Group Index, Alphabetical

Contents

Introduction to Multiplexing

The term "multiplexing" describes how the Business Class® M2 electrical system works. Multiplexing is defined as sending multiple electronic messages through the same signal path at the same time—in this case, through the M2 wiring.

Multiplexing allows the M2 electrical system to simultaneously perform tasks and to monitor components. A multiplexed system uses electronic control units (ECUs) to operate the system. The electrical system components, such as switches and lamps, are connected to the ECUs, which collect and control all information about the components by communicating on the data bus.

A less formal description might be that multiplexing is much like the interstate highway system. Trucks and cars share the roadway, with each vehicle bound for a different destination. Every vehicle travels at different speeds, enters and exits at different places, and the occupants of every vehicle have different objectives. Whether it is a truckdriver hauling goods from a factory to a store or a saleswoman heading home from work, highway users are like the electronic signals flashing along the datalink.

Multiplexing was introduced in vehicles in the 1980's with the first electronically controlled engines and the initial use of the J1708/J1587 datalink. The concept was taken a step further in the early 1990's when transmissions were electronically connected to engines in order to control engine speed and torque output during shifting. Multiplexing has now been applied to the entire vehicle.

General Information

The multiplexed electrical system replaces traditional power distribution module (PDM) devices, such as relays and circuit breakers, with electronic devices that communicate over the vehicle datalinks. These electronic devices control power distribution to the electric loads on the vehicle. This is done by monitoring inputs (such as sensors and switches) and supplying power to outputs (such as lighting, displays, gauges, and indicators). This distributed approach to handling switch inputs and controlling electrical load outputs sharply reduces the number of wires on a vehicle. Rather than having individual wires transmitting voltage from switches to relays that then supply power to the components, the multiplexed system continuously monitors the status of all switches (input devices) and sends messages over the shared-wire J1939 datalink to control outputs.

The system communicates on two datalinks: the J1939 datalink and the J1708/J1587 datalink. J1939 is the primary datalink and is used for all control messaging and troubleshooting; J1708/J1587 is the secondary datalink and is used for limited troubleshooting. Fault codes are displayed on the instrument cluster display and they may also be viewed on ServiceLink®.

The multiplexed system uses the following controllers:

- Bulkhead Module (BHM)
- Chassis Module (CHM)
- optional Expansion Module (EXM)

The most important part of the multiplexed electrical system is the BHM. The BHM is the brain of the entire system, and controls all of the outputs in response to changes in any of the inputs. The CHM and EXM are slaves to the BHM and respond to commands from the BHM and broadcast the status of the inputs and outputs connected to them. See **Fig. 1**.

See **Fig. 2** for an example of how the headlamp signal inputs and outputs are handled in the multiplexed system. When the headlamp switch is turned on, the BHM senses the input. The BHM is programmed to know which outputs it should activate for each input signal and where those outputs are located (such as on the BHM, CHM, EXM, or other controller). In this example, the outputs for the left headlamp low beam are located on the BHM and the outputs for the right headlamp low beam are located on the CHM. The BHM can directly activate the left headlamp low beam. However, because the right headlamp low beam outputs are located on the CHM, the BHM must send a message over J1939 to the CHM to tell it to activate those outputs. Once the CHM receives the message, it activates the correct outputs and sends a message back to the BHM reporting the new status of the outputs. This fail-safe design allows at least one headlight to work even if the BHM or CHM should fail.

For an example of the flash-to-pass function, see **Fig. 3**. In this case, the input comes from the multifunction turn signal switch mounted on the steering column. It goes into the instrumentation control unit, or ICU3-M2, for processing. The instrumentation con-

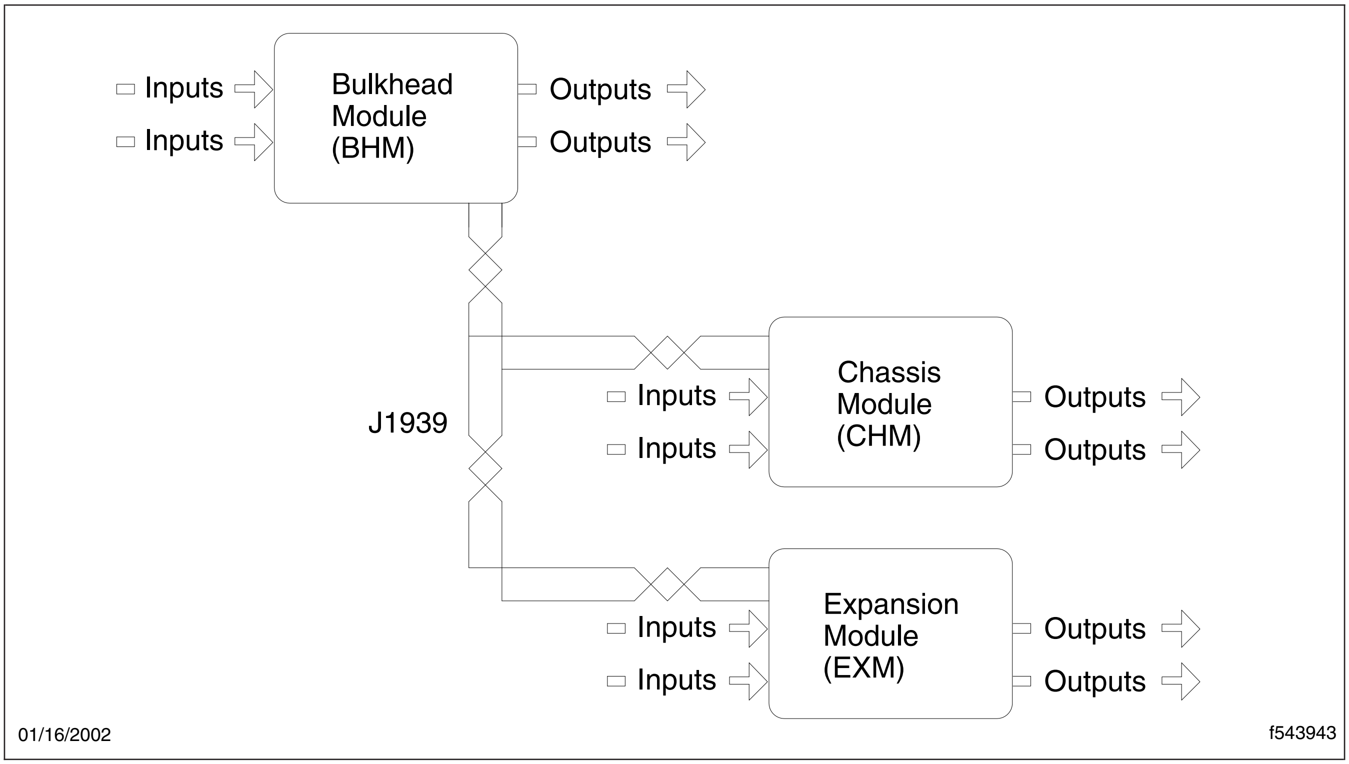


Fig. 1, Multiplexed System Controllers

trol unit (ICU) sends a message on J1939 to the BHM informing it of the multifunction turn signal switch status. The output for the right headlamp high beam is located on the BHM and the output for the left headlamp high beam is located on the CHM. The BHM directly flashes the right headlamp high beam and sends a message over J1939 to the CHM to tell it to flash the left headlamp high beam. Once the CHM receives the message, it flashes the headlamp high beam and sends a message back to the BHM reporting the new status of the output. To complete the loop, the BHM sends a message over J1939 to the ICU reporting that the command was completed. These messages are transmitted so quickly that the entire process takes only a fraction of a second.

The final example is the park brake telltale. See **Fig. 4**. To avoid driving away with the park brake set, the system is designed to warn the driver. When the driver pulls out the park brake switch on the dash to set the park brake, the CHM receives an electrical air pressure signal from either the air management unit (AMU), or a pressure switch located in the cab behind the center area of the dash on auxiliary air valve assembly (AAVA) vehicles. The CHM sends a J1939 message to the BHM, the BHM sends a J1939 message to the ICU, and the ICU turns on the park brake telltale dash light.

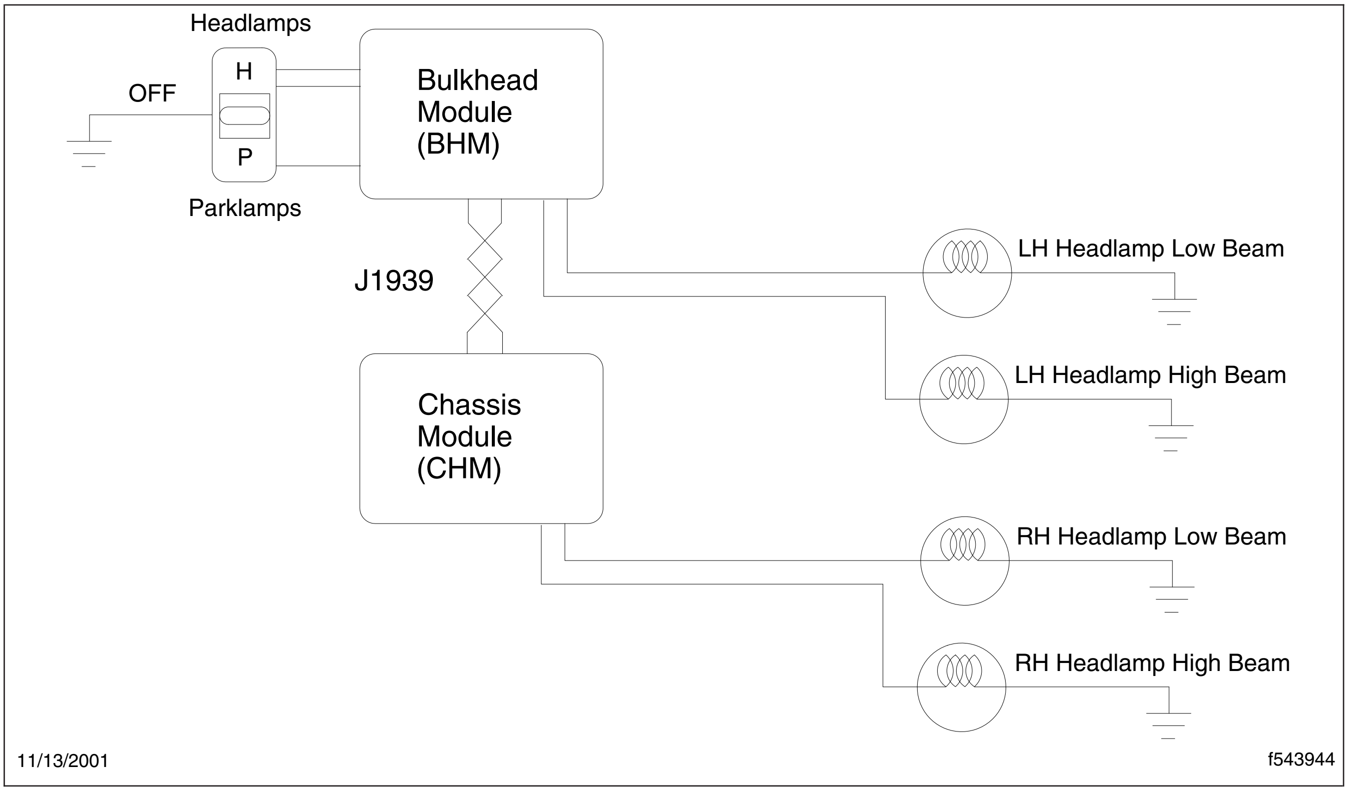


Fig. 2, Headlamp Switch Example

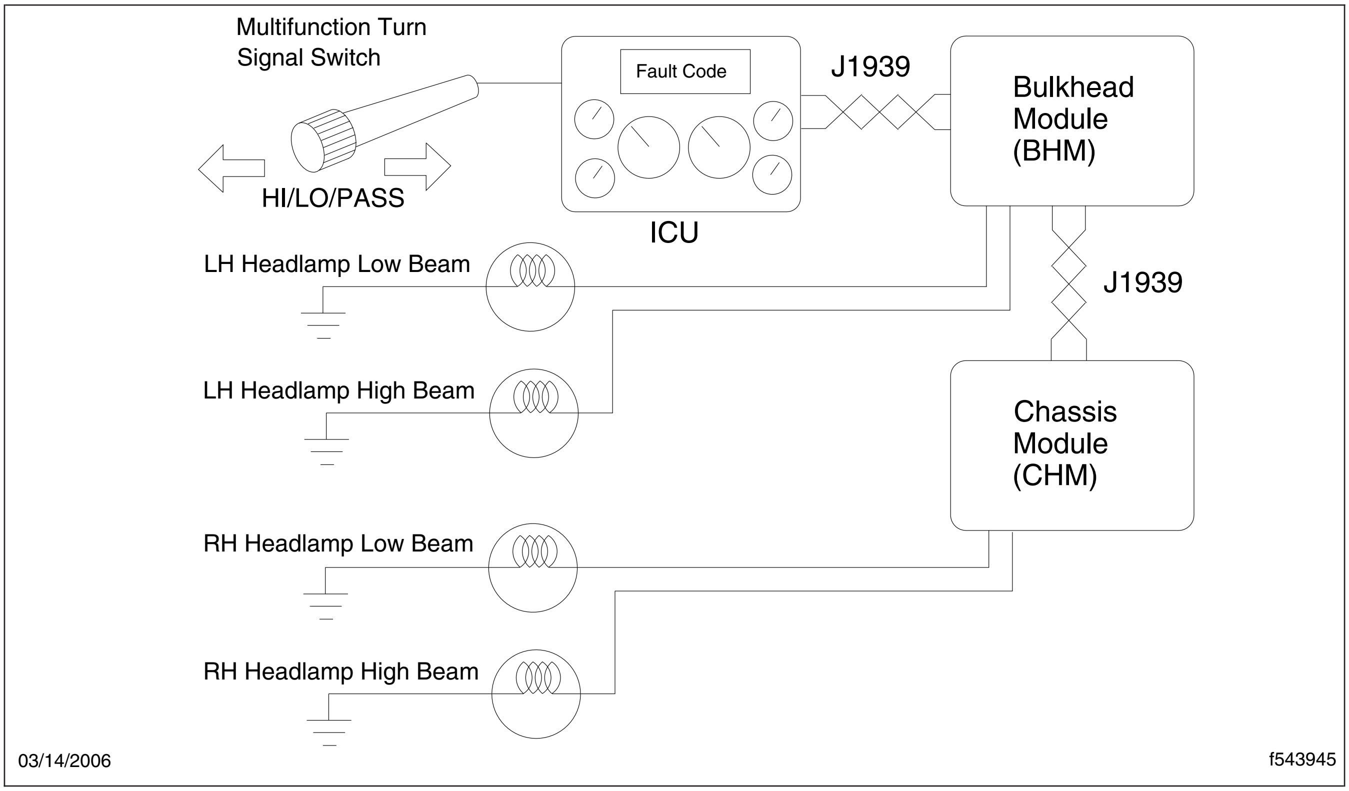


Fig. 3, Flash-To-Pass Example

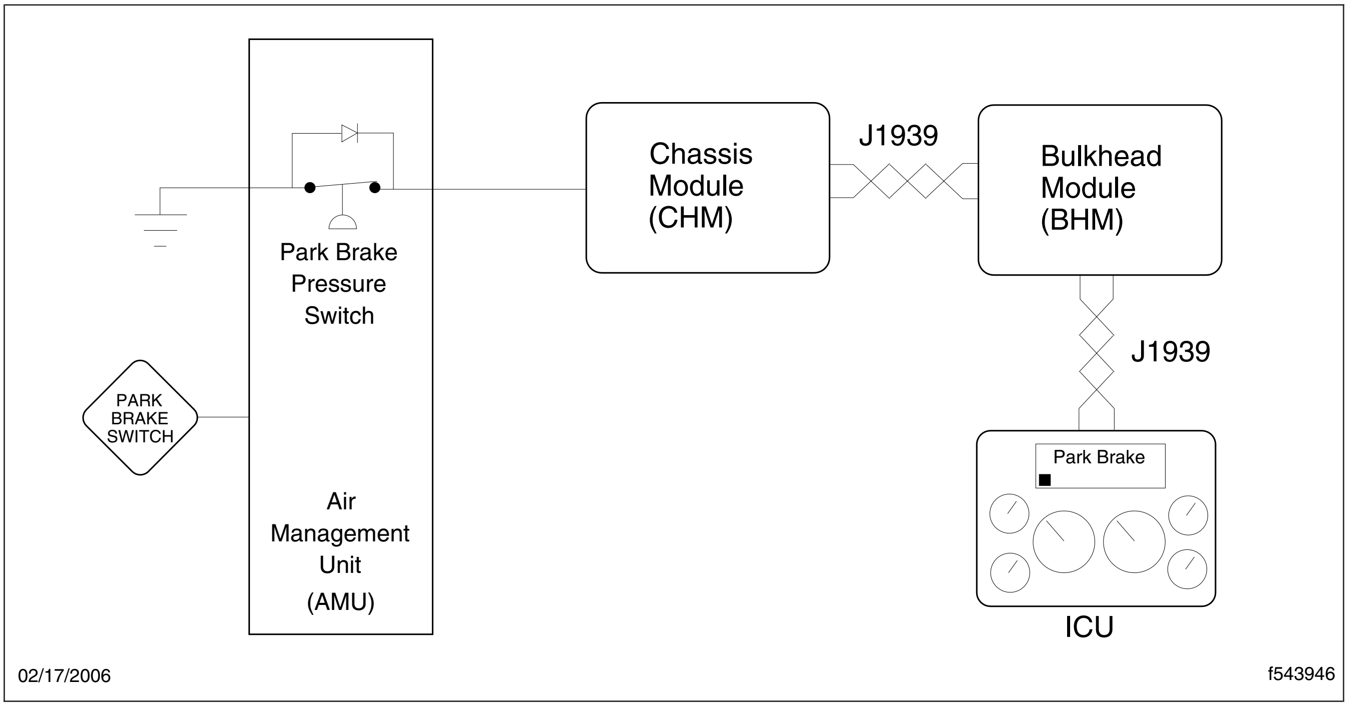


Fig. 4, Park Brake Telltale Example

Abbreviations and Terms

Use the following list to determine the meaning of the abbreviations and terms used in Group 54.

AAVA Auxiliary Air Valve Assembly

ABS Antilock Braking System

Activate To begin operating.

Address A unique location code for a device or data.

AMU Air Management Unit

API Application Programming Interface

ATC Automatic Traction Control

BHM Bulkhead Module

CAN Controller Area Network

CHM Chassis Module

Configure To set up a program or system for a particular device or set of devices.

Databus See datalink.

Datalink A collection of wires connecting system components through which data is transmitted.

DRL Daytime Running Lights

DTC Diagnostic Trouble Code

ECM Engine Control Module

ECU Electronic Control Unit, a device that communicates on a datalink.

EEPROM Electrically Erasable Programmable Read-Only Memory

EMC Electromagnetic Compatibility

EMI Electromagnetic Interference

EOL End of Line

ESD Electrostatic Discharge

EXM Expansion Module

Fault Code A limited set of alphanumeric characters representing a corresponding error message. Fault codes are limited to a maximum number of characters by the display output and cross-referenced to a more descriptive message. On J1939, fault codes are made up of a SA, SPN, and FMI. On J1708/J1587, fault codes are made up of an MID, PID/SID, and FMI.

FMEA Failure Mode Effects Analysis

FMI Failure Mode Indicator. The part of a J1708/J1587 or J1939 fault code that identifies how a part of or item on a device failed.

FMVSS Federal Motor Vehicle Safety Standard

HSD High Side Driver

HVAC Heating, Ventilating, and Air Conditioning

ICU Instrumentation Control Unit

Input A device that feeds a signal into the system, or signal that feeds a message into the system.

J1708/1587 An older vehicle communications network protocol intended to provide simple information exchange, including diagnostic data between electronic control devices.

J1939 A high speed vehicle communications network using the CAN protocol, which permits any device to transmit a message on the network when the datalink is idle. Each message includes an identifier that defines the message priority, who sent it, and what data is contained within it. Collisions are avoided due to the arbitration process that occurs while the identifier is transmitted, permitting high priority messages to get through with minimal delay.

LCD Liquid Crystal Display

LCL Low Coolant Level

LED Light-emitting Diode

Legend The icon, symbol or text on a warning light cover illuminated by a telltale lamp.

LSD Low Side Driver

MID Message Identifier. Identifies any device that communicates on J1708/J1587.

Multiplexing The process of combining several messages for transmission over the same signal path.

Output The signal or message that comes out of a system component or device.

Parameter A predetermined variable in a set, each of which restricts or defines the specific capabilities of the system as a whole. Used to customize the configuration of the system.

Pass-through Inputs and outputs on a device capable of allowing data to be transmitted through it without affecting the message or the device.

PCB Printed Circuit Board

Abbreviations and Terms

PID Parameter Identifier. The part of a J1708/J1587 fault code that identifies what part of or item on a device that failed. PIDs are not MID specific.

PLC Power Line Carrier

PRD Product Requirements Document

PWM Pulse Width Modulation

SA Source Address. Identifies any device that communicates on J1939.

SAE Society of Automotive Engineers

SID Subsystem Identifier. The part of a J1708/J1587 fault code that identifies what part of or item on a device that failed. SIDs are MID specific.

Smart Switch Configurable input device, called "smart" because it is recognized by the system not by its position or physical characteristics but by its resistance value.

SPN Suspect Parameter Number. The part of a J1939 fault code that identifies what part of or item on a device that failed.

Status Condition, position, or relative position of an input or output at a specific time.

TDS Technical Development Specifications

Telltale Any of a number of colored warning lights on the ICU instrument cluster that illuminates an icon, symbol, or text covering it.

UL Underwriters Laboratory

VCU Vehicle Control Unit

Reference Parameters

Reference parameters program the BHM to know which outputs to activate for each input and where those outputs are located. The two types of reference parameters are default and optional. Every vehicle has one default reference parameter and zero to any number of optional reference parameters.

The default reference parameter programs the BHM with features that come standard on each vehicle, such as headlights. Optional reference parameters program the BHM for vehicle-specific features, such as heated mirrors.

Each reference parameter is given a part number just like any other hardware part on the vehicle. A reference parameter only programs the parameters of the BHM.

Reflashing or reprogramming the software is separate from programming the parameters, just as it is in an engine controller.

Changing Features and Options

Features can be changed with ServiceLink® from the Features screen under the Bulkhead Module (BHM) icon. The Features screen displays the features that are installed in the BHM by listing the reference parameter numbers and their descriptions. From this screen, the user can reload all the currently installed features or make changes to the vehicle by entering new reference parameters.

General Information

When adding features to a Business Class® M2 vehicle, some important issues need to be considered. Read the information in this subject before adding features to the vehicle.

ServiceLink® must be used to add features to the unique multiplexed electrical system in the M2 vehicle.

1. To access ServiceLink training, go to **www.AccessFreightliner.com** and click on **Tools and Services**.
2. Click on **The Learning Center** and log on.
3. Select **More** from the software training icon.
4. From the **Web Based Training** course list, select **ServiceLink Web Based Training** (I.D. number WBTSLN-1).
5. Once you have started the training, click on **Features** to access the training that pertains to adding features.

If ServiceLink is not available, you will need to bypass the multiplexed electrical system and isolate circuits by connecting only to authorized vehicle interface points. The location of these interface points is explained in "Circuit Isolation."

Control Modules

The control modules of the multiplexed electrical system are the Bulkhead Module (BHM), Chassis Module (CHM), and any optional Expansion Module (EXM). While every vehicle will have a BHM and CHM, Expansion Modules will be added as needed to increase the capacity of the electrical system. The BHM is the main controller, or brain, of the system and is in constant communication with the CHM and any EXM over the J1939 datalink. Think of the CHM and any EXM as extensions of the BHM. The BHM uses the CHM and EXM as its arms and legs. The BHM controls inputs to and outputs from itself, the CHM, and any EXM based on the reference parameters that are programmed into it.

Reference Parameters

As with other electronic control units (ECU) on the vehicle, the BHM is programmed through the use of parameters. Reference parameters are used to add multiplexed features to the BHM. There is a reference parameter for each multiplexed feature, such as heated mirrors. It is these reference parameters that a technician will work with through ServiceLink. Each reference parameter has been given its own part number with the prefix 26-. Reference parameters can be found listed under their part number in bills of material (BOM) and in PartsPro®.

Floating Pins

Floating pins means that a pin in a connector is not necessarily always assigned to the same circuit on every vehicle. For that reason, you must use the Configuration screen in ServiceLink to verify pin assignment. G06 drawings are general guides and are not vehicle specific.

Adding a Feature

Use the following instructions to add features to the vehicle.

1. Using the *Freightliner Business Class® M2 Data Book*, select the applicable data code that applies to the requested add-on feature. For example, Daytime Running Lights, 311-001.
2. Contact Freightliner Parts Technical Support and provide the representative with the vehicle identification number (VIN) and the data code requested. The representative will advise of the availability of the feature.

NOTE: Reference parameters, such as 26-XXXXX-XXX, are needed to determine circuit availability for the desired feature.

NOTE: The following step should be done at the parts counter to ensure that all parts required for the job, including any EXM, are identified before a quote is given to the customer and the work begins. Since the Business Class M2 makes use of floating pins, it is possible that one truck may require an EXM to add a feature, and a seemingly identical vehicle will not.

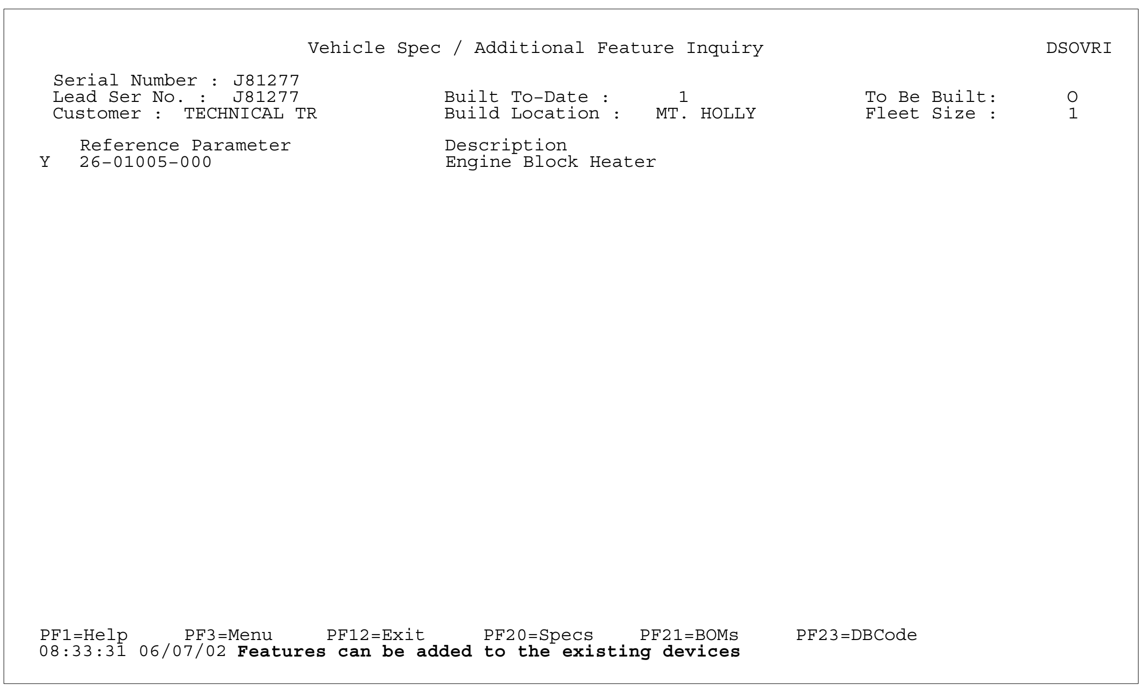
3. Log on to the Freightliner mainframe. From the SOS/MAX menu, press F11, **Additional Features Multiplexing Inquiry**.

3.1 Key in the vehicle serial number, or the last six digits of the VIN.

3.2 Key in the reference parameter numbers from **all** the bills of material that are being added at that time.

The screen will indicate if the feature can be added with the existing control modules or if an additional EXM is needed. See **Fig. 1** for a view of the response screen. See **Table 1** for possible responses and necessary actions.

4. To add a reference parameter to the vehicle, use the Features screen in ServiceLink. It is best to have ServiceLink connected to the host and the vehicle at the same time. If this is not possible, connect ServiceLink to the host and add the reference parameter, then take the ServiceLink computer to the vehicle and update the vehicle.



```
                    Vehicle Spec / Additional Feature Inquiry                    DSOVRI
  Serial Number : J81277
  Lead Ser No. :  J81277             Built To-Date :      1            To Be Built:     0
  Customer :  TECHNICAL TR           Build Location :   MT. HOLLY      Fleet Size :     1

     Reference Parameter             Description
 Y   26-01005-000                    Engine Block Heater

 PF1=Help     PF3=Menu     PF12=Exit     PF20=Specs     PF21=BOMs     PF23=DBCode
 08:33:31 06/07/02 Features can be added to the existing devices
```

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Fig. 1, SOS/MAX Additional Feature Inquiry Response Screen

5. When the reference parameters are applied to the BHM, ServiceLink will provide any necessary wiring instructions via a table with columns for device, connector, pin location, circuit number, and action. This table will be used to make circuit changes to the BHM, CHM, or EXM as necessary to add the features.

Circuit Isolation

If features must be added outside of the multiplexed electrical system, there are a few options for obtaining authorized interface points.

- Data code 353-XXX provides various options for vehicle wiring interfaces, including back of cab, frontwall, and end-of-frame locations. Data code 148-XXX provides options for engine wiring, and data code 34C-XXX provides options for transmission wiring. Go to **www.Access-Freightliner.com** for more information.
- Battery power connections must be made at the battery through one of the four available MEGA® Fuses.

- Inside the cab, there are splice packs behind the center dash that provide interface points for ignition voltage, ground, and panel lamp illumination.

IMPORTANT: When bypassing the multiplex electrical system, the interface points previously mentioned are the only authorized points. **Do not** splice in to any other electrical wiring.

SOS/MAX Additional Feature Inquiry Responses	
System Response	**Action Required**
Features can be added to the existing devices.	No other action is necessary to present a complete and accurate quote to the customer.
Features cannot be added to existing devices.	Expansion module required.
Feature requires additional engineering work.	Contact your District Service Manager (DSM).
Reference parameter not defined.	From the bill of material supplied, first verify and try re-entering the 26-XXXXX-XXX number(s) again. If this fails, contact Freightliner Parts Technical Support for further assistance.

Table 1, SOS/MAX Additional Feature Inquiry Responses

Troubleshooting

With the multiplexed electrical system, traditional multimeter-based current, voltage and resistance measurements are supplemented, or in some cases replaced, by software tools that can read and control the electronic signals and devices of the system. ServiceLink® is the tool that is used to troubleshoot the Business Class® M2 electrical system.

The modules of the multiplexed electrical system communicate on both J1939 and J1708/J1587. The primary datalink for the electrical system is J1939, and is used for all control messaging and troubleshooting. J1708/J1587 is the secondary datalink and is used for limited troubleshooting. Fault codes are displayed on the instrument cluster, and can also be viewed with ServiceLink.

Since the modules of the electrical system communicate on both J1939 and J1708/J1587, ServiceLink shows information for both datalinks. Although each module connected to the multiplexed electrical system is represented by an icon within ServiceLink, the Bulkhead Module (BHM) icon is the main icon for troubleshooting the system. This is because the Bulkhead Module is the main controller of the multiplexed system. The other icons are secondary and contain generic screens.

The following screens can be accessed under the Bulkhead Module icon:

- **General Info**—Displays information about the BHM such as make, model, hardware version, and software version.
- **Faults**—Displays the active and historic faults for all of the control modules on the multiplexed electrical system.
- **Configuration**—Displays the pinout for all of the control modules on the multiplexed electrical system compared to the host.
- **Features**—Displays the features that are installed in the BHM. From this screen the user can reload all the currently installed features, or make changes to the vehicle by entering new reference parameters.
- **Flashing**—Allows the user to update or reflash the software of the BHM.
- **Templates**—Gives a directory of Datalink Monitor Templates available for troubleshooting the multiplexed electrical system. These templates allow the user to monitor and manipulate the inputs and outputs of the electrical system.

The other control module icons, listed below, will have only a General Info screen, a Faults screen, and a Templates screen.

- Chassis Module (CHM)
- Expansion Module (EXM)

The General Info screen displays information about the particular module such as make, model, hardware version, and software version. The Faults screen displays the active and historic faults for the particular module on the particular datalink. The Templates screen gives a directory of Datalink Monitor Templates available for troubleshooting the particular module. These templates allow the user to monitor and manipulate the inputs and outputs of the electrical system.

NOTE: For more specific information about the Bulkhead Module see **Section 54.12**. For more specific troubleshooting information see **Section 54.12, Subject 300**.

Device Communications

For information on cross-referencing a J1587 Message Identifier (MID) and a J1939 Source Address (SA), see **Table 1**.

Device Communications on J1587 and J1939		
Device Description	**J1587 MID***	**J1939 SA†**
Engine	128	0
Transmission	130	3
Antilock Brakes	136	11
Instrument Cluster	140	23
Vehicle Security Unit (VSU)	163	—
Data Logging Unit (DLU)	179	251
Collision Avoidance System (Headway Controller)	219	42
Bulkhead Module	164	33
Chassis Module	249	71
Expansion Module #1	170	235
Expansion Module #2	187	236
Expansion Module #3	188	237
Expansion Module #4	178	238
Expansion Module #5	240	239

* Message Identifier

† Source Address

Table 1, Device Communications on J1587 and J1939

Contents

General Information

The on-highway environment places severe demands on a vehicle electrical system. The following material describes the methods for repairing and sealing electrical connections that will provide the durability necessary for the automotive environment.

There are four distinct considerations for making a wire repair that will withstand:

- the mechanical demands of vibration, strain, and thermal cycling
- the electrical requirement of oxidation free conductivity
- the insulating properties to resist shorting to adjacent objects
- the ability to seal for corrosion protection

When troubleshooting electrical systems, consider body height and suspension travel. Interference and strain may be caused by normal frame flexing and body accessories that are not apparent when a vehicle is stationary.

Wire Repair and Splicing

Disconnect the batteries at the negative terminals before performing any repairs to the electrical system.

IMPORTANT: Before repairing or replacing any damaged electrical system components, locate and correct the cause of the damage before continuing with the repair.

Wire that is discolored or melted due to an external heat source may need to be re-routed, or the installation of a heat shield may be necessary. If wire length permits, a splice may be made with a single connector. Often a length of wire will need to be added and two splices made. Carefully check damaged wire for signs of corrosion that has wicked up into the insulation and through the wire. If the wire conductor has become green or black, cut off the discolored wire and replace it with a new section.

Corrosion on battery cable terminals may be cleaned with a mild solution of baking soda and water, and scrubbed with a wire brush.

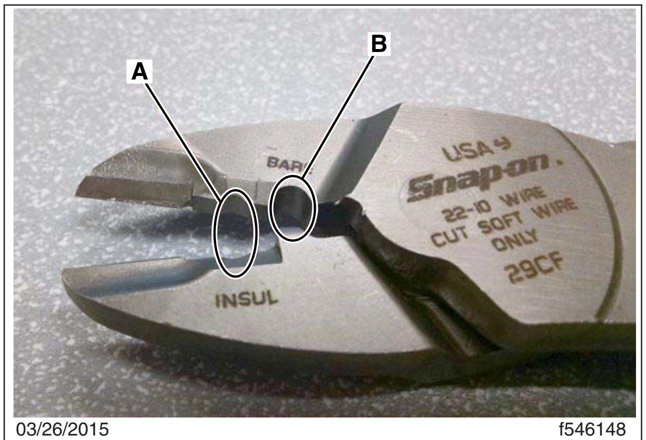
Wiring Repair Using Phillips STA-DRY® Solderless Connectors

Parts and Tools

Parts are available through the Parts Distribution Centers (PDCs) in packages of 25 connectors. Use the connectors and adhesive lined shrinkable tubing shown in **Table 1** when making a wiring splice.

Tools needed for wiring repair using solderless connectors include the following.

- A crimp tool with a minimum 3/16 inch width. See **Fig. 1** for an example of a proper crimp tool.
- A heat gun rated at 1000°F (538°C).



A. Section of the crimper to be used with a Phillips STA-DRY splice kit.

B. Section of the crimper to be used with DTNA Kit ESY ES66 404.

Fig. 1, Terminal Crimper

Procedure

1. Dress the wires to be spliced by stripping the insulation to expose 1/4 inch of copper. Slide a 3-inch section of adhesive coated shrink tubing onto one of the wires.
2. Crimp the splice connector onto the wires. Use the type of crimp tool that makes a dimple in the connector. The dimple must be at least 3/16 inch wide or there will be too much space inside the connector and the solder will not flow into the wire. This crimp provides the mechanical retention needed. See **Fig. 2**.

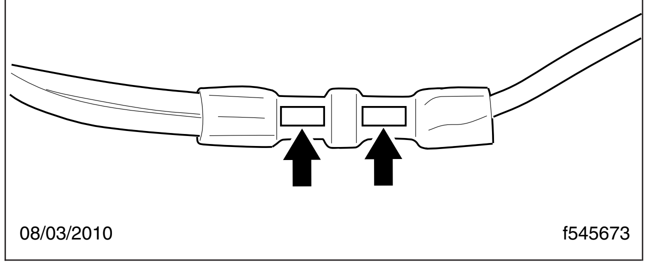


Fig. 2, Properly Crimped Splice

3. Pull test the wires by hand to ensure the crimp is mechanically solid.
4. A crimp tool that is too narrow will leave excessive air gaps in the crimp. The connection will not have the required amount of mechanical strength and the solder will not bond the wire to the connector. **Figure 3** shows an example of a bad crimp when the wrong tool is used.
5. Heat the properly crimped splice connector with the heat gun while slowly rotating the wire. The solder will take longer to flow than it will for the shrinkable insulation to contract. Heat until the solder band has completely melted into the connector. If the shrinkable insulation ruptures and a small amount of solder bubbles out, gently shake the splice to remove the solder. See **Fig. 4**.
6. When the connector has cooled, center the shrinkable tubing over the splice and heat the tubing until it has completely sealed the splice and a small fillet of adhesive is visible at the ends of the shrink tube. See **Fig. 4**.
7. A three-wire tap splice can be made following the same procedure. Use a connector that is large enough to fit all the strands of the wires. See **Fig. 5** for an example of the completed splice.

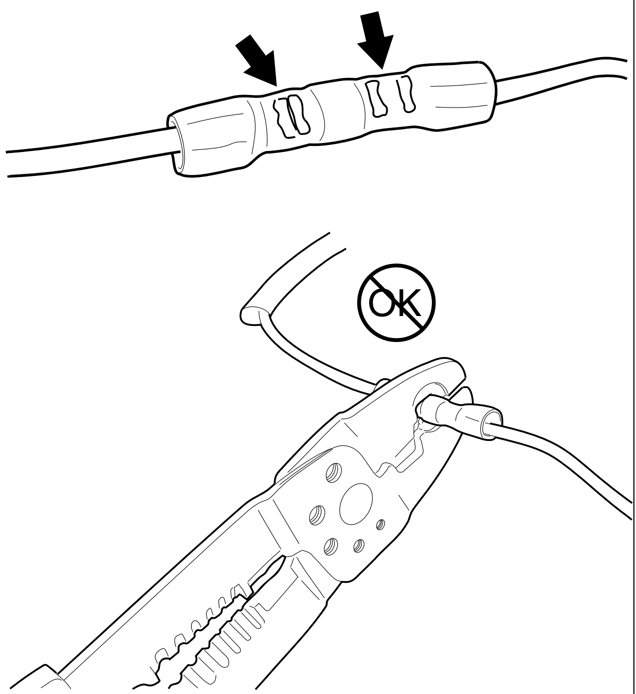
Solderless Connector Parts		
Wire Size: gauge (mm)	**Connector Part Number***	**Shrinkable Tubing (Daimler Part Number)**
20 to 18 (0.5 to 0.8)	PHM 1 1863	1/4 inch with internal adhesive coating (48-02461-025)

Wiring Repair Using Phillips STA-DRY® Solderless Connectors

Solderless Connector Parts		
Wire Size: gauge (mm)	**Connector Part Number***	**Shrinkable Tubing (Daimler Part Number)**
16 10 14 (1 to 2)	PHM 1 1862	1/4 inch with internal adhesive coating (48-02461-025)
12 to 10 (3 to 5)	PHM 1 1861	3/8 inch with internal adhesive coating–4 foot length (48-02461-038)
8 or larger (5 or larger)	Replace the terminal or the entire cable	Use adhesive lined red for positive cables and black for negative cables.

* Twenty-five connectors per pack.

Table 1, Solderless Connector Parts



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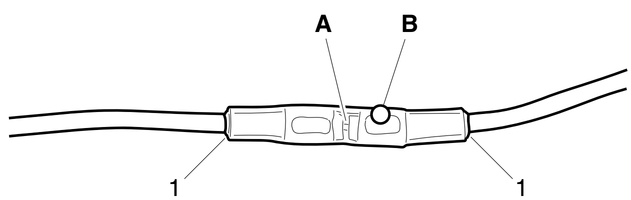
NOTE: Even with two crimps, there is too much air gap; the solder will not bond.

Fig. 3, Wrong Tool Being Used and a Crimp That Will Fail



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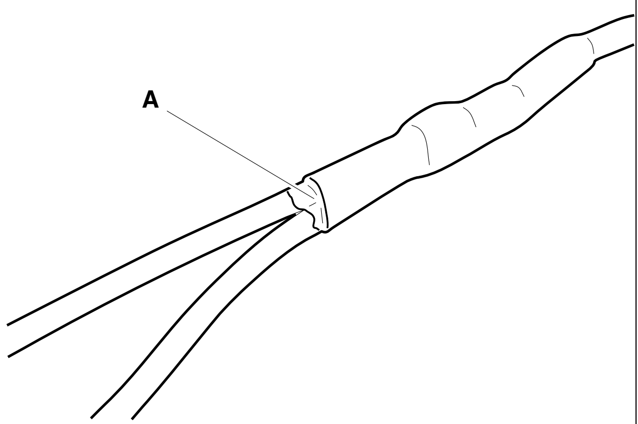
A. The solder band is completely melted.
B. Insulation rupture; gently shake off the solder bead.

1. Adhesive Fillet

Fig. 4, Solder Bead Rupture



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A. The fillet of adhesive at the ends of the shrink tube indicate a complete seal.

Fig. 5, Completed Three-Wire Tap Splice

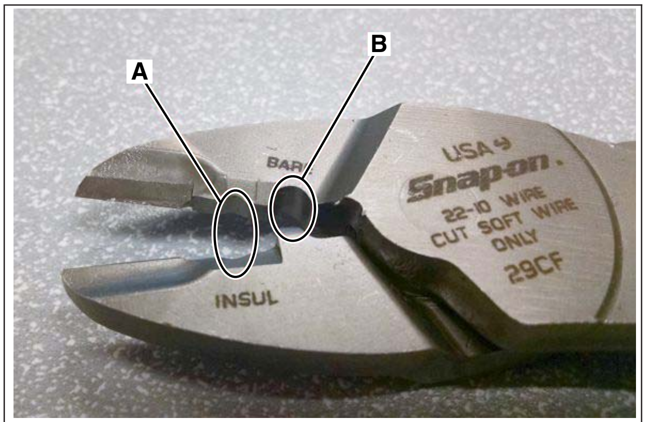
Wiring Repair Using Daimler Trucks North America (DTNA) Kit ESY ES66 404

Parts and Tools

Parts are available through the Parts Distribution Centers (PDCs) in kits with material for 50 splices. This kit may be used on 16 to 14 gauge (1 to 2 mm) wire.

Tools needed for wiring repair using solderless connectors include the following.

- A crimp tool with a minimum 3/16 inch width. See **Fig. 1** for an example of a proper crimp tool.
- A heat gun rated at 250°F (121°C).



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A. Section of the crimper to be used with a Phillips STA-DRY splice kit.

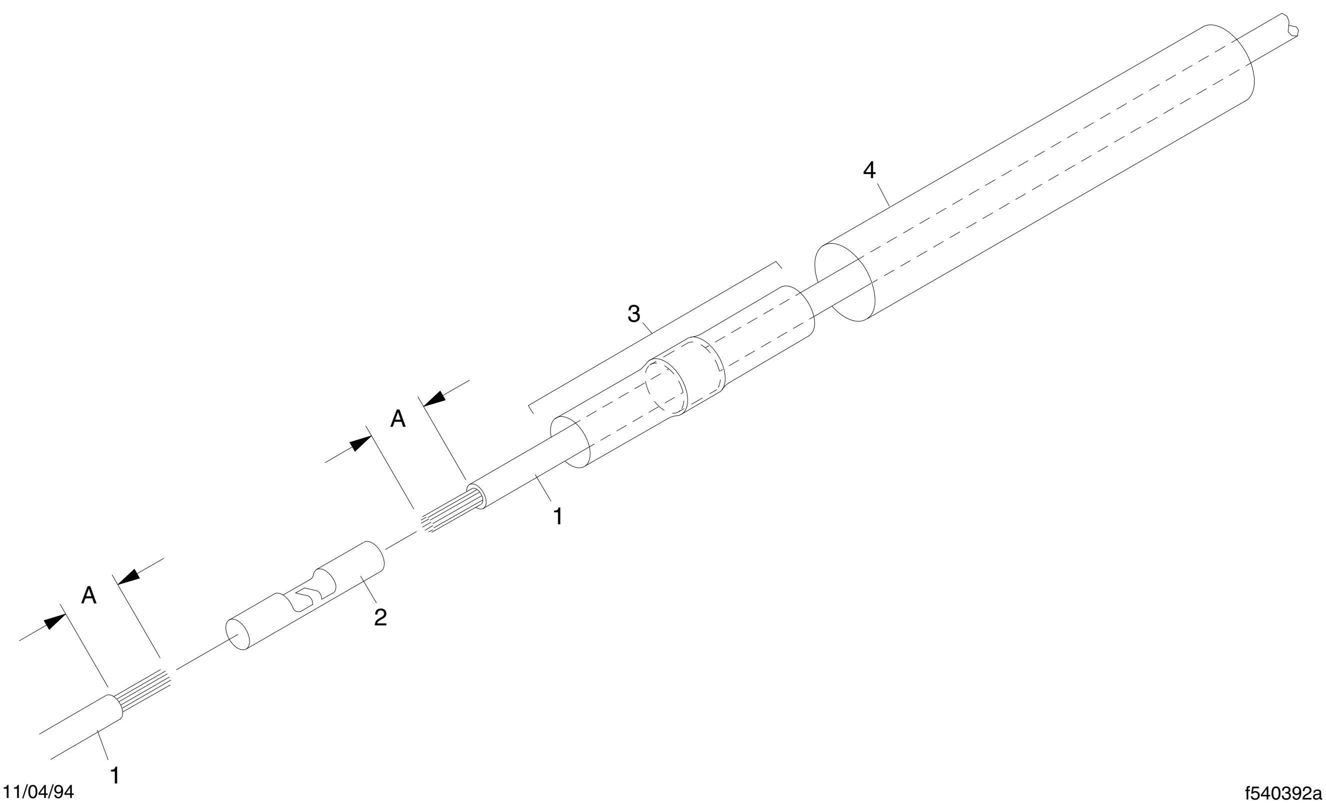
B. Section of the crimper to be used with DTNA Kit ESY ES66 404.

Fig. 1, Terminal Crimper

Procedure

1. Dress the wires to be spliced by stripping the insulation to expose 1/4 inch of copper. Slide a piece of the shrink tubing from the kit onto one of the wires.
2. Slide a shrinkable solder sleeve from the kit onto one of the wires.
3. Place the wires that will be spliced into each end of the barrel connector. See **Fig. 2** for an example of the splice.
4. Crimp each end of the barrel using a dimple-type crimp tool to secure the wires. See **Fig. 1** for an example of a proper crimp tool.
5. Pull test the wires by hand to ensure the crimp is mechanically solid.
6. Slide the shrinkable solder sleeve onto the barrel connector so the solder band is at the center of the barrel connector.
7. Heat the splice using a heat gun rated at 250°F (121°C) until the sleeve has completely shrunk against the wire and the solder flows into the barrel connector. A small fillet of adhesive may be visible at the ends of the connector. See **Fig. 3**.
8. Slide the shrinkable tubing over the splice and apply heat with a heat gun rated at 250°F (121°C) until it has completely shrunk against the wire insulation. A small fillet of adhesive should be visible at the ends of the shrinkable tubing.

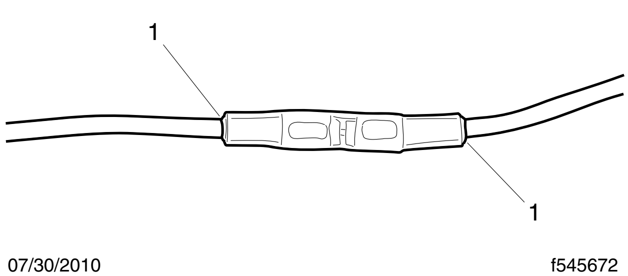
Wiring Repair Using Daimler Trucks North America (DTNA) Kit ESY ES66 404



A. 1/4 inch (6.4 mm)

1. Wire End
2. Barrel Connector
3. Solder Sleeve
4. Shrink Tube

Fig. 2, Splice Prepared with Parts in Kit ESY ES66 404



1. Adhesive Fillet

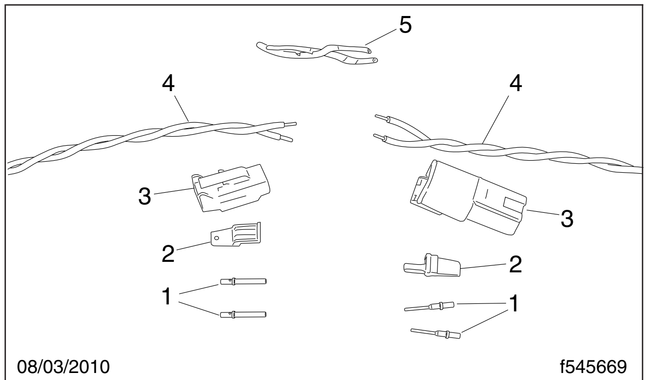
Fig. 3, Heated Solder Sleeve with Solder Band Melted into the Splice

Parts

Twisted-pair datalink wires may be spliced using a mating connector set. See **Table 1** for a typical set of datalink connector parts.

Procedure

1. Cut out any damaged section of datalink wire, keeping the lengths of the two wires equal. See **Fig. 1** for an example of a damaged section of datalink wire that has been removed and the datalink prepared for repair.
2. Crimp the terminals onto the wires using the proper crimp tool.
3. Pull test the terminals by hand to ensure the crimp is mechanically solid.
4. Insert the terminated wires into the connector body and install the terminal lock. The protocol for J1939 is for the yellow wire to be in cavity 1 and the green wire to be in cavity 2. Note that the lock is installed while holding the wires in position. Test the installation. If the wires slipped back during the lock installation, they will pull out of the connector.
5. Make certain the wires are twisted as close to the entry point of the connector as possible. Plug the two connector halves together. See **Fig. 2**.



1. Terminals
2. Terminal Lock
3. Connector
4. Twisted-Pair Datalink Wires
5. Damaged Section of Datalink Wires

Fig. 1, Datalink Splice Parts

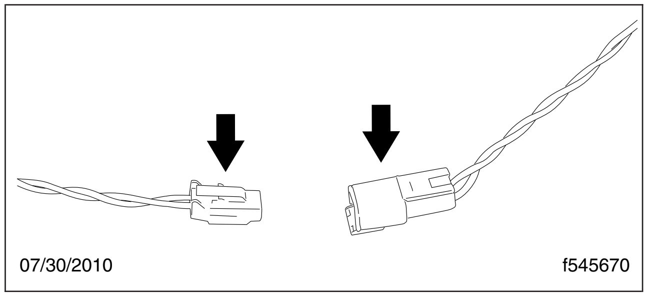


Fig. 2, Datalink Connectors

Datalink Connector Parts		
Description	**Part Number**	**Quantity**
Connector Body Plug	23-13148-204	1
Terminal Lock	23-13303-015	1
Terminals	23-13210-020	2
Connector Body Receptacle	23-13148-206	1
Terminal Lock	23-13303-013	1
Terminals	23-13210-030	2

Table 1, Datalink Connector Parts

Connection Protection

Use the dielectric protectants and procedures provided here to protect electrical connections from corrosion. A list of approved dielectric protectants is shown in **Table 1**.

The components listed in **Table 2** have electrical connections that need to be protected.

When disconnecting any of these circuits, clean the connection and remove the old dielectric material. Completely cover the exposed area after assembly using the product and procedure in this bulletin. Always follow the product manufacturers recommendations for work area ventilation.

Approved Dielectric Protectants			
Material	**Type**	**Manufacturer**	**Product**
Dielectric Red Enamel	Spray On	3M®	1602 IVI
		Glyptal	1201A
	Brush On	Glyptal	1201E 2100
Dielectric Grease	Lithium Base	Fiske Brothers Lubriplate® (FLP)	DS-ES
	Synthetic	Nye	Nyogel 760G

Table 1, Approved Dielectric Protectants

Electrical Component Protection and Procedure		
Protection	**Component**	**Procedure**
Dielectric Red Enamel	Starter - All Exposed Connections	Protect connections and cable terminals.
	Magnetic Switch	Protect connections and cable terminals.
	Alternator	Protect all connections. Do not allow dielectric material to enter the alternator.
	Bolt and Stud Ground Connections (outside cab)	Cover all terminals, studs, and nuts with dielectric enamel.
	Battery Cut-Off Switch Connections	Protect connections and cable terminals.
	Exposed Battery Cable Connections (located outside of the battery box)	Protect connections and cable terminals.
	Power Distribution Modules	Protect battery power studs on chassis mounted PDMs.
	Mega Fuses (when located outside of the battery box)	Place tape across the part of the fuse with the labeling, then apply the dielectric material. Remove the tape.

Electrical Connection Protection

Electrical Component Protection and Procedure		
Protection	**Component**	**Procedure**
Dielectric Grease, Lithium Base	Tail Lamp Bulb Sockets (non LED)	Remove the bulb, apply grease to the inside of socket. Replace the bulb.
	Battery Terminals	Apply grease to battery terminals before connecting interconnect cables.
	Battery Interconnect Cable Connections	Apply grease to connection studs and pads before connecting battery cables.
	Parked HVAC Power Connections	Disconnect the two power and one ground cable where they enter the basket on the underside of the cab. Apply grease, then connect.
	Inverter Power Connections	Disconnect the power and ground feeds at the cab pass through. Apply grease, then connect.
	Mega Fuses (if located in the battery box)	Apply grease to protect exposed terminals and connections.
Dielectric Grease, Synthetic	Connections with serial data circuits or with very low voltage signals.	Apply synthetic grease to the terminals inside the connector.

Table 2, Electrical Component Protection and Procedure

Guidelines for Repairing or Replacing an Electrical Harness

General Information

Use the guidelines in this subject to determine if a damaged electrical harness should be repaired or replaced.

Table 1 describes general guidelines for repairing or replacing a harness. There may be cases when more than one factor determines the course of action. For example, repairing a harness is recommended if shipping times for the replacement harness exceed one week. However, replacement may be the only option if damage to the harness is too extensive.

NOTE: When a harness is repaired, the source of the damage must also be identified and repaired.

Table 2 is a quick-reference for specific wire and terminal conditions.

IMPORTANT: Damaged connectors and seals can be replaced without replacing the harness. A drag test should be performed to make sure that the terminal can retain proper tension to the mating terminal. Refer to "Terminal Drag Test" in this bulletin for instructions. Discolored wires or melted insulation should be replaced before any other repairs are performed on the harness.

Repairing or Replacing a Harness	
Repair	**Replace**
Less than 20% of the harness is damaged. If the wire damage is greater than 6 inches (15 cm), an overlay harness can be added to replace the section of damaged wire.	More than 20% of the harness is damaged.
Wire is smaller than 12-gauge.	Wire is 12-gauge or larger.
The harness is not readily available, or shipping will take longer than one week.	The harness can be obtained in less than a week.
Wire insulation is cracked due to excessive heat from an external source. Repair is recommended if the damage is isolated to one section of the wire.	Wire insulation is cracked due to age, or damage is extensive and spread throughout the wire.
There is a clean cut to the wire, corrosion is wicked no more than 1 inch (2.5 cm) from the terminal end. If the damaged area is over 6 inches (15 cm), the harness can be repaired by adding overlay wiring over the damaged area. NOTE: If damage exceeds 1 inch (2.5 cm) from the terminal end, a quality repair may require adding a jumper wire to create enough slack in the wire. If adding extra splices stretches the wire too tightly it can degrade the integrity of the harness.	The harness is proprietary, such as a datalink with sheathing over a twisted pair, or a WABCO sensor and solenoid wiring.
Two harnesses are affected. For example, M2 24 pin lever lock connector (23-13144-010 and 23-13144-009) is corroded on both sides. Also, if the harness has minimal corrosion wicked up the wire, the connectors can be re-pinned. If the damaged area is over 6 inches (15 cm), the harness can be repaired by adding overlay wiring over the damaged area.	Extensive damage to the harness caused by foreign material such as DEF fluid, diesel fuel, or road/deicer fluid.

Table 1, Repairing or Replacing a Harness

Guidelines for Repairing or Replacing an Electrical Harness

Wire Damage Quick Reference	
Description	**Remedy**
Kinked Wire	Repair
Melted Insulation, Major.	Replace
Melted Insulation, Minor	Repair
Worn or Missing Insulation. See Fig. 1.	Repair
Discolored or Cracked Insulation, Major. See Fig. 2.	Replace
Discolored or Cracked Insulation, Minor.	Repair
Datalink, Twisted Wire NOTE: If only the terminals are damaged, the terminals can be replaced without replacing the twisted pair.	Replace
Corrosion in the Wire*	Repair
Corrosion in the Connector	Repair
Failed Terminal Pair Drag Test	Replace Terminal
Molded Cable†	Replace

* Corrosion is wicked no more than 1 inch (2.5 cm) from the terminal end, and no corrosion is wicked into the wire.

† An example is Meritor WABCO ABS sensor wiring.

