><th>Action</th></tr>
<tr><td>Turn off the ignition switch. Check the ignition ground circuit.</td><td colspan="2"> 

07/21/2004 X1 f544483d</td></tr>
<tr><td rowspan="2">With the ignition switch off, check for resistance between pins 18 and 21 (ground) of the X1 connector and the battery ground terminal.</td><td>Resistance is greater than 0.3 ohms.</td><td>Repair or replace the wiring as needed. See Section 54.06, Subject 100.</td></tr>
<tr><td>Resistance is 0.3 ohms or less.</td><td>Go to the next row in the table.</td></tr>
<tr><td>Turn off the ignition switch. Check the J1587 wiring.</td><td colspan="2"> 

07/21/2004 X1 f544483e</td></tr>
<tr><td rowspan="2">Check for DC voltage from pins 11 and 14 (J1587 datalink) of the X1 connector to the battery ground terminal.<br><br>NOTE: If the meter cannot display the rapidly shifting DC voltage, measure AC voltage instead.</td><td>Voltage is less than 1 or more than 4 volt(s) for DC (less than 1 or more than 3 for AC).</td><td>Troubleshoot the J1587 datalink.</td></tr>
<tr><td>Voltage is between 1 and 4 volts for DC (1–3 volts AC).</td><td>Go to the next row in the table.</td></tr>
<tr><td>Turn off the ignition switch. Check the J1939 wiring.</td><td colspan="2"> 

07/16/2004 X1 f544483a</td></tr>
</table>

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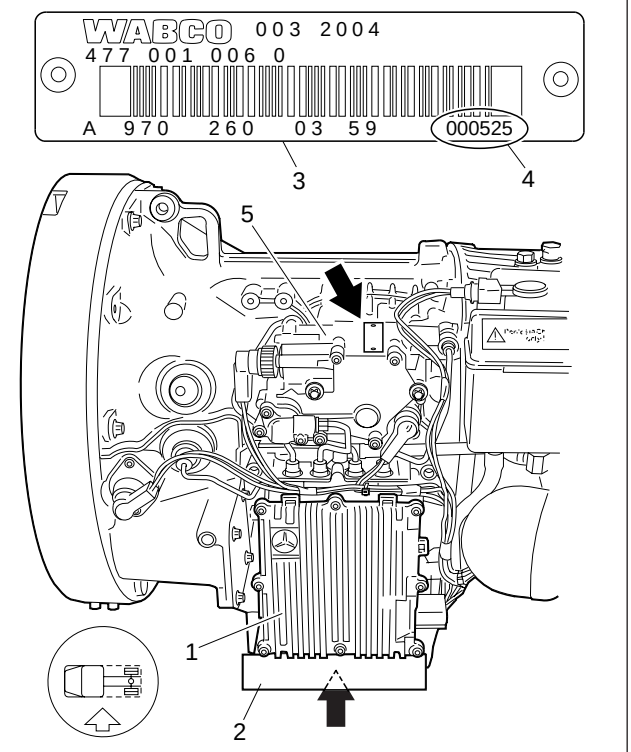
## Troubleshooting Without Fault Codes

| Electrical Pre-Test | | |
|---|---|---|
| **Procedure** | **Result** | **Action** |
| With the ignition switch off, remove the X1 connector from the TCU and check for resistance between pins 7 and 13 (J1939 datalink). | Resistance is less than 55 or greater than 65 ohms. | Troubleshoot the J1939 datalink. See Freightliner **Service Bulletin 54-133**. |
| | Resistance is between 55 and 65 ohms. | The vehicle has passed the electrical pre-test. Troubleshoot active fault codes, if any. |

**Table 1, Electrical Pre-Test**

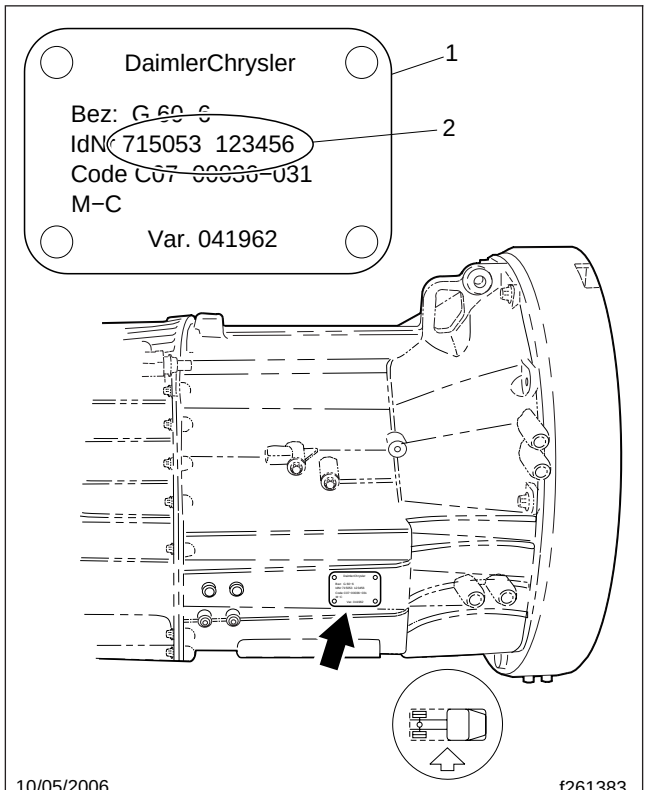
NOTE: To see the identification plate on the TCU it may be necessary to remove the splash guard.




NOTE: The TCU and X-Y Actuator each have their own WABCO identification plate (arrows) with unique serial numbers.

1. TCU (Transmission Control Unit)
2. Splash Guard
3. WABCO Identification Plate
4. Serial Number
5. X-Y Actuator

**Fig. 1, Serial Numbers for TCU and X-Y Actuator**




1. Transmission Identification Plate
2. Serial Number

**Fig. 2, Transmission Serial Number**

## Troubleshooting Tables, No Fault Codes

In a few cases there will be a definite problem and no J1587 fault code will be sent.

- If the engine will not crank and there are no transmission fault codes, see **Table 2**.

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# Transmission Range Faults

## Transmission Range-Selected Faults (PID 162)

There is one transmission range-selected fault covered in these procedures.

- For PID 162, FMI 02, see **Table 1** for procedures.

## Transmission Range-Attained Faults (PID 163)

There is one transmission range-attained fault covered in these procedures.

- For PID 163, FMI 02, see **Table 2** for procedures.

| PID 162, FMI 02—The Transmission Is Not Properly Calibrated | | | |
|---|---|---|---|
| **Failure Reason:**<br>• The gears are caught in an intermediate position.<br>• The transmission software does not allow shifting. | | | |
| **Problem** | **Procedure** | **Result** | **Action** |
| There are other active transmission faults. | Check for other MID 130 fault codes. | Other fault codes are active. | Troubleshoot the other active fault codes. |
| | | No other fault codes are active. | Go to the next step in the table. |
| The transmission needs to be recalibrated. | Complete a learning procedure using either ServiceLink or the SmartShift control.<br>To complete a learning procedure using the SmartShift control:<br>1. Ensure that the parking brake is set.<br>2. With the ignition turned off, pull and hold the SmartShift control toward steering wheel.<br>NOTE: The SmartShift control must be kept in this position until the gear display clears at the end of the procedure.<br>3. Turn on the ignition. The normal warm up procedure will initiate and an 'X' will display on the current gear indicator. Your transmission may be heard shifting.<br>4. Wait until the current gear indicator displays an 'N' (about 30 seconds) and an audible alert sounds. Start the engine within 10 seconds of the audible alert.<br>5. The engine will raise a few rpm, then fall back to idle, and an audible alert will sound. Turn off the engine within 10 seconds of audible alert. When the gear display clears, this procedure is complete.<br>NOTE: If during this procedure an 'SM' or 'X' (after the warm up procedure) appears in the gear display, stop, turn off the ignition, and wait for the gear display to go dark. Then start over. This may need to be repeated several times. | The fault is no longer active. | No further action is needed. |
| | | The fault is still active. | Contact Freightliner Technical Service Support. |

**Table 1, The Transmission Is Not Properly Calibrated**

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## Transmission Range Faults (PID 162 and 163)

| PID 163, FMI 02—The Gears Do Not Shift Properly | | | |
|---|---|---|---|
| **Failure Reason:**<br>• There is a defect in the TCU.<br>• There is a defect in the speed sensor.<br>• There is a defect in the actuator.<br>• The transmission software is not properly programmed.<br>• The datalink does not recognize the transmission type. | | | |
| **Problem** | **Procedure** | **Result** | **Action** |
| There are other active transmission faults. | Check for other MID 130 fault codes. | Other fault codes are active. | Troubleshoot the other active fault codes. |
| | | No other fault codes are active. | Go to the next step in the table. |
| There is a transmission software problem. | Using the ServiceLink diagnostics template, view the different gear positions, check that the clutch opens and closes, and that the x-y actuator moves from reverse, 1st, and 2nd gears. | The x-y actuator responds properly and the fault clears. | No further action is needed. |
| | | The fault is still active. | Go to the next step in the table. |
| There is component damage in the transmission. | Do a visual inspection of the x-y actuator, the hydraulic system, and the transmission shift system. | Damaged components are found. | Contact Mercedes-Benz Transmissions Service Support with the AGS codes and results of the electrical pre-test.<br>NOTE: One hour of troubleshooting time is alloted for printing the AGS codes and completing the electrical pre-test.<br>1. Using ServiceLink, print the AGS codes (130). |
| | | No damaged components are found. | 2. Complete the electrical pre-test result sheet in **Subject 301**.<br>3. With the results, contact Mercedes-Benz Transmissions Service Support by fax (503.961.8435), email (MBTServiceSupport@Freightliner.com), or phone (503.745.4965 or 503.745.4988). |

**Table 2, The Gears Do Not Shift Properly**

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# Output Shaft Speed Sensor Faults (PID 191)

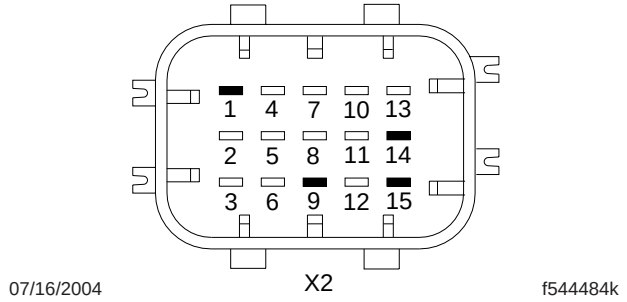
There are four output shaft speed sensor faults covered in these procedures. One troubleshooting procedure is used to correct FMI 02, 05, and 08. A separate procedure is used for FMI 14.

- For PID 191, FMI 02, 05, and 08 see **Table 1** for procedures and pin identification.
- For PID 191, FMI 14, see **Table 2** for procedures.

**PID 191, FMI 02, 05, 08—The Output Shaft Speed Sensor Circuit Gives Invalid Data, Is Open, or Not Broadcasting a Signal**

**Failure Reason:**

- The TCU has a hardware problem.
- The sensor is mounted too loose (air gap too big).
- The sensor connectors are damaged or bent.
- The wiring harness has had an electrical failure.
- Either one of the sensors or the TCU has failed.




| Procedure | Results | Action |
|---|---|---|
| Turn on the ignition switch and wait for the current gear display to power up. | Fault code SID 254, FMI 12 is active. | Go to **Subject 309** and troubleshoot SID 254, FMI 12. |
| | SID 254, FMI 12 is not active. | Go to the next row in the table. |
| Remove both output shaft speed sensors. Reinstall and tighten the sensor 28 lbf·ft (38 N·m). | The fault clears after a test drive. | No further action needed. |
| | The fault remains active. | Go to the next row in the table. |
| Turn off the ignition switch and wait for the current gear display to power down. Remove both sensor connectors and visually inspect the pins. | The connector pins are damaged or bent. | Repair or replace the damage. |
| | There is no damage to either connector. | Go to the next row in the table. |
| Check the upper sensor for continuity:<br>(1) X2 connector pin 1 to sensor pin 2;<br>(2) X2 connector pin 15 to sensor pin 1;<br>(3) X2 connector pin 14 to sensor pin 4. | There is an open circuit. | Replace the transmission wiring harness (see **Subject 180**). |
| | The wiring is OK. | Go to the next row in the table. |
| Check the lower sensor for continuity:<br>(1) X2 connector pin 1 to sensor pin 2;<br>(2) X2 connector pin 15 to sensor pin 1;<br>(3) X2 connector pin 9 to sensor pin 3. | There is an open circuit. | Replace the transmission wiring harness (see **Subject 180**). |
| | The wiring is OK. | Go to the next row in the table. |
| Check all four pins of each sensor connector for voltage and for continuity to ground. | Voltage or continuity is found. | Replace the transmission wiring harness (see **Subject 180**). |
| | There is zero voltage and no continuity. | Go to the next row in the table. |

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## Output Shaft Speed Sensor Faults (PID 191)

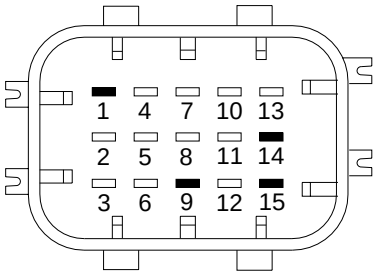
| PID 191, FMI 02, 05, 08—The Output Shaft Speed Sensor Circuit Gives Invalid Data, Is Open, or Not Broadcasting a Signal | | |
|---|---|---|
| **Failure Reason:**<br>• The TCU has a hardware problem.<br>• The sensor is mounted too loose (air gap too big).<br>• The sensor connectors are damaged or bent.<br>• The wiring harness has had an electrical failure.<br>• Either one of the sensors or the TCU has failed. |  <br>07/16/2004 f544484k | |
| **Procedure** | **Results** | **Action** |
| Using a sensor known to be good, replace each sensor in turn (see **Subject 120** for procedures). | The fault becomes inactive. | No further action needed. |
| | The fault is still active. | Contact Mercedes-Benz Transmissions Service Support with the AGS codes and results of the electrical pre-test.<br>NOTE: One hour of troubleshooting time is alloted for printing the AGS codes and completing the electrical pre-test.<br>1. Using ServiceLink, print the AGS codes (130).<br>2. Complete the electrical pre-test result sheet in **Subject 301**.<br>3. With the results, contact Mercedes-Benz Transmissions Service Support by fax (503.961.8435), email (MBTServiceSupport@Freightliner.com), or phone (503.745.4965 or 503.745.4988). |

**Table 1, The Output Shaft Speed Sensor Circuit Gives Invalid Data, Is Open, or Not Broadcasting a Signal**

| PID 191, FMI 14—The Output Shaft Speed Sensor Is Providing Invalid Data | | |
|---|---|---|
| **Failure Reason**<br>• The antilock brake system (ABS) is not broadcasting wheel speed data.<br>• There is a defective output shaft speed sensor. | | |
| **Procedure** | **Result** | **Action** |
| Check for other PID 191 fault codes. | Other PID 191 fault codes are active. | Troubleshoot PID 191. See **Table 1**. |
| | No other PID 191 fault codes are active. | Go to the next step in the table. |

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## Output Shaft Speed Sensor Faults (PID 191)

| PID 191, FMI 14—The Output Shaft Speed Sensor Is Providing Invalid Data | | |
|---|---|---|
| **Failure Reason**<br>• The antilock brake system (ABS) is not broadcasting wheel speed data.<br>• There is a defective output shaft speed sensor. | | |
| **Procedure** | **Result** | **Action** |
| Check for active fault codes in MID 136 (ABS). | Active MID 136 fault codes are found. | Troubleshoot the ABS system (see the applicable section in **Group 42**). |

**Table 2, The Output Shaft Speed Sensor Is Providing Invalid Data**

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For a schematic of the AGS transmission wiring behind the X2 (transmission) connector, see **Fig. 1**. For a schematic of the AGS transmission wiring behind the X1 (main vehicle) and X3 (electric motor) connectors, see drawing G06-49466.

For a list of special tools, see **Table 1**.

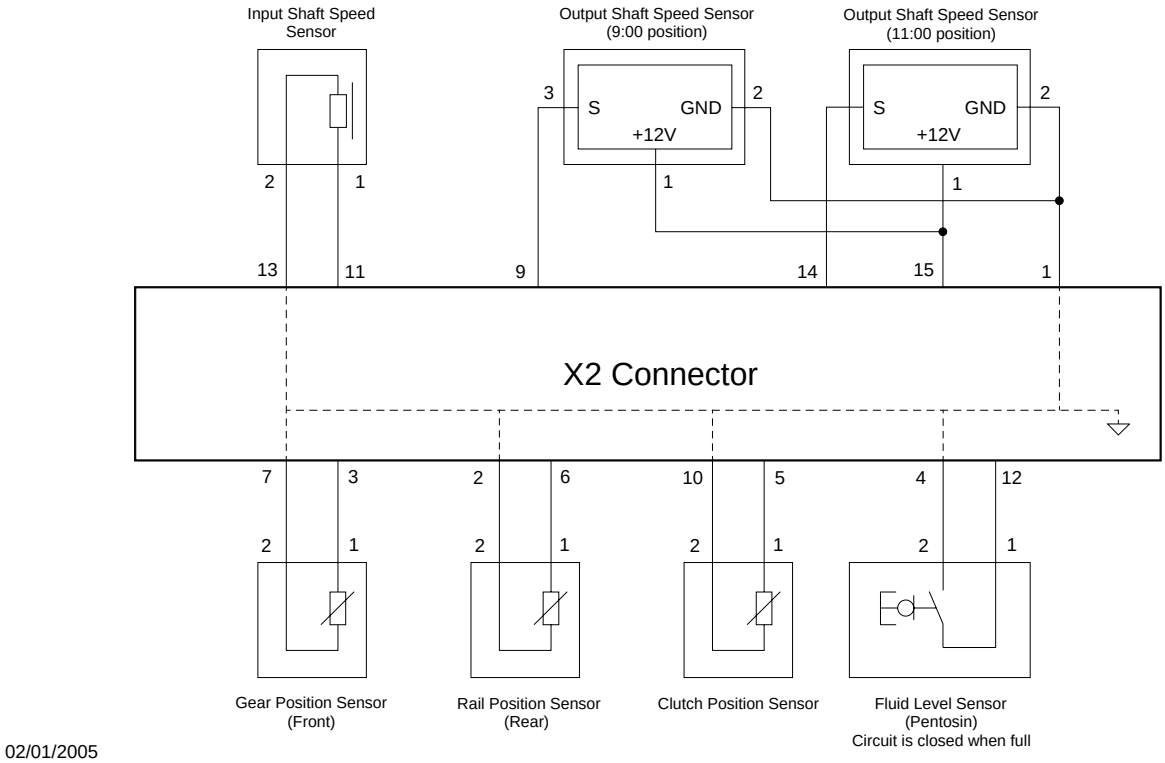
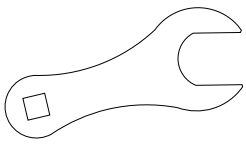



**Fig. 1, AGS Transmission Wiring, X2 Connector**

| Special Tools for AGS Transmission | | | |
|---|---|---|---|
| **Tool** | **Description** | **Manufacturer** | **Part Number** |
|  f580381 | Accumulator Torque Adaptor | Kent-Moore | J-47291 |
| f580379a | Low-Pressure Hose Disconnect Tool | Kent-Moore | J-47202 |

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## Specifications

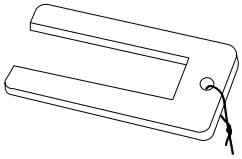
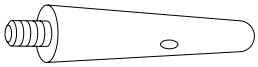
| Special Tools for AGS Transmission | | | |
|---|---|---|---|
| **Tool** | **Description** | **Manufacturer** | **Part Number** |
| f580379 | High-Pressure Line Disconnect Tool | Kent-Moore | J-47201 |
|  f580380 | Shift Finger Alignment Fork | Kent-Moore | J-47204 |
|  f580382 | Shift Mechanism End Guide | Kent-Moore | J-47203 |

**Table 1, Special Tools for AGS Transmission**

For transmission installation torque values, see **Table 2**.

| Transmission Installation Torque Values | | | |
|---|---|---|---|
| **Description** | **Size** | **Class** | **Torque: lbf·ft (N·m)** |
| Midship Bearing Bracket Capscrews | 3/4–11 | — | 91 (123) |
| Power Takeoff Unit (PTO) Mounting Capscrews | M10 | 10.9 | 43 (58) |
| Transmission Fluid Drain Plug | M24 | — | 42 (57) |
| Transmission Fluid Fill Plug | M24 | — | 42 (57) |
| Transmission Mounting Bolts | M10 x 1.5 | 8.8 | 33 (45) |
| U-Joint End Cap Bolts | 3/8–24 | — | 50 (68) |
| | 1/2–20 | — | 110 (149) |

**Table 2, Transmission Installation Torque Values**

For AGS assembly torque values, see **Table 3**.

| AGS Assembly Torque Values | | | |
|---|---|---|---|
| **Description** | **Size** | **Torque: lbf·ft (N·m)** | **Torque: lbf·in (N·cm)** |
| Accumulator Hydraulic Fitting | M30 | 59 (80) | — |
| X-Y Actuator Mounting Capscrews | M8 | 17 (23) | — |

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| AGS Assembly Torque Values | | | |
|---|---|---|---|
| **Description** | **Size** | **Torque: lbf·ft (N·m)** | **Torque: lbf·in (N·cm)** |
| AGS Central Unit Mounting Capscrews | M8 | 17 (23) | — |
| Clutch Actuator Hydraulic Fittings | M30 | 37 (50) | — |
| Clutch Actuator Mounting Capscrews | M8 | 17 (23) | — |
| Pressure-Limiting Valve Adjusting Screw | M6 | — | 63–71 (700–800) |
| Reservoir Base Fasteners | M8 | 11 (15) | — |
| Reservoir Top Fasteners | M6 | — | 71 (800) |
| Rotational Speed (RPM) Sensors | — | 28 (38) | — |
| Shift Rod Setscrew | M12 | 22 (30) | — |
| Transmission Control Unit (TCU) Mounting Screws | M8 | — | 44–53 (500–600) |
| TCU Splash Guard Mounting Capscrews | M8 | 17 (23) | — |

**Table 3, AGS Assembly Torque Values**

For AGS transmission gear ratios, see **Table 4**.

| AGS Transmission Gear Ratios | | |
|---|---|---|
| **Model** | **Gear** | **Ratio** |
| MBT520-6DA | 1 | 9.201 |
| | 2 | 5.230 |
| | 3 | 3.145 |
| | 4 | 2.034 |
| | 5 | 1.374 |
| | 6 | 1.000 |
| | R | 8.649 |
| MBT660-6OA | 1 | 6.700 |
| | 2 | 3.810 |
| | 3 | 2.290 |
| | 4 | 1.480 |
| | 5 | 1.000 |
| | 6 | 0.730 |
| | R | 6.290 |

**Table 4, AGS Transmission Gear Ratios**

For a list of proprietary fault codes viewable on ServiceLink, see **Table 5**.

| AGS Proprietary Fault Codes (J1708) | |
|---|---|
| **Fault Code** | **Description** |
| 3000109 | High voltage supply voltage—external (connector X1/12 and X1/15) |

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## Specifications

| AGS Proprietary Fault Codes (J1708) | |
|---|---|
| **Fault Code** | **Description** |
| 3000113 | High voltage ignition key line—external (connector X1/9) |
| 3000209 | Low voltage supply voltage—external (connector X1/12 and X1/15) |
| 3000213 | Low voltage ignition key line—external (connector X1/9) |
| 3001210 | EEPROM parameter values error—internal |
| 3001510 | Clutch displacement control module parameter error—internal |
| 3001781 | Clutch calibration offset off limit—internal |
| 3002009 | Open load supply voltage—external (connector X1/12 and X1/15) |
| 3002016 | Open load/Short circuit VCC temperature sensor circuit board—internal |
| 3002017 | Open load/Short circuit VCC temperature sensor pump—internal |
| 3002116 | Short circuit GND temperature sensor circuit board—internal |
| 3002117 | Short circuit GND temperature sensor pump—internal |
| 3002214 | Short circuit VCC peripherals supply—external (connector X2/15) |
| 3003001 | EBC1 message timeout—external (J1939) |
| 3003101 | EEC1 message timeout—external (J1939) |
| 3003201 | EEC2 message timeout—external (J1939) |
| 3003301 | EEC3 message timeout—external (J1939) |
| 3003401 | ERC1 message timeout—external (J1939) |
| 3003501 | Wheel speed information message timeout—external (J1939) |
| 3003601 | CruiseControl (VCU) message timeout—external (J1939) |
| 3003701 | CruiseControl (bulkhead) message timeout—external (J1939) |
| 3003801 | Engine configuration message timeout—external (J1939) |
| 3003901 | Retarder configuration message timeout—external (J1939) |
| 3004001 | Component identification message timeout—external (J1939) |
| 3004101 | PTO information message timeout—external (J1939) |
| 3006101 | Incorrect engine data—external (J1939) |
| 3006201 | Timeout converted engine data for clutch module (low priority)—internal |
| 3006701 | Incorrect retarder data—external (J1939) |
| 3006801 | Incorrect ABS data—external (J1939) |
| 3006901 | Incorrect internal data—internal |
| 3007001 | Incorrect clutch module data—internal |
| 3007101 | Incorrect automated gear shift module data—internal |
| 3007201 | Incorrect internal data—internal |
| 3008881 | Clutch overload—internal |
| 3009280 | Plausibility error actual transmission gear ratio—internal |
| 3009710 | Test software—internal |
| 3009810 | Test electronic—internal |

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| AGS Proprietary Fault Codes (J1708) | |
|---|---|
| **Fault Code** | **Description** |
| 3009910 | Test bench mode activated—internal |
| 3010390 | Automatic module: signal group cruise control / retarder—internal |
| 3010690 | Automatic module: signal output speed—internal |
| 3010790 | Automatic module: signal group MR—internal |
| 3010890 | Automatic module: signal group gear ratio—internal |
| 3010990 | Automatic module: learning values engine—internal |
| 3011081 | Plausibility error intended clutch position can not be reached within specified time—internal |
| 3011090 | Automatic module: learning values transmission—internal |
| 3011310 | Clutch calibration data missing/error—internal |
| 3011410 | Clutch parameter error—internal |
| 3011590 | Automatic module: signal group shifting time—internal |
| 3011690 | Automatic module: signal group ABS—internal |
| 3011790 | Automatic module: signal group pedal activation—internal |
| 3011890 | Automatic module: signal group lever—internal |
| 3011990 | Automatic module: error target system—internal |
| 3012014 | Open load peripherals supply—external (connector X2/15) |
| 3012019 | Plausibility error valve relay V-V2 on—internal |
| 3012035 | Open load power stage solenoid valve (clutch open 1)—internal |
| 3012036 | Open load power stage solenoid valve (clutch open 2)—internal |
| 3012037 | Open load power stage solenoid valve (clutch close 1)—internal |
| 3012038 | Open load power stage solenoid valve (clutch close 2)—internal |
| 3012050 | Open load speed sensor transmission output (DZ1)—external (connector X2/14) |
| 3012051 | Open load speed sensor transmission input—external (connector X2/11) |
| 3012052 | Open load speed sensor transmission output (D3)—external (connector X2/9) |
| 3012090 | Automatic module: system identification gearshift module—internal |
| 3012114 | Short circuit to GND peripherals supply—external (connector X2/15) |
| 3012118 | Plausibility error valve relay V-V1 off—internal |
| 3012119 | Plausibility error valve relay V-V2 off—internal |
| 3012136 | Short circuit GND power stage solenoid valve (clutch open 2)—internal |
| 3012138 | Short circuit GND power stage solenoid valve (clutch close 2)—internal |
| 3012151 | Short circuit GND speed sensor transmission input—external (connector X2/11 |
| 3012251 | Short circuit VCC speed sensor transmission input—external (connector X2/11) |
| 3012461 | Hydraulic level too low external—external |
| 3016201 | Timeout converted engine data for clutch module (medium priority)—internal |
| 3016401 | Timeout driving direction information—internal |
| 3016501 | Timeout internal communication shift module to clutch module (medium priority)—internal |

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## Specifications

| AGS Proprietary Fault Codes (J1708) | |
|---|---|
| **Fault Code** | **Description** |
| 3018681 | Plausibility error clutch open request while inlet valves are closed—internal |
| 3018781 | Plausibility error clutch open request while outlet valves are closed—internal |
| 3019480 | Plausibility error driving direction—internal |
| 3019621 | SmartShift lever data invalid—external (connector X1/8, X1/11, X1/14) |
| 3019650 | Tooth signal interruption speed sensor transmission output (DZ1)—external (connector X2/14) |
| 3019651 | Tooth signal interruption speed sensor transmission input—external (connector X2/11) |
| 3019652 | Tooth signal interruption speed sensor transmission output (D3)—external (connector X2/9) |
| 3020110 | High voltage distance sensor supply—internal |
| 3020111 | Power supply high voltage—external (connector X3/1) |
| 3020210 | Low voltage distance sensor supply—internal |
| 3020211 | Power supply low voltage—external (connector X3/1) |
| 3021010 | Flash checksum error—internal |
| 3021110 | EEPROM calibration values error—internal |
| 3021610 | Clutch displacement offset failure—internal |
| 3022011 | Supply voltage open load—external (connector X3/1) |
| 3022012 | Open load GND connection—external (connector X1/18 and X1/21) |
| 3022015 | Open load pressure sensor signal—internal |
| 3022018 | Plausibility error valve relay V-V1 on—internal |
| 3022020 | Open load GND pump motor—external (connector X3/2) |
| 3022030 | Open load power stage solenoid valve (selection direction R)—internal |
| 3022031 | Open load power stage solenoid valve (selection direction 5/6)—internal |
| 3022032 | Open load power stage solenoid valve—internal |
| 3022033 | Open load power stage solenoid valve (gear direction 1,3,5)—internal |
| 3022034 | Open load power stage solenoid valve (pressure regulation)—internal |
| 3022041 | Open load distance sensor (gear)—internal |
| 3022042 | Open load distance sensor (selection)—internal |
| 3022044 | Open load distance sensor (clutch)—internal |
| 3022060 | Open loop power stage pump motor—internal |
| 3022115 | Short circuit GND pressure sensor signal—internal |
| 3022130 | Short circuit GND power stage solenoid valve (selection direction R)—internal |
| 3022131 | Short circuit GND power stage solenoid valve (selection direction 5/6)—internal |
| 3022132 | Short circuit GND power stage solenoid valve (gear direction R,2,4,6)—internal |
| 3022133 | Short circuit GND power stage solenoid valve (gear direction 1,3,5)—internal |
| 3022134 | Short circuit GND power stage solenoid valve (pressure regulation)—internal |
| 3022135 | Short circuit GND power stage solenoid valve (clutch open 1)—internal |
| 3022137 | Short circuit GND power stage solenoid valve (clutch close 1)—internal |

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| AGS Proprietary Fault Codes (J1708) | |
|---|---|
| **Fault Code** | **Description** |
| 3022141 | Short circuit GND distance sensor (gear)—internal |
| 3022142 | Short circuit GND distance sensor (selection)—internal |
| 3022144 | Short circuit GND distance sensor (clutch)—internal |
| 3022160 | Short circuit GND power stage pump motor—internal |
| 3022215 | Short circuit VCC pressure sensor signal—internal |
| 3022241 | Short circuit VCC distance sensor (gear)—internal |
| 3022242 | Short circuit VCC distance sensor (selection)—internal |
| 3022244 | Short circuit VCC distance sensor (clutch)—internal |
| 3022317 | Over temperature power stage pump motor—internal |
| 3022590 | Automatic module: no signal vehicle speed—internal |
| 3022690 | Automatic module: signal group MR (high priority)—internal |
| 3022790 | Automatic module: signal group gear ratio (high priority)—internal |
| 3022890 | Automatic module: learning values engine (high priority)—internal |
| 3022990 | Automatic module: learning values transmission (high priority)—internal |
| 3024341 | Erratic distance sensor (gear)—internal |
| 3024342 | Erratic distance sensor (selection)—internal |
| 3024344 | Erratic distance sensor (clutch)—internal |
| 3024441 | Wrong coil resistance value distance sensor (gear)—internal |
| 3024442 | Incorrect coil resistance value distance sensor (selection)—internal |
| 3024444 | Incorrect coil resistance value distance sensor (clutch)—internal |
| 3024610 | Timeout displacement sensor value—internal |
| 3026001 | CAN bus off—external (connector X1/13 and X1/7) |
| 3026301 | Timeout converted engine data for clutch module (high priority)—internal |
| 3026501 | Timeout internal communication shift module to clutch module (high priority)—internal |
| 3027401 | No J1939 communication—internal / external (connector X1/13 and X1/7) |
| 3027501 | Timeout internal communication shift module to clutch module (high priority)—internal |
| 3028581 | Clutch displacement control failure—internal |
| 3029180 | No calculation of redundant transmission output speed—internal |
| 3029380 | Incorrect transmission type—internal |
| 3029580 | Plausibility error pressure build up—internal |

**Table 5, AGS Proprietary Fault Codes (J1708)**

For a list of learning procedure errors, see **Table 6**.

| Learning Procedure Errors | |
|---|---|
| **Error** | **Description** |
| 56 | Offset of clutch position out of range |

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## Specifications

| Learning Procedure Errors | |
|---|---|
| **Error** | **Description** |
| 57 | Offset of pressure modulation valve out of range |
| 58 | Gear position "neutral" out of range |
| 61 | Low gear position out of range |
| 62 | High gear position out of range |
| 63 | Low select position out of range |
| 66 | High select position out of range |
| 68 | Valve or sensor failure |
| 69 | Vehicle is moving |
| 70 | Low voltage or high voltage |
| 71 | Clutch open/closed |
| 72 | Stalk lever position changed during learning procedure |
| 73 | Type of gear box invalid |
| 74 | Park brake not activated |
| 76 | Engine is running |
| 77 | Engine torque invalid or out of range |
| 78 | Engine was not started in time |
| 80 | Accelerator pedal not idle |
| 82 | Countershaft speed not zero |

**Table 6, Learning Procedure Errors**

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# General Information

The Mercedes-Benz transmission (MBT) is offered in two 6-speed models:

- MBT520S-6D, direct drive, 520 lb·ft torque rating
- MBT660S-6O, overdrive, 660 lb·ft torque rating

The gear case holds 9.5 quarts (9.0 liters) of oil. MobilTrans SHC® DC is the approved oil.

Both models are fully synchronized for reduced shifting effort. Equipped with six forward speeds and one reverse speed, both models show a particularly large overall ratio between low and top gear. See **Specifications, 400** for gear ratios for each model.

To reduce fluid change intervals and to increase bearing life, MBT transmissions are designed with "clean" bearings. These bearings have covers on both sides. They cannot be damaged by the wear particles that accumulate in the fluid. The geometry of the gear teeth has been optimized to provide low-noise operation and extended gear life.

The bell housing has been designed around standard SAE bolt patterns. SAE2 is standard on both MBT660S-6O and MBT520S-6D models.

Other features of the MBT transmissions include:

- Light metal gear cases with integrated bell housings;
- Low installation height (the shift interface is positioned laterally);
- Double synchronization from 1st gear to 4th gear;
- Electronic vehicle speed sensor;
- Longer oil change intervals;
- Full range of PTO units available.

Each model requires a hydraulic clutch system. No clutches with manual control can be installed for use on MBT transmissions. With the hydraulic system installed, the clutch linkage is self-adjusting.

The hydraulic clutch system consists of the following parts:

- Hydraulic fluid reservoir;
- Clutch pedal unit;
- Master cylinder;
- Slave cylinder;
- Hydraulic lines connecting the various parts of the system.

The MBT transmission removal and installation procedures have been moved to **Subject 100** from their previous location in **Section 26.00**.

The teardown procedures included in this section also apply to the AGS automated transmission, with slight changes which are indicated at appropriate places in the procedures. If it is necessary to tear down the AGS transmission, be sure to remove the AGS assembly before proceeding. See **Section 26.03, Subject 200** for procedures.

On all transmissions, disassembly of the transmission main shaft is not recommended except when it is necessary to check for synchronizer wear. Disassembly of the countershaft is not recommended in any case.

It is important to check main shaft end play if either gear case half, the main shaft bearings, or the input shaft is replaced. For detailed procedures, see **Subject 250**.

To prevent premature tool wear, use extreme pressure lubricant such as Kent-Moore J 23444-A or equivalent on tool threads and at all friction and contact points.

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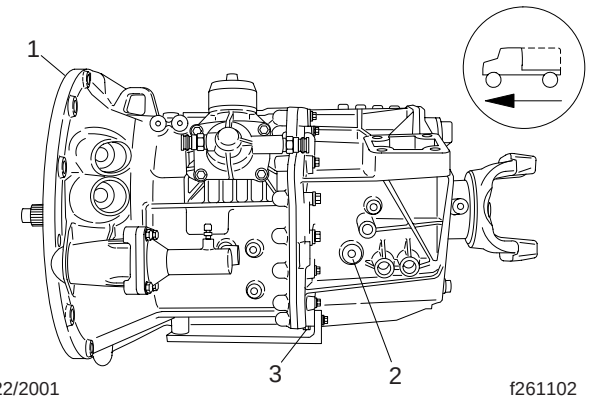
## Removal

1. Park the vehicle on a level surface. Shut down the engine, set the parking brake, and chock the rear tires.
2. Drain the transmission fluid. See **Fig. 1** for the location of the drain plug.

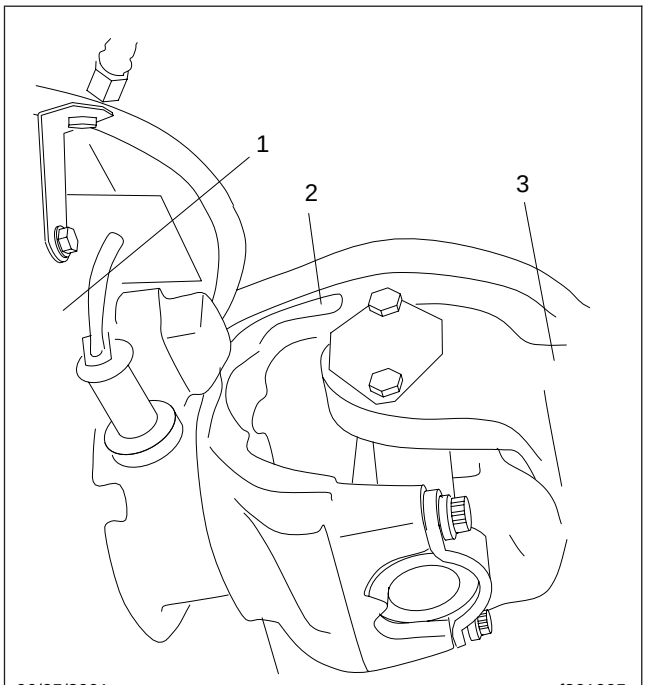



NOTE: The transmission is shown from the left-hand side.

1. Transmission
2. Fill Plug
3. Drain Plug

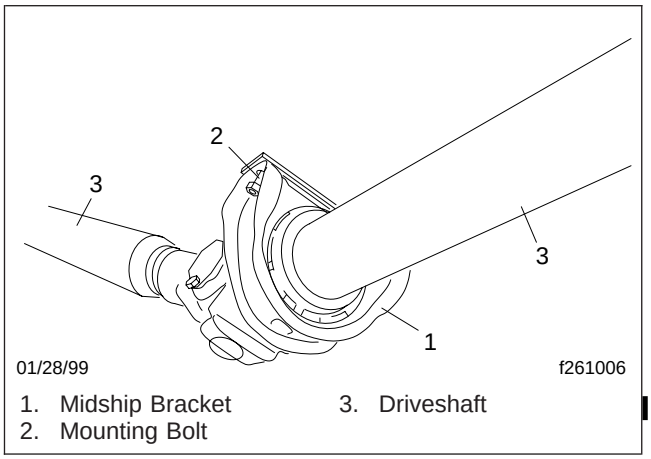
**Fig. 1, Transmission Drain and Fill Plugs**

3. Disconnect the driveshaft from the transmission.
   - 3.1 Support the midship bearing.
   - 3.2 Remove the bolts from the U-joint end caps and slide the front of the driveshaft out of the transmission output yoke. See **Fig. 2**.
   - 3.3 Remove the midship bearing bracket. See **Fig. 3**.
   - 3.4 Support the disconnected driveshaft and chain it out of the way. See **Fig. 4**.
4. Remove the shift lever from the transmission.
   - 4.1 Before removing the shift lever, place the transmission in high gear.
   - 4.2 Remove the four screws from the retaining ring around the shift lever boot. See **Fig. 5**. Remove the ring and the boot.
   - 4.3 Remove the head of the shift lever from the transmission. See **Fig. 6**. For ease of installation, mark the head of the shift lever and the attachment point on the transmission with a paint pen.
5. Remove the fuel lines and the fuel line standoff bracket from the transmission. See **Fig. 7**.




1. Transmission
2. Output Yoke
3. Driveshaft

**Fig. 2, Output Yoke**




1. Midship Bracket
2. Mounting Bolt
3. Driveshaft

**Fig. 3, Midship Bearing Bracket**

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## Transmission Removal and Installation

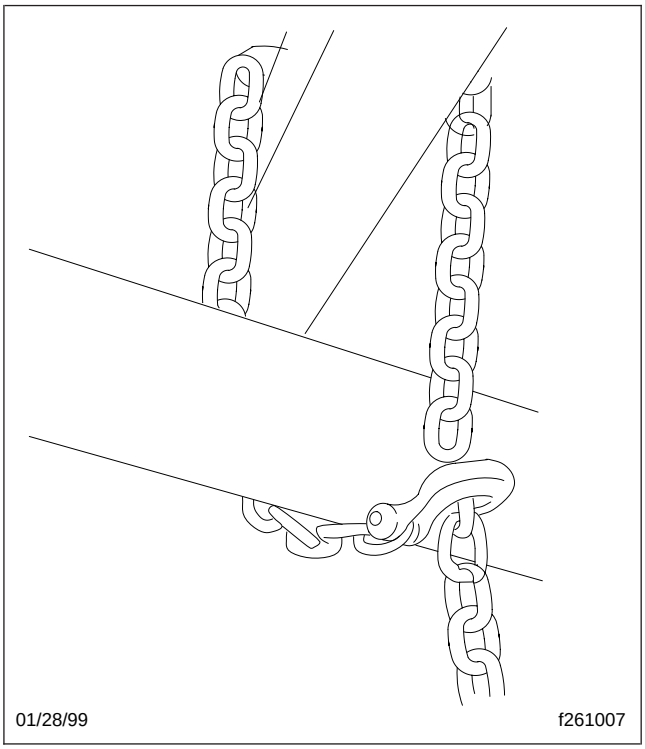



**Fig. 4, Supporting the Driveshaft**

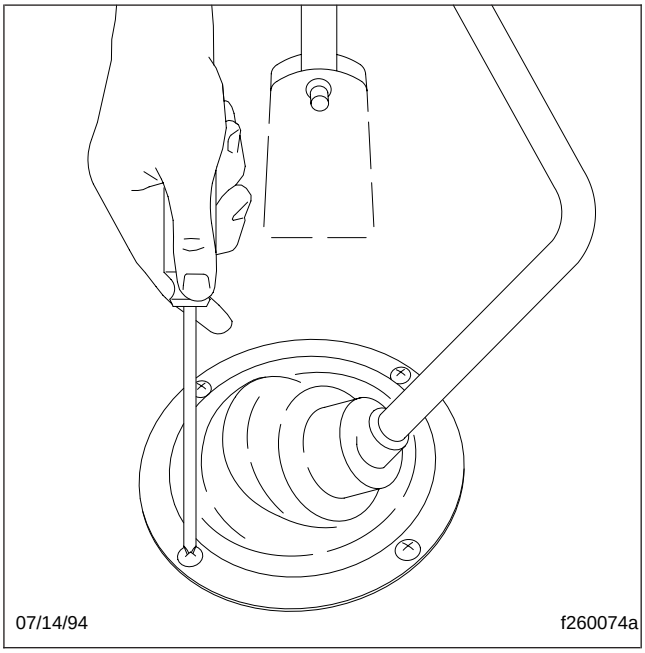
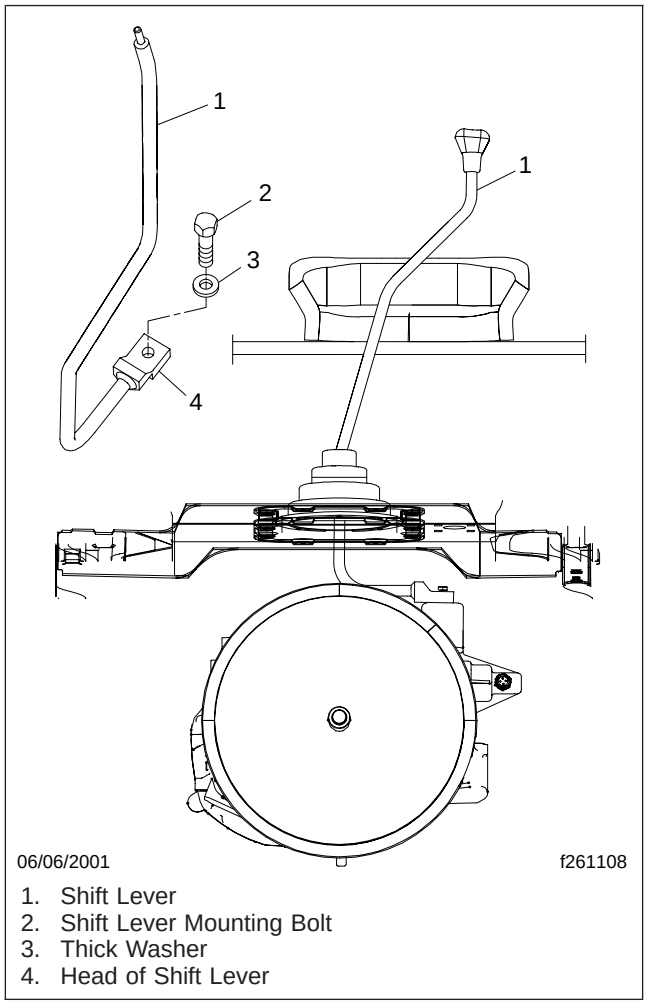



**Fig. 5, Shift Lever and Boot**




1. Shift Lever
2. Shift Lever Mounting Bolt
3. Thick Washer
4. Head of Shift Lever

**Fig. 6, Shift Lever Connection**

6. Disconnect the electrical connectors for the reverse gear switch and the optional starter lock switch (if installed). Mark with a paint pen for ease of installation.

**⚠ WARNING**

**Do not press down on the clutch pedal after removing the slave cylinder. Hydraulic brake fluid may squirt out, causing personal injury and damage to the vehicle.**

7. Remove the bolts that attach the clutch slave cylinder to the mounting flange on the gear case. Move the slave cylinder out of the way. See **Fig. 8**.

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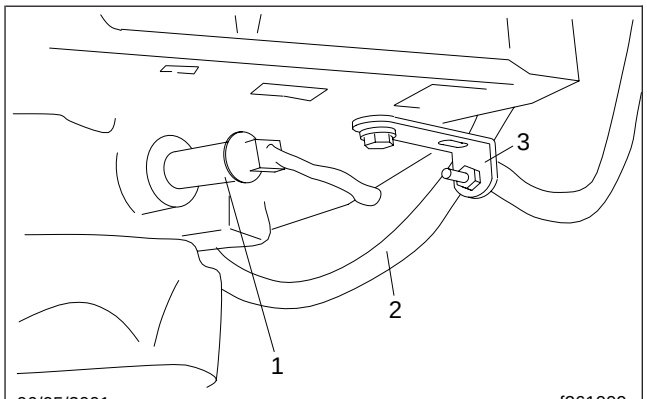
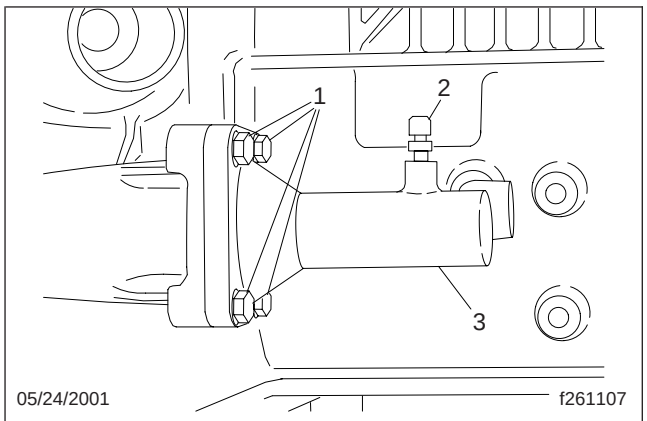



1. Speedometer Sensor
2. Fuel Line
3. Standoff Bracket

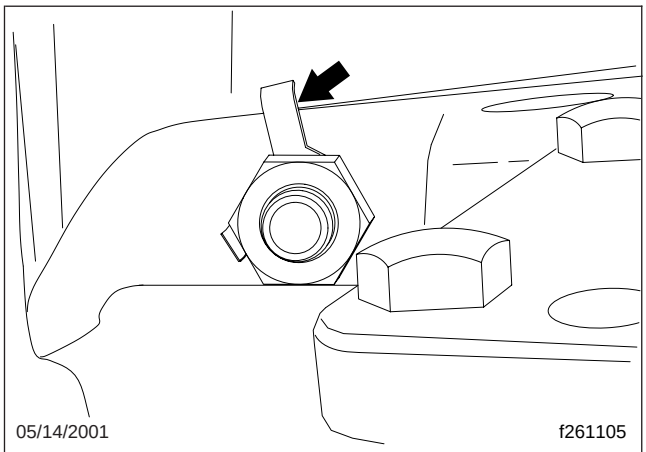
**Fig. 7, Fuel Line Standoff Bracket and Speedometer Sensor**




1. M8 Bolts
2. Bleed Valve
3. Slave Cylinder

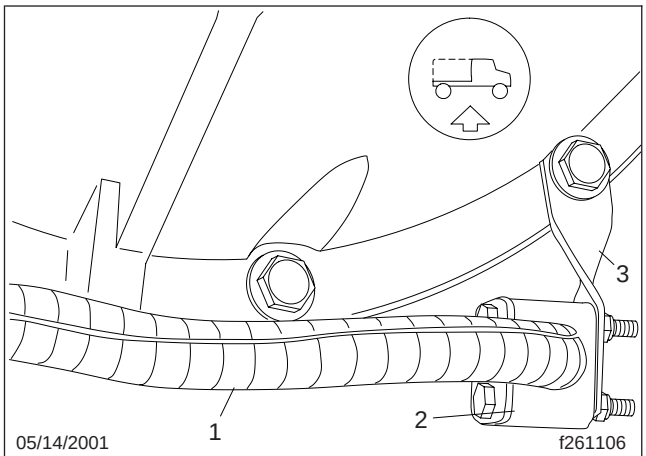
**Fig. 8, Hydraulic Clutch Slave Cylinder**

8. Bend back the nut retainers and remove the power take-off unit (PTO), if installed. See **Fig. 9**.
9. If the vehicle is equipped with optional dual fuel tanks, remove the fuel cross-over line and its support between the tanks.
10. Disconnect the electrical cable from the speedometer sensor and mark it with a paint pen for ease of installation. See **Fig. 7**.
11. Remove the battery cable bracket(s) around the transmission and move the battery cables out of the way. See **Fig. 10**.