Table 2, Wire Damage Quick Reference

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Fig. 1, Worn Insulation

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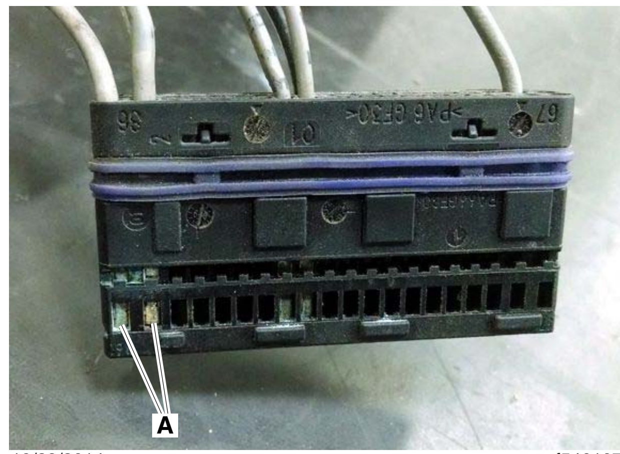
Fig. 2, Insulation Discoloration, Major

Guidelines for Repairing or Replacing an Electrical Harness

How to Identify a Repairable Wire

See **Table 3** to identify a repairable wire.

Identifying a Repairable Wire		
Condition	**Description**	**Example**
Corroded Terminal	If there is no further corrosion in the wire, and it is not blackened from corrosion, the wire can be repaired by cutting off the corroded terminal and stripping away the wire insulation. A new terminal can then be installed and inserted into the connector. NOTE: If the repair causes the wire to be pulled tight, or results in tension at the connector, a short piece of wire and new terminal can be added to reduce the tension. Otherwise, all terminals *must* be replaced.	 10/29/2014 f546107 A. Corroded terminal.
Corroded Wire	Corroded wires can be repaired by cutting out the damaged section. The wire needs to be cut until only clean wire is found for repair. It may be necessary to add a jumper wire to create slack and avoid wire tension. Refer to the instructions in this bulletin to install a jumper wire. The example shows a small amount of corrosion at the end of the wire.	 12/16/2014 f546117

Guidelines for Repairing or Replacing an Electrical Harness

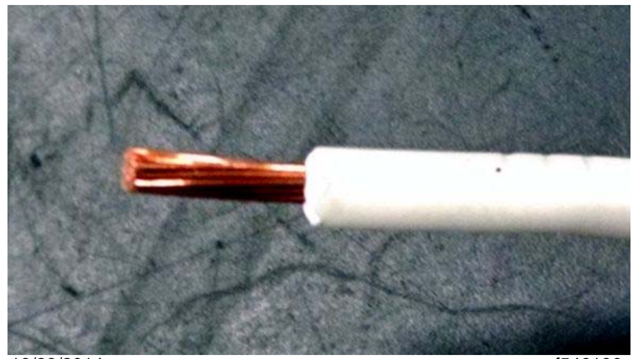
Identifying a Repairable Wire		
Condition	**Description**	**Example**
Cut Wire (clean) **or** **Worn Insulation**	If the wire shows no sign of corrosion, the wire can be repaired with a splice kit.	 10/29/2014 f546106

Table 3, Identifying a Repairable Wire

Broken or Corroded Wires

Whether or not a broken or corroded wire, or cracked insulation should be repaired or replaced depends on the extent of the damage.

A broken wire can be soldered together only if enough slack remains to avoid wire tension. If there is not sufficient slack, a new section of wire must be soldered between the two broken ends. This technique can also be used with small sections of corroded wire. Overlay wiring can also be used in the damaged area, however the entire harness must be replaced if the corrosion exceeds 6 inches (15 cm).

If terminals are corroded at the connector, the terminal can be replaced. However, the entire wire must be overlayed if corrosion exceeds 6 inches (15 cm). A jumper wire can be used in the case, if necessary.

Installing a Jumper Wire

1. Remove the terminal from the connector.
2. Cut out the damaged section of wire.
3. Crimp and solder the new terminal with a new seal (if required) on to the new section of wire.

NOTE: Make sure the wire is the same gauge and quality as the wire being replaced.

4. Insert the terminal into the connector. See **Fig. 3**.
5. Run the wire along the harness up to the section of wire that is being replaced. See **Fig. 4**.
6. Splice the wires using a Daimler splice kit ESY E66 404, or Phillips STA-DRY® Crimp and Solder connector parts. See **Fig. 5**.
7. Inspect the harness and make sure there is enough slack. See **Fig. 6**.
8. Wrap the harness with convolute tubing. See **Fig. 7**.

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Fig. 3, Terminal Inserted Into the Connector

Guidelines for Repairing or Replacing an Electrical Harness

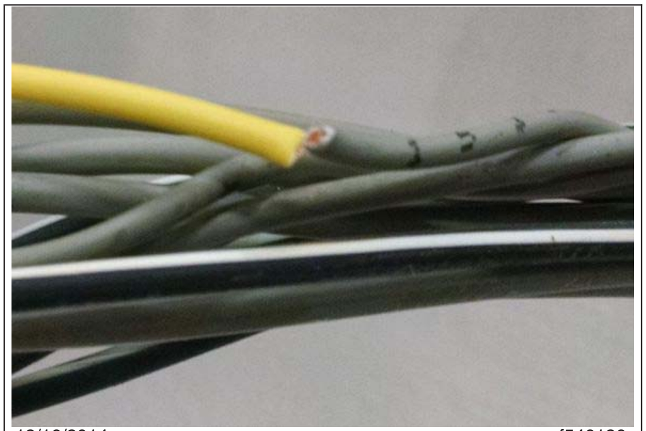

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Fig. 4, Section of Wire to be Replaced

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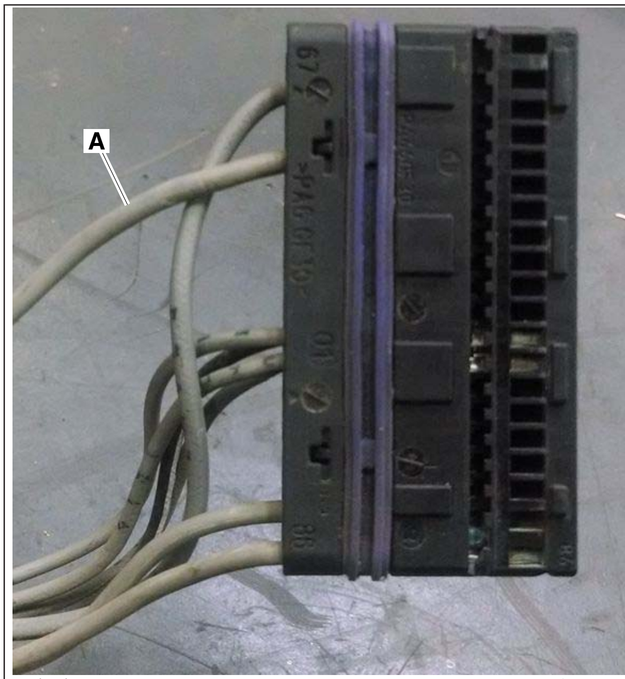
Fig. 5, Splicing the Wires

Repairing a Harness Wrapped in Fiber

IMPORTANT: Do not use a hook razor blade to cut fiber wrap. Use a sewing seam ripper to cut the fiber tape (**Fig. 8**), taking care not to cut the harness wires.

1. Locate damaged area and carefully make an opening in the fiber wrap using a sewing seam ripper. See **Fig. 9**.
2. Flip the tool over so the blunt end is facing wiring, then cut enough length to allow the fiber to be unwrapped. See **Fig. 10**.
3. Unwrap the fiber until a sufficient area is exposed to make the repair. See **Fig. 11** .
4. If an overlay is necessary, remove just enough fiber to allow for a splice into the damaged wire. See **Fig. 12**.



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A. The wire should be slack so that there is no tension.

Fig. 6, Slack in the Connector

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Fig. 7, Harness Wrapped with Convolute

5. Overlay the wire, then wrap the entire length to cover the overlay and integrate it with the harness.
6. Repair the wire as necessary. See **Fig. 13**.
7. Wrap the harness with fiber tape. Refer to 48-25910-000. Make sure enough tape is used to overlap the starting point. See **Fig. 14**.
8. When the harness is completely wrapped, secure both ends of the fiber wrap with electrical tape. See **Fig. 15**.

Guidelines for Repairing or Replacing an Electrical Harness


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Fig. 8, Sewing Seam Ripper

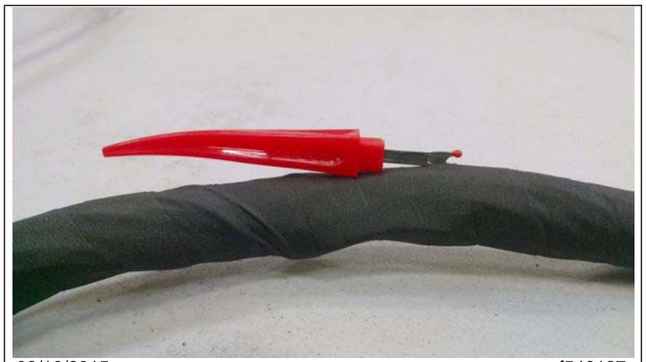
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Fig. 9, Cutting an Opening into the Fiber Wrap

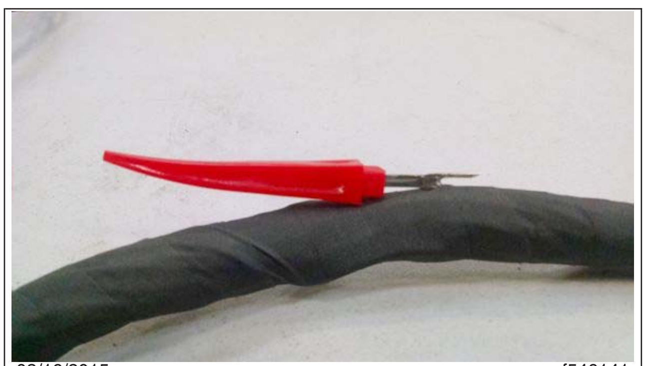
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Fig. 10, Cutting the Fiber Using the Blunt End of the Seam Cutter


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Fig. 11, Unwrapping the Harness


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Fig. 12, Overlay Added to the Damaged Area of the Harness

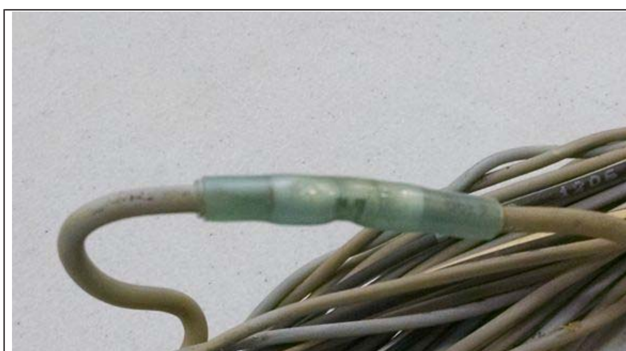
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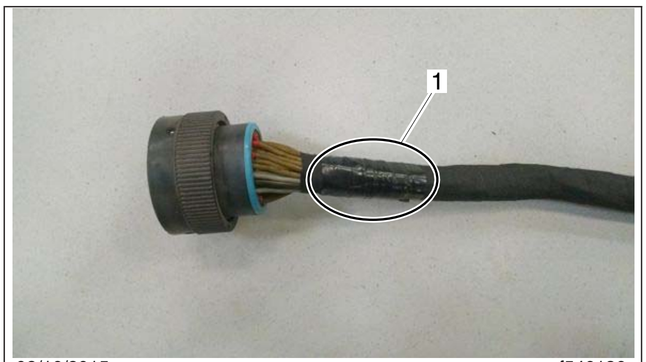
Fig. 13, Wire Repaired with Shrink Tubing

Terminal Drag Test

A drag test is performed between a single male and female terminal to determine if the engagement and retention forces between them are sufficient. Individual terminals that fail the drag test can be replaced. If the repair causes the wire to be pulled tight, or results in tension at the connector, a short piece of wire and new terminal can be added to reduce the tension. Otherwise, all terminals *must* be replaced.

Guidelines for Repairing or Replacing an Electrical Harness

Fig. 14, Wrapping the Harness with Fiber Tape



1. Fiber Wrap Secured with Electrical Tape

Fig. 15, Fiber Wrap Secured with Electrical Tape

1. Perform a drag test on a known good terminal pair.
   - 1.1 Select a mating female and male terminal pair that have the same part numbers as the affected female and male terminal pair.
   - 1.2 Manually insert, and then remove, the test mating male terminal into the test female terminal three times. On the known good test terminal pair, the mating terminal will fit securely when inserted into the terminal in the connector. There will be significant resistance (drag) when the mating terminal is removed.
2. Compare the amount of resistance to the affected terminal pair by performing the same test on the affected terminal pair. If the mating terminal does not have the same resistance as the good terminal pair, the terminal pair and the seals (if required) should be replaced.

General Specifications

See **Table 1** for standard wiring color-coding.

See **Table 2** for standard wiring circuit numbers and descriptions.

Standard Wiring Color-Coding		
Color	**Abbr**	**Typical Usage**
Black	BK	Ground, General
Black-White	BK-W	Ground, Clean or Isolated
Blue DK	DKBL	Backup/Windshield Wiper/Trailer Auxiliary
Blue LT	LTBL	HVAC/Circulation Fans/1922+
Blue LT-White	LTBL-W	Water, Oil Gauge and Indicator (Engine and Transmission)
Brown	BR	Marker, Tail and Panel Lamps
Gray	GY	Electronic Engine (or TXL Insulation)
Green DK	DKG	Turn Signal, RH/Driver's Display/Data Record/1587+/1939–
Green DK-White	DKG-W	Starting Aids/Fuel Heaters/Material Control/Winch/Tailgate
Green LT	LTG	Headlamp/Roadlamp/DRL
Green LT-White	LTG-W	Axle Controls and Indicators/Suspension/Fifth Wheel
Orange	O	ABS/EBS/1587–
Pink	PK	Start Control/Ignition/Charging/Volt and Ammeter/1922–
Pink-White	PK-W	Fuel Control and Indicators/Shutdown/Speed Limiter
Purple	PRP	Engine Fan/PTO/Auto Lube and Oil
Purple-White	PRP-W	Utility/Spot/Ad/Interior/Emergency Lighting
Red	R	Power Distribution, Constant
Red-White	R-W	Brake/Pneumatic/Hydraulic/Retarder/Stop
Tan	T	MPH, RPM Signals/Horn/Flasher/Pyro/Turbo
Tan-White	T-W	Audio/Video/Security/Window/Computer/Seat/Mirror/Cab-Tilt
White	W	Transmission (or SXL Insulation)
Yellow	Y	Turn Signal, LH/1939+ (or GXL Insulation)
Yellow-White	Y-W	Air Bag and SPACE

Table 1, Standard Wiring Color-Coding

Circuit Numbers		
Circuit Number	**Description**	**Modules**
1	Battery Cable, Ground	156 286 291
6	Battery Cable, Positive	224 281 291 292 293 295
14	Cab Power, Main	156 224 277 281 285 286 291 292 293 295 306 320 321
15	Starter, Crank Circuit	146 155 156 157 158 286 291 320 895
16	Alternator, Main Power	124 125 286 320 836 846

Specifications

Circuit Numbers		
Circuit Number	Description	Modules
18	Air Pressure Warning	320 486 838 840 877 880 882
19	Voltmeter	286 320 836 846
20	Headlamp, Left	27D 288 304 312 320 659
21	Headlamp, Right	27D 288 304 312 320 659
22	Headlamp, Low and High Beam	27D 288 304 312 320 659
23	Tail Lamps	288 294 296 301 302 304 30A 320 335
24	Horn, Electric	288 320 321 726
25	Horn, Air	288 320 321 726
27	Road Lamp	288 313 314 320
28	Fog Lamp	288 313 314 320
29	Instrument Panel Lamps	27D 288 296 302 304 30A 312 320 335 659 732 811 81B
30	Transmission Temperature and Filter	286 320 343 345 34B 34C 353 355 863 864
31	Transmission Aux Controls and Temp	286 320 343 345 34B 34C 353 355 863 864
34	Engine Oil Pressure	165 286 320 852
35	Engine Oil Temperature	286 320 854
36	Stop Lamps	288 294 296 301 320 335 486 838 840 877 880 882
38	Turn Signal	288 294 296 298 299 300 301 320 335 811
39	Stop/Turn Combination Lamp	288 294 296 301 320 335 880
40	Fan, Windshield/Sleeper	287 320 716 718
41	Dome/Interior Lamp	271 287 294 300 302 305 311 312 314 316 318 319 31A 31B 31C 31D 31E 320 322 324 325 327 328 32B 32C 469 470
42	Axle Oil Temperature, Forward	288 320 865 866
43	Axle Oil Temperature, Rear	288 320 865 866
44	Axle Oil Temperature, Center	288 320 865 866
45	Receptacle, Trailer	173 285 296 297 303 306 307 308 309 310 320 321 331 334 335
46	Marker Lamps	288 296 302 304 30A 320 335
47	Fuel Level	288 320 844 847
48	Fuel Control and Level, Natural Gas	148 150 152 162 164 283 286 288 320 811 814 844 847 860
52	Ignition Switch	156 285 306 320 321
55	Data Recorder	283 286 320 343 810 817
57	12V Power Outlet/Lighter	284 287 320 785
58	Heater, Auxiliary	130 287 320 700 703 70A 70C 723
73	Utility Lamps	287 288 318 31J 320 327 329 57W
74	Starter Mag Switch, Solenoid	155 156 157 158 286 320 895

Circuit Numbers		
Circuit Number	Description	Modules
75	Starter Mag Switch, Ground	146 155 156 157 158 286 895
76	Mirror Heat	320 656 744 74E
78	Spot Lamp	316 320 57V
81	Ignition Switch Control Devices	156 285 304 306 320 811 814 860
82	Starter Mag Switch Power	155 156 157 158 286 320 895
86	Axle Lock Solenoid	288 320 452 874 878 87A 87B 87F 896 900
87	Axle Lock	288 320 452 865 866 874 878 87A 87B 87F 896 900
88	Lubrication System, Automatic	288 594
90	Sander, Road	288 320 329
91	Heater, Diesel Fired Auxiliary	130 132 138 140 141 154 166 286 287 288 320 467 700 703 70A 70C 723
94	Air Dryer, Heated	288 480 48A 880
95	Speaker, Radio	287 320 746 74D 750 751 753 75B 75C 79F 79G
97	Air Conditioner	130 287 320 700 703 70A 70B 723
98	Heater – A/C Motor, Blower	130 156 283 285 286 287 320 321 700 703 70A 70B 70C 723
99	Fuel Solenoid, Engine Run	148 150 152 162 164 283 286 320
102	Parking Lamps	288 296 302 304 30A 320 335
108	Door Activated Lamps Courtesy/ Footwell/Door	320 324 325 32B 675 676 677 67E 67F 811 814 860
113	Baggage Compartment Lamps	287 320 322 324 325 32C
117	Speed Sensor +	283 286 320 343 810 817
118	Speed Sensor –	283 286 320 343 810 817
119	Coolant Temperature, Engine	198 199 286 320 732 810 812 830 836 838 83A 840 841 842 843 844 845 846 847 852 854 856 858 862 864 865 866 867 868 869
120	Back-Up Lamps	288 294 320 471 721
121	Brake, Engine	128 129 164 283 286
122	Back-Up Alarm	288 294 320 471 721
123	Alternator, Voltage Regulation/ Rectifier	124 125 156 286 836
125	Park Brake Indicator/Warning	288 294 296 301 320 335 486 838 840 877 880 882
132	Alternator Charge Monitor	124 125 156 286 836
137	Alternator Indicator/Relay	124 125 156 286 836
140	Oil Pressure, Engine	286 320 852
149	Fan Manual Controls, Engine	273 276 286 320
154	Auxiliary Air Pressure	288 320 486 838 840 865 866 877 880 882
155	Axle Lift Controls	288 320 452 874 878 87A 87B 87F 896 900
157	Power Mirror Controls	320 656 744 74E

Specifications

Circuit Numbers		
Circuit Number	**Description**	**Modules**
162	Tachometer Sensor +	283 286 320 812 819
163	Tachometer Sensor –	283 286 320 812 819
166	Engine Starting Aid, Ether	132 154 286 320 467
168	Hour Meter, Engine	286 320 812 813 81A 837 852
170	Fifth Wheel Slide Lock and Controls	173 296 297 303 307 308 309 310 331 334 581 87E
171	Brakesaver, Cat	128 129 286 343 34B 34C 34W 353
172	Clock	287 320 687 738
173	Coolant Level, Engine	152 286 320 856
182	Fuel Pressure	320 841 843 845
183	Air Cleaner Restriction, Engine	329 472
193	Cab Tilt Pump	288 320 670
196	Fuel Water Separator Heater	110 127 220 288
200	PTO Controls	148 283 286 288 320 372
203	Exhaust Brake	128 129 164 283 286
204	Seat Belt Indicator/Warning	320 74F 756 760 763
208	Axle Control, Tri Axle, Steer Lock	288 320 376 452 865 866 874 876 878 87A 87B 87C 87F 896 898 900
209	Axle, Two Speed Shift Control	283 286 288 320 343 376 810 817 876 87C 898
210	Power Distribution Module, Outside Cab	224 281 285 286 291 292 293 295 306 320 321
211	Security System, Rockwell	287 320 656 787
214	Generator, Auxiliary	124 125 286 599
218	Pyrometer	286 320 858
219	Turbo Pressure	286 320 842
221	Suspension Dump Controls	288 320 87D 888 910
222	Headlamp Dimmer Controls	27D 288 304 312 320 659
223	Transmission Controls, Auto Shift	160 283 285 286 288 320 330 343 345 34B 34C 355 376 732 736 810 811 813 814 817 876 87C 898
224	Transmission Controls	286 288 320 343 345 34B 34C 353 355 376 876 87C 898
225	Air Pressure Gauge, Primary	320 486 838 840 877 880 882
226	Air Pressure Gauge, Secondary	320 486 838 840 877 880 882
227	Air Pressure Gauge, Application	320 486 838 840 877 880 882
232	Transmission Controls Power Supply	160 283 285 286 320 330 343 345 34B 34C 353 355 732 736 811 813 814
234	Engine Fan Controls	273 276 286 320
236	Transmission Neutral Indicator	286 320 343 345 34B 34C 353 355
242	Seat Controls	320 74F 756 760 763

Circuit Numbers		
Circuit Number	Description	Modules
243	Shore Power, Power Inverter	274 277 284 287 307 320 336 337 33C 785
244	Speed Limiter, Vehicle, Hewitt	150 164 283 286
246	Electric Fuel Pump	148 150 152 162 164 283 286 320
250	Predictive Cruise Control	149 283 286
253	Cab Tilt Indicator	288 320 670
254	Roof Mounted Emergency Lamp/ Strobe	264 271 275 27A 27B 27C 27E 288 31A 31B 31C 31D 31G 320 327 33A
255	Advertising/Identification Lamp	288 296 302 304 30A 319 320 335
256	Optional Power Wire	285 286 306 320 321
261	Axle Lock, Controlled Differential	288 320 865 866
262	Retarder, Allison Transmission	128 129 286 343 34B 34C 34W 353
281	Oil Filter Change Indicator	165 286 320 852
285	Suspension Electric and Air Controls	288 320 87D 888 910
286	Fuel Water Separator Indicator	122 127 288 320 80F 844 845 847
294	Air Tank Auto Drain Valve	288 480 48A 880
295	Radio, AM/FM/CB/Disc	287 320 746 748 74D 750 751 752 753 75B 75C 79F 79G
299	Air Temperature, Exterior	320 860 867
300	Radio, Audio Signal	287 320 746 74D 750 751 753 75B 75C 79F 79G
303	Low Air Pressure	322 486 838 840 877 880 882
315	Windshield Wipers and Controls	320 321 660 66B
320	Windshield Washer	320 321 660 66B
331	Diagnostic Connector Power/Tach Ext Test	160 283 286 320 32A 330 338 343 725 732 733 736 811 812 813 819 835 888
338	HVAC Controls	130 287 320 700 703 70A 70B 70C 723
339	LBCU/ICU/Gauge Power/Data	320 732 811 814 860
347	Shutter, Engine Fan	273 276 286 320
359	Headlamp On Signal, LBCU/ICU	27D 288 304 312 320 659
363	Power Windows	320 654 656 66A
364	Power Windows, Rear	320 654 656 66A
372	Receptacle # 2, Trailer 7-Way, ISO 3731	173 296 297 303 307 308 309 310 331 334 335
376	Antilock Brake Controls	160 283 285 286 296 308 320 330 331 332 333 335 343 34B 414 447 44G 44H 454 490 493 732 736 811 813 814
377	Antilock Brake Sensors	308 330 331 332 333 414 447 44G 44H 454 490 493
378	Antilock Brake Valves	160 283 285 286 308 320 330 331 332 333 343 34B 414 447 44G 44H 454 490 493 732 736 811 813 814

Specifications

Circuit Numbers		
Circuit Number	**Description**	**Modules**
379	Daytime Running Lamps (DRL)	271 27D 288 294 300 302 304 305 311 312 314 316 318 319 31A 31B 31C 31D 31E 31F 320 322 324 325 327 328 469 470 659
388	Hydraulic Brake Power/Controls	288 320 486 49A 880
399	Optional Circuit, Cab/Chassis, Customer Specified	160 283 285 286 306 320 321 329 330 343 34B 472 732 736 811 813 814 860
400	Optional Circuit, Cab/Chassis, Customer Specified	329 472
402	Engine Start/Stop System, TAS	152 156 162 283 285 286 287 320 321
406	Emergency Lamp, Alternating, Access	264 271 275 27A 27B 27C 27E 287 288 318 31A 31B 31C 31D 31G 31J 320 327 33A 57W
407	—	—
408	Emergency Vehicle Accessory and Warning Lights	264 271 275 27A 27B 27C 27E 288 31A 31B 31C 31D 31G 320 327 33A
410	Emergency Siren and Bells	288 320 321 726
416	Refrigerator/Video Power	284 287 320 737 75B 785
417	Mobile Phone Power	320 789 79C
424	Headlamp Wiper/Washer	288 304 312 320
425	PNDB/CLDS Controls	224 277 281 285 291 292 293 295 306
427	Satellite Tracking System	287 320 786 78A 79H 80D
428	Battery Isolator Protection System	124 125 156 224 277 281 285 286 291 292 293 295 306 836
430	Windshield Wiper Heater	320 321 660 66B
431	Starting Aid, Engine Preheater	132 154 286 320 467
432	Seat Controls	320 74F 756 760 763
433	Data Recorder	160 286 320 813
434	Suspension Controls, ECAS	283 286 288 320 343 810 817 87D 888 910
435	Seat Belt Indicator/Warning	320 74F 756 760 763
436	Camera, Rear and Side View	160 288 320 736
437	Instrument Control Unit/LBCU	320 486 732 811 814 838 840 860 877 880 882
439	Engine ECU and Controls	106 128 129 148 152 156 162 164 283 286 372
440	Engine ECU and Controls	106 128 129 148 149 152 156 160 162 164 273 276 283 285 286 301 320 330 343 34B 732 736 811 813 814 856 880
441	Engine ECU and Controls	106 148 164 165 283 286 320 852
442	Data Recorder/Data Logger	160 286 320 813
443	Door Locks	320 655 656 787
444	Obstacle Detection System/VORAD	160 288 320 736 73B 73C
445	Body Controls/Dump Lock	288 320 329
446	Tire Pressure Monitor System	288 320 489

Circuit Numbers		
Circuit Number	**Description**	**Modules**
447	Battery Cutoff Protection System	130 156 224 277 281 285 287 291 292 293 295 306 320 700 703 70A 70B 723
448	Tail Gate Controls	288 320 329
449	Fueling Data Recording and Transmitter	198 199 283 286 288 320 343 732 810 812 817 830 836 838 83A 840 841 842 843 844 845 846 847 852 854 856 858 862 864 865 866 867 868 869
450	Mirror Dimming Controls	320 656 744 74E
453	Optional Customer Specified Wiring	164 283 285 286 306 320 321 329 343 345 34B 34C 353 355 472
454	Inflatable Restraint and Seat Pretension	160 283 285 286 320 330 343 34B 725 732 736 811 813 814
455	Instrument Left/Right Side Selection	320
457	Dash Controls, Datalink, (BPU)	164 283 286
458	Step Deployment Unit, Passenger Side	320 675 676 677 67E 67F
459	Steering Pump Controls	539
460	Transmission-Automatic, Controls	286 320 343 345 34B 34C 353 355
461	Transmission-Automatic, Controls	286 320 343 345 34B 34C 353 355
462	Headlamps, Auxiliary	27D 288 304 312 313 314 320 659
463	Headlamps, Auxiliary Right	27D 288 304 312 313 314 320 659
464	Transmission, Smart Shift Control	286 320 343 345 34B 34C 353 355
465	Headlamp, Flashing Control	27D 288 304 312 320 659
466	Land Departure System	160 288 320 736
467	Engine Coolant Flow Systems	152 286 320 856
468	Obstacle Detection System/VORAD	160 288 320 736 73B 73C
469	Level Control, Body/Chassis	288 320 329
470	Datalink Transmit	287 320 786 78A 79H 80D
471	Datalink Receive	287 320 786 78A 79H 80D
472	Engine ECU and Controls	106 128 129 148 152 156 162 164 283 286 320 343 34B 34C 34W 353 856
473	Multifunction Stalk Switch	329 472
474	Smart Switch, Resistance Identified, MUX	329 472
475	Engine Idler Controls	152 156 162 283 286
476	Adjustable Pedal Controls	288 320 486 49A 880
477	Hazard Lights, USPS	320 327 329
478	E-Stroke Brake Monitoring System	320 486 838 840 877 880 882

Specifications

Circuit Numbers		
Circuit Number	**Description**	**Modules**
479	CB Radio Antenna Coaxial	320 748 751 752
480	Switched Auxiliary Air Pressure	288 320 486 49A 880
481	Chassis Expansion Module	160 283 285 286 320 329 330 343 34B 472 732 736 811 813 814
482	Firetruck Pump Controls	148 283 286 372
483	Engine ECU and Controls	106 148 152 156 160 162 164 283 285 286 320 330 343 34B 372 732 736 811 812 813 814 819
484	Tire Chains	288 320 452 874 878 87A 87B 87F 896 900
485	Public Address System	287 320 746 74D 750 751 753 75B 75C 79F 79G
486	Vehicle Information Center	283 286 288 320 732 74F 756 760 763 811 812 814 819 860 867 877 882
487	Engine Emissions Detection and Monitor	148 150 152 162 164 283 286 320 811 814 860
488	Brake Wear Indicator	320 486 838 840 877 880 882
490	Bus Door and Window Sensing and Warning	287 288 294 300 320 327 329 654 655 656 66A 675 676 677 67E 67F 700 703 723 787 811 814 860
491	Engine Compartment Lights/Buzzer	287 320 327 329 656 787 811 814 860
492	Engine ECU and Controls	148 150 152 162 164 283 286 320 372
493	All Wheel Drive Controls	288 320 452 874 878 87A 87B 87F 896 900
494	Transmission Shift Controls	286 320 343 345 34B 34C 353 355
495	Emergency Medical Service Accessories	264 271 275 27A 27B 27C 27E 288 31A 31B 31C 31D 31G 320 327 33A
496	Steering Wheel Controls	329 472
497	Transmission Controls	286 320 343 345 34B 34C 353 355
498	Transmission Controls	286 320 343 345 34B 34C 353 355
499	Engine ECU and Controls	164 283 286
504	Dome/Interior Lamp	287 320 322 324 325 32C
506	Aerial Equipment Systems	264 271 275 27A 27B 27C 27E 288 31A 31B 31C 31D 31G 320 327 33A
507	MUX Control, MSF/CGW	287 320 786 78A 79H 80D
508	CAN Datalink	287 320 786 78A 79H 80D
509	Firetruck Pump And Hose Controls	264 271 275 27A 27B 27C 27E 288 31A 31B 31C 31D 31G 320 327 33A
510	Firetruck Pump And Hose Controls	265 271 275 27A 27B 27C 27E 288 31A 31B 31C 31D 31G 320 327 33A
511	Bus Door and Window Sensing and Warning	146 155 156 157 158 286 895
512	Emergency Vehicle Auxilixry Switches	—
513	Emergency Vehicle Door Switches	—

Circuit Numbers		
Circuit Number	Description	Modules
514	Emergency Vehicle Lights and Alarm	288 294 320 471 721
515	Emergency Vehicle Tank Level Systems	—
518	Emergency Vehicle Ladder and Rack Systems	—
519	Emergency Vehicle Body Lighting	—
520	Emergency Vehicle Body Lighting	—
521	Emergency Vehicle Body Lighting	—
522	Emergency Vehicle Body Lighting	—
523	Emergency Vehicle Body Lighting	—
524	Emergency Vehicle Power Source	—
525	Emergency Vehicle Warning Lights	—
526	Emergency Vehicle Body Lighting	—
527	Firetruck Pump And Hose Controls	—
528	Emergency Vehicle AC Power System	—
529	Windshield Defroster Grid	287 320 716 718
532	Aftertreatment Systems, Exhaust	160 164 283 285 286 320 330 343 34B 732 736 811 813 814
533	Engine ECU and Controls, Alternative Fuel	106 148 152 164 283 286 320 856
1587	J1587/J1708 Datalink	160 283 286 320 32A 330 338 343 725 732 733 736 811 812 813 819 835 888
1922	J1922 Datalink	160 283 286 330 343
1939	J1939 CAN Datalink	160 283 286 320 330 343 725 732 736 811 813 888

Table 2, Circuit Numbers

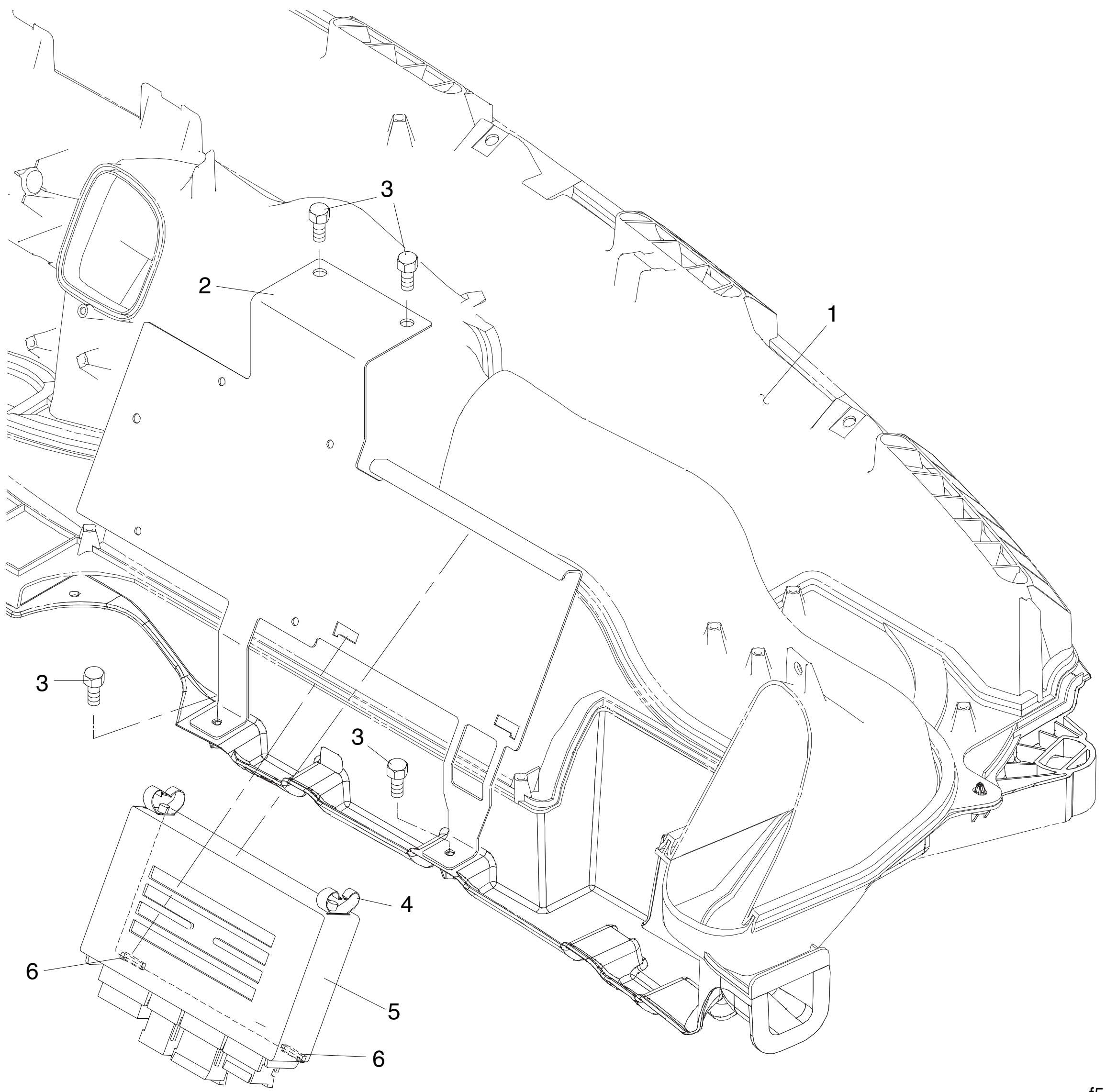
Contents

Subject **Subject Number**

Vehicle Control Unit Removal and Installation

Removal

1. Disconnect the three electrical connectors (violet, gray, and brown) by pressing the release at the bottom of each connector.
2. Press up on the bottom of the vehicle control unit (VCU) to compress the mounting clips. See **Fig. 1**.
3. With the mounting clips compressed, pull outward on the VCU to clear the mounting tabs from the slots in the VCU bracket.



1. Dash
2. Vehicle Control Unit Bracket
3. 10–14 Capscrew
4. Mounting Clip
5. Vehicle Control Unit
6. Mounting Tab

Fig. 1, VCU Removal and Installation

Vehicle Control Unit Removal and Installation

4. Pull downward to release the mounting clips from the lip of the bracket and remove the VCU from the bracket.

NOTE: Do the following steps if it is also necessary to remove the VCU bracket.

5. Using a T25 Torx® screwdriver, remove the four capscrews that attach the bracket to the dash.
6. Remove the bracket from the dash.

Installation

1. If removed, position the VCU bracket on the dash. Install the four capscrews to hold it in place. Using a T25 Torx® screwdriver, tighten the screws until firm in the threaded inserts.
2. Insert the VCU into the lip of the VCU bracket and press upward to compress the mounting clips on top of the VCU.
3. When the mounting clips are compressed enough, slide the tabs on the back of the VCU into the slots in the VCU bracket. Make sure the VCU is secured in place.
4. Connect the violet, gray, and brown electrical connectors to the VCU as removed.

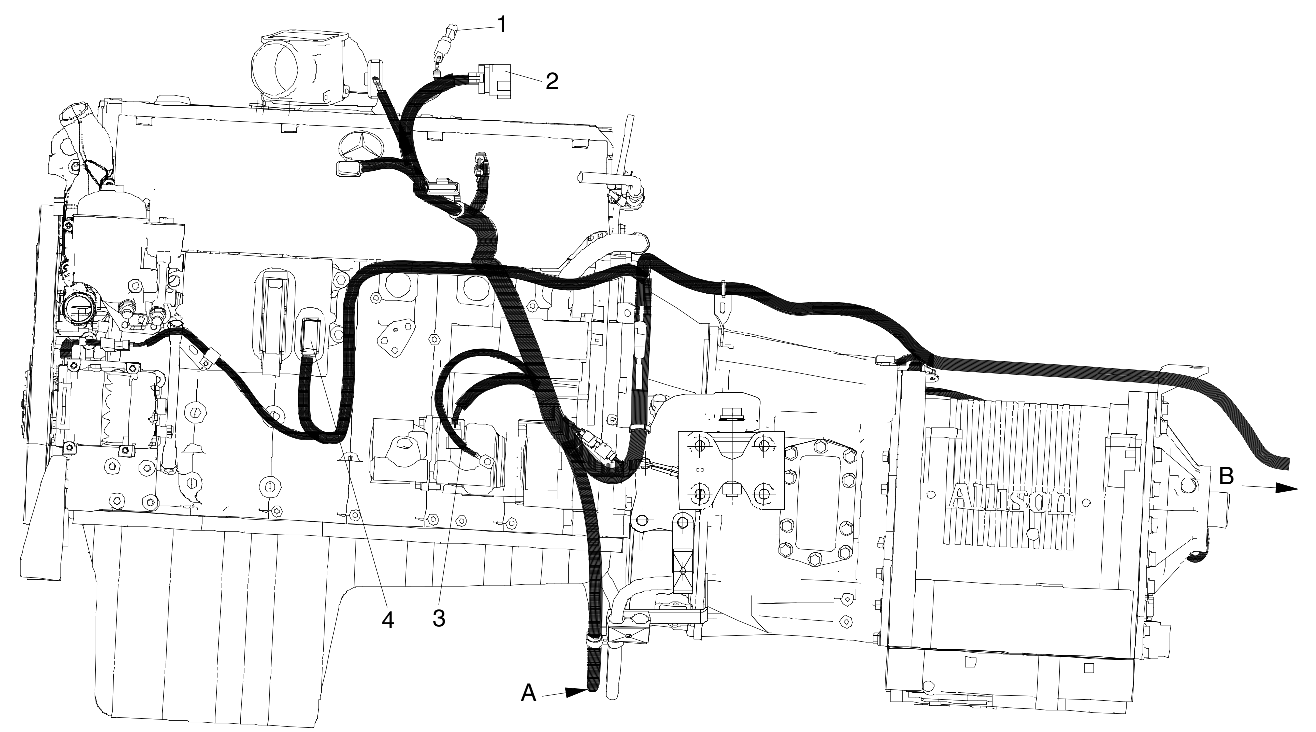
IMPORTANT: The connectors cannot be installed on the wrong plug location on the VCU because they each have different numbers of pins. Connector VC2 is not used at this time.

- Connector VC1 (brown) has 21 pins.
- Connector VC3 (gray) has 18 pins.
- Connector VC4 (violet) has 15 pins.

Harness Routing Diagrams

On a vehicle with an automatic transmission, see **Fig. 1** for a routing diagram of the engine wiring harnesses from the left side, and **Fig. 2** from the right side. **Fig. 3** shows the location of the transmission ECU (electronic control unit).

On a vehicle with a manual transmission, see **Fig. 4** for a routing diagram of the engine wiring harnesses from the left side, and **Fig. 5** from the right side.



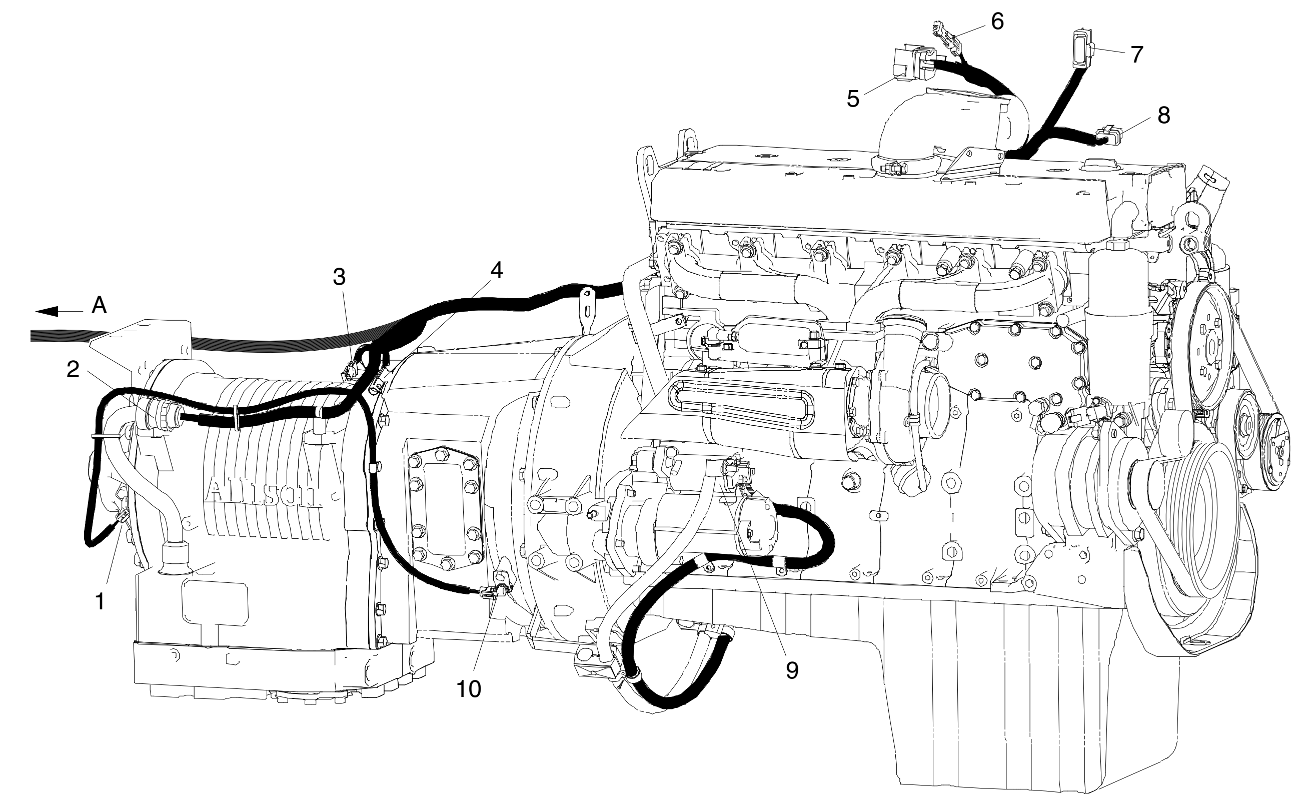
A. To Starter

B. To Transmission ECU

1. To Intake-air Heater (optional)
2. Bulkhead Connector
3. Engine Block Ground
4. PLD Vehicle Connector

Fig. 1, MBE900 Engine Harness Routing with Automatic Transmission, Left Side

Harness Routing Diagrams



A. To Transmission ECU

1. Vehicle Speed Sensor
2. Transmission Harness Connector
3. Trans-chassis Harness Connector
4. To Retarder
5. Bulkhead Connector
6. Intake-air Heater Harness Connector (optional)
7. To Bulkhead Module
8. To Main Power Distribution Module (fuse box)
9. Starter Solenoid
10. Engine Speed Sensor

Fig. 2, MBE900 Engine Harness Routing with Automatic Transmission, Right Side

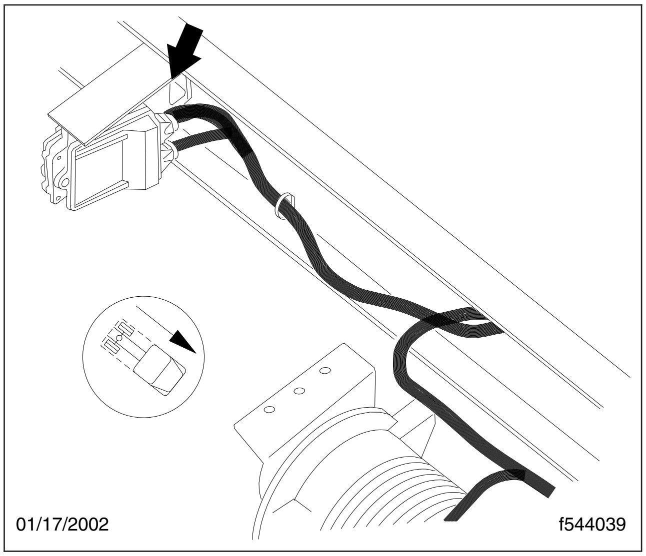
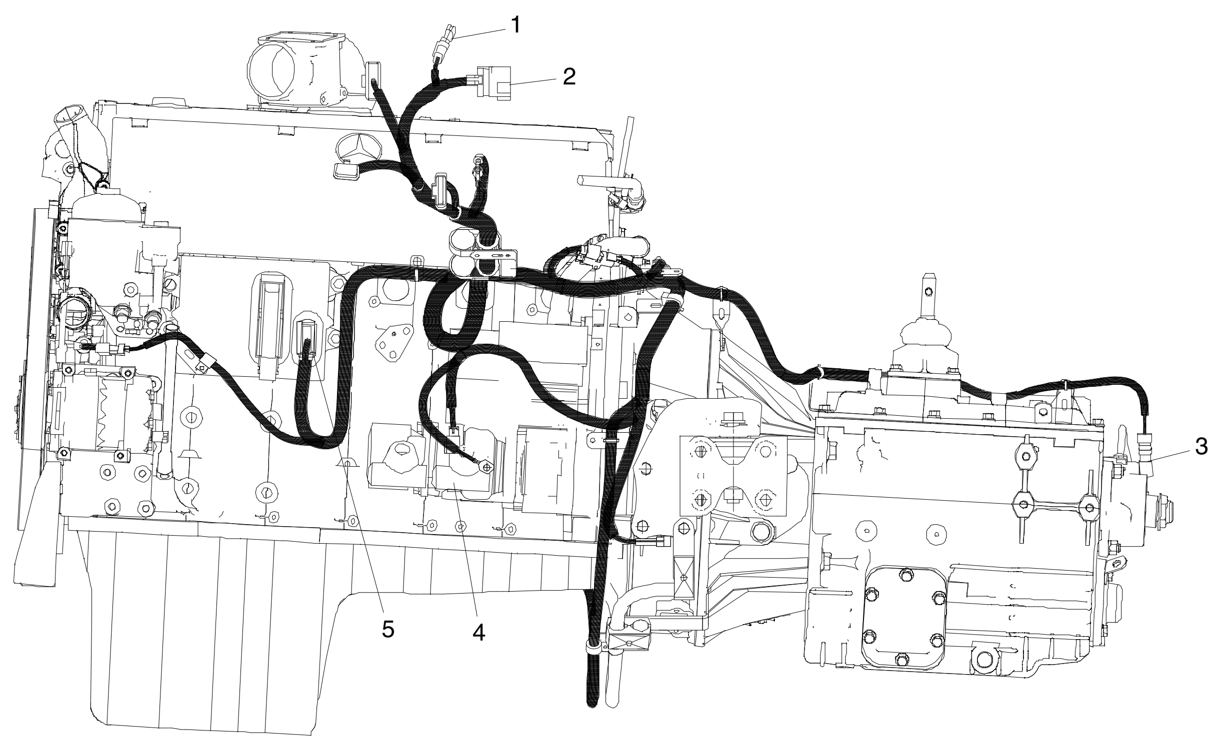


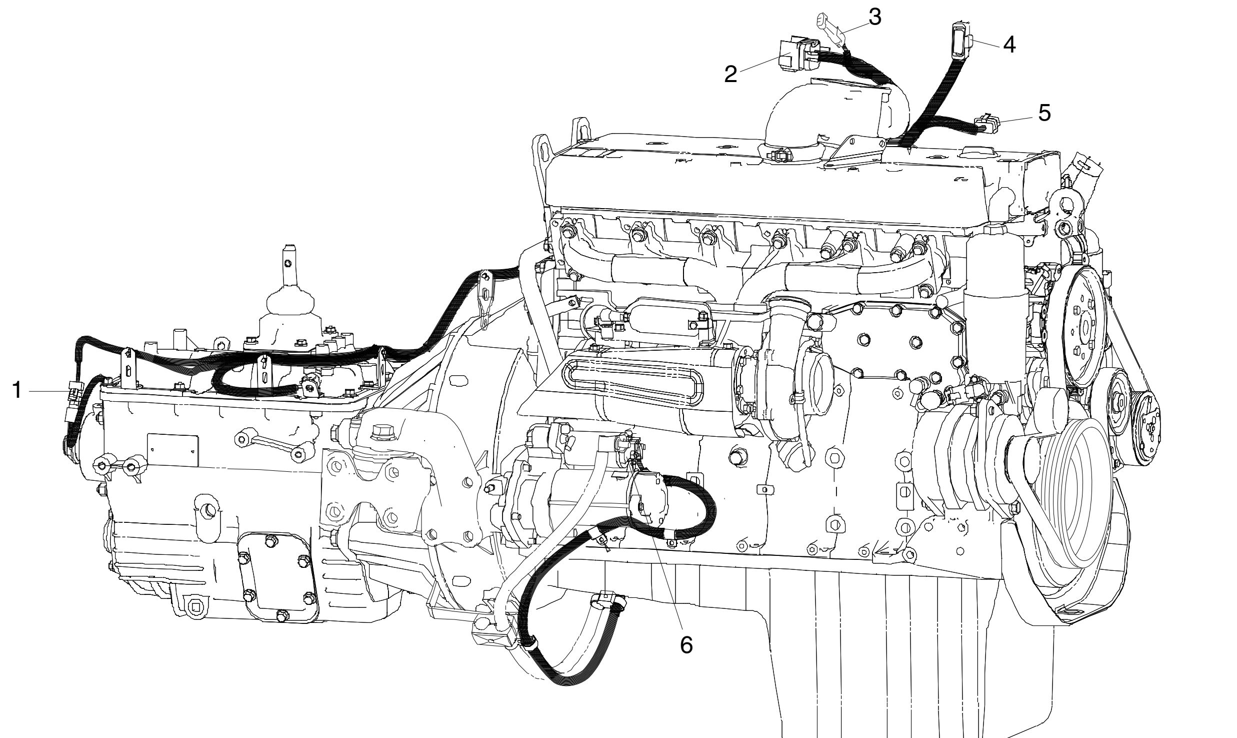
Fig. 3, Transmission Electronic Control Unit



1. To Intake-air Heater (optional)
2. Bulkhead Connector
3. Vehicle Speed Sensor
4. Engine Block Ground
5. PLD Vehicle Connector

Fig. 4, MBE900 Engine Harness Routing with Manual Transmission, Left Side

Harness Routing Diagrams



12/13/2001 f011999

A. To Vehicle Control Unit (VCU)

1. Vehicle Speed Sensor
2. Bulkhead Connector
3. Intake-air Heater Harness Connector (optional)
4. To Bulkhead Module
5. To Main Power Distribution Module (fuse box)
6. Starter Solenoid

Fig. 5, MBE900 Engine Harness Routing with Manual Transmission, Right Side

Schematics

On a vehicle with an automatic transmission, see **Fig. 1** for a schematic of the engine wiring between the PLD control unit and the bulkhead connector. For a detailed (partial) schematic of the wiring to the transmission electronic control unit (ECU), main power distribution module (PDM), engine fan, low coolant probe, and intake-air heater (optional), see **Fig. 2**. For a detailed (partial) schematic of the wiring to the bulkhead module (BHM), see **Fig. 3**.

harness. For a detailed (partial) schematic of the wiring for the engine protection system, see **Fig. 5**. For a detailed (partial) schematic of the wiring for the cruise control switches, panel lights, and engine fan switch, see **Fig. 6**.

On a vehicle with an automatic transmission, see **Fig. 7** for a schematic of the J1587 and J1939 datalink wiring.

On a vehicle with a manual transmission, see **Fig. 8** for a schematic of the engine wiring between the

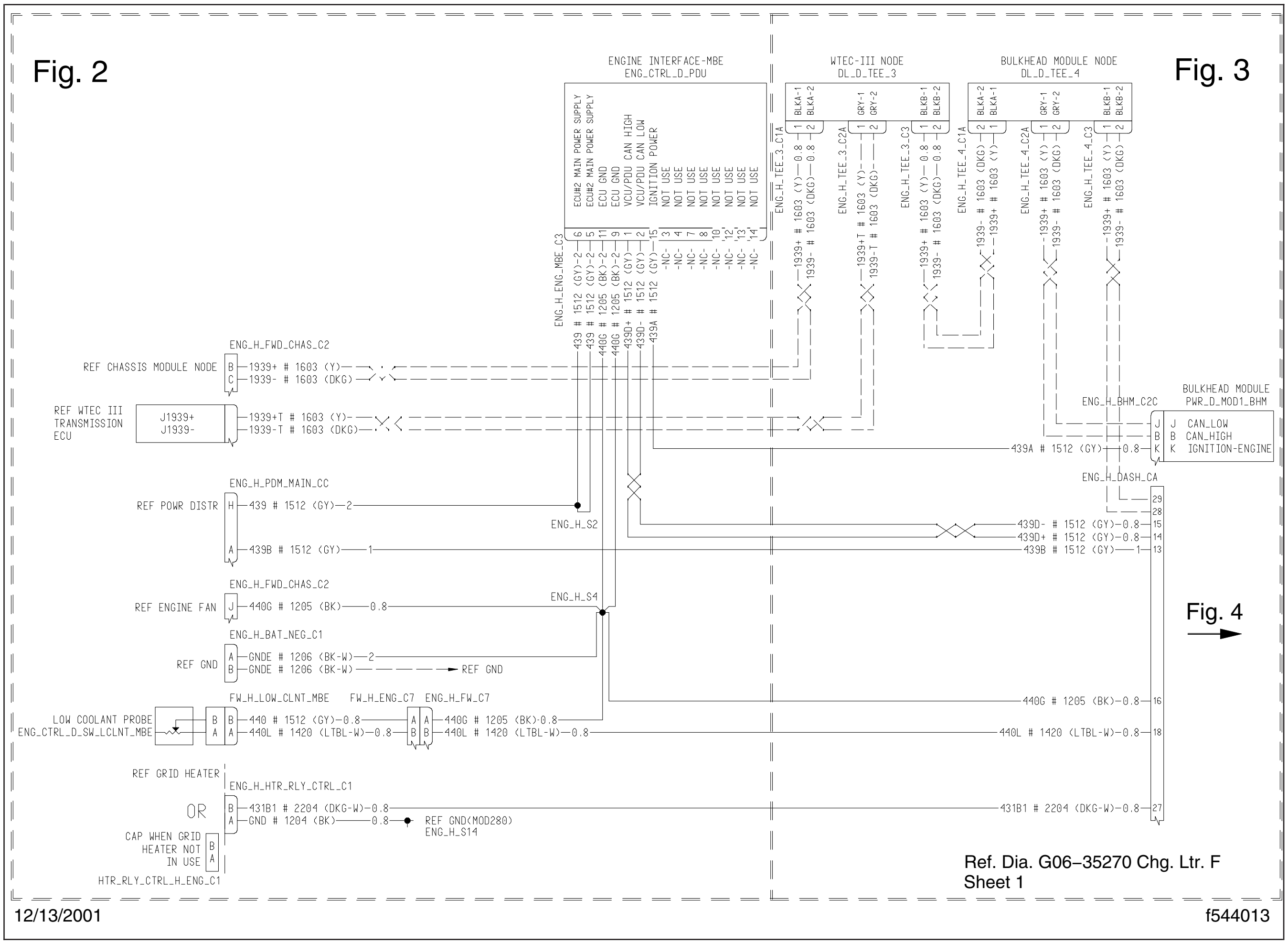


Fig. 1, MBE900 Engine Compartment Wiring Schematic, Automatic Transmission

On a vehicle with an automatic transmission, see **Fig. 4** for a schematic of the cab wiring between the bulkhead connector and the vehicle control unit (VCU), including the devices attached to the dash

PLD control unit and the bulkhead connector.

On a vehicle with a manual transmission, see **Fig. 9** for a schematic of the cab wiring between the bulkhead connector and the vehicle control unit (VCU),

Wiring Schematics

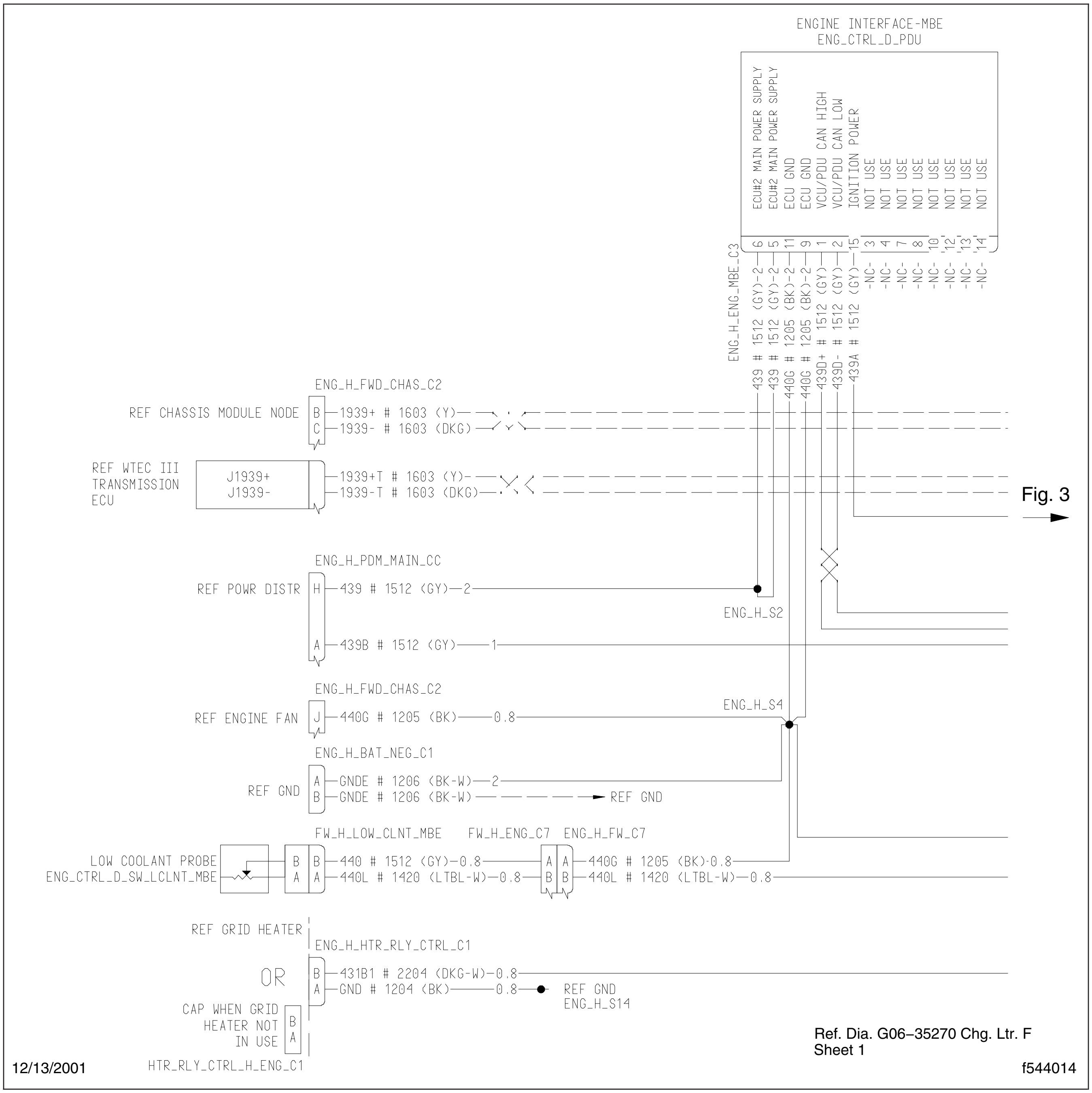


Fig. 2, MBE900 Engine Compartment Wiring Schematic, Automatic Transmission (detailed view, main PDM, trans ECU)

including the devices attached to the dash harness. For a detailed (partial) schematic of the wiring for the engine protection system, see **Fig. 10**. For a detailed (partial) schematic of the wiring for the cruise control switches, panel lights, and engine fan switch, see **Fig. 11**.

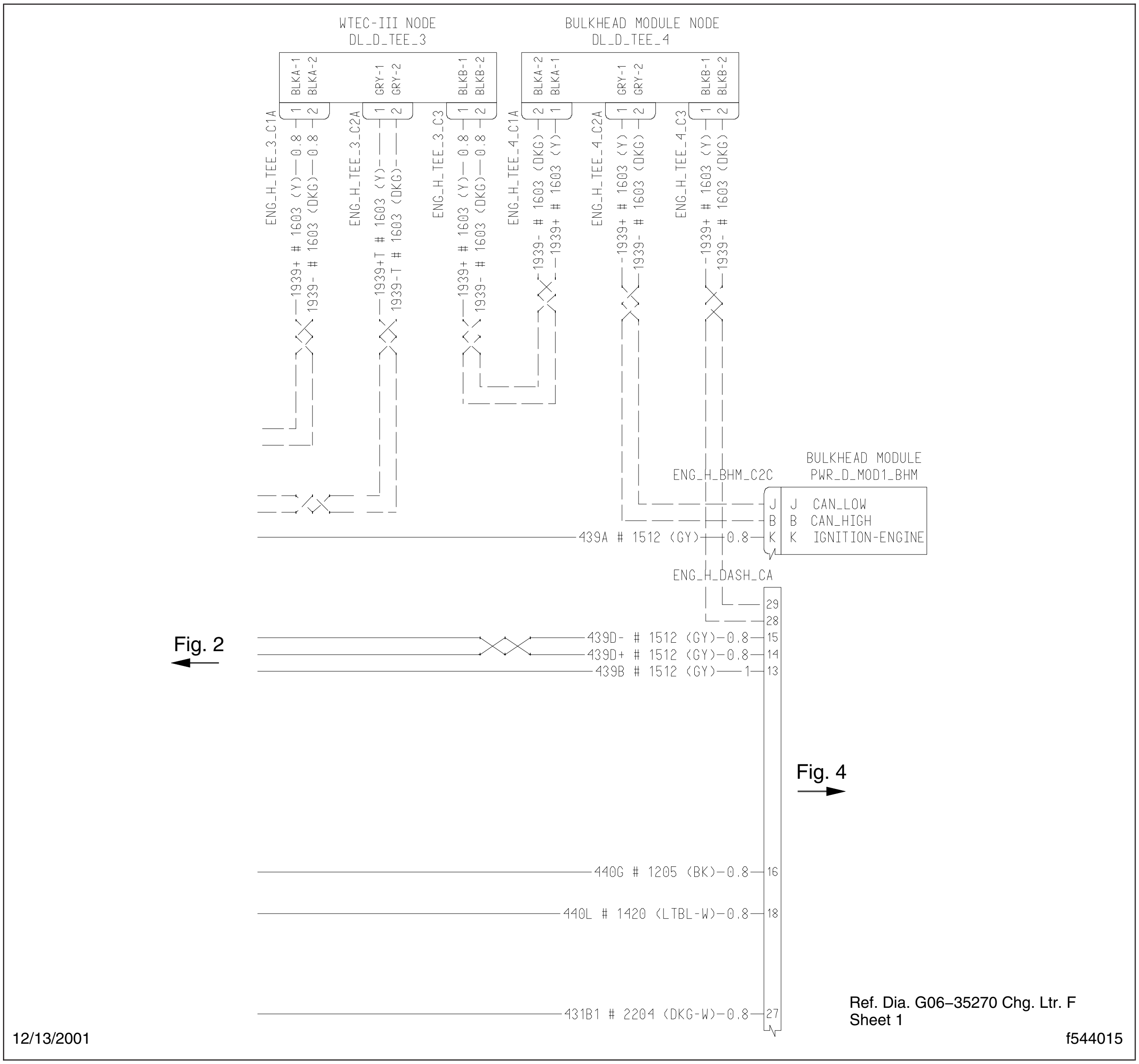


Fig. 3, MBE900 Engine Compartment Wiring Schematic, Automatic Transmission (detailed view, BHM)

On a vehicle with a manual transmission, see **Fig. 12** for a schematic of the J1587 and J1939 datalink wiring.

Wiring Schematics

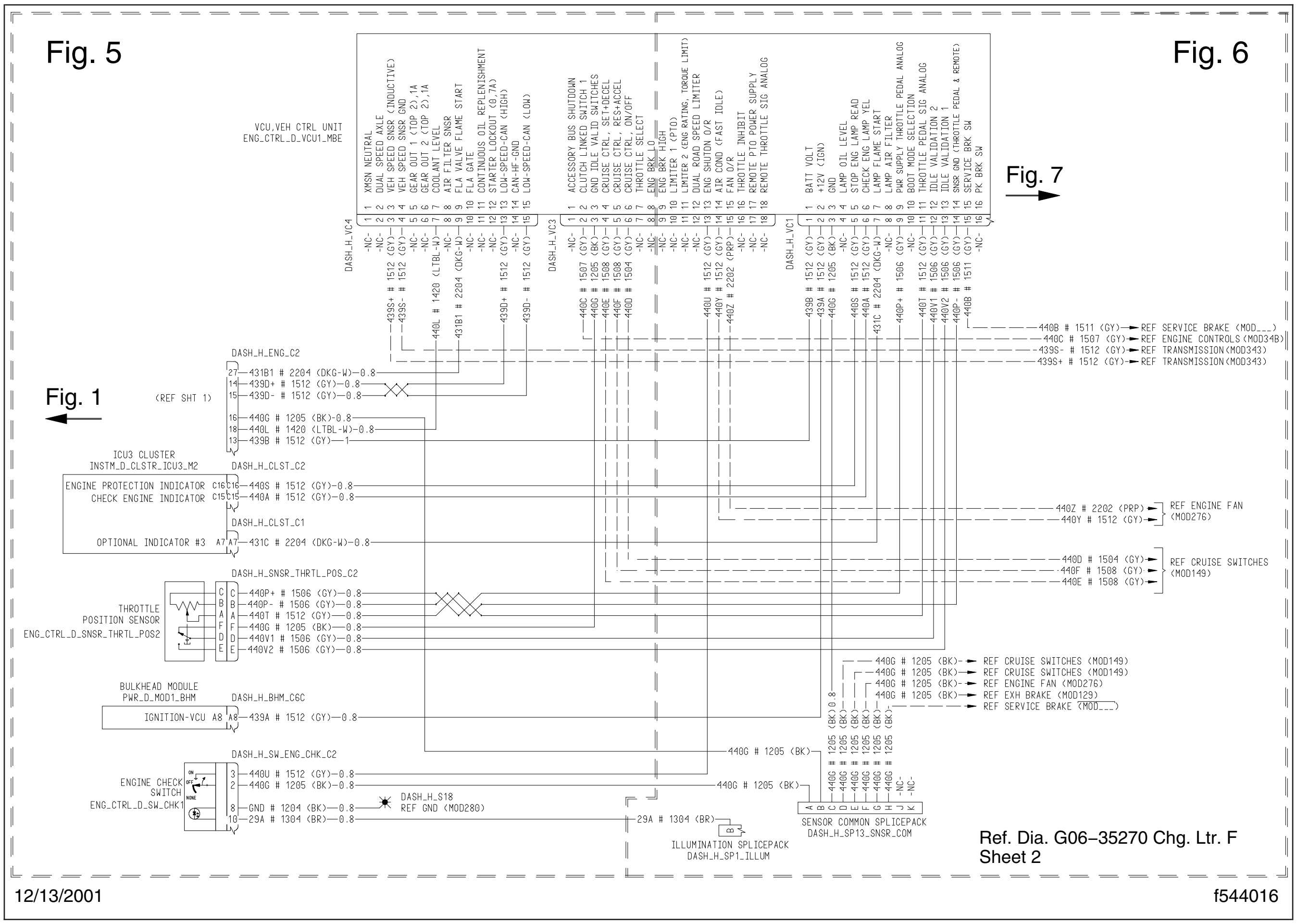


Fig. 4, MBE900 Cab Wiring Schematic, Automatic Transmission

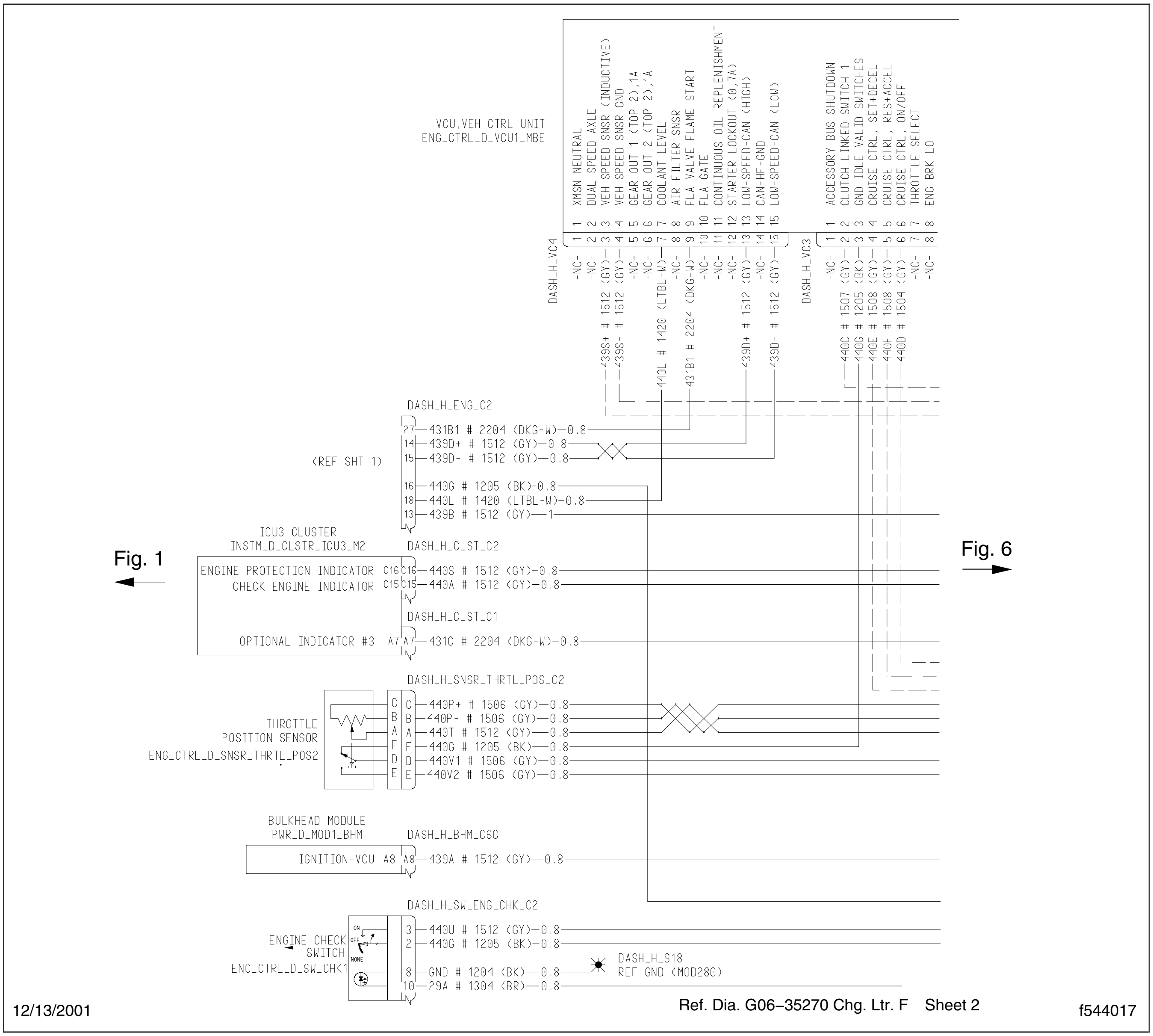


Fig. 5, MBE900 Cab Wiring Schematic, Automatic Transmission (detailed view, engine protection)

Wiring Schematics

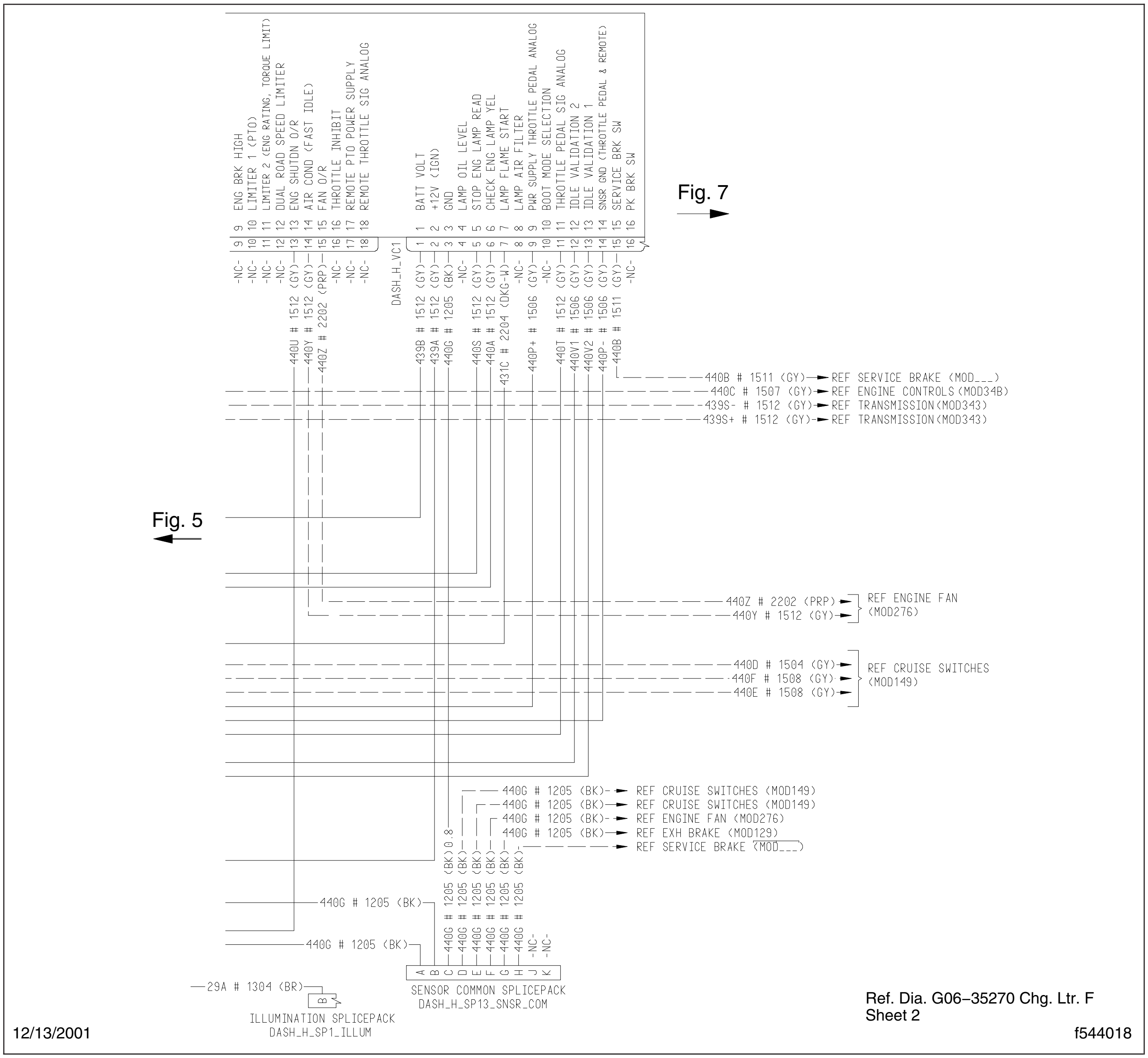


Fig. 6, MBE900 Cab Wiring Schematic, Automatic Transmission (detailed view, dash switches)

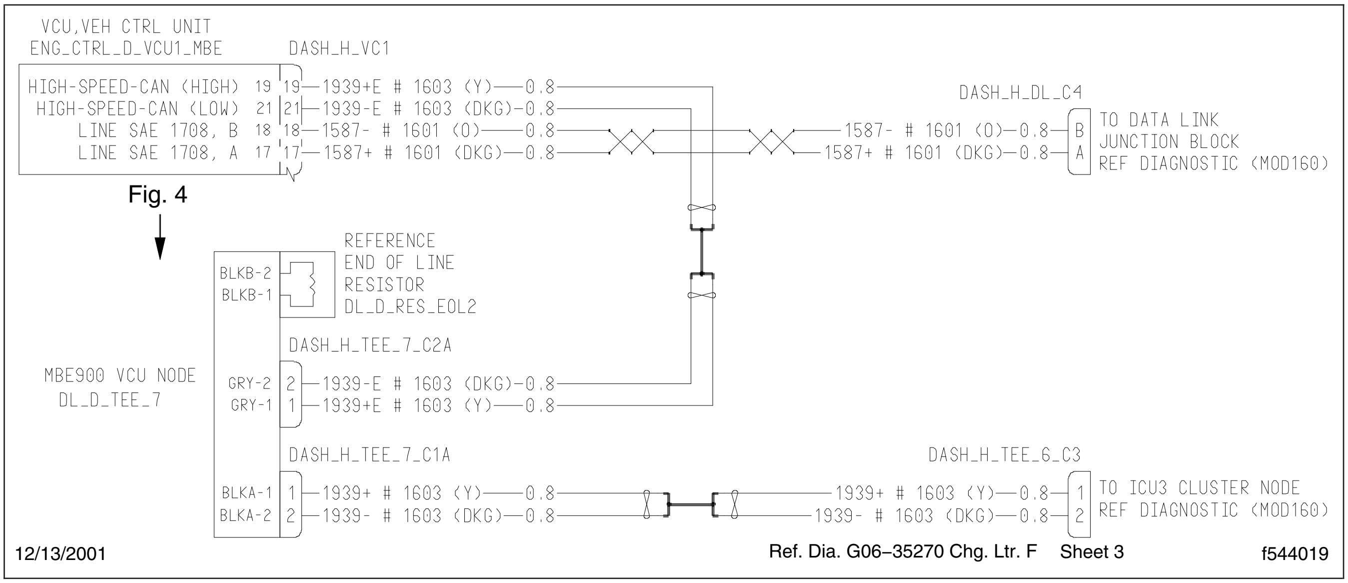


Fig. 7, MBE900 J1587 and J1939 Datalink Wiring Schematic, Automatic Transmission

Wiring Schematics

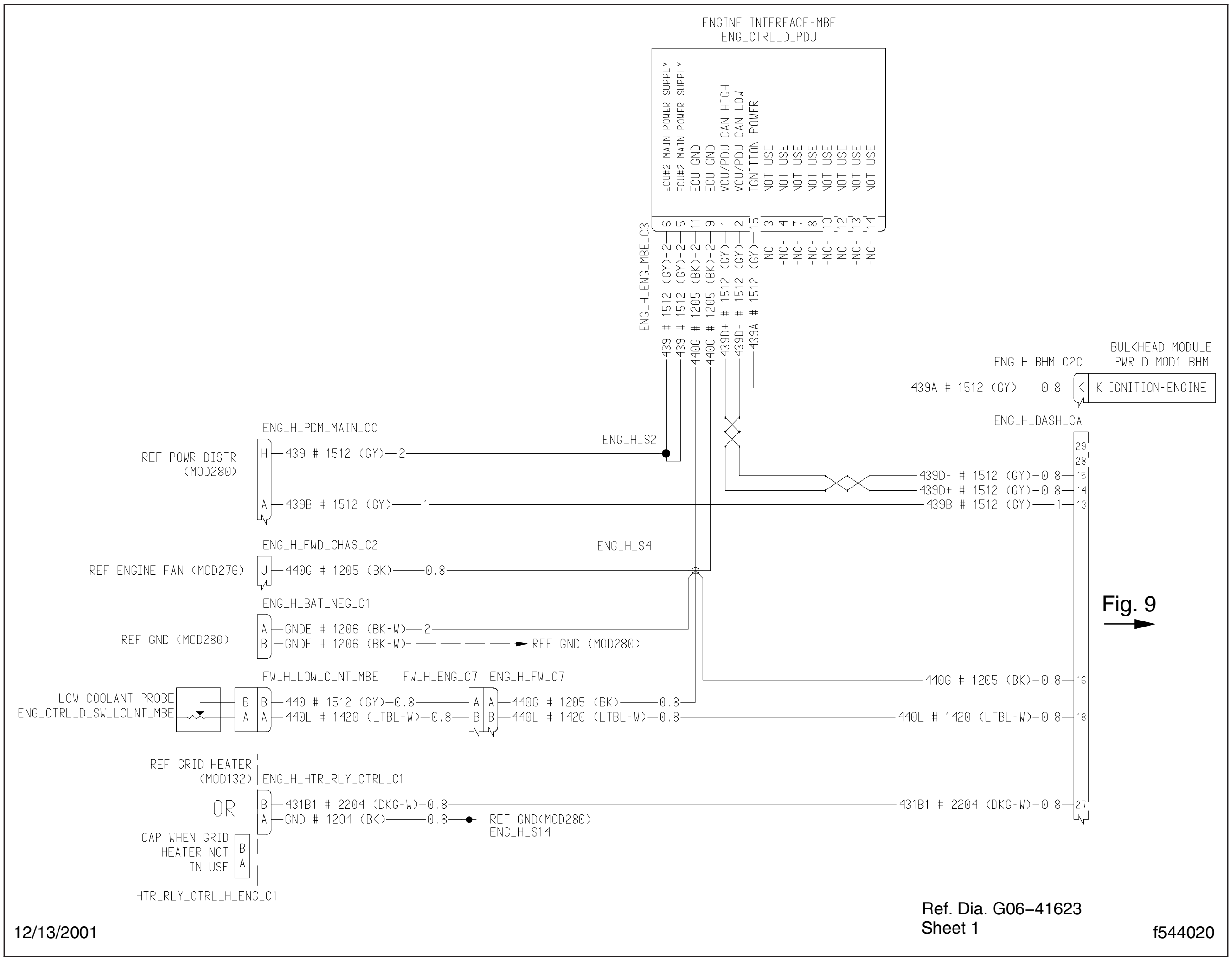


Fig. 8, MBE900 Engine Compartment Wiring Schematic, Manual Transmission

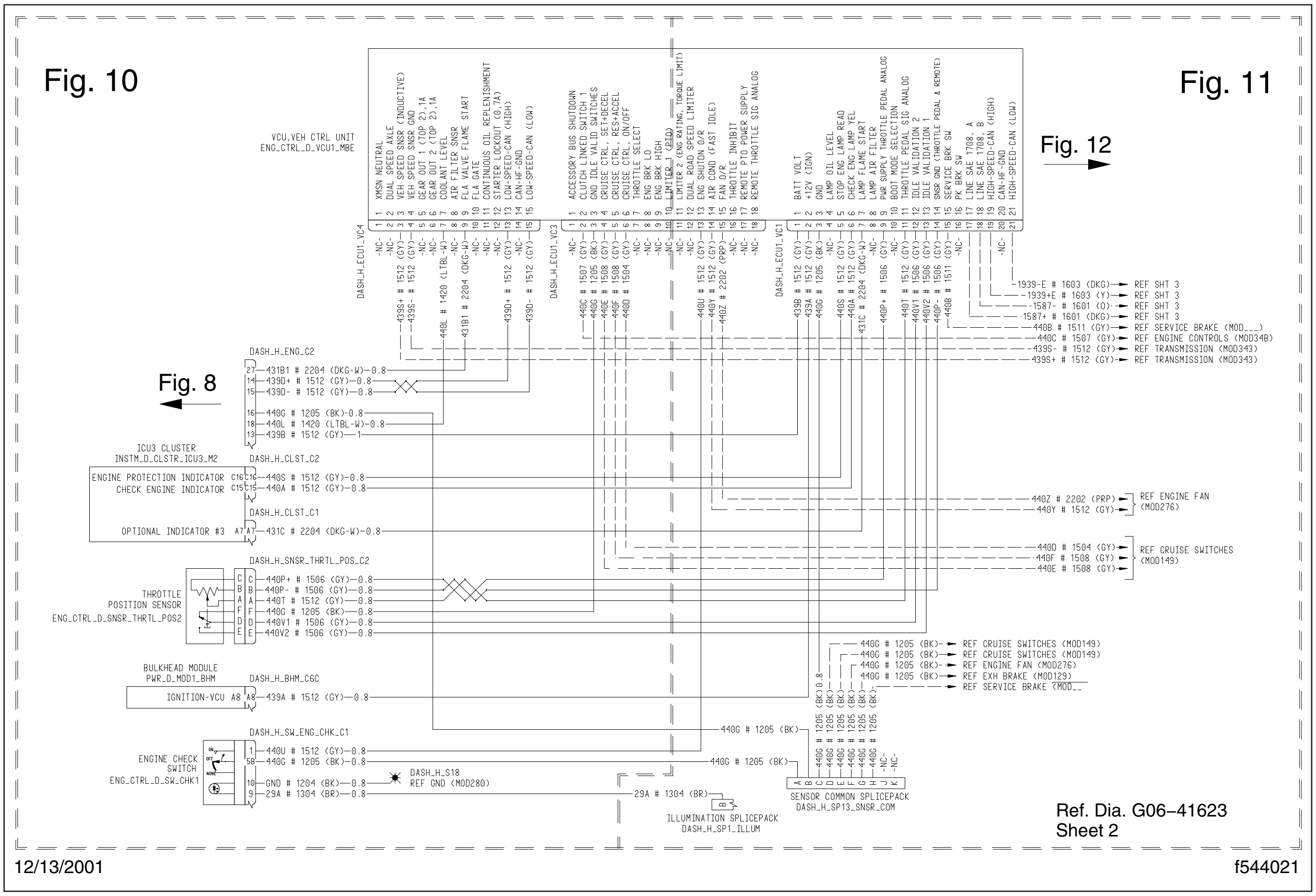


Fig. 9, MBE900 Cab Wiring Schematic, Manual Transmission

Wiring Schematics

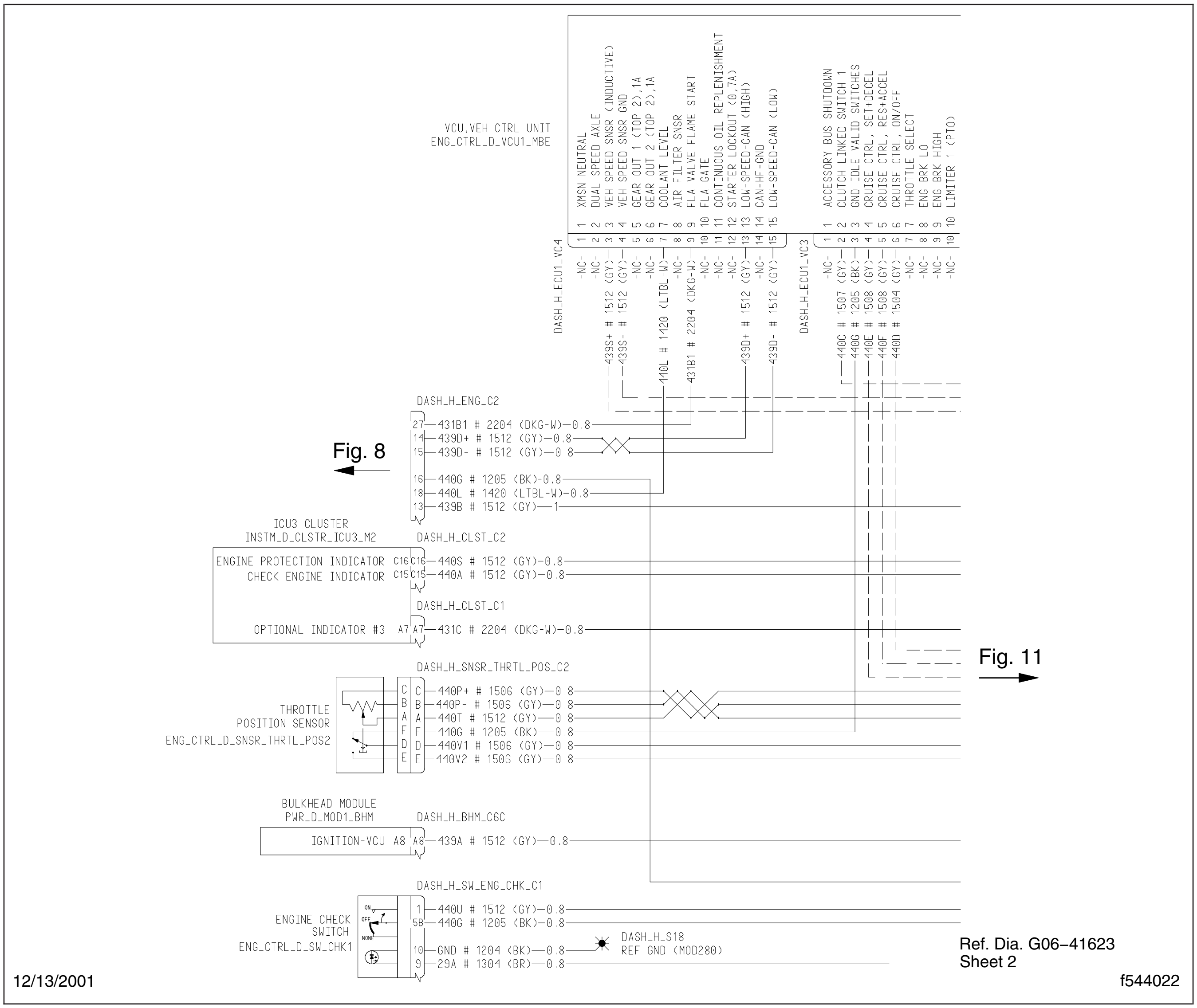


Fig. 10, MBE900 Cab Wiring Schematic, Manual Transmission (detailed view, engine protection)

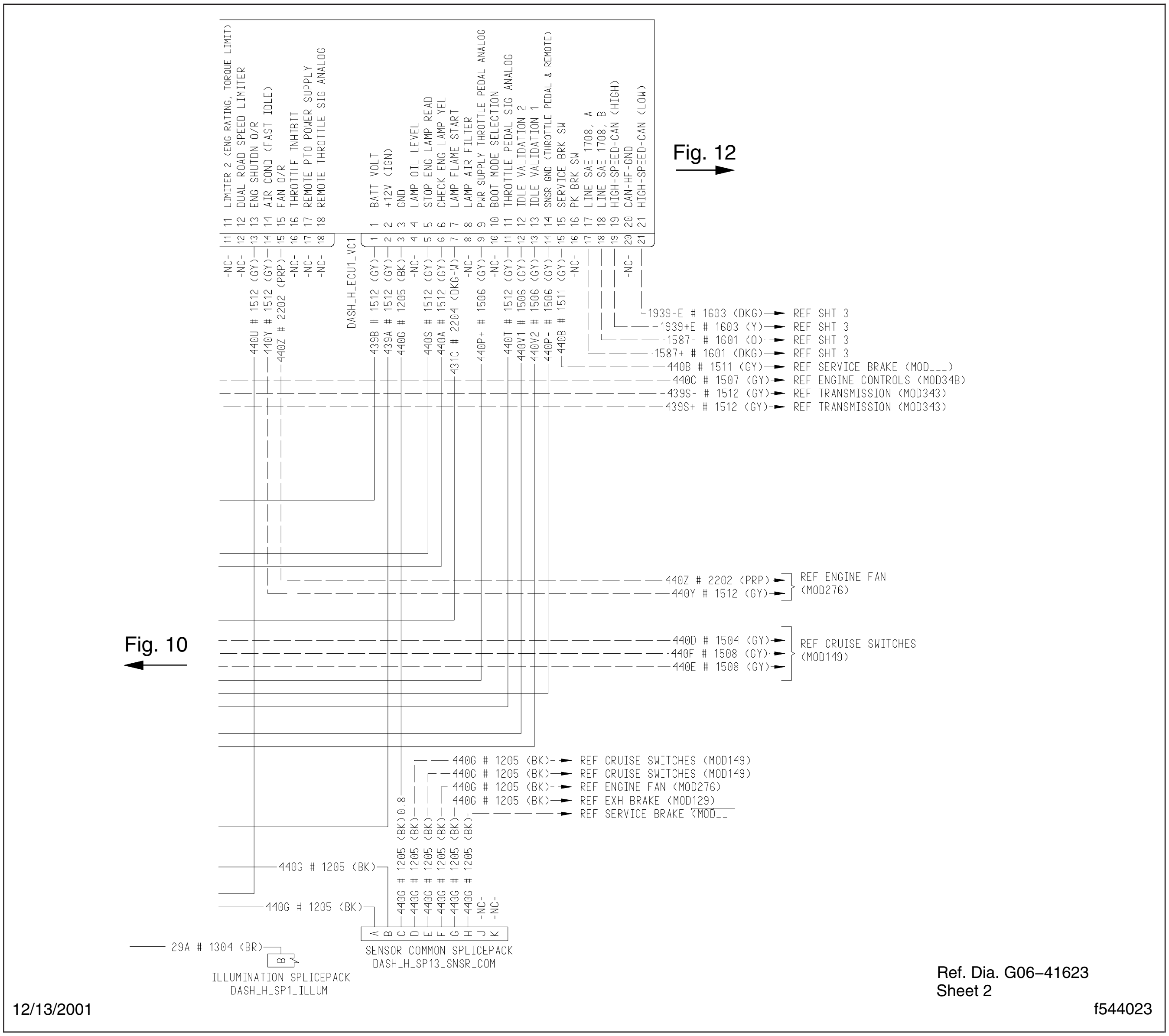


Fig. 11, MBE900 Cab Wiring Schematic, Manual Transmission (detailed view, dash switches)

Wiring Schematics

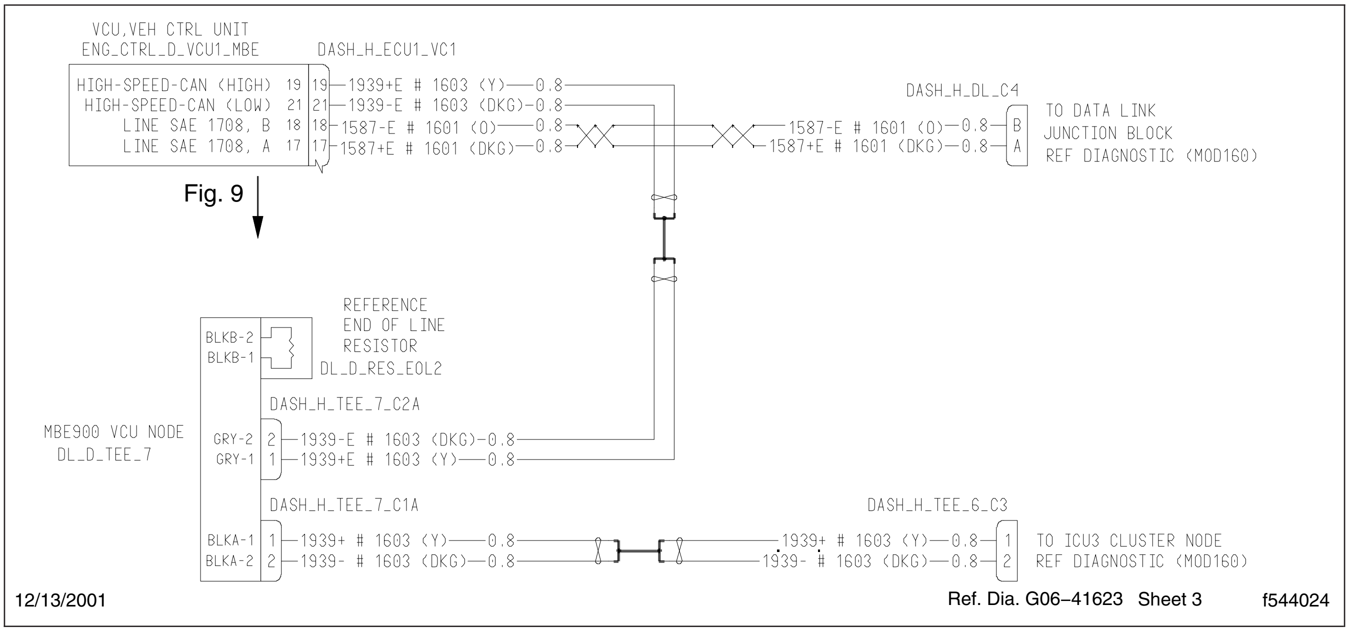


Fig. 12, MBE900 J1587 and J1939 Datalink Wiring Schematic, Manual Transmission

Harness Wiring

On a vehicle with an automatic transmission, see **Fig. 1** for a drawing of the engine harness.

For a detailed (partial) view of the bulkhead connector end, see **Fig. 2**. For a detailed (partial) view of the datalink connectors, see **Fig. 3**.

For a detailed (partial) view of the transmission and transchassis connectors, see **Fig. 4**.

For a detailed (partial) view of the engine connector end, see **Fig. 5**.

On a vehicle with a manual transmission, see **Fig. 6** for a drawing of the engine harness. For a detailed (partial) view of the engine connector end, see **Fig. 7**.

For a detailed (partial) view of the CAN datalink connector, see **Fig. 8**.

For a detailed (partial) view of the bulkhead connector end, see **Fig. 9**.

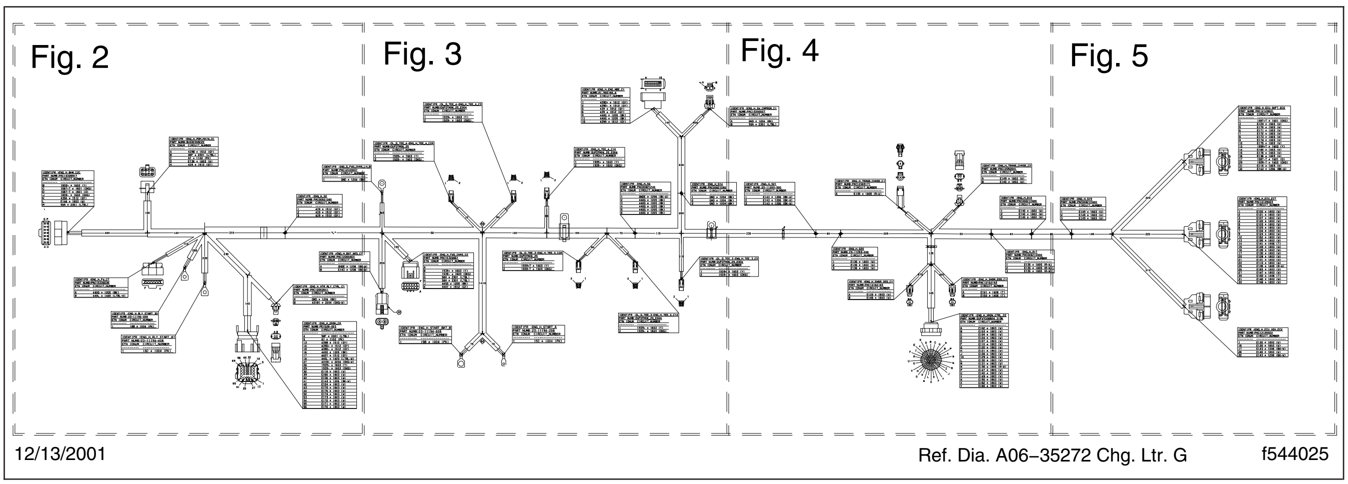


Fig. 1, MBE900 Engine Harness, Automatic Transmission

Harness Wiring

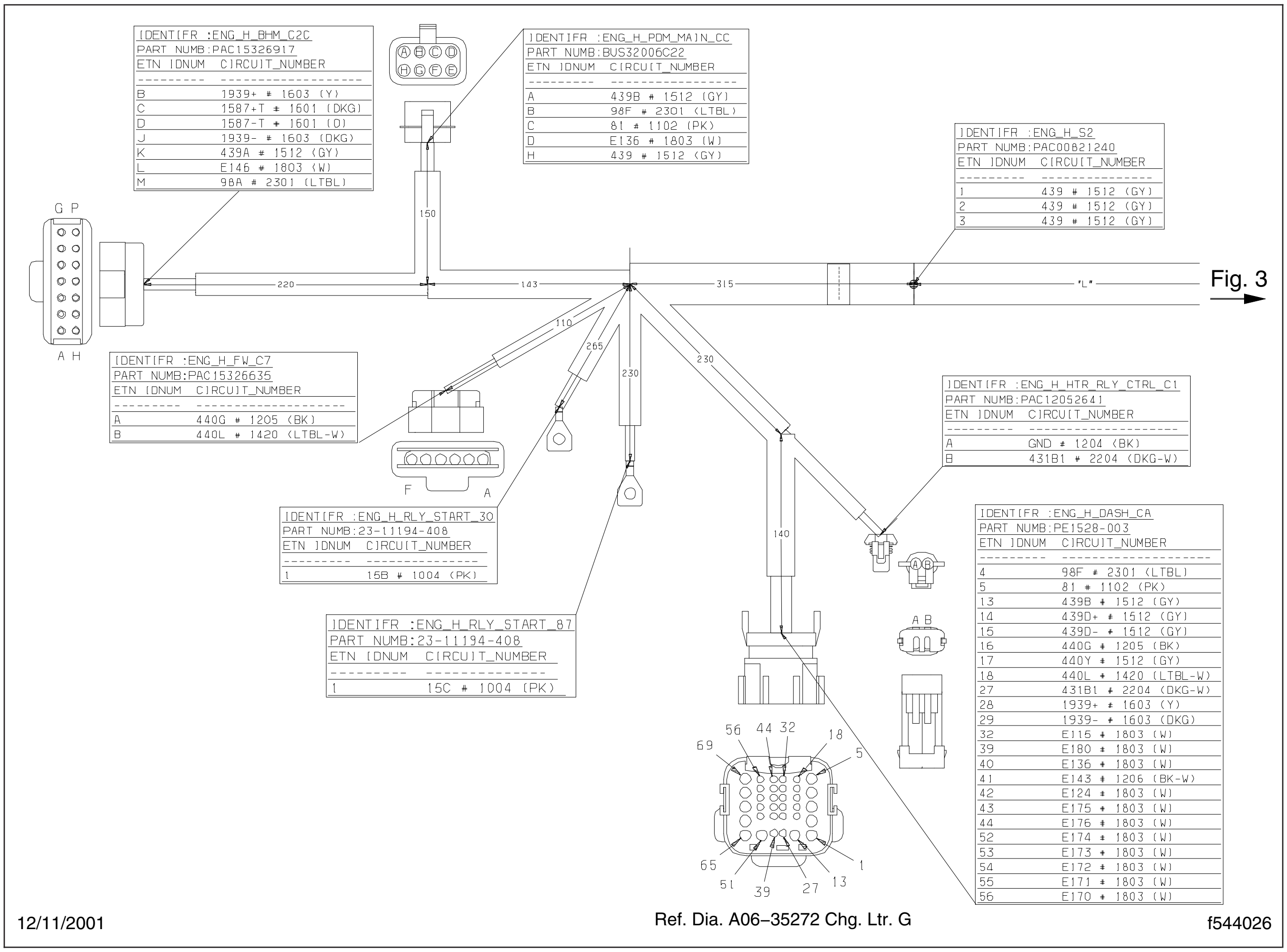


Fig. 2, MBE900 Engine Harness, Automatic Transmission (detailed view, bulkhead connector end)

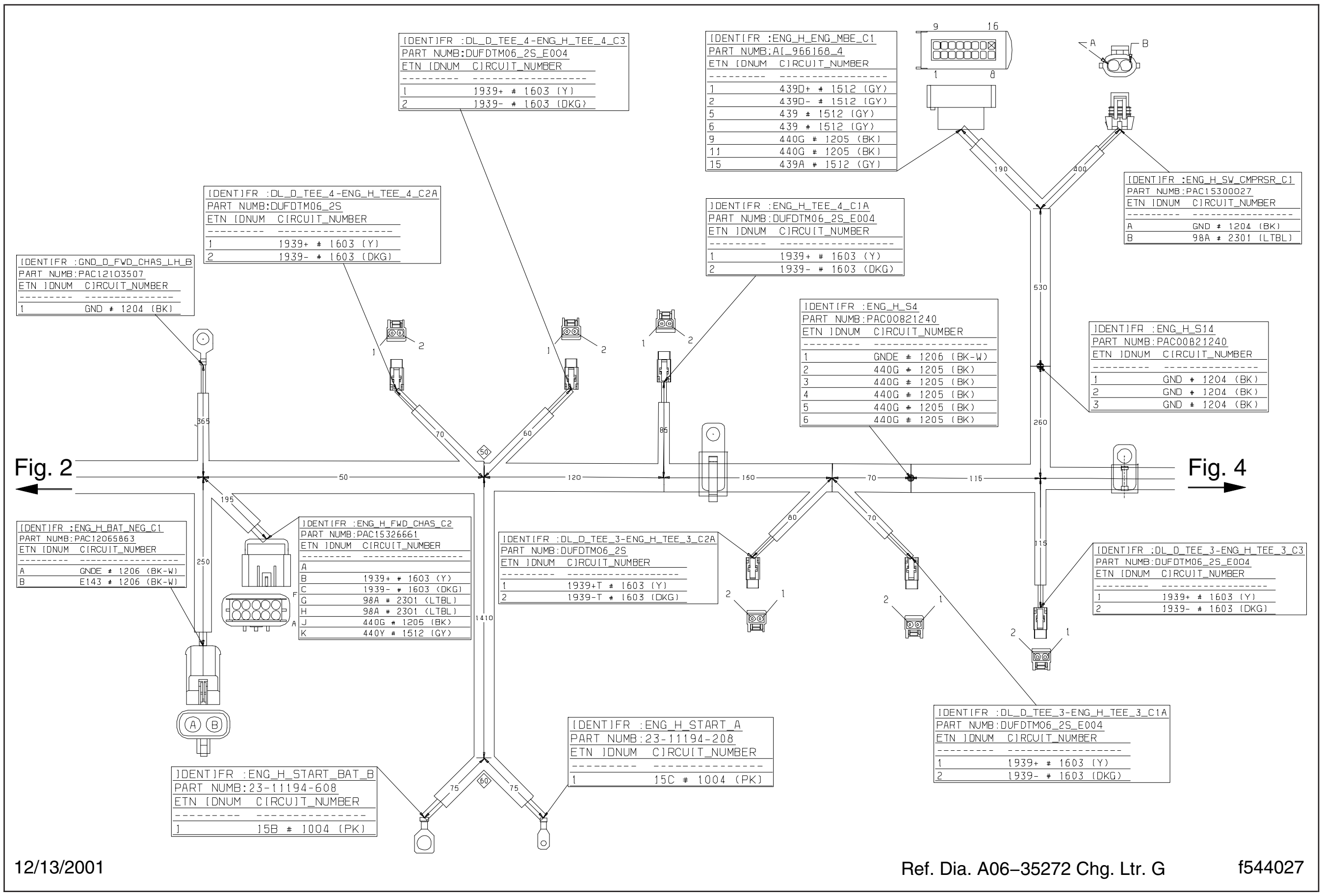


Fig. 3, MBE900 Engine Harness, Automatic Transmission (detailed view, datalink connectors)

Harness Wiring

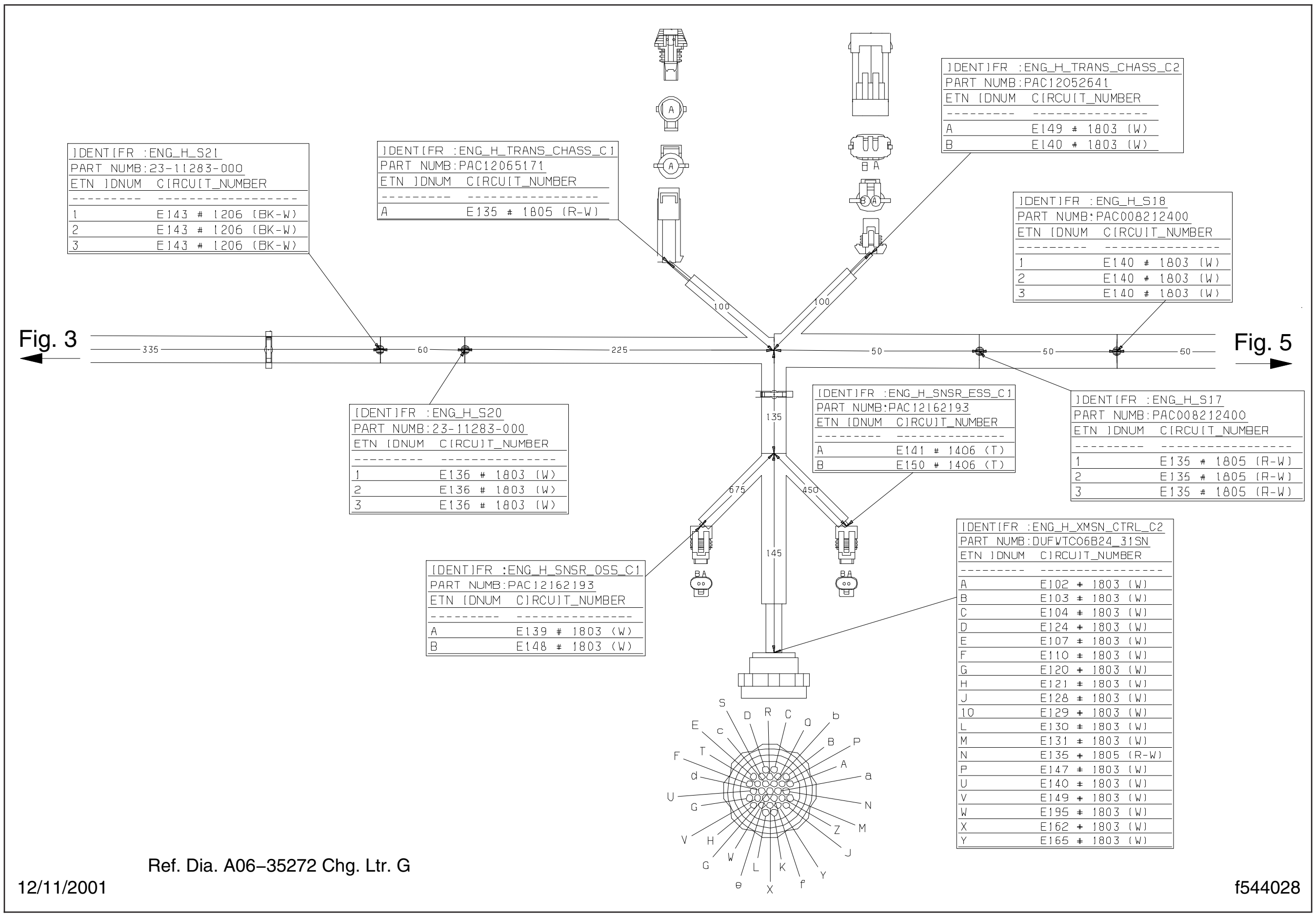
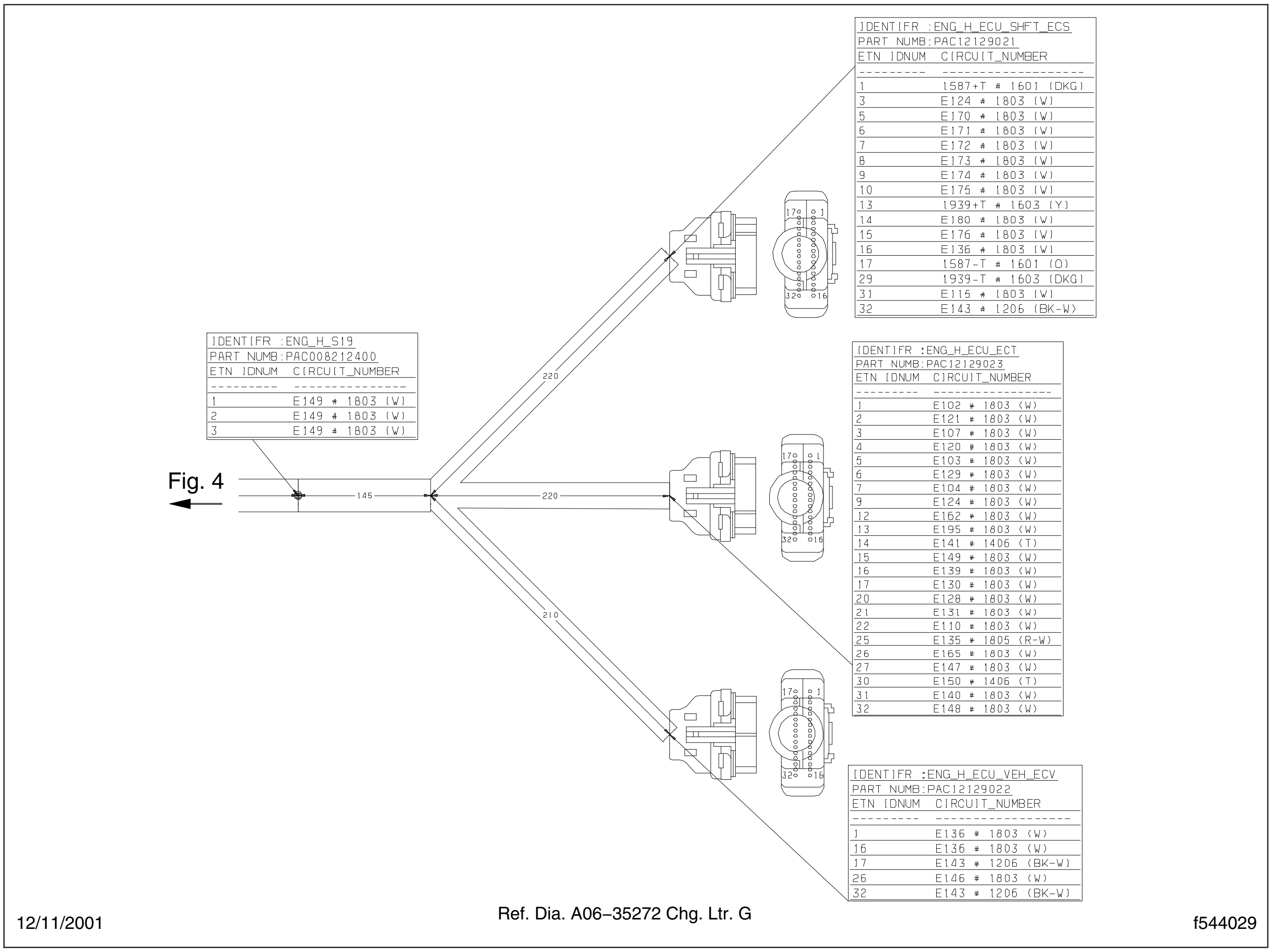