Bend back the nut retainer (arrow).

**Fig. 9, Power Take-Off Unit (PTO) Nut Retainers**




1. Battery Cable
2. Battery Cable Clamp
3. Battery Cable Bracket

**Fig. 10, Battery Cable Routing**

12. Remove the exhaust clamp at the exhaust elbow. For ease of transmission removal and installation, move the exhaust pipe to the side and out of the way.
13. Support the transmission with a jack. See **Fig. 11**.
    - 13.1 Position a transmission jack under the transmission and raise its support plates against the base of the transmission.
    - 13.2 Adjust the support plates to cradle the transmission.

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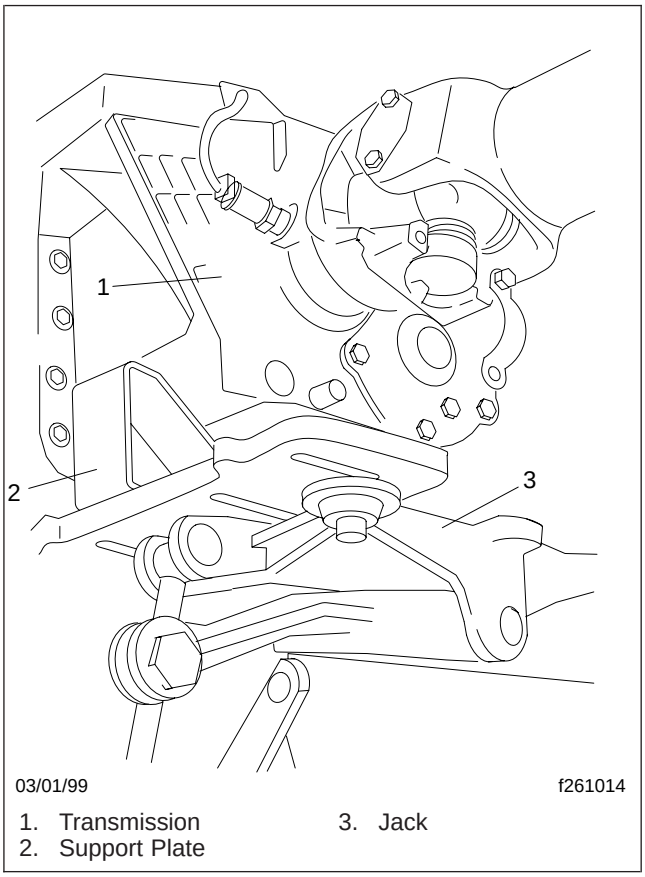
## Transmission Removal and Installation




1. Transmission
2. Support Plate
3. Jack

**Fig. 11, Supporting the Transmission**

13.3 Using a chain, secure the transmission to the jack.

14. Remove the 16-mm transmission mounting capscrews that attach the timing case to the bell housing. See **Fig. 12**.

14.1 Remove the eleven transmission mounting capscrews.

14.2 After removing the transmission, insert the capscrews into the holes in the timing case, rather than in the bell housing.

**⚠ CAUTION**

**Do not allow the rear of the transmission to drop, and do not allow the transmission to hang unsupported. Keep the flange of the bell housing parallel (all the way around) to the flange of the timing case, until the input shaft is clear of the flywheel. Taking these precautions will prevent damage to the input shaft, flywheel, and clutch.**

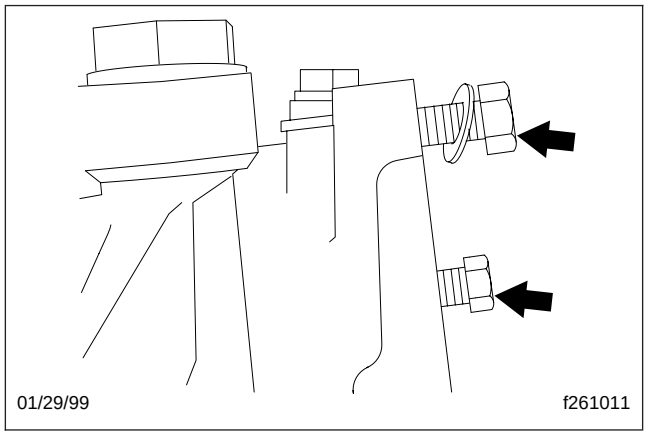
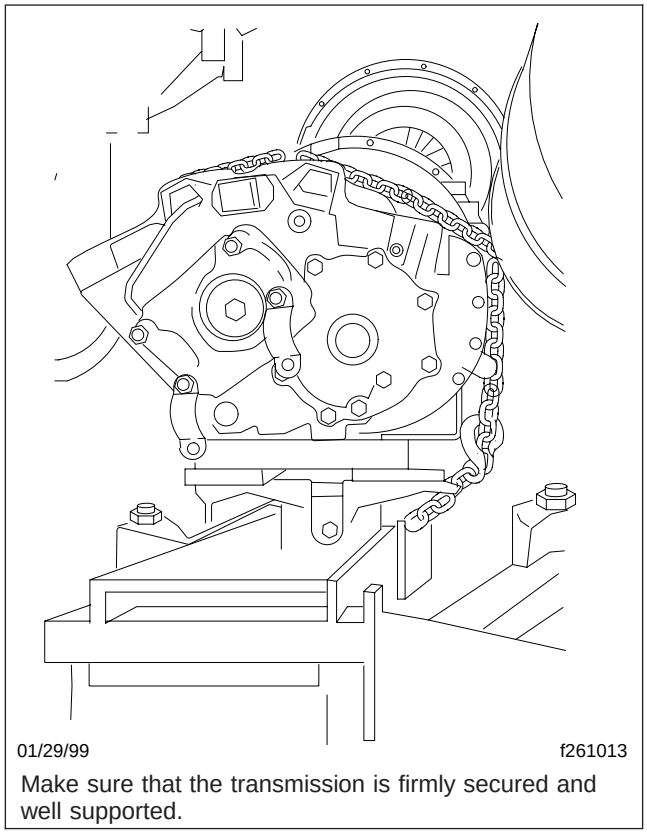



**Fig. 12, Capscrews Left in the Timing Case**

15. After making sure that the transmission is firmly secured and well supported, remove the transmission from the vehicle. See **Fig. 13**.




Make sure that the transmission is firmly secured and well supported.

**Fig. 13, Transmission Ready To Remove**

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15.1 Pull the transmission and jack straight back until the transmission input shaft is clear of the clutch.

15.2 Turn the left-hand front wheel to allow room for the transmission to pass. If necessary, lower the jack supporting the transmission. It might also be necessary to jack up the truck to get enough clearance to allow the transmission to pass.

IMPORTANT: Watch closely the clearance between the bell housing and the leaf spring.

15.3 Pull the transmission out through the space behind the front wheel.

## Installation

IMPORTANT: Before installing the transmission, make sure that the rear tires are chocked and that the transmission is securely chained to the support plates on the transmission jack.

1. Install the transmission. See **Fig. 14**.

   1.1 Align the jack and the transmission behind the engine.

   1.2 Raise the transmission and adjust the angle of the jack until the bell housing and the timing case flange are parallel.

   1.3 Push the transmission and jack straight forward.

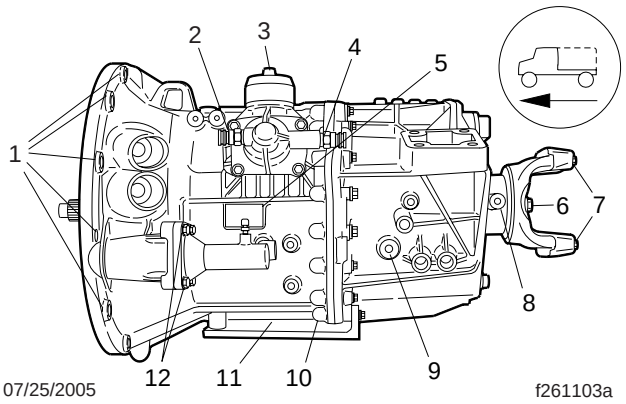
   NOTE: While installing the transmission mounting capscrews, also install the battery cable bracket(s), as removed.

   1.4 Install the eleven M10 transmission mounting capscrews. Use a crossover pattern. Do a final tightening of the capscrews to 33 lbf·ft (45 N·m).

   1.5 Remove the chain around the transmission and the jack; then remove the jack.

2. Install the exhaust clamp at the exhaust elbow, as removed.

3. If the vehicle is equipped with the optional dual fuel tanks, install the fuel cross-over line and its support between the tanks. Tighten the clamps




NOTE: The transmission is shown from the left-hand side.

1. Transmission Mounting Capscrews
2. Reverse Gear Switch
3. Shift Lever Mounting Bolt
4. Starter Lock Switch
5. Nameplate
6. Output Yoke Pressure Plate Mounting Capscrew
7. U-Joint End Cap Bolts
8. Speedometer Sensor Lock
9. Transmission Fluid Fill Plug
10. Transmission Fluid Drain Plug
11. PTO Mounting Capscrews
12. Clutch Slave Cylinder Mounting Bolts

**Fig. 14, Transmission Fasteners**

40 lbf·ft (54 N·m) and the mounting bolts 95 lbf·ft (129 N·m).

4. If removed, coat the mating surface of the PTO cover with Loctite® 509 or equivalent sealing compound. Install the PTO cover on the transmission. Tighten the M10 hardened mounting capscrews 43 lbf·ft (58 N·m). Lock the nut retainers in place.

5. Connect the driveshaft.

   5.1 Slide the front of the driveshaft into the transmission output yoke.

   5.2 Install the U-joint end caps on the output yoke. Tighten the bolt heads 50 lbf·ft (68 N·m) for 3/8-inch end cap bolts and 110 lbf·ft (149 N·m) for 1/2-inch end cap bolts.

   5.3 Install the midship bearing bracket, as removed. Tighten the nuts 95 lbf·ft (129 N·m).

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## Transmission Removal and Installation

6. Install the fuel line standoff bracket and connect the fuel lines to the bracket.
7. Connect the electrical connectors. Connect the electrical cable to the speedometer sensor. Connect the electrical connector(s) on the shift lever.
8. Install the shift lever.
   - 8.1 Fit the shift lever over the cone of the transmission tower.
   - 8.2 Coat the hardened M10 x 20 shift lever mounting bolt with Loctite 242 or equivalent thread-locking compound.
   - 8.3 Insert the M10 bolt and a thick washer into the hole in the shift lever. See **Fig. 6**. Use the markings made during removal to install the shift lever in the correct orientation, so as to avoid cab floor interference.

   IMPORTANT: Don't forget to install the washer. Without the washer, the shift lever may loosen. The driver could lose control of the vehicle.

   - 8.4 Tighten the M10 bolt 50 lbf·ft (68 N·m).
   - 8.5 Work the shift lever around to make sure it shifts comfortably in all gears.
   - 8.6 Install the rubber boot and the metal retaining ring. Install the four screws and tighten against the cab floor 28 lbf·ft (38 N·m). See **Fig. 5**.
9. Fasten the clutch slave cylinder to the mounting flange on the gear case and tighten the four M8 slave cylinder mounting bolts 15 lbf·ft (20 N·m).
10. If necessary, bleed the hydraulic clutch system. See **Section 25.02, Subject 140** for detailed instructions.
11. Clean the transmission drain plug and install it in the gear case, along with a new aluminum gasket. Tighten the drain plug 42 lbf·ft (57 N·m).
12. Add Mobiltrans SHC® DC until the transmission fluid is level with the lower edge of the fill opening. See **Fig. 1** for the location of the fill plug and **Fig. 15** for checking the correct level. About 9.5 quarts (9.0 liters) is needed.
13. Clean the transmission fill plug and install it in the gear case, along with a new aluminum gasket. Tighten the fill plug 42 lbf·ft (57 N·m).

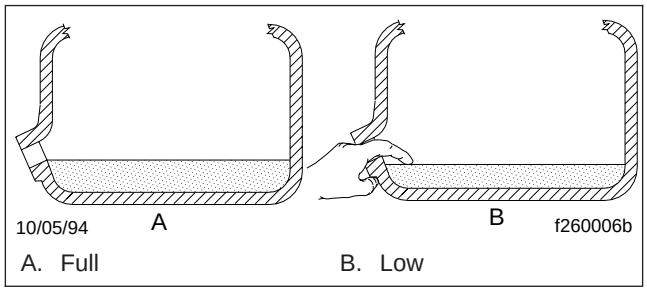


**Fig. 15, Transmission Fluid Level Checking**

14. Remove the chocks from the rear tires.

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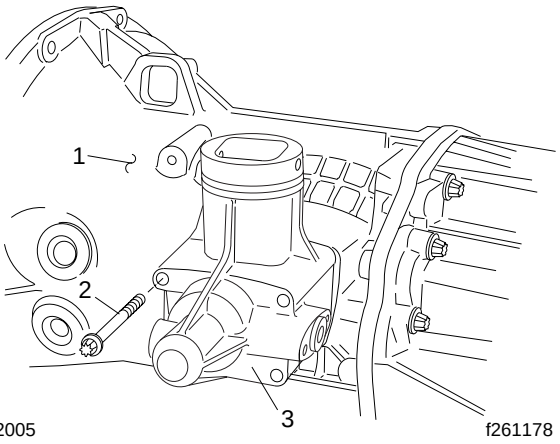
NOTE: These procedures are for the manual transmission with shift lever only. For the automated AGS transmission, see **Section 26.03, Subject 200**.

## Removal

1. Remove the transmission. For detailed procedures, see **Subject 100**.
2. Secure the transmission on a wooden pallet, or other device to keep it from moving.
3. Make sure the transmission is in neutral.
4. Remove the four capscrews that attach the shift rod housing to the flange on the front gear case. See **Fig. 1**.




1. Front Gear Case
2. Shift Rod Housing Capscrew
3. Shift Rod Housing

**Fig. 1, Shift Mechanism**

5. Remove the shift rod from the front gear case.
   - 5.1 From the right-hand side of the transmission, remove the setscrew that holds the end of the shift rod. Discard the old setscrew.
   - 5.2 Remove and discard the shift rod cover from the right-hand side of the gear case.
   - 5.3 Pull the shift rod all the way out of the gear case.

## Installation

NOTE: See the installation procedure in **Section 26.03, Subject 200** for more information on the proper alignment of the shift finger in the shift rod.

1. Make sure that the indent in the shift rod end (shown by the arrow in **Fig. 2**) is facing aft for proper engagement with the setscrew.
2. Install the shift rod in the front gear case.
   - 2.1 Insert the shift rod into the front gear case.
   - 2.2 Turn the shift rod until the dimple is at the 9 o'clock position.
3. Install the shift rod housing on the front gear case.
   - 3.1 Push the housing in until the indent in the rod end is showing in the setscrew hole.
   - 3.2 Coat the threads of a new setscrew with Loctite® 242 or equivalent thread-locking compound. Insert the new setscrew and tighten it 30 lbf·ft (40 N·m). See **Fig. 3**.
   - 3.3 Install a new shift rod cover in the shift cover housing.
   - 3.4 Position the shift rod housing over the flange in the front gear case. Coat the mating surfaces with a bead of Loctite 509 or equivalent sealing compound.
   - 3.5 Install the four capscrews that attach the shift rod housing to the front gear case. Coat the threads of the two lower capscrews with Loctite 242 or equivalent thread-locking compound. Tighten all four capscrews 18 lbf·ft (25 N·m).
4. Install the transmission. For detailed procedures, see **Subject 100**.

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6. Turn the ignition switch off.
7. If the voltage at the ECU is not within the specified range, check the battery voltage and test the wiring to the ECU and to ground.
8. Connect the X1 connector to the ECU and remove the chocks from the tires.

## ABS Pneumatic System Test

To check for air leaks in the ABS pneumatic system, listen for the sound of escaping air at each valve. To confirm a slow air leak, apply a soap-and-water solution to air line fittings and watch for bubbles.

## Wheel Speed Sensor Tests

### Wheel Speed Sensor and Circuit Resistance

To check the resistance in a wheel speed sensor circuit, perform the following test:

1. Park the vehicle on a level surface, set the parking brake, and shut down the engine. Chock the rear tires.
2. Disconnect the sensor cable connector from the ABS ECU. See **Table 1**.

**ABS/ATC Circuit Pin and Wire Numbers**

| Pin Connector | Pin Number | Wire Number | Circuit Description |
|---|---|---|---|
| X1 Gray | 1 | 376C | ECU Ignition Supply |
| | 2 | 376C | ECU #2 Positive 12 Volt Supply |
| | 3 | 376T | Wheel Spin Light and ATC Switch |
| | 4 | 1587+ | J1587+ |
| | 5 | 376R | Retarder Interrupt Signal |
| | 6 | 1922-/1939- | J1922–/1939– |
| | 7 | 1922+/1939+ | J1922+/1939+ |
| | 9 | 1587 | J1587– |
| | 10 | 376L | ABS Light |
| | 11 | XGRD | ECU Ground |
| | 12 | XGRD | ECU Ground |
| X2 Black | 1 | — | Not used |
| | 2 | 378LFI | Left Front Modulator Valve, In |
| | 3 | 378RF0 | Right Front Modulator Valve, Out |
| | 4 | 378RFI | Right Front Modulator Valve, In |
| | 5 | 377RF+ | Right Front Sensor, High |
| | 6 | 377RF– | Right Front Sensor, Low |
| | 7 | 377LF– | Left Front Sensor, Low |
| | 8 | 377LF+ | Left Front Sensor, High |
| | 9 | 378RF– | Right Front Modulator Valve, Ground |
| | 10 | 378LF0 | Left Front Modulator Valve, Out |
| | 11 | 378LF– | Left Front Modulator Valve, Ground |
| | 12 | — | Not used |

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| ABS/ATC Circuit Pin and Wire Numbers | | | |
|---|---|---|---|
| **Pin Connector** | **Pin Number** | **Wire Number** | **Circuit Description** |
| X3 Green | 1 | 377LR+ | Left Rear Sensor, High |
| | 2 | 377LR– | Left Rear Sensor, Low |
| | 3 | 377RR+ | Right Rear Sensor, High |
| | 4 | 377RR– | Right Rear Sensor, Low |
| | 5 | 378T+ | ATC Valve, High |
| | 6 | 378T– | ATC Valve, Low |
| | 7 | 378RR0 | Right Rear Modulator Valve, Out |
| | 8 | 378RR– | Right Rear Modulator Valve, Ground |
| | 9 | 378RRI | Right Rear Modulator Valve, In |
| | 10 | 378LR0 | Left Rear Modulator Valve, Out |
| | 11 | 378LR– | Left Rear Modulator Valve, Ground |
| | 12 | 378LRI | Left Rear Modulator Valve, In |

**Table 1, ABS/ATC Circuit Pin and Wire Numbers**

3. Connect ohmmeter probes to the sensor connector terminals and read the resistance.
    - If the resistance is 900 to 2000 ohms, the cable and the sensor circuit are good. Proceed to the "Wheel Speed Sensor Voltage" test.
    - If the resistance is less than 900 ohms or greater than 2000 ohms, perform the next test, "Wheel Speed Sensor Resistance."

## Wheel Speed Sensor Resistance

To check the resistance in a wheel speed sensor, perform the following test:

1. Park the vehicle on a level surface, set the parking brake, and shut down the engine. Chock the rear tires.
2. Disconnect the wheel sensor cable from the chassis harness.
3. Connect ohmmeter probes to the pins on the sensor and read the resistance.
    - If the resistance reading is 900 to 2000 ohms but the resistance noted in the previous test, "Wheel Speed Sensor and Circuit Resistance" was not, repair or replace the chassis harness wiring.
    - If the resistance is less than 900 ohms or greater than 2000 ohms, clean the terminals and check the resistance again.
    - If the resistance reading is still not correct, replace the sensor. See **Subject 110** for instructions.
4. Install the connectors and remove the chocks from the tires.

## Wheel Speed Sensor Voltage

NOTE: PC diagnostics can be used for this test to compare speed signal output of all sensors. A problem will be indicated by low or erratic output.

To check the voltage output of a wheel speed sensor:

1. Park the vehicle on a level surface, set the parking brake, and shut down the engine.
2. Chock the tires of the axle not being tested. Raise the vehicle and put jack stands under the axle so the wheels can rotate.
3. Disconnect the applicable connector from the ABS ECU for the sensor being tested. See **Table 1**.

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4. Set a digital multimeter to the AC voltmeter mode. Connect the probes to the cable connector terminals for the sensor being tested.
5. Rotate the wheel by hand at a speed of 30 rpm (one-half revolution per second) and read the voltage output. The wheel speed sensor must generate a minimum of 0.2 volt AC.
   - If the voltage is at least 0.2 volt AC, skip to the next step.
   - If the voltage reading is less than 0.2 volt AC, push the sensor in its holder until the sensor touches the tooth wheel. See **Subject 120** for instructions. Repeat the voltage test.
   - If the sensor output is still less than 0.2 volt AC, replace the sensor.
6. Install the connector on the ECU. Remove the jack stands, lower the vehicle, and remove the chocks from the tires.

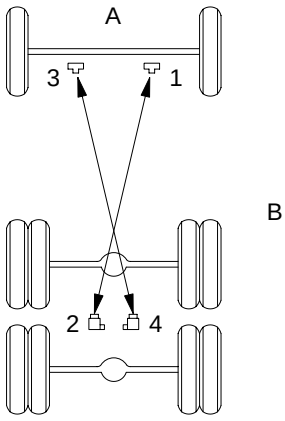
# Modulator Valve Tests

## Modulator Valve Function Check

NOTE: Valves can be tested using the Meritor WABCO PC Diagnostics software or the following procedure.

Modulator valves control the air pressure to each affected brake during an ABS function. To make sure the modulator valves are working, listen to them cycle during the ABS self-test.

1. Park the vehicle on a level surface, set the parking brake, and shut down the engine. Chock the rear tires.
2. Turn the ignition switch on.
3. When the ABS warning light comes on, listen for the modulator valves to cycle one by one, then together diagonally. See **Fig. 2**.
   - 4-Channel valve cycle: 1, 2, 3, 4; then 1 and 2 together followed by 3 and 4.
   - 6-Channel valve cycle: 1, 2, 3, 4, 5, 6; then 1, 2, and 3 together followed by 4, 5, and 6.
4. If the valves do not all cycle correctly, turn the ignition off and check the connectors for tightness. Repeat the self-test.

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NOTE: During the self-test, the valves cycle one by one in order (1–2–3–4), then in pairs diagonally (1/2 and 3/4). A 4-channel valve cycle is shown.

A. Cab B. Curbside
1. Right Front Modulator Valve
2. Left Rear Modulator Valve
3. Left Front Modulator Valve
4. Right Rear Modulator Valve

**Fig. 2, Modulator Valve Self-Test Sequence**

5. If the valves still do not cycle correctly, start the engine and check the air line connections to the valves for leaks. Shut down the engine and tighten the air line fittings. Repeat the self-test.
6. If the valves still do not cycle correctly, check for fault codes. Perform the next test, "Modulator Valve and Cable Resistance."

## Modulator Valve and Cable Resistance

To check the resistance in a modulator valve and cable circuit, perform the following test:

1. Park the vehicle on a level surface, set the parking brake, and shut down the engine. Chock the rear tires.
2. Disconnect the modulator valve connector from the ABS ECU. See **Table 1**.
3. Connect ohmmeter probes to the cable connector pins for the modulator valve "In" solenoid and "Ground." Read the resistance. Then, move the probes to the "Out" and "Ground" pins and read the resistance.

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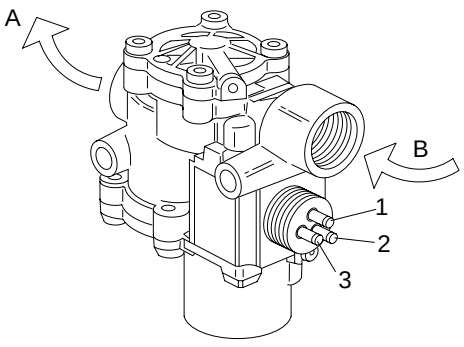
4. The resistance in each solenoid coil and cable circuit must be 4 to 8 ohms.
    - If the resistance in each solenoid circuit is 4 to 8 ohms, the cable and modulator valve are good. Install the connector on the ECU and remove the chocks from the tires.
    - If the resistance in either solenoid circuit is less than 4 ohms or greater than 8 ohms, go to the next test, "Modulator Valve Resistance."

## Modulator Valve Resistance

To check the resistance in the solenoid coils in an ABS modulator valve, perform the following test:

1. Park the vehicle on a level surface, set the parking brake, and shut down the engine. Chock the rear tires.
2. Disconnect the cable connector from the modulator valve being tested. See **Table 1**.
3. Connect ohmmeter probes to the modulator valve "In" solenoid and "Ground" terminals and read the resistance. Then, move the probes to the "Out" and "Ground" terminals and read the resistance. See **Fig. 3** for the modulator terminal locations.




A. Delivery Port
B. Supply Port
1. Ground (Common)
2. Exhaust Solenoid (Out)
3. Supply Solenoid (In)

**Fig. 3, Modulator Valve Terminals**

4. The resistance in each solenoid coil must be 4 to 8 ohms.
    - If the resistance in each solenoid coil is 4 to 8 ohms but the resistance noted in the previous test, "Modulator Valve and Cable Resistance" was not, repair or replace the chassis harness.
    - If the resistance is less than 4 ohms or greater than 8 ohms, clean the terminals on the modulator valve and check the resistance again.
    - If the resistance is still not correct, replace the valve. See **Subject 130** for instructions.
5. Install the cable connectors and remove the chocks from the tires.

# ATC Valve Tests

## ATC Valve and Cable Resistance

To check the resistance in the ATC valve and cable circuit, perform the following test:

1. Park the vehicle on a level surface, set the parking brake, and shut down the engine. Chock the rear tires.
2. Disconnect the ATC valve connector (X3) from the ABS ECU. See **Table 1**.
3. Connect ohmmeter probes to the cable connector pins 5 and 6 for the ATC valve and read the resistance.
4. The resistance in the ATC solenoid coil and cable circuit must be 6.4 to 12 ohms.
    - If the resistance is 6.4 to 12 ohms, the ATC valve and cable are good. Install the cable connector on the ECU and remove the chocks from the tires.
    - If the resistance is less than 6.4 ohms or greater than 12 ohms go to the next test, "ATC Valve Resistance."

## ATC Valve Resistance

To check the resistance in the solenoid coil in the ATC valve, perform the following test:

1. Park the vehicle on a level surface, set the parking brake, and shut down the engine. Chock the rear tires.

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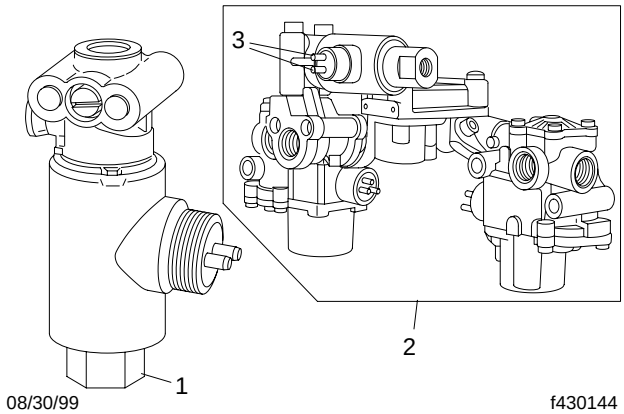
## Testing

2. Disconnect the cable connector from the ATC valve. See **Table 1**.
3. Connect ohmmeter probes to the ATC valve terminals and read the resistance. See **Fig. 4**.




1. ATC Valve
2. Rear Modulator Valve Assembly
3. ATC Solenoid Terminals

**Fig. 4, ATC Valve Terminals**

4. The resistance of the ATC solenoid coil and its wiring must be 6.4 to 12 ohms.
    - If the resistance is 6.4 to 12 ohms but the resistance noted in the previous test, "ATC Valve and Cable Resistance" was not, repair or replace the electrical cable.
    - If the resistance is less than 6.4 ohms or greater than 12 ohms, clean the terminals on the ATC valve and check the resistance again.
    - If the resistance is still not correct, replace the valve. See **Subject 140** for instructions.
5. Install the connectors and remove the chocks from the tires.

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## Troubleshooting Tables

Using the following tables, troubleshoot the ABS system by MID-SID.

| J1587 Fault Code Cross-Reference | | |
|---|---|---|
| **MID-SID** | **Description** | **Troubleshooting Table** |
| | Wheel Sensor | |
| 136-001 | Left Front | **Table 2** |
| 136-002 | Right Front | **Table 3** |
| 136-003 | Left Rear | **Table 4** |
| 136-004 | Right Rear | **Table 5** |
| | Modulator Valve | |
| 136-007 | Left Front | **Table 6** |
| 136-008 | Right Front | **Table 7** |
| 136-009 | Left Rear | **Table 8** |
| 136-010 | Right Rear | **Table 9** |

| J1587 Fault Code Cross-Reference | | |
|---|---|---|
| **MID-SID** | **Description** | **Troubleshooting Table** |
| 136-014 | Ground Faults | **Table 10** |
| 136-015 | | **Table 11** |
| 136-018 | ATC Valve (if equipped) | **Table 12** |
| 136-019 | Auxiliary Output | **Table 13** |
| 136-023 | ABS Warning Lamp | See **Subject 310** |
| 136-231 | J1939 Datalink | **Table 14** |
| 136-251 | Voltage | **Table 15** |
| 136-253 | Configuration Errors | **Table 16** |
| 136-254 | Miscellaneous Faults | **Table 17** |

**Table 1, J1587 Fault Code Cross Reference**

| Left Front Wheel Sensor Troubleshooting (SID 001) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 001 | 01 | Incorrect sensor air gap | 1. Adjust the sensor. Check the AC voltage across pins 7 and 8 of the black X2 ECU connector while rotating the LF wheel 30 rpm. | Voltage is 0.2 Vac or greater | Sensor adjustment solved the problem. |
| | | | | | Voltage is less than 0.2 Vac | Check for excessive wheel bearing end play and hub runout. Repair as needed. |
| 136 | 001 | 02 | Incorrect tire size | | | Check for correct tire size and mixed tire sizes. Check for correct number of teeth on tone wheel. Correct as needed. |
| 136 | 001 | 03 | Sensor shorted to power | 2. Measure the voltage across pins 7 of the X2 (black) connector and a good chassis ground. Repeat the test between pin 8 and ground. | Measurable voltage at either pin | Repair short to power in circuit(s) 377LF+ and 377LF– in chassis harness and sensor cable.<br>If problem is in the sensor harness, replace the sensor. |
| | | | | | No voltage at either pin | Repeat the test and check for intermittent short to power in circuits 377LF+ and 377LF–.<br>Suspect ECU is at fault if the problem persists. |

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## ABS System Troubleshooting

| Left Front Wheel Sensor Troubleshooting (SID 001) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 001 | 04 | Short to ground | 3. Measure the resistance between pin 7 of the X2 (black) connector and a good chassis ground. Repeat the test between pin 8 and ground. | Resistance between either pin and ground is less than 100,000 ohms | Repair the short to ground in circuit(s) 377LF+ and 377LF– in chassis harness or sensor cable.<br>If problem is in sensor harness, replace the sensor. |
| | | | | | Resistance between either pin and ground is greater than 100,000 ohms | Repeat the test for intermittent short to ground in circuits 377LF+ and 377LF–.<br>Suspect ECU is at fault if the problem persists. |
| 136 | 001 | 05 | Open circuit | 4. Measure the resistance between pins 7u and 8 of the X2 (black) connector. | Resistance is 900–2000 ohms | Repeat the test and check for intermittent open or short in circuits 377LF+ and 377LF–.<br>Suspect ECU at fault if the problem persists. |
| | | | | | Resistance is greater than 2000 ohms OR less than 900 ohm. | Perform test 5. |
| 136 | 001 | 05 | Open circuit | 5. Disconnect the sensor connector from the chassis harness. Measure the resistance between the pins on the sensor connector. | Resistance is 900–2000 ohms | Repair open or short in circuit(s) 377LF+ and 377LF– in chassis harness. |
| | | | | | Resistance is greater than 2000 ohms OR less than 900 ohms | Replace the sensor. |
| 136 | 001 | 06 | Short circuit | | | Perform tests 4 and 5. |
| 136 | 001 | 07 | Damaged tone ring | | | Inspect tone ring for damage and missing teeth. Make sure correct tooth wheel is installed (100-tooth is normal application). Repair as needed. |
| 136 | 001 | 08 | Excessive wheel slip | | | Check sensor adjustment. This fault usually occurs when there is excessive tire spin for more than 16 seconds. |
| 136 | 001 | 09 | Wire mismatch | 6. Check for mixed sensor connection. Using Meritor PC Diagnostics, spin each wheel individually. Check that output is from the correct sensor. | | Correct wiring connections, as needed. |

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| Left Front Wheel Sensor Troubleshooting (SID 001) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 001 | 10 | Intermittent signal | 7. Adjust the sensor. Using the wheel sensor output screen in Meritor PC Diagnostics, spin the wheel or drive the vehicle and check for intermittent or erratic signal. | Signal output OK | Adjustment solved the problem. Make sure brake chatter is not causing the problem. |
| | | | | | Signal output incorrect | Check for intermittent wheel sensor circuit connections. Cause could be due to brake chatter. Repair as needed. |
| 136 | 001 | 11 | Erratic signal | | | Perform test 7. |
| 136 | 001 | 12 | Frequency too high | 8. Check sensor wiring and connectors for intermittent contact. | Wiring OK | Suspect ECU at fault if problem persists. |
| | | | | | Wiring incorrect | Repair wheel sensor circuit, as needed. |

**Table 2, Left Front Wheel Sensor Troubleshooting (SID 001)**

| Right Front Wheel Sensor Troubleshooting (SID 002) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 002 | 01 | Incorrect sensor air gap | 1. Adjust the sensor. Check the AC voltage across pins 5 and 6 of the black X2 ECU connector while rotating the RF wheel 30 rpm. | Voltage is 0.2 Vac or greater | Sensor adjustment solved the problem. |
| | | | | | Voltage is less than 0.2 Vac | Check for excessive wheel bearing end play and hub runout. Repair as needed. |
| 136 | 002 | 02 | Incorrect tire size | | | Check for correct tire size and mixed tire sizes. Check for correct number of teeth on tone wheel. Correct as needed. |
| 136 | 002 | 03 | Sensor shorted to power | 2. Measure the voltage across pin 5 of the X2 (black) connector and a good chassis ground. Repeat the test between pin 8 and ground. | Measurable voltage at either pin | Repair short to power in circuit(s) 377RF+ and 377RF– in chassis harness and sensor cable.<br>If problem is in the sensor harness, replace the sensor. |
| | | | | | No voltage at either pin | Repeat the test and check for intermittent short to power in circuits 377RF+ and 377RF–.<br>Suspect ECU is at fault if the problem persists. |

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## ABS System Troubleshooting

| Right Front Wheel Sensor Troubleshooting (SID 002) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 002 | 04 | Short to ground | 3. Measure the resistance between pin 5 of the X2 (black) connector and a good chassis ground. Repeat the test between pin 6 and ground. | Resistance between either pin and ground is less than 100,000 ohms | Repair the short to ground in circuit(s) 377RF+ and 377RF– in chassis harness or sensor cable.<br>If problem is in sensor harness, replace the sensor. |
| | | | | | Resistance between either pin and ground is greater than 100,000 ohms | Repeat the test for intermittent short to ground in circuits 377RF+ and 377RF–.<br>Suspect ECU is at fault if the problem persists. |
| 136 | 002 | 05 | Open circuit | 4. Measure the resistance between pins 5 and 6 of the X2 (black) connector. | Resistance is 900–2000 ohms | Repeat the test and check for intermittent open or short in circuits 377RF+ and 377RF–.<br>Suspect ECU at fault if the problem persists. |
| | | | | | Resistance is greater than 2000 ohms OR less than 900 ohm. | Perform test 5. |
| | | | | 5. Disconnect the sensor connector from the chassis harness. Measure the resistance between the pins on the sensor connector. | Resistance is 900–2000 ohms | Repair open or short in circuit(s) 377RF+ and 377RF– in chassis harness. |
| | | | | | Resistance is greater than 2000 ohms OR less than 900 ohms | Replace the sensor. |
| 136 | 002 | 06 | Short circuit | | | Perform tests 4 and 5. |
| 136 | 002 | 07 | Damaged tone ring | | | Inspect tone ring for damage and missing teeth. Make sure correct tooth wheel is installed (100-tooth is normal application). Repair as needed. |
| 136 | 002 | 08 | Excessive wheel slip | | | Check sensor adjustment. This fault usually occurs when there is excessive tire spin for more than 16 seconds. |
| 136 | 002 | 09 | Wire mismatch | 6. Check for mixed sensor connection. Using Meritor PC Diagnostics, spin each wheel individually. Check that output is from the correct sensor. | | Correct wiring connections, as needed. |

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| Right Front Wheel Sensor Troubleshooting (SID 002) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 002 | 10 | Intermittent signal | 7. Adjust the sensor. Using the wheel sensor output screen in Meritor PC Diagnostics, spin the wheel or drive the vehicle and check for intermittent or erratic signal. | Signal output OK | Adjustment solved the problem. Make sure brake chatter is not causing the problem. |
| | | | | | Signal output incorrect | Check for intermittent wheel sensor circuit connections. Cause could be due to brake chatter. Repair as needed. |
| 136 | 002 | 11 | Erratic signal | | | Perform test 7. |
| 136 | 002 | 12 | Frequency too high | 8. Check sensor wiring and connectors for intermittent contact. | Wiring OK | Suspect ECU at fault if problem persists. |
| | | | | | Wiring incorrect | Repair wheel sensor circuit, as needed. |

**Table 3, Right Front Wheel Sensor Troubleshooting (SID 002)**

| Left Rear Wheel Sensor Troubleshooting (SID 003) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 003 | 01 | Incorrect sensor air gap | 1. Adjust the sensor. Check the AC voltage across pins 1 and 2 of the black X2 ECU connector while rotating the LR wheel 30 rpm. | Voltage is 0.2 Vac or greater | Sensor adjustment solved the problem. |
| | | | | | Voltage is less than 0.2 Vac | Check for excessive wheel bearing end play and hub runout. Repair as needed. |
| 136 | 003 | 02 | Incorrect tire size | | | Check for correct tire size and mixed tire sizes. Check for correct number of teeth on tone wheel. Correct as needed. |
| 136 | 003 | 03 | Sensor shorted to power | 2. Measure the voltage across pin 1 of the X3 (green) connector and a good chassis ground. Repeat the test between pin 2 and ground. | Measurable voltage at either pin | Repair short to power in circuit(s) 377LR+ and 377LR– in chassis harness and sensor cable.<br>If problem is in the sensor harness, replace the sensor. |
| | | | | | No voltage at either pin | Repeat the test and check for intermittent short to power in circuits 377LR+ and 377LR–.<br>Suspect ECU is at fault if the problem persists. |

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## ABS System Troubleshooting

| Left Rear Wheel Sensor Troubleshooting (SID 003) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 003 | 04 | Short to ground | 3. Measure the resistance between pin 1 of the X3 (green) connector and a good chassis ground. Repeat the test between pin 2 and ground. | Resistance between either pin and ground is less than 100,000 ohms | Repair the short to ground in circuit(s) 377LR+ and 377LR– in chassis harness or sensor cable.<br>If problem is in sensor harness, replace the sensor. |
| | | | | | Resistance between either pin and ground is greater than 100,000 ohms | Repeat the test for intermittent short to ground in circuits 377LR+ and 377LR–.<br>Suspect ECU is at fault if the problem persists. |
| 136 | 003 | 05 | Open circuit | 4. Measure the resistance between pins 1 and 2 of the X3 (green) connector. | Resistance is 900–2000 ohms | Repeat the test and check for intermittent open or short in circuits 377LR+ and 377LR–.<br>Suspect ECU at fault if the problem persists. |
| | | | | | Resistance is greater than 2000 ohms OR less than 900 ohm. | Perform test 5. |
| | | | | 5. Disconnect the sensor connector from the chassis harness. Measure the resistance between the pins on the sensor connector. | Resistance is 900–2000 ohms | Repair open or short in circuit(s) 377LR+ and 377LR– in chassis harness. |
| | | | | | Resistance is greater than 2000 ohms OR less than 900 ohms | Replace the sensor. |
| 136 | 003 | 06 | Short circuit | | | Perform tests 4 and 5. |
| 136 | 003 | 07 | Damaged tone ring | | | Inspect tone ring for damage and missing teeth. Make sure correct tooth wheel is installed (100-tooth is normal application). Repair as needed. |
| 136 | 003 | 08 | Excessive wheel slip | | | Check sensor adjustment. This fault usually occurs when there is excessive tire spin for more than 16 seconds. |
| 136 | 003 | 09 | Wire mismatch | 6. Check for mixed sensor connection. Using Meritor PC Diagnostics, spin each wheel individually. Check that output is from the correct sensor. | | Correct wiring connections, as needed. |

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| Left Rear Wheel Sensor Troubleshooting (SID 003) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 003 | 10 | Intermittent signal | 7. Adjust the sensor. Using the wheel sensor output screen in Meritor PC Diagnostics, spin the wheel or drive the vehicle and check for intermittent or erratic signal. | Signal output OK | Adjustment solved the problem. Make sure brake chatter is not causing the problem. |
| | | | | | Signal output incorrect | Check for intermittent wheel sensor circuit connections. Cause could be due to brake chatter. Repair as needed. |
| 136 | 003 | 11 | Erratic signal | | | Perform test 7. |
| 136 | 003 | 12 | Frequency too high | 8. Check sensor wiring and connectors for intermittent contact. | Wiring OK | Suspect ECU at fault if problem persists. |
| | | | | | Wiring incorrect | Repair wheel sensor circuit, as needed. |

**Table 4, Left Rear Wheel Sensor Troubleshooting (SID 003)**

| Right Rear Wheel Sensor Troubleshooting (SID 004) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 004 | 01 | Incorrect sensor air gap | 1. Adjust the sensor. Check the AC voltage across pins 3 and 4 of the black X2 ECU connector while rotating the RR wheel 30 rpm. | Voltage is 0.2 VAC or greater | Sensor adjustment solved the problem. |
| | | | | | Voltage is less than 0.2 VAC | Check for excessive wheel bearing end play and hub runout. Repair as needed. |
| 136 | 004 | 02 | Incorrect tire size | | | Check for correct tire size and mixed tire sizes. Check for correct number of teeth on tone wheel. Correct as needed. |
| 136 | 004 | 03 | Sensor shorted to power | 2. Measure the voltage across pin 3 of the X3 (green) connector and a good chassis ground. Repeat the test between pin 4 and ground. | Measurable voltage at either pin | Repair short to power in circuit(s) 377RR+ and 377RR– in chassis harness and sensor cable.<br>If problem is in the sensor harness, replace the sensor. |
| | | | | | No voltage at either pin | Repeat the test and check for intermittent short to power in circuits 377RR+ and 377RR–.<br>Suspect ECU is at fault if the problem persists. |

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## ABS System Troubleshooting

| Right Rear Wheel Sensor Troubleshooting (SID 004) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 004 | 04 | Short to ground | 3. Measure the resistance between pin 3 of the X3 (green) connector and a good chassis ground. Repeat the test between pin 4 and ground. | Resistance between either pin and ground is less than 100,000 ohms | Repair the short to ground in circuit(s) 377RR+ and 377RR– in chassis harness or sensor cable.<br>If problem is in sensor harness, replace the sensor. |
| | | | | | Resistance between either pin and ground is greater than 100,000 ohms | Repeat the test for intermittent short to ground in circuits 377RR+ and 377RR–.<br>Suspect ECU is at fault if the problem persists. |
| 136 | 004 | 05 | Open circuit | 4. Measure the resistance between pins 3 and 4 of the X3 (green) connector. | Resistance is 900–2000 ohms | Repeat the test and check for intermittent open or short in circuits 377RR+ and 377RR–.<br>Suspect ECU at fault if the problem persists. |
| | | | | | Resistance is greater than 2000 ohms OR less than 900 ohm. | Perform test 5. |
| | | | | 5. Disconnect the sensor connector from the chassis harness. Measure the resistance between the pins on the sensor connector. | Resistance is 900–2000 ohms | Repair open or short in circuit(s) 377RR+ and 377RR– in chassis harness. |
| | | | | | Resistance is greater than 2000 ohms OR less than 900 ohms | Replace the sensor. |
| 136 | 004 | 06 | Short circuit | | | Perform tests 4 and 5. |
| 136 | 004 | 07 | Damaged tone ring | | | Inspect tone ring for damage and missing teeth. Make sure correct tooth wheel is installed (100-tooth is normal application). Repair as needed. |
| 136 | 004 | 08 | Excessive wheel slip | | | Check sensor adjustment. This fault usually occurs when there is excessive tire spin for more than 16 seconds. |
| 136 | 004 | 09 | Wire mismatch | 6. Check for mixed sensor connection. Using Meritor PC Diagnostics, spin each wheel individually. Check that output is from the correct sensor. | | Correct wiring connections, as needed. |

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| Right Rear Wheel Sensor Troubleshooting (SID 004) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 004 | 10 | Intermittent signal | 7. Adjust the sensor. Using the wheel sensor output screen in Meritor PC Diagnostics, spin the wheel or drive the vehicle and check for intermittent or erratic signal. | Signal output OK | Adjustment solved the problem. Make sure brake chatter is not causing the problem. |
| | | | | | Signal output incorrect | Check for intermittent wheel sensor circuit connections. Cause could be due to brake chatter. Repair as needed. |
| 136 | 004 | 11 | Erratic signal | | | Perform test 7. |
| 136 | 004 | 12 | Frequency too high | 8. Check sensor wiring and connectors for intermittent contact. | Wiring OK | Suspect ECU at fault if problem persists. |
| | | | | | Wiring incorrect | Repair wheel sensor circuit, as needed. |

**Table 5, Right Rear Wheel Sensor Troubleshooting (SID 004)**

| Left Front Modulator Valve Troubleshooting (SID 007) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 007 | 03 | Short to power<br>*Inlet or outlet circuit shorted to battery supply or another modulator valve wire.* | 1. Measure the voltage between pins 2, 10, and 11 of the X2 (black) connector and a good chassis ground. | No voltage at either pin | Repeat test. Check circuits 378LFI, 378LFO, and 378LF– for intermittent short to power. Check above circuits for shorts to other modulator valve wires. Repair as necessary.<br>If problem persists, the suspect ECU is at fault. |
| | | | | | Measurable voltage at either pin | Repair short to power in circuit 378LFI, 378LFO, or 378LF–. |
| 136 | 007 | 05 | Open circuit<br>Inlet or outlet circuit open. | 2. Check the modulator valve inlet and outlet circuit resistance. Disconnect the connector from the valve and perform the modulator valve resistance test. | Resistance in both circuits is within 4 to 8 ohms. | Check harness wiring circuits 378LFI, 378LFO, or 378LF–. |
| | | | | | Resistance in both circuits is not within 4 to 8 ohms. | Replace the modulator valve. |
| 136 | 007 | 06 | Short to ground<br>*Inlet or outlet circuit shorted to ground.* | 3. Check the modulator valve inlet and outlet circuit resistance. Disconnect the connector from the valve and perform the modulator valve test. | Resistance in both circuits is within 4 to 8 ohms. | Check harness wiring circuits 378LFI, 378LFO, or 378LF– for short to ground. Repair as necessary. |
| | | | | | Resistance in both circuits is not within 4 to 8 ohms. | Replace modulator valve. |

**Table 6, Left Front Modulator Valve Troubleshooting (SID 007)**

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## ABS System Troubleshooting

| Right Front Modulator Valve Troubleshooting (SID 008) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 008 | 03 | Short to power<br>*Inlet or outlet circuit shorted to battery supply or another modulator valve wire.* | 1. Measure the voltage between pins 3, 4, and 9 of the X2 (black) connector and a good chassis ground. | No voltage at either pin | Repeat test. Check circuits 378RFO, 378RFI, and 378RF– for intermittent short to power. Check above circuits for shorts to other modulator valve wires. Repair as necessary.<br>If problem persists, the suspect ECU is at fault. |
| | | | | | Measurable voltage at either pin | Repair short to power in circuit 378RFO, 378RFI, or 378RF–. |
| 136 | 008 | 05 | Open circuit<br>Inlet or outlet circuit open. | 2. Check the modulator valve inlet and outlet circuit resistance. Disconnect the connector from the valve and perform the modulator valve resistance test. | Resistance in both circuits is within 4 to 8 ohms. | Check harness wiring circuits 378RFO, 378RFI, or 378RF–. |
| | | | | | Resistance in both circuits is not within 4 to 8 ohms. | Replace the modulator valve. |
| 136 | 008 | 06 | Short to ground<br>*Inlet or outlet circuit shorted to ground.* | 3. Check the modulator valve inlet and outlet circuit resistance. Disconnect the connector from the valve and perform the modulator valve test. | Resistance in both circuits is within 4 to 8 ohms. | Check harness wiring circuits 378RFO, 378RFI, or 378RF– for short to ground. Repair as necessary. |
| | | | | | Resistance in both circuits is not within 4 to 8 ohms. | Replace modulator valve. |

**Table 7, Right Front Modulator Valve Troubleshooting (SID 008)**

| Left Rear Modulator Valve Troubleshooting (SID 009) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 009 | 03 | Short to power<br>*Inlet or outlet circuit shorted to battery supply or another modulator valve wire.* | 1. Measure the voltage between pins 10, 11, and 12 of the X3 (green) connector and a good chassis ground. | No voltage at either pin | Repeat test. Check circuits 378LRI, 378LRO, and 378LR– for intermittent short to power. Check above circuits for shorts to other modulator valve wires. Repair as necessary.<br>If problem persists, the suspect ECU is at fault. |
| | | | | | Measurable voltage at either pin | Repair short to power in circuit 378LRI, 378LRO, or 378LR–. |
| 136 | 009 | 05 | Open circuit<br>Inlet or outlet circuit open. | 2. Check the modulator valve inlet and outlet circuit resistance. Disconnect the connector from the valve and perform the modulator valve resistance test. | Resistance in both circuits is within 4 to 8 ohms. | Check harness wiring circuits 378LRI, 378LRO, and 378LR–. |
| | | | | | Resistance in both circuits is not within 4 to 8 ohms. | Replace the modulator valve. |

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| Left Rear Modulator Valve Troubleshooting (SID 009) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 009 | 06 | Short to ground<br>*Inlet or outlet circuit shorted to ground.* | 3. Check the modulator valve inlet and outlet circuit resistance. Disconnect the connector from the valve and perform the modulator valve test. | Resistance in both circuits is within 4 to 8 ohms. | Check harness wiring circuits 378LRI, 378LRO, and 378LR– for short to ground. Repair as necessary. |
| | | | | | Resistance in both circuits is not within 4 to 8 ohms. | Replace modulator valve. |