Fig. 4, MBE900 Engine Harness, Automatic Transmission (detailed view, transmission and transchassis connectors)



IDENTIFR :ENG_H_ECU_SHFT_ECS
PART NUMB:PAC12129021

ETN IDNUM	CIRCUIT_NUMBER
1	1587+T # 1601 (DKG)
3	E124 # 1803 (W)
5	E170 # 1803 (W)
6	E171 # 1803 (W)
7	E172 # 1803 (W)
8	E173 # 1803 (W)
9	E174 # 1803 (W)
10	E175 # 1803 (W)
13	1939+T # 1603 (Y)
14	E180 # 1803 (W)
15	E176 # 1803 (W)
16	E136 # 1803 (W)
17	1587-T # 1601 (O)
29	1939-T # 1603 (DKG)
31	E115 # 1803 (W)
32	E143 # 1206 (BK-W)

IDENTIFR :ENG_H_S19
PART NUMB:PAC008212400

ETN IDNUM	CIRCUIT_NUMBER
1	E149 # 1803 (W)
2	E149 # 1803 (W)
3	E149 # 1803 (W)

IDENTIFR :ENG_H_ECU_ECT
PART NUMB:PAC12129023

ETN IDNUM	CIRCUIT_NUMBER
1	E102 # 1803 (W)
2	E121 # 1803 (W)
3	E107 # 1803 (W)
4	E120 # 1803 (W)
5	E103 # 1803 (W)
6	E129 # 1803 (W)
7	E104 # 1803 (W)
9	E124 # 1803 (W)
12	E162 # 1803 (W)
13	E195 # 1803 (W)
14	E141 # 1406 (T)
15	E149 # 1803 (W)
16	E139 # 1803 (W)
17	E130 # 1803 (W)
20	E128 # 1803 (W)
21	E131 # 1803 (W)
22	E110 # 1803 (W)
25	E135 # 1805 (R-W)
26	E165 # 1803 (W)
27	E147 # 1803 (W)
30	E150 # 1406 (T)
31	E140 # 1803 (W)
32	E148 # 1803 (W)

IDENTIFR :ENG_H_ECU_VEH_ECV
PART NUMB:PAC12129022

ETN IDNUM	CIRCUIT_NUMBER
1	E136 # 1803 (W)
16	E136 # 1803 (W)
17	E143 # 1206 (BK-W)
26	E146 # 1803 (W)
32	E143 # 1206 (BK-W)

Fig. 5, MBE900 Engine Harness, Automatic Transmission (detailed view, engine connector end)

Harness Wiring

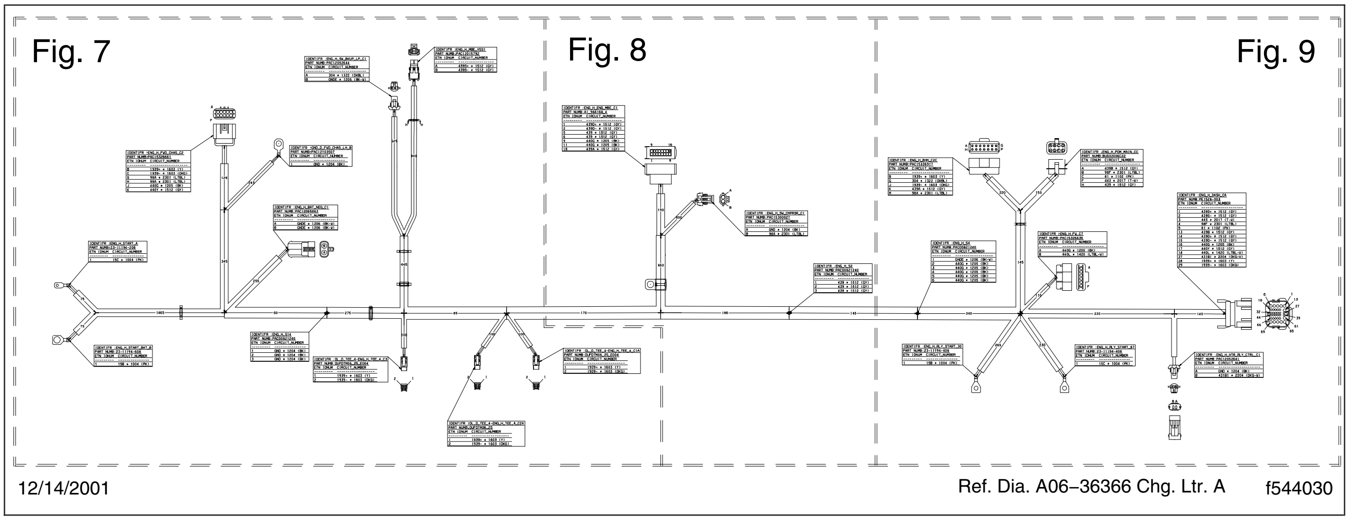


Fig. 6, MBE900 Engine Harness, Manual Transmission

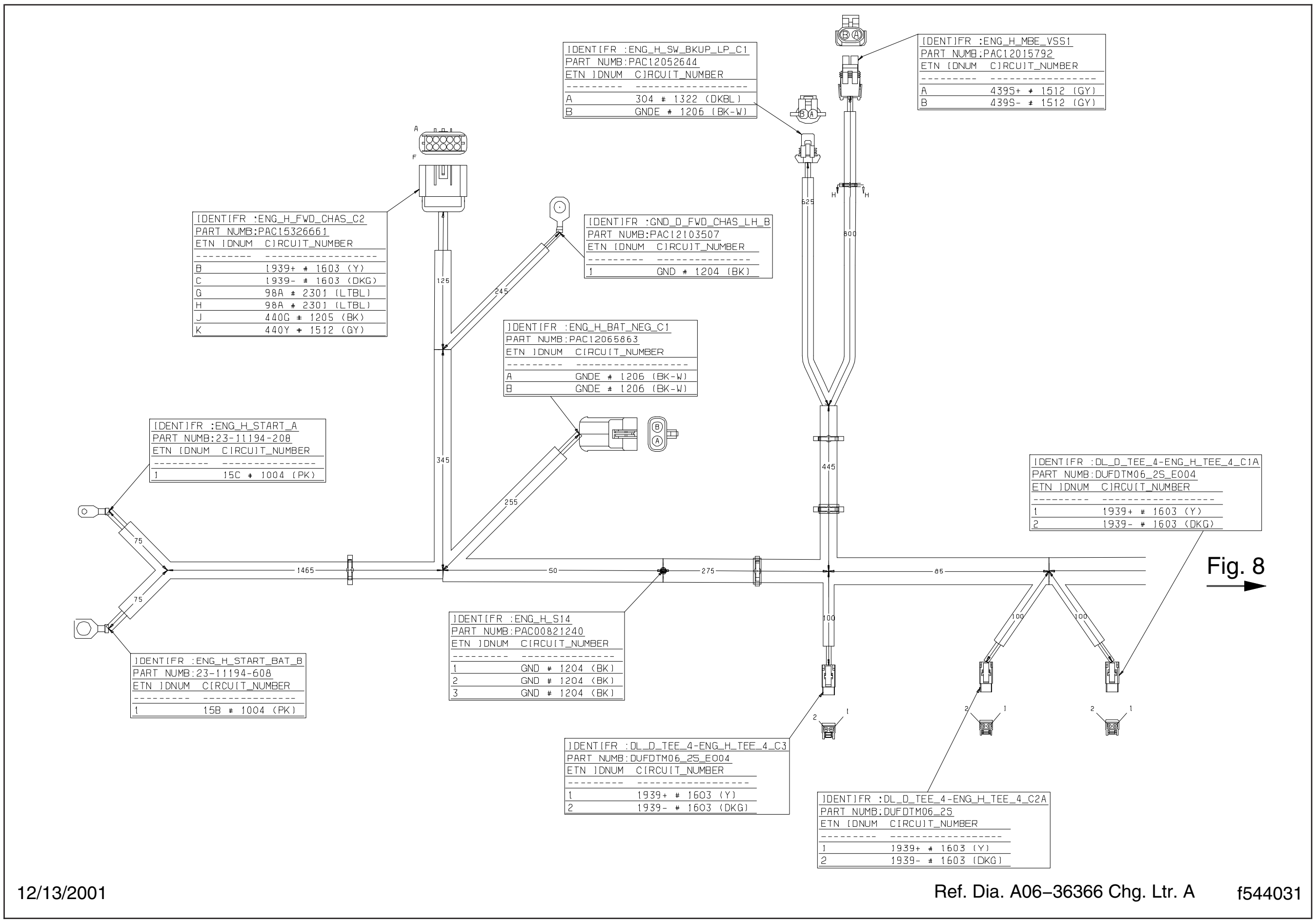


Fig. 7, MBE900 Engine Harness, Manual Transmission (detailed view, engine connector end)

Harness Wiring

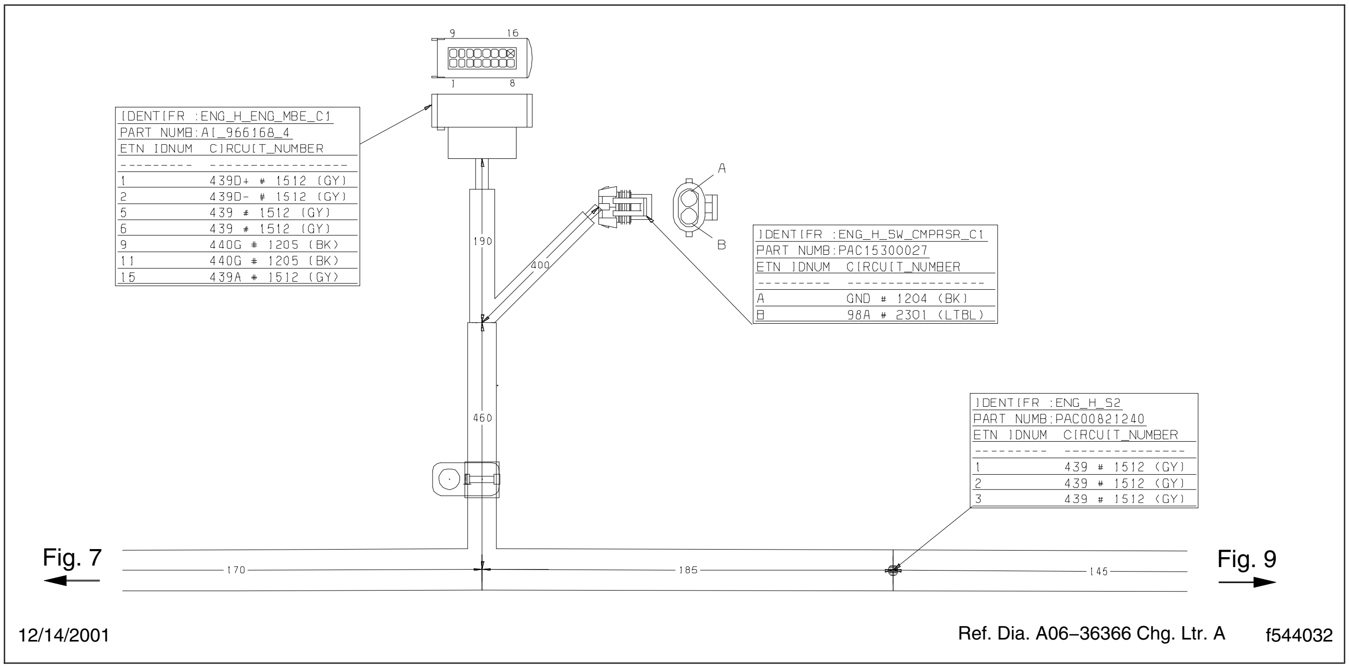


Fig. 8, MBE900 Engine Harness, Manual Transmission (detailed view, CAN datalink connector)

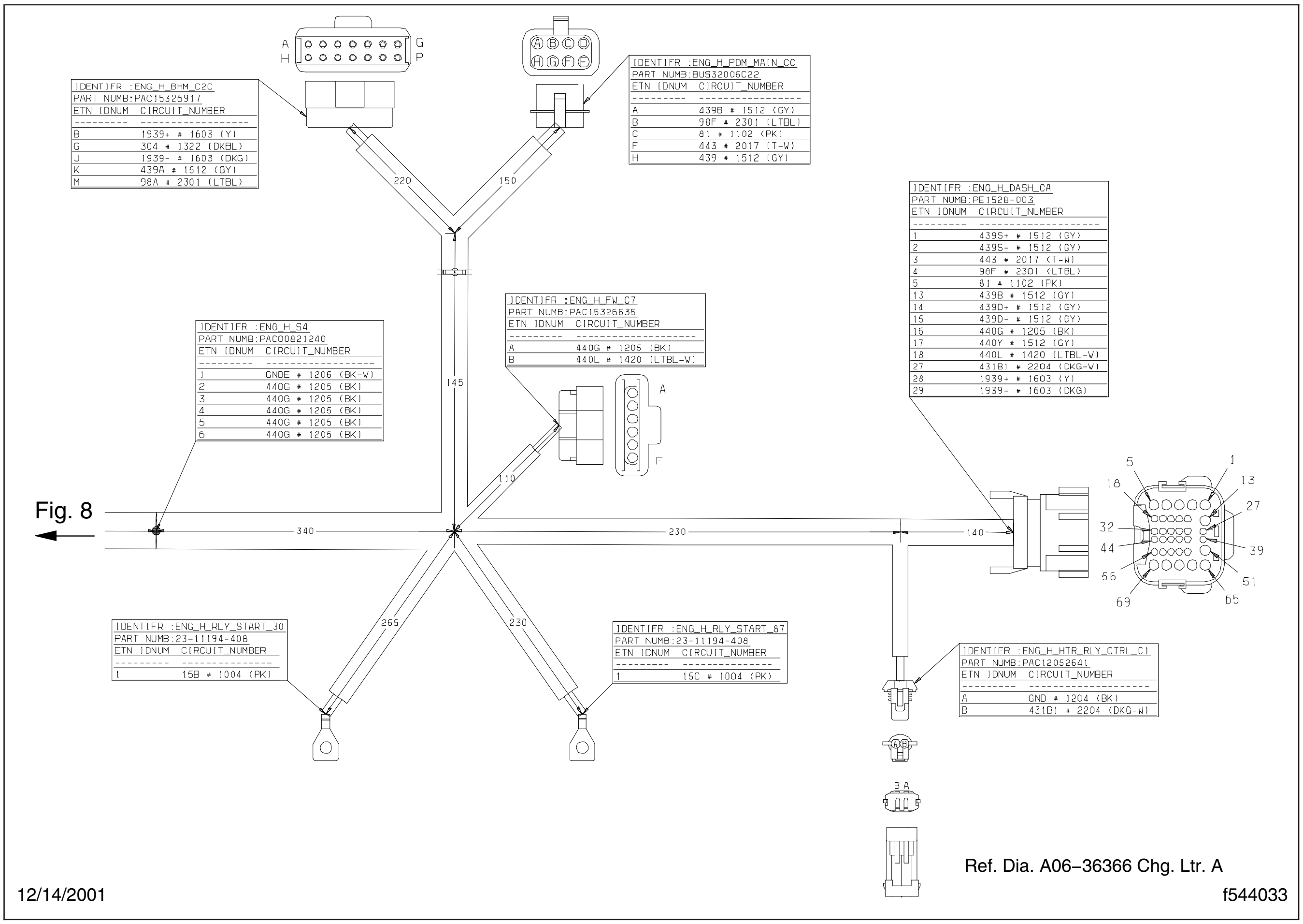


Fig. 9, MBE900 Engine Harness, Manual Transmission (detailed view, bulkhead connector end)

Contents

General Information

Lead-Acid Batteries

Batteries are electrochemical devices that store chemical energy. When the battery is connected to an external load, such as a starter, the chemical energy is converted into electrical energy and current flows through the circuit.

The battery has three functions:

- To supply power to start the engine.
- To stabilize the voltage in the electrical system. The battery filters high voltage transients and protects electronic components in the vehicle.
- To supply power when the vehicle's electrical load requirements go beyond what the charging system can supply or when the engine is not running.

All lead-acid batteries use plates made of two unlike metals held apart by separators. One of the metals becomes the positive plate, the other the negative plate. These plates are then grouped in pairs, alternating negative and positive. The groups are connected in series, and each plate group (cell) produces about two volts. Thus, a battery with six cells is a 12-volt battery.

In conventional liquid-electrolyte batteries (wet cells), each battery contains a group of plates immersed in a solution of electrolyte (dilute sulfuric acid).

Batteries may produce hydrogen gas when being charged. The vents allow the escape of gases produced in the battery.

NOTE: Liquid-electrolyte batteries must be kept in an upright position to prevent electrolyte leakage. Tipping a wet cell beyond a 45-degree angle in any direction can allow a small amount of electrolyte to leak out the vent holes.

Proper testing will indicate the battery condition. For more information, see **Troubleshooting 300**.

Absorbed Glass Mat (AGM) Batteries

Absorbed Glass Mat (AGM) batteries are lead-acid batteries in which the electrolyte is contained in a fiberglass mat. AGM batteries are physically similar to standard batteries. Carefully check the label on every battery to be certain it is AGM, and **never install AGM batteries in the same circuit with other types of batteries.**

AGM batteries are designed for high cranking amps and repeated cycle service to accommodate many of the auxiliary loads on vehicle electrical systems. They offer good protection against damage due to vibration, and are leak- and spill-proof, even if cracked or broken. Also, they self-discharge more slowly, and generate less heat when charging or discharging.

IMPORTANT: AGM batteries may be damaged or ruined by equipment designed for other types of batteries. AGM battery chargers must be regulated to a charge voltage less than 15.4 DCV; many chargers provide excessive voltage. To get full service from AGM batteries, carefully follow the battery manufacturer's instructions regarding charging rates and procedures.

Parasitic Battery Drain

Batteries are replenished each time the vehicle is driven with normal vehicle use. In long-term parking situations, however, parasitic drains may discharge the batteries enough that the starter will not be able to crank the engine.

A parasitic drain is an electrical load that draws current from the batteries when the ignition remains off.

A typical parasitic drain falls into the 25 to 325 mA (0.025 to 0.325 amps) range. Multiply the drain (in amps) by the time (in hours) the batteries sit without being recharged. The result is the amount of ampere-hours consumed by the parasitic drain. The actual drain may be small, but over time the batteries grow steadily weaker.

At warm temperature of 77°F (25°C), using approximately 40 percent of the total available ampere-hours will bring fully charged batteries to a no-start condition. In colder temperatures, the batteries will reach a no-start condition sooner.

General Safety Precautions

WARNING

Keep sparks, flames, burning cigarettes, etc. away from batteries. Batteries generate explosive gases, which could cause a battery to explode, causing serious personal injury, including blindness.

When charging the batteries, gas forms in each cell and escapes through the vent holes. In poorly ventilated areas, the gas lingers around the battery several hours after it has been charged. The gas is explosive around sparks, flame, or other intense heat; if ignited, it could cause the battery to explode. Follow these precautions when charging the batteries.

- Wear safety glasses or a face shield when working with batteries. When many batteries are handled, wear rubber gloves and an apron to protect clothing.
- Make sure that the area is well ventilated.
- Do not install any lead-acid battery in a sealed container or enclosure. Allow hydrogen gas caused by overcharging to escape. Exploding hydrogen gas can cause blindness or other bodily injury.
- Make sure that the charger cable leads are clean and making good connections. A poor connection could cause an electrical arc which could ignite the gas mixture and explode the battery.
- Do not break live circuits at the terminals because a spark usually occurs at the point where a live circuit is broken. Use care when connecting or disconnecting booster leads or cable clamps on chargers.
- Do not smoke near batteries that are being charged or have recently been charged. Keep the batteries away from open flames or sparks.
- If the battery is frozen, let it reach room temperature and completely thaw before trying to charge it. Check for leaks and cracks before charging the battery. Replace the battery if leaks or cracks are seen.
- Take care that tools or metal objects do not fall across the battery terminals.

WARNING

Do not install any lead-acid battery in a sealed container or enclosure. Allow hydrogen gas caused by overcharging to escape. Exploding hydrogen gas can cause blindness or other bodily injury.

CAUTION

If a metal object connects an ungrounded battery terminal to a nearby metal part of the vehicle which is grounded, it could short out the batteries, causing sparks and possible property damage.

Battery Electrolyte Safety Precautions

WARNING

Protect skin and eyes from battery electrolyte (acid). Electrolyte is corrosive and could result in serious personal injury if splashed on your skin or in your eyes.

If electrolyte is splashed on your skin or in your eye, force the eye open, rinse it with cool, clean water for about five minutes and call a doctor immediately. Do not add eye drops or other medication unless advised by the doctor.

If electrolyte is swallowed, drink several large glasses of milk or water. Follow with milk of magnesia, a beaten raw egg, or vegetable oil. Call a doctor immediately.

Use extreme care to avoid spilling or splashing electrolyte. Electrolyte spilled or splashed on your body or clothing should be neutralized with baking soda or household ammonia, then rinsed with clean water.

Electrolyte can also damage painted or unpainted metal vehicle parts. If electrolyte is spilled or splashed on any metal surface, neutralize and rinse it with clean water.

To prevent possible skin burns, do not wear watches, rings, or other jewelry while performing maintenance work on the batteries.

Battery Safety Precautions

WARNING

Do not apply pressure to the end walls of a plastic-case battery. This could cause electrolyte to squirt from the vents, possibly resulting in serious injury to skin or eyes.

When handling plastic-case batteries, use a battery carrier. If one is not available, lift these batteries with your hands placed at opposite corners of the battery.

Emergency Starting Using Booster Cables

WARNING

Before jump-starting a vehicle, read the instructions in Subject 100. Failure to follow the safety precautions could result in personal injury.

WARNING

Batteries release explosive gas. Do not smoke when working around batteries. Put out all flames and remove all sources of sparks or intense heat in the vicinity of the battery. Do not allow the vehicles to touch each other. Do not lean over the batteries when making connections, and keep all other persons away from the batteries. Failure to follow these precautions could lead to severe personal injury as a result of an explosion or acid burns.

NOTICE

Make sure both electrical systems are the same voltage. Electronic devices on both vehicles can be damaged when connected to a vehicle with a different operating voltage.

1. Apply the parking brakes and turn off all lights and other electrical devices. Ensure that the vehicles are not touching and both ignition switches are turned to the OFF position.

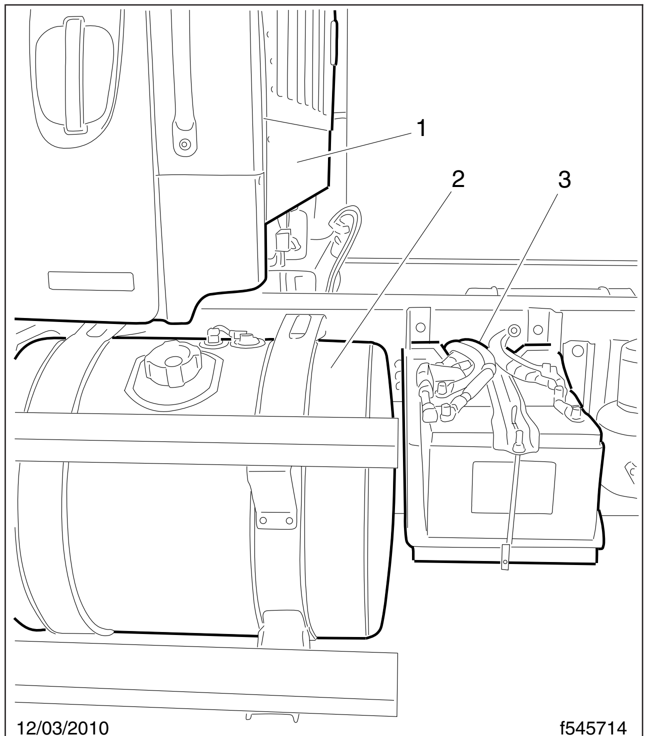
IMPORTANT: Do not attempt to jump start a damaged battery.

2. Remove the battery box cover. See Fig. 1 for the standard battery compartment location.

NOTICE

Always connect the batteries and jumper cables correctly (positive-to-positive and negative-to-negative). Connecting a charging device backwards (positive-to-negative) can severely damage the vehicle electrical content and cause non-warrantable failures.

IMPORTANT: On vehicles equipped with optional jump start posts, connect to these posts instead of the battery terminals. Jump start posts may be installed in various locations on the vehicle. See Fig. 2.



1. Back of Cab
2. Fuel Tank
3. Battery Compartment

Fig. 1, Standard Battery Compartment Location

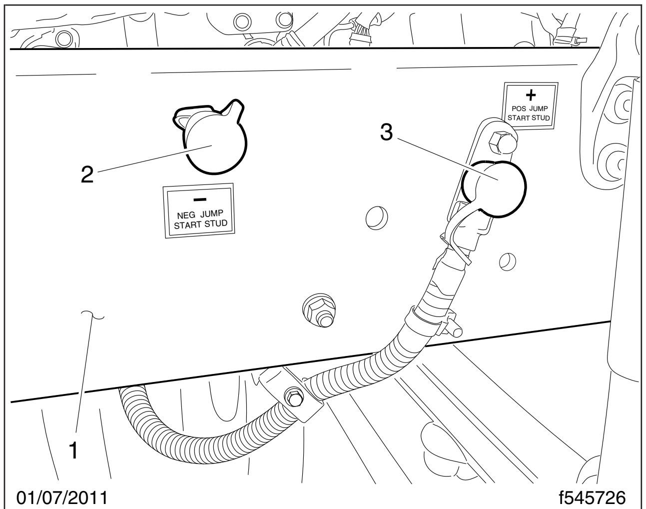
3. Connect the positive (+) jumper cable to the positive terminal or jump start post on the discharged battery. See Fig. 3.
4. Connect the other end of the positive jumper cable to the positive terminal or jump start post on the booster battery providing the charge.

WARNING

Connect the cables in the order listed. Do not allow the clamps of one cable to touch the clamps of the other cable, or a spark could occur near the battery causing an explosion, possibly resulting in severe personal injury and acid burns.

5. Connect the negative (-) jumper cable to the negative terminal or jump start post on the booster battery.

Emergency Starting Using Booster Cables



1. Frame Rail
2. Negative Jump Start Post
3. Positive Jump Start Post

Fig. 2, Possible Jump Start Post Location (passenger-side engine compartment)

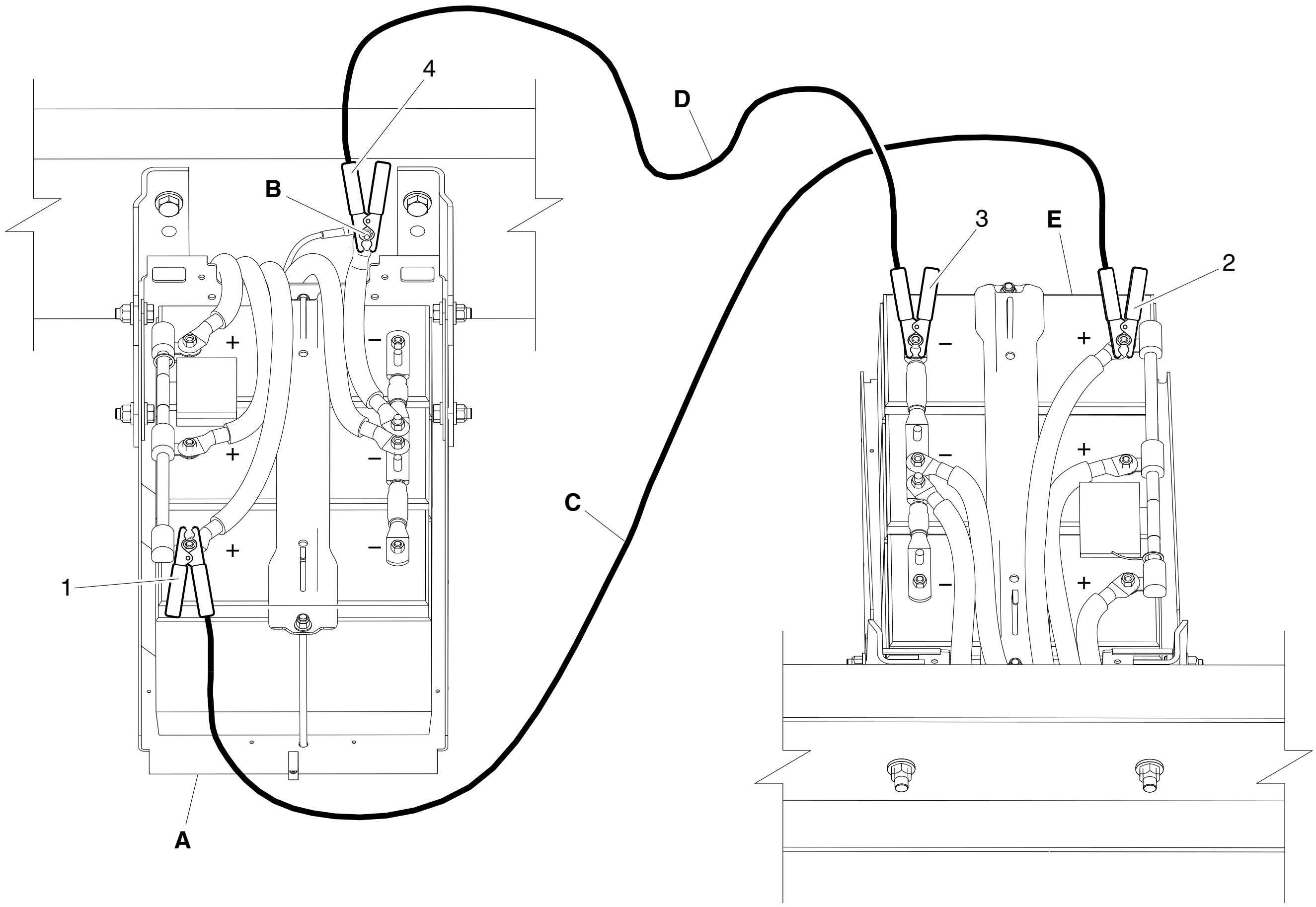
6. Connect the other end of the negative jumper cable to the negative ground stud on the vehicle requiring the jump start.
7. Start the engine of the vehicle providing the jump start and let the engine run a few minutes to charge the batteries of the other vehicle.
8. Attempt to start the engine of the vehicle receiving the jump. Do not operate the starter longer than 30 seconds, and wait at least two minutes between starting attempts to allow the starter to cool.
9. When the engine starts, let it idle a few minutes.

WARNING

Disconnect the cables in the order listed. Do not allow the clamps of one cable to touch the clamps of the other cable, or a spark could occur near the battery causing an explosion, possibly resulting in severe personal injury and acid burns.

10. Disconnect the negative jumper cable from the negative cable stud on the jump-started vehicle.
11. Disconnect the negative jumper cable from the booster battery.
12. Disconnect the positive cable from the booster battery.
13. Disconnect the other end of the positive jumper cable from the jump-started vehicle.
14. Install the battery box cover; be sure it is positioned properly before fastening the latch.

Emergency Starting Using Booster Cables



Disconnect jumper cables in the REVERSE order that they were connected.

A. Discharged Battery
B. Negative Ground Stud
C. Positive Jumper Cable
D. Negative Jumper Cable
E. Booster Battery

1. 1st Connection: Positive Jumper Cable to Discharged Battery
2. 2nd Connection: Positive Jumper Cable to Booster Battery
3. 3rd Connection: Negative Jumper Cable to Booster Battery
4. 4th Connection: Negative Jumper Cable to Negative Ground Stud (discharged battery)

Fig. 3, Jumper Connections

WARNING

Before charging a battery, read the instructions in Subject 100. Failure to follow the safety precautions could result in personal injury.

When charging batteries, always wear eye protection. During charging, batteries give off explosive hydrogen gas. Exploding gas can cause blindness or other bodily injury.

Battery Charging

AGM batteries may be charged only with a charger that is specified for AGM batteries. Many older chargers operate at a voltage that is too high for AGM batteries and will cause permanent damage. Never combine AGM and flooded batteries together for charging or for use in a vehicle.

See **Table 1** for voltage to approximate battery state of charge for flooded batteries.

Voltage to Approximate Battery State of Charge for Flooded batteries		
Voltage		State of Charge
Flooded	AGM	
12.6	12.8	100%
12.4	12.6	75%
12.2	12.3	50%
12.0	12.0	25%
11.8	11.8	0%

Table 1, Voltage to Approximate Battery State of Charge for Flooded batteries

1. If the batteries are not installed in the vehicle, install the lead adapters on the battery positive and negative posts.
2. Connect the charger to the battery following the manufacturer's instructions. Slightly rock the charger's clamps to insure a complete connection.

NOTICE

If the battery feels hotter than 125°F (52°C) or if rapid gassing or spewing of electrolyte occurs, lower the charging rate or stop charging the battery and allow it to cool.

3. When finished, turn the charger off.

WARNING

Always turn the charger off before disconnecting it. Touching a charger lead when the circuit is live could create a spark and cause an explosion, resulting in personal injury.

IMPORTANT: Make sure the surface charge is removed before performing a final test of the battery voltage. When the battery or the battery pack is charged to 100%, turn on the HVAC blower and the lights for five minutes, then check the voltage again.

Battery Removal, Cleaning and Inspection, and Installation

⚠ WARNING

Before doing any of the following procedures, read the instructions in Subject 100. Failure to follow the safety precautions could result in personal injury.

Removal

1. Before working on the battery, make sure all electrical loads such as lights, ignition, and accessories, are turned off.
2. Chock the tires.
3. Remove the battery box cover.
4. Disconnect the negative battery cable leads.
5. Disconnect the positive battery cable leads.
6. Disconnect the battery interconnect cables.
7. Remove the battery holddowns. Then remove the batteries from the carrier.

Cleaning and Inspection

1. Inspect all battery cables and interconnectors for wear, and replace them if necessary. Remove corrosion from cables, terminals, and battery posts with a wire brush and a solution of baking soda and water. Rinse thoroughly with clean water, and dry.
2. Clean and tighten the battery ground cable at the weld stud on the frame rail. Inspect and ensure that the nut is self-locking and that a flat washer is used. Do not use a split-lock washer or star washer. Torque the nut 15 to 18 lbf·ft (20 to 24 N·m). Seal the area with red dielectric enamel.
3. Inspect the retainer assembly and battery box. Replace worn or damaged parts. Remove any corrosion with a wire brush and wash with a weak solution of baking soda and water. Rinse with clean water and dry. To prevent rusting, paint the retainer assembly if needed.
4. Be sure foreign objects, such as stones, bolts, and nuts, are removed from the battery box.

Installation

1. Be sure that the replacement battery has a sufficient capacity to cover the electrical needs of the vehicle.

NOTICE

Using an under-capacity battery will result in poor performance and premature battery failure, resulting in damage or reduced life of the starter.

2. Be sure the battery is at full charge when installed. If the battery has been in storage for some time, or if the installation is being made in subfreezing temperatures, give the battery a top-off charge before installing it. For instructions, see **Subject 120**.
3. Place the batteries in the carrier with the terminals in the proper position as referenced earlier. The batteries must rest level in the carrier.
4. Install the battery holddown and tighten it to 12 lb·ft (8 N·m). See **Fig. 1**.

NOTICE

Do not overtighten the battery holddown. Overtightening could damage the batteries.

5. To provide corrosion protection, apply lithium dielectric grease liberally to the terminal pads, then install the interconnectors.

IMPORTANT: Many electrical components are located outside of the cab in areas subjected to harsh weather and road spray. Some components also have exposed metal electrical terminals, which, when subjected to harsh conditions, may suffer corrosion at the electrical connection.

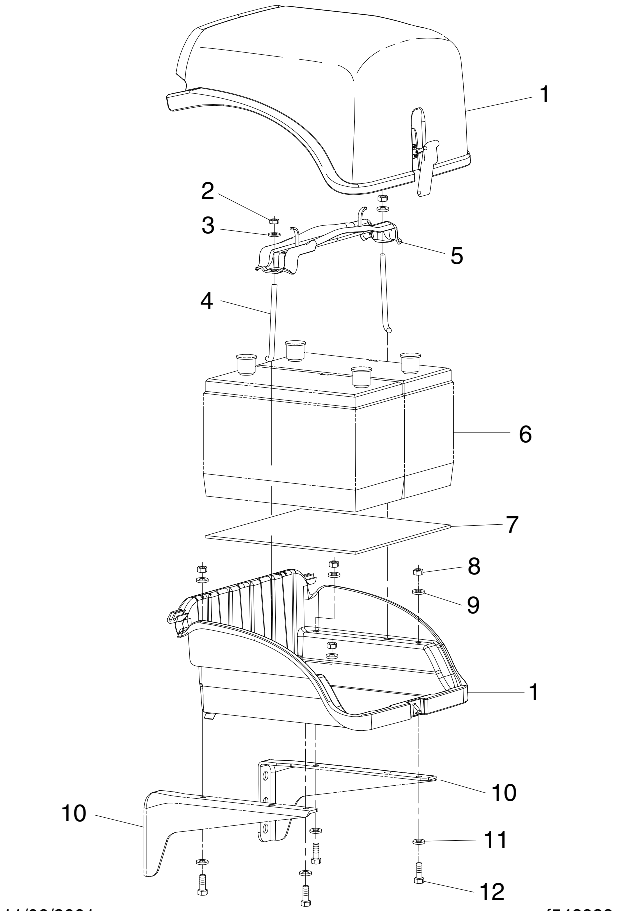
6. Connect the battery interconnecting cables to the batteries and check for correct polarity with respect to the vehicle. Connect the ground cables last.

NOTICE

Reversed polarity may cause serious damage to the electrical system.

7. Tighten all battery connections to the torque specifications listed on the battery. Generally

Battery Removal, Cleaning and Inspection, and Installation



1. Carrier and Cover
2. 3/8–16 Nut
3. Washer
4. Holddown Bolt
5. Battery Holddown
6. Battery
7. Liner
8. 5/16–18 Nut
9. Washer
10. Mounting Bracket
11. Washer
12. Capscrew

Fig. 1, Battery Box, Battery, and Battery Holddown

those are 10 to 15 lbf·ft (14 to 20 N·m). Proper torque is important for electrical system operation.

8. Start the engine and check the operation of the charging system. If needed, repair the charging system to obtain the correct charging output. For instructions, see the appropriate section in **Group 15**.

NOTICE

Make sure all battery posts are covered with dielectric grease to protect against corrosion.

Battery Box Removal and Installation

WARNING

Before doing any of the following procedures, read the instructions in Subject 100. Failure to follow the safety precautions could result in personal injury.

Plastic Battery Box

Removal

1. Before working on the battery box, make sure all electrical loads such as lights, ignition, and accessories are turned off.
2. Pull down on the cover latch to release it from the catch, then remove the battery box cover.
3. See **Subject 130** for procedures to remove the batteries.
4. Remove the four sets of fasteners attaching the battery box to the mounting brackets. See **Fig. 1**.
5. Remove the battery box.

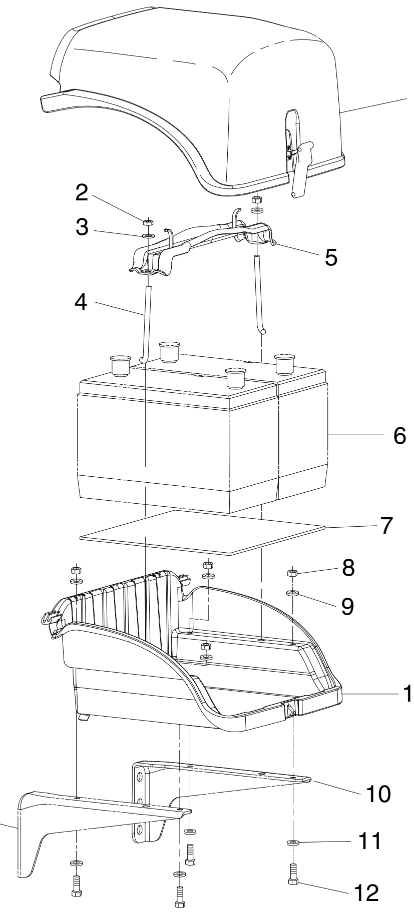
Installation

1. Line up the holes in the battery box with the holes in each mounting bracket.
2. Install the four sets of fasteners that attach the battery box to the mounting brackets. Tighten to 18 lbf·ft (24 N·m).
3. Place the batteries in the battery box with the terminals in the proper position. Make sure the batteries rest level in the box. See **Subject 130** for procedures to correctly install the batteries.
4. Install the battery holddowns. Tighten each nut to 10 lbf·ft (14 N·m).

CAUTION

Do not overtighten the battery holddowns. Overtightening could damage the batteries.

5. Place the battery box cover over the battery box and fasten the latch.



1. Cover
2. 3/8–16 Nut
3. Washer
4. Holddown Bolt
5. Battery Holddown
6. Battery
7. Liner
8. 5/16–18 Nut
9. Washer
10. Mounting Bracket
11. Washer
12. Capscrew

Fig. 1, M2 Frame-Mounted Plastic Battery Box

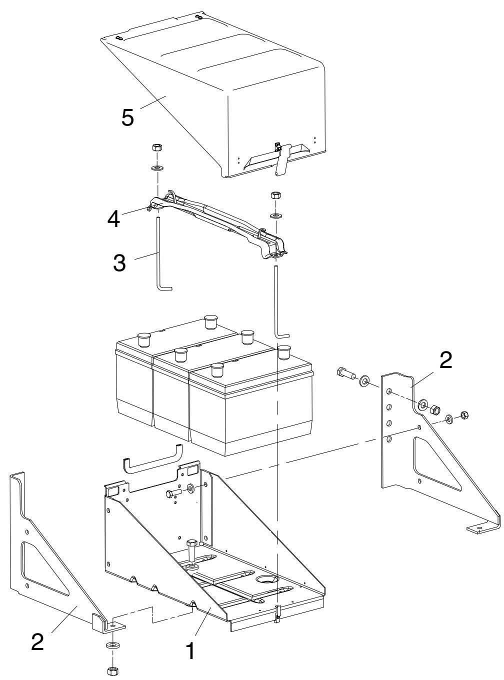
Steel Battery Box

Removal

1. Before working on the battery box, make sure all electrical loads such as lights, ignition, and accessories, are turned off.
2. See **Subject 130** for procedures to remove the batteries.

Battery Box Removal and Installation

3. Pull on the end of the holddown latch until the end clears the cover-mounted catch. Pivot the latch out of the way, then lift off the battery box cover. See **Fig. 2**.



1. Battery Box
2. Bracket, Battery Box
3. Holddown Bolt
4. Holddown
5. Battery Box Cover

Fig. 2, Steel Battery Box (typical)

4. Remove the fasteners that hold the battery box to the brackets.
5. Remove the battery box.

Installation

1. Line up the holes in the battery box with the holes in each mounting bracket.
2. Install the fasteners that attach the battery box to the mounting brackets. Tighten the fasteners to 18 lbf·ft (24 N·m).
3. Place the batteries in the battery box with the terminals in the proper position. Make sure the batteries rest level in the box. See **Subject 130** for procedures to correctly install the batteries.
4. Install the battery holddowns. Tighten each nut to 10 lbf·ft (14 N·m).

CAUTION

Do not overtighten the battery holddowns. Over-tightening could damage the batteries.

5. Place the battery box cover over the battery box and fasten the latch.

Troubleshooting

If the batteries pass testing, check for the following causes:

1. Accessories were left on overnight.
2. A slipping alternator belt, high resistance in the wiring, or a defective alternator is causing the batteries to discharge.
3. The electrical loads are exceeding the charging system capacity.
4. Wires in the electrical system are shorted or pinched.
5. There are loose or damaged battery cable-to-terminal connections.
6. The batteries are still connected in a vehicle that has been out of service. Small current drains of accessories that are connected all the time can discharge the batteries in a few days. Batteries left in a discharged condition are subject to freezing.

Electrical Drain and Parasitic Load

Batteries are replenished each time the vehicle is driven with normal vehicle use. In long-term parking situations, however, parasitic drains may discharge the batteries enough to cause a no-start condition.

A parasitic drain is an electrical load that draws current from the batteries when the ignition remains off. Some devices, such as the electronic control unit (ECU), the bulkhead module (BHM), the chassis module (CHM), the antilock braking system (ABS), and radio memory are intended to draw a very small current continuously. These draws are measured in milliamps (mA). Current draw should be less than 325 milliamps with no circuits active and the ECU, BHM, CHM, and ABS turned off.

Problem—The Batteries Are Undercharged

Problem—The Batteries Are Undercharged	
Possible Cause	**Remedy**
The drive belt is loose.	Check the drive belt and tensioner. Refer to the drive belt subject in the appropriate engine section in **Group 01** for instructions. If necessary, tighten to the manufacturer's specifications. Start the engine and check the alternator voltage and output. Refer to the troubleshooting subject in the alternator section in **Group 15** for instructions.
The drive belt is damaged or missing.	Check the drive pulleys for locked bearings. Repair or replace any damaged components. Replace the drive belt and start the engine. Check the alternator voltage and output. Refer to the troubleshooting subject in the alternator section in **Group 15** for instructions.
The batteries are undercharged.	Perform a battery test. Charge or replace batteries as needed. If the batteries were discharged, start the engine and check the alternator voltage and output. Refer to the troubleshooting subject in the appropriate alternator section in **Group 15** for instructions.
The alternator or battery cables are undersized.	Perform a cable load drop test.
The alternator is malfunctioning.	Refer to the troubleshooting subject in the appropriate alternator section in **Group 15** for instructions.
The isolator relay is not operating correctly (optional battery isolator system only).	Refer to **Group 82, Subject 300** in this manual for instructions.

Troubleshooting

Battery Troubleshooting

1. **Check battery pack voltage to determine state of charge**.

   If equipped, set Load Disconnect Switch to "Off." With the DMM probes on the positive and negative posts of the battery pack, record the voltage. Due to differences in their design and operation, flooded cell and AGM batteries have different voltages at the same state of charge.

   Batteries should be fully charged before further testing. If batteries are not fully charged, they will draw current to recharge during testing, invalidating the troubleshooting test results. Fully charged batteries ensure reliable diagnosis.

   See **Table 1** for voltage as an approximate indicator of state of charge for AGM and flooded batteries.

   If the battery pack will not charge to 100% state of charge, there may be a shorted cell. Break the pack into individual batteries and test individually using an approved tester. Go to **Check 3, Individual Battery Testing**. After batteries have been tested individually, verify pack voltage once again.

Flooded	AGM	SoC
12.6	12.8	100%
12.4	12.6	80%
12.3	12.4	60%
12.1	12.2	40%
12	12	20%
11.8	11.8	0%

Table 1, Voltage to Approximate State of Charge (SoC)

2. **Remove surface charge: HVAC blower, lights on, 5 min.**

   Surface charge refers to a higher initial charge (volts), when discharging, in recently-charged batteries. This charge is a "shallow" charge, meaning that the charging-induced chemical reaction has mostly occurred at the surface of the lead plates, and has not equalized throughout the lead. Drawing current from the batteries before testing removes the surface charge, allowing for a better assessment of the "deep charge" state of the lead plates.

   After the surface charge is removed, the batteries need to be at least 80% SoC for further testing. See **Table 1** for voltage as an approximate indicator of state of charge.

3. **Test Individual Batteries**.

   IMPORTANT: Batteries should only be tested individually.

   3.1 Remove the negative cables of the batteries first, and secure the leads out of the way before touching the positive cables. Remove the battery cables and clean the terminal pads with a wire brush. The adapters will not make sufficient contact with dirty or corroded contact pads.

   3.2 Connect the battery tester's positive and negative clamps to the lead base terminal pads at the positive and negative studs. See **Fig. 1**.

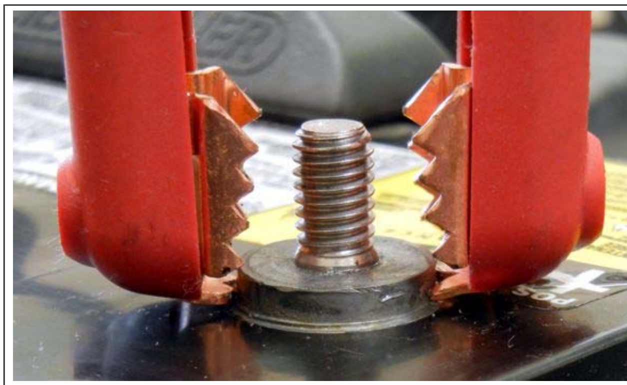


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Fig. 1, Tester Clamps Attached to the Post

The threaded portion of the battery posts are *not* the right place to clip: the steel threads won't make a good connection. The base of the post, on the lead, is the best place to clip. Taking a few extra seconds to make sure the tester, DMM, and carbon pile clips are well-connected can be the difference between a useful and a useless test.

NOTE: If the lead base is too small to clamp to, only lead stud adapters should be used, never nuts. The lead stud adapters must be screwed down tight against the cleaned lead base using a hand tool. Lead adapters are available at most tool vendors.

Refer to the battery tester instruction manual for complete testing instructions.

If the battery tester requires the CCA rating of the battery, it should be on the battery label. See **Fig. 2**.

3.3 If the battery fails, enter the battery serial number and print out the result. The sensor windows on the tester and printer must be aligned to transmit the test results to the printer.

Fig. 2, Battery Label

Specifications

See **Table 1** for recharge times. Refer to the commercial batteries page at **www.dekabatteries.com** for more information.

Recharge Time Using a Typical Charger (hours)						
Open Circuit Voltage		State of Charge	Charger Maximum Rate			
Flooded	AGM		50 Amps	30 Amps	20 Amps	10 Amps
12.6V	12.8V	100%	Ready to Use			
12.4V	12.6V	75%	0.6	0.9	1.3	2.5
12.2V	12.3V	50%	1.2	1.9	2.7	5.1
12.0V	12.0V	25%	1.8	2.9	4.3	10.7
11.8V	11.8V	0%	2.5	4.0	5.7	10.7

Table 1, Recharge Time Using a Typical Charger

Contents

General Information

General Information

The intake air restriction indicator indicates how much air filter capacity has been used and how much remains. The indicator registers the actual maximum restriction of the filter element when the engine is operating at full load. The indicator retains the reading so that the remaining capacity can be read after the engine is shut down.

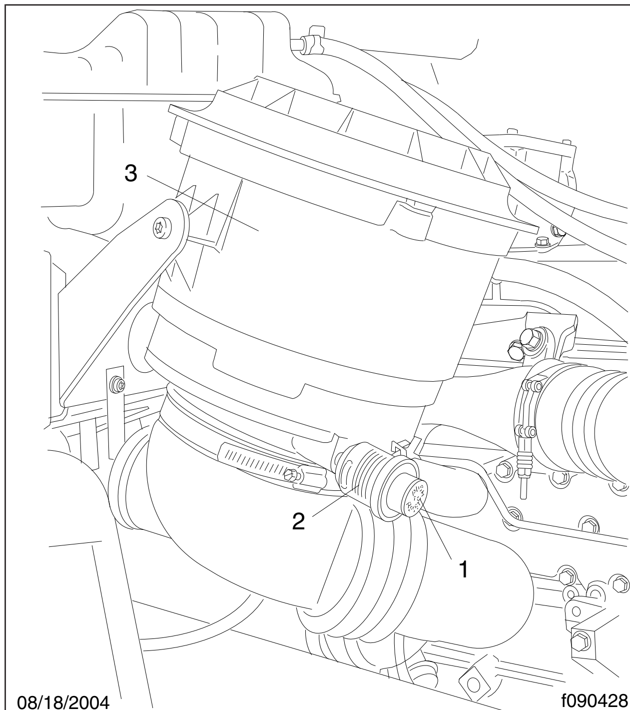
The intake air restriction indicator is mounted under the hood on the intake air piping, or in the cab on the dash panel. See **Fig. 1** and **Fig. 2**.

Do not open the air cleaner assembly until the indicator registers maximum restriction. When maximum restriction occurs, the air cleaner element needs to be serviced. For possible causes and corrective action, see **Troubleshooting 300**.

The intake air restriction indicator and the fitting may become plugged with moisture or engine vapors, possibly causing an incorrect reading. For troubleshooting procedures, see **Troubleshooting 300**.

An optional amber warning indicator is available and is displayed on the ICU3-M2, defined as "Air Filter Restriction."

NOTE: Most engine degreasers are harmful to the polycarbonate (Lexan) plastic that is used in the intake air restriction indicator. When cleaning the engine or other components, avoid getting degreaser on the indicator.



1. Reset Button
2. Intake Air Restriction Indicator
3. Air Cleaner Assembly

Fig. 1, Intake Air Restriction Indicator Mounted Under the Hood

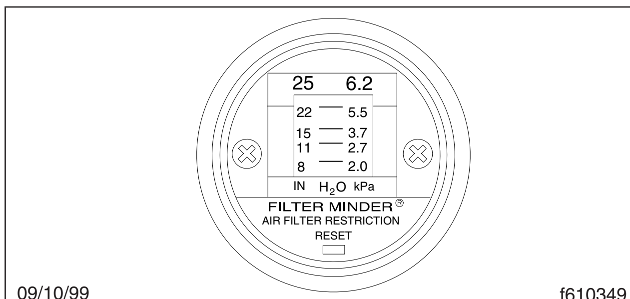


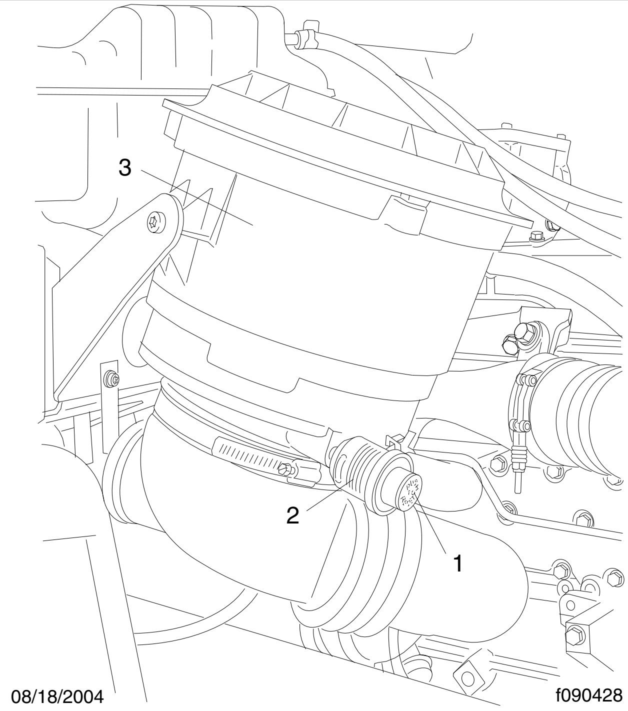
Fig. 2, Intake Air Restriction Indicator Mounted in the Cab

Air Restriction Indicator Removal and Installation

Intake Air Restriction Indicator Mounted Under the Hood

Removal

1. Turn off the engine, apply the parking brakes, and chock the tires.
2. Open the hood.
3. Using a wrench, remove the intake air restriction indicator from the intake air piping. See **Fig. 1**.



1. Reset Button
2. Intake Air Restriction Indicator
3. Air Cleaner Assembly

Fig. 1, Intake Air Restriction Indicator Mounted Under the Hood

Installation

1. Install the indicator on the intake air piping.
2. Close the hood and remove the chocks from the tires.

Intake Air Restriction Indicator Mounted in the Cab

Replacement

1. Turn off the engine, apply the parking brakes, and chock the tires.
2. Remove the necessary dash panels to access the intake air restriction indicator. For instructions, see **Section 60.08**, Subject 100.
3. Remove the electrical connector from the indicator. See **Fig. 2**.

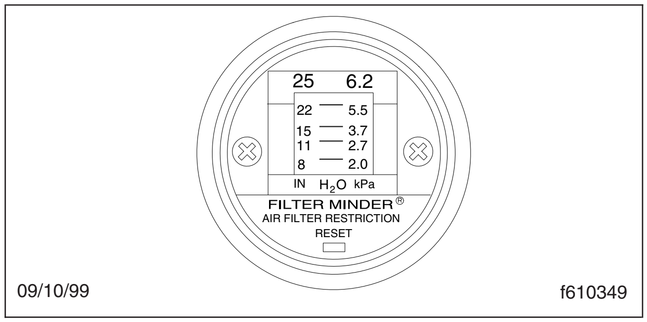


Fig. 2, Intake Air Restriction Indicator Mounted in the Cab

4. Remove the air line from the indicator.
5. Remove the screws that attach the indicator to the dash, and remove the indicator.
6. Using screws, attach a new indicator to the dash.
7. Attach the air line to the indicator.
8. Attach the electrical connector to the indicator.
9. Install the dash panels. For instructions, see **Section 60.08**, Subject 100.
10. Remove the chocks from the tires.

Troubleshooting Tables

Problem—No Restriction Reading

Problem—No Restriction Reading	
Possible Cause	**Remedy**
The gauge leaks.	Remove the air restriction gauge. Apply a vacuum to the gauge until the yellow indicator reaches the red line. With your thumb on the mounting fitting, close the end of the gauge airtight. Hold in the reset button. The yellow indicator will drop slightly and then not move unless the gauge has a leak. If the gauge is functioning properly, install it and press the reset button. If the yellow indicator continues to move, replace the air restriction gauge. Repeat the troubleshooting procedure to verify that the new gauge does not leak. When the gauge is functioning properly, install it and press the reset button.
The air cleaner or intake pipe fitting is plugged.	Remove the obstruction.
Engine airflow is too low to generate a reading.	Turbocharged engines must be at full load to pull full engine airflow. Restrictions can be simulated by gradually closing off air intake. If there is still no restriction reading, check for leaks in the gauge or vacuum hose, as appropriate, and take corrective action.
The safety filter, if equipped, is plugged.	Do not clean the safety filter. Replace it with a new one.

Problem—High Restriction Readings

Problem—High Restriction Readings	
Possible Cause	**Remedy**
The element is plugged.	Anytime a high restriction is noted, it should be verified by resetting the restriction indicator and checking it again after several hundred miles of normal operation. Install a new filter element.
The intake screens or ducts are plugged.	Check the system upstream from the air restriction gauge and remove any debris. Check for damage or improper installation, and take necessary corrective action.
Heavy snow or rain.	Temporary high restriction can occur during a rain or snow storm and disappear after drying out. Anytime a high restriction is noted, it should be verified by resetting the restriction indicator and checking it again after several hundred miles of normal operation.

Contents

Low Coolant Level Probe Replacement

Replacement

The low coolant level probe, which is located near the coolant reservoir, is only used on vehicles with a Caterpillar or Cummins engine.

1. Turn off the engine, apply the parking brakes, and chock the tires.
2. Open the hood.
3. Disconnect the electrical connector from the low coolant level probe. See **Fig. 1**.

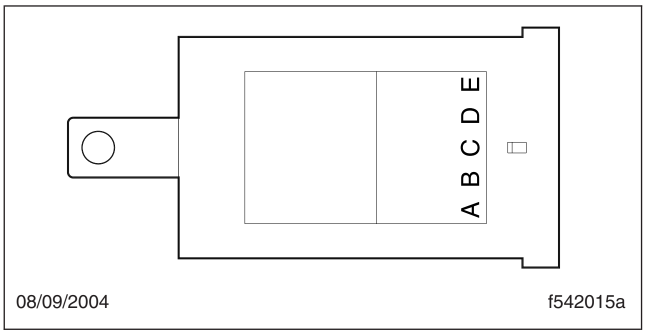


Fig. 1, Low Coolant Level Probe

4. Remove the probe from the mounting bracket.
5. Install a new probe on the mounting bracket.
6. Connect the electrical connector to the probe.
7. Run the engine and make sure there are no false indications of low coolant level.
8. Close the hood and remove the chocks from the tires.

Contents

General Information

A "datalink" is an electrical network that connects two or more computers to exchange data. The simplest datalink is a pair of wires between two computers. Freightliner uses datalinks to connect the Electronic Control Units (ECUs) for the electronically controlled vehicle systems with each other and with the Instrumentation Control Unit (ICU). A personal computer using Freightliner’s ServiceLink diagnostic software can also be connected to the network via a datalink.

Datalink Systems

Different types of datalinks are used to connect certain ECUs. The vehicle may have any of the following datalinks:

J1587/J1708

J1587/J1708 is a low-speed vehicle datalink that communicates information between the ECUs on the vehicle. The J1587 datalink is also referred to as J1708. See **Fig. 1**. J1708 refers to the SAE standard for the physical part of the datalink, such as the wiring and the electronic components. J1587 refers to the SAE standard for the messaging protocol that communicates on the J1708 network. In the context of vehicle repair, the terms J1708 and J1587 are used interchangeably.

The J1587 datalink uses a twisted pair of wires to reduce interference from digital messages being sent on the wires. Wire colors for the J1587 datalink are:

- Orange **J1587 Low**
- Green **J1587 High**

J1939

J1939 is a high-speed vehicle datalink that communicates information between ECUs on the vehicle. See **Fig. 2**.

Unlike the J1587 datalink, the J1939 datalink allows an ECU to broadcast requests as well as information. Examples of information that can be communicated on the J1939 datalink are:

- engine rotational speed;
- road speed;
- transmission tailshaft speed;
- engine retarder deactivation request;
- engine torque reduction request.

The J1939 datalink uses a twisted pair of wires to reduce interference from digital messages being sent on the wires. Wire colors for the J1939 datalink are:

- Yellow **J1939 High**
- Green **J1939 Low**

The back bone of the J1939 datalink is the section of the datalink that is between two terminating resistors. An ECU can be connected anywhere along the length of the backbone in between the terminating resistors. The wiring between the ECU and the J1939 backbone is called a circuit. The maximum distance of the terminating resistor is 3 feet from the last ECU or diagnostic connector.

The purpose of the terminating resistors is to minimize the reflection of data on the datalink which can cause J1939 messages to become partially or completely lost. Terminating resistors prevent this from occurring. Each terminating resistor is 120 Ohms, but the equivalent of two 120 Ohms resistors in parallel is 60 Ohms. With both resistors installed in the circuit, there should be 60 Ohms measured at any two points between **J1939 High** and **J1939 Low** in the circuit.

Each ECU is generally connected to the J1939 backbone using a tee connector or splice. See **Fig. 3**.

Making the Pinout Measurements Easier to See

The pins on the diagnostic connector may be difficult to see when testing. If the pins are difficult to see, use a Y-cable as an extension to the diagnostic connector to make test measurements easier. See **Fig. 4** for a drawing of the connector at the end of the Y-cable and the corresponding 9-pin diagnostic connector pins.

NOTE: Be sure to attach a meter with a proper jumper kit to prevent unintentional shorting to other pins and possible damage to ECUs.

The Roll Call

To check the readiness of the ECUs on the datalink, the ICU sends a signal to other ECUs and expects a response from each. This "Roll Call" procedure tells the ICU which ECUs are functioning correctly. When

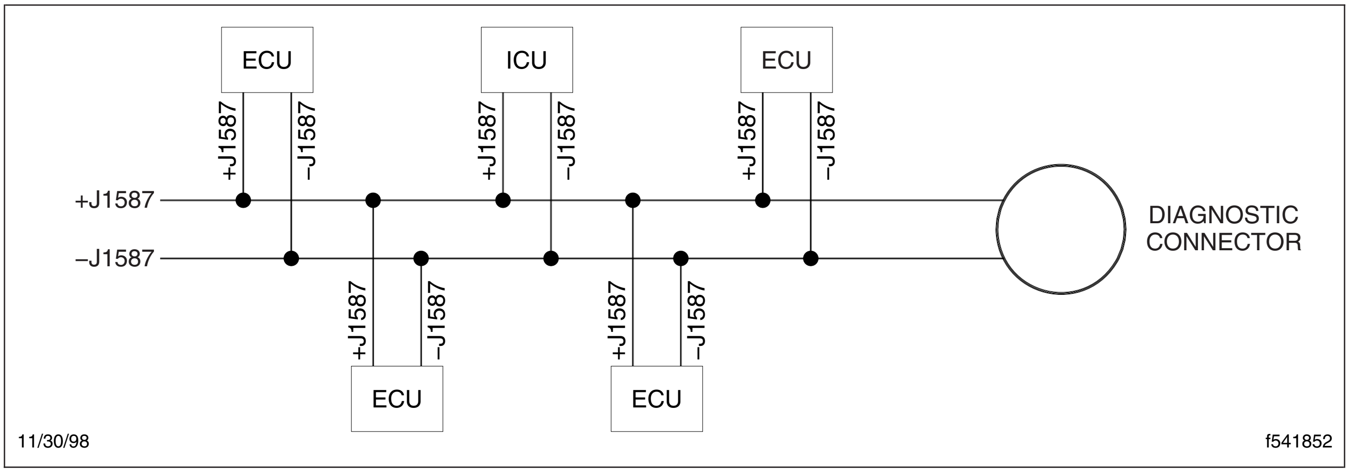


Fig. 1, J1587 Datalink

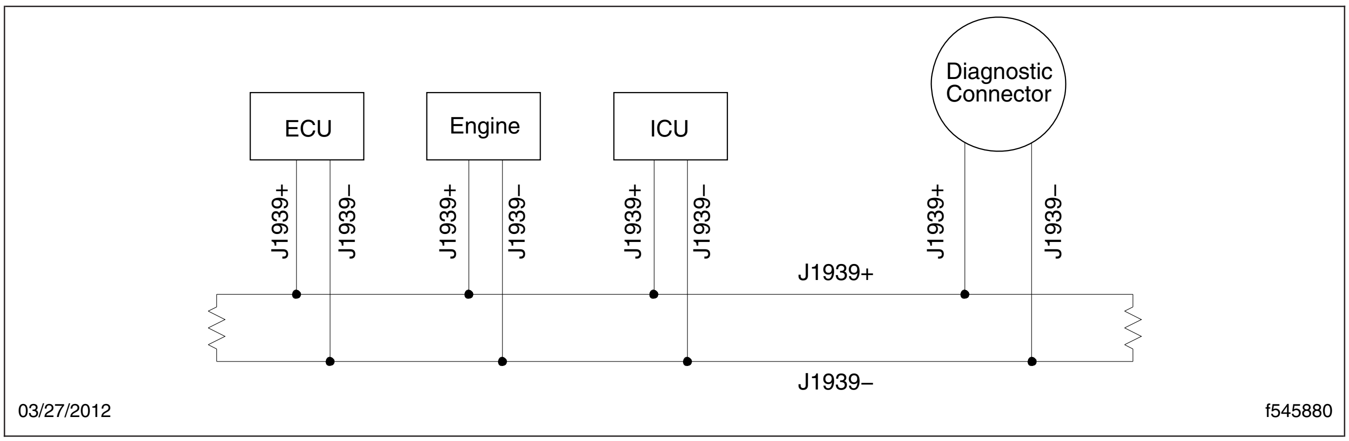
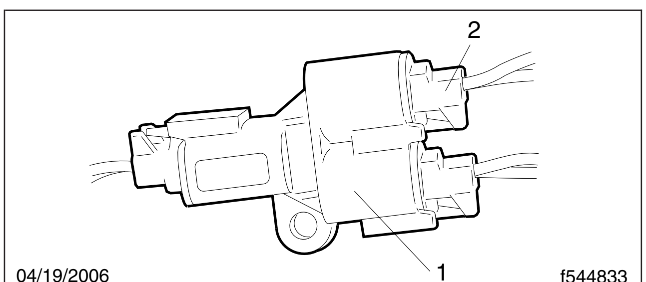


Fig. 2, J1939 Datalink



1. Branch to Backbone
2. Branch to ECU

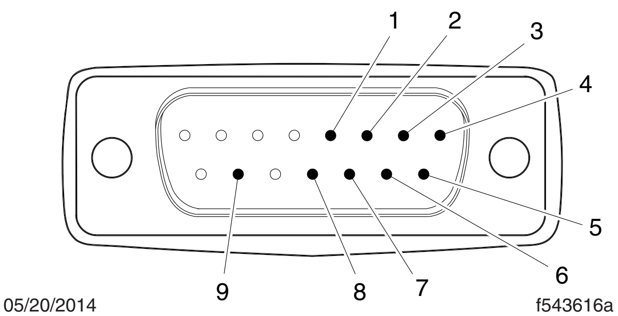
Fig. 3, J1939 Tee Connector

the list of functioning ECUs is compared against the parameter list of factory-installed ECUs that are supposed to respond, the technician can determine which ECUs or datalinks are bad.

If the ICU does not receive a signal on the datalink from one or more of the active ECUs, it displays a roll call fault. The roll call fault is displayed *only* on the dash driver display screen. It is not broadcast on the datalink; therefore, it cannot be read by Service-Link. However, Servicelink can be used to determine if an ECU is not responding because it polls all ECUs on the datalink when it first connects to the vehicle datalink.

Datalink Junction Blocks

For the J1587 datalink, the wires routed through the vehicle cab have two datalink junction blocks and two datalink connections. The ICU3 uses only one connection to the ICU.



1. Pin H (Diagnostic CAN High)
2. Pin A
3. Pin E
4. Pin B
5. Pin F
6. Pin G
7. Pin C (J1939 High)
8. Pin D (J1939 Low)
9. Pin J (Diagnostic CAN Low)

Fig. 4, Y-Cable Pinouts

Locating J1939 Wiring Diagrams

The J1939 wiring diagram can be found in module 160. Other modules may also contain datalink wiring information. See **Table 1**.

Component Module Locations	
Component	**Module Number**
General J1939 harness drawings, schematics, and installation drawings	160
Engine harness and installation drawings	283 and 286
Transmission harness and installation drawings	34A and 343
ABS harness and installation drawings	330, 332, and 333

Table 1, Component Module Locations

Use PartsPro® to obtain drawing numbers for installation drawings, harness assembly drawings, and wiring diagrams applicable to the vehicle being worked on.

Datalink Repairs

J1587 and J1922 Repairs

Use the same methods of repair for the twisted-pair datalink wiring as are used for the other wires on the vehicle. However, the datalink wires must be twisted at a rate of a minimum one turn per inch (25 mm) of length.

J1939 Repairs

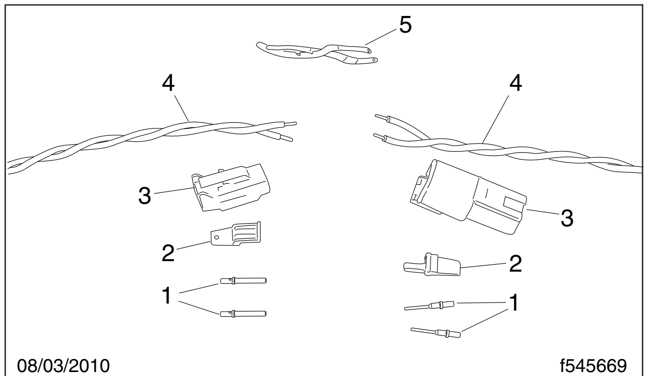
A special cable must be used for repairs to the J1939 datalink wiring. The two types of J1939 cable ("heavy" and "lite") can be spliced together as long as the pass-through connectors are the "heavy" type. The "lite" cable (because of its lower cost) is recommended for repairs on both types of J1939 cable. Refer to Appendix C of SAE J1939-11 for the special procedures for repairing the "heavy" J1939 datalink.

Parts

Twisted-pair datalink wires may be spliced using a mating connector set. See **Table 1** for a typical set of datalink connector parts.

Procedure

1. Cut out any damaged section of datalink wire, keeping the lengths of the two wires equal. See **Fig. 1** for an example of a damaged section of datalink wire that has been removed and the datalink prepared for repair.
2. Crimp the terminals onto the wires using the proper crimp tool.
3. Pull test the terminals by hand to ensure the crimp is mechanically solid.
4. Insert the terminated wires into the connector body and install the terminal lock. The protocol for J1939 is for the yellow wire to be in cavity 1 and the green wire to be in cavity 2. Note that the lock is installed while holding the wires in position. Test the installation. If the wires slipped back during the lock installation, they will pull out of the connector.
5. Make certain the wires are twisted as close to the entry point of the connector as possible. Plug the two connector halves together. See **Fig. 2**.



1. Terminals
2. Terminal Lock
3. Connector
4. Twisted-Pair Datalink Wires
5. Damaged Section of Datalink Wires

Fig. 1, Datalink Splice Parts

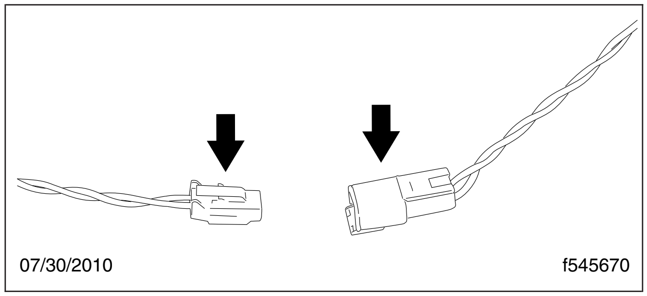


Fig. 2, Datalink Connectors

Datalink Repairs

Datalink Connector Parts		
Description	**Part Number**	**Quantity**
Connector Body Plug	23-13148-204	1
Terminal Lock	23-13303-015	1
Terminals	23-13210-020	2
Connector Body Receptacle	23-13148-206	1
Terminal Lock	23-13303-013	1
Terminals	23-13210-030	2

Table 1, Datalink Connector Parts

General Information

This Troubleshooting subject has three main parts:

- Troubleshooting Tables

  Use the Troubleshooting Tables to get ideas on what could be causing the problem and the possible remedies to that problem.
- Troubleshooting Procedures

  Follow the Troubleshooting Procedures section to isolate the areas that have faults and to know which tests to perform.
- Testing Procedures

  The Testing Procedures section has the individual tests and specifications needed to determine whether a part must be repaired or replaced.

NOTE: Be sure to attach a meter with a proper jumper kit to prevent unintentional shorting to other pins and possible damage to ECUs.

Troubleshooting Tables

Use the following troubleshooting tables to find remedies to possible causes of datalink problems.

Problem—Power-On Roll Call Reports Fault

Problem—Power-On Roll Call Reports Fault	
Possible Cause	**Remedy**
ECU does not support roll call function (ICU1/2M only).	Reset ECU parameter to disable roll call.
Datalink wiring has fault.	Repair or replace.
Wrong power supply voltage or ground to ECU.	Replace the fuse or circuit breaker, charge battery, and check connections.
Connector has fault - (Pass-through, Branch, Diagnostic)	Repair or replace wiring.
ECU has fault.	Replace the ECU.
ICU has fault.	Replace the ICU.
Terminating resistor for J1939 datalink is missing or has a fault.	Replace the terminating resistor.
Branch length is too long on J1939 datalink.	Shorten "lite" branch to less than 10 feet (3 m).
Battery is discharged or is bad.	Charge or replace the battery.

Problem—ServiceLink Will Not Connect

Problem—ServiceLink Will Not Connect	
Possible Cause	**Remedy**
ICU is older series that does not support roll call.	Use ICU for display of active fault codes only.
One or more ECUs has a fault.	Remove suspected ECUs one at a time until ServiceLink can be connected.
ServiceLink computer is not configured or connected correctly.	Check the computer settings, communication adaptor and cabling between the computer, communication adaptor, and diagnostic connector.
Connector types are different.	The J1939 datalink and new J1587 datalinks have 9-pin connectors. Connect an adapter or use the ICU for the diagnostics information display.
Battery is discharged, has a bad connection, or has a fault.	Charge, clean terminals, or replace battery.

Problem—Missing Data on Datalink-Driven Gauges

Problem—Missing Data on Datalink-Driven Gauges *	
Possible Cause	**Remedy**
ICU or engine ECU is not communicating on datalink.	Test wiring and ICU or engine ECU.
Datalink wiring has a fault.	Test and repair wiring.
Connector or junction block has a fault.	Repair or replace connector.
Incorrect voltage to ECUs	Test datalink and vehicle wiring.

* Datalink-driven gauges include: engine oil pressure, coolant temperature, engine oil temperature, turbo air pressure, tachometer, speedometer

Troubleshooting Procedures

To find the part of the datalink system that is causing a problem, follow the Troubleshooting Procedures and refer to the appropriate Troubleshooting Tests for the test points and specifications. Perform the steps of the Troubleshooting Procedures in sequence until you locate the fault.

The seven steps to diagnosing a datalink problem are:

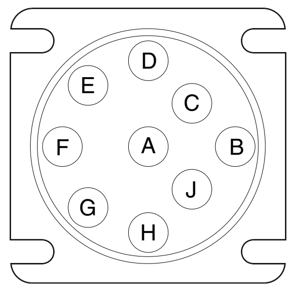
1. Determine which types of datalink are installed on the vehicle.
   1.1 Check the diagnostic connector. A 6-pin connector (or a 9-pin connector without pins C and D installed) is used for J1587 datalinks. See **Fig. 1** . J1939 datalinks have pins C and D installed in the 9-pin diagnostics connector.

   1.2 Check the wires. J1939 cable has a heavy jacket. Note that some non-Freightliner ECUs have their J1587 wires inside a jacket as well. If all the wiring has a jacket, the datalink is a J1939 datalink.

   If the J1939 cable has a drain wire inside the shielding, it is a "heavy" cable. The J1939 "lite" cable (with no drain wire) can be spliced into a section of "heavy" cable.

   1.3 Determine whether a Cummins IS Series, Caterpillar CFE, or a Mercedes-Benz engine is installed with an ABS system that has traction control. These systems use a J1939 datalink.

   1.4 A J1939 datalink is used when an Eaton® Fuller® AutoShift transmission is installed. The WABCO EBS (brake-by-wire) system and certain Eaton VORAD EVT-300 systems also require J1939 datalinks. Certain other ECUs may require a J1939 datalink.



NOTE: Pins C and D are not installed in the J1587 diagnostics connector.

1. Pin A Battery (Low)
2. Pin B Battery (High)
3. Pin C (J1939 High)
4. Pin D (J1939 Low)
5. Pin E (Shield)
6. Pin F (J1587 High)
7. Pin G (J1587 Low)
8. Pin H (Diagnostic CAN High)
9. Pin J (Diagnostic CAN LOW)

Fig. 1, J1939/J1587 9-Pin Diagnostics Connector

2. Determine which ECUs are not communicating with ServiceLink.
   2.1 Connect to the vehicle with ServiceLink

   2.2 Compare the ICU roll call list with ServiceLink ECU list.

   Note: Some ECUs cannot communicate with the ICU, but will appear on the ServiceLink parameter list. The ICU2L and ICU3 rollcall function is limited to the engine ECU and the ABS ECU.

   2.3 If an ECU is not communicating on the datalink, disconnect all the generic ECUs, one at a time, until no faults are displayed on the ICU screen or until ServiceLink connects to the system. The last ECU to be disconnected before the successful ServiceLink connection is the one causing the problem.

3. Check the suspected ECU.
   3.1 Check the resistance and voltage at the ECU connectors. See **Testing the ECUs** in the datalink testing procedures section of this subject.
   3.2 Temporarily replace the ECU with an ECU known to be good. If the ICU (or ServiceLink) now lists that ECU, install a new ECU.
4. Check the wires and connectors from the ICU at the connector for the suspected faulty ECU. See **Testing the J1587 Datalink** or **Testing the J1939 Datalink** in the datalink testing procedures section of this subject.
   4.1 Check the power supply voltage.
   4.2 Check the data signal voltage.
   4.3 Check the continuity and resistance to ground. If the readings are outside the acceptable range and are found at several test points, suspect that the datalink has a fault.
5. Determine which branch includes the suspected faulty ECU. Find the connectors and junction blocks that are in series with the suspected faulty ECU.
6. Check the wiring between the branch connector and the ECU and the wiring from the ICU to the branch connector. See **Testing the J1587 Datalink** or **Testing the J1939 Datalink** in the datalink testing procedures section of this subject.
   6.1 Check power supply voltage.
   6.2 Check the data signal voltage.
   6.3 Check the continuity and resistance to ground.
7. Check the ICU. See **Testing the ICU** in the datalink testing procedures section of this subject.
   7.1 Check the voltages at the junction block to the ICU.
   7.2 Replace the ICU with an ICU known to be good.

Datalink Testing Procedures

The following procedures give the test points and specifications for checking the various types of datalinks, connectors, ECUs and ICUs. Refer to the datalink troubleshooting procedures for information on when to test the particular parts of the datalink system.

Testing at the ECUs

1. Make sure that the vehicle battery is charged and the fuses and circuit breakers are good before testing the ECU connectors.
2. The keyswitch must be in the OFF position. Disconnect the ECU datalink circuit at the connector closest to the ECU. Turn the keyswitch to the ON position and check the voltage at the ECU harness connector. See **Table 1** for the acceptable results.
3. Connect the ECU to the datalink connector when the keyswitch is in the OFF position. Turn the keyswitch to the ON position for this test. Touch the probes of the digital multimeter (on the DC voltmeter scale) to the metal terminals of the ECU connector as shown in **Table 1** to test the ECU. Use the AC scale for the voltage tests if the multimeter will not display the rapidly changing DC voltage using the DC scale. If the test results are not within the range shown, replace the ECU and test again.

   NOTE: Voltages in **Table 1** will be varying.

ECU Harness Voltage Tests		
J1587 Datalink		
Meter (High) Probe	**Meter (Low) Probe**	**Acceptable Meter Reading (VDC)**
ECU Datalink High Terminal	ECU Datalink Low Terminal	1 to 4 VDC (1 to 3V on the AC Scale)

ECU Harness Voltage Tests		
J1587 Datalink		
Meter (High) Probe	**Meter (Low) Probe**	**Acceptable Meter Reading (VDC)**
Battery Positive Post	ECU Datalink High Terminal	6 to 11 VDC *
	ECU Datalink – Terminal	9 to 13.5 VDC *
J1939 Datalink		
Diagnostics Pin C (J1939 High)	Diagnostics Pin D (J1939 Low)	.2 to 5 VDC (.1 to 4V on the AC Scale)
Diagnostics Pin B (BAT High)	Diagnostics Pin C	6 to 11 VDC*
	Diagnostics Pin D	9 to 13.5 VDC*

* If datalink wire connections are reversed, the results are reversed.

Table 1, ECU Harness Voltage Tests

Testing the J1587 Twisted-Pair Datalink

1. Make sure that all fuses and circuit breakers are in good condition.
2. Turn the keyswitch to the OFF position before disconnecting or connecting any part of the datalink system. Disconnect the J1587 connector for the datalink section you are testing.

IMPORTANT: Do NOT disconnect the datalink by disconnecting the engine, frontwall or chassis electrical connectors.

IMPORTANT: The batteries **MUST** be disconnected and the ignition must be **OFF** prior to any J1587 resistance tests. Failure to do so may result in inconclusive resistance measurements. The J1939 datalink is not completely inactive with only the ignition off. It may be active even if there appears to be no voltage on the the datalink.

3. Turn the keyswitch to the OFF position. Test the continuity of a J1587 twisted-wire pair by touching the red (positive) probe of a digital multimeter (set to the ohmmeter mode) to the **J1587 High** terminal of the connector. Connect the black (negative) probe to the J1587– wire terminal. See **Table 2** for the results.

   Check the datalink isolation to the vehicle ground by holding one ohmmeter probe on the **J1587 Low** wire and the other probe to a good ground. Perform this test again with the ohmmeter leads reversed. **Table 2** shows the acceptable resistances for these tests.

J1587 Resistance Tests		
Meter (High) Probe	**Meter (Low) Probe**	**Acceptable Meter Reading (Ohms)**
High	Low	1k to 30k Ohms
High	Vehicle Ground	More than 1k Ohms
Low	Vehicle Ground	More than 1k Ohms

Table 2, J1587 Resistance Tests

4. Test the signal voltage on the J1587 twisted pair as shown in **Table 1**. The keyswitch must be in the ON position for the voltage tests. Use the AC scale for the voltage tests if your multimeter will not display the rapidly changing DC voltage using the DC scale.

NOTE: If any voltage reading is a steady 0 VDC or a steady 12 VDC, the ECU or datalink wiring has a fault.

Testing the J1939 Datalink

Use the following five basic steps in the order given to successfully locate J1939 datalink problems. Do not skip steps or tests unless directed to do so.

J1939 Resistance Test

This test checks whether or not both terminating resistors are installed, and ensures that there is a complete circuit from the diagnostic connector through the backbone loop. It does not ensure that branch circuits to each ECU are OK.

Tests in this subject are performed using a digital multimeter set to read ohms.

IMPORTANT: The batteries **MUST** be disconnected and the ignition must be **OFF** prior to any J1939 resistance tests. Failure to do so may result in inconclusive resistance measurements. The J1939 datalink is not completely inactive with only the ignition off. It may be active even if there appears to be no voltage on the the datalink.

1. Turn the ignition OFF and disconnect the batteries.
2. Connect the meter leads of a digital multimeter set to read ohms to pins C and D of the 9-pin diagnostic connector and measure the resistance.
3. Reconnect the batteries after the test is completed.

See **Table 3** for test results and possible causes.

J1939 Resistance Test	
Result	**Possible Cause**
60Ω ± 6Ω	The J1939 datalink backbone is intact and both terminating resistors are installed. Go to step 2.
120Ω ± 12Ω	Any of the following: • One of the terminating resistors is missing. • One of the terminating resistors is open. • The circuit may be open anywhere between the terminating resistors.
40Ω ± 4Ω	Three terminating resistors have been installed; one must be removed. There must be one terminating resistor at each end of the backbone for a total of two.
0Ω to 5Ω	**J1939 High** and **J1939 Low** have shorted together somewhere in the system.
Greater than 1000Ω	The most likely cause is an open circuit between the diagnostic connector and the J1939 backbone. It may also be that both terminating resistors are missing or open.
Any other readings	Any of the following: • Incorrect terminating resistor resistance. • Poor or corroded connections. • Short circuit to ground or an open circuit somewhere on the datalink. Go to step 2 to pinpoint the problem.

Table 3, J1939 Resistance Test

ECU Communication Test

The following series of tests check for communication with each ECU connected to the J1939 datalink. If one fails to communicate, pinpoint whether the problem is wiring or an ECU. If all ECUs communicate as they should, J1939 is probably not the problem.

1. **Check whether each ECU connected to the J1939 datalink responds.**

1.1 Connect the computer to the diagnostic connector.

1.2 Start the J1939 Datalink Monitor template.

NOTE: The template contains instructions on its use.

1.3 Check whether each ECU that is supposed to be connected to the datalink responds. See **Table 4** for test results and possible causes.

Check whether each ECU connected to the J1939 datalink responds	
Result	**Possible Cause**
All ECUs respond	The J1939 datalink is probably not the problem.
One ECU fails to respond.	Go to step 2.
No ECUs respond	Possible explanations are: • The **J1939 High** and **J1939 Low** pinouts may be reversed at the diagnostic connector, or at any other connector in the system. Check their polarity. • There may be a problem with the PC to vehicle interface. • The entire datalink may be down due to a short to power or short to ground. Go to Step 3 to pinpoint the problem.

Table 4, Check Whether Each ECU Connected to the J1939 Datalink Responds

2. **Check the J1939 datalink wiring to the ECU that does not respond.**

IMPORTANT: The batteries **MUST** be disconnected and the ignition must be **OFF** prior to any J1939 resistance tests.

2.1 Turn the ignition OFF and disconnect the batteries.

2.2 Locate the connector at the ECU in Step 2, Test 1 that did not respond and disconnect it.

2.3 Locate the pins for **J1939 High** and **J1939 Low**. Refer to Freightliner or component supplier literature or wiring diagrams for the specific component.

2.4 Check to make sure that **J1939 High** and **J1939 Low** polarity is correct at the component before proceeding. If not, this is the most likely problem.

2.5 Using a digital multimeter set to read ohms, measure the resistance across the two J1939 datalink pins at the connector to the suspect ECU.

2.6 Reconnect the batteries after the test is completed. See **Table 5** for test results and possible causes.

Check the J1939 datalink wiring to the ECU that does not respond	
Result	**Possible Cause**
$60\Omega \pm 6\Omega$	The datalink itself is probably not the problem. Make sure that any changeable J1939 parameters for this ECU are set correctly before proceeding. Also, make sure that there is power and ground to the suspect ECU. Go to **step 3** once the following have been confirmed: • J1939 parameters for the ECU (if they can be changed) are correct. • There is power and ground to the suspect ECU.

Check the J1939 datalink wiring to the ECU that does not respond	
Result	**Possible Cause**
Not 60Ω ± 6Ω	There is a problem with the J1939 wiring between the ECU connector and its connection to the J1939 backbone. Repair as necessary.

Table 5, Check the J1939 Datalink Wiring to the ECU That Does Not Respond

3. **Install a test ECU to confirm the problem.**
   3.1 Install a test ECU and make sure that all J1939 parameters (if changeable) are set correctly.
   3.2 Using the J1939 Datalink Monitor template, check to see if every ECU that is supposed to be connected to the datalink responds. See **Table 6** for test results and possible causes.

Install a test ECU to confirm the problem	
Result	**Possible Cause**
All ECUs respond	The ECU was faulty and the test ECU confirmed this. Replace the ECU.
The ECU still does not respond.	The problem has not been confirmed. Carefully repeat all the diagnostics. If the ECU still does not respond, contact your District Service Manager or the ECU supplier directly for assistance.

Table 6, Install a Test ECU to Confirm the Problem

Test J1939 Voltage for Circuit Faults (Shorts to Power and Ground)

These tests check for shorts to power and shorts to ground on the J1939 datalink.

NOTE: All tests are performed using a digital multimeter set to read voltage.

NOTE: Before proceeding, verify that battery voltage (approximately +12 VDC) is available at pin B of the diagnostic connector. With the ignition ON, use a digital multimeter to test for voltage at pin B by placing the red (+) lead on pin B and the black (-) lead on a good chassis ground.

1. **Test J1939 High for shorts to power and ground.**
   1.1 Turn the ignition ON.
   1.2 Touch the red (+) lead to pin B (+12 VDC) and the black (-) lead to pin C (**J1939 High**) of the diagnostic connector. See **Table 7** for test results and possible causes.

Shorts to Power and Ground (J1939 High)	
Result	**Possible Cause**
0 VDC	**J1939 High** is shorted to power. Continue to the next test, "Pinpointing Short Circuits on the J1939 Datalink."
12 VDC (battery voltage)	**J1939 High** is shorted to ground. Continue to the next test, "Pinpointing Short Circuits on the J1939 Datalink."
Any other reading	**J1939 High** is not shorted to power or ground. Go to step 2.

Table 7, Shorts to Power and Ground (J1939 High)

2. **Test J1939 Low for shorts to power and ground.**

    2.1 Turn the ignition ON.

    2.2 Touch the red (+) lead to pin B (+12 VDC) and the black (-) lead to pin D (**J1939 Low**) of the diagnostic connector. See Table 8 for test results and possible causes.

Shorts to Power and Ground (J1939 Low)	
Result	**Possible Cause**
0 VDC	**J1939 Low** is shorted to power. Continue to the next test, "Pinpointing Short Circuits on the J1939 Datalink."
12 VDC (battery voltage)	**J1939 Low** is shorted to ground. Continue to the next test, "Pinpointing Short Circuits on the J1939 Datalink."
Any other reading	**J1939 Low** is not shorted to power or ground. There may be a problem with the vehicle to computer interface. The datalink itself appears to be OK.

Table 8, Shorts to Power and Ground (J1939 Low)

Databus Quick Test

NOTE: All voltages in Table 1, except for BAT + and BAT – will be varying.

Databus Quick Test				
No.	Test	Red Lead/Black Lead	Specification	Result
Battery Connected – Ignition ON				
1	Bat+ to Bat-	Pin B to Pin A	Source Voltage (> 12.4)	
2	J1587+ to J1587–	Pin F to Pin G	1 – 5 VDC (0 – 4 VAC)	
3	Bat+ to J1587+	Pin B to Pin F	6 – 11 VDC	
4	Bat+ to J1587–	Pin B to Pin G	9 – 13.5 VDC	
5	J1939+ to J1939–	Pin C to Pin D	.2 – 5 VDC (.1 – 4 VAC)	
6	Bat+ to J1939+	Pin B to Pin C	6 – 11 VDC	
7	Bat+ to J1939–	Pin B to Pin D	9 – 13.5 VDC	
Ignition OFF – Battery Disconnected at Batteries – NOT Cab Load Disconnect Switch				
8	J1587+ to J1587–	Pin F to Pin G	1k – 30k Ohms	
9	J1587+ to Bat–	Pin F to Pin A	> 1k Ohms	
10	J1587- to Bat–	Pin G to Pin A	> 1k Ohms	
11	J1939+ to J1939–	Pin C to Pin D	55 – 65 Ohms	
12	J1939+ to Bat–	Pin C to Pin A	> 1k Ohms	
13	J1939- to Bat–	Pin D to Pin A	> 1k Ohms	
14	Terminating Resistors	—	110 – 130 ohms	

Table 1, Databus Quick Tests

NOTE: A J1939 ohm test can also be performed on Diagnostic CAN High – Pin H, and Diagnostic CAN Low – Pin J for similar results.

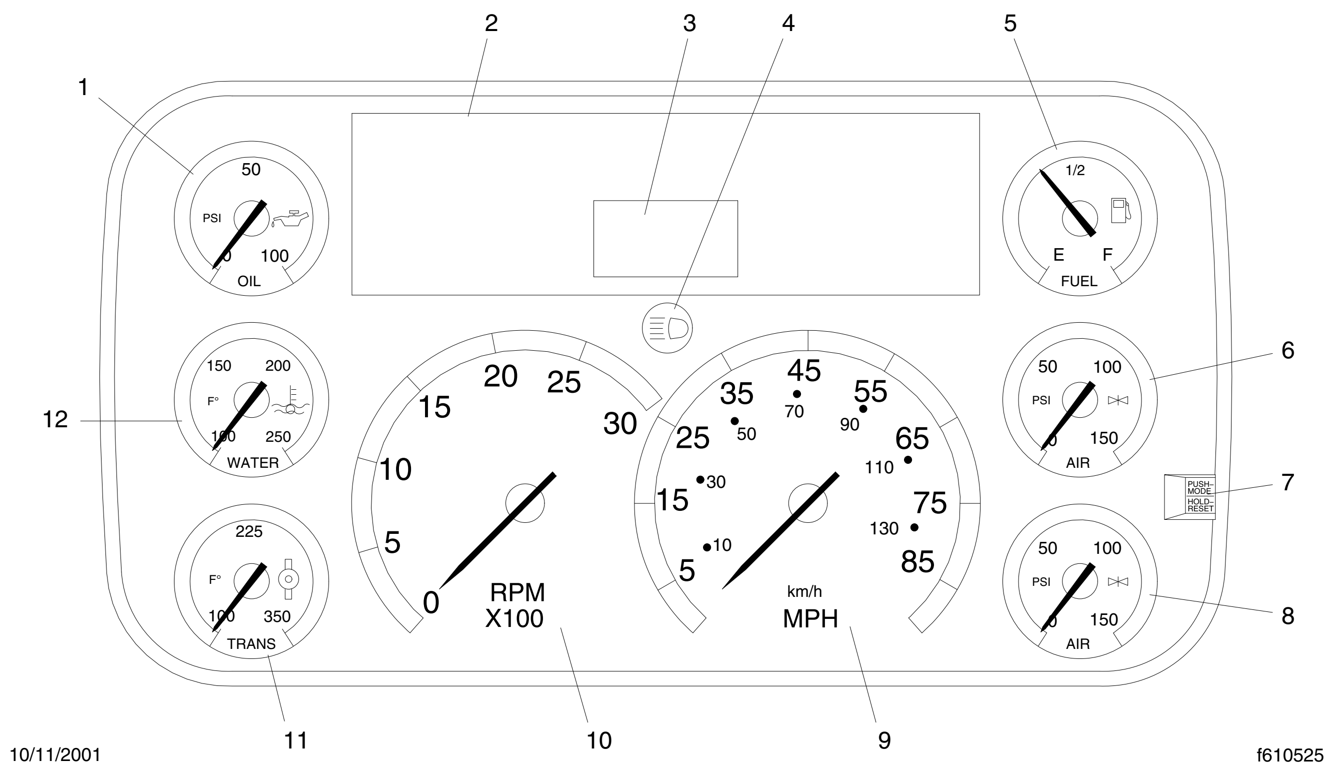
Contents

General Description

The ICU3 instrument cluster is comprised of gauges, warning lights, indicator lights, a buzzer, and a driver display screen built into a single unit to provide the driver with engine and vehicle information. The ICU3 receives data through datalink messages, hardwire inputs, and air pressure inputs. The ICU3 contains up to eight individual gauges, and up to six additional satellite gauges. See **Fig. 1**. The ICU3 contains a message center with a liquid crystal display (LCD), driver display, and up to 28 warning and indicator lamps. The ICU3 has no field changeable parameters, with the exception of those functions that can be set using the Mode/Reset button, and the display menus such as service intervals and odometer units.

Main ICU Gauges

The speedometer, fuel level, engine coolant temperature, tachometer, primary and secondary air pressure, and engine oil pressure gauges are standard on all ICU3 configurations. Vehicles may have additional optional gauges depending on the configuration. The ICU3 receives data to drive most of the gauges from either J1587 datalink messages on vehicles built with EPA07 emissions and prior, and over J1939 on EPA10 and later vehicles. Data is received from the engine controller or transmission controller, or from sensors wired directly to the ICU3. Air pressure gauges are connected directly to the air system they monitor. They are not controlled by the ICU directly, except for backlighting. The ICU3 gauges



1. Engine Oil Pressure Gauge
2. Dash Message Center
3. Dash Driver Display Screen
4. Headlight High-Beam Indicator
5. Fuel Level Gauge
6. Primary Air Pressure Gauge (optional)
7. Mode/Reset Button
8. Secondary Air Pressure Gauge (optional)
9. Speedometer (U.S. version)
10. Tachometer (optional)
11. Transmission Fluid Temperature Gauge (optional)
12. Coolant Temperature Gauge

Fig. 1, ICU3 Gauge Layout (typical U.S.)

General Information

sweep 270 degrees, except for the tachometer, which sweeps 180 degrees. ICU3 gauge pointers and backlighting are lit by light emitting diodes (LEDs). The only serviceable parts on the ICU3 are the air pressure gauge module, the nine top center indicator lamps and lenses, and the Mode/Reset button.

Remote-Mounted (Satellite) Gauges

The ICU3 can drive external satellite gauges connected to the proprietary datalink between the ICU3 and the satellite gauges. Four pins are used for this function: gauge power, gauge ground, data, and backlighting. Optional satellite gauges include engine oil temperature, turbo boost, pyrometer, forward-rear axle temperature, rear-rear axle temperature, application air, axle lift, and suspension air pressure.

Awake State and Sleep State

The Bulkhead Module (BHM), Chassis Module (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
- 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 determine whether or not the electrical system is going into a sleep state, do the following.

1. Enter the vehicle.
2. Shut the doors.
3. Do not apply the service brakes.
4. Make sure the ignition switch and hazard switch are in the OFF position.

   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.

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

Dash Message Center

The dash message center includes the warning and indicator lights and a liquid crystal display (LCD). The LCD is used to display the odometer, voltmeter, and service information.

Mode/Reset Button

The Mode/Reset button, located on the right side of the instrument cluster, is used to scroll through the message center displays, and to manage driver information settings. When the parking brake is applied, the message center presents additional displays that are not available when the parking brake is off. The following lists the displays that are available on an EPA10 vehicle when the parking brake is applied.

a. Trip distance

b. Trip hours

c. Temperature (EPA10 Only)

d. Select screen

e. Temperature alert screen

f. Diagnostic screen

g. Clear screen (with less than 254 miles)

h. Engine miles

i. Engine hours
j. Set Up
k. Back to odometer

Each press of the Mode/Reset button advances to the next display. Pressing and holding the Mode/Reset button in each display advances to any additional functions it may have. See subject 410 for detailed operation of the message center display screens.

Trip Miles

To reset trip miles and/or trip hours to zero, press and hold the Mode/Reset button for 1 second or longer.

Miles or Kilometers

To toggle between MI (miles) or KM (kilometers), press the Mode/Reset button while in the SELECT screen.

Fault Codes

When a fault code exists and the parking brake is applied, the display shows the message identifier (MID) on EPA07 and earlier vehicles, and the source address (SA) on EPA10 vehicles, of the ECU with the fault. For example, if the antilock brake system has a fault, the MID **AbS136** displays. If more than one ECU is reporting an active fault, the display cycles through the MIDs or SAs for each ECU.

Use the following instructions to display the active fault codes.

1. Press the mode/reset button until **dIAG n** displays. The letter "n" represents the number of active faults.
2. Press and hold the mode/reset button once to display the MID/SA of the fault.
3. Press the mode/reset button again to display details of the fault. Pre EPA10 vehicles will show the subsystem identifier (SID) or parameter identifier (PID). EPA10 vehicles will show the suspect parameter number (SPN).
4. Press the mode/reset button again to display the failure mode indicator (FMI) of the fault.
5. Press the mode/reset button again to return to the first fault display.
6. If more than one fault code is active, press and hold the mode/reset button to proceed to the next fault, then follow the previous four steps to display the additional faults.

Warning and Indicator Lights

The ICU3 has spaces for 28 warning and indicator lights. See **Fig. 2** for pre-EPA07 configuration, **Fig. 3** for EPA07 configuration, and **Fig. 4** for EPA10 configuration.

There are four rows of warning and indicator lights. The lights, or telltales, in the top row are optional. The light in position 8 (counting left to right across the top row) is a permanently mounted amber LED. The remaining top row indicators use replaceable incandescent lamps.

NOTE: Positions 1 through 8 are ground and databus-activated circuits. Position 9 is power activated and databus activated.

The lights on the other three rows are installed at fixed positions that do not vary. Some lights are optional. If an optional light is not requested, the position is blank (does not light up).

The following fixed-position lights are standard:

- stop engine warning (red)
- check engine indicator (amber)
- engine protection warning (red)
- low air pressure warning (red)
- low engine oil pressure warning (red)
- high coolant temperature warning (red)
- fasten seat belt warning (red)
- low battery voltage warning (red)
- parking brake on warning (red)
- tractor ABS indicator (amber)
- left-turn signal (green)
- right-turn signal (green)
- high beams on indicator (blue)

The following fixed-position lights are optional:

- air filter restriction indicator (amber)
- alternator no charge indicator (amber)

General Information

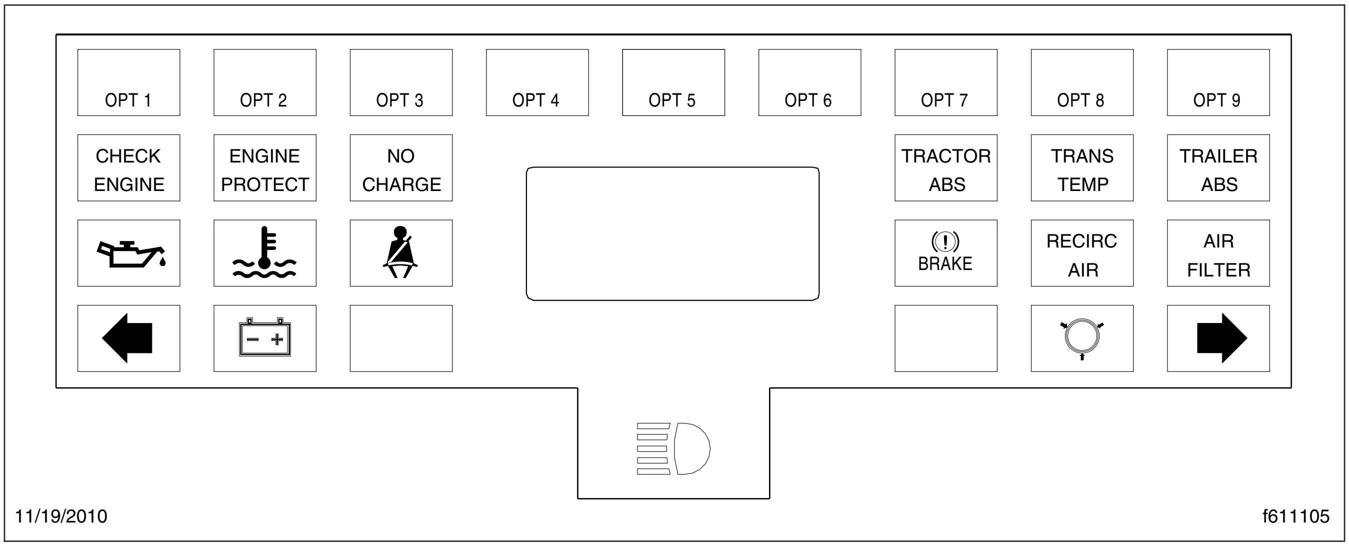


Fig. 2, Dash Message Center, ICU3 (pre-EPA07)

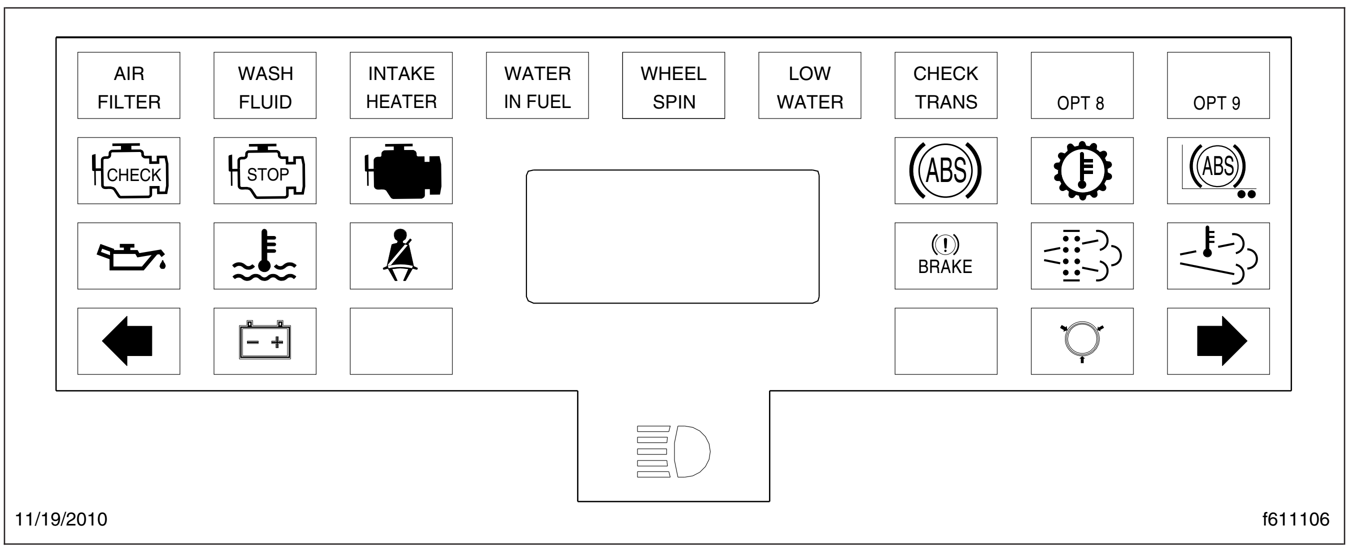


Fig. 3, Dash Message Center, ICU3 (EPA07)

- high transmission temperature warning (amber)–installed on vehicles with automatic transmissions
- recirculated air indicator (amber)
- trailer ABS indicator (amber)–installed on vehicles designed to be used with a trailer

The following lights are optional:

- low coolant level warning (red)
- electronic braking system (EBS) warning (red)
- check transmission indicator (amber)
- intake heater indicator (amber)
- low washer fluid indicator (amber)
- optimized idle indicator (amber)
- wait to start indicator (amber)
- water in fuel indicator (amber)
- wheel spin indicator (amber)

Other optional lights may be specified.

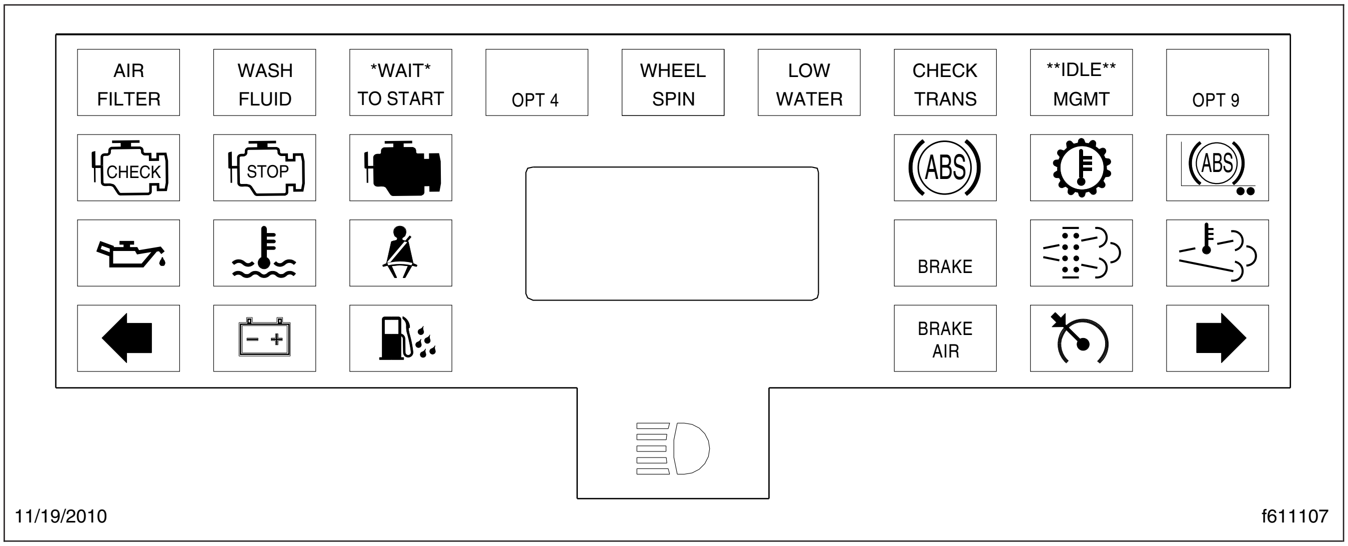


Fig. 4, Dash Message Center, ICU3 (EPA10)

Principles of Operation

Ignition Sequence

When the ignition is turned to ON, the ICU3 runs through the ignition sequence. See **Fig. 5**.

If only the headlights are turned on, the dash driver display screen displays the odometer.

IMPORTANT: When the ignition is first turned to ON, all the electronic gauges complete a full sweep of their dials, the warning and indicator lights light up, and the buzzer sounds for three seconds when the seat belt is latched.

The following warning and indicator lights go on during the ignition sequence.

- low engine oil pressure warning
- high coolant temperature warning
- low air pressure warning
- parking brake on warning
- low battery voltage indicator
- fasten seat belt warning illuminates for 15 seconds (unless pin D10 is hardwired on EPA10 ICUs. If pin D10 is hardwired, the light will remain on for only three seconds when the seat belt is latched.)
- all engine warning lights, including engine protection, check engine, and stop engine
- all ABS warning lights, including wheel spin, tractor ABS, and trailer ABS (if installed); and
- the DEF level indicator on EPA10 vehicles will illuminate all segments green, then turn them off one at a time before turning the left most segment amber then red.

NOTE: While the engine and ABS warning lights go on during the ignition sequence, they are not controlled by the ICU3, but by their own system ECU.

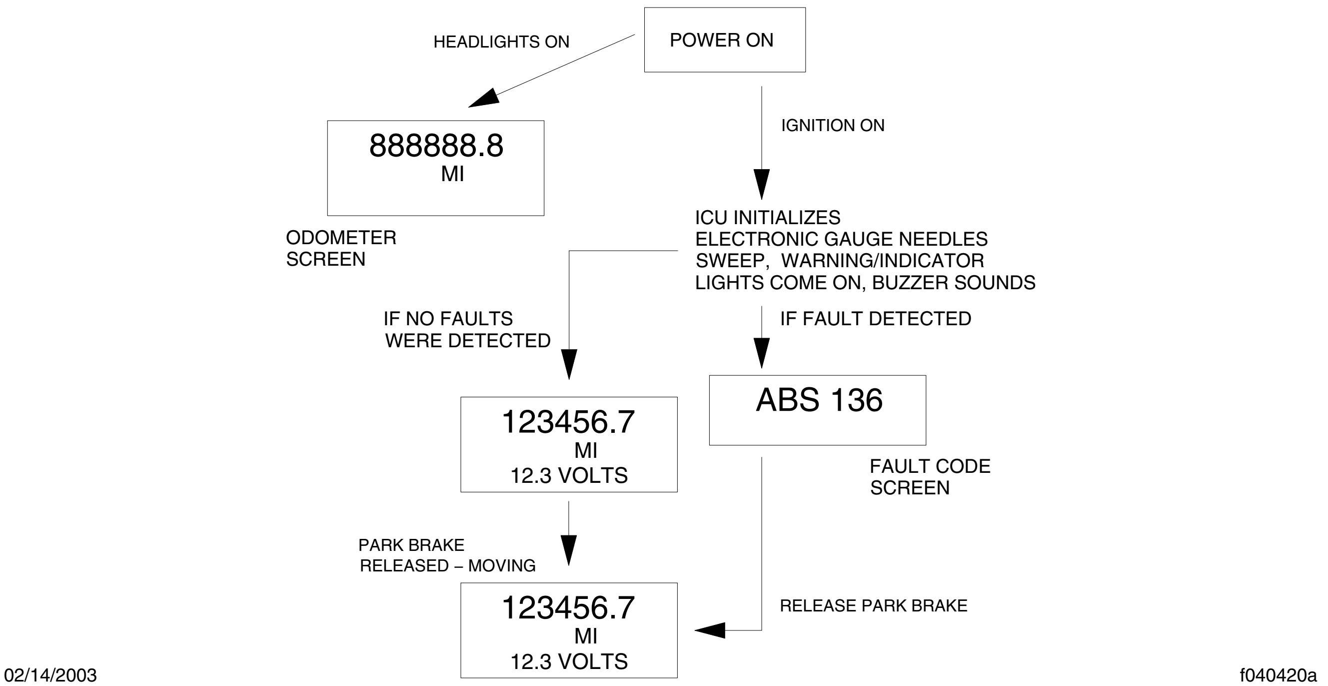
Once the ignition has been turned to ON, the ICU performs a self-test, and polls the databus for faults.

During the first half of the self-test, all segments of the dash driver display screen illuminate as "888888.8". During the second half of the self-test, the software revision level is displayed.

If there are no active faults, the screen then displays the odometer.

If the ICU3 has received active fault codes from other devices, it displays the three-letter acronym for the device broadcasting the fault. It also displays the MID or SA number for each for three seconds, one after the other, until the parking brake is released or the ignition is turned to OFF.

General Information



NOTES:

- During the first half of the self-test, all segments of the display illuminate. During the second half of the self-test, the software revision level is displayed.
- If there is more than one fault, the ICU3 displays them, one after another, changing every three seconds, until the park brake is released.

Fig. 5, ICU3 Ignition Sequence

The screen displays a code, called the message identifier (MID) for EPA07 and earlier vehicles, or source address (SA) for EPA10 and later vehicles. These identify the ECU or system that is broadcasting the fault code.

NOTE: If the ICU3 receives a message from an ECU that has not been preprogrammed into the memory of the ICU, it displays "SYS ###" instead, where ### is replaced by the MID/SA of the broadcasting device.

Once the parking brake is released, the ICU3 displays the odometer again.

Odometer

The odometer is set to display in either miles or kilometers, depending on the primary scale of the speedometer. The legend, either **MI** or **KM**, illuminates between the odometer and the volts display when the engine is running or the headlights are turned on.

To toggle between MI (miles) or KM (kilometers), press the Mode/Reset button while in the SELECT screen.

The odometer is a seven-digit display with a decimal point until the vehicle has traveled 999,999.9 miles or kilometers (km). At one million miles (km), the odometer rolls over to "1000000" without the decimal point, and can continue up to 9,999,999. The odometer only displays significant figures (no leading zeros).

The ICU compares odometer data received from the engine controller to its own stored value. It will only alter its stored value if the difference is less than two miles (three km). When the ICU is replaced, the odometer display will start from zero even though the engine controller odometer may be a much larger value.

IMPORTANT: Although the odometer uses data supplied by the engine control module (ECM) to update its count, it keeps its own mileage starting from zero, when it was first installed. The ICU odometer may not match the engine ECU odometer. This may occur if the engine has been operated with the ICU disconnected, as may occur during factory break-in or engine service, or if the ICU has been replaced.