**Table 8, Left Rear Modulator Valve Troubleshooting (SID 009)**

| Right Rear Modulator Valve Troubleshooting (SID 010) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 010 | 03 | Short to power<br>*Inlet or outlet circuit shorted to battery supply or another modulator valve wire.* | 1. Measure the voltage between pins 7, 8, and 9 of the X3 (green) connector and a good chassis ground. | No voltage at either pin | Repeat test. Check circuits 378RRO, 378RR–, and 378RRI for intermittent short to power. Check above circuits for shorts to other modulator valve wires. Repair as necessary.<br>If problem persists, the suspect ECU is at fault. |
| | | | | | Measurable voltage at either pin | Repair short to power in circuit 378RRO, 378RR–, or 378RRI. |
| 136 | 010 | 05 | Open circuit<br>Inlet or outlet circuit open. | 2. Check the modulator valve inlet and outlet circuit resistance. Disconnect the connector from the valve and perform the modulator valve test. | Resistance in both circuits is within 4 to 8 ohms. | Check harness wiring circuits 378RRO, 378RRI, and 378RR–. |
| | | | | | Resistance in both circuits is not within 4 to 8 ohms. | Replace the modulator valve. |
| 136 | 010 | 06 | Short to ground<br>*Inlet or outlet circuit shorted to ground.* | 3. Check the modulator valve inlet and outlet circuit resistance. Disconnect the connector from the valve and perform the modulator valve test. | Resistance in both circuits is within 4 to 8 ohms. | Check harness wiring circuits 378RRI, 378RRO, and 378RR– for short to ground. Repair as necessary. |
| | | | | | Resistance in both circuits is not within 4 to 8 ohms. | Replace modulator valve. |

**Table 9, Right Rear Modulator Valve Troubleshooting (SID 010)**

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## ABS System Troubleshooting

| Ground Faults Troubleshooting (SID 014) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 014 | 04 | Low voltage or open circuit | 1. Disconnect the X1 (gray) connector at the ABS ECU. With the ignition ON, measure the voltage between pins 1 and 12. | Voltage is 9.5 to 14 volts. | System voltage is acceptable. Check for intermittent low voltage. Check the batteries and charging system. Voltage may have been temporarily too low. Repair as necessary. |
| | | | | | Voltage is less than 9.5 volts. | Check vehicle batteries and charging system. Check ABS ECU power and ground circuits for open or high resistance. Repair as necessary. |
| 136 | 014 | 05 | Central group open or high resistance | 2. Disconnect the X1 (gray) connector at the ABS ECU. Check the ground circuit (pin 11) for high resistance or open circuit. | Ground is okay | Verify the fault. Check the ground circuits for open or high resistance. Repair as necessary. |
| | | | | | Ground is open or has high resistance | Repair ground circuit as necessary. |
| 136 | 014 | 06 | Internal relay does not open | | | If fault repeats, replace the ABS ECU. |

**Table 10, Ground Faults Troubleshooting (SID 014)**

| Ground Faults Troubleshooting (SID 015) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 015 | 03 | ATC valve grounded to power. | 1. Disconnect the X3 (green) connector, check for voltage between pin 6 and ground. | Voltage at pin 6. | Circuit 378T- is shorted to power. Locate fault and repair as necessary. |
| | | | | | No voltage at pin 6. | Verify fault. Check for intermittent fault in circuit 378-, repair as necessary. |
| 136 | 015 | 04 | Low voltage or open circuit | 2. Disconnect the X1 (gray) connector at the ABS ECU. With the ignition ON, measure the voltage between pin 2 and a good ground. | Voltage is 9.5 to 14 volts | System voltage is acceptable. Check for intermittent low voltage. Check the batteries and charging system. Voltage may have been temporarily too low. Repair as necessary. |
| | | | | | Voltage is less than 9.5 volts | Repair voltage supply to ECU. |
| 136 | 015 | 05 | ATC Valve - High Impedance | | | Replace ABS ECU if fault persists. |
| | | 06 | ATC Valve circuit shorted to ground | Disconnect the X3 (green) connector, check resistance between pin 6 and a good ground. | Resistance is less than 10,000 ohms | Verify fault. Check for intermittent fault in circuit 378-, repair as necessary. |
| | | | | | Resistance is great than 10,000 ohms | Verify fault. Check for intermittent fault in circuit 378T-, repair as necessary. |

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| Ground Faults Troubleshooting (SID 015) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 015 | 07 | Internal relay fault | | | If fault repeats, replace the ABS ECU. |

**Table 11, Ground Faults Troubleshooting (SID 015)**

| ATC Valve Troubleshooting (SID 018) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 018 | 03 | Short to power. | 1. Disconnect the X3 (green) connector from the ABS ECU. Disconnect the ATC valve connector. Measure the voltage between pin 5 of the X3 (green) connector and a good chassis harness. | Voltage | Circuit 378T+ is shorted to power. Repair as necessary. |
| | | | | | No voltage | Check circuit 378+ for intermittent short to power. Repair as necessary. If fault persists, suspect ECU at fault. |
| 136 | 018 | 05 | Open circuit | 2. Disconnect the ATC Valve connector. Measure the resistance across the two pins of the ATC valve.<br>NOTE If the vehicle does not have an ATC valve, reconfigure the ECU. | Resistance is 7 to 14 ohms. | Go to step 3. |
| | | | | | Resistance is not 7 to 14 ohms. | Replace ATC Valve. |
| | | | | 3. Reconnect the ATC valve connector. Measure the resistance across pins 5 and 6 of the X3 connector. | Resistance is 7 to 14 ohms. | Verify fault. Check for intermittent open circuit in 376T+ and 376 T-. Repair as necessary. |
| | | | | | Resistance is not 7 to 14 ohms. | Repair circuit 376T+ or 376T-. |
| 136 | 018 | 07 | Short to ground. | 4. Disconnect the X3 (green) connector, check resistance between pin 6 and a good ground. | Continuity | Circuit 376T+ is shorted to ground. Repair as necessary. |
| | | | | | No continuity | Verify fault. Check circuit 376T+ for intermittent short to ground. Repair as necessary. |

**Table 12, ATC Valve Troubleshooting (SID 018)**

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## ABS System Troubleshooting

| Auxiliary Output Troubleshooting (not currently used) (SID 019) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 019 | 03 | Short to power. | | | This fault should not appear. Re-configure the ECU. If fault continues to appear, check the wiring in the X2 (black) connector. This ABS ECU connector should be unused. Make sure there are no connections to these pins. If incorrect wiring is found, correct it and reconfigure the ECU. If this does not correct the problem, contact Meritor. |
| 136 | 019 | 05 | Open circuit | | | Verify fault. Contact Meritor WABCO if fault persists. |
| 136 | 019 | 06 | Short to ground | | | This fault should not appear. Reconfigure the ECU. If fault continues to appear, check the wiring in the X2 (black) connector. This ABS ECU connector should be unused. Make sure there are no connections to these pins. If incorrect wiring is found, correct it and reconfigure the ECU. If this does not correct the problem, contact Meritor. |

**Table 13, Auxiliary Output Troubleshooting (SID 019)**

| J1939 Datalink Troubleshooting (SID 231) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 231 | 02 | J1939 speed plausibility error.<br>NOTE: This fault indicates a discrepancy between vehicle speed reported on J1939 and ABS sensed vehicle speed. | | | Check the speedometer calibration. Check for the tire size mismatch. The vehicle speed reported on the J1939 databus does not agree with the wheel sensor speeds. |
| 136 | 231 | 05 | J1939 open/short | Refer to SB 54-133 for troubleshooting J1939. | | Repair J1939 datalink as necessary. |
| 136 | 231 | 06 | J1939 open/short<br>Code 13s231 05 may be active as well. | Check the driveline retarder ECU and wires. Check the J1939 Datalink.<br>Freightliner SB 54-133 | | Repair J1939 datalink as necessary. |

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| J1939 Datalink Troubleshooting (SID 231) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 231 | 07 | J1939 time out<br><br>NOTE: Fault occurs if engine retarder sends message incorrectly. | Check the driveline retarder ECU and wires.<br><br>Freightliner SB 54-133 | | Check J1939 datalink and driveline retarder ECU. Repair as necessary. |
| 136 | 231 | 08 | J1939 time out<br><br>NOTE: Fault occurs if engine retarder sends message incorrectly. | Check engine ECU and wires. Check J1939 datalink.<br><br>Freightliner SB 54-133 | | Check J1939 datalink and engine ECU. Repair as necessary. |
| 136 | 231 | 09 | J1939 time out<br><br>NOTE: Fault occurs if engine retarder sends message incorrectly. | Check engine and transmission ECUs and wires. Check J1939 datalink.<br><br>Freightliner SB 54-133 | | Check J1939 datalink, engine ECU, transmission ECU, and wiring. Repair as necessary. |
| 136 | 231 | 10 | J1939 time out<br><br>NOTE: Fault occurs if the exhaust retarder sends a message incorrectly. | Check the engine ECU and wires. Check the J1939 datalink.<br><br>Freightliner SB 54-133 | | Check J1939 datalink and engine ECU. Repair as necessary. |
| 136 | 231 | 12 | J1939 internal error | | | Verify fault. Clear code from the ECU memory. If fault persists, replace the ABS ECU. |

**Table 14, J1939 Datalink Troubleshooting (SID 231)**

| Voltage Troubleshooting (SID 251) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 251 | 03 | Overvoltage<br><br>Voltage to ECU was too high for more than 5 seconds. | Using Meritor PC Diagnostics, check the diagonal voltages with the engine running at governed speed, or measure the voltage at the batteries with the engine running at governed speed. | Voltage is 9.5 to 14 volts | Check for intermittent sources of high voltage. Check condition of charging system and batteries. Verify fault. |
| | | | | | Voltage is greater than 14 volts. | Check charging system. Repair as necessary. |

**Table 15, Voltage Troubleshooting (SID 251)**

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## ABS System Troubleshooting

| Configuration Errors Troubleshooting (SID 253) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 253 | 01 | ATC configuration error<br><br>NOTE: ATC valve is detected without engine datalink (J1939). | | | Check J1939 for proper wiring. Check engine ECU for communication. Repair as necessary, then reconfigure ECU. |
| 136 | 253 | 02 | ABS configuration/ wheel parameter incorrect. | | | Reconfigure ECU. If fault repeats then the wrong ECU is installed. Replace with the correct ECU. |
| 136 | 253 | 12 | Check sum error. | | | Check parameter setting. Check if diagnostic device was disconnected during active diagnosis. |

**Table 16, Configuration Errors Troubleshooting (SID 253)**

| Miscellaneous Faults Troubleshooting (SID 254) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 254 | 05 | ABS/ATC ECU, no loads | | | No modulator valve connected. Fault may have resulted from end of line test at factory. |
| 136 | 254 | 08 | Excessive wheel slip. | | | Check wheel speed sensor air gaps. One wheel was much faster than the other. May have been caused by testing vehicle on a dynamometer. |
| 136 | 254 | 09 | Modulator valve actuated too long. | | | Modulator valve was activated too long (more than 75% of 5 minutes). After a delay, function will return to normal. |
| 136 | 254 | 12 | Internal error | | | If fault persists, replace the ABS ECU. |
| 136 | 254 | 13 | Accelerometer out of range | | | If fault persists, replace the ABS ECU. |

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| Miscellaneous Faults Troubleshooting (SID 254) | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 254 | 14 | ECU Mounting | | | Check ECU mounting. Replace the ECU if fault persists. |
| | | | Extreme banked road (measured acceleration not plausible) | | | No correction required. This fault is for reporting only. |
| | | | Accelerometer linearity (measured acceleration not plausible) | | | |

**Table 17, Miscellaneous Faults Troubleshooting (SID 254)**

# PLC Troubleshooting

Special tools to test PLC are currently in development and will be available soon. It is anticipated that these tools will have the capability to do the following:

- Simulate a trailer ABS PLC message to the tractor ABS ECU to turn on the trailer ABS warning lamp. This tests the functionality of the vehicle portion of the system.
- Detect a PLC message from the trailer ABS. This tests the functionality of the trailer portion of the system.

At present, the only way to test the trailer ABS warning lamp system with PLC is to connect the vehicle to a trailer with PLC. When the ignition is turned on, the trailer ABS lamp should come on for a few seconds, then go out. This indicates that there is PLC communications, the warning lamp works, and there are no faults in the trailer ABS. If the trailer ABS lamp remains on, there is a fault in the trailer ABS. Refer to the trailer ABS manufacturer's literature for troubleshooting the trailer ABS system.

NOTE: It is also possible that the trailer ABS lamp circuit is shorted to ground, causing the lamp to stay on.

## PLC Filter Testing

Testing of the PLC filter is possible. Before performing these tests make sure the ignition is OFF. Disconnect the 2-wire connector (green/yellow wires) and the 2-wire connector (blue wires) from the filter.

The PLC filter is located near the trailer receptacle on the frame rail or crossmember. Follow the single blue wire from the PLC filter to the primary or supplemental receptacle. Whichever trailer receptacle the blue wire is connected to carries the PLC signal.

NOTE: For the following steps, you will need a digital multimeter (DMM) with capacitance measuring capability.

1. At the 2-pin connector with the green and yellow wires, use a DMM to measure the resistance across the green and yellow wires.
   - If the reading is less than 0.5 ohms, go to the next step.
   - If the reading is more than 0.5 ohms, the tractor ABS power circuit is open in the PLC filter. Replace the filter.
2. Determine the receptacle (primary or supplemental) that supplies power to the trailer ABS. Using a DMM, connect one lead to pin 7 of the receptacle that supplies power to the trailer ABS and the other lead to the 2-pin connector on the PLC filter that has the two blue wires. Measure the resistance at both pins on the 2-pin connector.
   - If the reading is less than 1.0 ohm, go to the next step.
   - If the reading is more than 1.0 ohm, there is an open circuit either between the 7-way trailer receptacle and the PLC filter, or in the PLC filter itself. Repair the harness or replace the PLC filter as necessary.

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## ABS System Troubleshooting

3. At the PLC filter, connect one lead of the DMM to the green wire (at the 2-pin connector with the green and yellow wires) and the other lead to one of the blue wires (at the 2-pin connector with the two blue wires). Measure the capacitance.
    - If the reading is 4.8 to 7.2 µF, go to the next step.
    - If the reading is less than 4.8 or more than 7.2 µF, one or more of the internal capacitors is faulty. This may affect PLC functionality and/or noise in the electrical system. Replace the PLC filter.
4. At the PLC filter, connect one lead of the DMM to one of the blue wires (at the 2-pin connector that has the two blue wires) and connect the other lead to the ground where the white wire terminates. Measure the capacitance.
    - If the reading is 9.91 to 11.91 µF, the PLC filter is functioning properly.
    - If the reading is less than 9.91 or more than 11.91 µF, check and clean the ground connection where the white wire terminates and retest. If the reading is still unsatisfactory, one or more of the internal capacitors is faulty. This may affect PLC functionality and/or noise in the electrical system. Replace the PLC filter.

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| Trailer ABS Warning Lamp Troubleshooting | | |
|---|---|---|
| **Symptom** | **Possible Cause** | **Action** |
| Trailer ABS lamp does not come on when the ignition is turned on. | There is no trailer connected or the trailer is not equipped with PLC. | The trailer ABS lamp will not illuminate at start-up unless a trailer equipped with PLC is connected to the vehicle.<br><br>Trailers manufactured on or after March 1, 2001 are equipped with PLC. |
| | The vehicle is not equipped with PLC. | Verify that the vehicle has PLC.<br><br>Check the vehicle ABS ECU:<br>• WABCO E-Version ABS ECUs have PLC.<br>• Bendix ABS EC-30 ECUs have PLC unless there is a label on it that says "ECU does not control trailer ABS warning lamp."<br>• Eaton Gen 5 ABS ECU has PLC.<br><br>Check if vehicle was manufactured on or after March 1, 2001. |
| | The trailer ABS warning lamp bulb is burned-out. | Replace the bulb. |
| | There is a circuit fault between the tractor ABS ECU and the trailer ABS warning lamp in the dash. | Check and correct, if necessary.<br><br>The trailer ABS warning lamp circuit can be tested at the tractor ABS ECU by grounding the pin to that circuit. This should cause the lamp to illuminate. |
| | There is faulty wiring (power or ground). | Check and correct as necessary. |
| | The PLC filter is faulty. | Check and replace as necessary. |
| | The tractor ABS ECU is faulty. | Be sure to check the trailer ABS lamp circuit and try connecting vehicle to a trailer where PLC is known to work. If the tractor ABS ECU is still faulty, replace. |
| | The trailer ABS ECU is faulty. | Be sure to check the trailer ABS lamp circuit and try connecting trailer to a vehicle where PLC is known to work. If the trailer ABS ECU is still faulty, replace. |
| Trailer ABS lamp stays on. | There is a trailer ABS fault. | Refer to the trailer ABS manufacturers literature for troubleshooting. Repair as necessary. |
| | Trailer ABS lamp circuit shorted to ground. | Repair as necessary. |

**Table 18, Trailer ABS Warning Lamp Troubleshooting**

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## ABS Warning Lamp Function

The ABS warning lamp in the instrument cluster warns the driver of a malfunction in the anti-lock brake system. When the system is operating normally, the lamp should come on for a few seconds when the ignition is first turned on, then it should turn off. If a fault occurs in the system, the lamp will illuminate as long as the fault remains active. If a wheel sensor fault is repaired or if the system is reconfigured, the light will remain on until the vehicle is driven over 4 mph (6.4 km/h).

The ABS warning lamp can be controlled by any of the following ways:

- **By wire (circuit 376L1):** The ABS warning lamp is hardwired between the ABS ECU and the instrument cluster through a relay. When the circuit to pin B11 at the instrument cluster is grounded, the lamp will turn on.

  NOTE: The relay is used to invert the ground signal between the ABS ECU and the instrument cluster (ground at ABS ECU pin = lamp off, while ground at the instrument cluster pin B11 = lamp on). It also ensures that the lamp will be on if the ABS ECU is disconnected from the vehicle harness.

- **J1587 Message:** The ABS ECU can send messages over the J1587 databus to turn the warning lamp on or off.
- **J1939 Message:** The ABS ECU can send messages over the J1939 databus to turn the warning lamp on and off.

The ABS warning lamp will be illuminated if circuit 376L1 connected to pin B11 at the instrument cluster or if either J1587 or J1939 databus message is broadcast to turn on the lamp. Any one of these will cause the lamp to turn on. See **Fig. 1** for ABS lamp wiring.

The ABS ECU will monitor the hardwired lamp circuit for faults (the portion that operates the control side of the relay).

## Troubleshooting Tables

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## ABS Lamp Troubleshooting

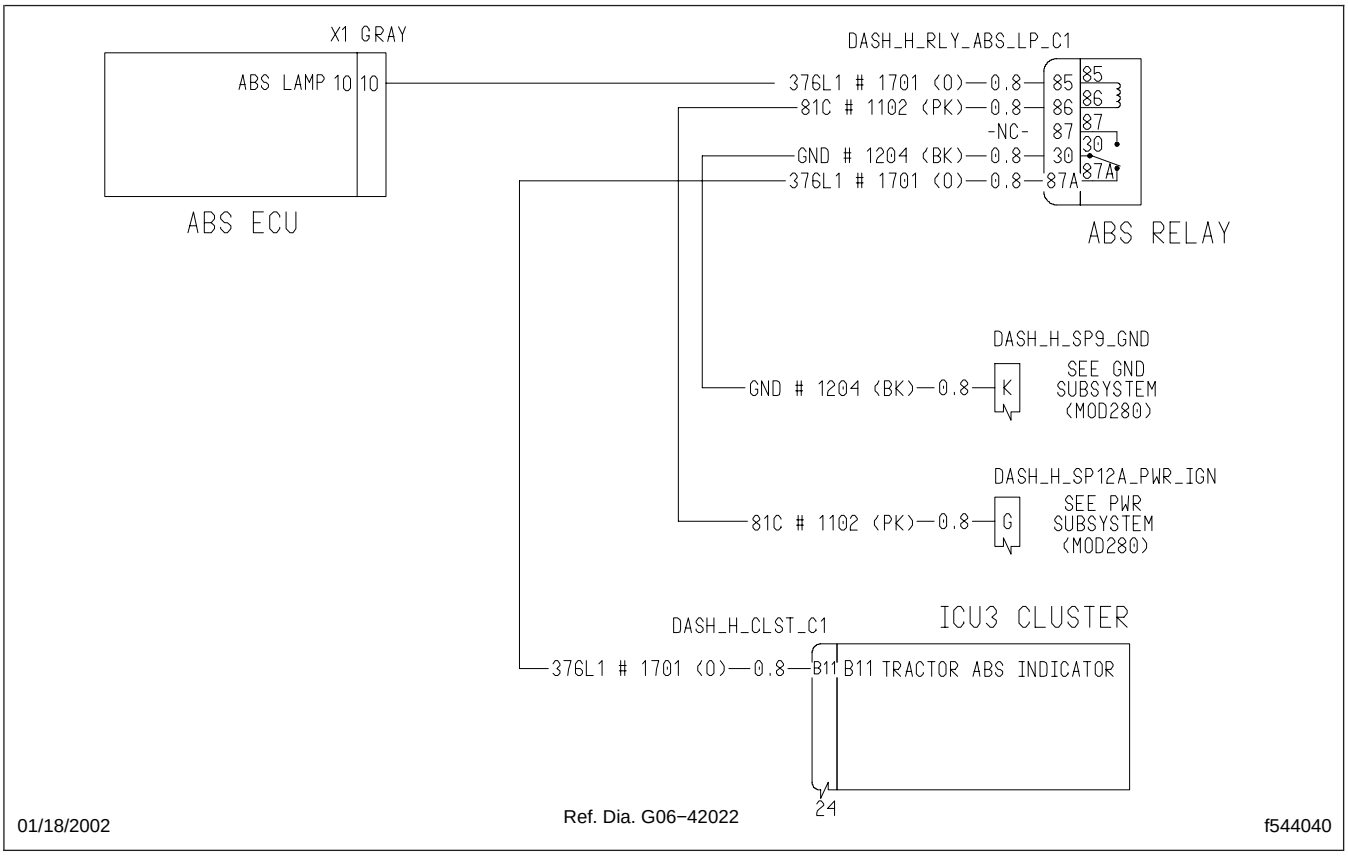


**Fig. 1, ABS Warning Lamp Wiring**

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| J1587 Fault Codes (MID 136 SID 023): ABS Warning Lamp Circuit | | | | |
|---|---|---|---|---|
| **FMI** | **Fault Description** | **Test** | **Test Result** | **Action** |
| 05 | Open Circuit | Test 1:<br>1. Disconnect the gray X1 connector at the ABS ECU.<br>2. Turn the ignition ON.<br>3. Check for voltage between pin 10 of the X1 connector (harness side) and a known good ground. | 12V (approx.) | Go to Test 3. |
| | | | 0V | Go to Test 2. |
| | | Test 2:<br>1. Remove the ABS relay.Check for voltage between circuit 81C and a known good ground.<br>2. Locate circuit 81C (corresponds to pin 86 of the relay.<br>3. Turn the ignition ON.<br>4. Check for voltage between circuit 81C and a known good ground. | 12V (approx.) | Go to Test 3. |
| | | | 0V | Check circuit 81C between the relay and the BHM. If OK, refer to group 54 for diagnosing the BHM. |
| | | Test 3:<br>1. Remove the ABS relay.<br>2. Measure resistance across pins 85 and 86 on the relay. | 70-90 Ohms | No problem found. Check circuit 376L1 between the ABS ECU and the ABS relay and check circuit 81C for intermittent open circuit. If OK, replace ABS ECU. |
| | | | Greater than 90 (an open relay coil should result in a reading of 680 Ohms) | Replace the ABS relay. |

**Table 1, J1587 Fault Codes (MID 136 SID 023): ABS Warning Lamp Circuit**

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## ABS Lamp Troubleshooting

| Diagnosing an ABS Lamp that Remains On | | | |
|---|---|---|---|
| **Symptom** | **Test** | **Test Result** | **Action** |
| Warning Lamp Stays On | Test 1:<br>Use Servicelink or Meritor Toolbox to check for J1587 fault codes (MID 136).<br>Are there any fault codes? | Yes | Go to Test 2. |
| | | No | Go to Test 3. |
| | Test 2:<br>Is there an active fault code for the ABS warning lamp circuit?<br>(Fault code is MID136 SID 023 FMI 05) | Yes | Refer to "Diagnosing Warning Lamp Fault Codes" in this section. |
| | | No | Go to Test 3. |
| | Test 3:<br>Did any of the following happen since the vehicle was last driven?<br>• Historic fault codes were cleared.<br>• A wheel sensor fault was corrected.<br>• The ABS ECU was reconfigured. | Yes | The ABS Warning Lamp should go out after the vehicle has been driven over 4 mph (6.4 km/h). |
| | | No | Go to Test 4. |
| | Test 4:<br>1. Remove the ABS relay.<br>2. Locate circuit 376L1 that corresponds to relay pin 87A (this is the circuit leading to the instrument cluster.<br>3. Turn the ignition ON.<br>4. Check for voltage between circuit 376L1 at the relay and ground. | 12V (approx) | Check the ABS relay, the contacts may be stuck. |
| | | 0V | Circuit 376L1 is shorted to ground between the relay and the instrument cluster. Repair as necessary. |

**Table 2, Diagnosing an ABS Lamp that Remains On**

Since the ABS warning lamp is controlled by three redundant methods, it is unlikely that all three would be inoperative at the same time. If the ABS warning lamp does not turn on when the ignition is switched on, manually ground pin B11 at the back of the instrument cluster (with connectors plugged in and ignition ON). If the ABS warning lamp still does not come on, replace the instrument cluster.

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## General Information

Meritor Q Plus brakes are standard for both front and rear axles. These Cam-Master® brakes are air-actuated, cam-operated, foundation brakes. The main components in each brake assembly (wheel end) include the following:

- an S-head camshaft
- a brake spider
- a camshaft-and-chamber bracket
- two brake shoe and lining assemblies
- two retaining springs
- a return spring
- two anchor pins

The S-head camshaft transfers braking force from the slack adjuster to the brake shoe assemblies. The camshaft passes through the brake spider and camshaft-and-chamber bracket before connecting to the slack adjuster. See **Fig. 1**.

Each brake shoe is mounted on an anchor pin on the brake spider and is controlled (moved) by either the outward braking force of the S-head camshaft or the inward restoring force of the return spring.

The heavy-duty, double-web brake shoes have notches on one end of the webs that fit on the anchor pins. Two retaining springs secure the brake shoes to each other near the anchor pins, creating a hinge for brake-shoe movement. This design makes quick-change brake service possible.

Meritor steer axles have seven 0.656-inch-diameter holes for attaching the spider to the axle flange. An oversized eighth hole (0.687-inch diameter) in the axle flange is for an antilock brake system (ABS) wheel speed sensor bushing. See **Fig. 2**. The eighth hole is in the 10 or 2 o'clock position, depending on which side of the axle is viewed.

Q Plus MX500 brakes are extended maintenance brakes. These brakes can be identified by an identification tag affixed to the brake shoe. An additional identification tag is affixed to the brake camshaft-and-chamber bracket (on top of the plugged grease hole). MX500 brakes and Meritor automatic slack adjusters do not have grease fittings.

## Principles of Operation

When the brake pedal is depressed, compressed air enters the brake chamber, causing the diaphragm to move a pushrod assembly.

The pushrod turns the slack adjuster and brake camshaft. As the camshaft turns, the S-type cam head forces the brake shoes against the brake drum and braking occurs.

When the brakes are released and air is exhausted from the brake chamber, the actuator return spring (within the brake chamber) and the brake shoe return spring return the camshaft, brake shoes, slack adjuster, and pushrod to their released positions.

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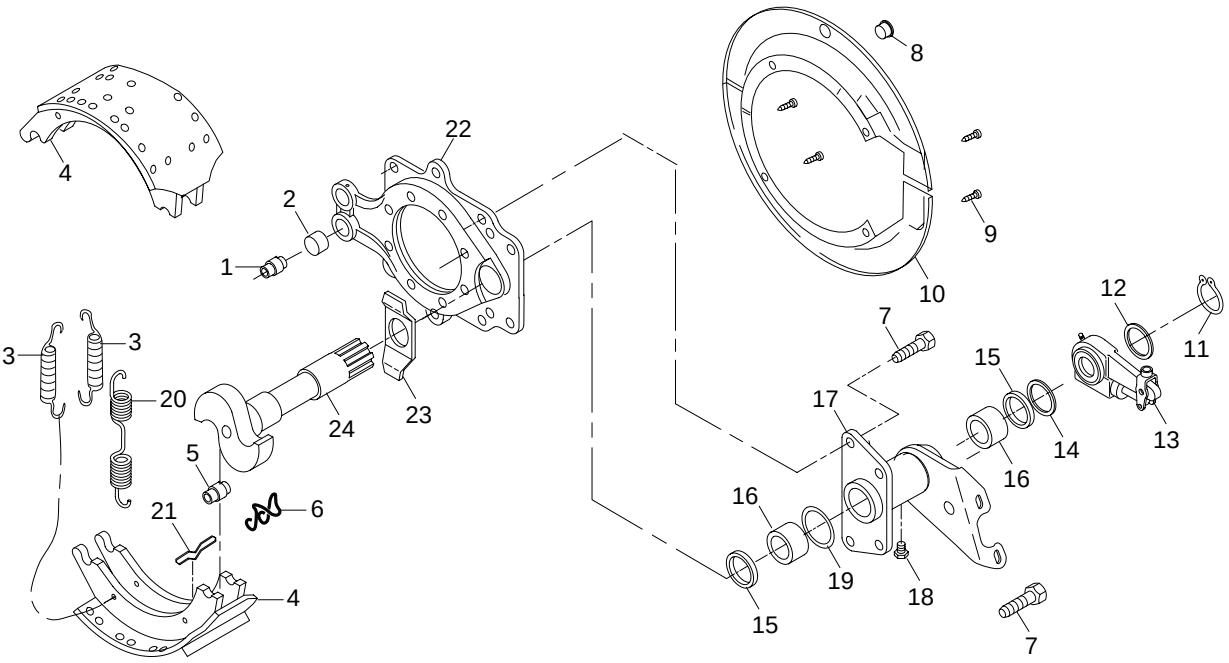
## General Information

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1. Anchor Pin
2. Anchor Pin Bushing
3. Retaining Spring
4. Brake Shoe and Lining Assembly
5. Cam Roller
6. Roller Retainer
7. Capscrew, Chamber Bracket
8. Plug
9. Capscrew, Dust Shield
10. Dust Shield
11. Camshaft Snap Ring
12. Washer (spacer)
13. Automatic Slack Adjuster
14. Washer (thick spacer)
15. Camshaft Grease Seal
16. Camshaft Bushing
17. Camshaft-and-Chamber Bracket
18. Grease Fitting
19. Chamber Bracket Seal
20. Return Spring
21. Return Spring Pin
22. Brake Spider
23. Washer, Camhead
24. S-Head Camshaft

**Fig. 1, Meritor Cam-Master Q Plus Brake (typical)**

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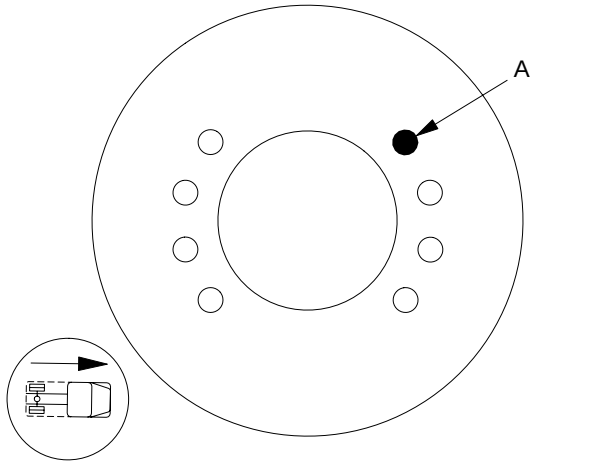


A. Oversized Hole (10 or 2 o'clock position) for ABS bushing.

**Fig. 2, Hole for ABS Wheel Speed Sensor Bushing**

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**WARNING**

**Before working on or around hydraulic brake systems and components, see Safety Precautions 100. Failure to do so may result in personal injury.**

## Voltage Check

NOTE: Along with the following, the voltage can also be checked using the Meritor WABCO TOOLBOX Software.

IMPORTANT: Voltage must be between 9.5 and 14 volts for the 12-volt hydraulic ABS to function properly.

1. Park the vehicle on a level surface and apply the parking brakes. Shut down the engine. Chock the rear tires to prevent vehicle movement.
2. Turn the ignition on.
3. Check the voltage between Pins 9 and 3, 9 and 2, and 9 and 11 on the black X2 ECU connector.
4. If voltage is not between 9.5 and 14 volts, verify proper wiring connections. Make corrections as required.
5. Remove the chocks from the rear tires.

## ABS Indicator Light

IMPORTANT: If the ABS indicator light does not come on after the ignition is turned on, check all ABS fuses or circuit breakers and replace if necessary. Check the wiring to the ABS indicator light and repair or replace the wiring as required.

1. Park the vehicle on a level surface and apply the parking brakes. Shut down the engine. Chock the rear tires to prevent vehicle movement.
2. Check the voltage potential at the light socket.
3. Check the continuity of the wires to the socket.
4. Replace the bulb.
5. Remove the chocks from the rear tires.

## Sensor Voltage Output Test

IMPORTANT: Sensor output voltage must be at least 0.2 volts AC at 30 rpm.

**WARNING**

**Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury can result.**

1. Park the vehicle on a level surface and apply the parking brakes. Shut down the engine. Chock the front and rear tires to prevent vehicle movement.
2. Turn the ignition off.
3. To measure voltage at the pins on the sensor connector, disconnect the sensor from the chassis harness.
4. Raise the vehicle off of the ground. Put safety stands under the axle.
5. Rotate the wheel by hand at 30 rpm (1/2 revolution per second).
6. Measure the voltage across the two pins at the sensor connector.
7. If the voltage is not greater than 0.2 volts AC, adjust the sensor and recheck. If the voltage is still not greater than 0.2 volts AC, replace the sensor.
8. Remove the safety stands and lower the vehicle.
9. Remove the chocks from the rear tires.

## Sensor Resistance

IMPORTANT: The sensor resistance must be between 500 and 2000 ohms. Measure resistance at the sensor connector or at the pins on the ECU connector.

1. Park the vehicle on a level surface and apply the parking brakes. Shut down the engine. Chock the rear tires to prevent vehicle movement.
2. Turn the ignition off.

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## Component Tests

3. Measure resistance at the sensor connector. Disconnect the sensor from the chassis harness.
4. Measure the resistance across the two pins at the sensor connector.
5. If the measurement is not between 500 and 2000 ohms, replace the sensor.
6. Remove the chocks from the rear tires.

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# Troubleshooting

## Meritor WABCO TOOLBOX Software

The Meritor WABCO TOOLBOX Software can be used to diagnose hydraulic antilock brake system (ABS) faults. This software is packaged and launched from ServiceLink and provides J1587 fault codes and on-screen information to make the necessary repairs or replacements. TOOLBOX must be used to reset the ECU memory. See *Meritor WABCO Maintenance Manual No. 39, Rev. 1/00*.

## ServiceLink

ServiceLink can be used to troubleshoot the Meritor WABCO hydraulic ABS. J1587 fault codes can be read by connecting the vehicle to the ServiceLink computer.

## J1587 Fault Codes

The J1587 fault codes are a combination of the message identifier (MID), which indicates the ECU or system with the fault (136 for the hydraulic ABS ECU), and the system identifier (SID), which indicates the specific component within the system with the fault. The failure mode indicator (FMI) identifies a specific problem with the system component. See **Table 1** for a listing of J1587 fault codes. This table also lists the appropriate troubleshooting table to consult for fault code diagnosis.

## ABS Warning Lamp Circuit

The ABS warning lamp circuit is controlled by wire alone. **It is NOT also controlled by the databus as with pneumatic ABS vehicles.** The ABS lamp circuit contains a relay located in the dash. The purpose of this relay is to turn on the ABS warning lamp in the instrument cluster should the ABS controller be disconnected from the vehicle harness.

When the ignition is turned on, the relay is energized. This causes the contact to open the circuit from ground to the instrument cluster (circuit 376L). If the ABS ECU becomes disconnected from the vehicles harness, the relay becomes de-energized (the ground provided by circuit 376L1 is now open), thus causing circuit 376L leading to the instrument cluster to be grounded through the relay. If a fault occurs in the ABS under normal operation, the ABS ECU will ground circuit 376L at pin 8 of the X2 connector, thus grounding the circuit leading to the instrument cluster and turning the ABS warning lamp on. See **Fig. 1** for ABS lamp relay wiring detail.

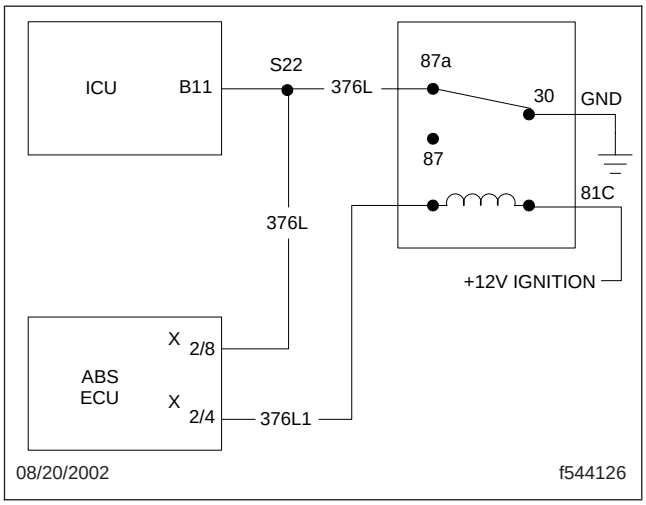


**Fig. 1, ABS Lamp Relay Wiring**

Refer to **Fig. 2** to identify a warning lamp condition, then **Fig. 3** to diagnose the condition.

Make the necessary repairs and clear the fault code from the ECU memory. If more than one fault exists, it will be displayed after the first one has been cleared from memory.

A volt ohmmeter (VOM) can determine the condition of the ABS valves, wheel end sensors and associated wiring. **Figure 4** displays pin locations at the ECU and **Fig. 5** displays pin locations at the ABS modulator valve. **Table 2** and **Table 3** display corresponding circuit to pin information.

IMPORTANT: The ignition switch must be off when connecting or disconnecting the ECU.

NOTE: The blink codes are erased from ECU memory as repairs are made. Once a repair has been made, cycle the ignition to ensure the blink code does not reappear. If there are any other outstanding faults, the next blink code will be displayed.

If the ABS light does not operate correctly after the ignition is turned on (the light does not come on at all or it does not go out after about 3 seconds), check all circuit breakers in the control unit panel and re-

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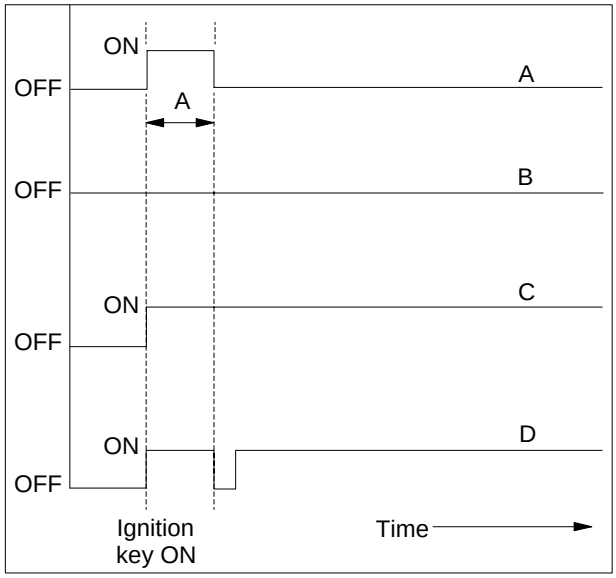


A. Normal Condition
B. Bulb or Wiring Problem
C. Connector, Wiring or ECU (warning light circuit problem)
D. ABS Fault

**Fig. 2, ABS Warning Lamp Conditions**

place if necessary. Check the wiring to warning light and repair or replace the wiring as needed. When checking the warning light:

- Replace the bulb;
- Check for a fault in the warning lamp circuit, use ServiceLink or Meritor PC-based diagnostics;

The ABS system needs between 9.5 and 14 volts.

NOTE: Wire repairs may require the use of special tools for certain connectors and terminals. See **Group 54** for information on special terminals and connectors and ordering tools for them.

See the wiring diagrams in **Specifications 400** when troubleshooting the ABS system. If a fault cannot be repaired or erased from ECU memory, contact your District Service Manager or call Meritor WABCO at 1-800-535-5560.

## Erasing a Fault from the ECU Memory

NOTE: An active fault cannot be erased until it has been corrected.

Meritor WABCO recommends that you erase all faults from the ECU memory after they have been noted and corrected.

Stored faults are erased from the ECU memory by clearing historic faults in ServiceLink or Meritor Toolbox.

# Reset Memorized (Learned Components)

The ECU learns whether or not a retarder interrupt circuit is present. Once the ECU has detected a retarder circuit, it expects to see it every time the vehicle is powered up and will monitor the circuit for faults. If the ECU senses a resistance on the retarder circuit it will automatically learn that the retarder circuit exists. If an engine retarder circuit does not exist, but the ECU has detected one and is indicating faults, something may have been connected (a multimeter, etc.) to the retarder circuit during testing. Moisture, faulty circuit wiring, or moving an ECU from one vehicle to another can also cause the ECU to mistakenly detect a non-existent retarder circuit. If necessary, use the "Reset Memorized" command in the Meritor WABCO TOOLBOX Software to clear the ECU memory of this component. For instructions, see *Meritor WABCO Maintenance Manual No. 39, Rev. 1/00*.

# Power Distribution Module

The main power distribution module (PDM) is mounted in the engine compartment on the left front quarter fender. See **Fig. 6** for the location of Fuse 16, ABS constant battery power. See **Group 54** for complete PDM information.

# Bulk Head Module

The Bulkhead Module (BHM) is the primary module of the vehicle electrical system, and controls the operation of the other multiplex modules in the system and a variety of other vehicle components either directly or indirectly.

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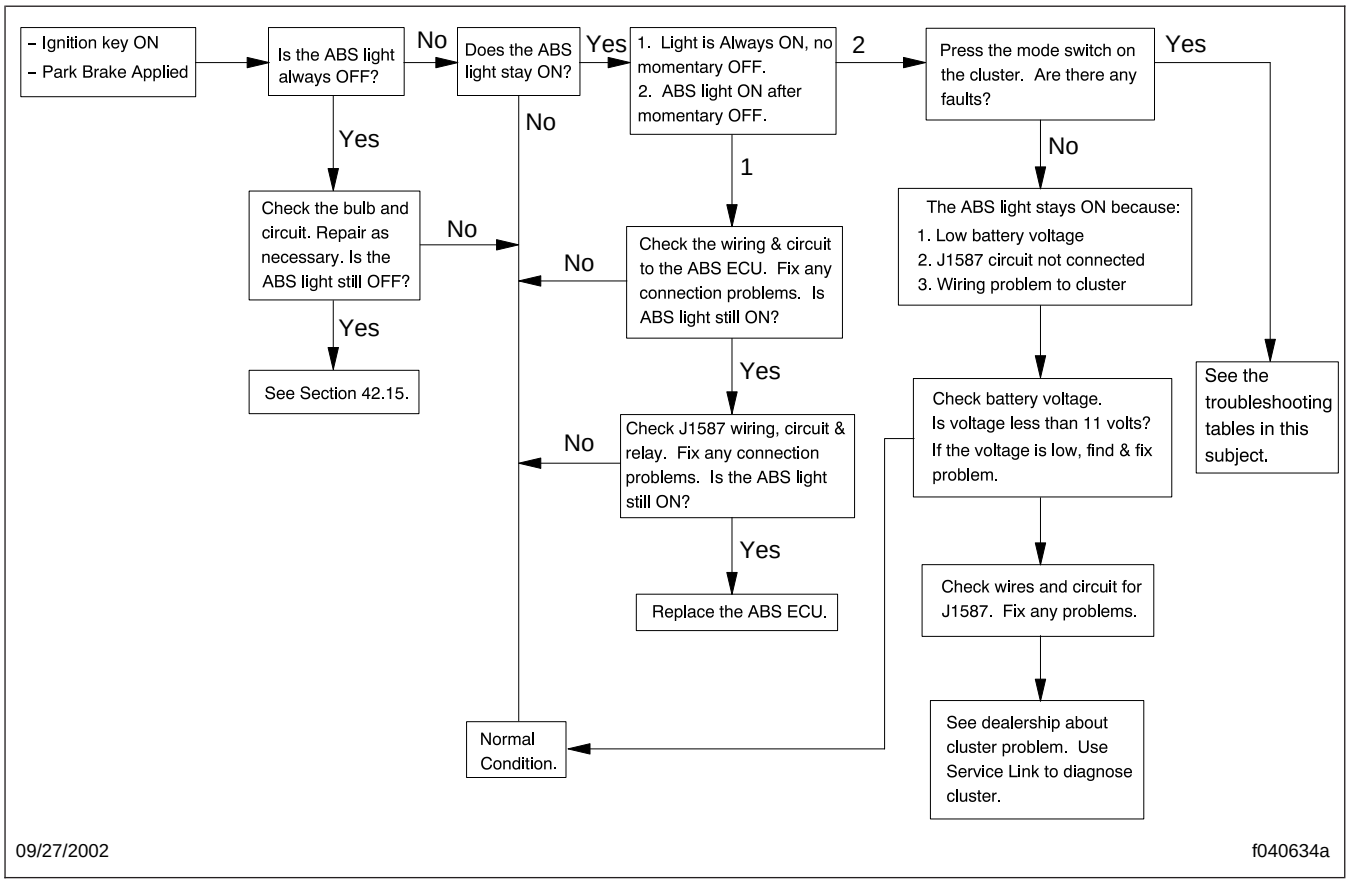


**Fig. 3, Flow Chart: ABS Warning Lamp Troubleshooting**

ABS ignition power is located at pin B1/P on the BHM (**Fig. 7**). For more information about the BHM, see **Section 54.12**.

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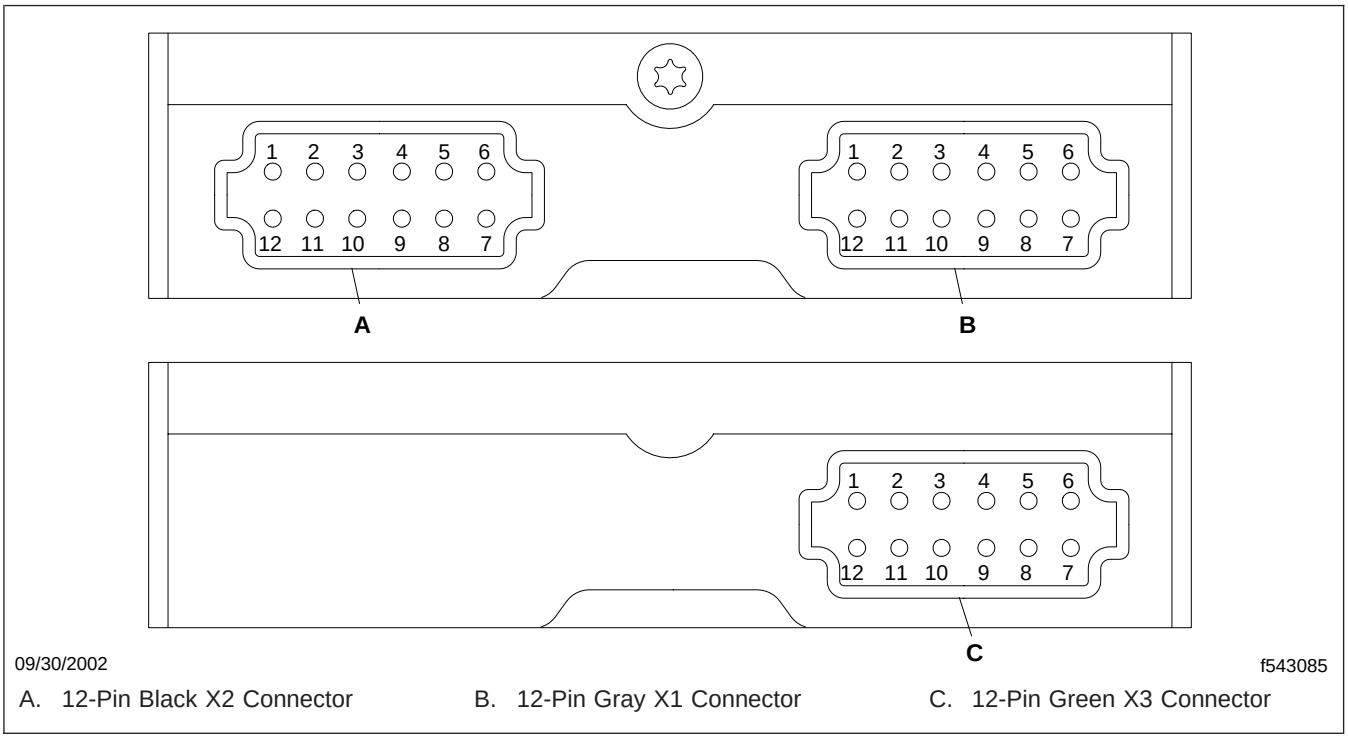
## Troubleshooting




A. 12-Pin Black X2 Connector B. 12-Pin Gray X1 Connector C. 12-Pin Green X3 Connector

**Fig. 4, ECU Connectors, D Version**

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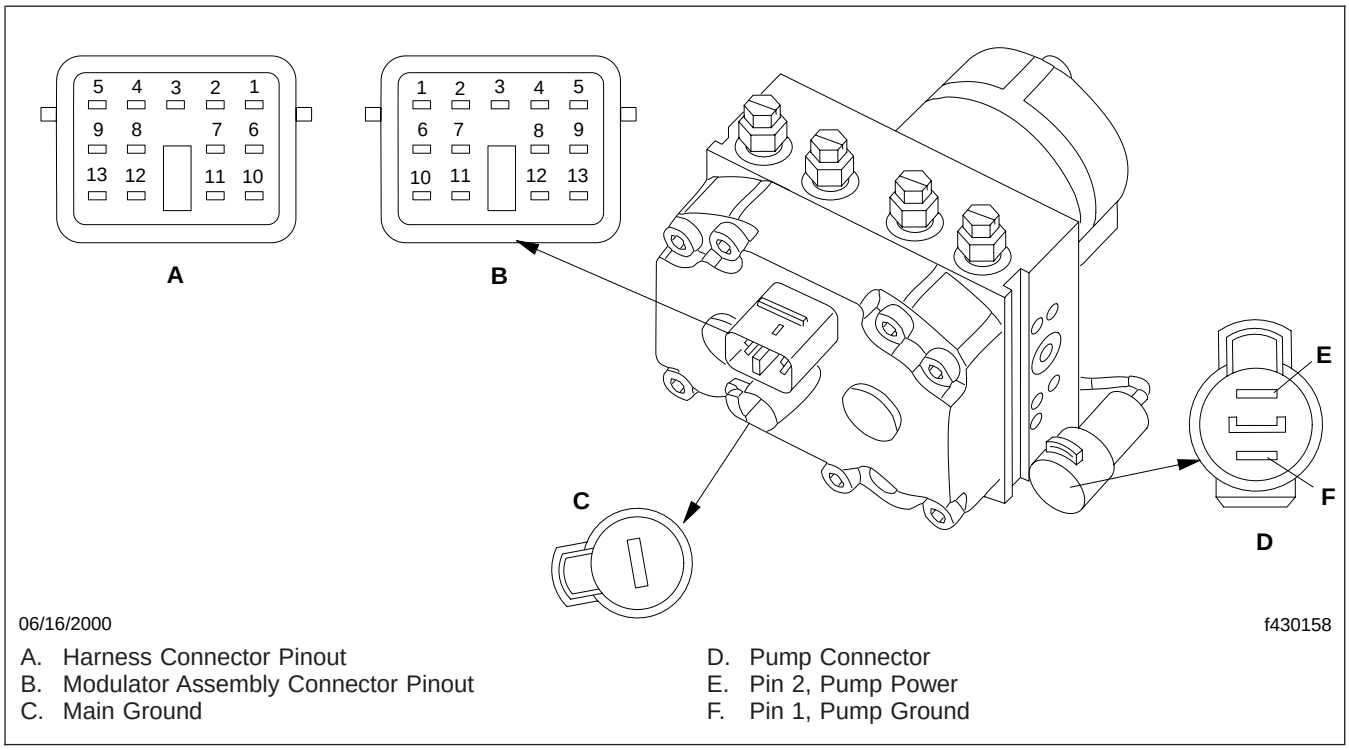


A. Harness Connector Pinout
B. Modulator Assembly Connector Pinout
C. Main Ground
D. Pump Connector
E. Pin 2, Pump Power
F. Pin 1, Pump Ground

**Fig. 5, ABS Modulator Assembly Pin Connectors, D Version**

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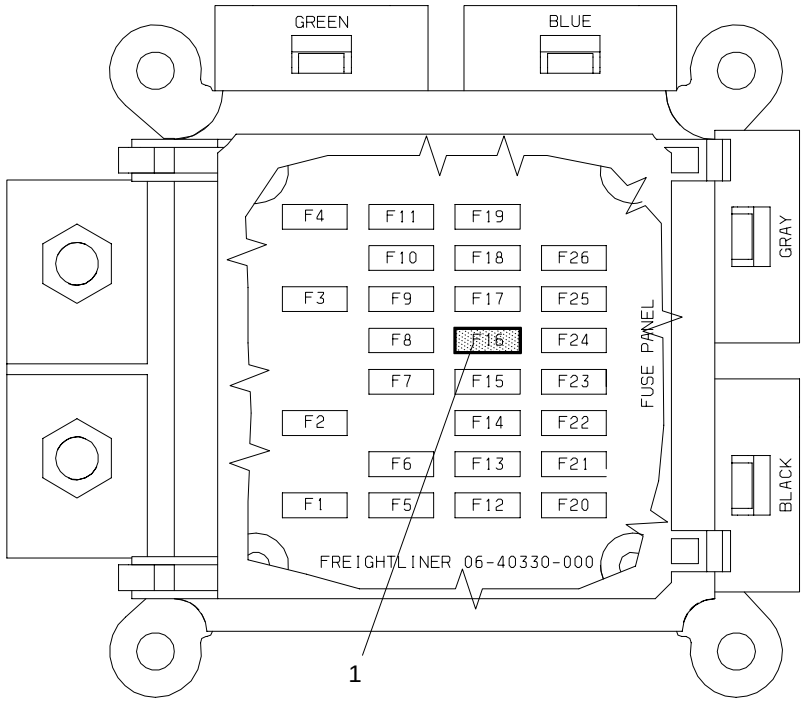


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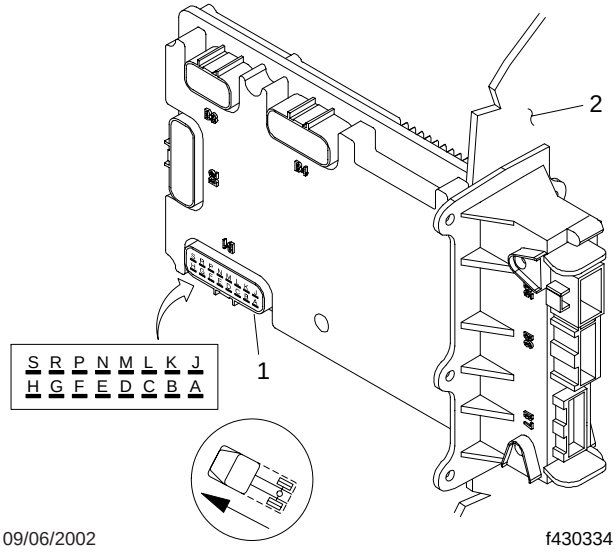
1. Fuse 16, ABS Constant Battery Power

**Fig. 6, Cab Power Distribution Module**

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1. B1 Connector
2. Frontwall

**Fig. 7, Bulkhead Module (BHM)**

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| Fault Codes | | |
|---|---|---|
| **J1587 Fault Code (MID-SID)** | **Description** | **Troubleshooting Table** |
| 136-001 | Left Front Wheel Sensor * | **Table 4** |
| 136-002 | Right Front Wheel Sensor | **Table 5** |
| 136-003 | Left Rear Wheel Sensor | **Table 6** |
| 136-004 | Right Rear Wheel Sensor | **Table 7** |
| 136-013 | Retarder | **Table 8** |
| 136-014 | Power | **Table 9** |
| 136-023 | ABS Warning Light | **Table 10** |
| 136-030 | Recirculation Pump Relay | **Table 11** |
| 136-042 | Left Front Inlet Solenoid Valve | **Table 12** |
| 136-043 | Right Front Inlet Solenoid Valve | **Table 13** |
| 136-044 | Left Rear Inlet Solenoid Valve | **Table 14** |
| 136-045 | Right Rear Inlet Solenoid Valve | **Table 15** |
| 136-048 | Left Front Outlet Solenoid Valve | **Table 16** |
| 136-049 | Right Front Outlet Solenoid Valve | **Table 17** |
| 136-050 | Left Rear Outlet Solenoid Valve | **Table 18** |
| 136-051 | Right Rear Outlet Solenoid Valve | **Table 19** |
| 136-054 | Recirculation Pump | **Table 20** |
| 136-055 | ECU | **Table 21** |
| 136-251 | Low Voltage | **Table 22** |
| 136-253 | Internal Tire Parameter | **Table 23** |
| 136-254 | ECU Internal Fault | **Table 24** |

* Blink codes 5-1, 5-3 and 5-4 indicate a fault with the right front, right rear and left rear wheel sensors respectively.