Buzzer/Chime

The buzzer sounds during the ignition sequence and whenever one of the following conditions exists:

- The engine oil pressure falls below the preset level, which is 5 to 9 psi (35 to 62 kPa) on most engines.
- The coolant temperature rises above the preset level, which is 215°F (102°C) on Caterpillar and Detroit Diesel engines, and 189°F (87°C) on MBE900 engines, and 225 to 230°F (107 to 110°C) on Cummins engines.
- The air pressure falls below the preset level of approximately 70 psi (483 kPa).
- The parking brake is set with the vehicle moving at a speed greater than 2 mph (3 km/h).
- The J1939 brake failure message is received from the ABS.
- The J1939 heartbeat message is not received from the ABS.
- The system voltage falls below 11.9 volts.
- An optional circuit connected to pin B12 will activate the buzzer when it is connected to ground.
- The door is open and the parking brake is not set.

ICU3 Removal and Installation

Removal

The instrumentation control unit, ICU3, is a one-piece unit, including housing, fixed gauges, a removable air gauge module, and the dash message center. See **Fig. 1**.

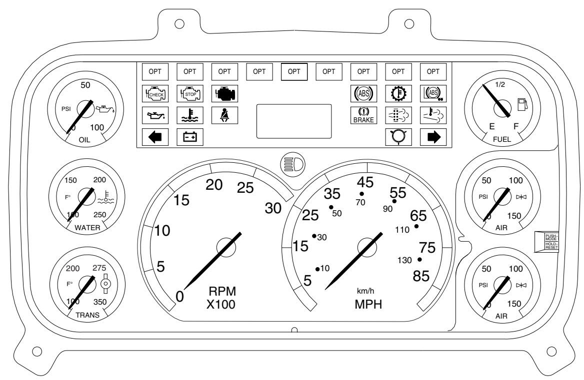


Fig. 1, ICU3, Front View

1. If replacing the ICU, attach a sticker to the driver side door frame indicating the mileage from the driver display, and the date that the ICU is being replaced.
2. Disconnect all negative leads from the batteries.

WARNING

Air lines under pressure can whip dangerously if disconnected. Drain all air from the air tanks before disconnecting air lines. Disconnecting pressurized air lines can cause personal injury and/or property damage.

3. Discharge the air pressure from the primary and secondary air tanks.
4. Remove the dash trim piece by removing the eleven screws that secure it. All fasteners for this procedure are 10–16 Torx® capscrews. See **Fig. 2**.

NOTICE

Do not forcibly pull the ICU3 from the dash. This may dislodge electrical connections or air lines from the back of the ICU3, causing damage to connections, lines, or the dash.

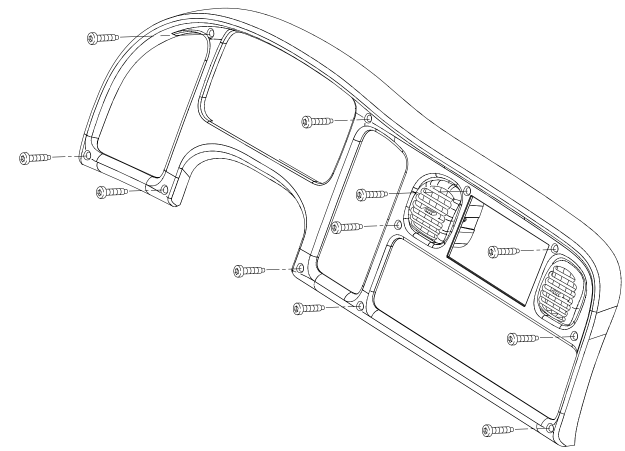
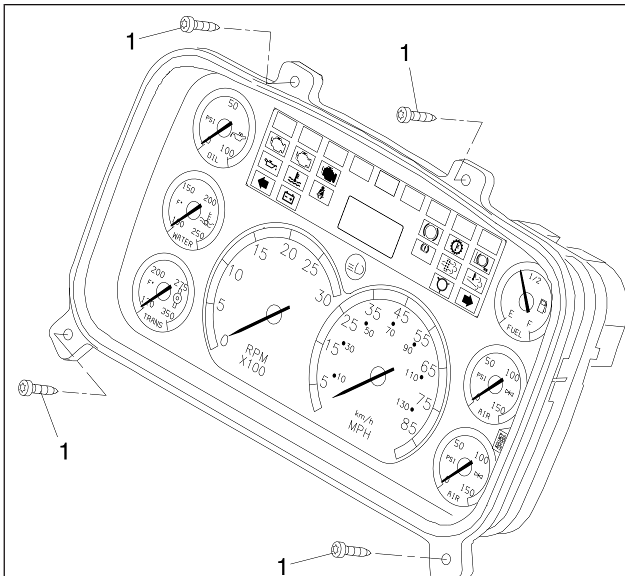


Fig. 2, Dash Trim Piece

5. Remove the four screws that secure the ICU. See **Fig. 3**.

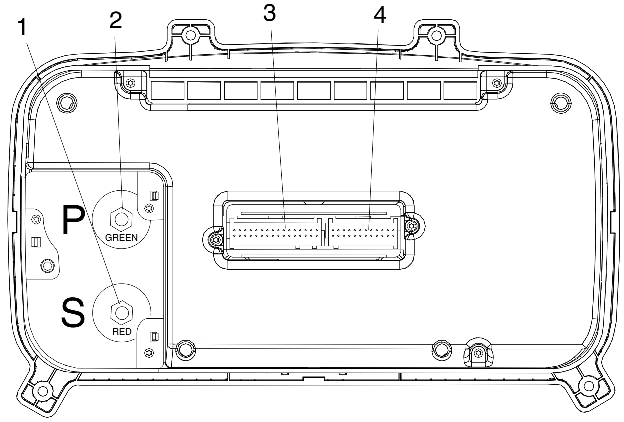


1. 10–16 Torx Capscrew

Fig. 3, ICU3 Installation

6. Disconnect the two electrical connectors from the back of the ICU. See **Fig. 4**.
7. Remove the air lines by pressing the push-lock connectors, then pulling the air lines away from the gauges. The lines are color-coded for ease

ICU3 Removal and Installation



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1. Secondary Air Pressure Gauge
2. Primary Air Pressure Gauge
3. 32-Pin Electrical Connector
4. 24-Pin Electrical Connector

Fig. 4, ICU3, Rear View

of installation. The primary air line is green and is connected to the upper gauge. The secondary air line is red and is connected to the lower gauge.

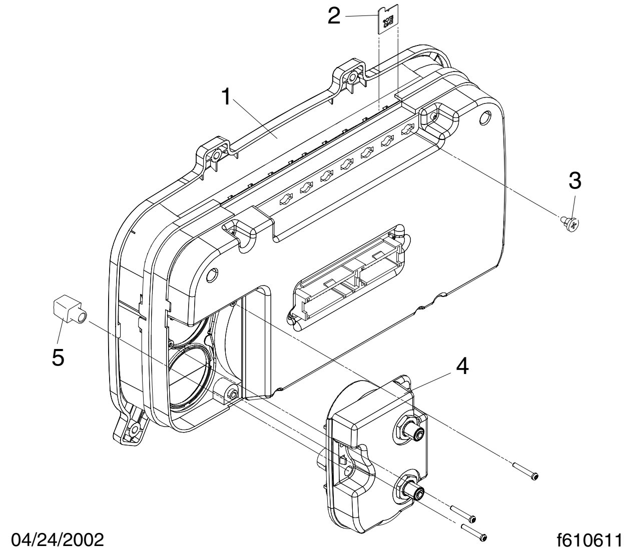
Air Pressure Gauge Module Replacement

The air pressure gauge mode/reset button module may be replaced as a sub-assembly. See **Fig. 5**. This avoids the need to replace the entire ICU3.

NOTICE

NOTICE: Be careful not to damage the ribbon electrical connector or the air gauge needles when removing the air gauge module. The gauge needles are exposed once the module is removed. A thin-ribbon electrical connector connects the air gauge module and the ICU3 housing. Once the fasteners that secure the air gauge module are removed, take care in separating the module from the ribbon electrical connector. Do not separate the air gauges from module cover.

NOTE: Placing the cluster on a clean towel or cloth will help keep the plastic face from getting scratched during this procedure.



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1. ICU3
2. Telltale
3. Light Bulb
4. Air Gauge Module
5. Mode/Reset Button

Fig. 5, ICU3, Rear View

1. Carefully place the ICU3 face down on a smooth surface and remove the three Torx® capscrews that secure the air gauge module to the ICU. See **Fig. 6**.

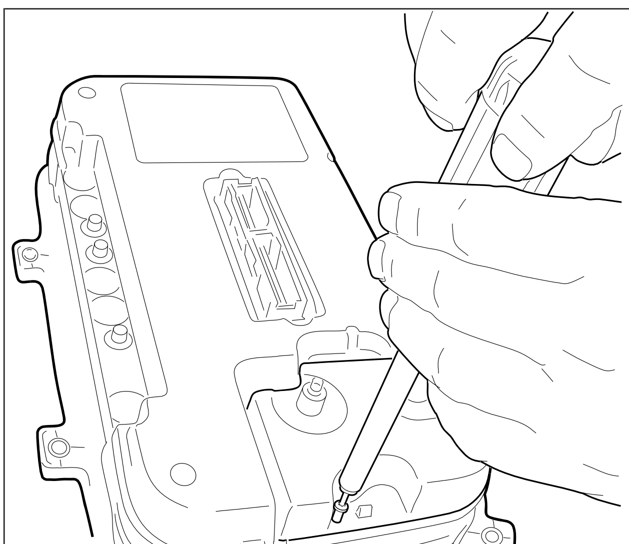

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Fig. 6, Removing the T-8 Screws

2. Separate the air gauge module slightly from the ICU to allow access to the electrical ribbon that connects the module to the ICU. See **Fig. 7**.
3. Disconnect the electrical connection ribbon from the ICU, not from the air gauge module. Grip the ribbon firmly on each side and lift out, then remove the air gauge module.
4. Position the air gauge module close to the opening it belongs in and connect the electrical ribbon connector in its slot. Gripping the ribbon end firmly, place the ribbon end into the slot and push it straight in until it stops.
5. Place the air gauge module into its opening in the ICU3. Make sure the electrical ribbon is inside the module, and that the mode/reset button shaft in the ICU cavity lines up with the receptacle in the air gauge module.
6. Install the three Torx capscrews and tighten them to secure the air gauge module.

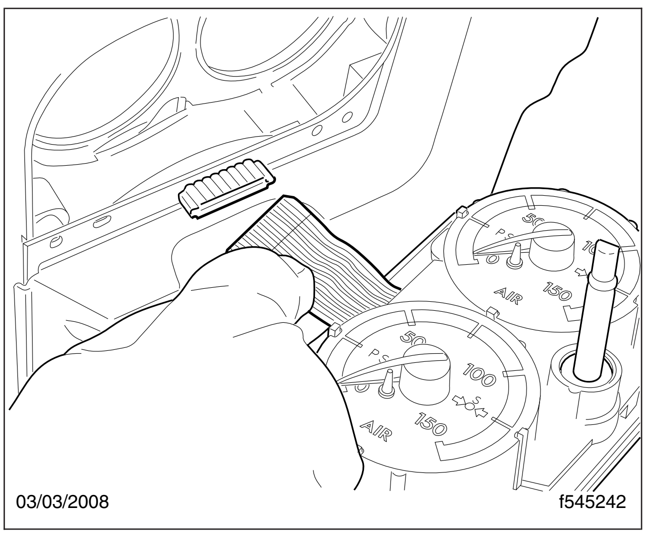

Fig. 7, Disconnecting the Ribbon Cable

Installation

1. Connect the air lines to the air gauges by pressing them firmly into the push-lock connector on the back of the gauge. The green air line connects to the primary (upper) gauge. The red air line connects to the secondary (lower) gauge. See **Fig. 4**.
2. Connect the electrical connectors to the back of the ICU3.
3. Place the ICU3 in the dash opening and secure it with the four capscrews. Tighten the capscrews 30 lbf·in (340 N·cm).
4. Install the dash trim piece and secure it with eleven capscrews. Tighten the capscrews 30 lbf·in (340 N·cm).
5. Connect the batteries.

NOTE: Mechanical (air) gauges do not make a sweep.

6. Turn on the ignition and test the operation of the cluster. All electronic gauges should make one complete sweep and return to their normal indicating positions. The warning and indicator lights should turn on, then off, as described is **Subject 050**.
7. Start the engine and verify proper operation of the air gauge module as the air pressure builds.

Lamp and Telltale Replacement

Background Information

The instrumentation control unit, ICU3, is a one-piece unit, including housing, fixed gauges, a removable air gauge module, and the dash message center. See **Fig. 1**.

NOTE: Since the top-row warning and indicator lamps are optional, some positions in the row may not have a lamp and telltale.

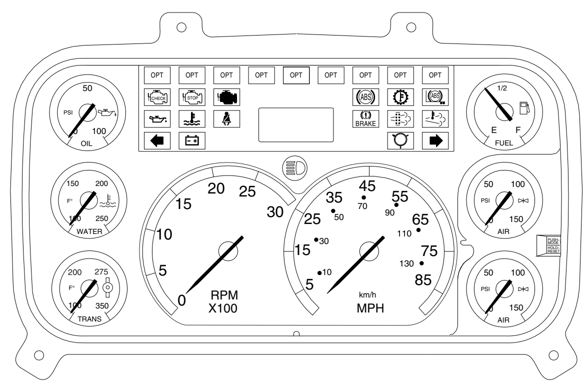

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Fig. 1, ICU3

The nine top-row warning and indicator lamps are all replaceable except for the lamp in position 8, counting left to right. The lamp in that position is a permanent LED.

The term "telltale" refers to the small plastic bezel in the top row with a warning or indicator message printed on it. Telltales are replaceable.

IMPORTANT: If more extensive service work on the ICU3 is required, the electrical and air gauge connections must be disconnected. See **Subject 100** for instructions.

NOTICE

Do not forcibly pull the ICU3 from the dash. This may dislodge electrical connections or air hoses from the back of the ICU3, causing damage to the connections, the air hoses, or the dash.

Lamp Replacement

1. Disconnect the negative leads from the batteries and discharge the pressure from the air tanks.
2. Remove the dash trim piece by removing the 11 capscrews that secure it. All fasteners for this procedure are 10–16 Torx® capscrews. See **Fig. 2**.

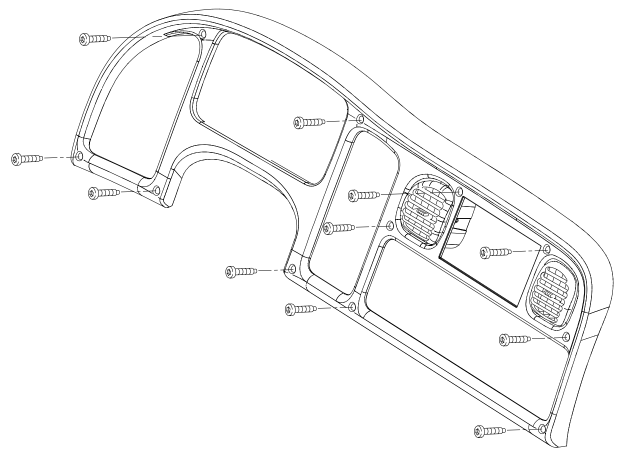

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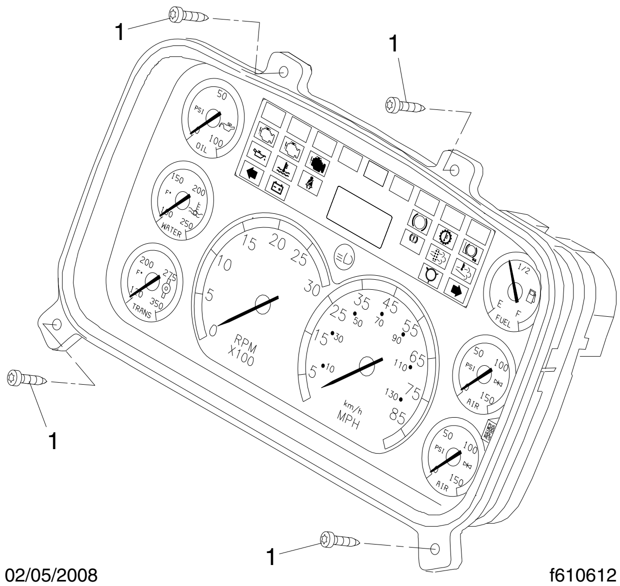
Fig. 2, Dash Trim Piece

3. Remove the four capscrews that secure the ICU3. See **Fig. 3**.
4. Place a clean towel over the front of the ICU3 before pulling it forward to prevent scratches. Carefully pull the ICU3 forward to access the top row of lamps and telltales.
5. Use a small screwdriver or flat blade to twist out the lamp by its base behind the telltale. Turn the lamp one-quarter turn and remove. See **Fig. 4**.
6. Place a new lamp in the opening and twist it one-quarter turn.
7. Using capscrews, install the ICU3.
8. Using capscrews, install the dash trim piece.
9. Connect the batteries.

Telltale Replacement

1. Disconnect the negative leads from the batteries and drain the air tanks.

Lamp and Telltale Replacement



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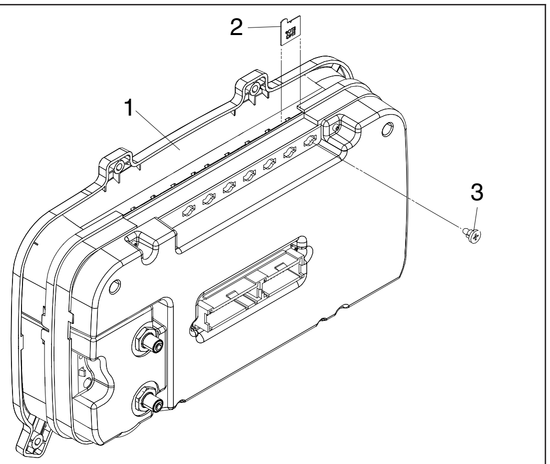
1. Torx Capscrew

Fig. 3, ICU3 Installation



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NOTE: Air gauge and electrical connections are shown removed for clarity.

1. ICU3
2. Telltale
3. Lamp

Fig. 4, ICU3, Rear View

2. Remove the dash trim piece by removing the 11 capscrews that secure it. All fasteners for this procedure are 10–16 Torx® capscrews. See **Fig. 2**.
3. Remove the four capscrews that secure the ICU3. See **Fig. 3**.
4. Place a clean towel over the front of the ICU3 before pulling it forward to prevent scratches. Carefully pull the ICU3 forward to access the top row of lamps and telltales.
5. Using a pair of needlenose pliers or a similar tool, grab the exposed tab at the top of the telltale slot and carefully pull the telltale out from the top of the ICU. See **Fig. 4**.
6. Place a new telltale in the slot the same way it was removed. Properly orient the telltale so the text is readable from the front, then grab the top tab of the telltale and slide it into the slot.
7. Using capscrews, install the ICU3.
8. Using capscrews, install the dash trim piece.
9. Connect the batteries.
10. Turn the ignition on. Check all lamps and telltales for correct operation.

IMPORTANT: Begin troubleshooting the ICU using Table 1.

ICU Instrumentation Troubleshooting – Start Here		
Problem Type	**Symptom**	**Procedure to Use**
Fault Code	A fault code is displayed on the ICU display	Table 14
	A Roll Call fault is present – Examples are "no ENG" or "no ABS"	Table 14
	"nO DATA" is displayed on the LCD	Table 14
	"nO J1939" is displayed on the LCD	Table 14
	"- - - - - - -" (seven dashes) is displayed on the LCD	Table 14
Gauges	Problem with a gauge in the ICU	Table 2
	Problem with a satellite gauge	Table 6
Backlighting	Problem with backlighting in the ICU	Table 19
	Problem with backlighting in a remote gauge	Table 19
Warning Indicators	Problem with an in-gauge indicator	Table 23
	Problem with an indicator in the ICU	Table 22
	Problem with the seat belt lamp	Table 24
	Problem with the DEF indicator	Table 12
LCD Display	A segment of the LCD does not work	Table 20
	The LCD is completely inoperative	Table 20
Mode/Reset Button	The mode/reset button is sticking or does not change the display	Table 21

Table 1, ICU Instrumentation Troubleshooting – Start Here

Gauge Diagnosis

ICU Gauge Diagnosis – Start Here			
Test	**Test Procedure**	**Test Result**	**Action**
1	Turn the ignition on without starting the engine. All the gauges, except air pressure gauges, should sweep full scale and back in unison. Do the gauges sweep correctly when the ignition is turned on, and does the DEF indicator cycle?	Yes	Go to Test 3.
		No	Go to Test 2.
2	Is the ICU completely nonresponsive?	Yes	Test for battery power-on pin D14, ignition power-on pin D15, and the ground on pin D13. Troubleshoot and repair any fault with these circuits as necessary. If these circuits are all working, replace the ICU.
		No	Replace the ICU.

Troubleshooting

ICU Gauge Diagnosis – Start Here			
Test	**Test Procedure**	**Test Result**	**Action**
3	Use **Table 3** to determine the gauge input source. Use the troubleshooting action based on the gauge input.	Fuel Level	Go to **Table 8**.
		DEF Level	Go to **Table 12**.
		Air Pressure	Go to **Table 7**.
		Sensor Driven	Go to **Table 9**.
		Data Driven	Go to **Table 10**.

Table 2, ICU Gauge Diagnosis – Start Here

Table 3 defines where each gauge, standard or optional, receives its input signal. Some gauges are datalink-driven, meaning the information is sent to the instrument cluster from some other ECU. Other gauges are controlled by a sensor wired directly to the instrument cluster or an air line connected directly to the gauge.

Standard and Optional Gauges: Input Source to ICU		
Gauge	**EPA07 and Earlier Input**	**EPA10 J1939 Input**
Ammeter*	Not part of the ICU	Not part of the ICU
Application Air Pressure	Air line connected to gauge	Air line connected to gauge
DEF Level	N/A	J1939 from engine (SA 00 SPN 1761) or J1939 from aftertreatment control module (ACM) (SA 61 SPN 1761)
Engine Coolant Temperature	J1587—from engine (MID 128 PID 110)	J1939 from engine (SA 00 SPN 110)
Engine Oil Pressure	J1587—from engine (MID 128 PID 100)	J1939 from engine (SA 00 SPN 100)
Engine Oil Temperature	J1587—from engine (MID 128 PID 175)	J1939 from engine (SA 00 SPN 175)
Forward Rear-Axle Temperature	Sensor connected to ICU	Sensor connected to ICU
Fuel Level	Sensor connected to ICU	Sensor connected to ICU
Low DEF Indicator	N/A	J1939 from engine (SA 00 SPN 5245)
Primary Air System Pressure	Air line connected to gauge	Air line connected to gauge
Pyrometer	J1587—from engine (MID 128 PID 173)	J1939 from engine (SA 00 SPN 3241)
Rear Rear-Axle Temperature	Sensor connected to ICU	Sensor connected to ICU
Secondary Air System Pressure	Air line connected to gauge	Air line connected to gauge
Speedometer	J1587—from engine (MID 128 PID 84)	J1939 from engine (SA 00 SPN 84
Suspension Air Pressure	Air line connected to gauge	Air line connected to gauge
Tachometer	J1587—from engine (MID 128 PID 190)	J1939 from engine (SA 00 SPN 190)
Transmission Oil Temperature	Manual, Eaton, and AGS - sensor connected to ICU Allison, and G transmissions - Data from transmission ECU	Manual, Eaton, and AGS - sensor connected to ICU Allison, and G transmissions - Data from transmission ECU SPN 177

Standard and Optional Gauges: Input Source to ICU		
Gauge	**EPA07 and Earlier Input**	**EPA10 J1939 Input**
Turbo Boost Pressure	J1587datalink—from engine (MID 128 PID 439)	J1939 from engine (SA 00 SPN 102)

* Ammeter is a stand-alone gauge that is not connected to the ICU.

Table 3, Standard and Optional Gauges: Input Source to ICU

Satellite Gauge Diagnosis

The ICU is capable of controlling up to eight additional gauges located in the dash panels. These gauges are controlled by a databus with backlighting, power, and ground sourced by the ICU. See **Table 4**.

Satellite gauges that are sensor or data driven will initialize at power-on with the same sequence as the gauges in the main ICU3. The air pressure gauges only use the backlighting power from the ICU3. If there is a short circuit in any of the satellite gauges or the interconnecting wiring harness, it is possible that none of the gauges will work.

Satellite Gauge Daisy Chain Circuits		
Connector/Pin	**Name**	**Function**
C6	Gauge Power	12 volt source for satellite gauges
C7	Gauge Ground	Ground supply for satellite gauges
D6	Illumination	Backlighting voltage source for satellite gauges
D7	Gauge Data	Databus to satellite gauges

Table 4, Satellite Gauge Daisy Chain Circuits

Table 5 identifies the satellite gauges that may be used with the ICU.

ICU Satellite Gauges	
Gauge	**Input Source**
Engine Oil Temperature	Data from the engine controller
Turbo Boost Pressure	Data from the engine controller
Pyrometer	Data from the engine controller
Forward Rear-Axle Temperature	Sensor connected to ICU
Rear Rear-Axle Temperature	Sensor connected to ICU
Application Air Pressure	Air line connected to gauge
Suspension Air Pressure	Air line connected to gauge
Lift Axle Air Pressure (up to 4)	Air line connected to gauge

Table 5, ICU Satellite Gauges

Troubleshooting

Satellite Gauge Diagnosis			
Test	**Test Procedure**	**Test Result**	**Action**
1	Turn the ignition to ON without starting the engine. All the satellite gauges, except air pressure gauges should sweep full scale and back in unison. Do the electrical satellite gauges sweep correctly when the ignition is turned to ON?	Yes	Go to Test 3.
		No	Go to Test 2.
2	Are all the electrical satellite gauges nonresponsive?	Yes	Troubleshoot for a short in the satellite gauge wiring by testing for ignition voltage on pin C6 and ground on pin C7. Disconnect the satellite gauges one at a time to troubleshoot for a short in a gauge that could be taking the databus down. Repair any wiring fault or replace any defective gauge. If no problem was found, replace the ICU.
		No	Troubleshoot for a fault in the connection to the inoperative gauge and repair as appropriate. Otherwise, replace the inoperative gauge.
3	Use Table 5 to determine the gauge input source. Use the troubleshooting procedure based on the gauge input.	Air Pressure	Go to Table 7.
		Sensor Driven	Go to Table 9.
		Data Driven	Go to Table 10.

Table 6, Satellite Gauge Diagnosis

Air Pressure Gauge Diagnosis

Air Pressure Gauge Diagnosis			
Test	**Test Description**	**Test Result**	**Action**
1	Which air pressure gauge is not functioning correctly?	Primary or Secondary	Go to Test 2.
		Application	Go to Test 3.
		Suspension	Go to Test 4.
		Lift Axle Pressure	Go to Test 5.
2	Drain the air tanks. Connect an accurate pressure gauge to the primary or secondary air tank depending on which gauge has a problem. Start the engine and build air pressure until the compressor cuts out. Is the air pressure gauge in the cluster within 11 psi (76 kPa) of the test gauge?	Yes	Gauge is OK. No problem found.
		No	Check air line to gauge for kinks, pinches, or wire ties that are crushing the air line feed. If OK, replace the air pressure gauge module.

Air Pressure Gauge Diagnosis			
Test	**Test Description**	**Test Result**	**Action**
3	Connect an accurate pressure gauge to a delivery port on the foot valve. Make a 90 psi (621 kPa) brake application while observing the application air pressure gauge in the cluster and the test gauge. Is the air pressure gauge in the cluster within 11 psi (76 kPa) of the test gauge?	Yes	Gauge is OK. No problem found.
		No	Check air line to gauge for kinks, pinches, or wire ties that are crushing the air line feed. If OK, replace the air pressure gauge.
4	Connect an accurate pressure gauge to the air suspension. Is the air pressure gauge in the cluster within 11 psi (76 kPa) of the test gauge?	Yes	Gauge is OK. No problem found.
		No	Check air line to gauge for kinks, pinches, or wire ties that are crushing the air line feed. If OK, replace the air pressure gauge.
5	Raise the lift axle. Connect an accurate pressure gauge to the application side of the lift axle air system. Lower the axle and adjust the pressure. Is the axle pressure on the instrument panel gauge within 11 psi of the test gauge?	Yes	If the pressure cannot be controlled with the adjustment knob, check the reverse switch and pressure dump valve. Check the pressure adjustment regulator, replace if it is not controlling the pressure. Otherwise, there is no problem.
		No	Check air line to gauge for kinks, pinches, or wire ties that are crushing the air line feed. If OK, replace the air pressure gauge.

Table 7, Air Pressure Gauge Diagnosis

Fuel Level Gauge Diagnosis

The fuel level gauge is controlled by the ICU using a variable resistance input from the fuel level sending unit that is located in the fuel tank. The fuel level sending unit resistance increases from 31±2Ω with a full tank to 247±3Ω when empty.

If the ICU3 is measuring a resistance greater than 284Ω between circuit 47 and ground, the EPA10 cluster will set a fault for fuel level circuit open. If the ICU3 is measuring less than 23.5Ω between circuit 47 and ground, the EPA10 cluster will set a fault for fuel level circuit shorted low. ServiceLink may be used to monitor for these faults on EPA10 J1939 clusters. On all model years of clusters, the gauge will read empty until the measurement from the sensor is between 284Ω and 23.5Ω. Refer to **Table 8** for the fuel level diagnostic procedure.

NOTE: If the fuel level sensor is below the minimum resistance (short to ground) or above the maximum (open), the fuel gauge will read empty. Shorting the fuel sensor wires will not drive the gauge to full scale.

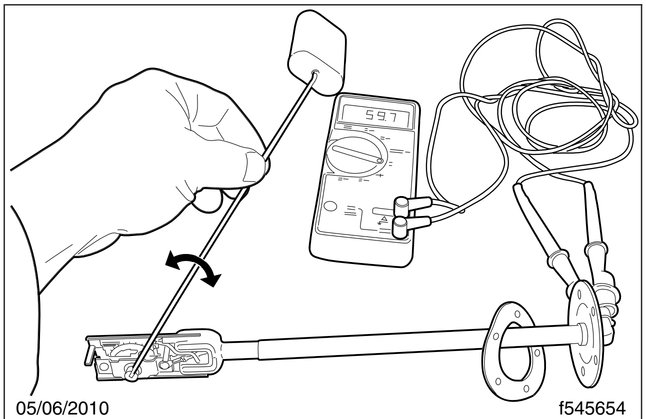
Clogged vents or fuel lines will cause a delay on fuel tank equalizing, resulting in inaccurate fuel gauge readings.

Changes with the fuel level will not be indicated by the fuel gauge for 60 seconds. The 60-second delay applies to activation and deactivation unless ignition power is cycled, then it will immediately indicate for the measured value.

Fuel Level Gauge Diagnosis			
Test	**Test Procedure**	**Test Result**	**Action**
1	If a 100 ohm resistor is available, disconnect the fuel level sender connector and place the resistor across circuit 47 and ground in the wiring harness connector to simulate the fuel level sending unit. Turn the ignition to the ON position and observe the fuel gauge. If, after gauge initialization, the gauge points closely to the 1/2 tank mark, then the wiring and ICU are all operating correctly. If there is no problem with the wiring and ICU, go to Test 4. Does the fuel level gauge stay at empty even though there is fuel in the tank or is the complaint an inaccurate and intermittent reading? Note - turn the ignition to OFF and disconnect the batteries before continuing.	Stays at Empty	Go to Test 2.
		Inaccurate or Intermittent	Go to Test 4.
2	Disconnect the connector at the fuel level sender and measure the resistance of the sender. What is the resistance of the sender?	Greater Than 246Ω or Less Than 30Ω	Go to Test 4.
		Between 246Ω and 30Ω	Go to Test 3.
3	Connect the fuel level sender and disconnect the connectors on the back of the ICU. Measure the resistance in the vehicle wiring between circuit 47 in connector pin D1 and the ground circuit in connector pin D2. What is the resistance of the circuit?	Greater than 246Ω	Troubleshoot and repair an open circuit on either circuit 47 or the ground between the ICU connector and the fuel level sender.
		Between 246Ω and 30Ω	This is the valid resistance range. If the fuel tank is full and the resistance is close to 31Ω, replace the ICU. Otherwise, verify mechanical integrity of the fuel sender. Go to Test 5.
		Less than 30Ω	Troubleshoot and repair a short to ground on circuit 47 between the ICU connector and the fuel level sender.
4	Remove the fuel level sending unit from the fuel tank. Connect an ohm meter to the pins at the fuel level sender connector. Slowly move the level of the float arm from full to empty. See Fig. 1. Does the resistance increase smoothly, without spikes, from 31±2Ω to 247±3Ω?	Yes	Troubleshoot and repair for corrosion or an intermittent connection in the circuitry between the ICU and the fuel level sender. Go to Test 5.
		No	Replace the fuel level sender.
5	Is the fuel tank rotated or the fuel sender float arm bent or interfering with the tank wall, return tubes or aux heater line? The fuel tank should be oriented such that the fuel sender is at the top.	Yes	Correct the condition causing incorrect fuel gauge readings.
		No	The fuel gauge is reading correctly.

Table 8, Fuel Level Gauge Diagnosis

Sensor-Driven Gauge Diagnosis



Slowly move the float arm from full to empty.

Fig. 1, Testing the Fuel Level Sending Unit

Sensor-Driven Gauge Diagnosis			
Test	**Test Procedure**	**Test Result**	**Action**
1	Does the gauge stay pegged at the full scale or the bottom of scale reading even though the temperature is at some mid-point or is the complaint an inaccurate reading? Note: Turn the ignition to OFF and disconnect the batteries before continuing.	Stays Pegged	Go to Test 2.
		Inaccurate	Go to Test 3.
2	Disconnect the connector at the sensor and measure the resistance of the sensor. Does the sensor measure open, shorted, or some mid-range resistance for that sensor, using the table in **Specifications 400**?	Open or Shorted	Replace the sensor.
		Mid-Range Resistance	Locate and repair the wiring fault for that sensor. Use the circuit and pin information tables in **Specifications 400** to identify the circuits to troubleshoot.
3	Remove the sensor and place it in a container of water with a thermometer and heat to a temperature where the resistance can be accurately measured with an ohm meter. Use the resistance table in **Specifications 400** for the sensor under test to determine if the measured resistance is appropriate for the temperature. Does the resistance value match the table value?	Yes	Measure the resistance of the wiring between the ICU and the sensor connector. Locate and repair a partially open or short circuit.
		No	Replace the sensor.

Table 9, Sensor-Driven Gauge Diagnosis

Data-Driven Gauge Diagnosis

Data-Driven Gauge Diagnosis			
Test	**Test Procedure**	**Test Result**	**Action**
1	If the problem is with the DEF level indicator, use the procedure in **Table 12**. Connect ServiceLink and open the datalink monitor template for the instrument cluster. Start the engine and let it run until the operating condition should register on the gauge. For example, oil temperature must be above the minimum position on the gauge. Is the display on the computer within 5% of the position of the gauge in the ICU?	Yes	Use the troubleshooting procedure for the sensor giving incorrect data. For example, use the engine manufacturer's troubleshooting procedure for sensors connected to the engine controller.
		No	Replace the ICU.

Table 10, Data-Driven Gauge Diagnosis

DEF Level Indicator Diagnosis

The DEF level indicator is integrated into the fuel gauge, and uses J1939 data from the ACM. The DEF level is measured by a sealed non-contact variable-resistance sensing assembly located in the DEF tank. The DEF level sensor resistance can be measured at the tank connector. For Detroit Diesel engines, the level sensor signal uses pins 1 and 2. For Cummins engines, the level sensor uses either pins 1 and 2 or 1 and 4 depending on the part. See **Table 13** to determine which pins to use. On Detroit Diesel engines, when the DEF tank is empty, the sensor will measure approximately 240Ω. When full, it will measure approximately 19.8KΩ. On Cummins engines, when the DEF tank is empty, the sensor will measure approximately 4.8KΩ. When full, it will measure approximately 68Ω, depending on the unit part number. Use the resistance to float height listed in **Table 13** to test the resistance for a specific float height. When there is no DEF in the tank or when there is a fault in the DEF level sensing circuit, the indicator will flash the red segment until the fault is corrected, or a sufficient amount of DEF is added to the tank. Perform the recommended action in **Table 11** to troubleshoot faults with the DEF level sensing circuitry indicated by fault codes with SPN 1761.

DEF Level Faults from SA 0 or SA 61				
SPN	**FMI**	**Description**	**Behavior**	**Action**
1761	1 17 18 31	DEF level low	The DEF level is low. MIL, CEL, STOP engine lamp, and engine derate may be active.	The DEF tank has run too low. Fill the DEF tank so that it is at least 25% full and idle the engine for 5 minutes. If the problem is still present use the DEF level diagnostic procedure in **Table 12**.
1761	3	DEF level circuit out of range high	The voltage on circuit 532F is greater than the ACM expects.	Troubleshoot circuits 532F and 532F- between the ACM and the temperature level sensor for a wiring fault and also for an open level sensor unit.
1761	4	DEF level circuit out of range low	The voltage on circuit 532F is close to 0 volts.	Troubleshoot circuit 532F between the ACM and the temperature level sensor for a wiring fault and also for a shorted level sensor unit.

Table 11, DEF Level Faults from SA 0 or SA 61

DEF Level Diagnostic Procedure			
Test	**Test Procedure**	**Test Result**	**Action**
1	Turn the ignition to ON but do not start the engine. Does the DEF level indicator illuminate all segments green, then turn them off beginning from the right, one at a time until the left one becomes amber then red, before either showing a mid-range level, or flashing the left segment red?	Yes	The DEF level indication display is working properly. Go to Test 2.
		No	Replace the ICU3.
2	Use Servicelink to check for any J1939 faults. Is there a fault for SPN 1761 with FMI 3 or 4 (DEF level sensor out of range) or are any J1939 communications fault codes active? NOTE: SPN 1761 FMI 1, 17, 18, or 31 indicate the DEF level is low. There is no wiring fault but there may be a problem with DEF level indication accuracy.	Yes	If the code is for a FMI 4, troubleshoot for a wiring fault in circuit 532F between the DEF level sensor and the ACM. If the code is FMI 3, go to Test 3. If there is a J1939 communications fault, use the troubleshooting information in this manual to locate and repair communications.
		No or Accuracy Problem	Go to Test 4.
3	Turn the ignition to OFF then disconnect the 4 wire connector at the DEF level sender. Use a short jumper wire to short pins 1 and 2 (for Detroit Diesel engine) or the pins indicated by part number in **Table 13** (for Cummins engine) together in the vehicle harness side of the connector. Turn the ignition on without starting the engine. Allow the indicator initialization sequence to complete, then check for fault codes. Is there an active fault for SPN 1761 FMI 4?	Yes	The wiring indicates continuity. Go to Test 4.
		No	Troubleshoot and repair for an open in circuit 532F and/or circuit 532F- between the DEF level sensor and the ACM.
4	Turn the ignition to OFF and disconnect the batteries. Remove the temperature/level sender unit from the DEF tank. Connect an ohm meter to pins 1 and 2 (for Detroit Diesel engine) or the pins indicated by part number in **Table 13** (for Cummins engine) at the 4 pin connector. Slowly raise the level of the float from empty to full. Record the resistance range measured. Does the vehicle have a Cummins or a DD engine?	Cummins	If the resistance did not vary as shown in **Table 13**, replace the temperature/level sender.
		Detroit Diesel	If the resistance did not vary from approximately 240Ω at empty to 19.68KΩ at the full position, replace the temperature/level sender unit.

Table 12, DEF Level Diagnostic Procedure

DEF Level Sensor Resistance Measurement				
Engine Type	**Detroit**	**Cummins**		
Part Number	04-27881-000 A04-27943-000 A04-27943-001 04-30774-000 04-30798-000	A04-27445-000	A04-27942-000	04-30774-001 04-30798-001

DEF Level Sensor Resistance Measurement				
Engine Type	**Detroit**	**Cummins**		
Test at Sensor Connector Pins NOTE: Pins are numbered left to right.	1 and 2	1 and 4	1 and 4	1 and 2
Resistance: Float at top of travel	19800Ω	68Ω	68Ω	68Ω
Resistance: Float at center of travel	2035Ω	730Ω	743Ω	742Ω
Resistance: Float at bottom of travel	240Ω	4812Ω	4809Ω	4732Ω

Table 13, DEF Level Sensor Resistance Measurement

Fault Code Diagnosis

The ICU3 will display fault codes that are broadcast from other devices on the databus. Follow the procedure in **Table 14** to determine if there is a problem with the ICU3, another device on the databus, a sensor that is connected to the ICU, or with the databus itself. Fault codes that are generated by the ICU3 can be read using ServiceLink.

Some circuitry faults within the ICU3 will cause the LCD to display "- - - - - - -" (seven dashes). Replace the ICU3 when this is displayed.

Roll call faults occur when the ICU3 is not receiving data from a device that had been on the databus in the past. If a device has been removed from an EPA10 vehicle (Qualcomm for example), perform the resetEE procedure from the ICU3 setup menu. See **Subject 410** for details of this procedure. Roll call fault messages are originated by the ICU3 for display only. They are not broadcast over the databus and cannot be read by ServiceLink or any other data analysis tool.

Fault codes originated by other devices are echoed on the display when the ignition is first turned to ON and the parking brake is set. **Table 17** and **Table 18** identify the most common ECUs that would broadcast these faults.

Fault Code Diagnosis			
Test	**Test Procedure**	**Test Result**	**Action**
1	Is the fault code from MID 140 on an EPA07 or earlier vehicle, or from SA 23 on an EPA10 vehicle, or some other fault?	MID 140	Use **Table 15** to identify the fault code and the troubleshooting procedure.
		SA 23	Use **Table 16** to identify the fault code and the troubleshooting procedure.
		Other	Go to Test 2.
2	Does the display only show seven dashes (- - - - - - -) or some other message?	Dashes	The ICU has an internal error. Replace the ICU.
		Other Message	Go to Test 3.
3	Is the message "nO dATA" or another message showing nO something?	Yes	If the message is "nO dATA" or "nO J1939", the ICU is unable to communicate with any other device on the vehicle. Troubleshoot the databus for loss of function. If the message is something with a 3-letter code, for example "no ENG" there is a roll call fault. A roll call fault will show SID 254 Fail 07 on J1587 systems and SPN 639 FMI 07 on J1939 vehicles. Use **Table 17** for EPA07 and earlier and **Table 18** for EPA10 vehicles to identify the device that is not communicating and causing a roll call fault.
		No	Go to Test 4.

Fault Code Diagnosis			
Test	**Test Procedure**	**Test Result**	**Action**
4	Is the vehicle an EPA07 or earlier, or an EPA10?	EPA07 or Earlier	Use **Table 17** to identify the device broadcasting the fault code. Refer to the troubleshooting subject for that device to determine how to proceed for the fault it is broadcasting.
		EPA10	Use **Table 18** to identify the device broadcasting the fault code. Refer to the troubleshooting subject for that device to determine how to proceed for the fault it is broadcasting.

Table 14, Fault Code Diagnosis

EPA07 ICU J1587/J1708 Fault Codes MID 140 (ICU)			
SID/PID	**FMI**	**Description**	**Behavior**
P168	1	Low System Voltage	The vehicle voltage measured by the ICU is less than 10.5 volts.
ACTION: Troubleshoot the vehicle charging system. Test the alternator, and test for voltage drop in the alternator cables and battery cables. If the vehicle is equipped with a remote sense circuit to the alternator, check the fuse for circuit 123E.			
S240	12	EEPROM Memory Fault	The ICU has an internal memory fault. The display may show "- - - - - - -", (seven dashes).
ACTION: Replace the ICU.			
S254	12	Internal Electronics Fault	The ICU microprocessor or other internal critical electronics has a fault. The display may show "- - - - - - -", (seven dashes).
ACTION: Replace the ICU.			

Table 15, EPA07 ICU J1587/J1708 Fault Codes MID 140 (ICU)

ICU3 J1939 Fault Codes SA 23 (ICU)				
SPN	**FMI**	**Conn/Pin**	**Description**	**Behavior**
96	5	D1 (+) D2 (–)	Fuel Level Circuit Open	The resistance between pins D1 and D2 is greater than 298 ohms. The gauge will point to empty.
ACTION: Use the troubleshooting procedure in **Table 8** beginning at Test 4.				
96	6	D1 (+) D2 (–)	Fuel Level Circuit Short	The resistance between pins D1 and D2 is less than 23.5 ohms. The gauge will point to empty.
ACTION: Disconnect the fuel level sensor connector at the sending unit. Turn the ignition to ON and check the fault code display. If the fault code for fuel level circuit short (FMI 6) is still active, locate and repair the short in circuit 47 between the LBCU and the fuel level sender. Otherwise use the troubleshooting procedure in **Table 8** beginning at Test 4.				
168	1	n/a	Low Voltage	The ICU is measuring a system voltage of less than 12.0 volts.
ACTION: Troubleshoot the charging system and test the battery cables for voltage drop.				
177	6	C12 (–) C13 (+)	Transmission Temp Sensor Short	The resistance between pins C12 and C13 is less than 70 ohms. The gauge will point full scale.
ACTION: Troubleshoot for a shorted transmission temperature sensor and for a short to ground in circuit 30.				
628	12	n/a	ICU Internal Memory Fault	The ICU has an internal memory fault. The display may show "- - - - - - -", (seven dashes).

Troubleshooting

ICU3 J1939 Fault Codes SA 23 (ICU)				
SPN	FMI	Conn/Pin	Description	Behavior
ACTION: Replace the ICU.				
629	12	n/a	ICU Internal Electronics Fault	The ICU microprocessor or other internal critical electronics has a fault. The display may show "- - - - - - -", (seven dashes).
ACTION: Replace the ICU.				
639	7	n/a	Roll Call Fault	Any other J1939 device that the ICU expects on the network but is not broadcasting will generate a fault code. The source address will be of the device that the ICU is not receiving messages from. Note that this is actually an ICU-generated fault code.
ACTION: If a device has been removed from the vehicle or if a used ICU is installed, a roll call reset must be performed. Use the "rESEt EE" Screen in the setup menu. If a J1939 device is not broadcasting due to an error, use the troubleshooting procedure for that device to determine the cause of it going off-line.				
2567	0	n/a	Excessive Broadcast Announce Messages (BAM)	Another device on the J1939 databus is transmitting an excessive number of fault messages that are intended for the ICU.
ACTION: Use ServiceLink or scroll through the fault codes that the ICU3 displays to determine which controller has many fault codes. Use the appropriate troubleshooting procedures for that controller to repair its system.				

Table 16, ICU3 J1939 Fault Codes SA 23 (ICU)

EPA07 and Earlier Displayed Fault Messages			
Message	System With Active Fault	Message	System With Active Fault
ECU 128	Engine Control Unit (engine control module)	rAd 221	Radio
tCU 130	Transmission Control Unit	tSU 223	Transmission Shift Unit
AbS 136	Antilock Brake System	CEL 231	Cellular Phone
SAT 181	Satellite Communications (Qualcomm)	SbU 232	Seat Belt Unit (SPACE/Airbag system)
CdU 219	Collision Detection Unit (VORAD)	SYS ###	Generic—system not defined in this table

Table 17, EPA07 and Earlier Displayed Fault Messages

EPA10 Displayed Fault Messages			
Message	System With Active Fault	Message	System With Active Fault
EnG 0	Engine Controller – CPC	EEC 61	Aftertreatment Control Module (ACM)
EnG 1	Engine Controller – MCM	CEL 74	Cellular Phone
tCU 3	Transmission Control Unit	SAt 75	Satellite Communications
tSU 5	Transmission Shift Unit	rAd 76	Radio
AbS 11	Antilock Brake Controller	SbU 83	Seat Belt Unit – Space

EPA10 Displayed Fault Messages			
Message	**System With Active Fault**	**Message**	**System With Active Fault**
CdU 42	Collision Detection Unit	SYS ###	Where ### is the source address of any other J1939 controller that is not in this list.

Table 18, EPA10 Displayed Fault Messages

Gauge Backlighting Diagnosis

Gauge Backlighting Diagnosis			
Test	**Test Description**	**Test Result**	**Action**
1	Is only the air pressure gauge module backlighting affected?	Yes	Go to Test 2.
		No	Go to Test 3.
2	Remove the three air gauge module screws and carefully lift the air gauge module off the back of the ICU while leaving the ribbon cable connected. Inspect the ribbon cable connection to the ICU PC board. Make sure that it is plugged in all the way. Is the ribbon cable connection OK?	Yes	Replace the air pressure gauge module.
		No	Repair the ribbon cable connection as necessary.
3	Turn the headlights on and press the dimmer switch to increase then decrease the backlighting. Is the backlighting inoperative for all of the HVAC, headlight switch, and ICU?	Yes	Use the troubleshooting procedures in **Section 54.30**.
		ICU only	Go to Test 4.
4	Access the back of the ICU and disconnect the two electrical connectors. Turn the headlights on. Measure voltage between pins A1(+) and D3(–) while increasing and decreasing the dimmer switch. The voltage should range between approximately 2.5V (dim) and 11.3V (full bright). Does the measured voltage change through this range?	Yes	Replace the ICU.
		No	Go to Test 4.
5	Measure voltage between pin A1(+) and a known good ground while increasing and decreasing the dimmer switch. The voltage should range between approximately 2.5V (dim) and 11.3V (full bright). Does the measured voltage change through this range?	Yes	Repair backlighting ground circuit to ICU pin D3 as necessary.
		No	Troubleshoot circuit 29A between BHM and ICU. Repair the wiring as appropriate.

Table 19, Gauge Backlighting Diagnosis

LCD Diagnosis

Troubleshooting

LCD Diagnosis			
Test	**Test Procedure**	**Test Result**	**Action**
1	Turn the headlights ON with the ignition in the OFF position. Does the LCD light up and display mileage?	Yes	Go to Test 2.
		No	Turn the ignition to ON without starting the engine. If the LCD initializes all segments, then use the troubleshooting procedure in **Section 54.12** to troubleshoot the ICU wakeup feature. Otherwise go to Test 2.
2	Turn the ignition to ON without starting the engine. Do all the segments of the LCD turn on and initialize or is the LCD completely inactive?	Only some segments initialize	Replace the ICU.
		LCD completely inactive	Test for battery power-on pin D14, ignition power-on pin D15, and the ground-on pin D13. Troubleshoot and repair any fault with these circuits as necessary. If these circuits are all working, replace the ICU.
		All segments initialize	There is no problem with the LCD or there is a more appropriate symptom to troubleshoot such as backlighting.

Table 20, LCD Diagnosis

Mode/Reset Button Diagnosis

Mode/Reset Button Diagnosis			
Test No.	**Test Description**	**Test Result**	**Action**
1	Press the Mode/Reset button several times to determine if it is sticking or binding. Does the button move freely?	Yes	Go to Test 2
		No	Remove the button cap and inspect for foreign substance in the shaft area. Clean as necessary. It may be necessary to remove the air gauge module from the ICU to clean the shaft and grommet.
2	Follow the procedure in **Subject 110** to remove the gauge module from the ICU. Note the ribbon cable connection when the gauge module is removed. Is the ribbon cable completely connected?	Yes	Replace the gauge module.
		No	Properly connect the ribbon cable and test the Mode/Reset button operation. Install the repaired ICU if it now works. Otherwise replace the gauge module.

Table 21, Mode/Reset Button Diagnosis

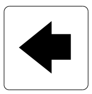
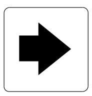
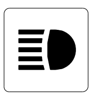
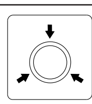
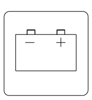
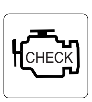
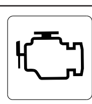
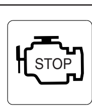
Warning and Indicator Lamps Diagnosis

Use **Table 22** to determine if an indicator lamp has a power-on bulb check and how it is activated.

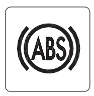
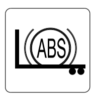
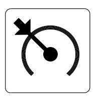
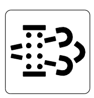
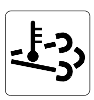
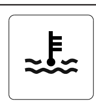
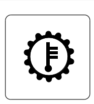
The ICU does not set fault codes for lamps that are inoperative. If an indicator does not illuminate, use the **Activation** and **Control Pin** information to determine if the problem is the signal that drives the lamp or if the lamp itself is inoperative.

For data-driven indicators, use ServiceLink to monitor the data for the indicator. If the ICU does not illuminate an indicator when ServiceLink shows that it is on, there is a problem with the indicator. The top row lamps are replaceable, for the others, the ICU must be replaced.

For indicators that are hardwired, monitor the voltage at the ICU input pin. Use the **Activation** column information to determine when the indicator should illuminate. Troubleshoot the vehicle wiring harness or switch as necessary. Indicators with a power-on bulb check (even though they are LEDs) are confirmed to work.

ICU Warning and Indicator Lamps					
Lamp	**Symbol**	**Bulb Check**	**Activation**	**Control Pin**	**Buzzer Operation**
Left Turn Signal		NO	Lamp is ON when 12V is applied to the control pin or lamp is ON when commanded over J1939 from the BHM.	C8	Beep sound when control pin is at 12V or commanded from the BHM
Right Turn Signal		NO	Lamp is ON when 12V is applied to the control pin or lamp is ON when commanded over J1939 from the BHM.	D8	Beep sound when control pin is at 12V or commanded from the BHM
High Beam		NO	Lamp is ON when 12V is applied to the control pin or lamp is ON when commanded over J1939 from the BHM.	A12	None
Park Brake		YES	Lamp is ON when commanded over J1939 from the ABS Controller or from the BHM.	Data	Buzzer active when vehicle speed is greater than 2 MPH (3 km/h) (Uses speed data from ABS)
Low Air Pressure		YES	Lamp is ON when commanded over J1939 from the BHM.	Data	Buzzer active whenever lamp is ON
Battery Voltage		YES	Lamp is ON when system voltage has been less than 12 volts for longer than 40 seconds. The message is broadcast by the engine controller.	Data	Buzzer active whenever lamp is ON
Fasten Seat Belt		YES	If pin D10 is not hardwired to seat belt buckle, lamp is ON for 15 seconds at power up only. If pin D10 is hardwired, the bulb check is 3 seconds long and the lamp is OFF when ground is applied to the control pin.	N/A or D10	Friendly chime for 10 seconds when pin D10 is hardwired if park brake is off and seat belt is not latched
Check Engine Lamp (CEL)		YES	Lamp is ON when ground is applied to the control pin or Lamp is ON/ FLASHING when commanded by the engine controller.	C15 and Data	None
Malfunction Indicator Lamp (MIL)		YES	Lamp is ON when ground is applied to the control pin.	A9	None
Stop Engine		YES	Lamp is ON when ground is applied to the control pin or Lamp is ON/ FLASHING when commanded by the engine controller.	C16 and Data	None

Troubleshooting

ICU Warning and Indicator Lamps					
Lamp	**Symbol**	**Bulb Check**	**Activation**	**Control Pin**	**Buzzer Operation**
Tractor ABS		YES	Lamp is ON when ground is applied to the control pin or Lamp is ON when commanded by the tractor ABS controller. The lamp will also be ON when the ICU is not receiving data from the ABS controller.	B11 and Data	None
Trailer ABS		YES	Lamp is ON when ground is applied to the control pin or Lamp is ON when commanded by the trailer ABS controller.	D12 and Data	None
Cruise Control		YES	Lamp is ON when the cruise enable switch is in the ON position.	B9	None
DPF Regeneration (REGEN)		YES	Lamp is ON when ground is applied to the control pin or Lamp is ON/ FLASHING when commanded by the engine controller.	C10 and Data	None
High Exhaust Temperature		YES	Lamp is ON when ground is applied to the control pin or Lamp is ON/ FLASHING when commanded by the engine controller.	A5 and Data	None
Water In Fuel (EPA10)		NO	Lamp is ON when ground is applied to the control pin or Lamp is ON when commanded by the engine controller.	C9 and Data	None
Low Oil Pressure		YES	Lamp is ON when commanded by the engine controller. The lamp will latch on for a minimum of 30 seconds.	Data	Buzzer is active when the lamp is ON
High Coolant Temperature		YES	Lamp is ON when commanded by the engine controller. The lamp will latch on for a minimum of 30 seconds.	Data	Buzzer is active when the lamp is ON
High Transmission Temperature		YES	Lamp is ON when ground is applied to the control pin or Lamp is ON/ FLASHING when commanded by the transmission controller or the retarder.	A4 and Data	None
Option 1 (Air Filter Restriction)	AIR FILTER	NO	Lamp is ON when ground is applied to the control pin or Lamp is ON when commanded by the BHM SA 33, SPN 5086.	C14 and Data	None
Option 2 (Washer Fluid Low)	WASH FLUID	NO	Lamp is ON when ground is applied to the control pin or Lamp is ON when commanded by the BHM SA 33, SPN 80.	A6 and Data	None

ICU Warning and Indicator Lamps					
Lamp	**Symbol**	**Bulb Check**	**Activation**	**Control Pin**	**Buzzer Operation**
Option 3 (EPA07 and earlier - Intake Heater EPA10 - Wait to Start)	INTAKE HEATER WAIT TO START	NO	Lamp is ON when ground is applied to the control pin or Lamp is ON when commanded by the engine controller SA 0, SPN 1081.	A7 and Data	None
Option 4 (EPA07 and Earlier - Water In Fuel)	WATER IN FUEL	NO	Lamp is ON when ground is applied to the control pin or Lamp is ON when commanded by the BHM SA 33 SPN 5086.	A8 and Data	None
Option 5 (Wheel Spin)	WHEEL SPIN	NO	Lamp is ON when ground is applied to the control pin or Lamp is ON when commanded by the BHM SA 33.	B1 and Data	None
Option 6 (Low Water)	LOW WATER	NO	Lamp is ON when ground is applied to the control pin or Lamp is ON when commanded by the engine controller SA 0.	B8 and Data	None
Option 7 (Check Transmission)	CHECK TRANS	YES	Lamp is ON when ground is applied to the control pin or Lamp is ON when commanded by the transmission controller	C11 and Data	None
Option 8 (Idle Management)	IDLE MGMT	NO	Lamp is ON when ground is applied to the control pin.	C1 and Data	None
Option 9	—	NO	—	D4 and Data	None

Table 22, ICU Warning and Indicator Lamps

In-gauge lamps illuminate during power-on initialization, and when the data to the gauge indicates a fault, or an out-of-normal-range condition. An illuminated in-gauge lamp indicates that immediate attention is necessary.