**Table 1, Fault Codes**

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## Troubleshooting

| Circuit Wire Numbers and Descriptions, "D" Version | | | |
|---|---|---|---|
| **Pin Connector** | **Pin Number** | **Vehicle Wire Number** | **WABCO Circuit Description** |
| 12-Pin Gray X1 | 1 | — | Not Used |
| | 2 | GND | Ground |
| | 3 | 378LFI | Left Front Inlet Valve |
| | 4 | 378RFI | Right Front Inlet Valve |
| | 5 | 378LRI | Left Rear Inlet Valve |
| | 6 | 378RRI | Right Rear Inlet Valve |
| | 7 | 378RRO | Right Rear Outlet Valve |
| | 8 | 376LRO | Left Rear Outlet Valve |
| | 9 | 378RFO | Right Front Outlet Valve |
| | 10 | 378LFO | Left Front Outlet Valve |
| | 11 | — | Not Used |
| | 12 | — | Not Used |
| 12-Pin Black X2 | 1 | J1587– | SAE J1587 (–) |
| | 2 | 376C | ECU Ignition Supply |
| | 3 | 376A | ECU Supply/Battery |
| | 4 | 376L1 | Warning Light Relay |
| | 5 | — | Not Used |
| | 6 | 376H | Pump Relay |
| | 7 | 376R | Retarder Relay |
| | 8 | 376L | ABS Indicator Light |
| | 9 | GND | Ground |
| | 10 | 376B | Motor Monitor |
| | 11 | 376A | ECU Supply/Battery |
| | 12 | J1587+ | SAE J1587 (+) |

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| Circuit Wire Numbers and Descriptions, "D" Version | | | |
|---|---|---|---|
| **Pin Connector** | **Pin Number** | **Vehicle Wire Number** | **WABCO Circuit Description** |
| 12-Pin Green X3 | 1 | — | Not Used |
| | 2 | — | Not Used |
| | 3 | 377LR+ | Left Rear Sensor |
| | 4 | 377RF– | Right Front Sensor |
| | 5 | 377LF+ | Left Front Sensor |
| | 6 | 377RR+ | Right Rear Sensor |
| | 7 | 377RR– | Right Rear Sensor |
| | 8 | 377LF– | Left Front Sensor |
| | 9 | 377RF+ | Right Front Sensor |
| | 10 | 377LR– | Left Rear Sensor |
| | 11 | — | Not Used |
| | 12 | — | Not Used |

**Table 2, Circuit Wire Numbers and Descriptions, "D" Version**

| ABS Modulator Assembly Pin Connectors | | |
|---|---|---|
| **Vehicle Wire Number** | **Pin Number** | **Circuit Description** |
| 1 | 376LRO | Left Rear Outlet Valve |
| 2 | 378LRI | Left Rear Inlet Valve |
| 3 | — | Not Used |
| 4 | 378RFI | Right Front Inlet Valve |
| 5 | 378RFO | Right Front Outlet Valve |
| 6 | — | Not Used |
| 7 | — | Not Used |
| 8 | GNDE | Ground |
| 9 | — | Not Used |

| ABS Modulator Assembly Pin Connectors | | |
|---|---|---|
| **Vehicle Wire Number** | **Pin Number** | **Circuit Description** |
| 10 | 378RRO | Right Rear Outlet Valve |
| 11 | 378RRI | Right Rear Inlet Valve |
| 12 | 378LFI | Left Front Inlet Valve |
| 13 | 378LFO | Left Front Outlet Valve |
| 1 | GND | Pump Ground |
| 2 | 376A | Pump Power |

**Table 3, ABS Modulator Assembly Pin Connectors**

# Troubleshooting Tables

| J1587 Fault 136-001 Left Front Wheel Sensor | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 001 | 01 | Incorrect sensor air gap | 1. Adjust the sensor. Check the AC voltage across Pins 5 and 8 of the green X3 ECU connector (Circuits 377LF+ and 377 LF–) while rotating the left front wheel 30 rpm. | Voltage greater than 0.2 VAC | Sensor adjustment solved the problem. Clear the stored faults and drive the vehicle 4 mph (6 km/h). |
| | | | | | Voltage less than 0.2 VAC | Check for excessive wheel bearing end play. Repair as necessary. |

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## Troubleshooting

| J1587 Fault 136-001 Left Front Wheel Sensor | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 001 | 02 | Intermittent open circuit or incorrect sensor resistance<br>NOTE: This SAE J1587 fault code can also be caused by incorrect or mixed tire size. Also see test 4. | 2. Measure the resistance across Pins 5 and 8 of the green X3 ECU connector (Circuits 377LF– and 377 LF+). | Resistance reading between 500 and 2000 ohms | Check for intermittent, loose or poor connections in Circuits 377LF+ and 377LF– and repair as necessary. If the problem persists, suspect the ECU is at fault. |
| | | | | | Resistance reading below 500 or above 2000 ohms | Go to Test 3. |
| | | | | 3. Disconnect the sensor at the sensor connector. Measure the resistance at the sensor connector (on the sensor side). | Resistance reading between 500 and 2000 ohms | Check the wiring between the ECU and the wheel sensor (Circuits 377LF+ and 377LF–). Repair as necessary. Go to Test 4. |
| | | | | | Resistance reading below 500 or above 2000 ohms | Replace the wheel sensor. |
| 136 | 001 | 02 | Incorrect or mixed tire size<br>NOTE: This SAE J1587 fault code can also be caused by an intermittent open circuit or incorrect sensor resistance. Also, see tests 2 and 3. | 4. Check for tire size deviation in excess of 16 percent. Mixed tire sizes can cause this fault. | Correct tire size and size variation does not exceed 16 percent | Perform Test 2 and Test 3 if not already done. If the problem is not found, verify the fault and check the ECU. |
| | | | | | Incorrect tire size or size variation exceeds 16 percent | Install the correct size tires. |

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| J1587 Fault 136-001 Left Front Wheel Sensor | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 001 | 05 | Open circuit | 5. Measure the resistance across Pins 5 and 8 of the green X3 ECU connector (Circuits 377LF– and 377LF+). | Resistance reading between 500 and 2000 ohms | Check for intermittent, loose or poor connections in Circuits 377LF+ and 377LF– and repair as necessary. If the problem persists, suspect the ECU is at fault. |
| | | | | | Resistance reading below 500 or above 2000 ohms | Go to Test 6. |
| | | | | 6. Disconnect the sensor at the sensor connector. Measure the resistance at the sensor connector (on the sensor side). | Resistance reading between 500 and 2000 ohms | Check the wiring between the ECU and the wheel sensor (Circuits 377LF+ and 377LF–). Repair as necessary. |
| | | | | | Resistance reading below 500 or above 2000 ohms | Replace the wheel sensor. |

**Table 4, J1587 Fault 136-001 Left Front Wheel Sensor**

| J1587 Fault 136-002 Right Front Wheel Sensor | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 002 | 01 | Incorrect sensor air gap | 1. Adjust the sensor. Check the AC voltage across Pins 4 and 9 of the green X3 ECU connector (Circuits 377RF+ and 377RF–) while rotating the right front wheel 30 rpm. | Voltage greater than 0.2 VAC | Sensor adjustment solved the problem. Clear the stored faults and drive the vehicle 4 mph (6 km/h). |
| | | | | | Voltage less than 0.2 VAC | Check for excessive wheel bearing end play. Repair as necessary. |

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## Troubleshooting

| J1587 Fault 136-002 Right Front Wheel Sensor | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 002 | 02 | Intermittent open circuit or incorrect sensor resistance | 2. Measure the resistance across Pins 4 and 9 of the green X3 ECU connector (Circuits 377RF– and 377RF+). | Resistance reading between 500 and 2000 ohms | Check for intermittent, loose or poor connections in Circuits 377RF+ and 377RF– and repair as necessary. If the problem persists, suspect the ECU is at fault. |
| | | | | | Resistance reading below 500 or above 2000 ohms | Go to Test 3. |
| | | | | 3. Disconnect the sensor at the sensor connector. Measure the resistance at the sensor connector (on the sensor side). | Resistance reading between 500 and 2000 ohms | Check the wiring between the ECU and the wheel sensor (Circuits 377RF+ and 377RF–). Repair as necessary. |
| | | | | | Resistance reading below 500 or above 2000 ohms | Replace the wheel sensor. |
| 136 | 002 | 05 | Open circuit | 4. Measure the resistance across Pins 4 and 9 of the green X3 ECU connector (Circuits 377RF– and 377RF+). | Resistance reading between 500 and 2000 ohms | Check for intermittent, loose or poor connections in Circuits 377RF+ and 377RF– and repair as necessary. If the problem persists, suspect the ECU is at fault. |
| | | | | | Resistance reading below 500 or above 2000 ohms | Go to Test 5. |
| | | | | 5. Disconnect the sensor at the sensor connector. Measure the resistance at the sensor connector (on the sensor side). | Resistance reading between 500 and 2000 ohms | Check the wiring between the ECU and the wheel sensor (Circuits 377RF+ and 377RF–). Repair as necessary. |
| | | | | | Resistance reading below 500 or above 2000 ohms | Replace the wheel sensor. |

**Table 5, J1587 Fault 136-002 Right Front Wheel Sensor**

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| J1587 Fault 136-003 Left Rear Wheel Sensor | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 003 | 01 | Incorrect sensor air gap | 1. Adjust the sensor. Check the AC voltage across Pins 3 and 10 of the green X3 ECU connector (Circuits 377LR+ and 377LR–) while rotating the left rear wheel 30 rpm. | Voltage greater than 0.2 VAC | Sensor adjustment solved the problem. Clear the stored faults and drive the vehicle 4 mph (6 km/h). |
| | | | | | Voltage less than 0.2 VAC | Check for excessive wheel bearing end play. Repair as necessary. |
| 136 | 003 | 02 | Intermittent open circuit or incorrect sensor resistance | 2. Measure the resistance across Pins 3 and 10 of the green X3 ECU connector (Circuits 377LR– and 377LR+). | Resistance reading between 500 and 2000 ohms | Check for intermittent, loose or poor connections in Circuits 377LR+ and 377LR– and repair as necessary. If the problem persists, suspect the ECU is at fault. |
| | | | | | Resistance reading below 500 or above 2000 ohms | Go to Test 3. |
| | | | | 3. Disconnect the sensor at the sensor connector. Measure the resistance at the sensor connector (on the sensor side). | Resistance reading between 500 and 2000 ohms | Check the wiring between the ECU and the wheel sensor (Circuits 377LR+ and 377LR–). Repair as necessary. |
| | | | | | Resistance reading below 500 or above 2000 ohms | Replace the wheel sensor. |
| 136 | 003 | 05 | Open circuit | 4. Measure the resistance across Pins 3 and 10 of the green X3 ECU connector (Circuits 377LR– and 377LR+). | Resistance reading between 500 and 2000 ohms | Check for intermittent, loose or poor connections in Circuits 377LR+ and 377LR– and repair as necessary. If the problem persists, suspect the ECU is at fault. |
| | | | | | Resistance reading below 500 or above 2000 ohms | Go to Test 5. |
| | | | | 5. Disconnect the sensor at the sensor connector. Measure the resistance at the sensor connector (on the sensor side). | Resistance reading between 500 and 2000 ohms | Check the wiring between the ECU and the wheel sensor (Circuits 377LR+ and 377LR–). Repair as necessary. |
| | | | | | Resistance reading below 500 or above 2000 ohms | Replace the wheel sensor. |

**Table 6, J1587 Fault 136-003 Left Rear Wheel Sensor**

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## Troubleshooting

| J1587 Fault 136-004 Right Rear Wheel Sensor | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 004 | 01 | Incorrect sensor air gap | 1. Adjust the sensor. Check the AC voltage across Pins 6 and 7 of the green X3 ECU connector (Circuits 377RR+ and 377RR–) while rotating the right rear wheel 30 rpm. | Voltage greater than 0.2 VAC | Sensor adjustment solved the problem. Clear the stored faults and drive the vehicle 4 mph (6 km/h). |
| | | | | | Voltage less than 0.2 VAC | Check for excessive wheel bearing end play. Repair as necessary. |
| 136 | 004 | 02 | Intermittent open circuit or incorrect sensor resistance | 2. Measure the resistance across Pins 6 and 7 of the green X3 ECU connector (Circuits 377RR– and 377RR+). | Resistance reading between 500 and 2000 ohms | Check for intermittent, loose or poor connections in Circuits 377RR+ and 377RR– and repair as necessary. If the problem persists, suspect the ECU is at fault. |
| | | | | | Resistance reading below 500 or above 2000 ohms | Go to Test 3. |
| | | | | 3. Disconnect the sensor at the sensor connector. Measure the resistance at the sensor connector (on the sensor side). | Resistance reading between 500 and 2000 ohms | Check the wiring between the ECU and the wheel sensor (Circuits 377RR+ and 377RR–). Repair as necessary. |
| | | | | | Resistance reading below 500 or above 2000 ohms | Replace the wheel sensor. |
| 136 | 004 | 05 | Open circuit | 4. Measure the resistance across Pins 6 and 7 of the green X3 ECU connector (Circuits 377RR– and 377RR+). | Resistance reading between 500 and 2000 ohms | Check for intermittent, loose or poor connections in Circuits 377RR+ and 377RR– and repair as necessary. If the problem persists, suspect the ECU is at fault. |
| | | | | | Resistance reading below 500 or above 2000 ohms | Go to Test 5. |
| | | | | 5. Disconnect the sensor at the sensor connector. Measure the resistance at the sensor connector (on the sensor side). | Resistance reading between 500 and 2000 ohms | Check the wiring between the ECU and the wheel sensor (Circuits 377RR+ and 377RR–). Repair as necessary. |
| | | | | | Resistance reading below 500 or above 2000 ohms | Replace the wheel sensor. |

**Table 7, J1587 Fault 136-004 Right Rear Wheel Sensor**

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| J1587 Fault 136-013 Retarder | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 013 | 03 | Short to power | 1. Disconnect the black X2 connector at the ECU. Disconnect the retarder relay. With the ignition ON, measure the voltage between Pin 7 of the black X2 ECU connector and a good chassis ground. | Voltage zero | Check for an intermittent short to power in Circuit 376R. If okay, ECU may be at fault. |
| | | | | | Voltage not zero | Check for a short to power in Circuit 376R. Repair as necessary. |
| 136 | 013 | 05 | Open circuit | 2. Disconnect the black X2 connector at the ECU. Disconnect the retarder relay. Measure the resistance between Pin 7 of the black X2 ECU connector and relay connector cavity that corresponds to pin 85 of the relay. | Resistance less than 1 ohm | Check relay coil resistance (should be 60-85 Ohms). If okay, check circuit 81C (power to relay coil) for open. Repair as necessary. |
| | | | | | Resistance more than 1 ohm | Repair open in circuit 376R. |
| 136 | 013 | 06 | Short to ground | 3. Disconnect the black X2 connector at the ECU. Disconnect the retarder relay. Measure the resistance between pin 7 of the X2 connector and a good chassis ground. | Resistance is less than 10 Ohms | Check circuit 376R for short to ground. Repair as necessary. |
| | | | | | Resistance is much greater than 10 Ohms | Check for intermittent short to ground in circuit 376R. If okay, ECU may be at fault. |

**Table 8, J1587 Fault 136-013 Retarder**

| J1587 Fault 136-014 Power | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 014 | 03 | Voltage supplied to ECU with ignition OFF | 1. Check for voltage backfeeding to ECU with the ignition off, especially to pins 7/X2 and 10/X2. | Voltage zero | Repair as necessary. |
| 136 | 014 | 04 | No voltage supplied to ECU with ignition ON | 2. With the ignition ON, measure the voltage between Pin 3 of the black X2 ECU connector and a good chassis ground. Repeat between pin 11 and ground. | Voltage between 9.5 and 14 volts at both pins. | Check Circuit 376A for an intermittent open circuit. If the problem persists, suspect the ECU is at fault. |
| | | | | | Voltage below 9.5 volts at one or both pins. | Check Circuit 376A for an open circuit and check Fuse F16. Repair as necessary. |

**Table 9, J1587 Fault 136-014 Power**

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## Troubleshooting

| J1587 Fault 136-023 ABS Warning Light | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 023 | 05 | Open circuit or low current | 1. Disconnect the black X2 connector from the ECU. Turn the ignition ON. | ABS light illuminates | Check circuit 376L for open circuit between splice S22 and X2/8 at the ABS connector. Repair as necessary. |
| | | | | | ABS light does not illuminate | Check the bulb and wire (circuit 376L between splice S22 and ICU pin B11. If okay, replace the ICU. |

**Table 10, J1587 Fault 136-023 ABS Warning Light**

| J1587 Fault 136-030 Recirculation Pump Relay | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 030 | 03 | Relay shorted to power | 1. Disconnect the black X2 ECU connector. With the ignition ON, measure the voltage between Pin 6 and a good chassis ground. | Voltage zero | If the problem persists, suspect the ECU is at fault. |
| | | | | | Voltage not zero | Circuit 376H is shorted to power. Repair as necessary. |
| 136 | 030 | 05 | Relay open circuit | 2. Disconnect the black X2 ECU connector. Measure the resistance between Pin 6 and a good chassis ground. | Resistance between 50 and 200 ohms | If the problem persists, suspect the ECU is at fault. |
| | | | | | Resistance below 50 or above 200 ohms | Check the relay coil, relay coil ground circuit, and Circuit 376H for an open circuit. Repair as necessary. |
| 136 | 030 | 06 | Relay short to ground | 3. Disconnect the black X2 ECU connector. Measure the resistance between Pin 6 and a good chassis ground. | Resistance between 50 and 200 ohms | If the problem persists, suspect the ECU is at fault. |
| | | | | | Resistance below 50 or above 200 ohms | Check Circuit 376H for a short to ground. Repair as necessary. |

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| J1587 Fault 136-030 Recirculation Pump Relay | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 030 | 07 | Pump relay sticks, pump continues to run when ECU deactivates the relay<br><br>NOTE: The problem may be intermittent and a new relay may be required to correct the fault. | 4. If the fault is active, disconnect the black X2 connector from the ECU. With the ignition ON, check to see if the recirculation pump is running. | Pump OFF | The ABS pump relay (located in the chassis harness, near the ABS valve) may be intermittently sticking. Try a new relay and verify that the problem is solved. |
| | | | | | Pump ON | The ABS pump relay (located in the chassis harness, near the ABS valve) is sticking. Replace the relay. |

**Table 11, J1587 Fault 136-030 Recirculation Pump Relay**

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## Troubleshooting

| J1587 Fault 136-042 Left Front Inlet Solenoid Valve | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 042 | 03<br>05<br>06 | Shorted to power (inlet valve)<br>Open circuit (inlet valve)<br>Shorted to ground (inlet valve)<br>NOTE: Check for an open circuit in the wiring between the ECU and the modulator valve. Check the ground circuit to the modulator valve. | 1. Measure the resistance across Pins 3 and 2 of the gray X1 ECU connector (Circuits 378LFI and GRDE). | Resistance reading 6.5±0.5 ohms | Check for intermittent wiring connections. If the wiring is OK, suspect the ECU is at fault. |
| | | | | | Resistance reading not 6.5±0.5 ohms | Go to Test 2. |
| | | | | 2. Check the ground circuit by measuring the resistance between Pin 2 of the gray X1 ECU connector and a good chassis ground. | Resistance reading close to zero | Go to Test 3. |
| | | | | | Resistance reading not close to zero | Check and repair the ground circuit. |
| | | | | 3. With the modulator valve connector removed, measure the resistance between Pin 8 on the modulator connector and a good chassis ground. | Resistance reading close to zero | Go to Test 4. |
| | | | | | Resistance reading not close to zero | Check the modulator ground circuit, repair as necessary. |
| | | | | 4. Measure the resistance in Circuit 378LFI between modulator connector Pin 12 and connector Pin 3 on the gray X1 ECU connector. | Resistance reading close to zero | Go to Test 5. |
| | | | | | Resistance reading not close to zero | Repair Circuit 378LFI. |
| | | | | 5. With the modulator valve connector removed, measure the resistance across Pins 12 and 8 on the modulator connector. | Resistance reading 6.5±0.5 ohms | Repeat Tests 1 through 5. The problem may be intermittent. If the wiring is OK, suspect the ECU is at fault. |
| | | | | | Resistance reading not 6.5±0.5 ohms | Replace the modulator valve. |

**Table 12, J1587 Fault 136-042 Left Front Inlet Solenoid Valve**

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| J1587 Fault 136-043 Right Front Inlet Solenoid Valve | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 043 | 03<br>05<br>06 | Shorted to power (inlet valve)<br>Open circuit (inlet valve)<br>Shorted to ground (inlet valve)<br>NOTE: Check for an open circuit in the wiring between the ECU and the modulator valve. Check the ground circuit to the modulator valve. | 1. Measure the resistance across Pins 4 and 2 of the gray X1 ECU connector (Circuits 378RFI and GRDE). | Resistance reading 6.5±0.5 ohms | Check for intermittent wiring connections. If the wiring is OK, suspect the ECU is at fault. |
| | | | | | Resistance reading not 6.5±0.5 ohms | Go to Test 2. |
| | | | | 2. Check the ground circuit by measuring the resistance between Pin 2 of the gray X1 ECU connector and a good chassis ground. | Resistance reading close to zero | Go to Test 3. |
| | | | | | Resistance reading not close to zero | Check and repair the ground circuit. |
| | | | | 3. With the modulator valve connector removed, measure the resistance between Pin 8 on the modulator connector and a good chassis ground. | Resistance reading close to zero | Go to Test 4. |
| | | | | | Resistance reading not close to zero | Check the modulator ground circuit, repair as necessary. |
| | | | | 4. Measure the resistance in Circuit 378RFI between modulator connector Pin 4 and connector Pin 4 on the gray X1 ECU connector. | Resistance reading close to zero | Go to Test 5. |
| | | | | | Resistance reading not close to zero | Repair Circuit 378RFI. |
| | | | | 5. With the modulator valve connector removed, measure the resistance across Pins 4 and 8 on the modulator connector. | Resistance reading 6.5±0.5 ohms | Repeat Tests 1 through 5. The problem may be intermittent. If the wiring is OK, suspect the ECU is at fault. |
| | | | | | Resistance reading not 6.5±0.5 ohms | Replace the modulator valve. |

**Table 13, J1587 Fault 136-043 Right Front Inlet Solenoid Valve**

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## Troubleshooting

| J1587 Fault 136-044 Left Rear Inlet Solenoid Valve | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 044 | 03<br>05<br>06 | Shorted to power (inlet valve)<br>Open circuit (inlet valve)<br>Shorted to ground (inlet valve)<br>NOTE: Check for an open circuit in the wiring between the ECU and the modulator valve. Check the ground circuit to the modulator valve. | 1. Measure the resistance across Pins 5 and 2 of the gray X1 ECU connector (Circuits 378LRI and GRDE). | Resistance reading 6.5±0.5 ohms | Check for intermittent wiring connections. If the wiring is OK, suspect the ECU is at fault. |
| | | | | | Resistance reading not 6.5±0.5 ohms | Go to Test 2. |
| | | | | 2. Check the ground circuit by measuring the resistance between Pin 2 of the gray X1 ECU connector and a good chassis ground. | Resistance reading close to zero | Go to Test 3. |
| | | | | | Resistance reading not close to zero | Check and repair the ground circuit. |
| | | | | 3. With the modulator valve connector removed, measure the resistance between Pin 8 on the modulator connector and a good chassis ground. | Resistance reading close to zero | Go to Test 4. |
| | | | | | Resistance reading not close to zero | Check the modulator ground circuit, repair as necessary. |
| | | | | 4. Measure the resistance in Circuit 378LRI between modulator connector Pin 2 and connector Pin 5 on the gray X1 ECU connector. | Resistance reading close to zero | Go to Test 5. |
| | | | | | Resistance reading not close to zero | Repair Circuit 378LRI. |
| | | | | 5. With the modulator valve connector removed, measure the resistance across Pins 2 and 8 on the modulator connector. | Resistance reading 6.5±0.5 ohms | Repeat Tests 1 through 5. The problem may be intermittent. If the wiring is OK, suspect the ECU is at fault. |
| | | | | | Resistance reading not 6.5±0.5 ohms | Replace the modulator valve. |

**Table 14, J1587 Fault 136-044 Left Rear Inlet Solenoid Valve**

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| J1587 Fault 136-045 Right Rear Inlet Solenoid Valve | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 045 | 03<br>05<br>06 | Shorted to power (inlet valve)<br>Open circuit (inlet valve)<br>Shorted to ground (inlet valve)<br>NOTE: Check for an open circuit in the wiring between the ECU and the modulator valve. Check the ground circuit to the modulator valve. | 1. Measure the resistance across Pins 6 and 2 of the gray X1 ECU connector (Circuits 378RRI and GRDE). | Resistance reading 6.5±0.5 ohms | Check for intermittent wiring connections. If the wiring is OK, suspect the ECU is at fault. |
| | | | | | Resistance reading not 6.5±0.5 ohms | Go to Test 2. |
| | | | | 2. Check the ground circuit by measuring the resistance between Pin 2 of the gray X1 ECU connector and a good chassis ground. | Resistance reading close to zero | Go to Test 3. |
| | | | | | Resistance reading not close to zero | Check and repair the ground circuit. |
| | | | | 3. With the modulator valve connector removed, measure the resistance between Pin 8 on the modulator connector and a good chassis ground. | Resistance reading close to zero | Go to Test 4. |
| | | | | | Resistance reading not close to zero | Check the modulator ground circuit, repair as necessary. |
| | | | | 4. Measure the resistance in Circuit 378RRI between modulator connector Pin 11 and connector Pin 6 on the gray X1 ECU connector. | Resistance reading close to zero | Go to Test 5. |
| | | | | | Resistance reading not close to zero | Repair Circuit 378RRI. |
| | | | | 5. With the modulator valve connector removed, measure the resistance across Pins 11 and 8 on the modulator connector. | Resistance reading 6.5±0.5 ohms | Repeat Tests 1 through 5. The problem may be intermittent. If the wiring is OK, suspect the ECU is at fault. |
| | | | | | Resistance reading not 6.5±0.5 ohms | Replace the modulator valve. |

**Table 15, J1587 Fault 136-045 Right Rear Inlet Solenoid Valve**

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## Troubleshooting

| J1587 Fault 136-048 Left Front Outlet Solenoid Valve | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 048 | 03<br>05<br>06 | Shorted to power (outlet valve)<br>Open circuit (outlet valve)<br>Shorted to ground (outlet valve)<br>NOTE: Check for an open circuit in the wiring between the ECU and the modulator valve. Check the ground circuit to the modulator valve. | 1. Measure the resistance across Pins 10 and 2 of the gray X1 ECU connector (Circuits 378LFO and GRDE). | Resistance reading 3.5±0.5 ohms | Check for intermittent wiring connections. If the wiring is OK, suspect the ECU is at fault. |
| | | | | | Resistance reading not 3.5±0.5 ohms | Go to Test 2. |
| | | | | 2. Check the ground circuit by measuring the resistance between Pin 2 of the gray X1 ECU connector and a good chassis ground. | Resistance reading close to zero | Go to Test 3. |
| | | | | | Resistance reading not close to zero | Check and repair the ground circuit. |
| | | | | 3. With the modulator valve connector removed, measure the resistance between Pin 8 on the modulator connector and a good chassis ground. | Resistance reading close to zero | Go to Test 4. |
| | | | | | Resistance reading not close to zero | Check the modulator ground circuit, repair as necessary. |
| | | | | 4. Measure the resistance in Circuit 378LFO between modulator connector Pin 13 and connector Pin 10 on the gray X1 ECU connector. | Resistance reading close to zero | Go to Test 5. |
| | | | | | Resistance reading not close to zero | Repair Circuit 378LFO. |
| | | | | 5. With the modulator valve connector removed, measure the resistance across Pins 13 and 8 on the modulator connector. | Resistance reading 3.5±0.5 ohms | Repeat Tests 1 through 5. The problem may be intermittent. If the wiring is OK, suspect the ECU is at fault. |
| | | | | | Resistance reading not 3.5±0.5 ohms | Replace the modulator valve. |

**Table 16, J1587 Fault 136-048 Left Front Outlet Solenoid Valve**

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| J1587 Fault 136-049 Right Front Outlet Solenoid Valve | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 049 | 03<br>05<br>06 | Shorted to power (outlet valve)<br>Open circuit (outlet valve)<br>Shorted to ground (outlet valve)<br>NOTE: Check for an open circuit in the wiring between the ECU and the modulator valve. Check the ground circuit to the modulator valve. | 1. Measure the resistance across Pins 9 and 2 of the gray X1 ECU connector (Circuits 378RFO and GRDE). | Resistance reading 3.5±0.5 ohms | Check for intermittent wiring connections. If the wiring is OK, suspect the ECU is at fault. |
| | | | | | Resistance reading not 3.5±0.5 ohms | Go to Test 2. |
| | | | | 2. Check the ground circuit by measuring the resistance between Pin 2 of the gray X1 ECU connector and a good chassis ground. | Resistance reading close to zero | Go to Test 3. |
| | | | | | Resistance reading not close to zero | Check and repair the ground circuit. |
| | | | | 3. With the modulator valve connector removed, measure the resistance between Pin 8 on the modulator connector and a good chassis ground. | Resistance reading close to zero | Go to Test 4. |
| | | | | | Resistance reading not close to zero | Check the modulator ground circuit, repair as necessary. |
| | | | | 4. Measure the resistance in Circuit 378RFO between modulator connector Pin 5 and connector Pin 9 on the gray X1 ECU connector. | Resistance reading close to zero | Go to Test 5. |
| | | | | | Resistance reading not close to zero | Repair Circuit 378RFO. |
| | | | | 5. With the modulator valve connector removed, measure the resistance across Pins 5 and 8 on the modulator connector. | Resistance reading 3.5±0.5 ohms | Repeat Tests 1 through 5. The problem may be intermittent. If the wiring is OK, suspect the ECU is at fault. |
| | | | | | Resistance reading not 3.5±0.5 ohms | Replace the modulator valve. |

**Table 17, J1587 Fault 136-049 Right Front Outlet Solenoid Valve**

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## Troubleshooting

| J1587 Fault 136-050 Left Rear Outlet Solenoid Valve | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 050 | 03<br>05<br>06 | Shorted to power (outlet valve)<br>Open circuit (outlet valve)<br>Shorted to ground (outlet valve)<br>NOTE: Check for an open circuit in the wiring between the ECU and the modulator valve. Check the ground circuit to the modulator valve. | 1. Measure the resistance across Pins 8 and 2 of the gray X1 ECU connector (Circuits 378LRO and GRDE). | Resistance reading 3.5±0.5 ohms | Check for intermittent wiring connections. If the wiring is OK, suspect the ECU is at fault. |
| | | | | | Resistance reading not 3.5±0.5 ohms | Go to Test 2. |
| | | | | 2. Check the ground circuit by measuring the resistance between Pin 2 of the gray X1 ECU connector and a good chassis ground. | Resistance reading close to zero | Go to Test 3. |
| | | | | | Resistance reading not close to zero | Check and repair the ground circuit. |
| | | | | 3. With the modulator valve connector removed, measure the resistance between Pin 8 on the modulator connector and a good chassis ground. | Resistance reading close to zero | Go to Test 4. |
| | | | | | Resistance reading not close to zero | Check the modulator ground circuit, repair as necessary. |
| | | | | 4. Measure the resistance in Circuit 378LRO between modulator connector Pin 1 and connector Pin 8 on the gray X1 ECU connector. | Resistance reading close to zero | Go to Test 5. |
| | | | | | Resistance reading not close to zero | Repair Circuit 378LRO. |
| | | | | 5. With the modulator valve connector removed, measure the resistance across Pins 1 and 8 on the modulator connector. | Resistance reading 3.5±0.5 ohms | Repeat Tests 1 through 5. The problem may be intermittent. If the wiring is OK, suspect the ECU is at fault. |
| | | | | | Resistance reading not 3.5±0.5 ohms | Replace the modulator valve. |

**Table 18, J1587 Fault 136-050 Left Rear Outlet Solenoid Valve**

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| J1587 Fault 136-051 Right Rear Outlet Solenoid Valve | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 051 | 03<br>05<br>06 | Shorted to power (outlet valve)<br>Open circuit (outlet valve)<br>Shorted to ground (outlet valve)<br>NOTE: Check for an open circuit in the wiring between the ECU and the modulator valve. Check the ground circuit to the modulator valve. | 1. Measure the resistance across Pins 7 and 2 of the gray X1 ECU connector (Circuits 378RRO and GRDE). | Resistance reading 3.5±0.5 ohms | Check for intermittent wiring connections. If the wiring is OK, suspect the ECU is at fault. |
| | | | | | Resistance reading not 3.5±0.5 ohms | Go to Test 2. |
| | | | | 2. Check the ground circuit by measuring the resistance between Pin 2 of the gray X1 ECU connector and a good chassis ground. | Resistance reading close to zero | Go to Test 3. |
| | | | | | Resistance reading not close to zero | Check and repair the ground circuit. |
| | | | | 3. With the modulator valve connector removed, measure the resistance between Pin 8 on the modulator connector and a good chassis ground. | Resistance reading close to zero | Go to Test 4. |
| | | | | | Resistance reading not close to zero | Check the modulator ground circuit, repair as necessary. |
| | | | | 4. Measure the resistance in Circuit 378RRO between modulator connector Pin 10 and connector Pin 7 on the gray X1 ECU connector. | Resistance reading close to zero | Go to Test 5. |
| | | | | | Resistance reading not close to zero | Repair Circuit 378RRO. |
| | | | | 5. With the modulator valve connector removed, measure the resistance across Pins 10 and 8 on the modulator connector. | Resistance reading 3.5±0.5 ohms | Repeat Tests 1 through 5. The problem may be intermittent. If the wiring is OK, suspect the ECU is at fault. |
| | | | | | Resistance reading not 3.5±0.5 ohms | Replace the modulator valve. |

**Table 19, J1587 Fault 136-051 Right Rear Outlet Solenoid Valve**

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## Troubleshooting

| J1587 Fault 136-054 Recirculation Pump | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 054 | 03 | Recirculation pump on without being activated by ECU<br><br>NOTE: In this case the ECU is sensing voltage on the pump monitor circuit (Pin 10 of the black X2 connector) when the pump relay was not activated by the ECU (Pin 6 of the black X2 connector). | 1. Remove the black X2 connector from the ECU. With the ignition ON, measure the voltage between Pin 10 and a good chassis ground. | Voltage zero | Check the ECU and verify the fault. |
| | | | | | Voltage not zero | Go to Test 2. |
| | | | | 2. Remove the ABS pump relay (R17) and repeat Test 1. | Voltage zero | Check the ABS pump relay R17; it may be sticking or shorted. |
| | | | | | Voltage not zero | Check for a short to power in Circuit 376B causing the pump to run when it should not be. Repair as necessary. |
| 136 | 054 | 04 | Recirculation pump does not switch on when activated by the ECU<br><br>NOTE: In this case the ECU does not sense voltage on the pump monitor circuit (Pin 10 of the black X2 ECU connector) when the pump relay was activated by the ECU (Pin 6 of the black X2 ECU connector). | 3. Remove the black X2 connector from the ECU. With the ignition ON, link Pins 6 and 3 while measuring the voltage between Pin 10 and a good chassis ground. The pump should run (do not hold for more than 1 minute). | Voltage between 9.5 and 14 volts | Check for intermittent connections in Circuit 376B and check the ABS pump relay for intermittent operation. Repair as necessary. |
| | | | | | Voltage below 9.5 or above 14 volts | Check Circuit 376A and check Relay R17. Repair as necessary. |
| 136 | 054 | 07 | Recirculation pump sticks or is locked<br><br>NOTE: In this case, the ECU senses high current on the pump monitor circuit (Pin 10 of the black X2 ECU connector) indicating the pump motor is locked. | 4. Remove the black X2 connector from the ECU. With the ignition ON, momentarily link Pins 6 and 3. The pump should run (do not hold for more than 1 minute). | Pump runs | Repeat the test to verify. If the fault persists, suspect a problem with the ECU. |
| | | | | | Pump does not run | Replace the recirculation pump. |

**Table 20, J1587 Fault 136-054 Recirculation Pump**

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| J1587 Fault 136-055 ECU | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 055 | 02 | Reference to ground interrupted | 1. With the ignition OFF, measure the voltage between Pin 2 of the gray X1 ECU connector (Circuit GND) and a good chassis ground. | Voltage zero volts | Go to Test 2. |
| | | | | | Voltage not zero volts | Check the ground circuit for a short to positive voltage. |
| | | | | 2. Measure the resistance between Pin 2 of the gray X1 ECU connector and a good chassis ground. | Resistance near zero ohms | Check the ECU ground circuit (GND) for an intermittent or loose connection. Check ground Splice S10. If the problem persists, suspect the ECU is at fault. |
| | | | | | Resistance above zero ohms | Check the ECU ground circuit (GND). Repair as necessary. |

**Table 21, J1587 Fault 136-055 ECU**

| J1587 Fault 136-251 Low Voltage | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 251 | 03 | Voltage too high<br>NOTE: Voltage to the ABS ECU must be between 9.5 and 14 volts to function properly. | 1. Disconnect the black X2 ECU connector. Start the engine and run it at governed speed while measuring the voltage between Pins 3 and 9. | Voltage between 9.5 and 14 volts | Check the electrical system. If the problem persists, suspect the ECU is at fault. |
| | | | | | Voltage below 9.5 or above 14 volts | Check the batteries and charging system for malfunction. Repair as necessary. |
| 136 | 251 | 04 | Low voltage to ABS solenoid valves<br>NOTE: Voltage to the ABS ECU must be between 9.5 and 14 volts to function properly. | 2. Disconnect the black X2 ECU connector. Start the engine and run it at idle while measuring the voltage between Pins 3 and 9 of the black X2 ECU connector. | Voltage between 9.5 and 14 volts | Verify that the batteries were not drained or the charging system was not overloaded when the fault occurred. If the problem persists, suspect the ECU is at fault. |
| | | | | | Voltage below 9.5 or above 14 volts | Check the batteries and charging system for malfunction. Repair as necessary. |

**Table 22, J1587 Fault 136-251 Low Voltage**

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## Troubleshooting

| J1587 Fault 136-253 Internal Tire Parameter | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 253 | 02 | Incorrect internal tire parameter | — | — | Contact Meritor WABCO (1-800-535-5560). |

**Table 23, J1587 Fault 136-253 Internal Tire Parameter**

| J1587 Fault 136-254 ECU Internal Fault | | | | | | |
|---|---|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Problem** | **Test** | **Test Result** | **Action** |
| 136 | 254 | 12 | Internal ECU Fault | — | — | Replace the ECU. |

**Table 24, J1587 Fault 136-254 ECU Internal Fault**

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For a full view of the hydraulic ABS wheel sensor and modulator assembly (ECU green and gray connectors) wiring diagram, see **Fig. 1**.

For partial (detailed) views of the hydraulic ABS wheel sensor and modulator assembly (ECU green and gray connectors) wiring diagram, see **Fig. 2** and **Fig. 3**.

For hydraulic ABS pump and dash wiring (ECU black connector) wiring, see **Fig. 4**.

For partial (detailed) views of hydraulic ABS pump and dash wiring (ECU black connector) wiring, see **Fig. 5**, **Fig. 6**, and **Fig. 7**.

For retarder relay wiring, see **Fig. 8**.

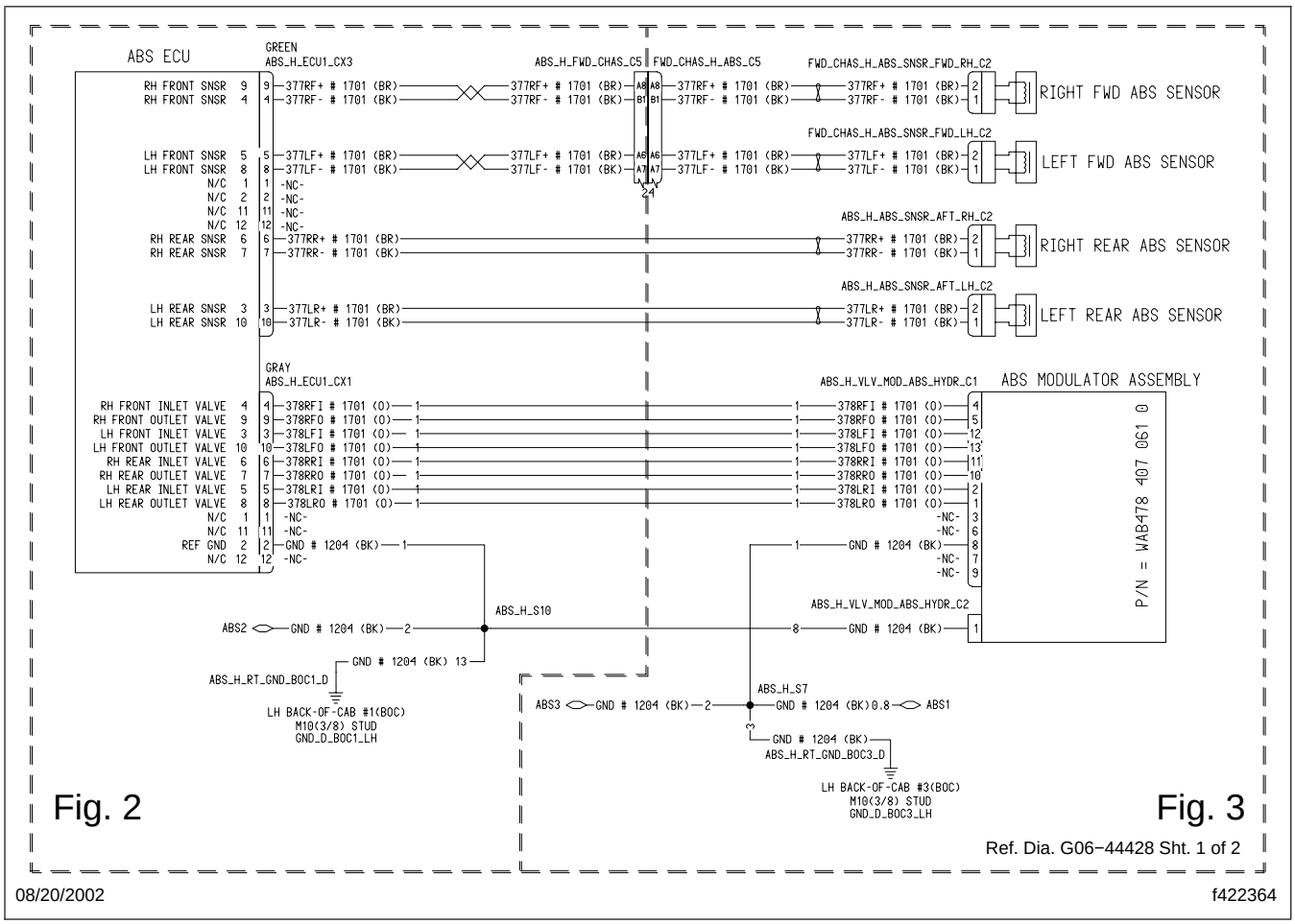


**Fig. 1, Wiring Diagram, ABS Wheel Sensor and Modulator Assembly (full view)**

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| Park Brake (pneumatic) Function | | |
|---|---|---|
| **Input to CHM from Park Brake Pressure Switch** | **Input to BHM from CHM via J1939 Park Brake Status** | **Output from BHM to ICU via J1939 Park Brake Light Status** |
| Closed | Engaged | On |
| Open | Disengaged | Off |

**Table 21, Park Brake (pneumatic) Function**

| Park Brake (pneumatic) Function Fault Conditions* | |
|---|---|
| **Description of Fault** | **Action Taken by BHM** |
| CHM transmits J1939 park brake switch status unavailable or in error to the BHM. | BHM may transmit J1939 message park brake light status unavailable. |

* This fault also occurs when the CHM is unable to determine the switch status. This does not necessarily mean that the park brake pressure switch is faulty.

**Table 22, Park Brake (pneumatic) Function Fault Conditions**

| Parameters | | |
|---|---|---|
| **Parameter Part Number** | **Description** | **Hours** |
| 26-01017-002 | Switched Center Pin Power | 24 |
| 26-01019-003 | Exterior Lighting | 16,667 |
| 26-01019-004 | Exterior Lighting | 16,667 |

| Parameters | | |
|---|---|---|
| **Parameter Part Number** | **Description** | **Hours** |
| 26-01019-005 | Exterior Lighting | 16,667 |

**Table 23, Parameters**

| Wake Circuits Troubleshooting Procedures | | | |
|---|---|---|---|
| **Test No.** | **Test Procedure** | **Test Result** | **Action** |
| 1 | Open the "Wake Function" Datalink Monitor template. See **Fig. 12**.<br>Put the system into a sleep state by:<br>• Closing the doors.<br>• Turning off the headlight switch.<br>• Turning off the hazard lights switch.<br>• Turning off the ignition switch.<br>• Removing your foot from the brake pedal.<br>Are any of the BHM and CHM initiating inputs still in an active state on the template (yellow)? | Yes | Check the inputs that are remaining active.<br>For example, if the driver door switch remains active (open) when the door is closed, check the door switch itself and the circuit wiring.<br>Repair as necessary. |
| | | No | **Go to test no. 2.** |

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## Troubleshooting

| Wake Circuits Troubleshooting Procedures | | | |
|---|---|---|---|
| **Test No.** | **Test Procedure** | **Test Result** | **Action** |
| 2 | If everything works correctly after meeting the conditions in test no. 1, the system should go to sleep within 60 seconds. The template indicates this when all of the annunciators show an exclamation mark (!)*.<br><br>NOTE: If the vehicle has one of the following reference parameters, the system will remain awake for 24 hours or longer: 26-01017-002, 26-01019-003, 26-01019-004, or 26-01019-005.<br><br>NOTE: This troubleshooting step describes a special circumstance that is not typical of the majority of vehicles.<br><br>If the system is not working correctly, one or more of the Wake Circuits in the right column of the "Wake Function" Datalink Monitor template remains active (yellow) after 60 seconds.<br><br>Within 60 seconds of meeting the conditions in test no. 1, do all of the annunciators on the template show an exclamation mark (!)*? | Yes | **Go to test no. 6.** |
| | | No | **Go to test no. 3.** |
| 3 | In the second column of the template under "Other Module Wake Circuits–Status" is the status of all the annunciators "LOW-Wake" (yellow)?<br><br>NOTE: Disregard the annunciators for modules not on the vehicle; these will show an exclamation mark (!)*. | Yes | Check the wake circuits between the BHM and the following modules for a short to ground:<br>• CHM<br>• EXM<br>• SEM<br><br>Repair as necessary. |
| | | No | **Go to test no. 4.** |
| 4 | If the B5.D BHM to ICU annunciator status is "ON" in the second column of the template under "BHM Wake Circuits–Status," continue with this test. If not, **go to test no. 5.**<br><br>Disconnect BHM connector B5.<br><br>Test for voltage on pin B5.D (harness side).<br><br>Is voltage present? | Yes | The wake circuit between the BHM and ICU is shorted to power.<br><br>Repair as necessary. |
| | | No | **Go to test no. 5.** |
| 5 | In the second column of the template under "BHM Wake Circuits–Status," check the status of the annunciator labeled<br><br>**B1.B BHM to CHM**<br><br>**B4.H BHM to EXM**<br><br>**B6.A2 BHM to SEM**.<br><br>Is the annunciator status "LOW-Wake" (yellow)? | Yes | If this is the only active annunciator, replace the BHM. |
| | | No | Check the multiplexed modules for ignition circuits that are shorted to power (not powering down when the ignition is off). If no problem is found, the system may not be going to sleep because the BHM is not sending the J1939 go-to-sleep message. Try a test BHM to confirm. |

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| Wake Circuits Troubleshooting Procedures | | | |
|---|---|---|---|
| **Test No.** | **Test Procedure** | **Test Result** | **Action** |
| 6 | Starting with the system in the sleep state, activate one of the inputs that initiates a wake, such as opening the driver's door.<br>If the system is functioning properly, all of the annunciators on the template in the second column should be active (yellow) for ECUs equipped on the vehicle as long as the input remains active. For example, the door is open.<br>NOTE: If the vehicle is not equipped with an SEM or EXM, it is normal for the status of these annunciators to be "!"*.<br>Are all of the appropriate second column annunciators active? | Yes | **Go to test no. 8.** |
| | | No | **Go to test no. 7.** |
| 7 | Which annunciator is not active? | B5.D BHM to ICU | Replace the BHM. |
| | | B1.B BHM to CHM<br>B4.H BHM to EXM<br>B6.A2 BHM to SEM | Replace the BHM. |
| | | Any one of the "Other Module Wake Circuits–Status" for ECUs that are on the vehicle. | Check for an open in the wake circuit between the BHM and the module that is not showing active.<br>If OK, check power, ground, and the J1939 datalink to the ECU that is not responding. |
| 8 | Does the ICU wake up when the door is opened? This is indicated by the odometer being displayed. | Yes | No problem found. |
| | | No | Check the wake circuit between the BHM and ICU for open.<br>If OK, check fuse 20 and VBAT2 power supply to BHM B4.G.<br>If OK, ICU may be faulty.<br>Repair as necessary. |

* The exclamation mark (!) will show on the versions of this template released with ServiceLink version 4.0 and higher. On templates released in ServiceLink versions prior to 4.0, if the annunciator is flashing, the flashing takes precedence over the status that it is displaying.

**Table 24, Wake Circuits Troubleshooting Procedures**

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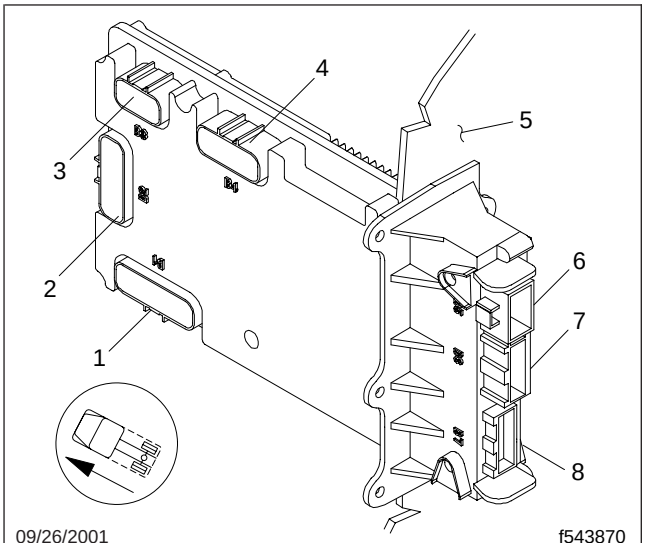
See **Fig. 1** for an illustration of the Bulkhead Module (BHM) Harness Connections.

See **Fig. 2** for maximum allowable current load for the full BHM output pins (part numbers A06-40959-000 and A06-40959-002).

See **Fig. 3** for an illustration of the BHM with pinout assignments and harness connections.




1. B1, Forward Chassis Harness
2. B2, Engine Harness
3. B3, Frontwall Harness
4. B4, Frontwall Harness
5. Frontwall
6. B5, Dash Harness
7. B6, Dash Harness
8. B7, Dash Harness

**Fig. 1, Bulkhead Module Harness Connections**

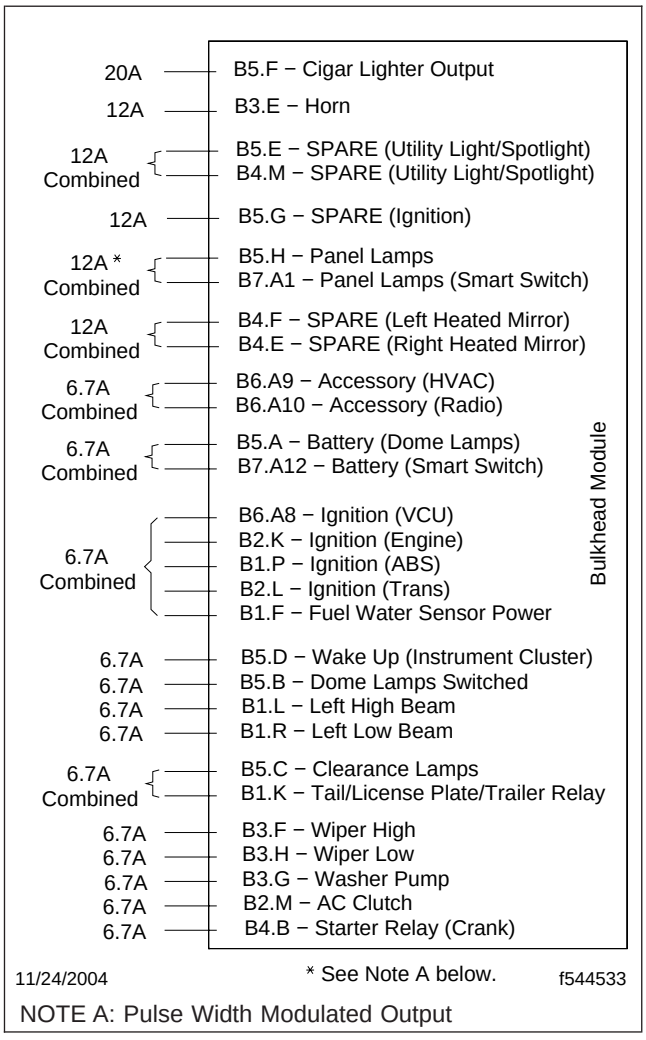



**Fig. 2, Maximum Allowable Current Load for the Full-Feature Bulkhead Module Output Pins (part numbers A06-40959-000 and A06-40959-002)**

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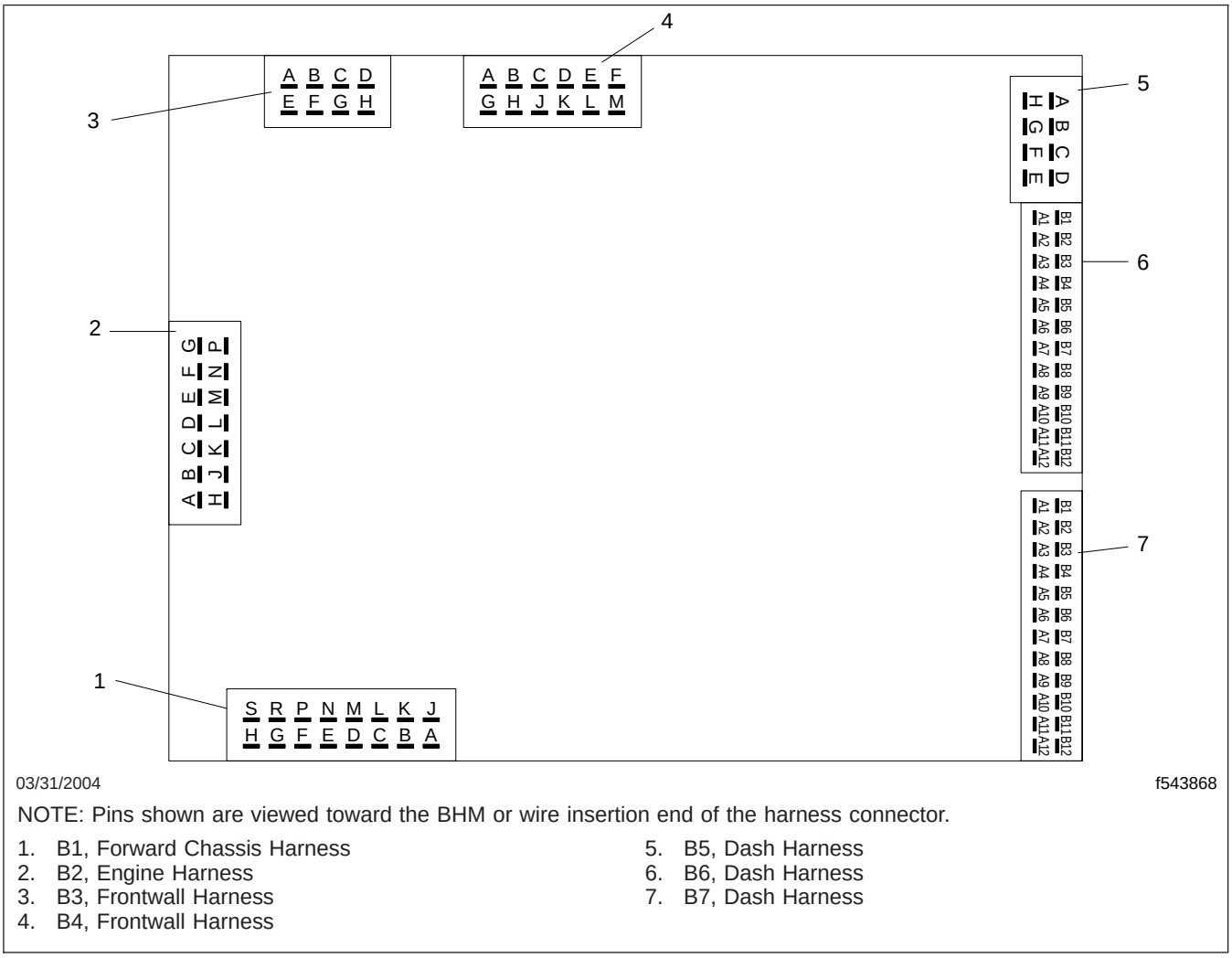
## Specifications




NOTE: Pins shown are viewed toward the BHM or wire insertion end of the harness connector.

1. B1, Forward Chassis Harness
2. B2, Engine Harness
3. B3, Frontwall Harness
4. B4, Frontwall Harness
5. B5, Dash Harness
6. B6, Dash Harness
7. B7, Dash Harness

**Fig. 3, Bulkhead Module With Pinout Assignments and Harness Connections**

| Connector B1 Forward Chassis Harness Pinouts | | |
|---|---|---|
| **Connector Pin** | **Signal Name** | **Signal Type** |
| B1-A | — | — |
| B1-B | Module Wake-Up Signal | Digital Input/ Output |
| B1-C | Spare Digital Input 4 | Digital Input |
| B1-D | — | — |
| B1-E | Ground | Power Ground |
| B1-F | Fuel/Water Sensor Ignition Power | Digital Output |
| B1-G | Ground | Signal Ground |
| B1-H | J1587+ Datalink | Datalink |

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| Connector B1 Forward Chassis Harness Pinouts | | |
|---|---|---|
| **Connector Pin** | **Signal Name** | **Signal Type** |
| B1-J | Battery Power (VBAT5) | Power |
| B1-K | Tail Lamps/License Plate Lamp/Trailer Tail Relay | Digital Output |
| B1-L | Left High Beam | Digital Output |
| B1-M | Fuel/Water Separator (spare digital input 5) | Digital Input |
| B1-N | Battery Power (VBAT3) | Power |
| B1-P | ABS Ignition Power | Digital Output |
| B1-R | Left Low Beam | Digital Output |
| B1-S | J1587– Datalink | Datalink |

**Table 1, Connector B1 Forward Chassis Harness Pinouts**

| Connector B2 Engine Harness Pinouts | | |
|---|---|---|
| **Connector Pin** | **Signal Name** | **Signal Type** |
| B2-A | J1587+ Datalink | Datalink |
| B2-B | J1939+ Datalink | Datalink |
| B2-C | J1587+ Datalink | Datalink |
| B2-D | J1587– Datalink | Datalink |
| B2-E | — | — |
| B2-F | — | — |
| B2-G | Backup Switch (spare digital input 3) | Digital Input |
| B2-H | J1587– Datalink | Datalink |
| B2-J | J1939– Datalink | Datalink |
| B2-K | Engine ECU Ignition Power | Digital Output |
| B2-L | Transmission ECU Ignition Power | Digital Output |
| B2-M | A/C Clutch | Digital Output |
| B2-N | — | — |
| B2-P | Alternator Charging | Digital Input |

**Table 2, Connector B2 Engine Harness Pinouts**

| Connector B3 Frontwall Harness Pinouts | | |
|---|---|---|
| **Connector Pin** | **Signal Name** | **Signal Type** |
| B3-A | J1939– Datalink | Datalink |
| B3-B | J1939+ Datalink | Datalink |
| B3-C | Wiper Parked Position | Digital Input |
| B3-D | Main Battery Power (VBAT1) | Power |
| B3-E | Horn | Digital Output |
| B3-F | Wiper Motor High Speed | Digital Output |

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| Connector B3 Frontwall Harness Pinouts | | |
|---|---|---|
| **Connector Pin** | **Signal Name** | **Signal Type** |
| B3-G | Washer Pump | Digital Output |
| B3-H | Wiper Motor Low Speed | Digital Output |

**Table 3, Connector B3 Frontwall Harness Pinouts**

| Connector B4 Frontwall Harness Pinouts | | |
|---|---|---|
| **Connector Pin** | **Signal Name** | **Signal Type** |
| B4-A | Air Filter Restriction/Spare #9 | Digital Input |
| B4-B | Starter Relay | Digital Output |
| B4-C | Ground | Ground |
| B4-D | Spare Digital Input 2 | Digital Input |
| B4-E | Right Heated Mirror (spare digital output) | Digital Output |
| B4-F | Left Heated Mirror (spare digital output) | Digital Output |
| B4-G | Main Battery Power (VBAT2) | Power |
| B4-H | Module Wake-Up Signal | Digital Input/Output |
| B4-J | — | — |
| B4-K | Main Battery Power (VBAT4) | Power |
| B4-L | Washer Fluid Level (spare digital input 8) | Digital Input |
| B4-M | Utility Light/Spotlight (spare digital output) | Digital Output |

**Table 4, Connector B4 Frontwall Harness Pinouts**

| Connector B5 Dash Harness Pinouts | | |
|---|---|---|
| **Connector Pin** | **Signal Name** | **Signal Type** |
| B5-A | Dome Lamps Battery | Digital Output |
| B5-B | Dome Lamps Switched | Digital Output |
| B5-C | Clearance Lamps (cab) | Digital Output |
| B5-D | Instrument Cluster Wake-Up | Digital Output |
| B5-E | Utility Light/Spotlight (spare digital output) | Digital Output |
| B5-F | Cigar Lighter | Digital Output |
| B5-G | Ignition Power, Other (spare digital output) | Digital Output |
| B5-H | Panel Lamps | Digital Output |

**Table 5, Connector B5 Dash Harness Pinouts**

| Connector B6 Dash Harness Pinouts | | |
|---|---|---|
| **Connector Pin** | **Signal Name** | **Signal Type** |
| B6-A1 | Ignition Switch Accessory Position | Digital Input |
| B6-A2 | Module Wake-Up Signal | Digital Input |

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| Connector B6 Dash Harness Pinouts | | |
|---|---|---|
| **Connector Pin** | **Signal Name** | **Signal Type** |
| B6-A3 | Ignition Switch On | Digital Input |
| B6-A4 | — | — |
| B6-A5 | Ignition Switch Start | Digital Input |
| B6-A6 | Passenger Door Open (spare digital input 10) | Digital Input |
| B6-A7 | Driver Door Open | Digital Input |
| B6-A8 | VCU Ignition Power | Digital Output |
| B6-A9 | HVAC Power | Digital Output |
| B6-A10 | Radio Power | Digital Output |
| B6-A11 | J1587– Datalink | Datalink |
| B6-A12 | J1587+ Datalink | Datalink |
| B6-B1 | Horn Switch | Digital Input |
| B6-B2 | Top of Clutch Switch (spare digital input 7) | Digital Input |
| B6-B3 | Bottom of Clutch Switch (spare digital input 6) | Digital Input |
| B6-B4 | — | — |
| B6-B5 | Panel Lamps Increase | Digital Input |
| B6-B6 | Panel Lamps Decrease | Digital Input |
| B6-B7 | A/C Clutch Request | Digital Input |
| B6-B8 | Hazard Switch | Digital Input |
| B6-B9 | Headlamp Switch PARK Position | Digital Input |
| B6-B10 | Headlamp Switch On Position | Digital Input |
| B6-B11 | Headlamp Switch On 2 Position | Digital Input |
| B6-B12 | — | — |

**Table 6, Connector B6 Dash Harness Pinouts**

| Connector B7 Dash Harness Pinouts | | |
|---|---|---|
| **Connector Pin** | **Signal Name** | **Signal Type** |
| B7-A1 | Panel Lamps (smart switch) | Digital Output |
| B7-A2 | Smart Switch 3 ID 1 | Analog Input |
| B7-A3 | Smart Switch 3 ID 2 | Analog Input |
| B7-A4 | Smart Switch 3 Input | Analog Input |
| B7-A5 | Smart Switch 3 Indicator | Digital Output |
| B7-A6 | Smart Switch 4 ID 1 | Analog Input |
| B7-A7 | Smart Switch 4 ID 2 | Analog Input |
| B7-A8 | Smart Switch 4 Input | Analog Input |
| B7-A9 | Smart Switch 4 Indicator | Digital Output |
| B7-A10 | Smart Switch 5 ID 1 | Analog Input |

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## Specifications

| Connector B7 Dash Harness Pinouts | | |
|---|---|---|
| **Connector Pin** | **Signal Name** | **Signal Type** |
| B7-A11 | Smart Switch 5 ID 2 | Analog Input |
| B7-A12 | Smart Switch Battery Power | Digital Output |
| B7-B1 | Smart Switch 1 ID 1 | Analog Input |
| B7-B2 | Smart Switch 1 ID 2 | Analog Input |
| B7-B3 | Smart Switch 1 Input | Analog Input |
| B7-B4 | Smart Switch 1 Indicator | Digital Output |
| B7-B5 | Smart Switch 2 ID 1 | Analog Input |
| B7-B6 | Smart Switch 2 ID 2 | Analog Input |
| B7-B7 | Smart Switch 2 Input | Analog Input |
| B7-B8 | Smart Switch 2 Indicator | Digital Output |
| B7-B9 | Ground | Signal Ground |
| B7-B10 | Smart Switch 5 Indicator | Digital Output |
| B7-B11 | Smart Switch 5 Input | Analog Input |
| B7-B12 | — | — |

**Table 7, Connector B7 Dash Harness Pinouts**

| Power Supply Fuses and Associated Outputs for the Bulkhead Module | | | | |
|---|---|---|---|---|
| **BHM Power Input** | **BHM Power Input Pin** | **Fuse Supplying BHM Power Input** | **BHM Outputs Supplied** | **BHM Output Pin** |
| **Power In** | | | **Power Out** | |
| VBAT1 | B3.D | Fuse 22 (30A) | Battery (dome lamps) | B5.A |
| | | | Battery (smart switches) | B7.A12 |
| | | | Ignition (VCU) | B6.A8 |
| | | | Ignition (engine) | B2.K |
| | | | Ignition (ABS) | B1.P |
| | | | Ignition (trans) | B2.L |
| | | | Fuel Water Sensor Power | B1.F |
| | | | Dome Lamps Switched | B5.B |
| | | | Left Low Beam | B1.R |
| | | | A/C Clutch | B2.M |
| | | | Smart Switch 1 Indicator | B7.B4 |
| | | | Smart Switch 2 Indicator | B7.B8 |
| | | | Smart Switch 3 Indicator | B7.A5 |
| | | | Smart Switch 4 Indicator | B7.A9 |
| | | | Smart Switch 5 Indicator | B7.B10 |
| | | | Battery (smart switch) | B7.A12 |

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## Specifications

| Power Supply Fuses and Associated Outputs for the Bulkhead Module | | | | |
|---|---|---|---|---|
| **BHM Power Input** | **BHM Power Input Pin** | **Fuse Supplying BHM Power Input** | **BHM Outputs Supplied** | **BHM Output Pin** |
| **Power In** | | | **Power Out** | |
| VBAT2 | B4.G | Fuse 20 (30A) | Accessory (HVAC) | B6.A9 |
| | | | Accessory (radio) | B6.A10 |
| | | | Wake Up (instrument cluster) | B5.D |
| | | | Left High Beam | B1.L |
| | | | Wiper High | B3.F |
| | | | Horn | B3.E |
| VBAT3 | B1.N | Fuse 18 (30A) | Wiper Low | B3.H |
| | | | Spare 8.0A HSD (ignition) | B5.G |
| | | | Panel Lamps | B5.H |
| | | | Panel Lamps (smart switch) | B7.A1 |
| VBAT4 | B4.K | Fuse 15 (30A) | Clearance Lamps | B5.C |
| | | | Tail Lamps/License Plate Lamp/Trailer Tail Relay | B1.K* |
| | | | Washer Pump | B3.G |
| | | | 12V Output (cigar lighter) | B5.F |
| VBAT5 | B1.J | Fuse 7 (30A) | Spare 8.5A (utility light/spotlight) | B5.E / B4.M |
| | | | Left Heated Mirror | B4.F |
| | | | Right Heated Mirror | B4.E |

* This output supplies power to the Chassis Module pass-through for the tail lamps, license plate lamp, and trailer tail lamp relay.

**Table 8, Power Supply Fuses and Associated Outputs for the Bulkhead Module**

NOTE: Currents listed are the maximum allowable combined current load for each output pin or group of pins. When maximum allowable current load is exceeded, the BHM software will shut off the output pin or group of pins.

In Test Mode, the outputs will deliver more current load than the maximum allowable current values shown. When testing, do not exceed the maximum combined values for more than a few minutes or the life of the output driver inside the BHM may be shortened.

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# Bulkhead Module Fault Code Information

## General Information

Subject 410 contains information on all proprietary Bulkhead Module (BHM) fault codes for J1587 and J1939 datalink protocols, how to view these codes, and what the codes mean. Each fault code contains three distinct pieces of information.

J1587 fault codes consist of the following elements in the order listed:

- Module Identifier (MID) – Identifies which electronic control unit (ECU) the fault is coming from. The J1587 MID identifying all Bulkhead Module information faults is 164.
- Subsystem Identifier (SID) – Indicates what function on the ECU has failed. All J1587 SIDs for the BHM are listed in **Table 1**.
- Failure Mode Indicator (FMI) – Indicates in what way the function failed.

J1939 fault codes consist of the following elements in the order listed:

- Source Address (SA) – Identifies which ECU the fault is coming from. The J1939 SA identifying all Bulkhead Module faults is 33.
- Suspect Parameter Number (SPN) – Indicates what function on the ECU has failed. All J1939 SPNs for the BHM are listed in **Table 2**.
- Failure Mode Indicator (FMI) – Indicates in what way the function failed.

See **Table 3** for a list of all failure mode identifiers for both datalink protocols.

References such as BHM B1.A indicate that the fault is sensed to be coming from the Bulkhead Module, connector B1, pin A. Similarly, CHM indicates the Chassis Module on a vehicle.

J1587 fault codes are shown under J1708 in ServiceLink. J1587 and J1708 are essentially the same datalink protocol.

Because the SAE J1939 subcommittee approves new SPNs for use in J1939 messaging on a continual basis, J1939 SPNs used for diagnostic messages could change when the Bulkhead Module part changes. These changes could impact any diagnostic message with an SPN value of 6915 or higher.

**J1587 SIDs for Bulkhead Module (BHM) MID 164**

| SID | Description | Possible FMI |
|---|---|---|
| 000 | Backlighting Dimmer Switch Fault | 7 |
| 001 | Clutch Switch Fault | 7 |
| 002 | Reserved for Future Use | — |
| 003 | Headlamp Switch Disagreement–Both park and on inputs are closed | 7 |
| 004 | Multifunction Turn Signal Switch High Beam Input Fault | 2 |
| 005 | Ignition Switch Fault | 7 |
| 006 | Marker Interrupt Switch Fault | 7 |
| 007 | Multifunction Turn Signal Switch Disagreement–Both wiper high and wiper low inputs are on. | 2 |
| 008 | Multifunction Turn Signal Switch Disagreement–Wiper on/off is off and wiper high or low input is on | 2 |
| 009 | Wiper Park Input Fault | 7 |
| 010 | ICU3-M2 Hazard Switch CAN Feedback Error | 2 |
| 011 | Multifunction Turn Signal Switch Left Turn Signal Input Fault | 2 |
| 012 | Multifunction Turn Signal Switch Right Turn Signal Input Fault | 2 |
| 013 | Multifunction Turn Signal Switch Washer Switch Input Fault | 2 |
| 014 | Multifunction Turn Signal Switch Wiper On/Off Input Fault | 2 |

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## Bulkhead Module Fault Code Information

| J1587 SIDs for Bulkhead Module (BHM) MID 164 | | |
|---|---|---|
| **SID** | **Description** | **Possible FMI** |
| 015 | Multifunction Turn Signal Switch Wiper Low Input Fault | 2 |
| 016 | Multifunction Turn Signal Switch Wiper High Input Fault | 2 |
| 017 | Wheel-Based Vehicle Speed CAN Message Error | 2 |
| 018 | Wake-up Hardware Fault–Modules are kept awake | 7 |
| 019 | Unknown Keep Awake Fault–Modules are kept awake. | 7 |
| 020 | Extra Smart Switch | 7 |
| 021 | Duplicate Smart Switch | 7 |
| 022 | Missing Smart Switch | 7 |
| 023 | Fifth Wheel Solenoid Unexpected Pressure Feedback | 7 |
| 024 | Fifth Wheel Solenoid No Pressure Feedback | 7 |
| 025 | End of Frame Air Unexpected Pressure Feedback | 7 |
| 026 | End of Frame Air No Pressure Feedback | 7 |
| 027 | Axle Lift Unexpected Pressure Feedback | 7 |
| 028 | Axle Lift No Pressure Feedback | 7 |
| 029 | Suspension Dump Unexpected Pressure Feedback | 7 |
| 030 | Suspension Dump No Pressure Feedback | 7 |
| 031 | Suspension Proportioning Unexpected Pressure Feedback | 7 |
| 032 | Suspension Proportioning No Pressure Feedback | 7 |
| 033 | Cigar Lighter Output Fault | 7 |
| 034 | BHM/ICU3-M2 Ignition Mismatch | 7 |
| 035 | BHM/ICU3-M2 Hazard Switch Mismatch | 2 |
| 036 | BHM/ICU3-M2 Wiper Park Mismatch | 2 |
| 037 | Missing Transmission CAN Message | 9 |
| 038 | Missing Chassis Module CAN Message | 9 |
| 039 | Remote Bucket Switch Stuck Fault | 7 |
| 040 | Axle Lift 2 Unexpected Pressure Feedback | 7 |
| 041 | Axle Lift 2 No Pressure Feedback | 7 |
| 042 | PTO 1 Unexpected Pressure Feedback | 7 |
| 043 | PTO 1 No Pressure Feedback | 7 |
| 044 | PTO 2 Unexpected Pressure Feedback | 7 |
| 045 | PTO 2 No Pressure Feedback | 7 |
| 046 | CHM No PWM DRLs Fault | 8 |
| 047–049 | Reserved for Future Use | — |
| 050 | BHM B1.A—Fuel Level Input Fault (Not Used) | 3, 4 |
| 051 | BHM B1.F, B1.P, B2.K, B2.L, B6.A8—Ignition Power Output Fault | 5, 6 |
| 052 | BHM B1.J—Main BHM Power VBAT5 Input Fault | 3, 4 |

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## Bulkhead Module Fault Code Information

| J1587 SIDs for Bulkhead Module (BHM) MID 164 | | |
|---|---|---|
| **SID** | **Description** | **Possible FMI** |
| 053 | BHM B1.K, B5.C—Tail/Clearance Lamp Output Fault | 5, 6 |
| 054 | BHM B1.L—Left High Beam Output Fault | 5, 6 |
| 055 | BHM B1.N—Main BHM Power VBAT3 Input Fault | 3, 4 |
| 056 | BHM B1.R—Left Low Beam Output Fault | 5, 6 |
| 057 | BHM B2.M—A/C Clutch Output Fault | 5, 6 |
| 058 | BHM B3.D—Main BHM Power VBAT1 Input Fault | 3, 4 |
| 059 | BHM B3.E—Horn Output Fault | 3, 4, 5, 6 |
| 060 | BHM B3.F—Wiper High Speed Output Fault | 5, 6 |
| 061 | BHM B3.G—Washer Pump Output Fault | 5, 6 |
| 062 | BHM B3.H—Wiper Low Speed Output Fault | 5, 6 |
| 063 | BHM B4.B—Starter Relay Output Fault | 5, 6 |
| 064 | BHM B4.E, B4.F—Spare Output Fault | 3, 4, 5, 6 |
| 065 | BHM B4.G—Main BHM Power VBAT2 Input Fault | 3, 4 |
| 066 | BHM B4.K—Main BHM Power VBAT4 Input Fault | 3, 4 |
| 067 | BHM B4.M, B5.E—Spare Output Fault | 3, 4, 5, 6 |
| 068 | BHM B5.A, B7.A12—Dome Lamp Battery Power Output Fault | 5, 6 |
| 069 | BHM B6.A9, B6.A10—HVAC/Radio Ignition Power Output Fault | 5, 6 |
| 070 | BHM B5.B—Dome Lamp Switched Power Output Fault | 5, 6 |
| 071 | BHM B5.D—ICU Wake Output Fault | 5, 6 |
| 072 | BHM B5.F—Cigar Light Output Fault | 3, 4, 5, 6 |
| 073 | BHM B5.G—Spare Ignition Power Output Fault | 3, 4, 5, 6 |
| 074 | BHM B5.H, B7.A1—Panel Lamps Output Fault | 3, 4, 5, 6 |
| 075 | CHM C1.A, C1.H, C1.J—Backup Lamps/Alarm Output Fault | 5, 6 |
| 076 | CHM C1.G, C2.H, C3.N—Left Turn Signal Output Fault | 5, 6 |
| 077 | CHM C1.L—Right Stop Lamp Output Fault | 5, 6 |
| 078 | CHM C1.N—Left Stop Lamp Output Fault | 5, 6 |
| 079 | CHM C1.P, C2.E, C3.R—Right Turn Signal Output Fault | 5, 6 |
| 080 | CHM C2.A—Trailer Power Relay Output Fault | 3, 4 |
| 081 | CHM C2.F, C4.C, C4.D, C4.L, C4.M—Park/Marker Lamp Output | 3, 4, 5, 6 |
| 082 | CHM C3.A—Spare Output Fault | 3, 4, 5, 6 |
| 083 | CHM C3.C, C3.D—Spare Output Fault | 5, 6 |
| 084 | CHM C3.E—Low Air Pressure Input Fault | 3, 4 |
| 085 | CHM C3.F—Park Brake Input Fault | 3, 4 |
| 086 | CHM C3.J—Main CHM Power VBAT2 Input Fault | 3, 4 |
| 087 | CHM C3.K—Right DRL Output Fault | 5, 6 |
| 088 | CHM C3.L—Right Low Beam Output | 5, 6 |

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## Bulkhead Module Fault Code Information

| J1587 SIDs for Bulkhead Module (BHM) MID 164 | | |
|---|---|---|
| **SID** | **Description** | **Possible FMI** |
| 089 | CHM C4.F—Left DRL Output Fault | 5, 6 |
| 090 | CHM C4.J—Main CHM Power VBAT3 Input Fault | 3, 4 |
| 091 | CHM C4.K—Right High Beam Output | 5, 6 |
| 092 | CHM C4.P—Main CHM Power VBAT1 Input Fault | 3, 4 |
| 093 | CHM C5.A—Solenoid #0 Pressure Feedback Fault | 3, 4 |
| 094 | CHM C5.B—Solenoid #1 Pressure Feedback Fault | 3, 4 |
| 095 | CHM C5.F—Solenoid #2 Pressure Feedback Fault | 3, 4 |
| 096 | CHM C5.G—Solenoid #3 Pressure Feedback Fault | 3, 4 |
| 097 | CHM C5.H—Solenoid #0 Output Fault | 3, 4 |
| 098 | CHM C5.J—Solenoid #1 Output Fault | 3, 4 |
| 099 | CHM C5.L—Solenoid #2 Output Fault | 3, 4 |
| 100 | CHM C5.M—Solenoid #3 Output Fault | 3, 4 |
| 101 | EXM Fault (Fault in one of the EXM Outputs) | 3, 4, 5, 6 |

**Table 1, J1587 SIDs for Bulkhead Module (BHM) MID 164**

| J1939 SPNs for Bulkhead Module (BHM) SA 33 | | |
|---|---|---|
| **SPN** | **Description** | **Possible FMI** |
| 70 | Parking Brake Switch | 2 |
| 80 | Washer Fluid Level | 2 |
| 84 | Wheel-based Vehicle Speed | 19 |
| 96 | Fuel Level | 19 |
| 97 | Water In Fuel Indicator | 19 |
| 163 | Transmission Current Range | 12, 19 |
| 177 | Transmission Oil Temperature Sensor | 3, 4 |
| 523 | Transmission Current Gear | 12, 19 |
| 524 | Transmission Selected Gear | 12, 19 |
| 597 | ABS Service Brake Switch | 2 |
| 598 | Clutch Switch | 7 |
| 879 | Front Left Turn Signals Output Fault | 5, 6 |
| 880 | Trailer Stop Lamp Relay Output Fault | 4 |
| 881 | Front Right Turn Signals Output Fault | 5, 6 |
| 882 | Park/Marker Lights Output Fault | 4, 5, 6 |
| 973 | Engine Retarder Selection | 19 |
| 1487 | Backlighting Dimmer Switch Fault | 7 |
| 1550 | A/C Clutch Output Fault | 5, 6 |
| 2003 | Missing Transmission CAN Message | 9 |

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## Bulkhead Module Fault Code Information

| J1939 SPNs for Bulkhead Module (BHM) SA 33 | | |
|---|---|---|
| **SPN** | **Description** | **Possible FMI** |
| 2071 | Missing Chassis Module CAN Message | 9 |
| 6890 | CHM No PWM DRLs Fault | 8 |
| 6897 | Fuel Water Separator Heater Output Fault | 6 |
| 6898 | Brake Air Dryer Output Fault | 6 |
| 6906 | PTO 2 No Pressure Feedback | 7 |
| 6907 | PTO 2 Unexpected Pressure Feedback | 7 |
| 6908 | PTO 1 No Pressure Feedback | 7 |
| 6909 | PTO 1 Unexpected Pressure Feedback | 7 |
| 6910 | Axle Lift 2 No Pressure Feedback | 7 |
| 6911 | Axle Lift 2 Unexpected Pressure Feedback | 7 |
| 6912 | Remote Bucket Switch Stuck Fault | 7 |
| 6915 | Lamp and Gauge Ignition Output Fault | 4, 5, 6 |
| 6916 | BHM/ICU3-M2 Wiper Park CAN Message Mismatch | 2 |
| 6917 | BHM/ICU3-M2 Hazard Switch CAN Message Mismatch | 2 |
| 6918 | Missing Smart Switch | 7 |
| 6919 | Duplicate Smart Switch | 7 |
| 6920 | Extra Smart Switch | 7 |
| 6921 | Unknown Keep Awake Fault–Modules are kept awake | 7 |
| 6922 | Wake-up Hardware Fault–Modules are kept awake | 7 |
| 6923 | Wiper Parked Input Fault | 7 |
| 6924 | Multifunction Turn Signal Switch Disagreement–Wiper on/off input is off and wiper high or low input is on | 2 |
| 6925 | Multifunction Turn Signal Switch Disagreement–Both wiper high and wiper low inputs are on | 2 |
| 6926 | Marker Interrupt Switch Fault | 7 |
| 6927 | Utility Lamp Output Fault | 3, 4, 5, 6 |
| 6928 | Suspension Proportioning No Pressure Feedback | 7 |
| 6929 | Suspension Proportioning Unexpected Pressure Feedback | 7 |
| 6930 | Suspension Proportioning Solenoid Output Fault | 3, 4, 5, 6 |
| 6931 | Suspension Dump No Pressure Feedback | 7 |
| 6932 | Suspension Dump Unexpected Pressure Feedback | 7 |
| 6933 | Suspension Dump Solenoid Output Fault | 3, 4, 5, 6 |
| 6934 | Spotlights Output Fault | 3, 4, 5, 6 |
| 6935 | Snow Plow Relay Output Fault | 3, 4, 5, 6 |
| 6936 | Rear 2 Differential Lock Pressure Feedback Fault | 7 |
| 6937 | Rear 2 Differential Lock Solenoid Output Fault | 3, 4, 5, 6 |
| 6938 | Rear 1 Differential Lock Pressure Feedback Fault | 7 |

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## Bulkhead Module Fault Code Information

| J1939 SPNs for Bulkhead Module (BHM) SA 33 | | |
|---|---|---|
| **SPN** | **Description** | **Possible FMI** |
| 6939 | Rear 1 Differential Lock Solenoid Output Fault | 3, 4, 5, 6 |
| 6940 | Optional Feature Output Fault | 3, 4, 5, 6 |
| 6941 | Heated Mirrors Output Fault | 3, 4, 5, 6 |
| 6942 | Interaxle Pressure Feedback Fault | 7 |
| 6943 | Interaxle Solenoid Output Fault | 3, 4, 5, 6 |
| 6944 | Fuel Water Separator Heater Output Fault | 4, 5, 6 |
| 6945 | Front Differential Lock Pressure Feedback Fault | 7 |
| 6946 | Front Differential Lock Solenoid Output Fault | 3, 4, 5, 6 |
| 6947 | Fog Lamp Output Fault | 5, 6 |
| 6949 | Fire Pump Pressure Feedback Fault | 7 |
| 6950 | Fire Pump Solenoid Output Fault | 3, 4, 5, 6 |
| 6951 | Fifth Wheel Slide No Pressure Feedback | 7 |
| 6952 | Fifth Wheel Slide Unexpected Pressure Feedback | 7 |
| 6953 | Fifth Wheel Slide Solenoid Output Fault | 3, 4, 5, 6 |
| 6954 | End of Frame Air No Pressure Feedback | 7 |
| 6955 | End of Frame Air Unexpected Pressure Feedback | 7 |
| 6956 | End of Frame Air Solenoid Output Fault | 3, 4, 5, 6 |
| 6957 | Daytime Running Lights (DRL) Output Fault | 5, 6 |
| 6958 | Brake Line Air Dryer Output Fault | 3, 4, 5, 6 |
| 6959 | Axle Shift Pressure Feedback Fault | 7 |
| 6960 | Axle Shift Solenoid Output Fault | 3, 4, 5, 6 |
| 6961 | Axle Lift No Pressure Feedback | 7 |
| 6962 | Axle Lift Unexpected Pressure Feedback | 7 |
| 6963 | Axle Lift Solenoid Output Fault | 3, 4, 5, 6 |
| 6964 | Air Horn Solenoid Output Fault | 5, 6 |
| 6965 | BHM VBAT 5 Input Fault | 3, 4 |
| 6966 | BHM VBAT 4 Input Fault | 3, 4 |
| 6967 | BHM VBAT 3 Input Fault | 3, 4 |
| 6968 | BHM VBAT 2 Input Fault | 3, 4 |
| 6969 | BHM VBAT 1 Input Fault | 3, 4 |
| 6970 | Wiper High Output Fault | 5, 6 |
| 6971 | Wiper Low Output Fault | 5, 6 |
| 6972 | Multifunction Turn Signal Switch Wiper High Input Fault | 2 |
| 6973 | Multifunction Turn Signal Switch Wiper Low Input Fault | 2 |
| 6974 | Multifunction Turn Signal Switch Wiper On/Off Input Fault | 2 |
| 6975 | ICU3-M2 Wiper Park CAN Feedback Error | 2 |

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## Bulkhead Module Fault Code Information

| J1939 SPNs for Bulkhead Module (BHM) SA 33 | | |
|---|---|---|
| **SPN** | **Description** | **Possible FMI** |
| 6976 | Washer Pump Output Fault | 5, 6 |
| 6977 | Multifunction Turn Signal Switch Washer Switch Input Fault | 2 |
| 6978 | Multifunction Turn Signal Switch Right Turn Signal Input Fault | 2 |
| 6979 | Multifunction Turn Signal Switch Left Turn Signal Input Fault | 2 |
| 6980 | Right Stop Lamp Output Fault | 5, 6 |
| 6981 | Left Stop Lamp Output Fault | 5, 6 |
| 6982 | Wake Up Hardware Fault | 5, 6 |
| 6983 | Starter Relay (mag switch) Output Fault | 5, 6 |
| 6984 | Ignition System, Accessory Power Outputs Fault | 5, 6 |
| 6985 | Ignition System, Ignition Power Outputs Fault | 2, 5, 6 |
| 6986 | Ignition Switch Fault | 7 |
| 6987 | Taillights, Clearance Lights, License Plate Lights Output Fault | 5, 6 |
| 6988 | Left Low Beam Output Fault | 5, 6 |
| 6989 | Right Low Beam Output Fault | 5, 6 |
| 6990 | Left High Beam Output Fault | 5, 6 |
| 6991 | Right High Beam Output Fault | 5, 6 |
| 6992 | Multifunction Turn Signal Switch High Beam Input Fault | 2 |
| 6993 | Headlamp Switch Disagreement–Both park and on inputs are closed. | 7 |
| 6994 | ICU3-M2 Hazard Switch CAN Feedback Error | 19 |
| 6995 | Horn Output Fault | 3, 4, 5, 6 |
| 6996 | Dome Lamps Switched Power Output Fault | 5, 6 |
| 6997 | Cigar Lighter Output Fault | 3, 4, 5, 6 |
| 6998 | Dome Lamps Battery Power Output Fault | 5, 6 |
| 6999 | Backup Lamps/Alarm Output Fault | 5, 6 |
| 7000 | Panel Lamp Backlighting PWM Output Fault | 3, 4, 5, 6 |
| 524280 | Component ID Mismatch | 31 |
| 524281 | Application to Parameter Incompatibility | 31 |
| 524282 | Parameter Checksum Failure | 12 |
| 524283 | Application Checksum Failure | 12 |
| 524284 | Boot Block Checksum Failure | 12 |
| 524285 | Boot Hold Line is Active | 4 |
| 524286 | Ram Failure | 12 |

**Table 2, J1939 SPNs for Bulkhead Module (BHM) SA 33**

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## Bulkhead Module Fault Code Information

| Failure Mode Identifiers | | |
|---|---|---|
| **FMI** | **J1939 Description** | **J1587 Description** |
| 00 | Data valid but above normal operational range–Most severe level | Data valid but above normal operational range (engine overheating) |
| 01 | Data valid but below normal operational range–Most severe level | Data valid but below normal operational range (engine oil pressure too low) |
| 02 | Data erratic, intermittent, or incorrect | Data erratic, intermittent, or incorrect |
| 03 | Voltage above normal or shorted high | Voltage above normal or shorted high |
| 04 | Voltage below normal or shorted low | Voltage below normal or shorted low |
| 05 | Current below normal or open circuit | Current below normal or open circuit |
| 06 | Current above normal or grounded circuit | Current above normal or grounded circuit |
| 07 | Mechanical system not responding or out of adjustment | Mechanical system not responding properly |
| 08 | Abnormal frequency, pulse width, or period | Abnormal frequency, pulse width, or period |
| 09 | Abnormal update rate | Abnormal update rate |
| 10 | Abnormal rate of change | Abnormal rate of change |
| 11 | Root cause not known | Failure mode not identifiable |
| 12 | Bad intelligent device or component | Bad intelligent device or component |
| 13 | Out of Calibration | Out of Calibration |
| 14 | Special Instructions | Special Instructions |
| 15 | Data valid but above normal operational range–Least severe level | Reserved for future assignment by the SAE Subcommittee |
| 16 | Data valid but above normal operational range–Moderately severe level | — |
| 17 | Data valid but below normal operational range–Least severe level | — |
| 18 | Data valid but below normal operational range–Moderately severe level | — |
| 19 | Received network data in error | — |
| 31 | Condition Exists | — |

**Table 3, Failure Mode Identifiers**

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# General Information

The Chassis Module (CHM) and the Expansion Module (EXM) both serve the same function in the M2 electrical system by acting as slaves to the Bulkhead Module (BHM). The CHM and EXM respond to commands from the BHM and broadcast the status of the inputs and outputs that are sent to and delivered by the modules.

A Business Class M2 vehicle will always have a Chassis Module, but will only have an Expansion Module when optional features require it. The CHM and EXM both have five harness connectors, though they may not all be used.

## Chassis Module

The CHM is usually mounted on the left frame rail, aft of the cab. See **Fig. 1**. The CHM is available in two configurations depending on the vehicle options:

- standard Chassis Module
- full Chassis Module

The vehicle will have either a standard CHM or a full CHM, but not both. The standard CHM uses only the C1, C3, and C4 harness connectors. The remaining harness connectors are sealed. See **Fig. 2**.

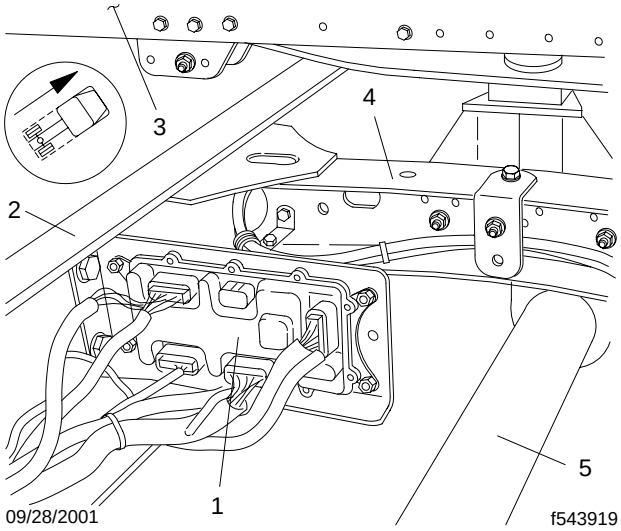
Both the standard CHM and full CHM are supported by one version of software.

### Alternate Mounting Location of the CHM

On some M2 vehicles the CHM is factory installed under the cab instead of on the frame rail behind the cab. This alternate location affects the C5 connector on the CHM, which controls any air management unit (AMU) solenoid that the vehicle may be equipped with.

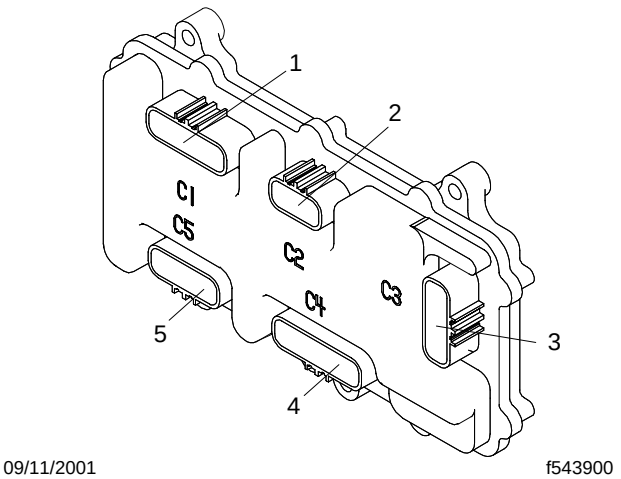
When the CHM is mounted on the frame rail behind the cab, the harness for the AMU solenoids plugs directly into the C5 connector on the CHM. When the CHM is factory installed under the cab, a jumper loom is required between the plug coming from the AMU solenoids and the C5 connector on the CHM.

The jumper loom is part of the forward chassis harness that is used with the CHM when it is factory installed under the cab. The jumper loom has generic circuit numbers and is present regardless of whether or not the AMU circuits are used on the vehicle.




1. Chassis Module
2. Left Frame Rail
3. Cab Backwall
4. Crossmember
5. Driveline

**Fig. 1, Chassis Module Installation on Frame Rail**




1. C1, Taillight Harness
2. C2, Trailer Module Harness, Full CHM Only
3. C3, Forward Chassis Harness
4. C4, Forward Chassis Harness
5. C5, Air Management Unit Harness, Full CHM Only

**Fig. 2, Chassis Module Harness Connectors**

NOTE: See **Specifications 400** for information on how a factory-installed CHM under the cab affects the wiring.

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## General Information

### Awake State and Sleep State

The BHM, CHM, and instrumentation control unit (ICU) are, as a group, in an awake state or a sleep state depending on vehicle conditions. When any of these electronic components are awakened, the remaining components wake up if they are not already awake. When the BHM, CHM, and ICU are in an awake state, the odometer reading appears on the dash driver display screen.

One of the following actions will cause the BHM, CHM, or ICU to go into an awake state:

- opening the door switch
- turning on the hazard switch
- turning the ignition switch to any position other than off
- turning on the headlight/parking light switch
- depressing the service brake

The BHM, CHM, and ICU will enter a sleep state when they are no longer actively controlling any outputs or responding to any inputs and all other power down requirements are met.

To check whether or not the electrical system is going into a sleep state:

1. Enter the vehicle.
2. Shut the doors.
3. Remove your foot from the service brake.
4. Make sure the ignition switch and hazard switch are in the off position.

NOTE: One minute after these conditions are met, and provided that one of the parameters in **Table 1** has not been added to the BHM, the odometer reading should disappear. If the odometer reading does not disappear, the electrical system is not going to sleep.

### Expansion Module

The EXM is mounted on the aft chassis. Only one Expansion Module is available on a vehicle. See **Fig. 3** for an illustration of the Expansion Module.