ICU In-Gauge Warning Lamps			
Lamp	**Bulb Check**	**Input Source**	**Activation**
Low Fuel Level	YES	Fuel Level Sensor	When the fuel level is less than 1/8th of a tank, the lamp will be ON. A 60-second delay applies to activation and deactivation unless ignition power is cycled and it will immediately indicate for the measured value.
Low DEF Level	YES	Data	When the DEF level is less than 15% of tank capacity, the low DEF light will be ON. When DEF level is less than 5% of tank capacity, the low DEF light will flash.

Table 23, ICU In-Gauge Warning Lamps

Troubleshooting

Seat Belt Lamp Troubleshooting			
Test	**Test Procedure**	**Test Result**	**Action**
1	Turn the ignition to OFF, then turn it to the ON position without starting the engine. Does the lamp always stay on, never illuminate, or only illuminate for 3 to 15 seconds at power-on?	Always ON	The ICU has learned that it is in a vehicle that has a seat belt buckle switch hardwired to ICU pin D10. Troubleshoot for an open seat belt buckle switch or open circuit between the seat belt buckle and the ICU. If the vehicle does not have a hardwired seat belt buckle switch, perform the ICU3 reset EE procedure as described in **Specifications 400**.
		Never ON	The lamp itself is open circuit, replace the ICU3.
		Only ON 3 to 15 seconds	A vehicle that does not have a hardwired seat belt buckle switch illuminates the lamp for 15 seconds at power-on. A vehicle that has a hardwired seat belt switch illuminates this lamp for 3 seconds at power-on and then will turn it off if the seat belt input is at ground (seat belt connected). There is no problem with the lamp circuit if it operates according to this description.

Table 24, Seat Belt Lamp Troubleshooting

Figure 1 is an overview schematic of the ICU3 as it is connected to the vehicle.

The two ICU3 main cab harness connectors are pink and plug into pins located in the center of the unit on the back. Connector-1 has 24 cavities numbered A1 through A12 and B1 through B12. See Table 1.

Connector-2 has 32 cavities, numbered C1 through C16, and D1 through D16. See Table 2.

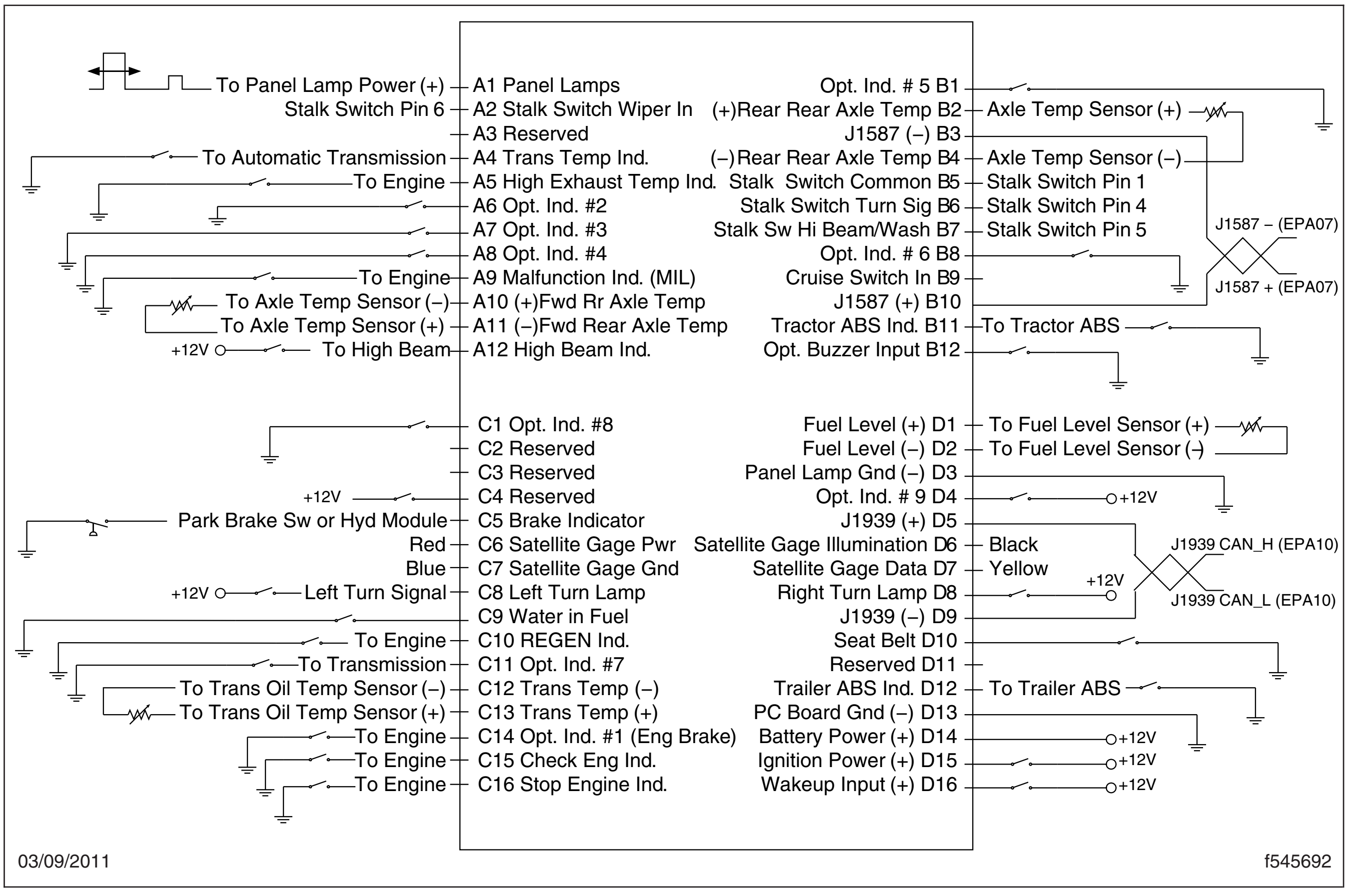


Fig. 1, ICU3 Overview Schematic

Specifications

ICU3 Connector-1 Pin Assignments, Pins A1 Through B12		
Pin	Description	Wire
A1	Panel Backlight Power (+)	29A
A2	Multifunction Turn Signal Switch Wiper Input	473C
A3	Reserved	18B
A4	Transmission High Temperature Indicator	30A
A5	High Exhaust Temperature Indicator	429L
A6	Optional Indicator 2	376T
A7	Preheater Relay 1 Coil Signal (optional indicator 3)	431B1
A8	Optional Indicator 4	—
A9	Malfunction Indicator Lamp (MIL)	400
A10	Fwd Rear-Axle Temperature (+)	42
A11	Fwd Rear-Axle Temperature (–)	42G
A12	High Beam Indicator	222A
B1	Wheel Spin Warning Lamp (optional indicator 5)	376S
B2	Rear Rear-Axle Temperature Sensor (–)	43
B3	J1708 Network (–)	—
B4	Rear Rear-Axle Temperature Sensor (+)	43G
B5	Multifunction Turn Signal Switch Common Input	473
B6	Multifunction Turn Signal Switch Turn Signal Input	473A
B7	Multifunction Turn Signal Switch High Beam/Washer Input	473B
B8	Optional Indicator 6	—
B9	Cruise Control Switch Input	440D
B10	J1708 Network (+)	—
B11	Tractor ABS Indicator	376L
B12	Optional Buzzer Input	29G

Table 1, ICU3 Connector-1 Pin Assignments, Pins A1 Through B12

ICU3 Connector-2 Pin Assignments, Pins C1 Through D16		
Pin	Description	Wire
C1	Optional Indicator 8	E115
C2	Reserved	—
C3	Reserved	—
C4	Reserved	—
C5	Park Brake Indicator	125S
C6	Satellite Gauge Drive Power	Red
C7	Satellite Gauge Drive Gnd	Blue

ICU3 Connector-2 Pin Assignments, Pins C1 Through D16		
Pin	Description	Wire
C8	Left Turn Indicator	38J
C9	Water In Fuel Indicator	286
C10	REGEN Indicator	492J
C11	Wheel Spin Warning Lamp (optional indicator 7)	376S
C12	Transmission Oil Temperature (–)	30G
C13	Transmission Oil Temperature (+)	30
C14	Optional Indicator 1	—
C15	Check Engine Warning Lamp	440A
C16	Stop Engine Warning Lamp	440S
D1	Fuel Level (+)	47
D2	Fuel Level (–)	47G
D3	Panel Backlight Ground (–)	GND
D4	Optional Indicator 9	—
D5	J1939 (+)	1939+
D6	Satellite Gauge Illumination	Black
D7	Satellite Gauge Data	Yellow
D8	Right Turn Indicator	38K
D9	J1939 (–)	1939–
D10	Optional Seat Belt (EPA10)	—
D11	Reserved	—
D12	Trailer ABS Warning Lamp	376F1
D13	ICU System Ground (–)	GND
D14	Battery Power (+)	437
D15	Ignition Power (+)	81C
D16	Headlamp Power (+)	81C

Table 2, ICU3 Connector-2 Pin Assignments, Pins C1 Through D16

Fuel Level Sensor Resistance		
Gauge Reading	Sensor Resistance in Ohms	
	Acceptable Range	Nominal
Empty Stop	244.0 to 249.0	246.5
Empty	232.0 to 239.2	235.6
1/8	190.8 to 196.9	193.8
1/4	149.6 to 154.5	152.1
3/8	126.1 to 129.0	127.5
1/2	102.5 to 103.5	103.0

Specifications

Fuel Level Sensor Resistance		
Gauge Reading	Sensor Resistance in Ohms	
	Acceptable Range	Nominal
5/8	84.4 to 85.7	85.0
3/4	66.2 to 67.8	67.0
7/8	47.8 to 49.2	48.5
Full	29.4 to 30.6	30.0

Table 3, Fuel Level Sensor Resistance

Transmission Oil Temperature Sensor Resistance			
Gauge Temperature in °F	Sensor Resistance in Ohms	Gauge Temperature in °C	Sensor Resistance in Ohms
125	3318	60	2490
163	1626	80	1255
200	837	100	680
238	460	120	390
275	267	140	234
313	162	160	145
350	102	180	95

Table 4, Transmission Oil Temperature Sensor Resistance

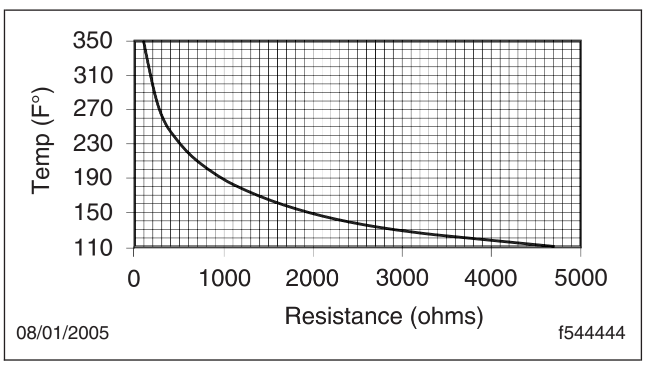


Fig. 2, Transmission Oil Temperature Sensor Resistance (°F)

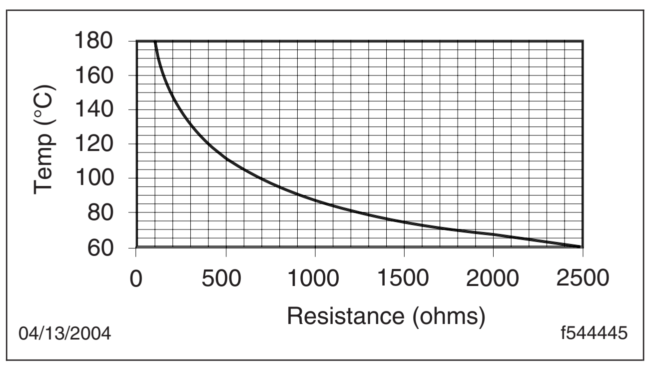


Fig. 3, Transmission Oil Temperature Sensor Resistance (°C)

Axle Oil Temperature Sensor Resistance, Standard Gauge	
Gauge Temperature	**Sensor Resistance (ohms)**
100°F	5933
125°F	3419
150°F	2079
175°F	1283
200°F	837
225°F	557
250°F	380
275°F	267
300°F	190

Table 5, Axle Oil Temperature Sensor Resistance, Standard Gauge

Axle Oil Temperature Sensor Resistance, Metric Gauge	
Gauge Temperature	**Sensor Resistance (ohms)**
30°C	8060
45°C	4465
60°C	2490
75°C	1503
90°C	915
105°C	595
120°C	390
135°C	267
150°C	185

Table 6, Axle Oil Temperature Sensor Resistance, Metric Gauge

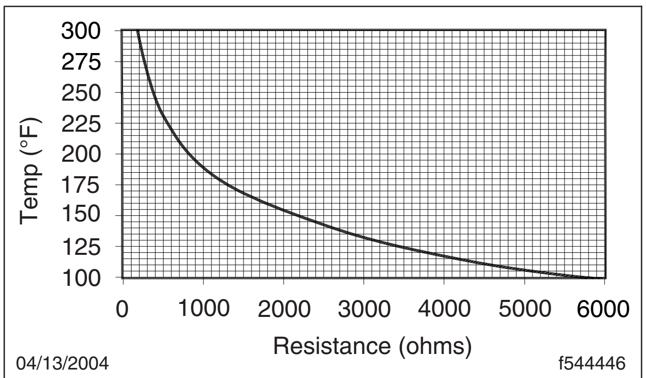


Fig. 4, Axle Oil Temperature Sensor Resistance (°F)

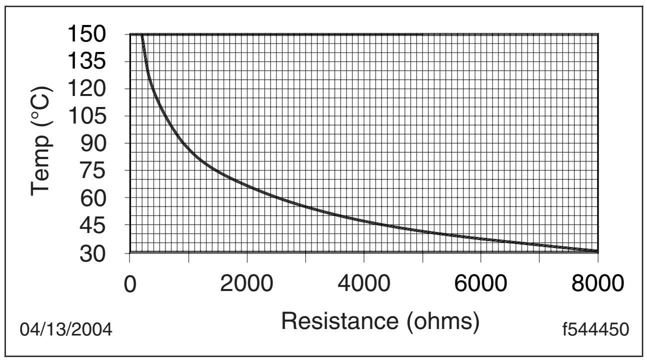


Fig. 5, Axle Oil Temperature Sensor Resistance (°C)

DEF Level Sensor Resistance Measurement				
Engine Type	**Detroit**	**Cummins**		
Part Number	04-27881-000 A04-27943-000 A04-27943-001 04-30774-000 04-30798-000	A04-27445-000	A04-27942-000	04-30774-001 04-30798-001
Test at Sensor Connector Pins NOTE: Pins are numbered left to right.	1 and 2	1 and 4	1 and 4	1 and 2
Resistance: Float at Top of Travel	19800Ω	68Ω	68Ω	68Ω
Resistance: Float at Center of Travel	2035Ω	730Ω	743Ω	742Ω

Specifications

DEF Level Sensor Resistance Measurement				
Engine Type	**Detroit**	**Cummins**		
Resistance: Float at Bottom of Travel	240Ω	4812Ω	4809Ω	4732Ω

Table 7, DEF Level Sensor Resistance Measurement

NOTE: **Fig. 6** and **Fig. 7** are for reference only and are not exact measurements.

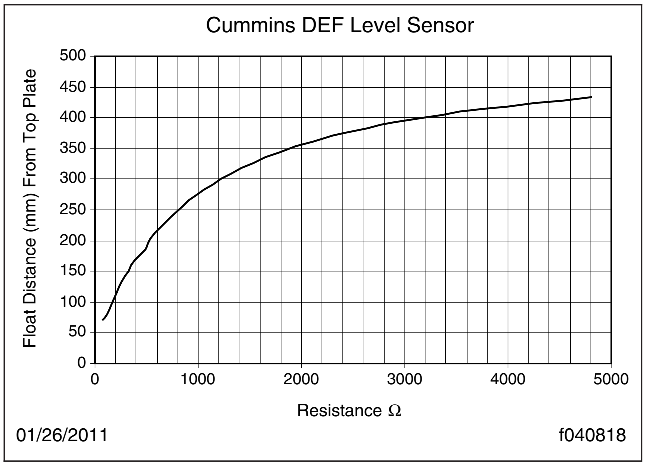


Fig. 6, Cummins DEF Level Sensor Resistance

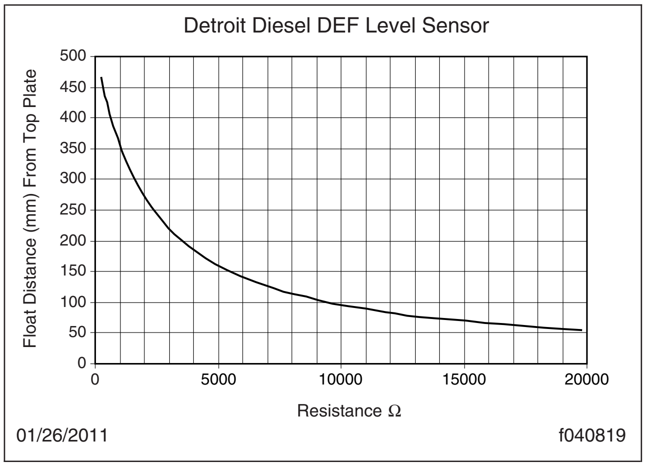


Fig. 7, DDC DEF Level Sensor Resistance

rESEt EE Procedure

To reset the EE memory in the ICU3, perform the following procedure. This will reset the memory to "forget" all the devices that have been learned.

1. Press the mode/reset button until the display shows SEt UP.
2. Hold the button until the display makes a beep and the word service appears. Depending on the options programmed, some other word may also appear.
3. Hold the button until the display shows rESEt.
4. Press the button once quickly so that EE is also displayed. This is the rESEt EE screen.
5. Hold the button until donE is displayed.

Mode/Reset Switch Functions

Use the following flow charts to cycle through the Mode/Reset switch functions and screens.

See **Fig. 1**, **Fig. 2**, **Fig. 3**, **Fig. 4**, **Fig. 5**, **Fig. 6**, and **Fig. 7**.

Mode/Reset Switch Functions

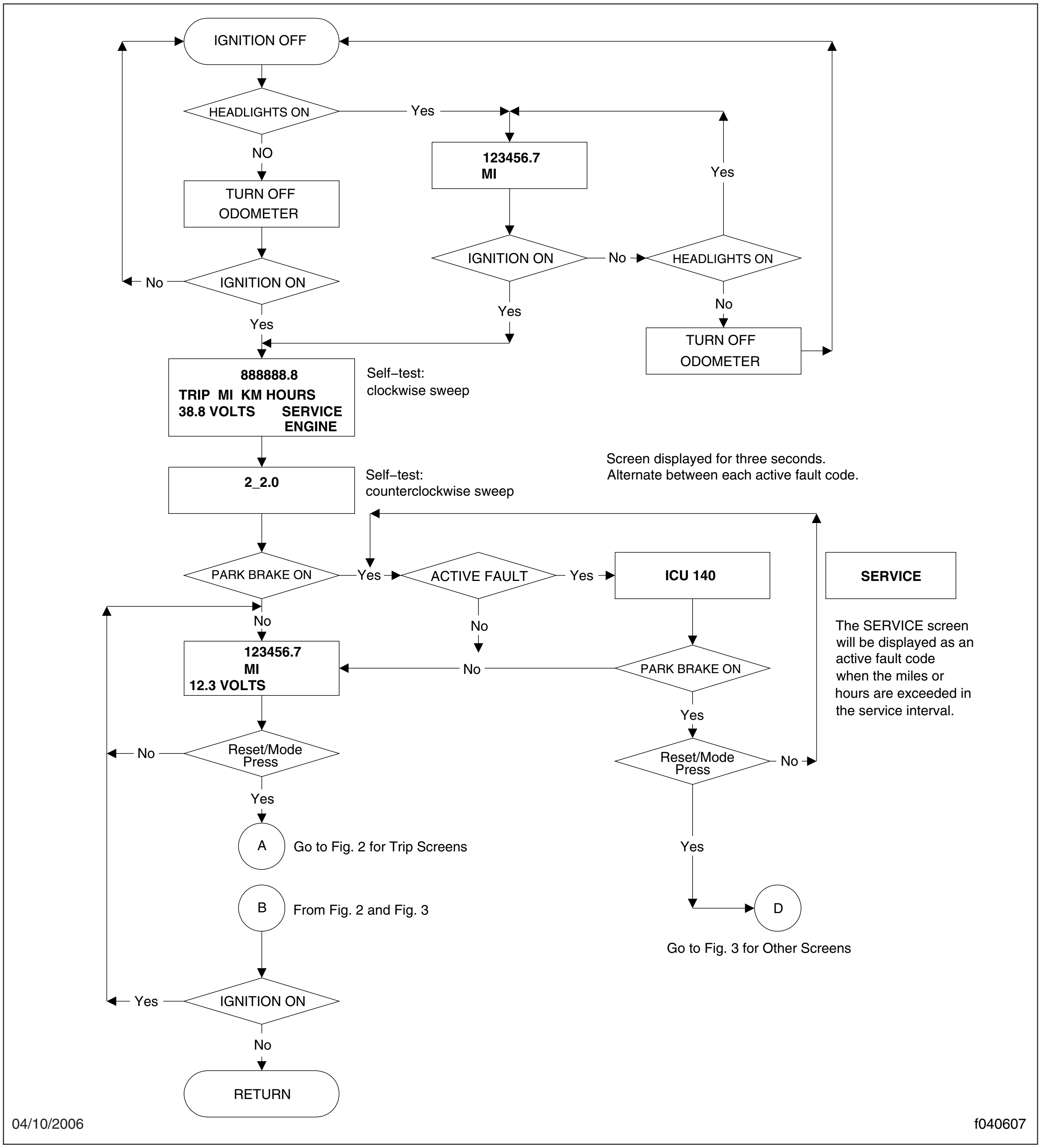


Fig. 1, Mode/Reset Switch Start Sequence

Mode/Reset Switch Functions

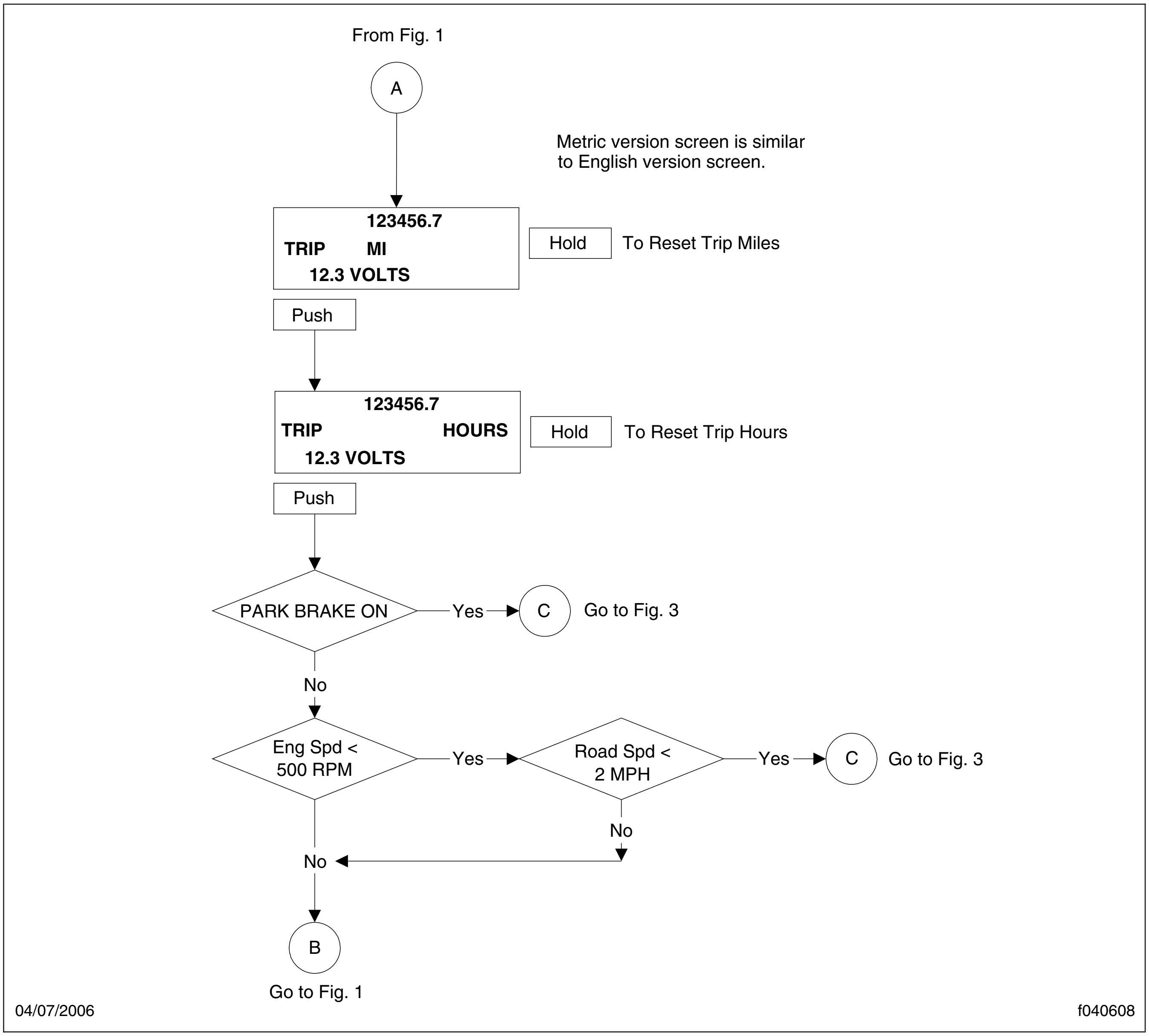


Fig. 2, Mode/Reset Switch Trip Screens

Mode/Reset Switch Functions

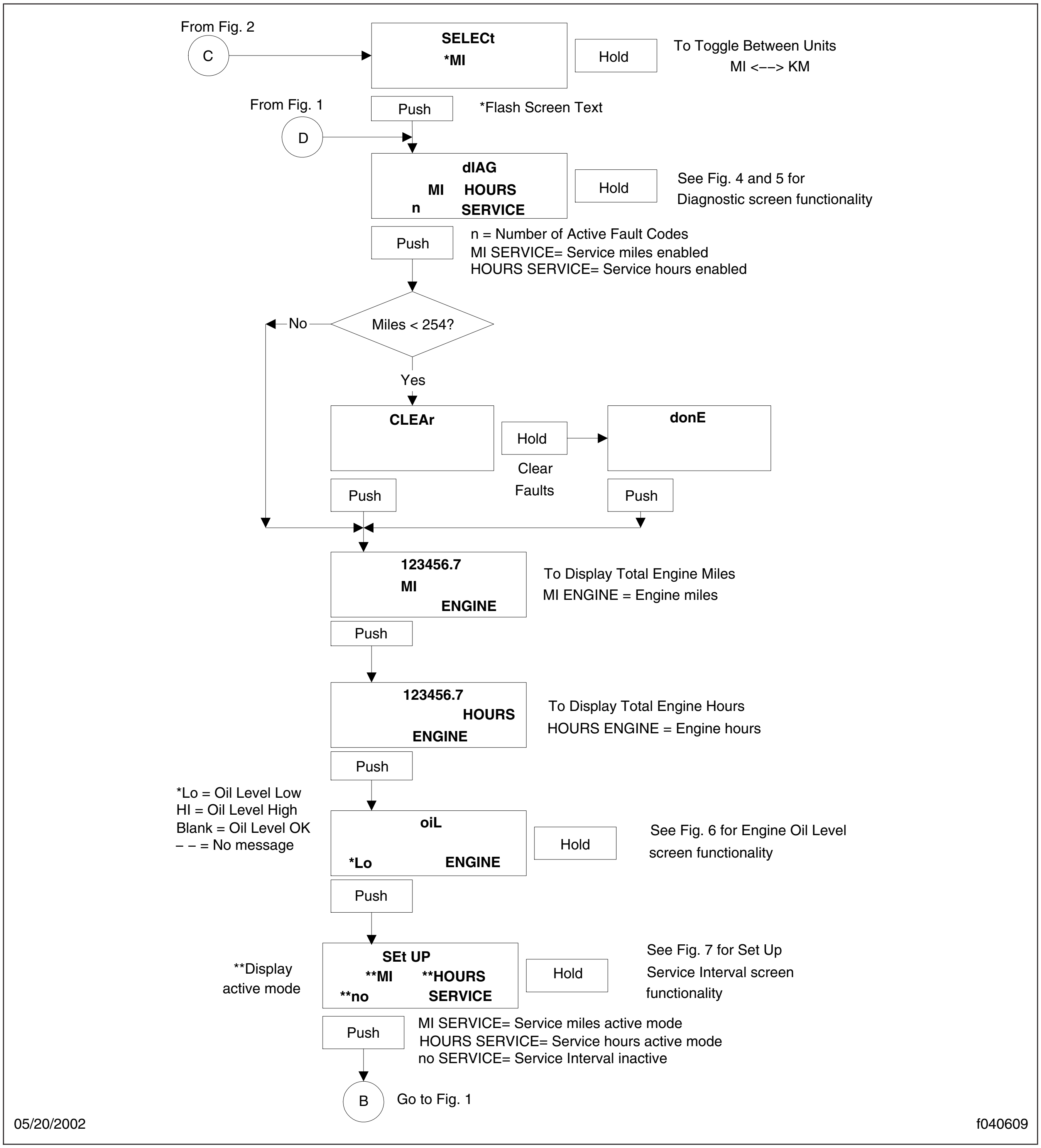


Fig. 3, Mode/Reset Switch Engine Miles and Service Screens

Mode/Reset Switch Functions

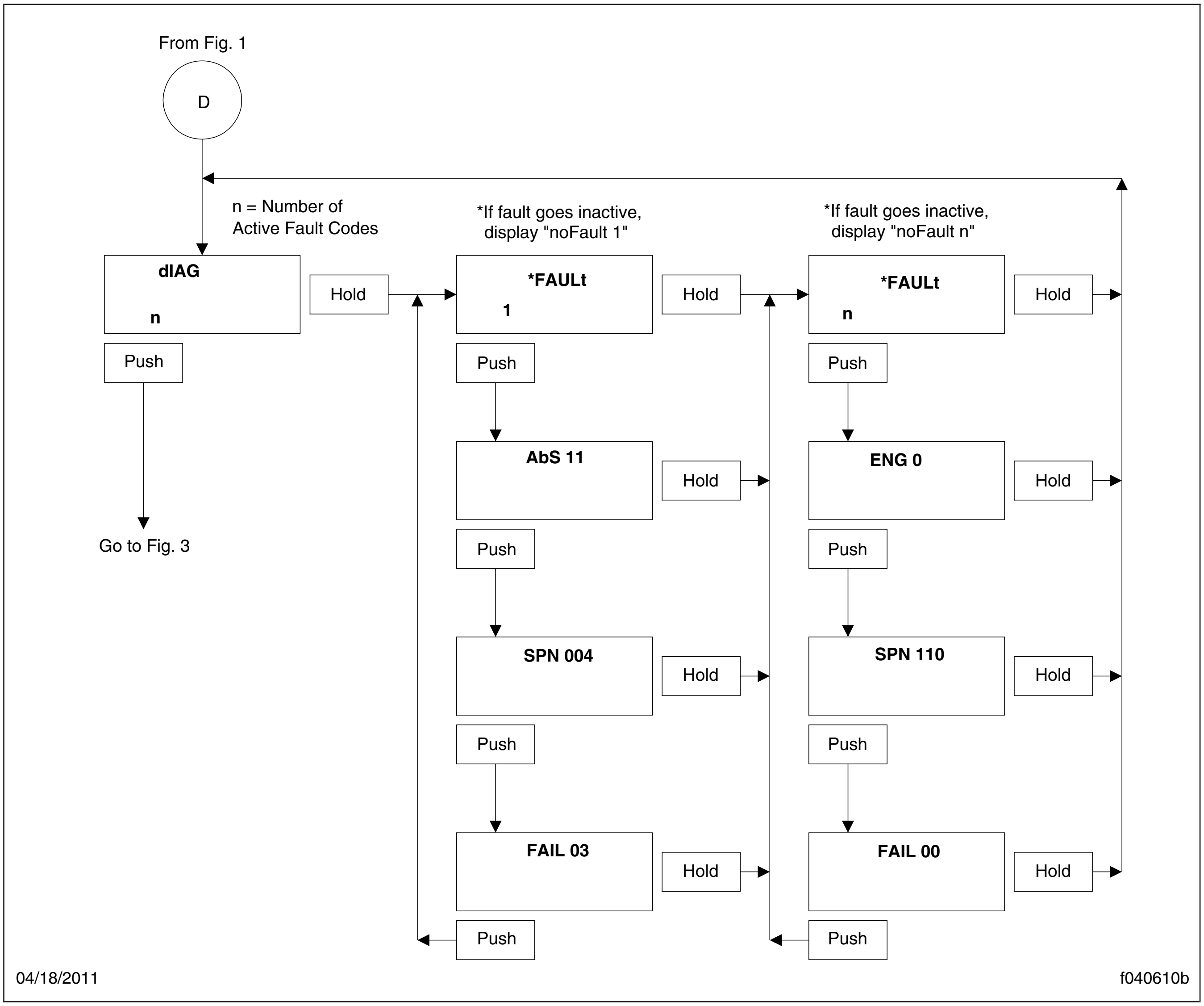


Fig. 4, Mode/Reset Switch Fault Screens

Mode/Reset Switch Functions

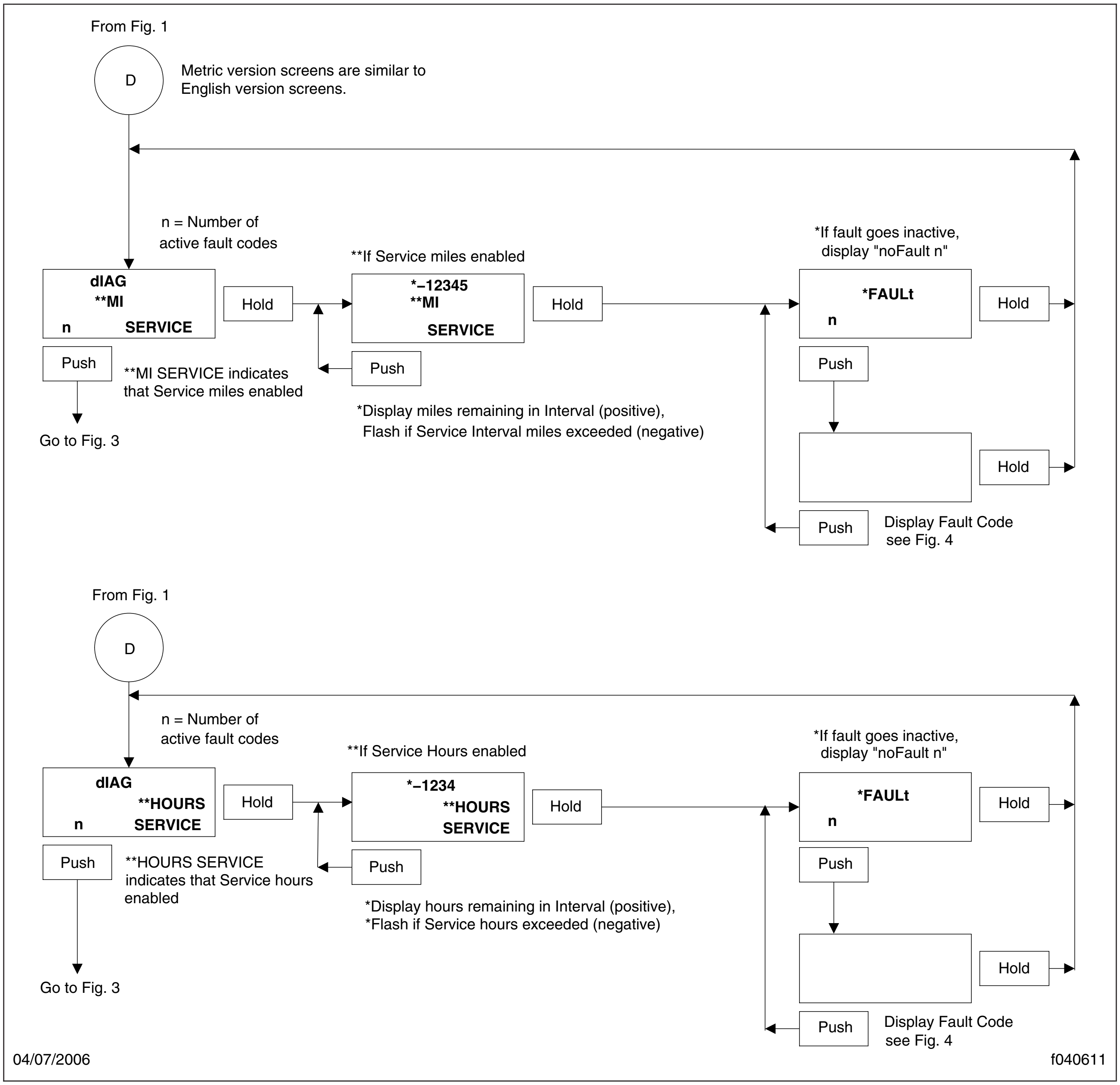


Fig. 5, Mode/Reset Switch Service Screens

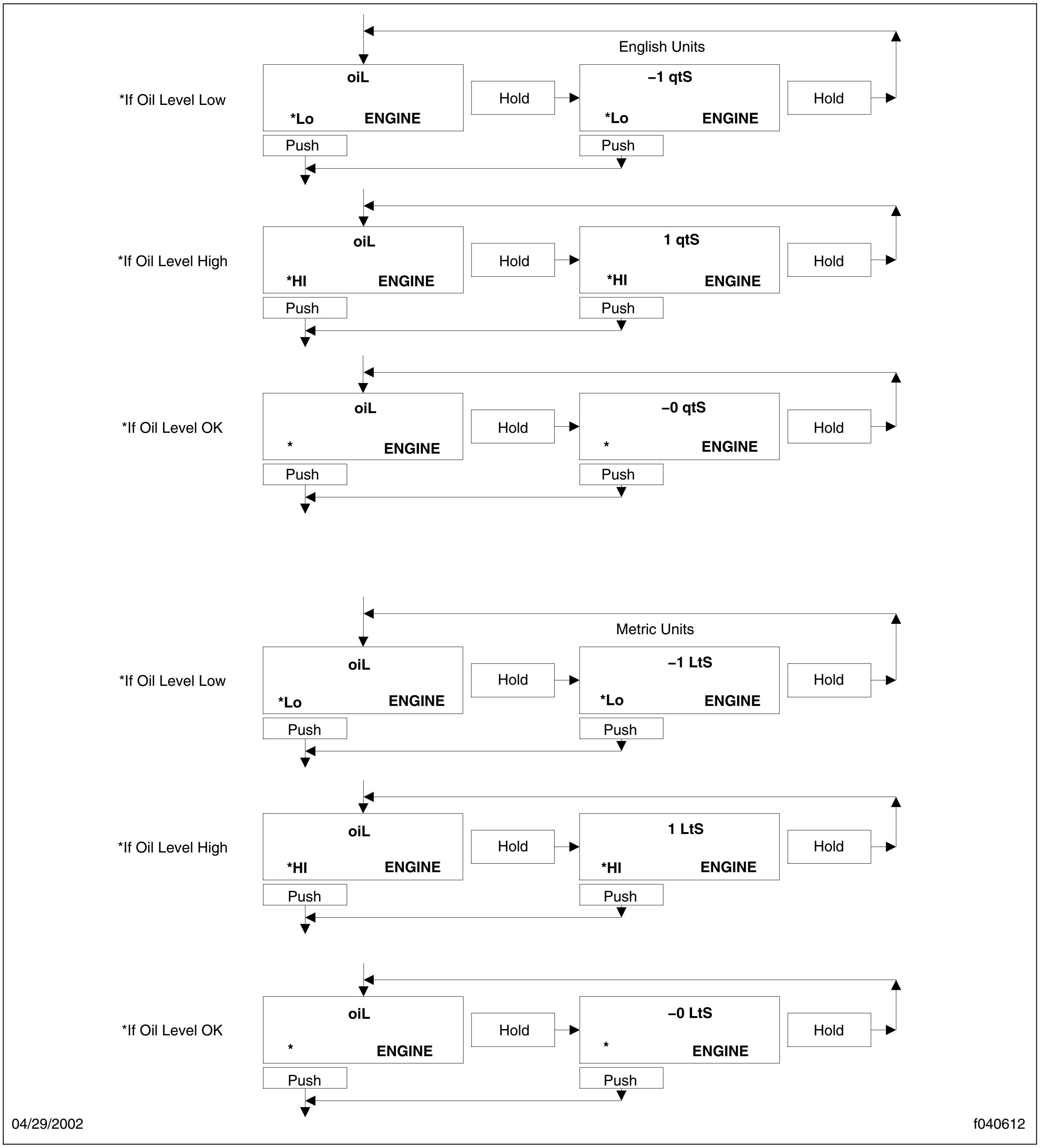


Fig. 6, Mode/Reset Switch Oil Level Screens

Mode/Reset Switch Functions

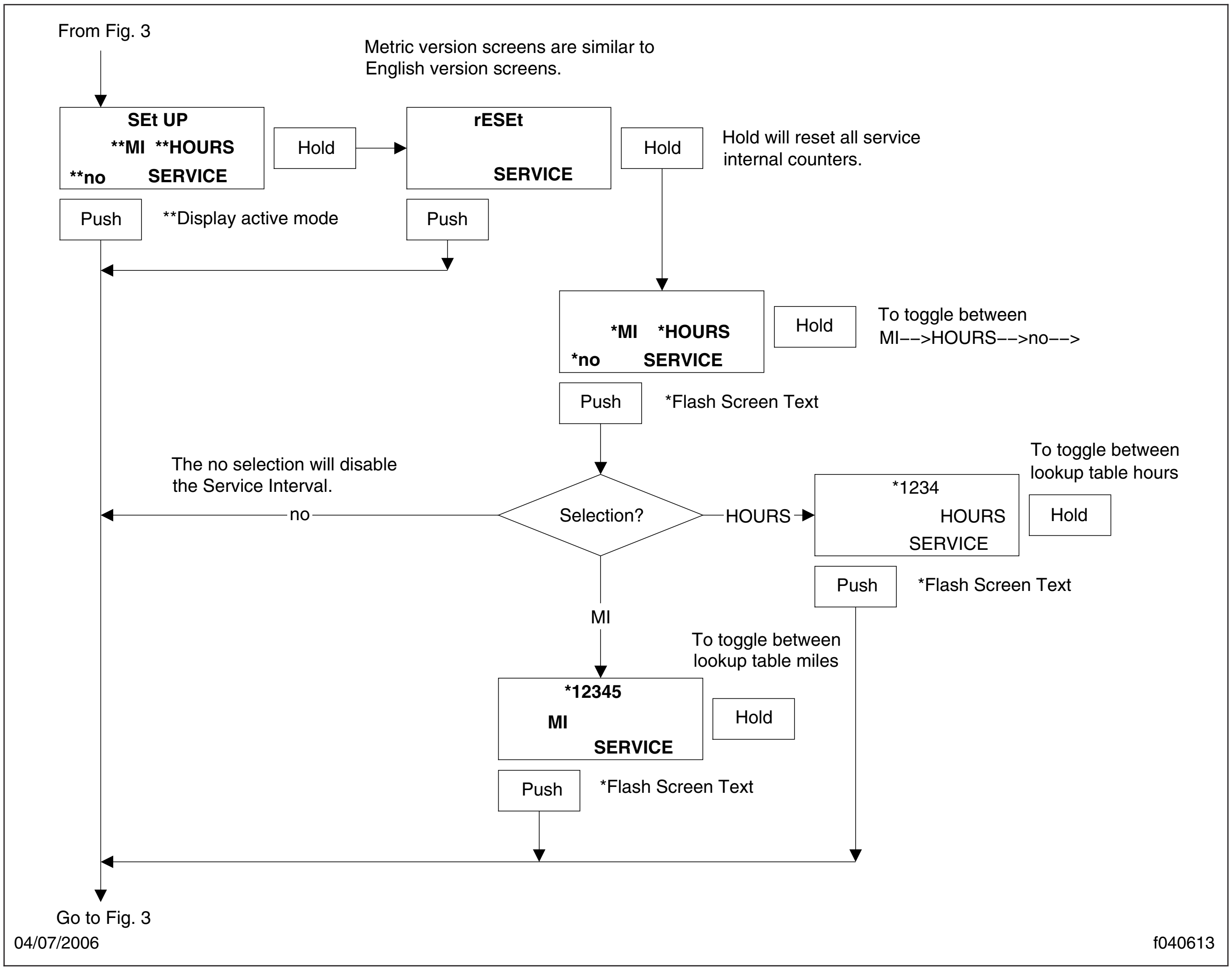


Fig. 7, Mode/Reset Switch Reset and Toggle Screens

Contents

General Information

The Bulkhead Module (BHM) is the primary module of the M2 electrical system. The BHM controls the operation of the other multiplex modules in the system along with a variety of other vehicle components either directly or indirectly.

The Bulkhead Module is mounted on the cab side of the frontwall and extends through an opening in the frontwall into the engine side of the frontwall. The BHM is located slightly below and outboard of the steering column.

The BHM has four harness connections on the engine side of the frontwall and three harness connections on the cab side. Connections on the engine side include:

- forward chassis harness
- engine harness
- two frontwall harnesses

Connections on the cab side include up to three dash harness connectors.

For more information about the M2 electrical system, see **Section 54.00** "Electrical System."

Awake State and Sleep State

The Bulkhead Module, Chassis Module (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.

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

Bulkhead Module Replacement

Replacement

IMPORTANT: It is normally not necessary to replace the Bulkhead Module (BHM). Removing and installing the BHM should be a last resort to solving electrical problems, unless the unit needs replacing due to physical damage.

Follow troubleshooting procedures in this section to solve electrical problems before replacing the Bulkhead Module. If troubleshooting indicates a malfunction of the module, try flashing the parameters and the software before replacing the module. For flashing instructions, see **Subject 110**.

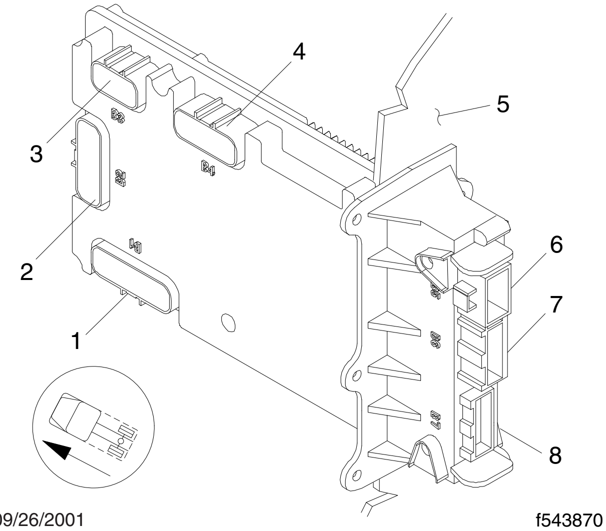
Also check the external wiring. See **Troubleshooting 300**.

See **Section 54.00, Subject 050**, for information about the M2 electrical system and **Section 54.00, Troubleshooting 300**, for information on troubleshooting the entire M2 electrical system.

1. Open the hood.
2. Disconnect the negative leads from the batteries.

NOTE: The bulkhead module is located on the frontwall slightly below and outboard of the steering column. See **Fig. 1**.

3. Disconnect bulkhead harnesses B1 through B4 from the engine side of the frontwall. See **Fig. 2**.
4. Disconnect bulkhead harnesses B5 through B7 from the bulkhead module on the cab side of the frontwall. See **Fig. 3**.
5. Remove the tread plate from the driver door entry.
6. Remove the kick panel from the left side of the driver footwell.
7. Remove the five Torx® capscrews that secure the BHM to the cab side of the frontwall, then remove the BHM by pulling it through the opening into the cab.
8. Place the BHM through the frontwall opening from the cab side, then secure it with five Torx capscrews and torque them 48 lbf·in (540 N·cm).
9. Install the kickpanel in the left side of the driver footwell and secure it with Torx capscrews.

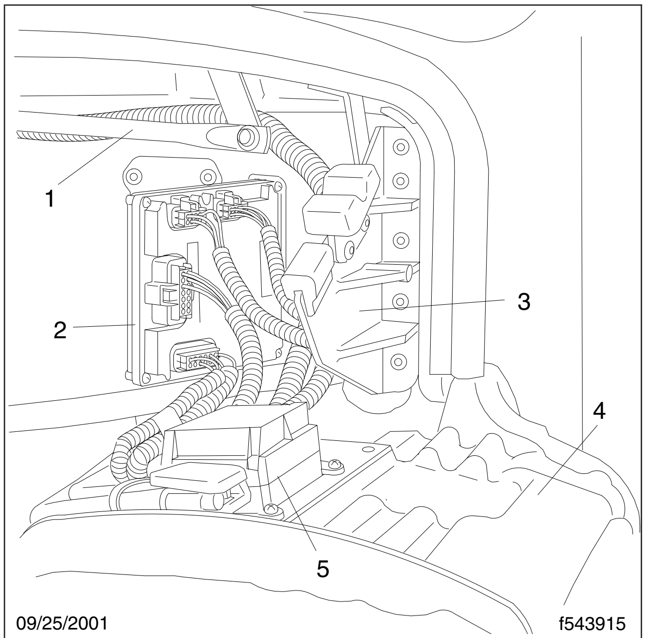


1. B1, Forward Chassis Harness
2. B2, Engine Harness
3. B3, Frontwall Harness
4. B4, Frontwall Harness
5. Frontwall
6. B5, Dash Harness
7. B6, Dash Harness
8. B7, Dash Harness

Fig. 1, Bulkhead Module Harness Connections

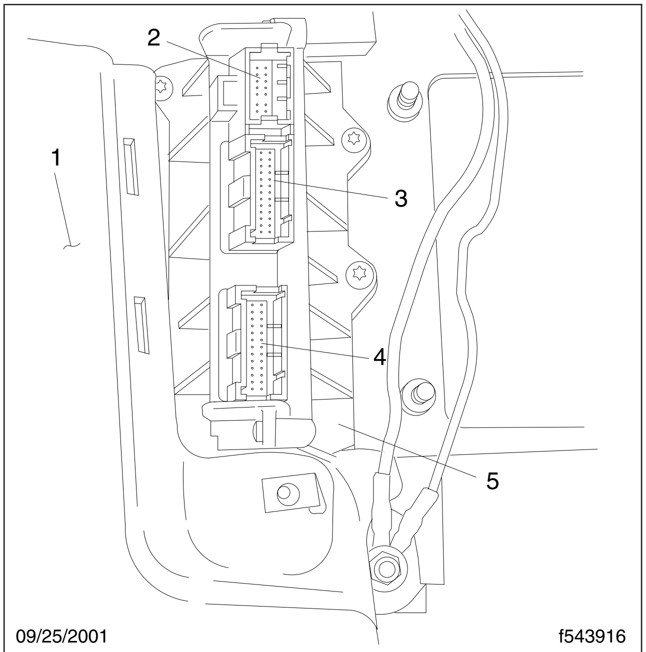
10. Install the tread plate at the driver door entry.
11. Connect the bulkhead harnesses B5 through B7 to the BHM on the cab side of the frontwall.
12. Connect the bulkhead harnesses B1 through B4 to the BHM on the engine side of the frontwall.
13. Connect the batteries.
14. Close the hood.
15. For instructions on flashing the BHM, see **Subject 110**.

Bulkhead Module Replacement



1. Wiper Linkage Arm
2. Bulkhead Module
3. Hood Support Bracket
4. Quarter Fender
5. Power Distribution Module

Fig. 2, Bulkhead Module from the Engine Side



1. Driver Footwell Kick Panel
2. B5, Dash Harness
3. B6, Dash Harness
4. B7, Dash Harness
5. Bulkhead Module

Fig. 3, Bulkhead Module from the Cab Side

Flashing the Bulkhead Module

When the Bulkhead (BHM) is flashed, both the application software and reference parameters are flashed to the BHM.

Flashing is done in ServiceLink® in the BHM "Flashing" screen. See the *ServiceLink User Guide* for more information on flashing.

Normally, it is only necessary to flash the BHM in one of the following situations:

- When, as a last resort in the troubleshooting process, the BHM is suspected of being faulty. This is to confirm that the problem is hardware related.
- When a replacement BHM is installed on a vehicle that originally had software version 6.1.

In all other situations, it is only necessary to perform the "Refresh Features List" in ServiceLink in the "Features" screen. This applies the appropriate reference parameters to the BHM specific to the vehicle. See the *ServiceLink User Guide* for more information on refreshing the features list.

NOTE: Pay particular attention to the first "NOTICES" screen when you open ServiceLink. This screen will contain timely details on matters pertaining to successfully flashing and applying reference parameters to the BHM.

IMPORTANT: The following is a general description of how the M2 electrical system works. ServiceLink® is the diagnostic tool for troubleshooting the M2 electrical system. For specific circuit and pin information for how the vehicle is wired, go to the Configuration screen in ServiceLink and select the specific function in which you are interested. To troubleshoot specific inputs and outputs of this system, go to the Templates screen in ServiceLink and select the template for the function in which you are interested.

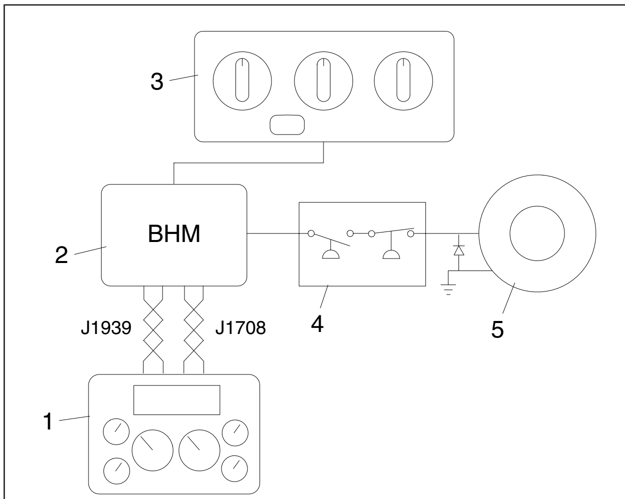
Contents of Subject 300

A/C Clutch Function

Description

The HVAC control panel does not directly control the clutch on the A/C compressor. When the driver selects the A/C button and other control conditions are met, the control panel sends an A/C clutch request signal to the Bulkhead Module (BHM). See **Group 83** for more information. Upon receiving this input, the BHM responds by activating the A/C compressor clutch. See **Fig. 1**.

Compressor cycling is handled in the same manner. When the control panel determines that the compressor needs to be cycled, it sends a signal to the BHM. The BHM reacts by cycling the compressor. The HVAC control panel contains the logic to prevent the compressor from cycling more than four times per minute.



1. Instrumentation Control Unit
2. Bulkhead Module
3. HVAC Control Panel
4. Binary Pressure Switch
5. A/C Compressor Clutch

Fig. 1, A/C Clutch Function

The BHM monitors the A/C compressor clutch wiring and is capable of detecting a shorted circuit when the A/C clutch is being driven. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink.

Input and Output Conditions

Table 5 displays the A/C clutch system inputs to the BHM and how it will react to these inputs.

Fault Conditions

Table 6 displays how the BHM handles faults that it encounters in the A/C clutch system. The reference parameters that program the BHM determine whether or not a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted. If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on either or both the J1939 and J1708 datalinks until the ignition switch is off.

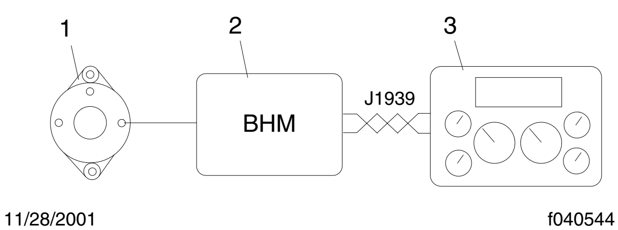
Troubleshooting

Alternator Charging Function (optional)

Description

NOTE: Some vehicles will have the alternator "I" terminal hardwired directly to the NO CHARGE light on the ICU.

The NO CHARGE light on the Instrumentation Control Unit (ICU) is an optional indicator used to alert the operator to the presence of a problem with the alternator. The Bulkhead Module (BHM) monitors a voltage input from the "I" terminal on the alternator and sends a J1939 message to the ICU to report the status of the alternator. This message is used by the ICU to turn the NO CHARGE light on or off. The NO CHARGE light illuminates when the BHM does not detect voltage at the "I" terminal of the alternator. Once illuminated, the NO CHARGE light remains on until the BHM detects 14 volts at the alternator "I" terminal. Once off, the NO CHARGE light remains off until the BHM detects 0 volts at the alternator "I" terminal. See **Fig. 2**.



1. Alternator
2. Bulkhead Module
3. Instrumentation Control Unit

Fig. 2, Alternator Charging Function

Input and Output Conditions

Table 7 displays the charging system inputs to the BHM and how it will react to these inputs.

Backup Function

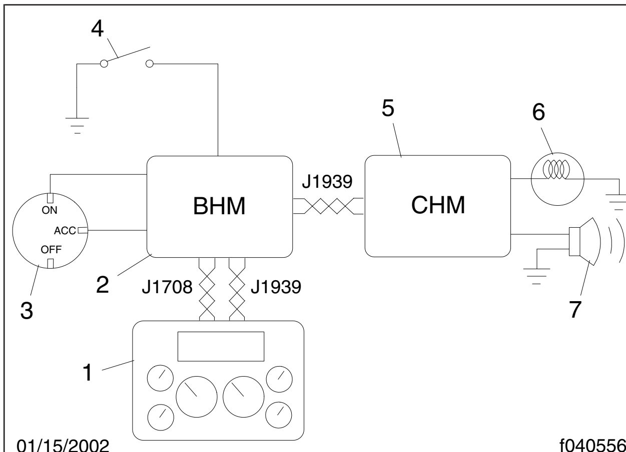
Description

The backup function provides a warning to anyone standing behind when the vehicle begins to back up. When the transmission is placed into reverse gear, the Bulkhead Module (BHM) sends a J1939 message to the Chassis Module (CHM) activating the backup lights and alarm.

The BHM is capable of detecting short circuits in the backup lights/alarm wiring on the CHM. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink.