NOTE: The harness connector numbers on the CHM and EXM are the same since the hardware for the two modules is the same. However, the harness connector names for the CHM and EXM are not the same since the connectors on the EXM serve different functions than the connectors on the CHM.

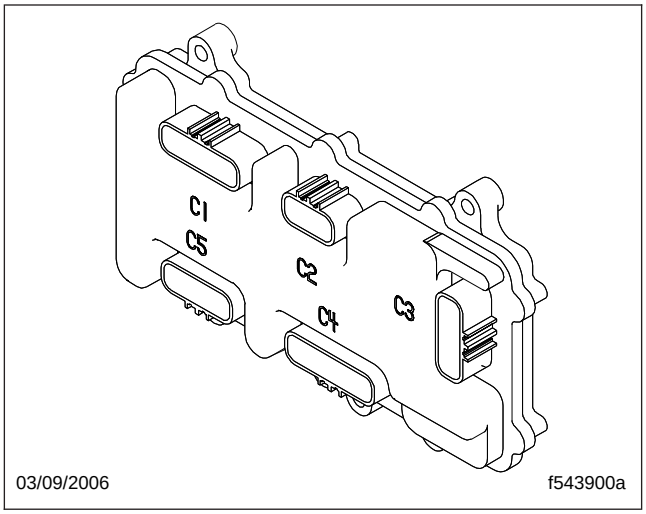


**Fig. 3, Expansion Module Harness Connectors**

The EXM configuration uses external strapping. External strapping is a process that assigns a unique, predefined J1939 Source Address and J1587 Message ID to the module, which is viewable in ServiceLink®.

| Parameters | | |
|---|---|---|
| **Parameter Part Number** | **Description** | **Hours** |
| 26-01017-002 | Switched Center Pin Power | 24 |
| 26-01019-003 | Exterior Lighting | 16,667 |
| 26-01019-004 | Exterior Lighting | 16,667 |
| 26-01019-005 | Exterior Lighting | 16,667 |

**Table 1, Parameters**

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External strapping is the interconnection of specific pins on the module in order to select a desired feature. In the external strapping of the Expansion Module, the J1939 source address and the J1587 message ID are used to identify the module on the vehicle datalinks. Pins on the C4 connector of the Expansion Module are connected as specified in **Table 2**. See the "Pinouts at Connector C4" table in **Specifications 400** to match the address ID to the actual pin locations.

| Module Configuration and External Strapping IDs | | | | | | |
|---|---|---|---|---|---|---|
| System Definition | Address ID Connections on Connector C4* | | | | J1939 Source Address | J1587 MID |
| | A | B | C | D | | |
| EXM | X | — | — | X | 235 | 170 |
| CHM | No Connections | | | | 71 | 249 |

* Connections are shown as address IDs, not as pin numbers.

**Table 2, Module Configuration and External Strapping IDs**

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## Specifications

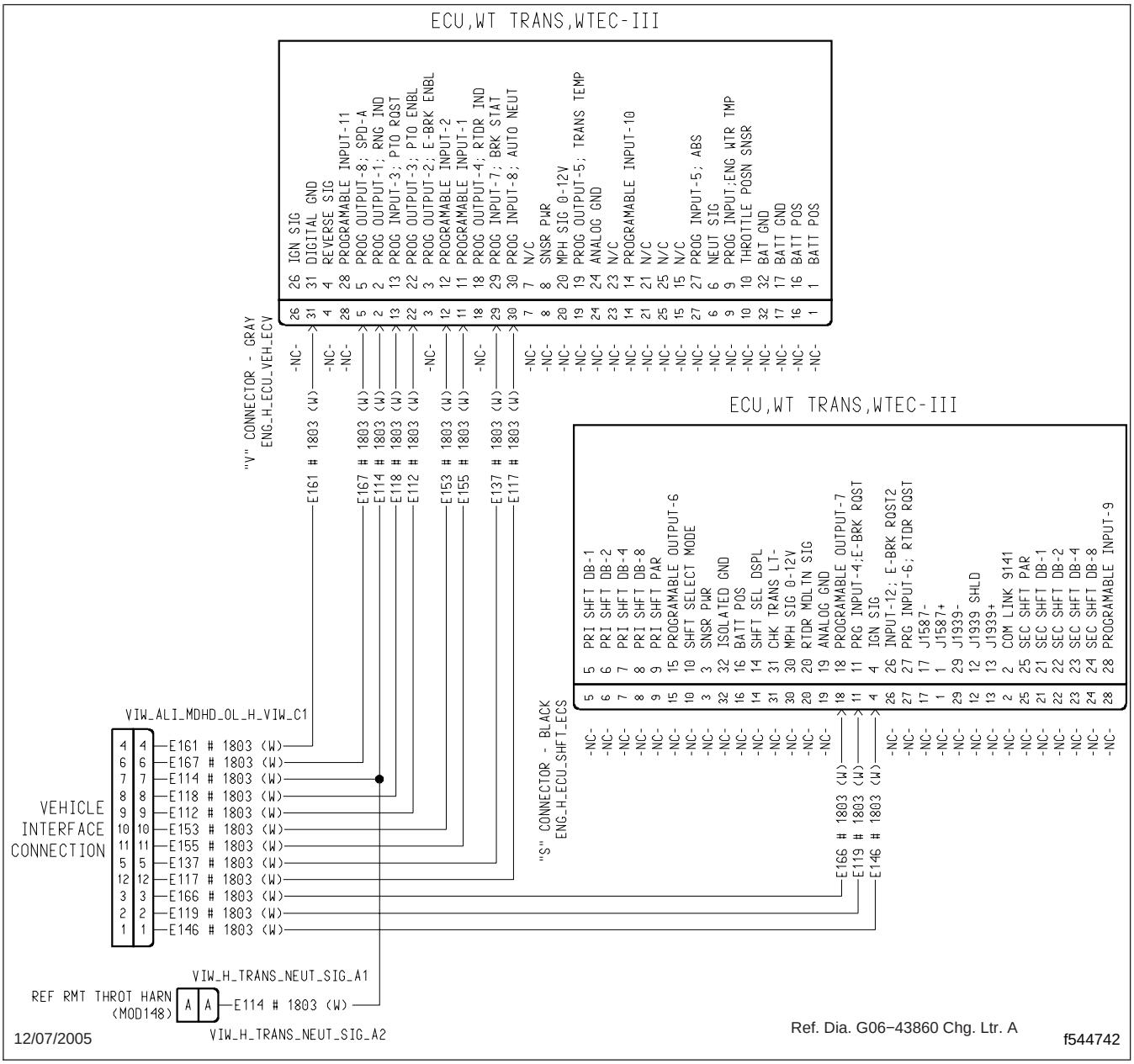


**Fig. 2, Allison Transmission 3000/4000 Series VIW Connector Wiring Diagram**

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# General Information

A PTO (power takeoff) and pump controls are options that can be ordered for a Business Class® M2 vehicle at the time the vehicle is ordered, after the vehicle is delivered, or when buying a used vehicle.

A vehicle with a Mercedes-Benz AGS[1] transmission must have PTO controls installed via the M2 electrical system. This is because the AGS electronics require some messages to be broadcast to disengage the clutch from the flywheel so that the PTO mechanism can be engaged, and then to engage the clutch on the flywheel after the PTO mechanism is engaged. If the vehicle has a Mercedes-Benz AGS transmission and is not equipped with PTO controls, see **Section 54.00, Subject 110**, for instructions on adding a feature.

A vehicle that is equipped with a transmission other than a Mercedes-Benz AGS is not required to use Freightliner PTO controls. PTO controls can be wired around the Business Class M2 electronic controls.

A vehicle with an Allison automatic transmission and body builder-installed PTO controls must have the transmission controller's PTO request input circuit connected to the activation switch.

PTO and pump controls use low-current outputs and digital inputs on the chassis module at the C5 electrical connector.

Feedback from the PTO or pump mechanism is required for correct operation of the PTO and pump controls. Feedback is provided by a ground input to the chassis module. A grounded feedback circuit indicates that the system is activated. An open feedback circuit indicates that either the system is not activated (PTO switch is not turned on), or there is a malfunction (PTO switch is turned on).

## Definitions

**Air shift PTO**—Air pressure is used to shift the PTO mechanism.

**Hydraulic shift PTO**—Hydraulic pressure is used to shift the PTO mechanism. This is usually only available with an automatic transmission.

**Normally closed AMU solenoid**—Blocks the flow of air until power is applied to the solenoid coil.

**Normally open AMU solenoid**—Allows air to flow until power is applied to the solenoid coil.

**Pump**—Also called a split shaft PTO. The main driveshaft is "split" by the PTO. The PTO is actually a transfer case.

## PTO Controls

The PTO controls include two types of electrical designs. The controls for air shift PTOs drive an AMU or AAVA solenoid. The controls for hydraulic shift PTOs drive a relay. Hydraulic solenoids require about 1.5 amps of current to engage a PTO mechanism.

## Pump Controls

The pump controls comprise a single electrical design. Two solenoid outputs are used to shift the transfer case. One solenoid provides air when the feature is activated (normally closed). The other solenoid turns off the air supply when the feature is deactivated (normally open).

[1] The AGS and AGS2 designations refer to the same Mercedes-Benz transmission. References to AGS2 may be found in ServiceLink®.

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## PTO and Fire Pump Controls Electrical Troubleshooting

Use **Table 1** or **Table 2** to begin troubleshooting. For power takeoff (PTO) function electrical diagnosis, see **Table 1**. For fire pump controls function diagnosis, see **Table 2**.

Additional tables included in this subject are:

- **Table 3**: PTO and Fire Pump Control Switch and Interlocks Test
- **Table 4**: PTO Interlocks by Reference Parameter
- **Table 5**: Fire Pump Control Interlocks by Reference Parameter
- **Table 6**: PTO and Fire Pump Control J1587 Fault Codes
- **Table 7**: PTO and Fire Pump Control J1939 Fault Codes

| PTO Function Electrical Diagnosis | | | |
|---|---|---|---|
| **Test No.** | **Test Procedure** | **Test Result** | **Action** |
| 1 | In ServiceLink®, use the Chassis Module (CHM) Configuration screen to determine which CHM solenoid output number controls the solenoid for the PTO.<br>Then open the "AMU Solenoids Circuits" or "AAVA Solenoids Circuits" in the appropriate Datalink Monitor template.<br>Make sure the vehicle has full air pressure. Turn the ignition on.<br>Attempt to engage the PTO using the smart switch in the dash while observing the status of the solenoid output under the "Outputs from BHM" heading for the solenoid number determined above. See **Fig. 1** and **Fig. 3.**<br>Does the output status turn on at all? It may turn on, then drop out. | Yes | **Go to test no. 2.** |
| | | No | Perform the PTO and Fire Pump Control Switch and Interlocks Test in **Table 3.** |
| 2 | Using the appropriate solenoids Datalink Monitor template, enter Test Mode.<br>Attempt to turn the PTO solenoid on using the **ON** button on the template.<br>NOTE: When done, exit Test Mode.<br>When you attempt to turn on the PTO solenoid, can you hear it click? | Yes | **Go to test no. 3.** |
| | | No | **Go to test no. 5.** |
| 3 | Make sure the vehicle has full air pressure. Turn the ignition on.<br>Using the appropriate solenoids Datalink Monitor template, attempt to engage the PTO using the smart switch in the dash while observing the status of the pressure switch under the "Inputs to BHM" heading for the solenoid number that controls the PTO. See **Fig. 2** and **Fig. 3.**<br>Does the status of the pressure switch say AIR ON at all, even if it comes on, then goes off? | Yes | **Go to test no. 4.** |
| | | No | Check PTO solenoid pressure switch feedback circuit.<br>Check the solenoid pressure switch. See **Section 42.19.**<br>Check if air line is connected to solenoid.<br>If the above items are OK, replace CHM. |

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## Troubleshooting

| PTO Function Electrical Diagnosis | | | |
|---|---|---|---|
| **Test No.** | **Test Procedure** | **Test Result** | **Action** |
| 4 | In ServiceLink, open the "PTO Interlocks" Datalink Monitor template.<br>Using **Table 4**, determine which PTO interlocks are used based on the PTO reference parameter programmed in to the BHM.<br>Engage the PTO using the switch in the dash.<br>Do any of the necessary interlocks drop out when the PTO solenoid drops out? | Yes | Determine the cause for interlock drop out and repair as necessary. |
| | | No | Check PTO solenoid output circuit amperage. If it exceeds 0.85A, make necessary repair or modification.<br>If amperage is OK, check for mechanical problem. |
| 5 | In ServiceLink, open the "Chassis Module Battery Inputs" Datalink Monitor template.<br>Is Battery Power Feed No. 3 at approximately battery voltage? | Yes | The problem may be in the PTO solenoid output circuit.<br>Make sure the PTO is wired to the correct CHM output pin per the ServiceLink CHM Configuration screen.<br>Check PTO solenoid output circuit from the CHM to the solenoid, including the solenoid coil ground circuit, for opens. If CHM solenoid output circuit contains a relay, check the relay and the rest of its circuits to the solenoid.<br>Check the solenoid output circuit between the CHM and solenoid (or relay if equipped) for short to ground. This will cause the CHM solenoid output to shut off due to high current. The current draw must not exceed 0.85A.<br>Check the solenoid. See **Section 42.19.**<br>If all of the above is OK, replace the CHM. |
| | | No | Check fuse 13 in the power distribution module (PDM). If blown, locate and correct the source of high current.<br>If fuse 13 is OK, check wiring between PDM fuse 13 and CHM pin C4-J for open circuit. |

**Table 1, PTO Function Electrical Diagnosis**

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| Fire Pump Controls Function Electrical Diagnosis | | | |
|---|---|---|---|
| **Test No.** | **Test Procedure** | **Test Result** | **Action** |
| 1 | In ServiceLink, use the Chassis Module (CHM) Configuration screen to determine which CHM solenoid output numbers control the two solenoids for the fire pump.<br>Then open the "AMU Solenoids Circuits" or "AAVA Solenoids Circuits" in the appropriate Datalink Monitor template.<br>Make sure the vehicle has full air pressure. Turn the ignition on.<br>Attempt to engage the pump using the smart switch in the dash while observing the status of solenoid output under the "Outputs from BHM" heading for both of the solenoid numbers determined above. See **Fig. 1** and **Fig. 3.**<br>Does the status of the solenoid output for both solenoids turn on at all? They may turn on, then drop out. | Yes | **Go to test no. 2.** |
| | | No | Perform the PTO and Fire Pump Control Switch and Interlocks Test in **Table 3.** |
| 2 | Using the appropriate solenoids Datalink Monitor template, enter Test Mode.<br>Attempt to turn the fire pump control solenoids on one at a time using the **ON** buttons on the template.<br>NOTE: When done, exit Test Mode.<br>NOTE: If operating normally, one solenoid should exhaust air when turned on, the other will exhaust air when turned off.<br>What happens when the solenoids are turned on? | Both operate | **Go to test no. 3.** |
| | | Neither operate | **Go to test no. 5.** |
| | | Only one operates | Make sure one of the reference parameters in **Table 5** is applied to the vehicle. If not, correct as necessary.<br>For the solenoid that is not working, make sure it is wired to the correct CHM output pins per the ServiceLink CHM Configuration screen.<br>Check the solenoid output circuit from the CHM to the solenoid, including the solenoid coil ground circuit, for opens.<br>Check the solenoid output circuit between the CHM and solenoid for short to ground. This will cause the CHM solenoid output to shut off due to high current. The current draw must not exceed 0.85A.<br>Check the solenoid. See **Section 42.19.**<br>If all of the above is OK, replace the CHM. |

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## Troubleshooting

| Fire Pump Controls Function Electrical Diagnosis | | | |
|---|---|---|---|
| **Test No.** | **Test Procedure** | **Test Result** | **Action** |
| 3 | Make sure the vehicle has full air pressure. Turn the ignition on.<br><br>Using the appropriate solenoids Datalink Monitor template, attempt to engage the fire pump using the smart switch in the dash while observing the status of the pressure switch under the "Inputs to BHM" heading for the two solenoids that control the fire pump. See **Fig. 2** and **Fig. 3.**<br><br>NOTE: Under normal operation with the switch off, one solenoid should indicate air pressure, the other one should not. When the switch is turned on and the pump engages, the solenoid that indicated pressure should now be off, and the one that was off should now indicate pressure.<br><br>Does the status of the pressure switch change for both solenoids when the switch is turned on, even if it reverts back to its initial state? | Yes | **Go to test no. 4.** |
| | | No | For the solenoid that does not change pressure switch status:<br>• Check solenoid pressure switch feedback circuit.<br>• Check the solenoid pressure switch. See **Section 42.19.**<br>• Check the air lines.<br><br>If the above items are OK, replace CHM. |
| 4 | In ServiceLink, open the "Fire Pump Interlocks" Datalink Monitor template.<br><br>Using **Table 5**, determine which fire pump interlocks are used based on the reference parameter programmed into the BHM.<br><br>Engage the fire pump using the switch in the dash.<br><br>Do any of the necessary interlocks drop out when the fire pump solenoids drop out? | Yes | Determine the cause for interlock drop out and repair as necessary. |
| | | No | Check both fire pump solenoid output circuits for amperage. If either exceeds 0.85A, make necessary repair or modification.<br><br>If amperage is OK, check for mechanical problem. |

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| Fire Pump Controls Function Electrical Diagnosis | | | |
|---|---|---|---|
| **Test No.** | **Test Procedure** | **Test Result** | **Action** |
| 5 | In ServiceLink, open the "Chassis Module Battery Inputs" Datalink Monitor template.<br>Is Battery Power Feed No. 3 at approximately battery voltage? | Yes | The problem is in one or both of the fire pump solenoid output circuits.<br>Make sure the fire pump solenoids are wired to the correct CHM output pins per the ServiceLink CHM Configuration screen.<br>Check both fire pump solenoid output circuits from the CHM to the solenoids, including the solenoid coil ground circuit, for opens.<br>Check both solenoid output circuits between the CHM and solenoids for short to ground. This will cause the CHM solenoid output to shut off due to high current. The current draw must not exceed 0.85A.<br>Check the solenoid(s). See **Section 42.19.**<br>If all of the above is OK, replace the CHM. |
| | | No | Check fuse 13 in the PDM. If blown, locate and correct the source of high current.<br>If fuse 13 is OK, check wiring between PDM fuse 13 and CHM pin C4-J for open circuit. |

**Table 2, Fire Pump Controls Function Electrical Diagnosis**

| PTO and Fire Pump Control Switch and Interlocks Test | | | |
|---|---|---|---|
| **Test No.** | **Test Procedure** | **Test Result** | **Action** |
| 1 | In ServiceLink, open the "Dash Smart Switches" Data Monitor template.<br>NOTE: Be sure to open the correct template for the BHM software version on the vehicle.<br>Look at each of the five BHM outputs: SS1 ID#, SS2 ID#, SS3 ID#, SS4 ID#, and SS5 ID#.<br>If diagnosing the PTO, are any of the five SSn ID#s equal to 38?<br>If diagnosing the fire pump controls, are any of the five SSn ID#s equal to 104? | Yes | **Go to test no. 6.** |
| | | No | **Go to test no. 2.** |

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## Troubleshooting

| PTO and Fire Pump Control Switch and Interlocks Test | | | |
|---|---|---|---|
| **Test No.** | **Test Procedure** | **Test Result** | **Action** |
| 2 | Are any of the five SSn ID#s equal to 0? | Yes | **Go to test no. 5.** |
| | | No | **Go to test no. 3.** |
| 3 | In ServiceLink, open the "Switch Expansion Module 1, Smart Switches" Datalink Monitor template.<br>Look at each of the six SEM to BHM outputs: SS1 ID#, SS2 ID#, SS3 ID#, SS4 ID#, SS5 ID#, and SS6 ID#.<br>If diagnosing the PTO, are any of the five SSn ID#s equal to 38?<br>If diagnosing the fire pump controls, are any of the five SSn ID#s. equal to 104? | Yes | **Go to test no. 6.** |
| | | No | **Go to test no. 4.** |
| 4 | Are any of the six SSn ID#s. equal to 0? | Yes | **Go to test no. 5.** |
| | | No | Repeat test no. 3 using the next SEM template. For example, "Switch Expansion Module 2, Smart Switches." |
| 5 | Is fault code 164 s022 07 active? | Yes | Check the following and make the necessary repairs:<br>• Check if PTO or PUMP smart switch is installed and connected.<br>• Check smart switch wiring.<br>• Check the smart switch.<br>• If the smart switch is installed in SEM, check SEM. |
| | | No | The PTO or fire pump controls smart switch is not programmed for the vehicle. Check and apply the proper 26-01032-xxx reference parameter. |
| 6 | Toggle the PTO smart switch on and off several times while observing the Datalink Monitor template which shows SSn ID# equal to 38 for PTO diagnosis, or 104 for fire pump controls diagnosis.<br>If using the Smart Switches template, look for a change under the "BHM Inputs" heading in the input voltage for the smart switch.<br>If using one of the Switch Expansion Modules templates under "SEM to BHM" heading, look for a change in the state of the "SSn Pos" annunciator for the smart switch.<br>Is there a change in voltage or state when toggling the PTO switch? | Yes | **Go to test no. 7.** |
| | | No | Check the following and make necessary repairs:<br>• Check smart switch wiring.<br>• Check the smart switch.<br>• If the smart switch is installed in SEM, check SEM. |

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| PTO and Fire Pump Control Switch and Interlocks Test | | | |
|---|---|---|---|
| **Test No.** | **Test Procedure** | **Test Result** | **Action** |
| 7 | In ServiceLink, open one of the following Datalink Monitor templates:<br>• If testing the PTO controls, open the "PTO Interlocks" template.<br>• If testing fire pump controls, open the "Fire Pump Interlocks" template.<br>Using **Table 4** for PTO controls or **Table 5** for fire pump controls, determine which interlocks are used based on the reference parameter programmed into the BHM.<br>While attempting to engage the PTO or fire pump using the switch in the dash, are all of the interlocks associated with the reference parameter met? | Yes | Reapply the PTO or fire pump control reference parameter.<br>If the PTO or fire pump control continues to be inoperable, contact the Freightliner Customer Assistance Center at 1-800-FTL-HELP or 1-800-385-4357. There may be an error in the reference parameter. |
| | | No | Determine the reason for the interlock not being met. Either repair the problem or advise the driver of proper operation. |

**Table 3, PTO and Fire Pump Control Switch and Interlocks Tests**

| PTO Interlocks by Reference Parameter | | | | | |
|---|---|---|---|---|---|
| **Reference Parameter*** | **Description** | **Interlocks** | | | |
| | | **Neutral (from transmission)** | | **Ignition (BHM input)** | **Park Brake (from CHM)** |
| | | **J1939 Current Gear** | **J1939 Selected Gear** | | |
| 26-01032-003 | PTO End of Frame Air Control, w/Ign Interlock (Smart Switch ID#38) | — | — | On | — |
| 26-01032-005 | PTO End of Frame Air Control, w/Neut & Ign Interlocks (Smart Switch ID#38) | Neutral | Neutral | On | — |
| 26-01032-008 | PTO End of Frame Air Control, AGS† Trans (Smart Switch ID#38) | — | — | On | Set |
| 26-01032-014 | PTO End of Frame Air Control, w/Neut Interlock (Smart Switch ID#38) | Neutral | Neutral | On | — |
| 26-01032-019 | PTO End of Frame Air Control, w/Park Brk Interlock (Smart Switch ID#38) | — | — | On | Set |
| 26-01032-020 | PTO End of Frame Air Cont,AGS Trans,Prk Brk & Neut Intlocks (Smart Switch ID#38) | Neutral | Neutral | On | Set |

* For a given reference parameter, all the interlocks for that parameter must be in the state shown in order for the PTO solenoid to engage.

† The AGS and AGS2 designations refer to the same Mercedes-Benz transmission. References to AGS2 may be found in ServiceLink.

**Table 4, PTO Interlocks by Reference Parameter**

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## Troubleshooting

| Fire Pump Control Interlocks by Reference Parameter | | | | |
|---|---|---|---|---|
| Reference Parameter | Description | Interlocks | | |
| | | Indicated Vehicle Speed from Engine* | Ignition (BHM input) | Park Brake (from CHM) |
| 26-01032-004 | PTO Fire Pump Control (Smart Switch ID#104) | — | On | Set |
| 26-01032-010 | PTO Fire Pump Control, w/Park Brake & Veh Spd Interlocks (Smart Switch ID#104) | Approximately 5 mph (8 km/h) | On | Set |

* The fire pump is driven by a transfer case. When the transfer case is shifted to deliver power to the fire pump, the transmission is put into gear to drive the transfer case (the vehicle will be stationary). Since the transmission drives the transfer case, an apparent output shaft speed will register indicating vehicle speed. In order to engage the fire pump, this apparent output shaft speed must be under 5 mph (8 km/h). Once the transfer case is engaged, it will remain engaged regardless of the apparent output shaft speed as long as the ignition is on, the park brake is set, and the pump smart switch remains on.

**Table 5, Fire Pump Control Interlocks by Reference Parameter**

| PTO and Fire Pump Control J1587 Fault Codes | | | | |
|---|---|---|---|---|
| MID | SID | FMI | Description | Action |
| 164 | 025 | 07 | End of Frame Air (PTO and fire pump control)–unexpected air pressure feedback | Solenoid is not activated, but CHM senses that the pressure switch is in an unexpected state. For example, a normally closed solenoid is off, but air pressure is detected.<br>Check the following:<br>• Air system<br>• Pressure feedback circuit including the ground.<br>• Solenoid–pressure switch may be stuck. |
| | 026 | 07 | End of Frame (PTO and fire pump control)–no air pressure feedback | Chassis Module engages solenoid, but the pressure switch does not change status indicating that the solenoid supplied, or exhausted, air downstream.<br>Check the following:<br>• Air system<br>• Pressure feedback circuit including the ground.<br>• Solenoid–pressure switch may be stuck. |

**Table 6, PTO and Fire Pump Control J1587 Fault Codes**

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| PTO and Fire Pump Control J1939 Fault Codes | | | | |
|---|---|---|---|---|
| **SA** | **SPN** | **FMI** | **Description** | **Action** |
| 33 | 6954 | 07 | End of Frame (PTO and fire pump control)–no air pressure feedback | Solenoid is not activated, but CHM senses that the pressure switch is in an unexpected state. For example, a normally closed solenoid is off, but air pressure is detected.<br>Check the following:<br>• Air system<br>• Pressure feedback circuit including the ground.<br>• Solenoid–pressure switch may be stuck. |
| | 6955 | 07 | End of Frame (PTO and fire pump control)–unexpected air pressure feedback | Chassis Module engages solenoid, but the pressure switch does not change status indicating that the solenoid supplied, or exhausted, air downstream.<br>Check the following:<br>• Air system<br>• Pressure feedback circuit including the ground.<br>• Solenoid–pressure switch may be stuck. |

**Table 7, PTO and Fire Pump Control J1939 Fault Codes**

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## Troubleshooting

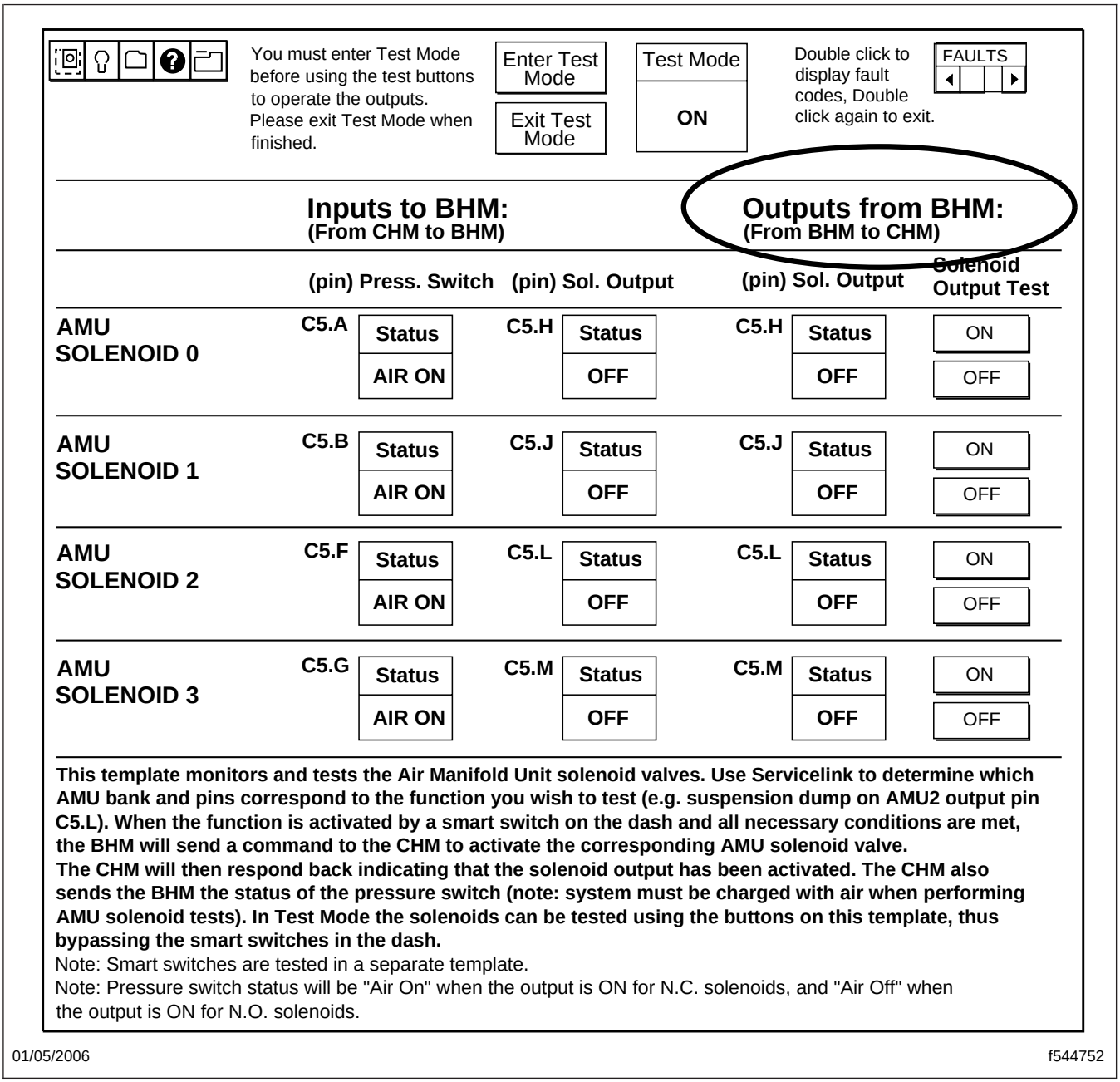


**Fig. 1, AMU Solenoids Template, Outputs from BHM**

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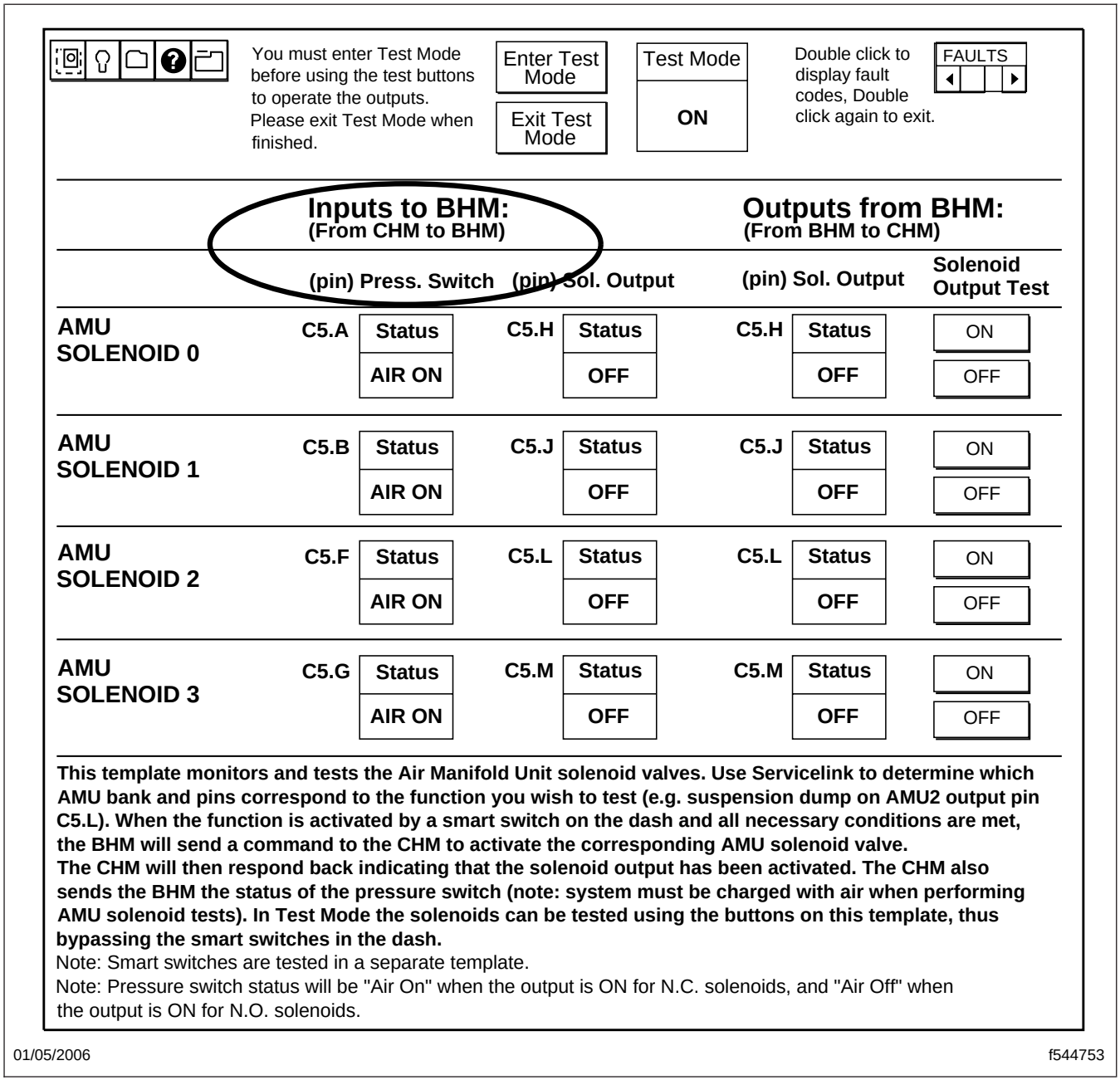


**Fig. 2, AMU Solenoids Template, Pressure Switch Status**

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## Troubleshooting

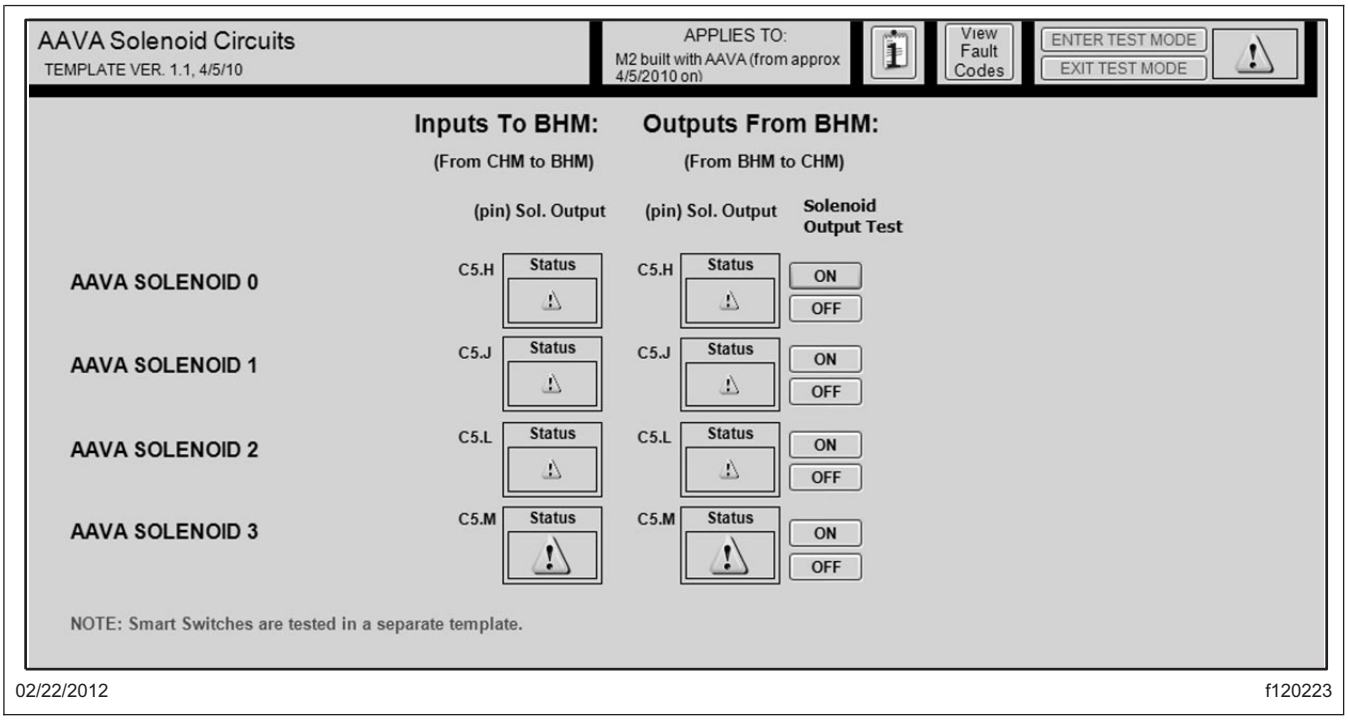


**Fig. 3, AAVA Solenoids Template, Outputs from BHM**

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## Specifications

See **Fig. 1** for a typical wiring diagram of an Allison hydraulic PTO.

See **Fig. 2** for a typical wiring diagram of an Allison hydraulic PTO with a 4th generation TCU.

See **Fig. 3** for a typical wiring diagram of a pneumatic PTO.

See **Fig. 4** for a typical wiring diagram of a split shaft PTO.

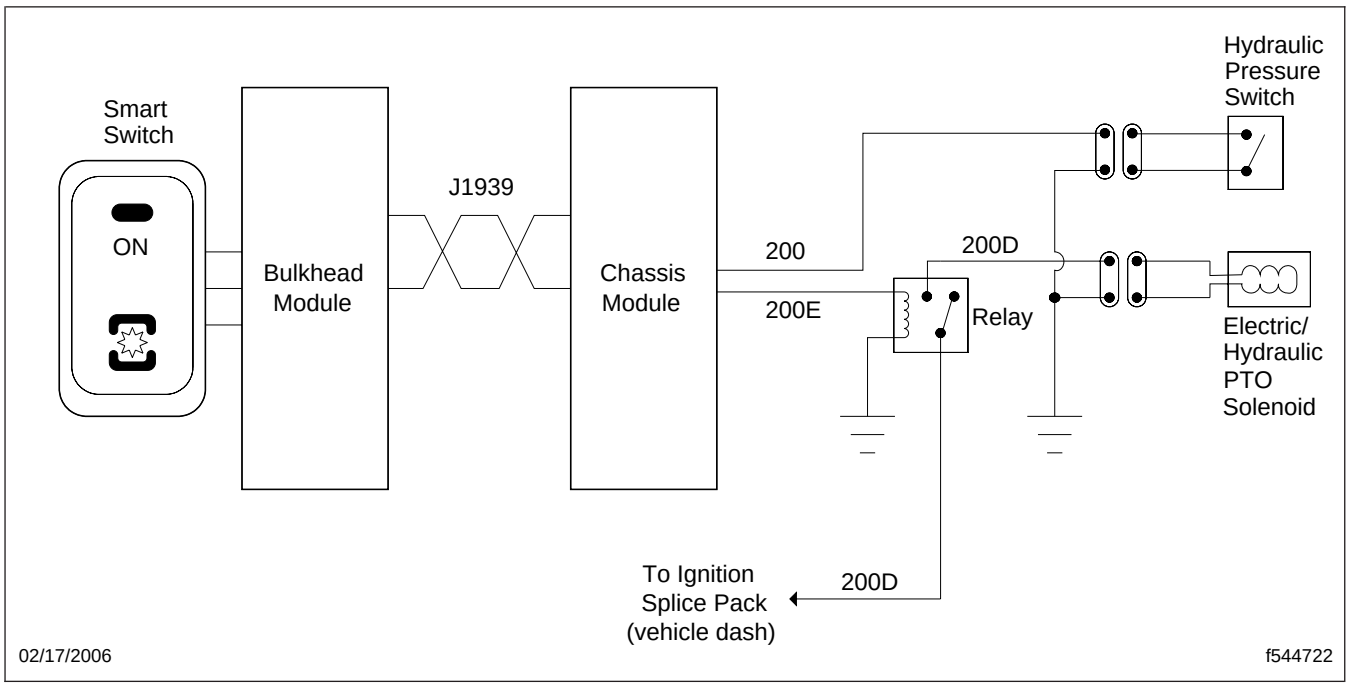


**Fig. 1, Typical Wiring Diagram of an Allison Hydraulic PTO**

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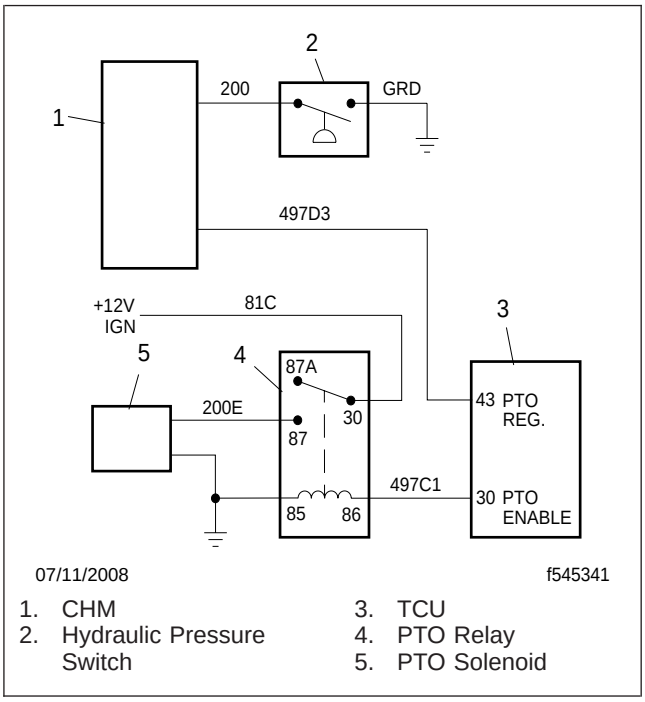
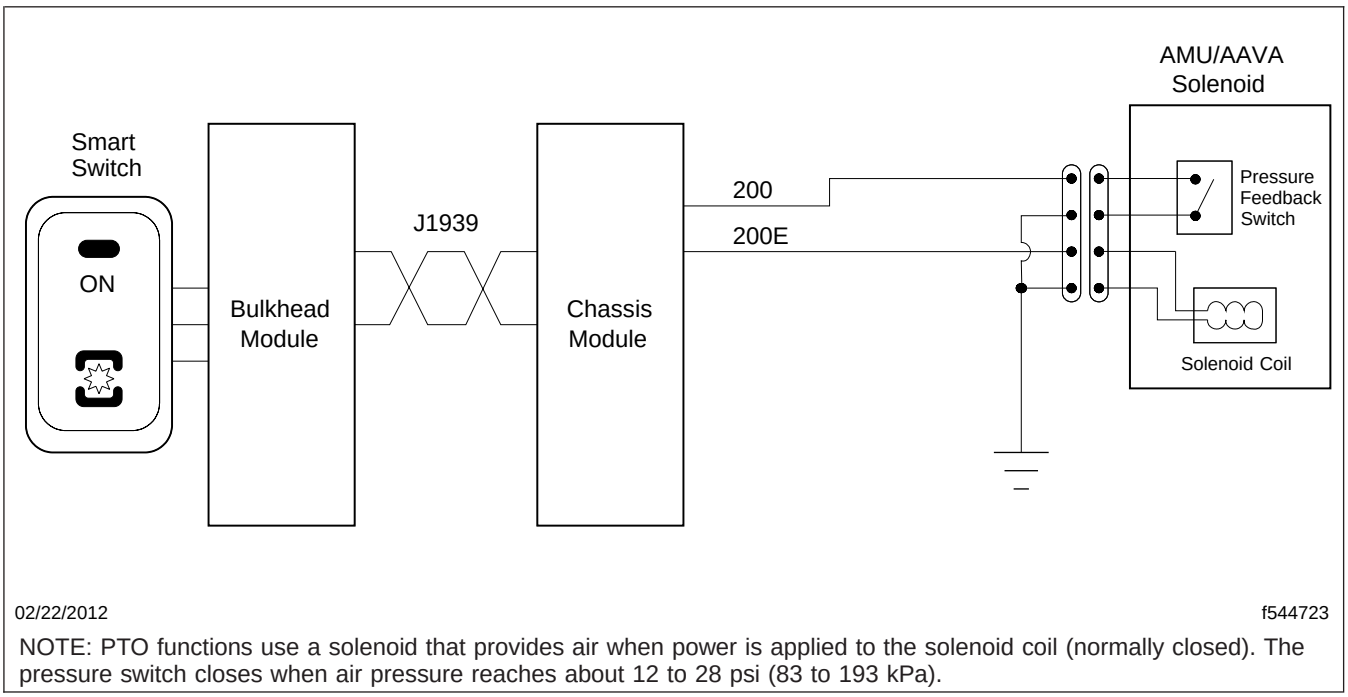
## Specifications




1. CHM
2. Hydraulic Pressure Switch
3. TCU
4. PTO Relay
5. PTO Solenoid

**Fig. 2, Typical Wiring Diagram of an Allison Hydraulic PTO with 4th Generation TCU**




NOTE: PTO functions use a solenoid that provides air when power is applied to the solenoid coil (normally closed). The pressure switch closes when air pressure reaches about 12 to 28 psi (83 to 193 kPa).

**Fig. 3, Typical Wiring Diagram of a Pneumatic PTO**

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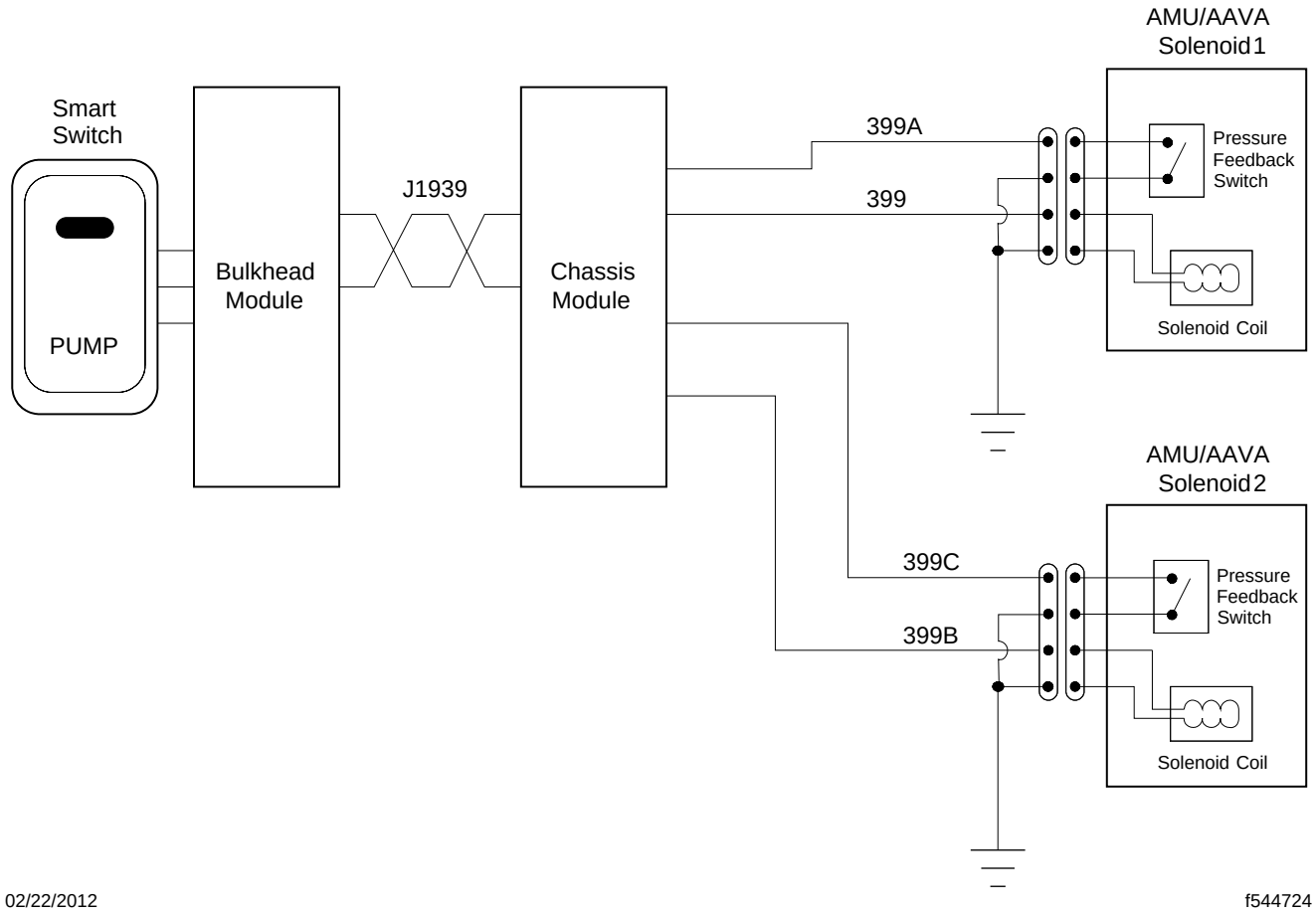


NOTES:

- Pump functions require two solenoids to shift the transfer case. Solenoid 1 provides air when power is applied to the solenoid coil (normally closed). Solenoid 2 provides air when power is removed from the solenoid coil (normally open).
- The pressure switch closes when air pressure reaches about 12 to 28 psi (83 to 193 kPa).
- Only the feedback from the pressure switch in the normally closed solenoid is used by the pump control system. The other circuit is wired, but is not used.

**Fig. 4, Typical Wiring Diagram of a Split Shaft PTO**

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# Introduction

Optional power switches are factory-installed, switch-controlled power provisions that can be ordered for a Business Class® M2 vehicle. Optional switches can be ordered in a one-, two-, or four-switch configuration. All optional switches mount on the dash, provide fuse-protected battery power, and route to a customer access point. Optional switches are commonly used to provide battery-powered lighting, such as dome, spot, or beacon lights. Other applications include using the optional switch as a triggering mechanism to enable other features, such as hydraulic lift operations or access panel locks.

# Overview

Available optional switch configurations include:

- one switch with a customer-access junction block
- one switch with a blunt-cut output
- two switches with blunt-cut outputs
- four switches with blunt-cut outputs

Optional power switches are mounted on the dash to the right of the steering column. Each switch is equipped with two LED lights; one LED provides switch illumination while the other indicates when the switch is in the on position. Battery-powered power distribution module (PDM) fuses, located under the hood, provide a constant power feed to each switch. When a switch is turned to the on position, the switch contacts close and supply battery power to an output circuit.

For vehicles with a single optional switch and junction block configuration, the output circuit from the optional switch is a red wire that connects to the 5-post junction block. The junction block is usually located on the frame rail near the Chassis Module (CHM) and provides a connection point that permits easy access. The red wire in the junction block is connected to the 15-amp optional switch output, while the yellow wire is connected to a marker light feed from the CHM. See **Section 54.35** for information on the junction block marker light feed.

For all other optional switch configurations, the output circuits from the optional switches route along the chassis toward the back of the cab where the circuits terminate inside the left frame rail near the standard location of the CHM on a vehicle with a day cab. On a vehicle with an extended cab or a crew cab, the circuits terminate under the cab.

Output circuits terminate as blunt-cut ends sealed in heat shrink. The blunt-cut ends extend a few inches out from the harness loom and are individually tagged with an identification label. The label identifies which switch is powering the circuit and also the current capacity of the circuit. See **Fig. 1**.

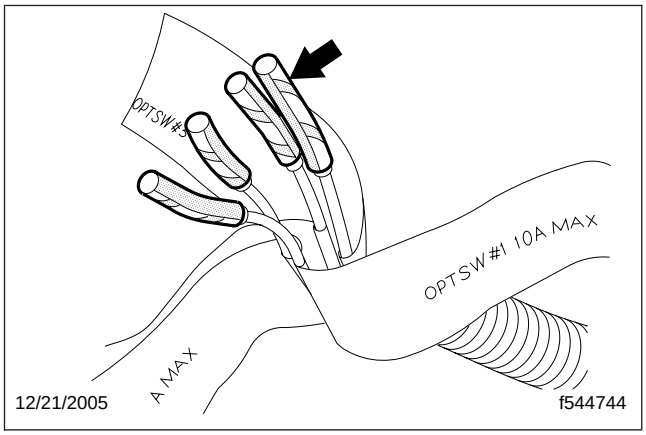


**Fig. 1, Blunt-cut End**

## Current Capacity

It is important to note that the current capacities for optional switch outputs are not the same for all configurations. Current capacities differ according to the number of switches that come installed on a vehicle. For instance, for a two-switch configuration, the fused battery feed for both switches is supplied by one PDM fuse. This means that the total combined load from both switches cannot exceed the fuse rating. For optional-switch current capacities, see **Table 1**.

| Optional-Switch Current Capacity | | | | | |
|---|---|---|---|---|---|
| No. of Switches | PDM Fuse F25 | | PDM Fuse F26 | | Switch Output Current Capacity |
| | Rating | Switch Protected | Rating | Switch Protected | |
| 1 | 15A | Switch 1 | — | — | 15A |

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## General Information

| Optional-Switch Current Capacity | | | | | |
|---|---|---|---|---|---|
| No. of Switches | PDM Fuse F25 | | PDM Fuse F26 | | Switch Output Current Capacity |
| | Rating | Switch Protected | Rating | Switch Protected | |
| 2 | 30A | Shared by switch 1 and 2 | — | — | 15A |
| 4 | 20A | Shared by switch 1 and 2 | 20A | Shared by switch 3 and 4 | 10A |

**Table 1, Optional-Switch Current Capacity**

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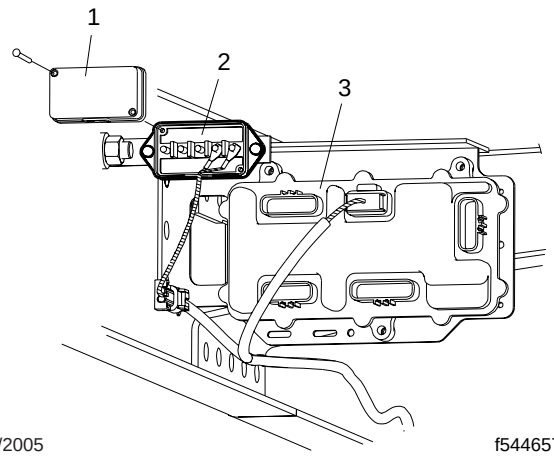
## Connecting to One Switch With a Junction Block

1. Turn off the engine, apply the parking brakes, and chock the tires.
2. Disconnect the negative leads from the batteries or, if the vehicle is equipped with a battery disconnect switch, turn the switch to the off position.
3. Locate the junction block attached to the frame rail near the Chassis Module (CHM.) See **Fig. 1**.




1. Junction Block Cover
2. Junction Block
3. Chassis Module

**Fig. 1, Junction Block**

4. Remove the capscrews that attach the junction block cover to the junction block, and remove the cover.
5. Locate the red wire in the junction block. The red wire receives power from the output circuit of the optional switch.

IMPORTANT: The power distribution module (PDM) fuse supplying power to the optional switch is rated for 15 amps. **Do not exceed a combined current load of 15 amps at the red wire in the junction block**.

6. Connect to the red wire in the junction block using a #10 ring terminal. The optional switch can provide 15 amps of fused battery power at the red wire.
7. Using capscrews, attach the junction block cover to the junction block.
8. Connect the batteries or turn the battery disconnect switch to the on position.
9. Verify the operation of the circuit(s) connected to the red wire in the junction block. The optional switch should control the electrical feature(s) connected to the red wire.
10. Remove the chocks from the tires.

## Connecting to One Switch Without a Junction Block or Multiple Switches

1. Turn off the engine, apply the parking brakes, and chock the tires.
2. Disconnect the negative leads from the batteries or, if the vehicle is equipped with a battery disconnect switch, turn the switch to the off position.
3. Locate the customer connection end of the optional-switch output circuit. The connection end of the output circuit is located on the chassis behind the cab. The circuit end is an exposed blunt-cut wire sealed with heat shrink. There will be a blunt-cut circuit for each optional switch. See **Fig. 2**.
4. Use the identification label that is taped to the blunt-cut end to properly match the correct circuit with the corresponding optional switch.

NOTE: The following method of splicing the optional-switch circuits to load circuits is approved by Freightliner. Use solder splice repair kit ESY ES66 404, which works for 14 and 16 gauge wire.

5. Remove the heat shrink by cutting the optional-switch circuit wire near the end of the heat shrink.
6. Strip the insulation 3/8 to 1/2 inch (10 to 13 mm) from the ends of the optional-switch circuit wire and the wire for the load.
7. Place the three-inch (76-mm) length of heat shrink from the repair kit over the circuit that is being spliced to the optional-switch circuit.
8. Place the solder sleeve from the repair kit over one of the stripped wires.

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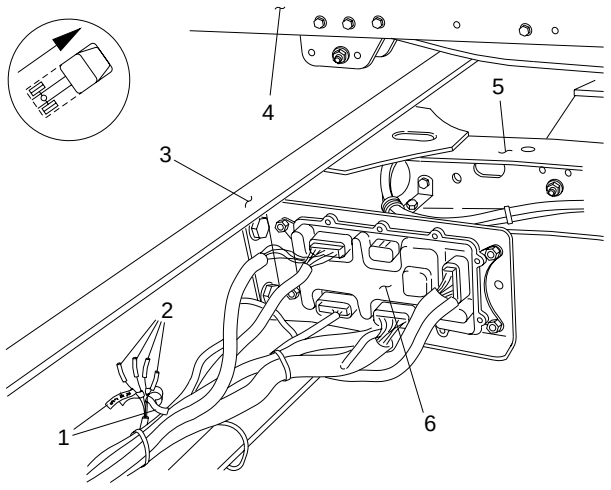
## Optional Switch Connections




1. Optional-switch Circuit Identification Label
2. Optional-switch Output Wire
3. Frame Rail
4. Back of Cab
5. Crossmember
6. Chassis Module

**Fig. 2, Optional Switch Outputs**

9. Use a suitable crimping tool and the crimp splice from the repair kit to crimp the wires together.
   - 9.1 Insert one of the stripped wire ends into the crimp splice until it touches the wire stop in the center of the crimp splice.
   - 9.2 Center the crimping tool between the wire stop and the end of the crimp splice over the wire.
   - 9.3 Crimp the splice on the wire.
   - 9.4 Check the crimp to be sure that the wire is held in place.
   - 9.5 Repeat the previous substeps for the other wire.
10. Place the solder sleeve over the crimp splice and center the solder ring over the crimp splice. Then apply 250°F (121°C) to the solder sleeve until the solder flows into the crimp splice and the plastic sleeve has shrunk against the wire and crimp splice. Be sure to keep the heat source well away from the heat shrink by sliding the heat shrink at least 4 inches (102 mm) from the splice joint.
11. Allow the solder sleeve to cool for a few minutes.
12. Place the heat shrink over the splice and center it as best you can. Then apply 250°F (121°C) to the heat shrink until it has shrunk completely over the wire insulation. Some of the sealant material should be bubbling out of the ends of the heat shrink.
13. When routing additional electrical wiring, make sure all circuits are properly protected and secured.
14. Connect the batteries or turn the battery disconnect switch to the on position.
15. Verify the operation of the electrical feature(s) connected to the optional switch output.
16. Remove the chocks from the tires.

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## Troubleshooting

For electrical troubleshooting, see **Table 1**.

| Electrical Troubleshooting | |
|---|---|
| **Description of Fault** | **Possible Cause** |
| No power at an optional switch output. Switch is on. | Check appropriate power distribution module (PDM) fuse to see if it is open or missing. F25 supplies switches 1 and 2. F26 supplies switches 3 and 4. |
| No power at an optional switch output. Switch is on and power supply fuse is proven good. | Check the identification label on the output circuit. Make sure the output circuit is identified as belonging to the optional switch in use. |
| Intermittent or no operation. | Loss of connection. Could be caused by loose electrical connection(s), disengaged terminal connection(s), or damaged wire(s). Trace the suspect circuit. |

**Table 1, Electrical Troubleshooting**

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## Wiring Diagrams

For a wiring diagram of the one-switch configuration, see **Fig. 1**.

For a wiring diagram of the two-switch configuration, see **Fig. 2**.

For a wiring diagram of the four-switch configuration, see **Fig. 3**.

## Circuit Identification

For a pinout chart of a typical optional switch connector, see **Table 1**.

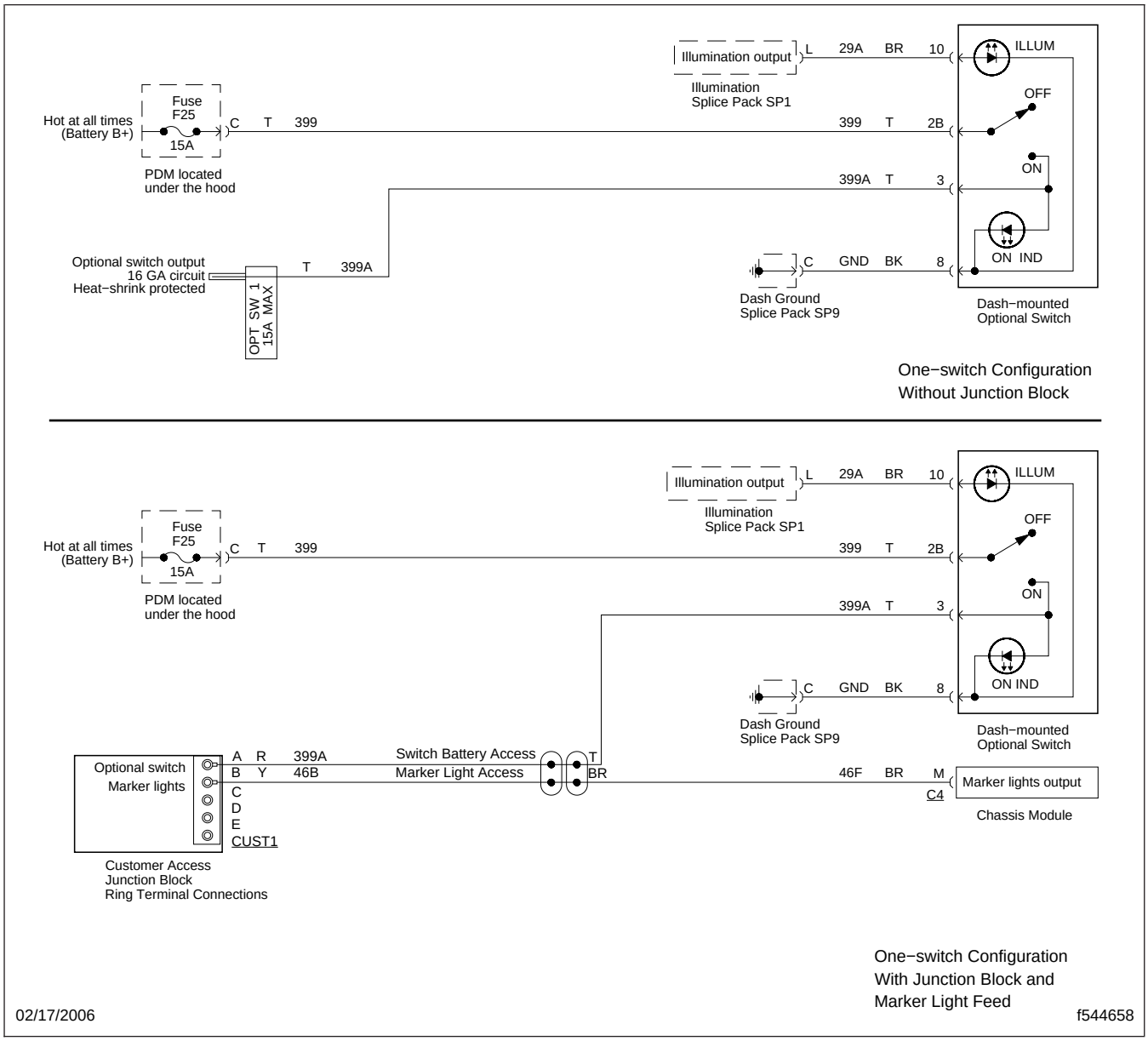


**Fig. 1, One-Switch Configuration Wiring Diagram**

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## Specifications

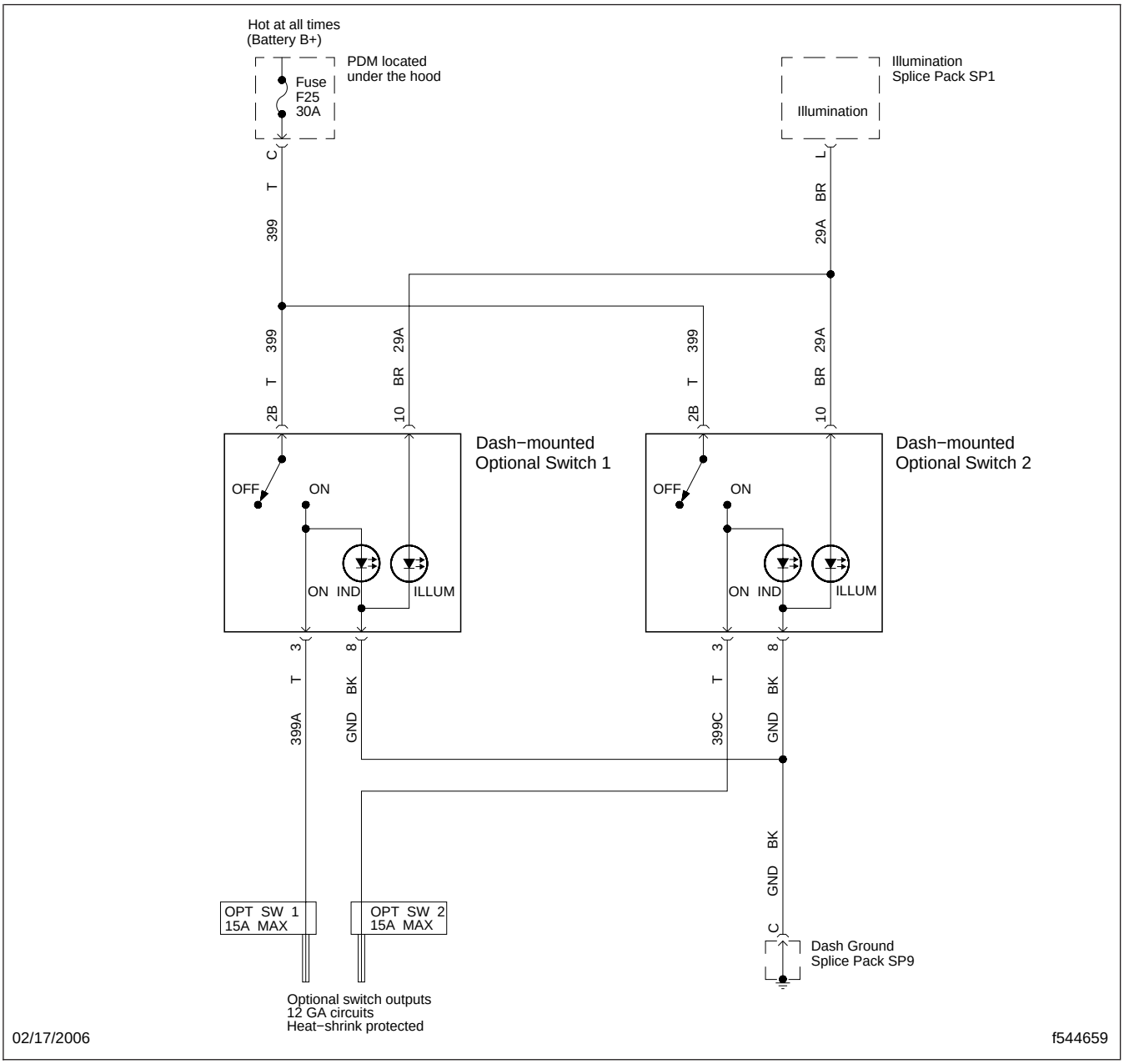


**Fig. 2, Two-Switch Configuration Wiring Diagram**

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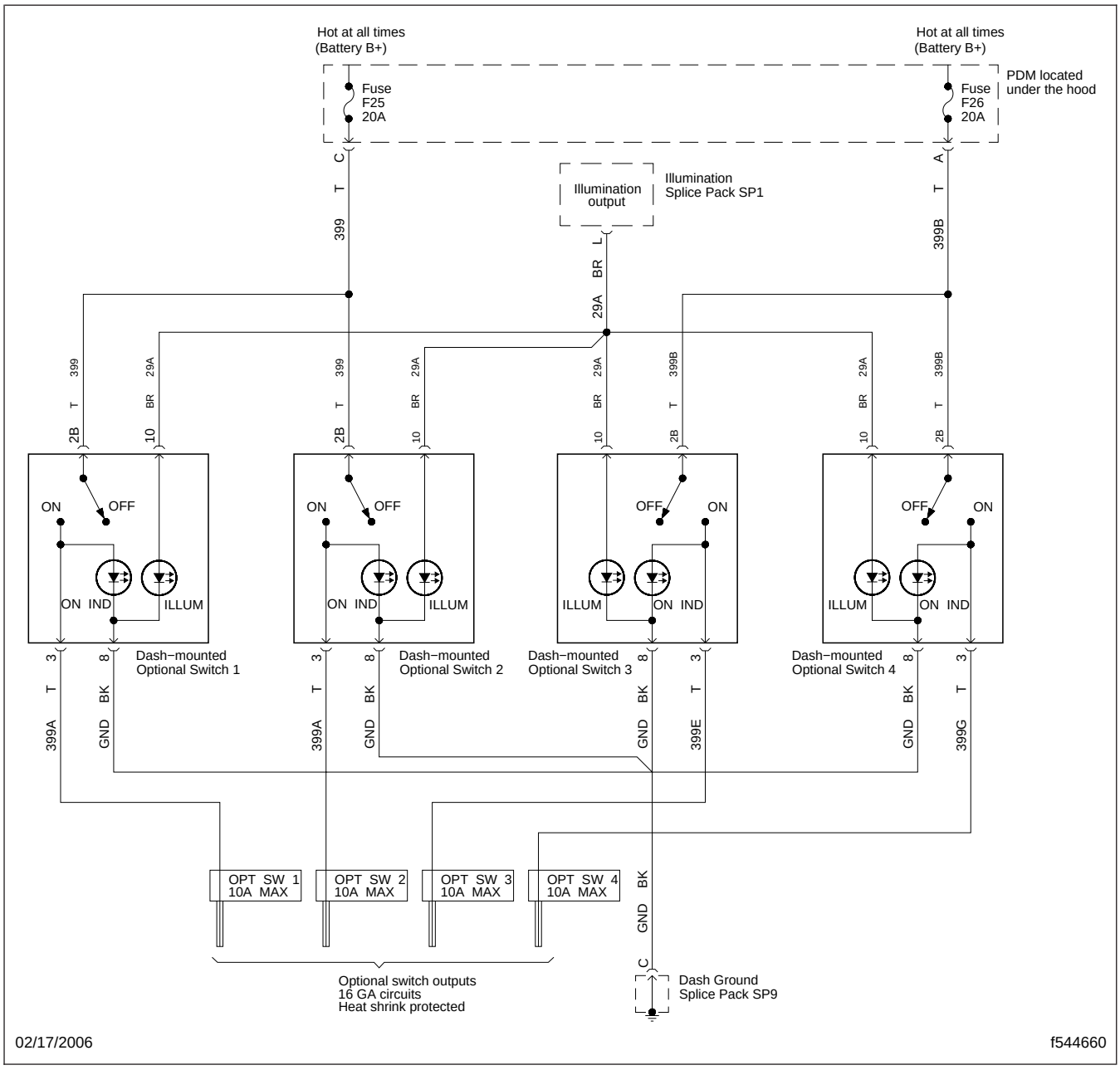


**Fig. 3, Four-Switch Configuration Wiring Diagram**

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## Specifications

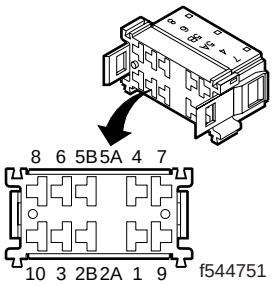
| Optional Switch Connector | | | | |
|---|---|---|---|---|
| **Connector Pin** | **Signal Name** | **Signal Type** | **Circuit Color** | **Circuit Number** |
|  | | | | |
| 1 | — | — | — | — |
| 2B | Fused Battery Power | Input | T | 399 for optional switches 1 and 2. 399B for optional switches 3 and 4. |
| 3 | Optional Switch Output | Output | T | 399A for optional switch 1. 399C for optional switch 2. 399E for optional switch 3. 399G for optional switch 4. |
| 4 | — | — | — | — |
| 5B | — | — | — | — |
| 6 | — | — | — | — |
| 7 | — | — | — | — |
| 8 | Ground | Ground | BK | GND |
| 9 | — | — | — | — |
| 10 | Illumination Feed | Input | BR | 29A |

**Table 1, Optional Switch Connector**

| Replacement Parts | | |
|---|---|---|
| **Description** | **Freightliner Part Number** | **Vendor Part Number** |
| Optional Switch | A06-03769-014 | — |
| Eaton Connector | ETN285623 | 285623 |
| Packard Metri-Pack 630 Terminal | PAC12015869 | 12015869 |

**Table 2, Replacement Parts**

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# Background Information

Chassis electrical control systems are optional features on a Business Class® M2 vehicle. These features include:

- interaxle lock
- axle shift
- suspension dump
- fifth wheel slide
- tag/pusher axle lift
- differential lock

The chassis electrical control systems are similar in their electronic operation and control. Most of these systems are activated by dash-mounted smart switches.

Smart switches contain internal resistors that communicate switch identification, location, function, and activation positions. Smart-switch signals are sent directly to the Bulkhead Module (BHM). The BHM reads the smart-switch resistor codes and communicates the necessary signals that request system operation.

Each smart switch is equipped with two light-emitting diodes (LED). One LED provides switch illumination while the other indicates when the switch is on and the system is activated. For more information concerning smart switches, see **Section 54.14**.

The BHM transmits system control requests via the J1939 data line to the Chassis Module (CHM). The CHM uses low-current outputs and digital inputs to control and monitor the different chassis electrical control systems.

# Interaxle Lock

The interaxle lock is available on a vehicle with a tandem axle or a tri-drive axle. When activated, the interaxle differential is locked. This essentially makes the driveshaft a solid connection between the rear axles. Power entering the forward axle is transmitted straight through to the rear axle. Driveline torque is now delivered equally between the rear drive axles. In slippery conditions, without the interaxle lock activated, one drive axle receives the majority of the driveline torque when its wheels lose traction; however, with the interaxle lock activated, the rear drive axles spin equally and improve traction by turning all rear wheels at the same speed.

NOTE: Operating the vehicle with the interaxle lock activated under normal driving conditions increases driveline and tire wear. The interaxle lock should be used only when improved traction is needed.

## Interaxle Lock Controls

With the engine running, the interaxle lock can be activated using a momentary, two-position smart switch. Press the upper half of the interaxle lock switch to activate the interaxle lock. Press the upper half of the interaxle lock switch again to deactivate the interaxle lock. See **Fig. 1**. If the interaxle lock is activated and the engine is then turned off, the system will deactivate the interaxle lock.

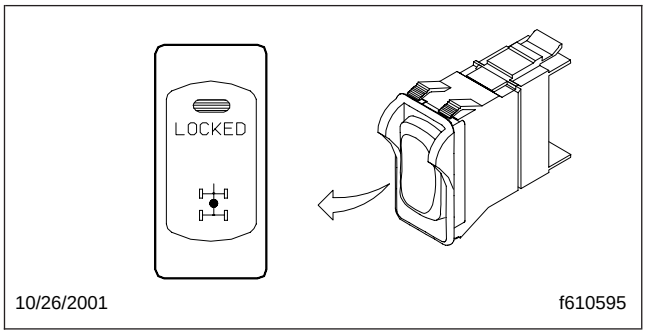


**Fig. 1, Interaxle Lock Switch**

When the interaxle lock switch is activated, the CHM transmits a low-current output to a normally closed air management unit (AMU) solenoid. On auxiliary air valve assembly (AAVA) vehicles, the solenoid current is about 1.5 amps. The 2010 CHM does not have the current sourcing ability to drive these solenoids, so a relay in the chassis PDM is added to the circuit. The energized AMU/AAVA solenoid opens and supplies compressed air to the forward rear axle differential housing. The air sent to the housing applies a lock to the interaxle differential causing all driveline torque to be shared equally by the rear axles.

Feedback from the AMU/AAVA solenoid is required for correct operation of the interaxle lock controls. Feedback is provided by a ground input to the CHM. The ground input is delivered when the pressure switch closes. On AAVA-equipped vehicles, the pressure switch is in the air line. On AMU equipped vehicles, the pressure switch is in the AMU module. A

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grounded feedback circuit from the closed pressure switch indicates that the interaxle lock is activated and pressure is being supplied to the interaxle lock. An open feedback circuit indicates that the interaxle lock is not activated, or there is a malfunction; the interlock switch is turned on but the pressure switch is still open.

On a vehicle with a two-speed tandem axle, the electronic controls of the interaxle lock need to take into account the range position of the axles. Both axles must be in the same state (either high or low range) for the interaxle lock to be turned on or remain activated.

The electronic controls of the interaxle lock incorporate axle range position input as well as a second pressure-switch feedback to the CHM. Utilizing the feedback from the axle and pressure switches, the control logic provides a time delay to ensure proper function and to prevent damage. Once the interaxle lock is activated, any axle-range change may cause the interaxle lock to deactivate. A shift made from one range to another while the interaxle lock is activated requires that both axles reach the change state quickly before feedback indicates that the axles are not in the same drive range. For a description of the axle shift feature, see the information under the "Axle Shift" heading in this subject.

## Axle Shift

Two-speed axle shift is an option available on a vehicle with a single or tandem axle. This option is available on a vehicle with a manual or automatic transmission; however, nonmultiplexed controls are only available on a vehicle with a manual transmission. A vehicle with a two-speed axle allows the operator to shift the drive axle between high and low gear ranges. At any time, the operator may change axle speeds to take mechanical advantage of different driving conditions.

NOTE: Since axle speed can be changed at any time, it is the driver's responsibility to ensure that axle speed selection is not done under harmful conditions, such as selecting low gear when the engine is at high rpm.

### Multiplexed Controls

Multiplexed controls for the two-speed axle are available on a vehicle with a manual or automatic transmission. With the engine running, the two-speed axle is shifted between high and low ranges by a momentary, two-position smart switch. Press the upper half of the axle shift switch to change the axle speed. See **Fig. 2**. If the engine is turned off, then restarted, the two-speed axle will default to low range.

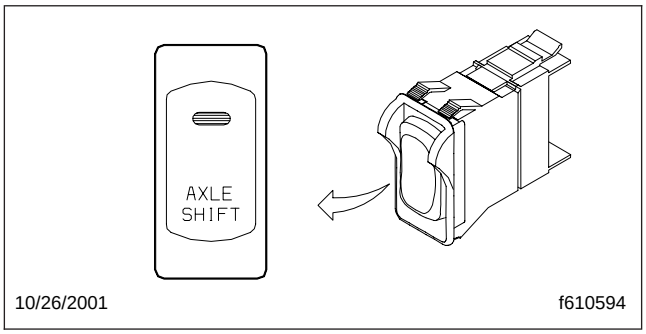


**Fig. 2, Axle Shift Switch**

When the axle shift switch is activated, the CHM transmits a low-current output to a normally closed air management unit (AMU) solenoid. On AAVA vehicles, the solenoid current is about 1.5 amps. The 2010 CHM does not have the current sourcing ability to drive these solenoids, so a relay in the chassis PDM is added to the circuit. The energized solenoid opens and supplies compressed air to the gear housing. The air sent to the housing shifts the axle into high gear. Pressing the axle shift switch again directs the CHM to remove the current supply to the AMU/AAVA solenoid, which stops the air supply to the gear housing. With a no-air condition at the housing, the axle shifts into low gear.

Feedback to the CHM is provided by switches located on each drive axle. When an axle shifts into the low-speed range, the axle switch closes and completes a ground signal to the CHM. The CHM uses the feedback signal(s) to determine if the system is functioning properly (axle shift switch confirms axle shift switch selection), or if there is a malfunction (axle shift switch does not confirm axle shift switch selection). Each rear axle of a tandem-axle vehicle has its own AMU/AAVA solenoid and axle switch. The CHM also monitors the feedback of both axle shift switches to make sure that the rear axles are in the same speed range.

Two-speed axle feedback is also provided to the Engine Control Module (ECM). For the MBE900 engine, the system provides axle position input via the J1939 data line messages between the CHM, BHM, and

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ECM. For other engine configurations, the system controls a relay that provides a ground input as the ECM feedback. With the system set for low range, the relay coil receives no power and a ground input is provided to the ECM through the closed switch contacts of the relay. The operating power for this relay is provided by a splice connection into the CHM output that also controls the the AMU/AAVA solenoid. Pressing the axle shift switch shifts the axle to high range which causes the CHM to power both the the AMU/AAVA solenoid and the relay. The energized relay swings the switch contacts open and removes the ground signal from the ECM, thus communicating that the axle is in high range.

## Nonmultiplexed Controls

On a vehicle with a manual transmission, the axle shift switch that activates the two-speed axle is built into the transmission shift knob. Because of the axle shift switch location, the controls are nonmultiplexed. The switch signals go directly to the AMU/AAVA solenoid that supplies the airflow to shift the two-speed axle. The axle shift switch operates as a two-position, latching switch with selections for low or high speed ranges. If the engine is turned off, then restarted, the two-speed axle defaults to low range.

With the engine running, selecting high range with the axle shift switch within the transmission shift knob closes the switch contacts and supplies power to a normally closed AMU/AAVA solenoid. The energized solenoid opens and supplies compressed air to the gear housing. The air sent to the housing shifts the axle into high gear. Selecting low range with the control switch opens the switch contacts and removes the power supply to the AMU/AAVA solenoid, stopping the air supply to the gear housing. With a no-air condition at the housing, the axle shifts into low gear.

For nonmultiplexed two-speed axle controls, axle range feedback is supplied to the ECM. An axle switch controls a relay that delivers a ground input to the ECM. The absence or presence of this ground signal indicates to the ECM what gear range the axle is in. In low range, the axle switch closes and completes a ground path for the relay. Since the relay receives power from a BHM-powered splice pack, the completed ground path through the axle switch allows the relay to energize. In high range, the relay is not energized because the axle shift switch is open and the relay is not grounded.

# Suspension Dump

The suspension dump is available on a vehicle with rear air suspension. When activated, the suspension dump deflates the suspension air bags to lower the rear of the vehicle. Most vehicles with a suspension dump have an automatic refill that will inflate the rear suspension when the engine is turned off.

NOTE: To protect the chassis, the suspension dump is turned off when the vehicle speed reaches approximately 5 mph (8 km/h).

The suspension dump is available in two options. The first option has a lock solenoid that keeps the suspension in the last selected state when the engine is turned off. The second option does not have a lock solenoid; when the engine is turned off, the suspension inflates.

## Suspension Dump Controls

With the engine running, the suspension dump can be activated using a momentary, two-position smart switch. Press the upper half of the suspension dump switch to deflate the suspension air bags and lower the rear of the vehicle. Press the upper half of the suspension dump switch again to raise the suspension to its normal height. See **Fig. 3**. The rear suspension also inflates when:

- Vehicle speed reaches approximately 5 mph (8 km/h);
- The engine is turned off and the autofill feature activates.

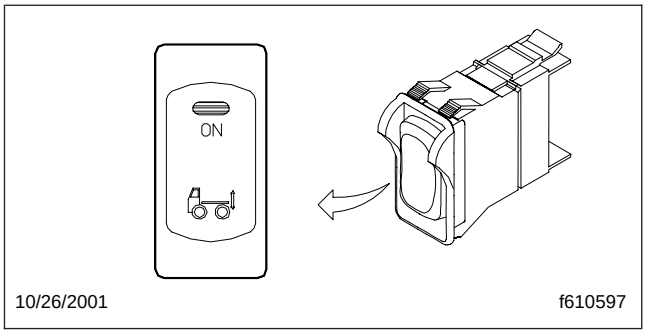


**Fig. 3, Suspension Dump Switch**

When the suspension dump switch is activated, the CHM transmits a low-current output to a normally closed air management unit (AMU) solenoid. On AAVA vehicles, the solenoid current is about 1.5

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amps. The 2010 CHM does not have the current sourcing ability to drive these solenoids, so a relay in the chassis PDM is added to the circuit. The energized solenoid opens and directs air flow by means of a three-port valve. An open solenoid removes the air supply to the rear suspension and vents the existing suspension pressure, allowing the rear of the vehicle to be lowered.

Feedback from the suspension dump solenoid air circuit is required for correct operation of the suspension dump controls. Feedback is provided by a ground input to the CHM. The input is at ground when a pressure switch within the AMU solenoid closes. On AAVA-equipped vehicles, the pressure switch is in the air line. A grounded feedback circuit from the closed pressure switch indicates that the system is activated. An open feedback circuit indicates that the suspension dump is not activated (suspension dump switch is not turned on), or there is a malfunction (suspension dump switch is turned on but the pressure switch is still open).

On a suspension dump with a lock solenoid, there is a second normally open AMU/AAVA solenoid that activates a double check valve in the rear suspension air supply. This valve keeps the rear suspension in the last selected state when the engine is turned off. This feature permits an override of the automatic refill, allowing the suspension to stay lowered. The lock solenoid receives power through a BHM-supplied splice pack.

A remote-activation switch is commonly installed in ambulances so that the suspension dump can be activated when the rear door opens. Freightliner provides a circuit that the body builder uses to install a remote-activation switch. The remote-activation switch is usually located at the rear of the ambulance. The remote-activation switch receives power through a direct wiring connection to the BHM.

# Fifth Wheel Slide

A sliding fifth wheel is an option on an M2 vehicle. A sliding fifth wheel allows the weight of the trailer to be transferred between the tractor axles, thereby increasing or decreasing the distance between the front of the trailer and the back of the cab. A sliding fifth wheel can be adjusted to allow enough distance between the trailer and the cab to prevent the trailer from hitting the cab during a turn.

## Fifth Wheel Slide Controls

With the engine running, the fifth wheel slide can be activated using a momentary, two-position smart switch. Pressing the upper half of the fifth wheel slide switch activates the fifth wheel slide. Pressing the upper half of the fifth wheel slide switch again deactivates the fifth wheel slide. See **Fig. 4**. If the fifth wheel slide is activated and the engine is turned off, the system will deactivate the fifth wheel slide. Drivers may activate the fifth wheel slide when vehicle speeds are below 8 mph (13 km/h). The fifth wheel slide automatically deactivates when the vehicle reaches speeds greater than 10 mph (16 km/h).

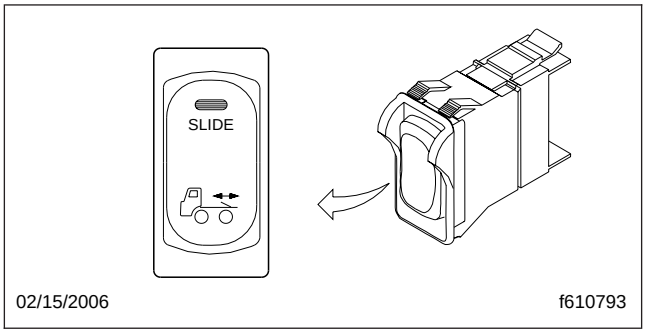


**Fig. 4, Fifth Wheel Slide Switch**

When the fifth wheel slide switch is activated, the CHM activates a low-current output to a normally closed air management unit (AMU) solenoid. On AAVA vehicles, the solenoid current is about 1.5 amps. The 2010 CHM does not have the current sourcing ability to drive these solenoids, so a relay in the chassis PDM is added to the circuit. The energized solenoid opens and supplies pressurized air to an air cylinder located on the fifth wheel. The cylinder operates a mechanical linkage that moves two plunger arms that are used to lock the fifth wheel in position. The spring return plungers are located on each rail of the fifth wheel mounting assembly. When the air cylinder is pressurized, the plungers withdraw and the fifth wheel is free to slide along the mounting rails. When the fifth wheel slide is deactivated, the springs on the linkage arms return the plungers to a lock position on the rails. See **Fig. 5**.

Feedback from the fifth wheel slide air cylinder circuit is required for correct operation of the fifth wheel slide controls. Feedback is provided by a ground input to the CHM. The ground input is delivered when a pressure switch within the AMU solenoid closes. On AAVA-equipped vehicles, the pressure

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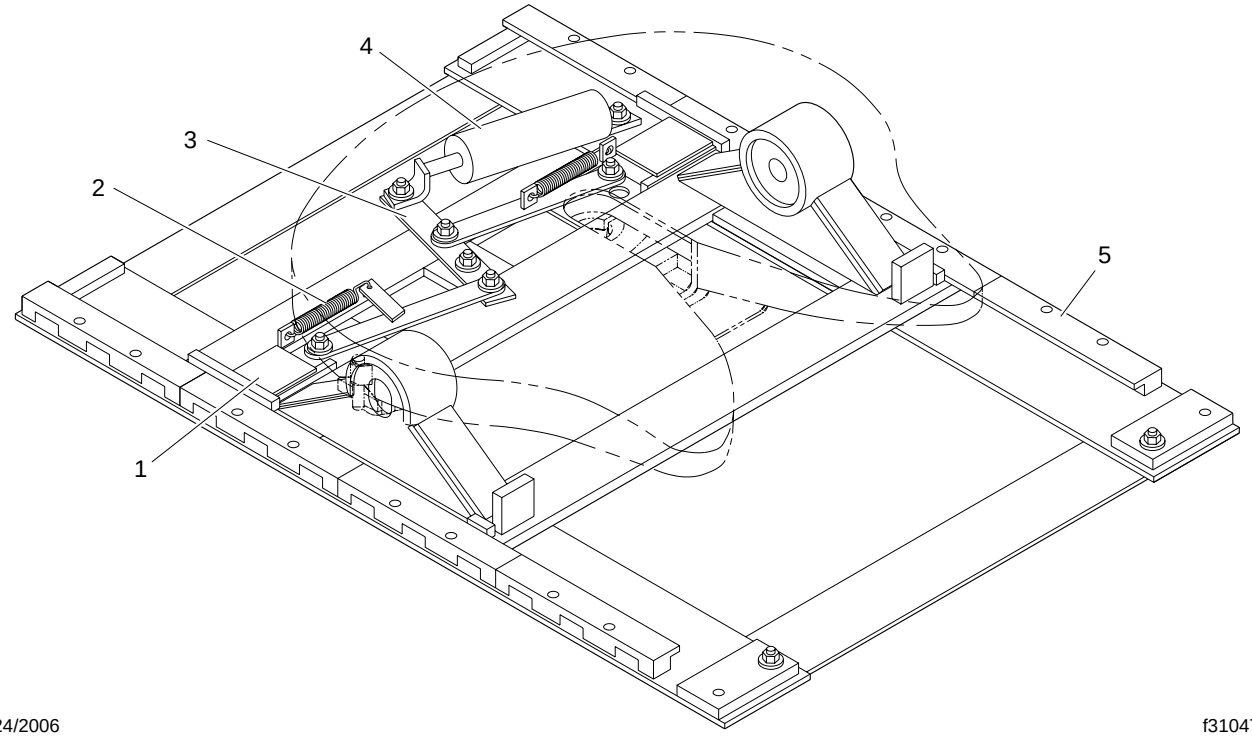


1. Lock Plunger
2. Return Spring
3. Control Linkage
4. Air Cylinder
5. Slide Rail

**Fig. 5, Fifth Wheel Slide Assembly**

switch is in the air line. A grounded feedback circuit from the closed pressure switch indicates that the fifth wheel slide is activated and pressure is being supplied to the fifth wheel slide air cylinder. An open feedback circuit indicates that the fifth wheel slide is not activated, or there is a malfunction; the fifth wheel slide is turned on but the pressure switch is still open.

## Tag/Pusher Axle Lift

Tag and pusher axles are available on a variety of M2 vehicles. Tag and pusher axles are free-spinning axles that are not part of the vehicle drivetrain. Using air pressure, these axles are raised or lowered on the vehicle chassis.

When lowered, tag and pusher axles increase the weight capacity of a vehicle by distributing the vehicle load over more wheels. When increased weight capacity is not needed, the operator can raise the axle and save wear on the tires and axle. Tag axles are located behind the rear drive axles. Pusher axles are located in front of the rear drive axles. The control system for operating a tag or pusher axle is commonly referred to as axle lift.

Tag and pusher axles may only be lowered at vehicle speeds slower than 5 mph (8 km/h), but may be raised at any speed. To avoid damage to a tag or pusher axle, most axle lift controls automatically raise the axle when the vehicle is backing up. The tag or pusher axle returns to the lowered position when the vehicle is shifted out of reverse.

A vehicle with a reverse caster axle does not automatically raise the axle when backing up. These axles have air controls that change the caster angle of the axle to allow the axle to self-steer according to the direction of travel. Shifting the vehicle into reverse prompts the CHM to signal a caster angle change. With the axle's caster angle adjusted so that

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If a leak exists in the system and it cannot be traced to other parts or fittings, suspect damage to one of the evaporator coils.

## Condenser

The condenser is usually trouble-free. Normally, the temperature of the condenser outlet line is noticeably cooler than the inlet line. However, when road debris such as leaves or dirt build up, the airflow over the condenser fins is blocked. Air is not able to absorb enough heat to turn the hot refrigerant gas into a liquid. High head pressures will result. In these cases, carefully clean the outer surfaces of the condenser with compressed air or a soap and water solution. Be careful not to bend the fins.

High head pressures will also occur if the condenser tubing is abnormally bent, blocking the flow of refrigerant. Frost will appear at the point where the flow is restricted.

Less common internal blockages, such as bits of foreign material or metallic grit buildup, will stop the flow of refrigerant.

When troubleshooting a suspected condenser problem, remember that the problem may be caused by the radiator transferring high levels of heat to the condenser. See **Group 20** of this manual for cooling system troubleshooting, and see the engine manufacturer's service manual for other information about cooling system problems.

## Line Restrictions

A restricted suction line causes low suction pressure at the compressor and little or no cooling. A restriction in a line between the compressor and the expansion valve can cause high discharge and low suction pressure, and insufficient cooling.

Areas of ice or frost buildup usually mean a blockage. Parts that often freeze are probably corroded or inoperative and should be replaced. Parts, such as the expansion valve, that freeze once in a while may do so because of moisture in the system. If this happens, recover the refrigerant charge, evacuate/recycle the system refrigerant, replace the receiver-drier, and recover, evacuate, and charge the system with refrigerant.

## Temperature Blend Door Actuator Circuit Tests

The temperature blend door actuator controls the amount of air that is routed through the heater core. The temperature blend door actuator is controlled by the temperature control switch on the control head (climate control panel). The control head senses the door position by reading the feedback voltage from the actuator position sensor. The feedback voltage will be less than the 5V reference voltage sent by the control head to the sensor.

The target position is based on the temperature control switch setting and internal control head algorithms. The desired position is considered reached when one of the following conditions is true, although this does not necessarily mean that the position actually corresponds to the desired temperature setting (for example, if the actuator movement is limited due to an obstruction).

- The actuator feedback position has been reached.
- The actuator is stalled for more than 1 second; the actuator feedback position does not change for more than 1 second.
- The target position corresponds to an end stop and an additional 1 second extra drive in the same direction (to guarantee sealing) has been performed.

The temperature blend door should move from one extreme position to the other when turning the temperature control switch from cold to hot or from hot to cold.

Follow the tests in **Table 3** in the sequence presented. The directions under the column "What to Do if Test Fails" are sometimes dependent on good results from previous tests. If any of the tests fail, stop and perform the specified repair or check. If the temperature blend door actuator passes the tests in **Table 3** and the actuator still does not operate properly, check for mechanical problems with the actuator.

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| Temperature Blend Door Actuator Circuit Tests | | | | |
|---|---|---|---|---|
| **Test** | **Conditions** | **Test Point** | **Good Result** | **What to Do if Test Fails** |
| actuator motor drive circuit | key on, engine off<br>temperature blend door actuator connector removed<br>fan (blower) switch on low<br>change temperature setting while observing the digital multimeter (DMM) | Measure across pins 5 and 6 of the temperature blend door actuator connector. | 9V+ for about 1 second* | Check wiring between control head and temperature blend door actuator.<br>If wiring is okay, replace the control head. |
| actuator position sensor reference voltage circuit | key on, engine off<br>temperature blend door actuator connector removed | Measure between pin 7 of the temperature blend door actuator connector and the battery negative post. | 5V | |
| actuator position sensor reference ground circuit | key on, engine off<br>temperature blend door actuator connector removed | Measure between pin 8 of the temperature blend door actuator connector and the battery positive post. | 12V* | |
| actuator position sensor feedback signal circuit | key on, engine off<br>all connectors connected | Backprobe pins B11 and B5 at control head connector. | 0.50V (full hot) to 4.00V (full cold)† | Check wiring between control head and temperature blend door actuator.‡<br>If wiring is okay, replace the actuator.‡ |

* The voltage should be approximately the same as the battery voltage.

† Values are approximate.

‡ It is assumed that reference voltage and ground circuits are functioning.

**Table 3, Temperature Blend Door Actuator Circuit Tests**

## Air Distribution Door Actuator Circuit Tests

The air distribution (mode) door actuator controls the direction the air is routed through the HVAC ducts in the cab. The air distribution door actuator is controlled by the air selection switch on the control head (climate control panel). The control head senses the air distribution door position by reading the feedback voltage from the actuator position sensor. The feedback voltage will be less than the 5V reference voltage sent by the control head to the sensor.

The target position is based on the air selection switch setting and internal control head algorithms. The desired position is considered reached when one of the following conditions is true, although this does not necessarily mean that the position actually corresponds to the desired air selection setting (for example, if the actuator movement is limited due to an obstruction).

- The actuator feedback position has been reached.
- The actuator is stalled for more than 1 second; the actuator feedback position does not change for more than 1 second.
- The target position corresponds to an end stop and an additional 1 second extra drive in the same direction (to guarantee sealing) has been performed.

The air distribution door should move from one extreme position to the other when turning the air selection switch from the far left to the far right or from the far right to the far left.

Follow the tests in **Table 4** in the sequence presented. The directions under the column "What to Do if Test Fails" are sometimes dependent on good results from previous tests. If any of the tests fail, stop and perform the specified repair or check. If the air distribution door actuator passes the tests in **Table 4**

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and the actuator still does not operate properly, check for mechanical problems with the actuator. To quickly check for normal operation, feel for air flowing from the correct outlet in each air selection setting.

| Air Distribution Door Actuator Circuit Tests | | | | |
|---|---|---|---|---|
| **Test** | **Conditions** | **Test Point** | **Good Result** | **What to Do if Test Fails** |
| actuator motor drive circuit | key on, engine off<br>air distribution door actuator connector removed<br>fan (blower) speed on low<br>change the air selection setting while observing the digital multimeter (DMM) | Measure across pins 5 and 6 of the air distribution door actuator connector. | 9V+ for about 1 second* | Check wiring between control head and air distribution door actuator.<br>If wiring is okay, replace the control head. |
| actuator position sensor reference voltage circuit | key on, engine off<br>air distribution door actuator connector removed | Measure between pin 10 of the air distribution door actuator connector and the battery negative post. | 5V | |
| actuator position sensor reference ground circuit | key on, engine off<br>air distribution door actuator connector removed | Measure between pin 8 of the air distribution door actuator connector and the battery positive post. | 12V* | |
| actuator position sensor feedback signal circuit | key on, engine off<br>all connectors connected | Backprobe pins B10 and B5 at control head connector. | 0V (far right) to 5V (far left) | Check wiring between control head and air distribution door actuator.†<br>If wiring is okay, replace the actuator.† |

* The voltage should be approximately the same as the battery voltage.

† It is assumed that reference voltage and ground circuits are functioning.

**Table 4, Air Distribution Door Actuator Circuit Tests**

## Recirculation Door Actuator Circuit Tests

The recirculation door actuator controls the source of the air, fresh or recirculated, that is routed through the HVAC ducts in the cab. The recirculation door actuator is controlled by the recirculation button on the control head (climate control panel).

Vehicles built from May 2, 2003, have partial recirculation. For information on this feature, see **Subject 050**.

The control rules for the recirculation mode are as follows:

- The recirculation mode is not available in the defrost settings.
- The default at power up is fresh air unless the fan switch is in the off position. When the fan switch is in the off position, the recirculation mode is the default mode, but the LED is not illuminated.
- When the recirculation mode is enabled, it will remain on until one of the following occurs:
  - the air selection switch is moved to a defrost mode;
  - the recirculation button is pressed;
  - the ignition is cycled;
  - 20 minutes have passed and the recirculation timer has expired.

NOTE: On vehicles built prior to May 2, 2003, the recirculation mode is canceled until the recirculation button is pressed again. On vehicles built from May 2, 2003, the system enters partial recirculation mode for five minutes, then re-

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sumes full recirculation mode for 20 minutes. This cycle repeats as long as the system remains in recirculation mode.

The control head senses the recirculation door position by reading the feedback voltage from the actuator position sensor. The feedback voltage will be less than the 5V reference voltage sent by the control head to the sensor.

The target position is based on the recirculation button setting and internal control head algorithms. The desired position is considered reached when one of the following conditions is true, although this does not necessarily mean that the position actually corresponds to the desired recirculation button setting (for example, if the actuator movement is limited due to an obstruction).

- The actuator feedback position has been reached.
- The actuator is stalled for more than 1 second; the actuator feedback position does not change for more than 1 second.
- The target position corresponds to an end stop and an additional 1 second extra drive in the same direction (to guarantee sealing) has been performed.

The recirculation door should move from one extreme position to the other when the recirculation button is pressed on and then pressed off.

Perform the tests in **Table 5** in the sequence presented. The directions under the column "What to Do if Test Fails" are sometimes dependent on good results from previous tests. If any of the tests fail, stop and perform the specified repair or check. If the recirculation door actuator passes the tests in **Table 5** and the actuator still does not operate properly, check for mechanical problems with the actuator. To quickly check for normal operation, set the fan switch to high and listen for a change in the sound of the blower near the HVAC unit while pressing the recirculation button on and off. The blower will be louder when recirculation is enabled.

**Recirculation Door Actuator Circuit Tests**

| Test | Conditions | Test Point | Good Result | What to Do if Test Fails |
|---|---|---|---|---|
| actuator motor drive circuit | key on, engine off<br>recirculation door actuator connector removed<br>fan (blower) speed on low<br>change the recirculation setting while observing the digital multimeter (DMM) | Measure across pins 5 and 6 of the recirculation door actuator connector. | 9V+ for about 1 second* | Check wiring between control head and recirculation door actuator.<br>If wiring is okay, replace the control head. |
| actuator position sensor reference voltage circuit | key on, engine off<br>recirculation door actuator connector removed | Measure between pin 10 of the recirculation door actuator connector and the battery negative post. | 5V | |
| actuator position sensor reference ground circuit | key on, engine off<br>recirculation door actuator connector removed | Measure between pin 8 of the recirculation door actuator connector and the battery positive post. | 12V* | |

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## Troubleshooting

| Recirculation Door Actuator Circuit Tests | | | | |
|---|---|---|---|---|
| **Test** | **Conditions** | **Test Point** | **Good Result** | **What to Do if Test Fails** |
| actuator position sensor feedback signal circuit | key on, engine off<br>all connectors connected | Backprobe pins A11 and B5 at control head connector. | 0.8V (recirc. on) to 4.7V (recirc. off) | Check wiring between control head and recirculation door actuator.†<br>If wiring is okay, replace the actuator.† |

* The voltage should be approximately the same as the battery voltage.

† It is assumed that reference voltage and ground circuits are functioning.

**Table 5, Recirculation Door Actuator Circuit Tests**

# Blower Motor Circuit Tests

The blower motor power and ground are supplied directly to the blower motor assembly. The blower speed is controlled by the fan switch on the control head (climate control panel). The control head sends a pulse width modulated (PWM) signal to the blower motor. The frequency of this signal is 2000 Hz. The pulse width varies with the fan switch selection.

The protection modes for the blower motor are as follows:

- Reverse Voltage Protection—The motor will not operate if the polarity of the motor leads, circuits 98F and ground, are reversed.
- Current Protection—If the motor exceeds the maximum limit, the speed will be reduced until the current is within the limits (23.5A maximum).
- Temperature Protection—If the motor's internal temperature sensor senses that the temperature is too high, the blower speed is reduced to 1000 rpm to reduce the load on the motor and a comparison is made between the sensor reading and the maximum limit. If the temperature is still too high, the blower speed is further reduced to the minimum value of approximately 500 rpm and a temperature comparison is made to the maximum. If, after the second comparison, the temperature is still too high, the motor will shut down until it has cooled sufficiently.

Perform the tests in **Table 6** in the sequence presented. The directions under the column "What to Do if Test Fails" are sometimes dependent on good results from previous tests. If any of the tests fail, stop and perform the specified repair or check. If the blower motor passes the tests in **Table 6** and the blower still does not operate properly, check the blower motor. To quickly check for normal operation, set the fan switch to high and listen for a change in the sound of the blower near the HVAC unit while pressing the recirculation button on and off. The blower will be louder when recirculation is enabled.

| Blower Motor Circuit Tests | | | | |
|---|---|---|---|---|
| **Test** | **Conditions** | **Test Point** | **Good Result** | **What to Do if Test Fails** |
| main power to blower motor | battery switch on (if equipped)<br>key off<br>blower motor connector removed | Measure between pin 4 of blower motor connector and negative battery post. | 12V* | Check fuse F2 in the PDM under the hood. If the fuse is blown, check for shorted wiring or a damaged blower motor.<br>Check for an open in circuit 98F. |

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| Blower Motor Circuit Tests | | | | |
|---|---|---|---|---|
| **Test** | **Conditions** | **Test Point** | **Good Result** | **What to Do if Test Fails** |
| blower motor ground circuit | battery switch on (if equipped)<br>key off<br>blower motor connector removed | Measure between pin 3 of blower motor connector and the positive battery post. | 12V* | Check for an open in blower motor ground circuit. |
| PWM signal from control head | battery switch on (if equipped)<br>key on, engine off<br>blower motor connector disconnected<br>change the fan (blower) speed setting on the control head and observe frequency using the digital multimeter (DMM) | Probe pins 4 and 5 of the blower motor connector, harness side (DMM set to measure frequency). | 0 Hz fan off<br>0 Hz fan on high<br>2000 Hz all other speeds | Check circuit 338H.<br>Check control head. |
| voltage drop (power circuit) | battery switch on (if equipped)<br>key on, engine off<br>all connectors connected<br>fan (blower) speed on high | Backprobe pin 4 at the blower motor connector, other lead on positive battery post. | less than 0.5V | Locate high resistance or open in circuit 98F. |
| voltage drop (ground circuit) | battery switch on (if equipped)<br>key on, engine off<br>all connectors connected<br>fan (blower) speed on high | Backprobe pin 3 at the blower motor connector, other lead on negative battery post. | less than 0.5V | Locate high resistance or open in blower motor ground circuit. |
| blower motor current draw | battery switch on (if equipped)<br>key on, engine off<br>all connectors connected<br>fan (blower) speed on high | Use current clamp around circuit 98F or blower motor ground wire. | less than 23.5A | Check blower motor. |

* The voltage should be approximately the same as the battery voltage.

**Table 6, Blower Motor Circuit Tests**

## Evaporator Probe Circuit Tests

The evaporator temperature sensor is a resistive element, where the resistance increases as the temperature decreases. The control head (climate control panel) uses this sensor to determine the evaporator temperature. The control head uses the temperature information to determine if the A/C compressor should be engaged or not in order to prevent the evaporator core from freezing. As refrigerant flows through the evaporator, condensation will form on the surface of the evaporator. If this condensation freezes because the evaporator temperature is too low, airflow will be restricted through the core and poor cooling will result. The control head will shut off the compressor when the evaporator temperature is near the point where freezing may occur. See **Table 7** for evaporator probe temperature versus resistance values for units manufactured up to and including January 7, 2007. See **Table 8** for evaporator probe temperature versus resistance values for units manufactured on or after January 8, 2007.

Perform the tests in **Table 9** in the sequence presented. The directions under the column "What to Do if Test Fails" are sometimes dependent on good results from previous tests. If any of the tests fail, stop and perform the specified repair or check.

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## Troubleshooting

| Evaporator Probe Temperature/Resistance (up to January 7, 2007) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Temperature | | Resistance: ohms | Temperature | | Resistance: ohms | Temperature | | Resistance: ohms |
| °F | °C | | °F | °C | | °F | °C | |
| 5 | –15 | 36,780 | 66 | 19 | 6500 | 84 | 29 | 4170 |
| 14 | –10 | 27,830 | 68 | 20 | 6210 | 86 | 30 | 3995 |
| 23 | –5 | 21,250 | 70 | 21 | 5935 | 88 | 31 | 3828 |
| 32 | 0 | 16,360 | 72 | 22 | 5673 | 90 | 32 | 3669 |
| 41 | 5 | 12,690 | 73 | 23 | 5426 | 91 | 33 | 3518 |
| 50 | 10 | 9927 | 75 | 24 | 5189 | 93 | 34 | 3373 |
| 59 | 15 | 7823 | 77 | 25 | 4964 | 95 | 35 | 3236 |
| 61 | 16 | 7466 | 79 | 26 | 4751 | 97 | 36 | 3104 |
| 63 | 17 | 7125 | 81 | 27 | 4548 | 99 | 37 | 2979 |
| 64 | 18 | 6805 | 82 | 28 | 4354 | 100 | 38 | 2860 |

**Table 7, Evaporator Probe Temperature/Resistance (up to January 7, 2007)**

| Evaporator Probe Temperature/Resistance (from January 8, 2007) | | | | | |
|---|---|---|---|---|---|
| Temperature: °F (°C) | Resistance: ohms | Temperature: °F (°C) | Resistance: ohms | Temperature: °F (°C) | Resistance: ohms |
| -40 (-40) | 92757 | 41 (5) | 6998 | 122 (50) | 993.2 |
| -31 (-35) | 66870 | 50 (10) | 5485 | 131 (55) | 823.2 |
| -22 (-30) | 48790 | 59 (59) | 4330 | 140 (60) | 685.8 |
| -13 (-25) | 35937 | 68 (20) | 3443 | 149 (65) | 574.2 |
| -4 (-20) | 26757 | 77 (25) | 2757 | 158 70) | 482.9 |
| 5 (-15) | 20103 | 86 (30) | 2221 | 167 (75) | 408.3 |
| 14 (-10) | 15252 | 95 (35) | 1800 | 176 (80) | 346.8 |
| 23 (-5) | 11664 | 104 (40) | 1468 | 185 (85) | 295.6 |
| 32 (0) | 9000 | 113 (45) | 1204 | — | — |

**Table 8, Evaporator Probe Temperature/Resistance (from January 8, 2007)**

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| Evaporator Probe Circuit Tests | | | | |
|---|---|---|---|---|
| **Test** | **Conditions** | **Test Point** | **Good Result** | **What to Do if Test Fails** |
| evaporator temperature probe | key off, engine off<br>sensor probe removed and disconnected<br>fill a cup with ice then add water to make an ice-water bath<br>NOTE: use mostly ice and allow time for temperature to stabilize at 32°F (0°C)<br>place the tip of the evaporator probe in the ice-water bath for 5 minutes before testing—leave the tip immersed while taking the resistance measurement—be sure the meter reading is stable before noting the final measurement | Measure across pins on the temperature probe. | for pre-1-8-07: 16,000 to 16,730Ω at 32°F (0°C)<br>—<br>for 1-8-07 on: 8910 to 9090Ω at 32°F (0°C) | Replace temperature probe. |
| evaporator temperature probe circuit test | battery switch on (if equipped)<br>key on, engine off<br>sensor probe installed, but connector is disconnected | Measure across temperature probe connector terminals. | 5V | Check for an open in circuits 338K and 338GP.<br>If wiring is okay, replace the control head. |

**Table 9, Evaporator Probe Circuit Tests**

## A/C Clutch Circuit Tests for Diagnosing No A/C Clutch Engagement

The A/C compressor clutch is controlled by the control head (climate control panel). When the control head determines that the A/C compressor is required, it grounds the A/C request input to the bulkhead module (BHM). When the BHM receives the A/C request signal from the climate control panel, it will apply power to the A/C clutch output when the following conditions are met—

- engine has been running more than 5 seconds;
- battery voltage is greater than 9.25V;
- low air pressure warning is not active on the ICU;
- A/C clutch has not been engaged in the previous 15 seconds.

NOTE: The **A/C clutch cycle timer strategy** is implemented differently, depending on BHM software versions. With BHM software version 6.1, the total A/C clutch cycle time (on + off time) is a minimum of 15 seconds. This ensures that the A/C compressor does not cycle more than 4 times per minute. With BHM software versions 6.4 and 6.5, the minimum compressor off time is 15 seconds. This means the total cycle time (on + off time) will always exceed 15 seconds. This too, ensures that the A/C compressor does not cycle more than 4 times per minute.

The BHM sends power to energize the A/C clutch. A binary switch is wired into this circuit, which will prevent the compressor clutch from engaging if the refrigerant pressure is too high or too low.

When **all** of the following conditions are met, the control head will send the A/C request signal to the bulkhead module:

- The air selection switch is in one of the A/C or defrost settings, or the recirculation mode is on.

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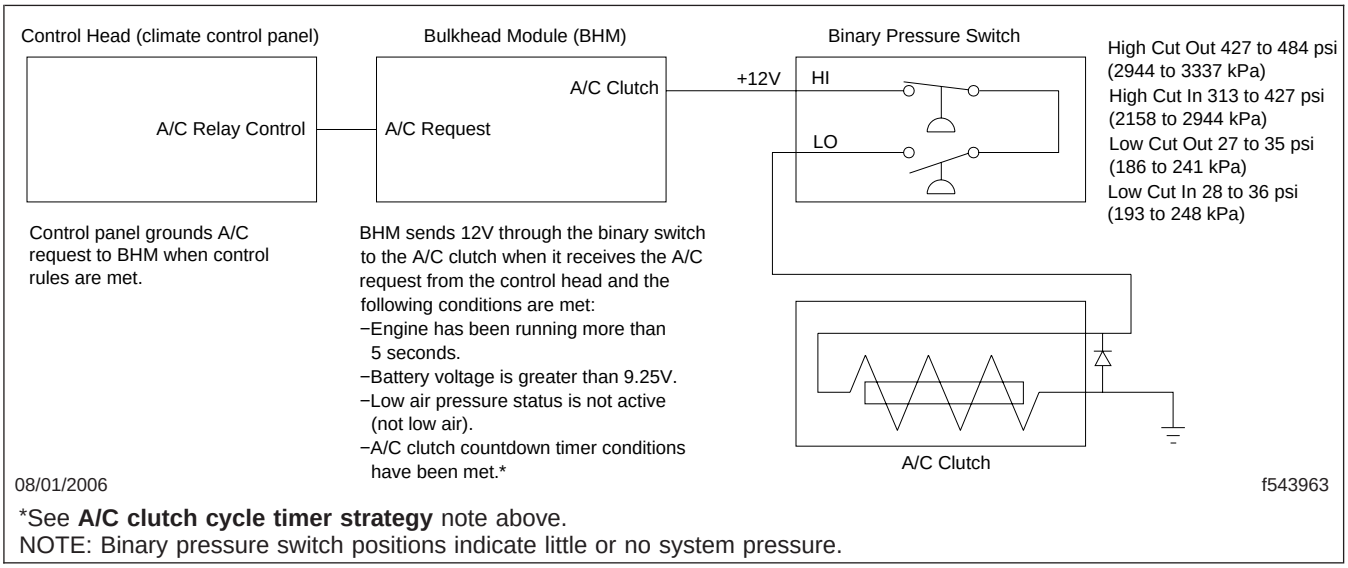
## Troubleshooting

- The fan switch is on any setting other than off.
- The evaporation sensor temperature is above 40.1°F (4.5°C).

When these conditions exist, the control head sends the A/C request signal to the bulkhead module. See **Fig. 2**.

NOTE: The A/C signal will remain active until the evaporator sensor reaches 38.3°F (3.5°C), the fan is turned off, or the air selection switch is taken out of defrost or A/C mode.




*See **A/C clutch cycle timer strategy** note above.
NOTE: Binary pressure switch positions indicate little or no system pressure.

**Fig. 2, A/C Clutch Control Circuit**

See **Table 10** for the A/C clutch circuit tests. Perform the tests in **Table 10** in the sequence presented. The directions under the column "What to Do if Test Fails" are sometimes dependent on good results from previous tests. If any of the tests fail, stop and perform the specified repair or check.

NOTE: If these tests pass and the A/C clutch still will not engage, check the following—

- make sure that the air system does not have an active low air pressure warning;
- make sure that the battery voltage to all BHM inputs is above 9.25V;
- make sure that the engine speed is available (make sure it registers on the tachometer).

## Backlighting Circuit Tests

See **Table 11** for the backlighting circuit tests. Perform the tests in **Table 11** in the sequence presented. The directions under the column "What to Do if Test Fails" are sometimes dependent on good results from previous tests. If any of the tests fail, stop and perform the specified repair or check. If all of the tests pass and the backlighting at the control head still does not operate properly, check the control head.

# Fault Codes

If the A/C clutch is not working, use ServiceLink to check for fault codes. See **Table 12** and **Table 13** for a description of the fault codes.

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| A/C Clutch Circuit Tests for Diagnosing No A/C Clutch Engagement | | | | |
|---|---|---|---|---|
| **Test** | **Conditions** | **Test Point/Method** | **Good Result** | **What to Do if Test Fails** |
| A/C request input | key on, engine on<br>air selection switch in one of A/C settings<br>fan (blower) speed on any setting but off<br>connect ServiceLink and use the "A/C Clutch Function" Datalink Monitor template to see if the A/C request is seen by the BHM | ServiceLink/Datalink Monitor<br>NOTE: Make sure the Datalink Monitor template is **not** in Test Mode. The control head should request A/C. This will cause the "A/C Request" annunciator on the template to indicate that the request is on. If the annunciator does not indicate that a request for A/C is received, check the settings on the control head before proceeding with "What to Do if Test Fails." | A/C request is received by the BHM | Perform the "Evaporator Probe Circuit Tests."<br>Check wiring between the control head and the bulkhead module. Check for an open circuit.<br>Check the control head.<br>Check the bulkhead module. Try to manually ground the A/C request input while observing the template to confirm. |
| A/C clutch circuit* | key on, engine off<br>connect ServiceLink and use the "A/C Clutch Function" Datalink Monitor template to manually actuate the A/C clutch output | ServiceLink/Datalink Monitor<br>NOTE: Put the template in "Test Mode" and actuate the A/C clutch by selecting the button for "Clutch On." You should hear a distinct click when the clutch engages. The A/C clutch annunciator (BHM to clutch) should turn on when the output is energized. If this annunciator indicates that the output is on but the clutch does not engage, then the problem is in the A/C clutch circuit and not with the BHM. If the A/C clutch annunciator does not indicate that the output is energized when the output is turned on and the clutch does not engage, then the problem is with the BHM. | A/C clutch should engage | Check continuity across the binary switch. If the circuit is open, check if the refrigerant pressure is within operating range of the binary switch. (Refrigerant pressure may be very low or too high.) If pressures are okay, replace binary switch.<br>Check for faulty wiring.<br>Check for faulty A/C clutch ground circuit.<br>Check for faulty A/C clutch coil (coil resistance should be 3Ω ±0.5Ω).<br>Check for faulty BHM (see note in Test Point/Method column). |

* Circuit faults with the A/C clutch output may generate bulkhead module fault codes.

**Table 10, A/C Clutch Circuit Tests for Diagnosing No A/C Clutch Engagement**

| Backlighting Circuit Tests | | | | |
|---|---|---|---|---|
| **Test** | **Conditions** | **Test Point** | **Good Result** | **What to Do if Test Fails** |
| backlighting circuit ground test | battery switch on (if equipped)<br>key off, engine off<br>control head connector disconnected | Measure between pin B8 of the control head connector and the positive battery post. | 12V* | Check for an open in the control head ground circuit. |

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## Troubleshooting

| Backlighting Circuit Tests | | | | |
|---|---|---|---|---|
| **Test** | **Conditions** | **Test Point** | **Good Result** | **What to Do if Test Fails** |
| backlighting power test | battery switch on (if equipped)<br>key off, engine off<br>control head connector disconnected<br>headlight switch on | Measure voltage between pins A2 (positive lead) and B8 (negative lead) on the control head connector while toggling the dimmer switch between full dim and full bright. | voltage should be about 1.2V at full dim and 10.8V at full bright | Check circuit 29A for an open/short.<br>If okay, refer to **Group 54** for further diagnosis. |
| backlighting pulse width modulated (PWM) signal test | battery switch on (if equipped)<br>key off, engine off<br>control head connector disconnected<br>headlight switch on | Measure frequency between pins A2 and B8 on the control head connector. | 400 Hz | Check circuit 29A for an open/short.<br>If okay, refer to **Group 54** for further diagnosis. |

* The voltage should be approximately the same as the battery voltage.

**Table 11, Backlighting Circuit Tests**

| J1587 Fault Codes, HVAC (bulkhead module related) MID 164 | | | | |
|---|---|---|---|---|
| **MID** | **SID** | **FMI** | **Fault Description** | **Action** |
| 164 | 057 | 05 | A/C clutch output open circuit (low current) | Check circuit 98A for an open circuit.<br>Check binary switch; it may be open. If open, check for low or high refrigerant pressure. Also check the switch itself.<br>Check A/C clutch coil for an open circuit. |
| | | 06 | A/C clutch output shorted to ground (high current) | Check circuit 98A for a short to ground. |

**Table 12, J1587 Fault Codes, HVAC (bulkhead module related) MID 164**

| J1939 Fault Codes, HVAC (bulkhead module related) Source Address (SA) 33 | | | | |
|---|---|---|---|---|
| **SA** | **SPGN** | **FMI** | **Fault Description** | **Action** |
| 33 | 1550 | 05 | A/C clutch output open circuit (low current) | Check circuit 98A for an open circuit.<br>Check binary switch; it may be open. If open, check for low or high refrigerant pressure. Also check the switch itself.<br>Check A/C clutch coil for an open circuit. |
| | | 06 | A/C clutch output shorted to ground (high current) | Check circuit 98A for a short to ground. |

**Table 13, J1939 Fault Codes, HVAC (bulkhead module related) Source Address (SA) 33**

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## Refrigerant

**WARNING**

**R–134a is the only refrigerant that is approved for use on Freightliner vehicles. Several companies offer less expensive, hydrocarbon-based refrigerant, such as propane and methane. Use of these refrigerants will void the warranty on the air conditioning system, cause damage to the air conditioning system, and possibly result in personal injury or property damage. Leaking air conditioning systems charged with hydrocarbon-based refrigerants pose a serious risk of fire or explosion under the hood, or inside the passenger compartment. No vehicle built by Freightliner Trucks can be safely charged with hydrocarbon-based refrigerants, regardless of what the refrigerant supplier states.**

When servicing an air conditioning system, always use a refrigerant identifier to ensure that the system has not been charged with something other than R–134a. This should be standard practice since there is no way to tell what services have been previously performed. Identification by service technicians will help to avoid the risk of explosion and help to guard against contamination of equipment when refrigerant is recovered and recycled.

Refrigerant recovery/charge stations can be purchased from:

SPX Kent-Moore
28635 Mound Road
Warren, Michigan 48092-3499
1-800-328-6657

The vehicle's refrigerant charge level is printed on a sticker in the engine bay, on the right side of the vehicle. If the sticker is missing, check Group 83 in PartsPro (module/subgroup 700) for the proper sticker and charge information, using the vehicle's serial number.

## Refrigerant Oil

IMPORTANT: Using the wrong refrigerant oil in the HVAC system will prevent proper lubrication, and may cause early failure of system components. Always verify that the correct oil is being used in the system. See **Table 1** for refrigerant oil specifications.

| Refrigerant Oil Specification | |
|---|---|
| **Refrigerant Oil** | **Capacity** |
| Sanden PAG SP–20 or SP–15 | 10 fl oz (300 mL) |

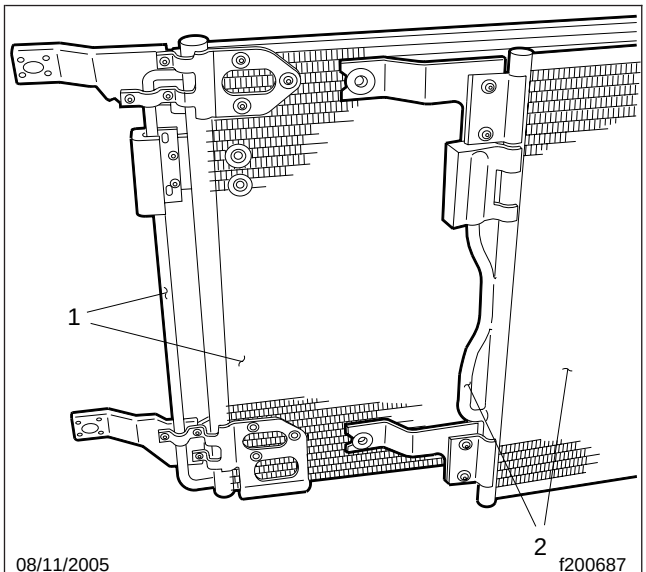
**Table 1, Refrigerant Oil Specification**

## Temperature/Pressure Specification Tables (pre-EPA07 vehicles)

### Determining Cooling Package Size

Before using the temperature/pressure specifications in **Table 2**, **Table 3**, **Table 4**, and **Table 5**, determine whether the vehicle has a small cooling package or a large cooling package, and what brand of condenser is installed. This can be done by looking at the condenser size and the condenser mounting location.

- See **Fig. 1** for an illustration that shows the difference between the Behr and Modine condensers.




1. Behr Condenser
2. Modine Condenser

**Fig. 1, Behr and Modine Condensers**

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## Specifications

- Small Cooling Package: The condenser is mounted below the charge air cooler and does not cover the entire face of the radiator. See **Fig. 2**.

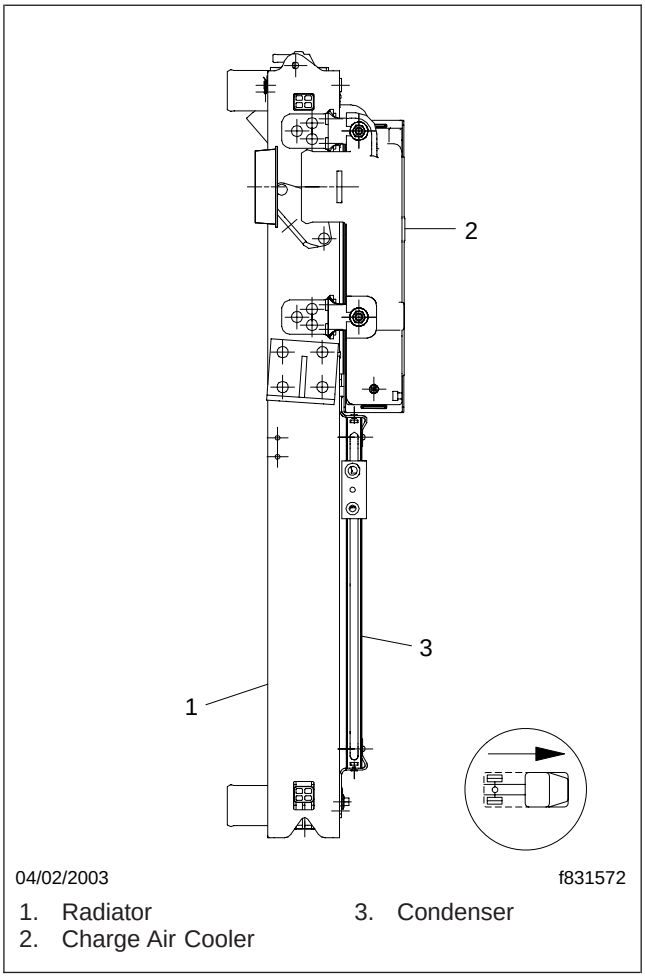


**Fig. 2, Small Cooling Package**

- Large Cooling Package: The condenser is mounted in front of the charge air cooler. See **Fig. 3**.

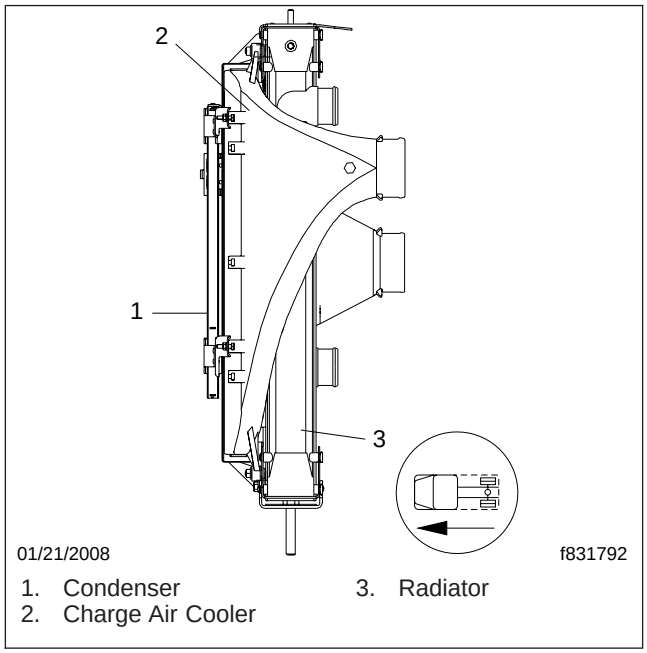


**Fig. 3, Large Cooling Package**

## Determine Fins per Inch (fpi) of a Small Cooling Package Condenser

Early Business Class M2 vehicles with a small cooling package were equipped with a 14-fpi condenser. In October 2002, the 14-fpi condenser began being phased out and replaced with a 19-fpi condenser. The 14-fpi condenser may still be found on vehicles built through March 2003. For vehicles built from October 2002 through March 2003, it is necessary to determine whether the vehicle was built with a 14-fpi or 19-fpi condenser.

If the vehicle has a large cooling package, it is not necessary to determine the number of fins per inch on the condenser to determine which temperature/pressure specification table to use. All Business Class M2 vehicles with a large cooling package use a 14-fpi condenser.

Use the following steps to determine whether the condenser has 14 fpi or 19 fpi.

1. Locate a section on the condenser face that is free of bent fins, and place a white sheet of paper over that area.
2. Using a soft-lead pencil, rub the lead lightly on the paper to transfer the impression of the fins to the sheet of paper. Transfer the impression to obtain an area about 1 inch by 3 inches (25 mm by 76 mm) on the paper.

IMPORTANT: Be careful not to bend the fins while transferring the impression.

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3. Place the sheet of paper on a clean, flat surface and place a ruler on the impression. Line the ruler up with one of the fin marks.
4. Count the number of fin marks from the zero-inch (zero-mm) mark to the two-inch (51-mm) mark on the ruler. Divide the number of fins counted by 2 to obtain the approximate number of fins per inch. For example, 29 fins divided by 2 equals 14.5 or approximately 14 fins per inch.

**Temperature/Pressure Specifications for a Vehicle With a Small Cooling Package* and a 14-fpi Condenser†**

| Ambient Air Temp. | Humidity (approximate) | Dash Outlet Temperature (approximate) | Service Port Pressures | | A/C Compressor Status | A/C Compressor Status Comments |
|---|---|---|---|---|---|---|
| | | | High Side psi (kPa) | Low Side psi (kPa) | | |
| 70°F (21°C) | Low 25% | 45–53°F (7–12°C) | 77–142 (531–979) | 8–31 (55–214) | Cycling | Off about 1 minute; On about 2 minutes |
| | High 55% | 45–56°F (7–13°C) | 82–181 (565–1248) | 8–45 (55–310) | Cycling | Off about 1 minute; On about 4 minutes |
| 80°F (27°C) | Low 25% | 45–52°F (7–11°C) | 103–176 (710–1213) | 11–37 (76–255) | Cycling | Off about 1 minute; On about 5 minutes |
| | High 55% | 50–59°F (10–15°C) | 177–182 (1220–1255) | 17–18 (117–124) | On | On steady |
| 90°F (32°C) | Low 25% | 51–53°F (11–12°C) | 206–210 (1420–1448) | 17–18 (117–124) | On | On steady |
| | High 55% | 58–60°F (14–16°C) | 225–231 (1551–1593) | 23–24 (159–165) | On | On steady |
| 100°F (38°C) | Low 25% | 57–58°F (14°C) | 256–258 (1765–1779) | 22–23 (152–159) | On | On steady |
| | High 55% | 67–69°F (19–21°C) | 282–288 (1944–1986) | 29–30 (200–207) | On | On steady |

Test conditions:

- engine at 1500 rpm
- engine fan locked on (six-blade viscous with lock brackets)
- normal A/C mode, outside air
- blower speed on high, about 13.5 vdc
- cab doors open
- hood open
- parked out of direct sunlight
- no wind speed or less than 5 mph (8 km/h)
- stabilize at each point
- the condenser is mounted below the charge air cooler

* Refer to "Temperature/Pressure Specification Tables" to determine whether the vehicle has a small or large cooling package.

† Refer to "Temperature/Pressure Specification Tables" to determine the number of fins per inch on the condenser.

**Table 2, Temperature/Pressure Specifications for a Vehicle With a Small Cooling Package and a 14-fpi Condenser**

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## Specifications

| Temperature/Pressure Specifications for a Vehicle With a Small Cooling Package* and a 19-fpi Condenser† | | | | | | |
|---|---|---|---|---|---|---|
| Ambient Air Temp. | Humidity (approximate) | Dash Outlet Temperature (approximate) | Service Port Pressures | | A/C Compressor Status | A/C Compressor Status Comments |
| | | | High Side psi (kPa) | Low Side psi (kPa) | | |
| 70°F (21°C) | Low 25% | 43–52°F (6–11°C) | 81–107 (558–738) | 8–53 (55–365) | Cycling | On about 12 seconds; off about 12 seconds |
| | High 55% | 48–55°F (9–13°C) | 93–120 (641–827) | 11–51 (76–352) | Cycling | On about 15 seconds; off about 8 seconds |
| 80°F (27°C) | Low 25% | 45–52°F (7–11°C) | 108–144 (745–993) | 9–44 (62–303) | Cycling | On about 20 seconds; off about 9 seconds |
| | High 55% | 49–51°F (9–11°C) | 140–149 (965–1027) | 13–15 (90–103) | On | On steady |
| 90°F (32°C) | Low 25% | 49–50°F (9–10°C) | 170–187 (1172–1289) | 16–17 (110–117) | On | On steady |
| | High 55% | 57–59°F (14–15°C) | 185–191 (1276–1317) | 23–24 (159–165) | On | On steady |
| 100°F (38°C) | Low 25% | 55–57°F (13–14°C) | 210–220 (1448–1517) | 22–23 (152–159) | On | On steady |
| | High 55% | 66–68°F (19–20°C) | 234–242 (1613–1669) | 30–32 (207–221) | On | On steady |

Test conditions:

- engine at 1500 rpm
- engine fan locked on (six-blade viscous with lock brackets)
- normal A/C mode, outside air
- blower speed on high
- cab doors open
- hood open
- parked out of direct sunlight
- no wind speed or less than 5 mph (8 km/h)
- stabilize at each point
- the condenser is mounted below the charge air cooler
- no wind speed or less than 5 mph (8 km/h)

* Refer to "Temperature/Pressure Specification Tables" to determine whether the vehicle has a small or large cooling package.

† Refer to "Temperature/Pressure Specification Tables" to determine the number of fins per inch on the condenser.

**Table 3, Temperature/Pressure Specifications for a Vehicle With a Small Cooling Package and a 19-fpi Condenser**

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| Temperature/Pressure Specifications for a Vehicle With a Large Cooling Package and a Behr Condenser but No Auxiliary HVAC Unit* | | | | | | |
|---|---|---|---|---|---|---|
| **Ambient Air Temp.** | **Humidity (approximate)** | **Dash Outlet Temperature (approximate)** | **Service Port Pressures** | | **A/C Compressor Status** | **A/C Compressor Status Comments** |
| | | | **High Side psi (kPa)** | **Low Side psi (kPa)** | | |
| 70°F (21°C) | Low 25% | 44–53°F (7–12°C) | 73–104 (503–717) | 8–50 (55–345) | Cycling | On about 16 seconds; off about 32 seconds |
| | Medium 50% | 44–52°F (7–11°C) | 74–112 (510–772) | 7–50 (48–345) | Cycling | On about 17 seconds; off about 19 seconds |
| | High 70% | 46–54°F (8–12°C) | 70–112 (483–772) | 8–50 (55–345) | Cycling | On about 18 seconds; off about 17 seconds |
| 80°F (27°C) | Low 25% | 44–53°F (7–12°C) | 87–127 (600–876) | 8–47 (55–324) | Cycling | On about 24 seconds; off about 13 seconds |
| | Medium 50% | 45–55°F (7–13°C) | 90–135 (621–931) | 10–49 (69–338) | Cycling | On about 40 seconds; off about 10 seconds |
| | High 70% | 47–56°F (8–13°C) | 128–134 (883–924) | 14–20 (97–138) | On | On steady |
| 90°F (32°C) | Low 25% | 46–55°F (8–13°C) | 110–162 (758–1117) | 10–48 (69–331) | Cycling | On about 73 seconds; off about 9 seconds |
| | Medium 50% | 48–52°F (9–11°C) | 155–160 (1069–1103) | 19–20 (131–138) | On | On steady |
| | High 70% | 55–57°F (13–14°C) | 167–170 (1151–1172) | 22–23 (152–159) | On | On steady |
| 100°F (38°C) | Low 25% | 53–54°F (12°C) | 192–196 (1324–1351) | 22–23 (152–159) | On | On steady |
| | Medium 50% | 60–62°F (16–17°C) | 201–204 (1386–1407) | 26–28 (179–193) | On | On steady |
| | High 70% | 66–69°F (19–21°C) | 211–214 (1455–1475) | 29–30 (200–207) | On | On steady |

Test conditions:

- engine at 1500 rpm
- engine fan locked on
- normal A/C mode, outside air
- blower speed on high
- cab doors open
- hood open
- parked out of direct sunlight

* Refer to "Temperature/Pressure Specification Tables" to determine whether the vehicle has a small or large cooling package.

**Table 4, Temperature/Pressure Specifications for a Vehicle With a Large Cooling Package and a Behr Condenser but No Auxiliary HVAC Unit**

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## Specifications

| Temperature/Pressure Specifications for a Vehicle With a Large Cooling Package, a Behr Condenser, and an Auxiliary HVAC Unit* | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ambient Air Temp. | Humidity (approximate) | Dash Outlet Temperature (approximate) | Auxiliary Unit Lower Louver Temperature | Service Port Pressures | | A/C Compressor Status | A/C Compressor Status Comments |
| | | | | High Side psi (kPa) | Low Side psi (kPa) | | |
| 70°F (21°C) | Low 25% | 43–50°F (6–10°C) | 45–53°F (7–12°C) | 73–114 (503–786) | 14–40 (97–276) | Cycling | On about 26 seconds; off about 15 seconds |
| | Medium 50% | 44–53°F (7–12°C) | 47–54°F (8–12°C) | 74–119 (510–820) | 16–42 (110–290) | Cycling | On about 35 seconds; off about 13 seconds |
| | High 70% | 45–54°F (7–12°C) | 49–58°F (9–14°C) | 73–120 (503–827) | 16–45 (110–310) | Cycling | On about 48 seconds; off about 10 seconds |
| 80°F (27°C) | Low 25% | 46–54°F (8–12°C) | 49–56°F (9–13°C) | 88–143 (607–986) | 18–44 (124–303) | Cycling | On about 48 seconds; off about 11 seconds |
| | Medium 50% | 48–50°F (9–10°C) | 54–56°F (12–13°C) | 145–150 (1000–1034) | 24–26 (165–179) | On | On steady |
| | High 70% | 54–55°F (12–13°C) | 59–61°F (15–16°C) | 158–164 (1089–1131) | 28–29 (193–200) | On | On steady |
| 90°F (32°C) | Low 25% | 50–51°F (10–11°C) | 56–57°F (13–14°C) | 177–182 (1220–1255) | 25–26 (172–179) | On | On steady |
| | Medium 50% | 58–60°F (14–16°C) | 64–66°F (18–19°C) | 194–199 (1338–1372) | 32–34 (221–234) | On | On steady |
| | High 70% | 62–63°F (17°C) | 68–69°F (20–21°C) | 195–207 (1344–1427) | 35–37 (241–255) | On | On steady |
| 100°F (38°C) | Low 25% | 58–59°F (14–15°C) | 64–66°F (18–19°C) | 227–235 (1565–1620) | 31–33 (214–228) | On | On steady |
| | Medium 50% | 67–68°F (19–20°C) | 71–72°F (22°C) | 242–247 (1669–1703) | 40–41 (276–283) | On | On steady |
| | High 70% | 74–75°F (23–24°C) | 79–81°F (26–27°C) | 261–265 (1800–1827) | 49–50 (338–352) | On | On steady |

Test conditions:

- engine at 1500 rpm
- engine fan locked on
- normal A/C mode, outside air
- blower speed on high
- cab doors open
- hood open
- parked out of direct sunlight

* Refer to "Temperature/Pressure Specification Tables" to determine whether the vehicle has a small or large cooling package.

**Table 5, Temperature/Pressure Specifications for a Vehicle With a Large Cooling Package, a Behr Condenser, and an Auxiliary HVAC Unit**

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## Temperature/Pressure Specification Tables (EPA07 compliant vehicles)

Before using the temperature/pressure specifications in **Table 7**, **Table 8**, **Table 9**, and **Table 10**, determine what condenser is installed on the vehicle. To do so, identify the vehicle rating, or measure the condenser. See **Table 6** for condenser identification.

| Condenser Identification: EPA07 Compliant Vehicles | | | |
|---|---|---|---|
| **Vehicle Rating** | **Condenser** | **Width: in. (cm)** | **Height: in. (cm)** |
| M2 106 (MD) | Valeo MD-1 | 27 (69) | 20 (52) |
| M2 112 (HD) | Valeo HD-1 | 33 (84) | 19 (48) |

**Table 6, Condenser Identification: EPA07 Compliant Vehicles**

| Day Cab with Valeo MD–1 Condenser | | | | | | |
|---|---|---|---|---|---|---|
| **Ambient Air Temp.** | **Humidity (approximate)** | **Dash Outlet Temperature (approximate)** | **Service Port Pressures** | | **A/C Compressor Status** | **A/C Compressor Status Comments** |
| | | | **High: psi (kPa)** | **Low: psi (kPa)** | | |
| 70°F (21°C) | Low 25% | 51–59°F (11–15°C) | 70–130 (483–896) | 10–60 (69–414) | Cycling | On 6 sec; Off 9 sec |
| | Med 50% | 53–59°F (12–15°C) | 74–130 (510–896) | 10–52 (69–359) | Cycling | On 6 sec; Off 10 sec |
| | High 70% | 55–62°F (13–17°C) | 75–130 (517–896) | 11–58 (76–400) | Cycling | On 7 sec; Off 8 sec |
| 80°F (27°C) | Low 25% | 53–60°F (12–16°C) | 92–130 (634–896) | 12–56 (83–386) | Cycling | On 7 sec; Off 8 sec |
| | Med 50% | 55–61°F (13–16°C) | 90–150 (621–1034) | 13–60 (90–414) | Cycling | On 11 sec; Off 7 sec |
| | High 70% | 52°F (11°C) | 143 (986) | 18 (124) | On | On steady |
| 90°F (32°C) | Low 25% | 52–58°F (11–14°C) | 120–160 (827–1103) | 15–50 (103–345) | Cycling | On 11 sec; Off 5 sec |
| | Med 50% | 55°F (13°C) | 169 (1165) | 21 (145) | On | On steady |
| | High 70% | 61°F (16°C) | 177 (1220) | 25 (172) | On | On steady |
| 100°F (38°C) | Very Low 10% | 51–56°F (11–13°C) | 140–185 (965–1276) | 16–55 (110–379) | Cycling | On 19 sec; Off 5 sec |
| | Low 25% | 54°F (12°C) | 187 (1289) | 21 (145) | On | On steady |
| | Medium 40% | 60°F (16°C) | 196 (1351) | 26 (179) | On | On steady |

Test conditions:

- engine at 1500 rpm
- engine fan locked on
- normal A/C mode, outside air
- blower speed on high, about 13.5 vdc
- cab doors open
- hood open
- parked out of direct sunlight
- no wind speed or less than 5 mph (8 km/h)
- stabilize at each point

**Table 7, Day Cab with Valeo MD–1 Condenser**

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## Specifications

| Crew Cab with Valeo MD-1 Condenser, Behr Aux HVAC | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ambient Air Temp: °F (°C) | Humidity (approximate) | Dash Outlet Temperature (approximate) | Auxiliary Unit Lower Louver Temperature | Service Port Pressures | | A/C Compressor Status | A/C Compressor Status Comments |
| | | | | High: psi (kPa) | Low: psi (kPa) | | |
| 70 °F (21 °C) | Low 25% | 50–56°F (10–13°C) | 56–60°F (13–16°C) | 90–110 (621–758) | 20–53 (138–365) | Cycling | On 6 sec; Off 9 sec |
| | Med 50% | 54–60°F (12–16°C) | 57–60°F (14–16°C) | 95–115 (655–793) | 23–53 (159–365) | Cycling | On 9 sec; Off 8 sec |
| | High 70% | 56–63°F (13–17°C) | 57–62°F (14–17°C) | 95–120 (655–827) | 24–50 (165–345) | Cycling | On 14 sec; Off 5 sec |
| 80 °F (27 °C) | Low 25% | 55–60°F (13–16°C) | 57–61°F (14–16°C) | 120–135 (827–931) | 22–52 (152–359) | Cycling | On 10 sec; Off 7 sec |
| | Med 50% | 51°F (11°C) | 58°F (14°C) | 140 (965) | 26 (179) | On | On steady |
| | High 65% | 52°F (11°C) | 60°F (16°C) | 145 (1000) | 28 (193) | On | On steady |
| 90 °F (32 °C) | Low 25% | 51°F (11°C) | 58°F (14°C) | 170 (1172) | 26 (179) | On | On steady |
| | Med 40% | 58°F (14°C) | 65°F (18°C) | 175 (1207) | 32 (221) | On | On steady |
| 100 °F (38 °C) | Very Low 10% | 54°F (12°C) | 62°F (17°C) | 190 (1310) | 28 (193) | On | On steady |
| | Low 25% | 58°F (14°C) | 66°F (19°C) | 195 (1344) | 32 (221) | On | On steady |
| | Med 35% | 62°F (17°C) | 69°F (21°C) | 200 (1379) | 36 (248) | On | On steady |

Test conditions:

- engine at 1500 rpm
- engine fan locked on
- normal A/C mode, outside air
- blower speed on high, about 13.5 vdc
- cab doors open
- hood open
- parked out of direct sunlight
- no wind speed or less than 5 mph (8 km/h)
- stabilize at each point

**Table 8, Crew Cab with Valeo MD-1 Condenser, Behr Aux HVAC**

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## Specifications

| Day Cab with Valeo HD-1 Condenser | | | | | | |
|---|---|---|---|---|---|---|
| Ambient Air Temp: °F (°C) | Humidity (approximate) | Dash Outlet Temperature (approximate) | Service Port Pressures | | A/C Compressor Status | A/C Compressor Status Comments |
| | | | High: psi (kPa) | Low: psi (kPa) | | |
| 70 (21) | Low 25% | 50–56°F (10–13°C) | 80–100 (552–689) | 12–53 (83–365) | Cycling | On 4 sec; Off 11 sec |
| | Med 50% | 52–56°F (11–13°C) | 80–95 (552–655) | 13–52 (90–359) | Cycling | On 5 sec; Off 10 sec |
| | High 70% | 53–58°F (12–14°C) | 85–105 (586–724) | 14–55 (97–379) | Cycling | On 6 sec; Off 6 sec |
| 80 (27) | Low 25% | 52–58°F (11–14°C) | 120–125 (827–862) | 16–58 (110–400) | Cycling | On 6 sec; Off 9 sec |
| | Med 50% | 54–60°F (12–16°C) | 120–125 (827–862) | 18–60 (124–414) | Cycling | On 12 sec; Off 8 sec |
| | High 70% | 53–61°F (12–16°C) | 120–135 (827–931) | 19–59 (131–407) | Cycling | On 26 sec; Off 4 sec |
| 90 (32) | Low 25% | 51–57°F (12–14°C) | 125–150 (862–1034) | 18–59 (124–407) | Cycling | On 7 sec; Off 5 sec |
| | Med 50% | 51°F (12°C) | 155 (1069) | 21 (145) | On | On steady |
| 100 (38) | Very Low 10% | 52–63°F (11–17°C) | 140–170 (965–1172) | 18–60 (124–414) | Cycling | On 19 sec; Off 4 sec, then On 6 sec; Off 9 sec |
| | Low 25% | 50°F (10°C) | 175 (1207) | 20 (138) | On | On steady |
| | Med 40% | 54°F (12°C) | 180 (1241) | 23 (159) | On | On steady |

Test conditions:

- engine at 1500 rpm
- engine fan locked on
- normal A/C mode, outside air
- blower speed on high, about 13.5 vdc
- cab doors open
- hood open
- parked out of direct sunlight
- no wind speed or less than 5 mph (8 km/h)
- stabilize at each point

**Table 9, Day Cab with Valeo HD-1 Condenser**

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## Specifications

| Crew Cab with Valeo HD-1 Condenser and Behr Aux HVAC | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ambient Air Temp: °F (°C) | Humidity (approximate) | Dash Outlet Temperature (approximate) | Auxiliary Unit Lower Louver Temperature | Service Port Pressures | | A/C Compressor Status | A/C Compressor Status Comments |
| | | | | High: psi (kPa) | Low: psi (kPa) | | |
| 70 (21) | Low 25% | 52–56°F (11–13°C) | 52–55°F (11–13°C) | 85–105 (586–724) | 19–48 (131–331) | Cycling | On 6 sec; Off 9 sec |
| | Med 50% | 53–58°F (12–14°C) | 53–55°F (12–14°C) | 90–110 (621–758) | 22–50 (152–345) | Cycling | On 7 sec; Off 9 sec |
| | High 70% | 54–60°F (12–16°C) | 56–61°F (13–16°C) | 95–115 (655–793) | 23–53 (159–365) | Cycling | On 7 sec; Off 7 sec |
| 80 (27) | Low 25% | 54–59°F (12–15°C) | 56–58°F (13–14°C) | 120–140 (827–965) | 23–52 (159–359) | Cycling | On 6 sec; Off 11 sec |
| | Med 50% | 53–58°F (12–14°C) | 56–59°F (13–15°C) | 120–140 (827–965) | 26–40 (179–276) | Cycling | On 24 sec; Off 5 sec |
| | High 70% | 55°F (13°C) | 62°F (17°C) | 145 (1000) | 30 (207) | On | On steady |
| 90 (32) | Low 25% | 51–58°F (11–14°C) | 57–60°F (14–16°C) | 135–160 (931–1103) | 25–48 (172–331) | Cycling | On 36 sec; Off 5 sec |
| | Med 50% | 60°F (16°C) | 67°F (19°C) | 175 (1207) | 35 (241) | On | On steady |
| 100 (38) | Very Low 10% | 52°F (11°C) | 61°F (16°C) | 185 ()1276 | 27 (186) | On | On steady |
| | Low 25% | 56°F (13°C) | 64°F (18°C) | 190 (1310) | 31 (214) | On | On steady |
| | Med 40% | 62°F (17°C) | 69°F (21°C) | 195 (1344) | 36 (248) | On | On steady |

Test conditions:

- engine at 1500 rpm
- engine fan locked on
- normal A/C mode, outside air
- blower speed on high, about 13.5 vdc
- cab doors open
- hood open
- parked out of direct sunlight
- no wind speed or less than 5 mph (8 km/h)
- stabilize at each point

**Table 10, Crew Cab with Valeo HD-1 Condenser and Behr Aux HVAC**

## Torque Specifications

**Table 11** shows torque specifications for Stat-O-Seal Assembly Bolts.

| Stat-O-Seal Assembly Bolt Torque Specs | |
|---|---|
| HVAC Component | Torque: lbf·ft (N·m) |
| Refrigerant Compressor | 11–15 (15–20) |
| Condenser | 11–15 (15–20) |
| Receiver-Drier | 11–15 (15–20) |
| Expansion Valve (to lines to receiver-drier) | 11–15 (15–20) |

| Stat-O-Seal Assembly Bolt Torque Specs | |
|---|---|
| HVAC Component | Torque: lbf·ft (N·m) |
| Expansion Valve (small screws to evaporator lines) | 35 lbf·in (395 N·cm) |
| Evaporator | 11–15 (15–20) |
| Junction Block | 11–15 (15–20) |

**Table 11, Stat-O-Seal Assembly Bolt Torque Specs**

## Wiring Diagrams

See **Fig. 4** and **Fig. 5** for the HVAC wiring diagram.