Input and Output Conditions

Activation of the backup lights/alarm is different depending on the transmission type. A manual transmission uses a standard switch to tell the BHM when the transmission is in reverse. Automatic transmissions send a J1939 message to the BHM when they are placed into reverse gear. See **Fig. 3** and **Fig. 4**. Also see **Table 8**.



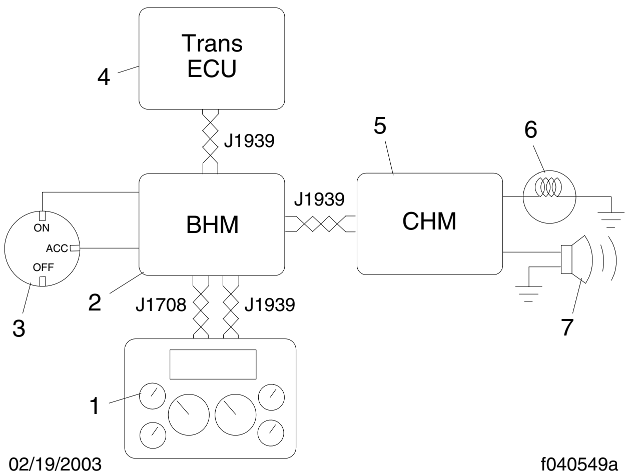
1. Instrumentation Control Unit
2. Bulkhead Module
3. Ignition Switch
4. Reverse Switch
5. Chassis Module
6. Backup Lights
7. Optional Backup Alarm

Fig. 3, Backup Function, Manual Transmission

Table 9 displays the backup lights and alarm system inputs to the BHM and how it will react to these inputs.

Fault Conditions

Table 10 displays how the BHM handles faults it encounters in the backup lights and alarm system. The reference parameters that program the BHM determine whether or not a fault code is broadcast. There-



1. Instrumentation Control Unit
2. Bulkhead Module
3. Ignition Switch
4. Transmission ECU
5. Chassis Module
6. Backup Lights
7. Optional Backup Alarm

Fig. 4, Backup Function, Automatic Transmission

fore, even if the BHM detects a fault, a fault code may not be transmitted. If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on either or both the J1939 and J1708 datalinks until the ignition switch is turned off.

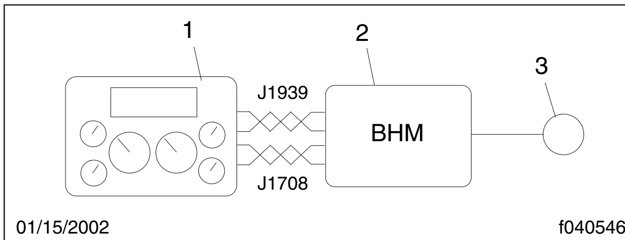
On vehicles with automatic transmissions, the BHM has the following **additional** J1939 fault messages. Any J1939 fault message may be transmitted until the ignition switch is turned off. See **Table 11**.

Cigar Lighter Function

Description

The cigar lighter provides 12 volt power (up to 15 amps) to any device plugged into it. The Bulkhead Module (BHM) supplies power at this port regardless of the position of the ignition switch.

The BHM is capable of detecting short circuits in the cigar lighter wiring. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink. See **Fig. 5**.



1. Instrumentation Control Unit
2. Bulkhead Module
3. Cigar Lighter

Fig. 5, Cigar Lighter Function

Fault Conditions

Table 12 displays how the BHM handles faults that it encounters in the cigar lighter system. The reference parameters that program the BHM determine whether or not a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted. If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on either or both the J1939 and J1708 datalinks until the ignition switch is turned off.

Clutch Switch Function

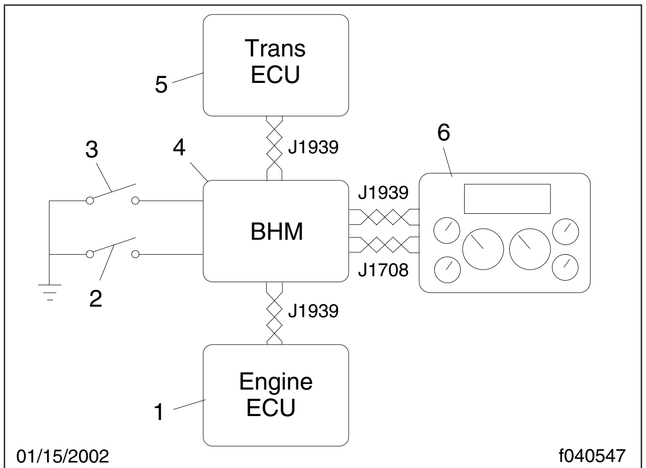
Description

NOTE: Only vehicles with a manual or three-pedal automated mechanical (AMT) transmission are equipped with a clutch pedal. The clutch switch is integrated into the clutch pedal assembly. See **Section 54.25** for information on the starter control system including the bottom-of-clutch switch input.

The Bulkhead Module (BHM) reads the position of the top-of-clutch and bottom-of-clutch switches. The top-of-clutch switch information is broadcast over J1939 datalink for use by the engine and, optionally, other ECUs. The bottom-of-clutch switch input is used for a starter system interlock; the switch position information is not broadcast for other ECUs. The BHM, engine ECU, and transmission ECU use the clutch position status information as inputs for systems such as starting and cruise control.

While both switches are mounted to the clutch pedal assembly, they are activated at different times during the operation of the clutch. As the clutch pedal is pressed towards the floor, the top-of-clutch switch changes from closed to open, and the BHM transmits this information over the J1939 datalink. Based on this information, if the cruise control is active the engine ECU will turn it off. As the clutch pedal reaches the floor, the bottom-of-clutch switch is activated. It will change from open to closed, as the pedal is fully depressed.

The BHM monitors the top- and bottom-of-clutch switch wiring and is capable of detecting error conditions. Faults discovered by the BHM will be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink. See **Fig. 6**.



1. Engine ECU
2. Bottom-of-Clutch Switch (normally open)
3. Top-of-Clutch Switch (normally closed)
4. Bulkhead Module
5. Transmission ECU
6. Instrumentation Control Unit

Fig. 6, Clutch Switch Function

Input and Output Conditions

Table 13 displays the clutch switch system inputs to the BHM and how it will react to these inputs.

Fault Conditions

Table 14 displays how the BHM handles faults it encounters in the clutch switch system. The reference parameters that program the BHM determine whether or not a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted. If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on either or both the J1939 and J1708 datalinks until the ignition switch is turned off.

Horn (electric) Function

Description

The electric horn is controlled by the bulkhead module (BHM). See **Fig. 7**. The horn switch in the steering wheel grounds circuit 25 to activate the input at BHM connector B6, B1. This input activates the WAKE circuit. When ground is applied to this input, the BHM, CHM, and other ECUs on J1939 are powered.

To activate the horn, the BHM supplies battery power to the output circuit at connector B3, E. Fault code SPN 6995 indicates a fault on this output circuit.

The horn bracket is an important part of the horn system. If the bracket is cracked, distorted, or has contact with other components, then the horn will not sound correctly.

Input and Output Conditions

When the horn switch input on BHM connector B6, B1 is at ground, the BHM activates the horn output on connector B3, E. The output is powered using the VBAT2 and VBAT6 power supply to the BHM. The horn input is one of the "wake" inputs to the BHM. If the BHM is powered down and in the sleep state, activating the horn input will "wake" the BHM. This also "wakes" the other modules in the system. See **Fig. 7**.

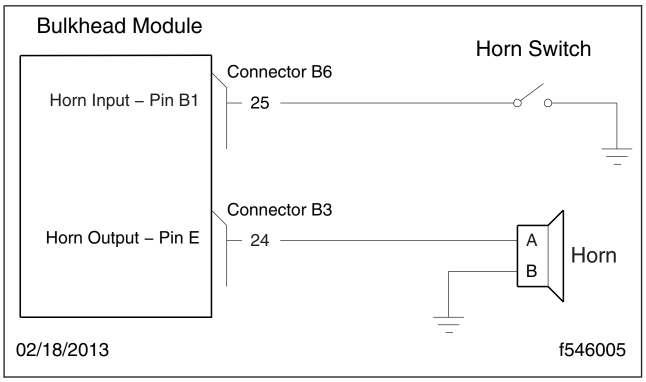


Fig. 7, Horn (electric) Function

Refer to **Table 1** for horn troubleshooting topics.

Electric Horn Troubleshooting	
Problem	**Reference Table**
Fault code SPN 6995 is active.	**Table 2**
The horn stays on all the time.	**Table 3**
The horn does not work at all.	**Table 4**

Table 1, Electric Horn Troubleshooting

Fault Code SPN 6995 from Source Address 33 is Active			
Test No.	**Test Procedure**	**Test Result**	**Action**
1	Connect ServiceLink, and read BHM fault codes. Is SPN 6995 with FMI 4 or 6 active?	Yes	The BHM disables the horn output circuit until the next key switch cycle when this fault is logged. Troubleshoot circuit 24 for a short to ground, or for multiple horns connected. When the problem is repaired, cycle the ignition switch and clear history codes with ServiceLink.
		No	Go to step 2.
2	Is SPN 6995 with FMI 5 active?	Yes	Troubleshoot for an open horn, and for a wiring fault on circuit 24 between the BHM and the horn.
		No	Refer to **Table 3** or **Table 4**.

Table 2, Fault Code SPN 6995 from Source Address 33 is Active

The Horn Stays ON All the Time			
Test No.	**Test Procedure**	**Test Result**	**Action**
1	Connect ServiceLink, then open the BHM template for the electric horn. Does the template show that the horn switch is active?	Yes	Remove the horn button from the steering wheel and test for continuity. The horn button should only have continuity when it is pressed. If the horn button is OK, continue to troubleshoot circuit 25 between the steering column and the BHM for a wiring fault short to ground.
		No	Troubleshoot circuit 24 between the BHM and the horn for a short to battery power.

Table 3, The Horn Stays ON All the Time

Troubleshooting

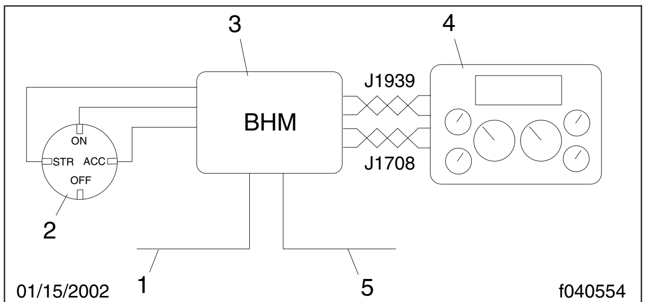
The Horn Does Not Work at All			
Test No.	**Test Procedure**	**Test Result**	**Action**
1	Connect ServiceLink, then open the BHM template for the electric horn. Press and hold the horn button. Does the template show that the horn button input is active?	Yes	Go to step 2.
		No	Remove the horn button from the steering wheel. Test continuity of the horn button. It should show very low resistance when pressed. If the horn button is OK, continue to troubleshoot for an open in circuit 25 between the steering wheel and the BHM.
2	When the horn button is pressed, does the template show that the output becomes active?	Yes	Troubleshoot for an open horn, and for a wiring fault on circuit 24 between the BHM and the horn.
		No	Troubleshoot for a short to ground in circuit 24, between the BHM and the horn. When the wiring fault is repaired, cycle power to the BHM to reset the horn inhibit.

Table 4, The Horn Does Not Work at All

Ignition System

Description

The ignition system is made up of multiple components. The Bulkhead Module (BHM) takes input from the ignition switch and uses the information to crank the starter and to supply ignition and accessory power to the vehicle. See **Fig. 8**.



1. Accessory Power (12V+)
2. Ignition Switch
3. Bulkhead Module
4. Instrumentation Control Unit
5. Ignition Power (12V+)

Fig. 8, Ignition System Function

Ignition System, Accessory Power Function

Description

The Bulkhead Module (BHM) continuously monitors the position of the ignition switch to determine if the accessory power outputs should be energized. Accessory power is provided to the HVAC control panel and the radio. Separate power feeds are used for each of the accessory outputs.

The BHM is capable of detecting shorted circuits in the accessory power outputs. Faults discovered by the BHM will be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink. See **Fig. 8**.

Input and Output Conditions

Table 15 displays the accessory power system inputs to the BHM and how it reacts to these inputs.

Fault Conditions

Table 16 displays how the BHM will handle faults it encounters in the accessory power system. The reference parameters that program the BHM determine whether or not a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted. If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on either or both the J1939 and J1708 datalinks until the ignition switch is turned off.

Ignition System, Ignition Power Function

Description

The Bulkhead Module (BHM) continuously monitors the position of the ignition switch to determine if the ignition power outputs should be energized. Ignition power is provided to the following components:

- antilock brake system electronic control unit (ABS ECU)
- instrumentation control unit (ICU)
- engine ECU
- transmission ECU
- vehicle control unit (VCU), if equipped

Separate power feeds are used for each of the ignition outputs.

The BHM is capable of detecting shorted circuits in the ignition power outputs. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink. See **Fig. 8**.

Input and Output Conditions

Table 17 displays the ignition power system inputs to the BHM and how it will react to these inputs.

Fault Conditions

Table 18 displays how the BHM handles faults it encounters in the ignition power system. The reference parameters that program the BHM determine whether or not a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted. If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on either or both the J1939 and J1708 datalinks until the ignition switch is turned off.

Ignition System, Ignition Switch Function

Description

The ignition switch has four positions: off, accessory, on, and start. The Bulkhead Module (BHM) continuously monitors the position of the ignition switch and broadcasts this information on the J1939 datalink. There are three circuits that run from the ignition switch to the BHM. One is for the accessory position, one is for the on position, and one is for the start position.

The BHM monitors the ignition switch wiring and is capable of detecting error conditions in the ignition switch circuits. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink. See **Fig. 8**.

Input and Output Conditions

Table 20 displays how the BHM reacts given the status of the ignition switch.

Fault Conditions

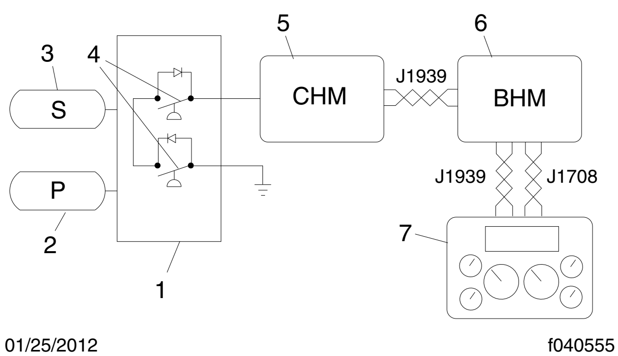
Table 20 displays ignition switch circuit conditions that will create a fault. The reference parameters that program the BHM determine whether or not a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted. If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on either or both the J1939 and J1708 datalinks until a valid ignition switch status is detected.

Low Air Pressure Warning Function

Description

The Chassis Module (CHM) monitors the low air pressure switches and sends a J1939 message to the Bulkhead Module (BHM) indicating the switch status. The BHM sends a J1939 message to the instrumentation control unit (ICU) indicating whether the low air pressure warning light should be on or off. The ICU alerts the driver when the air pressure in the primary or secondary air systems is below 65 to

75 psi (450 to 520 kPa) by illuminating a telltale indicator. There are two normally open pressure switches wired in series in the air management unit (AMU) pressure switch module. On vehicles equipped with an auxiliary air valve assembly (AAVA), these switches are located in the air lines, inside the cab near the center of the dash. Both switches must close in order to complete the circuit to the CHM to change the low air pressure warning status from on to off. See Fig. 9. Faults detected by the BHM may be reported over J1939 and/or J1708 and may be viewed through ServiceLink.



1. Air Management Unit (AMU) or Stand Alone Switches
2. Primary Air
3. Secondary Air
4. Low Air Pressure Switches
5. Chassis Module
6. Bulkhead Module
7. Instrumentation Control Unit

Fig. 9, Low Air Pressure Warning Function

Input and Output Conditions

Table 21 displays the low air pressure warning inputs to the BHM and how it will react to these inputs.

Fault Conditions

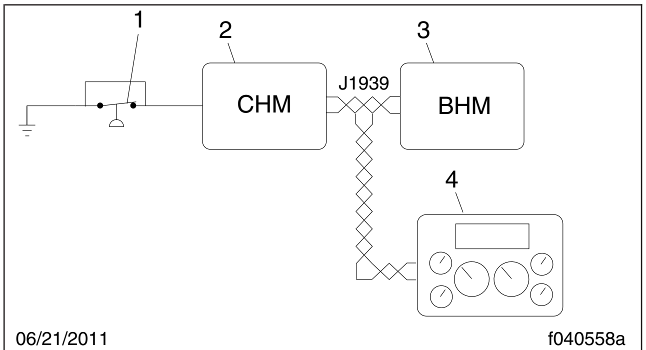
Table 22 displays how the BHM handles faults that it encounters in the low air pressure warning system. The reference parameters that program the BHM determine whether or not a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted. If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on either or both the J1939 and J1708 datalinks.

NOTE: This fault also occurs when the CHM is unable to determine the switch status. This does not necessarily mean that the low air pressure switches are faulty.

Park Brake (pneumatic) Function

Description

The Chassis Module (CHM) monitors the park brake switch and sends a J1939 message to the Bulkhead Module (BHM). The park brake switch is located in the air line, inside the cab near the center of the dash on vehicles equipped with an auxiliary air valve assembly (AAVA), and in the air management unit (AMU) valve on vehicles equipped with an AMU. The BHM sends the park brake status via a J1939 message to the instrumentation control unit (ICU). The park brake status is also broadcast over the J1939 datalink for other ECUs to use. The ICU alerts the operator when the parking brake is engaged. When the park brake is not set and the driver's door is open, the ICU will chime. See Fig. 10. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink.



1. Park Brake Pressure Switch
2. Chassis Module
3. Bulkhead Module
4. Instrumentation Control Unit

Fig. 10, Park Brake (pneumatic) Function

Input and Output Conditions

Table 23 displays the park brake system inputs to the BHM and how it will react to these inputs.

Fault Conditions

Table 24 displays how the BHM handles faults that it encounters in the park brake system. The reference parameters that program the BHM determine whether or not a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted. If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on the J1939 and/or J1708 datalinks.

NOTE: 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.

Wake Function

See Subject 050 for general information on the awake state and sleep state of the Bulkhead Module (BHM).

Wake-Up Initiation

The Bulkhead Module (BHM) wakes up the Chassis Module (CHM), Expansion Module (EXM), and Switch Expansion Module (SEM) by pulling the wake circuits from 12V down to approximately 4V. The EXM and SEM are optional.

The wake circuits remain active at 4V only as long as one or more of the inputs that initiate a wake remain active. See Fig. 11 for wake circuit connectivity and inputs that initiate a wake.

The BHM wakes up the instrumentation control unit (ICU) by applying 12V to its wake circuit.

The BHM initiates other modules to wake up when one or more of the following inputs to the BHM is active:

- driver door open
- passenger door open (optional input)
- headlight switch ON
- hazard lights switch ON
- ignition switch ON
- electric horn switch ON
- BHM wake-up line input grounded

The CHM initiates a wake to the BHM, which in turn wakes all other modules when the:

- service brakes are applied.

When any of the above initiating inputs are inactive, the wake circuits float back to approximately 12V (except the wake circuit between the BHM and ICU). The ICU wake circuit remains active at 12V until the system goes to sleep.

Sleep Initiation

When the inputs that initiate a wake are inactive for 60 seconds, the BHM signals the modules to go to sleep by sending a message via J1939. The BHM also causes the ICU to go to sleep by removing power from its wake circuit.

NOTE: One minute after these conditions are met, and provided that one of the parameters in Table 25 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.

Troubleshooting Quick Checks

If the ICU chimes when the door is opened, check for an open or short to power in the wake circuit between the BHM and CHM—the BHM cannot determine the park brake status and assumes it is not set while the door is open.

If the ICU does not display the odometer when the door is opened, check fuse 20 and check for an open in the BHM to ICU wake circuit.

To thoroughly check wake functionality, follow the troubleshooting procedures in Table 26.

Troubleshooting

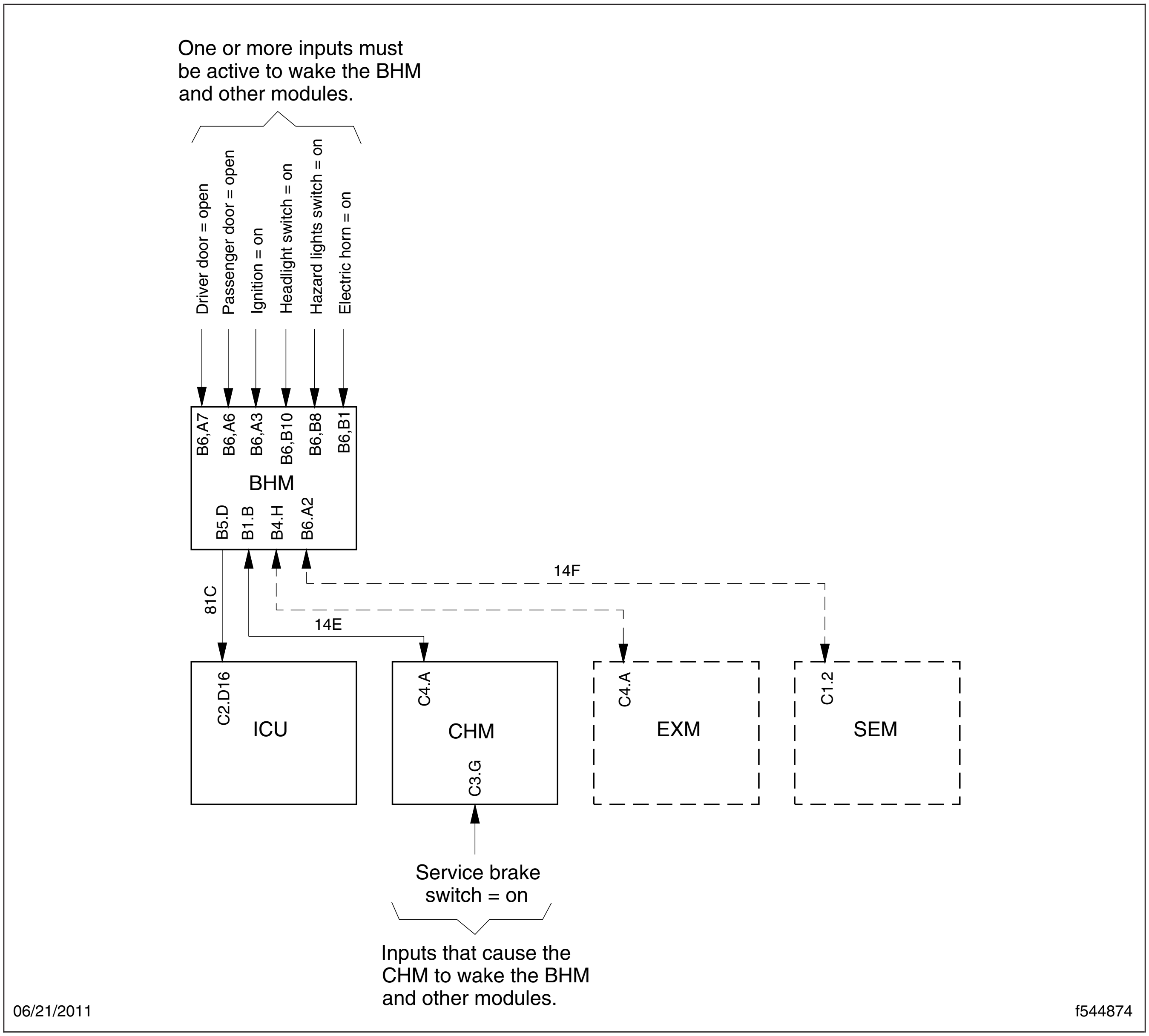


Fig. 11, Simplified Wake Schematic

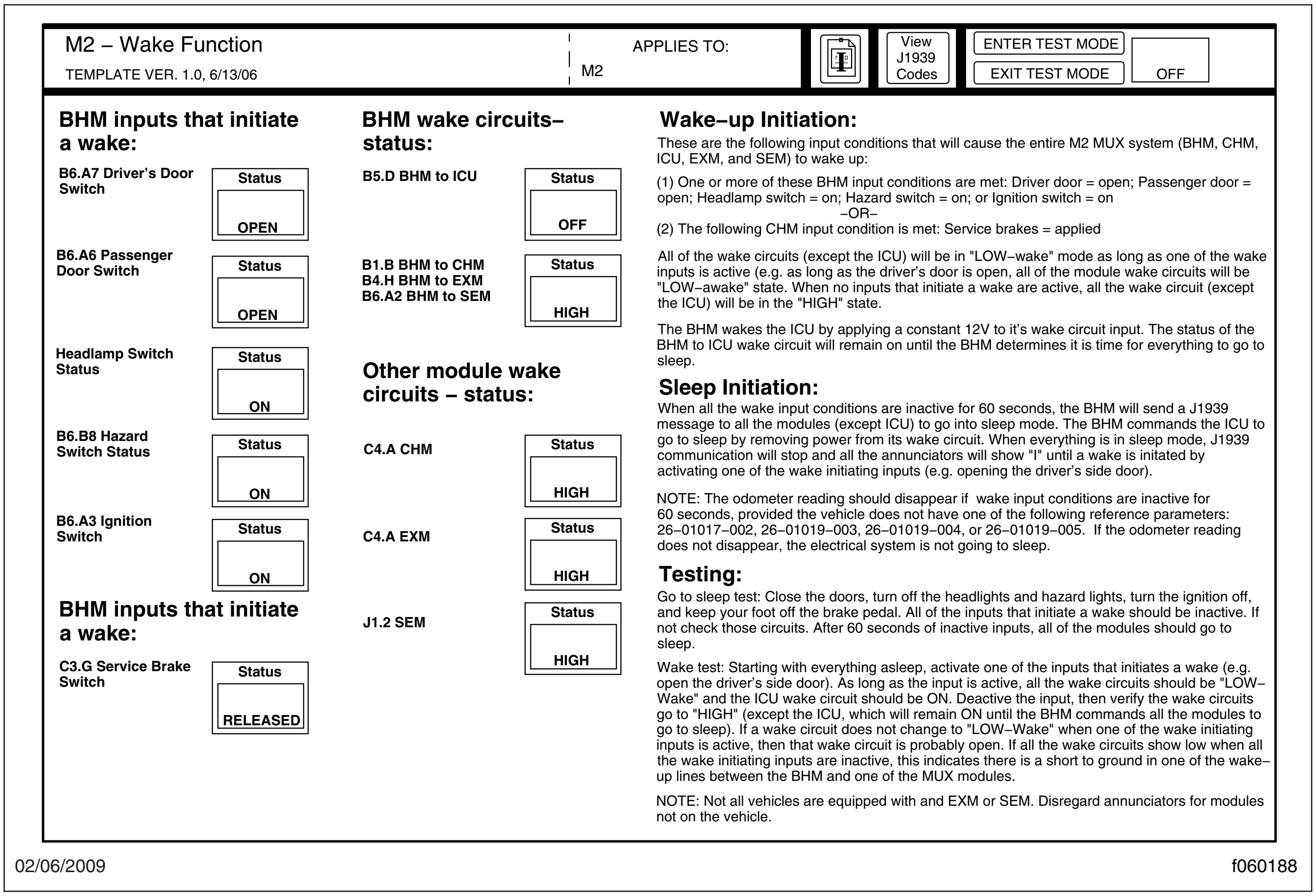


Fig. 12, Wake Function Datalink Monitor Template

A/C Clutch Function Input/Output Conditions		
Inputs to BHM		Output from BHM
Ignition Switch	A/C Clutch Request	A/C Clutch
On/Acc	On	Engaged
On/Acc	Off	Not Engaged
Off	On	Not Engaged

Table 5, A/C Clutch Function Input/Output Conditions

A/C Clutch Function Fault Conditions	
Description of Fault	Action Taken by BHM
Status and or position of the ignition switch is in error.	BHM will assume the ignition switch is on.

Troubleshooting

A/C Clutch Function Fault Conditions	
Description of Fault	**Action Taken by BHM**
A/C clutch wiring is shorted.	BHM may transmit a J1939 and/or a J1708 fault message.

Table 6, A/C Clutch Function Fault Conditions

Alternator Charging Function Input/Output Conditions		
Input to BHM from Alternator "I" Terminal	**Output from BHM via J1939 Message to ICU**	**Output from ICU**
14 volts	Charge status of J1939 message is high.	NO CHARGE light is off.
0 volts	Charge status of J1939 message is low.	NO CHARGE light is on.

Table 7, Alternator Charging Function Input/Output Conditions

Backup Function		
Transmission Type	**Input to BHM**	**BHM Conclusion**
Manual transmission	Backup switch is closed.	Transmission is in reverse.
Automatic transmissions	J1939 message from transmission indicates either: • Current Gear = Reverse • Selected Gear = Reverse • Gear Range = R	Transmission is in reverse.

Table 8, Backup Function

Backup Function Input/Output Conditions		
Inputs to BHM		**Output from BHM**
Ignition Switch	**Transmission Status**	**Backup Lights/Alarm***
On/Acc	Reverse	On
On/Acc	Not Reverse	Off
Off	Reverse	Off
Off	Not Reverse	Off

* Via J1939 message to the CHM

Table 9, Backup Function Input/Output Conditions

Backup Function Fault Conditions	
Description of Fault	**Action Taken by BHM**
Ignition switch status is in error.	BHM will assume the ignition switch is in the on position and may transmit a fault message on the J1939 and/or J1708 datalinks.
Backup lights/alarm wiring shorted.	BHM may transmit a J1939 and/or a J1708 fault message.

Table 10, Backup Function Fault Conditions

Backup Function Fault Conditions, Automatic Transmissions	
Description of Fault	**Action Taken by BHM**
BHM fails to receive five consecutive J1939 messages from the transmission ECU.	BHM may transmit a J1939 fault message and assume the transmission is in reverse.
Transmission ECU sends an error indicator in the J1939 message to the BHM.	BHM may transmit a J1939 fault message and assume the transmission is in reverse.

Table 11, Backup Function Fault Conditions, Automatic Transmissions

Cigar Lighter Function Fault Conditions	
Description of Fault	**Action Taken by BHM**
Cigar lighter wiring shorted.	BHM may transmit a J1939 and/or a J1708 fault message.

Table 12, Cigar Lighter Function Fault Conditions

Clutch Function Input/Output Conditions		
Inputs to BHM		**Output from BHM**
Top-of-Clutch Switch	**Bottom-of-Clutch Switch**	**J1939 Clutch Switch Message**
Closed	Open	Clutch pedal is released.
Open	Closed	Clutch pedal is depressed.
Open	Open	Clutch pedal is partially depressed.
Closed	Closed	Clutch pedal is released.*

* This is an error condition, see the Fault Conditions paragraph for more information.

Table 13, Clutch Function Input/Output Conditions

Clutch Function Fault Conditions		
Inputs to BHM		**Output from BHM**
Top-of-Clutch Switch	**Bottom-of-Clutch Switch**	
Closed	Closed	BHM transmits a J1939 and/or a J1708 fault message.

Table 14, Clutch Function Fault Conditions

Accessory Power Function Input/Output Conditions	
Input to BHM from Ignition Switch	**Output from BHM to Accessory Power Circuits**
Acc	On
Off	Off
On	On
Start	Off

Table 15, Accessory Power Function Input/Output Conditions

Accessory Power Function Fault Conditions	
Description of Fault	**Action Taken by BHM**
Ignition switch is in error.	BHM will assume the ignition switch is on, and will transmit a fault message on the J1939 and/or J1708 datalinks.

Troubleshooting

Accessory Power Function Fault Conditions	
Description of Fault	**Action Taken by BHM**
The accessory power output wiring is shorted.	BHM may transmit a J1939 and/or a J1708 fault message.

Table 16, Accessory Power Function Fault Conditions

Ignition Power Function Input/Output Conditions	
Input to the BHM from the Ignition Switch	**Output from the BHM to the Ignition Power Circuits**
Acc	Off
Off	Off
On	On
Start	On

Table 17, Ignition Power Function Input/Output Conditions

Ignition Power Function Fault Conditions	
Description of Fault	**Action Taken by BHM**
Ignition switch is in error.	BHM will assume the ignition switch is on, and may transmit a fault message on the J1939 and/or J1708 datalinks.
The ignition power output wiring is shorted.	BHM may transmit a J1939 and/or a J1708 fault message.

Table 18, Ignition Power Function Fault Conditions

Ignition Switch Function Input/Output Conditions			
Inputs to BHM			**Output from BHM**
Ignition Switch Accessory Circuit	**Ignition Switch On Circuit**	**Ignition Switch Start Circuit**	**J1939 Ignition Switch Position Message**
Open	Open	Open	Off
Closed	Open	Open	Acc
Closed	Closed	Open	On
Open	Closed	Closed	Start
Open	Open	Closed	On*
Closed	Open	Closed	On*
Open	Closed	Open	On*

* These are error conditions. For more information see the "Fault Conditions" paragraph under the "Ignition System, Ignition Switch Function" heading.

Table 19, Ignition Switch Function Input/Output Conditions

Ignition Switch Function Fault Conditions			
Description of Fault			**Action Taken by BHM**
Ignition Switch Accessory Circuit	**Ignition Switch On Circuit**	**Ignition Switch Start Circuit**	
Open	Open	Closed	BHM transmits a J1939 and/or a J1708 fault message.

Ignition Switch Function Fault Conditions			
Description of Fault			Action Taken by BHM
Ignition Switch Accessory Circuit	Ignition Switch On Circuit	Ignition Switch Start Circuit	
Closed	Open	Closed	BHM transmits a J1939 and/or a J1708 fault message.
Open	Closed	Open	BHM transmits a J1939 and/or a J1708 fault message.

Table 20, Ignition Switch Function Fault Conditions

Low Air Pressure Warning Function Input/Output Conditions				
Inputs to CHM		Input to BHM from CHM	Output from BHM to ICU	Input from ICU to BHM
Secondary Air Pressure Switch	Primary Air Pressure Switch	J1939 Low Air Pressure Switch Status Message	J1939 Low Air Pressure Warning Light Command Message	J1939 Low Air Pressure Warning Light Status Message
Open	Open	Open	Enabled	On
Open	Closed	Open	Enabled	On
Closed	Open	Open	Enabled	On
Closed	Closed	Closed	Disabled	Off

Table 21, Low Air Pressure Warning Function Input/Output Conditions

Low Air Pressure Warning Function Fault Conditions*	
Description of Fault	Action Taken by BHM
CHM transmits J1939 low air pressure status unavailable or in error to the BHM.	BHM may transmit J1939 low air pressure warning light status unavailable.

* This fault also occurs when the CHM is unable to determine the switch status. This does not necessarily mean that the low air pressure switches are faulty.

Table 22, Low Air Pressure Warning Function Fault Conditions

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 23, 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 24, Park Brake (pneumatic) Function Fault Conditions

Troubleshooting

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 25, Parameters

Wake Circuits Troubleshooting Procedures			
Test No.	**Test Procedure**	**Test Result**	**Action**
1	Open the "Wake Function" Datalink Monitor template. See **Fig. 12**. Put the system into a sleep state by: • Closing the doors. • Turning off the headlight switch. • Turning off the hazard lights switch. • Turning off the ignition switch. • Removing your foot from the brake pedal. 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. For example, if the driver door switch remains active (open) when the door is closed, check the door switch itself and the circuit wiring. Repair as necessary.
		No	**Go to test no. 2.**
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 (!)*. 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. NOTE: This troubleshooting step describes a special circumstance that is not typical of the majority of vehicles. 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. 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.**

Wake Circuits Troubleshooting Procedures			
Test No.	**Test Procedure**	**Test Result**	**Action**
3	In the second column of the template under "Other Module Wake Circuits–Status" is the status of all the annunciators "LOW-Wake" (yellow)? 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: • CHM • EXM • SEM 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.** Disconnect BHM connector B5. Test for voltage on pin B5.D (harness side). Is voltage present?	Yes	The wake circuit between the BHM and ICU is shorted to power. 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 **B1.B BHM to CHM** **B4.H BHM to EXM** **B6.A2 BHM to SEM**. 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.
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. 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. NOTE: If the vehicle is not equipped with an SEM or EXM, it is normal for the status of these annunciators to be "!"*. Are all of the appropriate second column annunciators active?	Yes	**Go to test no. 8.**
		No	**Go to test no. 7.**

Troubleshooting

Wake Circuits Troubleshooting Procedures			
Test No.	**Test Procedure**	**Test Result**	**Action**
7	Which annunciator is not active?	B5.D BHM to ICU	Replace the BHM.
		B1.B BHM to CHM B4.H BHM to EXM 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. 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. If OK, check fuse 20 and VBAT2 power supply to BHM B4.G. If OK, ICU may be faulty. 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.

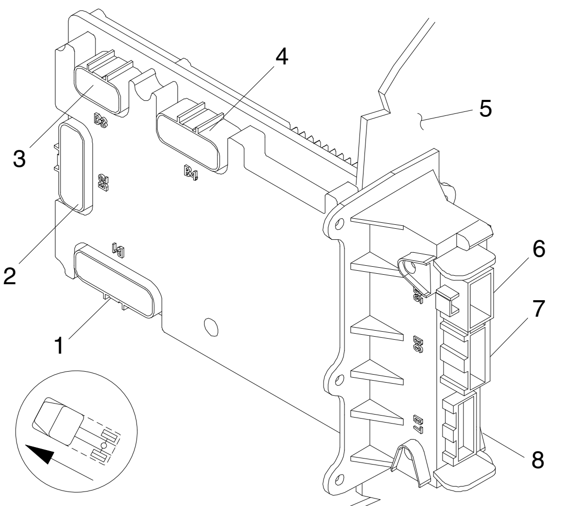
Table 26, Wake Circuits Troubleshooting Procedures

Specifications

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.



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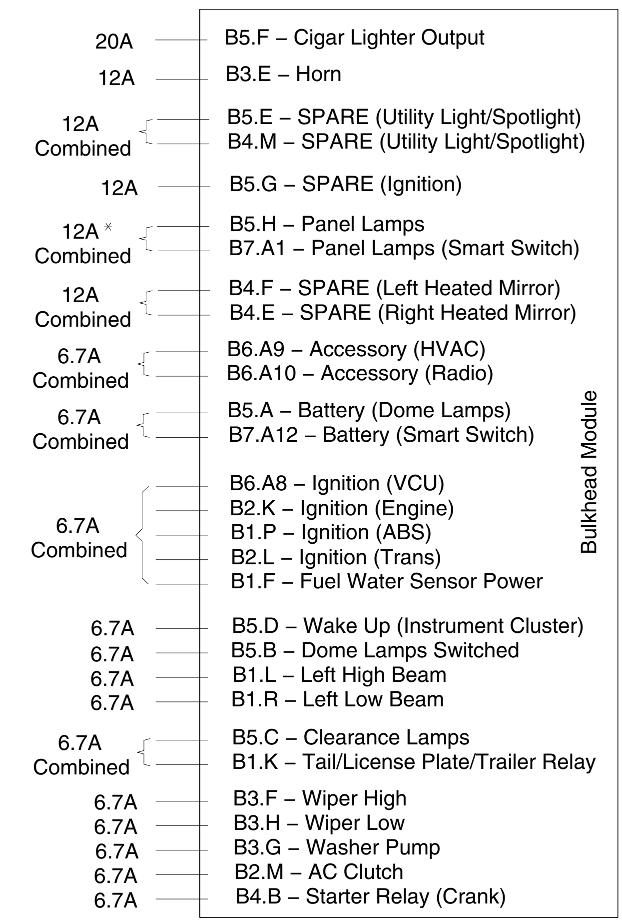
1. B1, Forward Chassis Harness
2. B2, Engine Harness
3. B3, Frontwall Harness
4. B4, Frontwall Harness
5. Frontwall
6. B5, Dash Harness
7. B6, Dash Harness
8. B7, Dash Harness

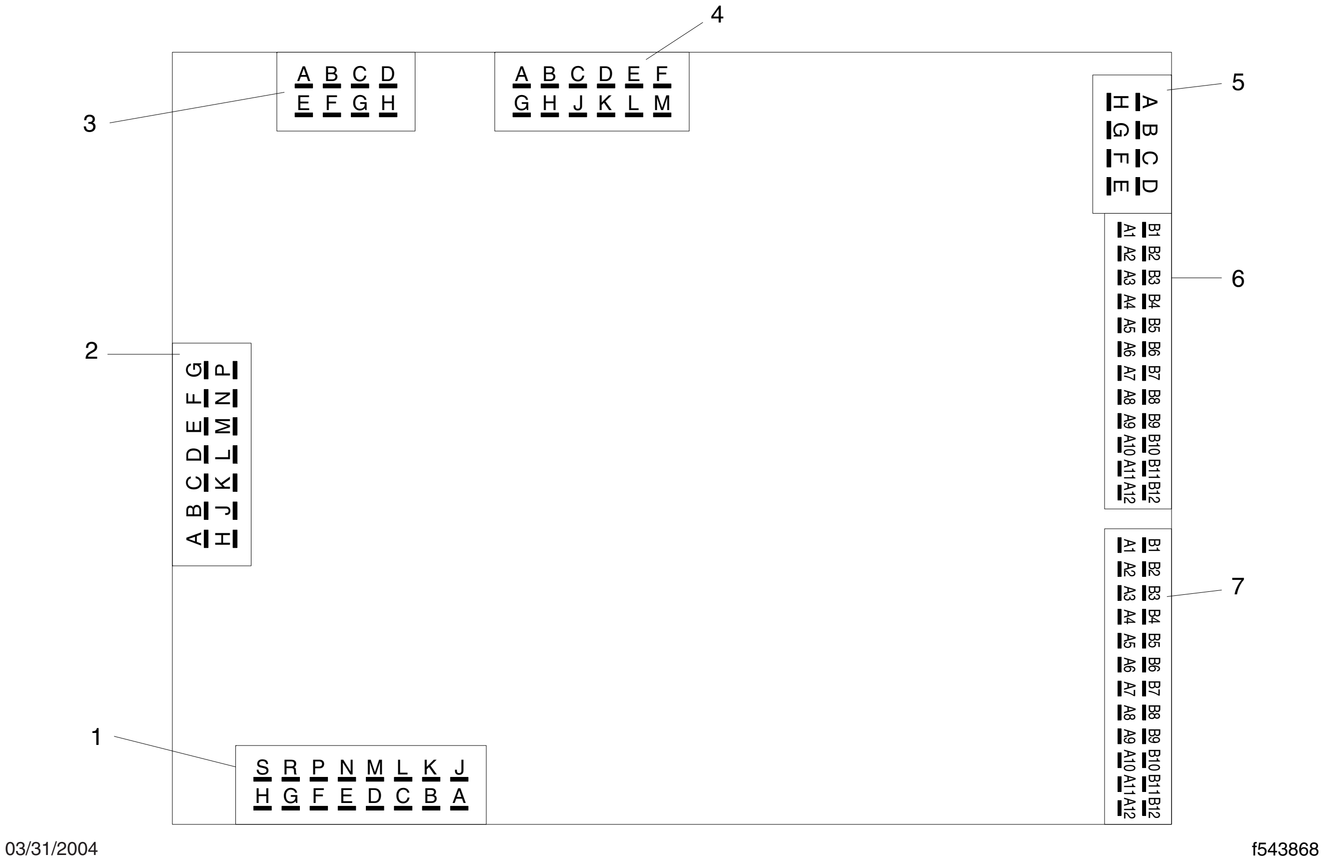
Fig. 1, Bulkhead Module Harness Connections



NOTE A: Pulse Width Modulated Output

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

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

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

Specifications

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

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

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

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.

Bulkhead Module Fault Code Information

General Information

Use **Table 1** to identify J1939 fault codes and an overview of the diagnostic procedure for fault codes generated by the bulkhead module, SA 33.

Use **Table 2** to identify J1587/J1708 bulkhead module (BHM) fault codes. J1587 fault codes consist of the following elements in the order listed:

- Message Identifier (MID) – Identifies which electronic control unit (ECU) the fault is coming from. The J1587 MID identifying all BHM information faults is 164.
- Subsystem Identifier (SID) – Indicates what function on the ECU has failed.
- Failure Mode Indicator (FMI) – Indicates in what way the function failed. See **Table 3** for a list of the J1587 failure mode indicators.

The information in the connector column indicates the typical connector and pin for the affected circuit.

Always use the appropriate schematic for the vehicle as different option content modifies which connector and pin are actually used. BHM B1, A indicates that the typical circuit is BHM connector B1, pin A. CHM indicates the Chassis Module. See **Fig. 1** for a diagram of BHM and CHM outputs.

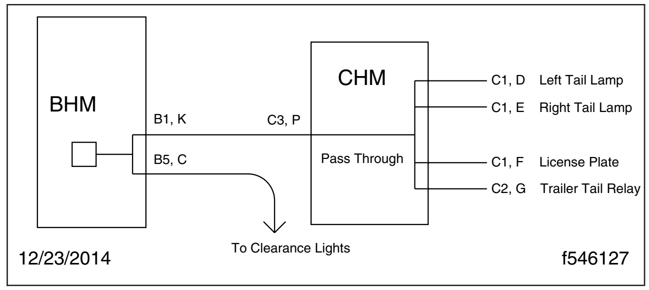


Fig. 1, BHM and CHM Outputs

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

J1939 Fault Codes From Bulkhead Module (SA 33)

SPN	FMI	Fault Description	Diagnosis	Circuit	ECU Conn/ Pin
84	19	Vehicle speed received data error	Troubleshoot for a fault with the vehicle speed sensor and wiring, as described in the engine service literature. The vehicle speed sensor is part of the engine management system, and the data is broadcast from the engine ECU over J1939 or J1708 on EPA07 and older vehicles.	data	—
598	7	Clutch switch fault	The top-of-clutch switch and bottom-of-clutch switch are both measured as closed at the same time. Troubleshoot for clutch switch shorted, or for a wiring fault between the clutch switch and the BHM. Engine starting is disabled and other optional functions may be interrupted until the fault is corrected and the ignition switch is cycled.	440C top 15K bottom	**BHM** B6, B2 B6 (top) B3 (bottom)
879	5	Front left turn lamp — current below expected value	The BHM measures the current on this circuit when the lamp is commanded ON. This fault indicates the bulb is open, or the wiring between the BHM and the bulb is an open circuit.	38L	**CHM** C3, N
879	6	Front left turn lamp — current above expected value	The BHM measures the current on this circuit when the lamp is commanded ON. This fault indicates that the lamps connected to this circuit are drawing more current than the circuit is designed to supply, or there is a wiring fault shorting this circuit to ground.	38L	**CHM** C3, N
881	5	Front right turn lamp — current below expected value	The BHM measures the current on this circuit when the lamp is commanded ON. This fault indicates that the bulb is open, or the wiring between the BHM and the bulb is an open circuit.	38R	**CHM** C3, R

Bulkhead Module Fault Code Information

J1939 Fault Codes From Bulkhead Module (SA 33)					
SPN	**FMI**	**Fault Description**	**Diagnosis**	**Circuit**	**ECU Conn/ Pin**
881	6	Front right turn lamp — current above expected value	The BHM measures the current on this circuit when the lamp is commanded ON. This fault indicates that the lamps connected to this circuit are drawing more current than the circuit is designed to supply, or there is a wiring fault shorting this circuit to ground.	38R	**CHM** C3, R
882	4	Marker lamps — voltage below expected value	The BHM drives the 5 cab overhead clearance and ID lamps from connector B5, pin C on circuit 46. All other marker and tail lamps are driven from BHM connector B1, K on circuit 23. This circuit connects to the CHM as an input at connector J3, P. The CHM passes the signal through to power the tail lamps and marker lamps from connector C2, pin G and also from connector C1, pins D, E, and F. Troubleshoot for a wiring short-to-ground fault on any of the CHM output or BHM output circuits discussed above. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	23, 46, 23A, 23C	**BHM** B1, K B5, C **CHM** J3, P C2, G C1, D C1, E C1, F
882	5	Marker lamps — current below expected value	The BHM measures the current on this circuit when the lamps are commanded ON. This fault indicates some bulbs are open or the wiring between the BHM and the bulbs is open circuit.	23, 46, 23A, 23C	**BHM** B1, K B5, C **CHM** J3, P C2, G C1, D C1, E C1, F
882	6	Marker lamps — current above expected value	The BHM drives the 5 cab overhead clearance and ID lamps from connector B5 pin C on circuit 46. All other marker and tail lamps are driven from BHM connector B1,K on circuit 23. This circuit connects to the CHM as an input at connector J3,P. The CHM passes the signal through to power the tail lamps and marker lamps from connector C2 pin G and also from connector C1 pins D, E, and F. Troubleshoot for a wiring short to ground fault on any of the CHM output or BHM output circuits discussed above. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	23, 46, 23A, 23C	**BHM** B1, K B5, C **CHM** J3, P C2, G C1, D C1, E C1, F
1487	7	Backlighting intensity switch circuit fault	The backlighting dimmer switch connects ground to circuit 29C in the increase intensity position. It connects ground to circuit 29 in the decrease intensity position. If both circuits are at ground, this fault is set.	29, 29C	**BHM** B6, B5 B6, B6
1550	5	AC compressor clutch — current below expected value	The BHM measures the current on this circuit when the AC compressor is commanded ON. This fault indicates the clutch circuit is open or the wiring between the BHM and the AC compressor clutch is high resistance or open.	97F, 97C, 98Z	**BHM** B2, M

Bulkhead Module Fault Code Information

J1939 Fault Codes From Bulkhead Module (SA 33)					
SPN	**FMI**	**Fault Description**	**Diagnosis**	**Circuit**	**ECU Conn/ Pin**
1550	6	AC compressor clutch — current above expected value	The BHM measures the current on this circuit when the AC compressor clutch is commanded ON. This fault indicates that the circuit is drawing more current than it is designed to supply, and possibly there is a wiring fault shorting this circuit to ground. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	97F, 97C, 98Z	**BHM** B2, M
2003	19	Transmission controller not broadcasting expected message	The BHM expects to receive data from the transmission controller. This fault indicates that the transmission ECU is not broadcasting or there is a fault with the J1939 databus. Also troubleshoot the power feed circuits to the transmission controller.	data	—
2071	19	Chassis module not broadcasting expected message	The BHM expects to receive data from the chassis module. This fault indicates that the CHM is not broadcasting or there is a fault with the J1939 databus. Also troubleshoot the power feed circuits to the CHM.	data	—
6890	8	DRL output fault	The CHM does not suupport PWM type DRLs. The vehicle has a BHM mismatch with the CHM. Replace the CHM with one that is compatible with the BHM.	379L 379R	**CHM** C3, K C4, F
6891	4	CHM power feed VBAT1 — low voltage	The output circuits that are powered by VBAT1 will all be inoperative. Other fault codes may be present, but troubleshoot for this first. The fuse in the main PDM powering this circuit may be open. The root cause could be excessive loads on an output, or a short to ground in the VBAT1 supply to the CHM.	14G	**CHM** C4, P
6892	4	CHM power feed VBAT2 — low voltage	The output circuits that are powered by VBAT2 will all be inoperative. Other fault codes may be present, but troubleshoot for this first. The fuse in the main PDM powering this circuit may be open. The root cause could be excessive loads on an output, or a short to ground in the VBAT2 supply to the CHM.	14G	**CHM** C3, J
6893	4	CHM power feed VBAT3 — low voltage	The output circuits that are powered by VBAT3 will all be inoperative. Other fault codes may be present, but troubleshoot for this first. The fuse in the main PDM powering this circuit may be open. The root cause could be excessive loads on an output, or a short to ground in the VBAT3 supply to the CHM.	14G	**CHM** C4, J
6897	6	CHM Right Side Air/ Elec Entrance— Short to ground	The BHM measures the current on this circuit. This fault indicates that the circuit is drawing more current than it is designed to supply. The heater on the Davco 382 fuel/water separator is wired directly to the CHM. The CHM cannot process the added current draw. Install harness A06-65516-000 to remedy the current draw issue. See G06-65515-000. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	196	**CHM** C3, A
6906	7	PTO 2 no pressure feedback	The PTO 2 output circuit has been commanded ON, but air pressure is not detected at the pressure feedback switch. Troubleshoot for PTO 2 air solenoid fault, and for air pressure switch open circuit fault.	variable	variable

Bulkhead Module Fault Code Information

J1939 Fault Codes From Bulkhead Module (SA 33)					
SPN	**FMI**	**Fault Description**	**Diagnosis**	**Circuit**	**ECU Conn/ Pin**
6907	7	PTO 2 pressure detected fault	The PTO 2 output circuit is commanded OFF, but air pressure is detected at the pressure feedback switch. Troubleshoot for PTO 2 air solenoid fault, and for air pressure switch short circuit fault.	variable	variable
6908	7	PTO 1 no pressure feedback	The PTO 1 output circuit has been commanded ON, but air pressure is not detected at the pressure feedback switch. Troubleshoot for PTO 2 air solenoid fault, and for air pressure switch open circuit fault.	variable	variable
6909	7	PTO 1 pressure detected fault	The PTO 1 output circuit is commanded OFF, but air pressure is detected at the pressure feedback switch. Troubleshoot for PTO 2 air solenoid fault, and for air pressure switch short circuit fault.	variable	variable
6910	7	Axle lift 2 no pressure feedback	The axle lift 2 output circuit has been commanded ON, but air pressure is not detected at the pressure feedback switch. Troubleshoot for axle lift 2 air solenoid fault, and for air pressure switch open circuit fault.	variable	variable
6911	7	Axle lift 2 pressure detected fault	The axle lift 2 output circuit is commanded OFF, but air pressure is detected at the pressure feedback switch. Troubleshoot for axle lift 2 air solenoid fault, and for air pressure switch short circuit fault.	variable	variable
6912	7	Remote start switch stuck in crank	BHM connector B6, A5 is at battery voltage for more than 30 seconds and the key is in the ON position. The remote start switch circuit 15D is at ground, and the remote start relay is active. Troubleshoot the pneumatic remote start switch system in vehicles with a bucket lift, or the remote start switch applicable to the vehicle. NOTE: On vehicles without remote start/stop, this fault can be caused by flashing the BHM with low battery voltage. To resolve this fault, connect a battery charger and flash the BHM.	15D, 15	**BHM** B6, A5
6915	4	BHM 8 amp ignition output circuit — voltage below expected value	The BHM supplies battery power on this circuit when the key is in the RUN or CRANK positions. Troubleshoot for a wiring fault shorting this circuit to ground or for too many optional circuits spliced into it that is causing the BHM to turn it off. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	81C	**BHM** B5, G
6915	5	BHM 8 amp ignition output circuit — current below expected value	The BHM supplies battery power on this circuit when the key is in the RUN or CRANK positions. Troubleshoot for an open circuit fault.	81C	**BHM** B5, G
6915	6	BHM 8 amp ignition output circuit — current above expected value	The BHM supplies battery power on this circuit when the key is in the RUN or CRANK positions. Troubleshoot for a wiring fault shorting this circuit to ground or for too many optional circuits spliced into it that is causing the BHM to turn it off. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	81C	**BHM** B5, G

Bulkhead Module Fault Code Information

J1939 Fault Codes From Bulkhead Module (SA 33)					
SPN	**FMI**	**Fault Description**	**Diagnosis**	**Circuit**	**ECU Conn/ Pin**
6916	19	Wiper park position — data fault	The wiper switch is in the OFF position and the BHM park input from the wiper motor is not in park position. Troubleshoot for a wiper motor park switch circuit fault.	—	**BHM** B3, C **ICU** A2
6917	19	Four way flashers — data fault	The ICU broadcasts the state of the turn signal indicators to the BHM. When this fault is active, the four-way flashers are on and the ICU is not controlling the turn signal indicators according to the BHM command. Replace the ICU.	—	**BHM** B6, B8
6918	7	Missing smart switch	The BHM is not detecting the presence of all the smart switches it is configured to have. Use ServiceLink to determine which smart switch is missing. From the BHM screen, click on the "Configuration" tab then click the "Check for Missing Smart Switches" box. The switch ID will be missing from the Smart Switch the vehicle is expected to have.	—	—
6919	7	Duplicate smart switch	The BHM is detecting more than one smart switch with the same ID number present on the vehicle. The outputs controlled by the switch and the indicator in the switch are commanded OFF. The position information for the switch becomes Not Available. Remove the duplicate Smart Switch, then use ServiceLink to verify that the correct Smart Switches are configured for the vehicle. From the BHM screen, click the "Features" tab. The reference parameters that configure the Smart Switches are identified in this list.	—	—
6920	7	Extra smart switch	The BHM is detecting one or more smart switches connected to the vehicle that have not been configured with BHM parameters. Use ServiceLink to identify which Smart Switches are configured for the vehicle. From the BHM screen, click the "Features" tab. The reference parameters that configure the Smart Switches are identified in this list. Determine if the extra switch is not required for the vehicle or if the switch has been installed but the necessary reference parameter has not been programmed into the BHM.	—	—
6921	7	BHM microprocessor fault	Replace the BHM.	—	—
6922	7	Wake up circuit fault	The wake up circuit is powered to a battery voltage circuit. One of the ECUs using circuit 14E is holding this circuit ON, or there is a wiring fault. Use the procedure in service bulletin **54-266**.	14E	**BHM** B1, B B1, D B4, H B6, A2 **CHM** C4, A **SHM** J1, C **SEM** J1, 2

Bulkhead Module Fault Code Information

J1939 Fault Codes From Bulkhead Module (SA 33)					
SPN	**FMI**	**Fault Description**	**Diagnosis**	**Circuit**	**ECU Conn/ Pin**
6923	7	Wiper park circuit fault	When the wiper switch is turned to the OFF position, the BHM expects to see ground on the park switch circuit within 5 seconds. This fault is set if ground is not detected. Troubleshoot for an open in circuit 317, or an open park switch in the wiper motor.	317	**BHM** B3, C
6924	19	Wiper switch ON/OFF logic fault	The ICU reads the wiper switch position and sends the status of the switch to the BHM. This fault becomes active when the ICU reads that either the LO speed or HI speed is active when the wiper switch is also in the OFF position. Troubleshoot for a inoperative stalk switch.	473C	**ICU** A2
6925	19	Wiper switch HI/LO logic fault	The ICU reads the wiper switch position and sends the status of the switch to the BHM. This fault becomes active when the ICU reads that both LO speed and HI speed are active at the same time. Troubleshoot for an inoperative stalk switch.	473C	**ICU** A2
6926	7	Marker interrupt switch fault	The BHM reads the marker-interrupt smart switch. If the switch input is activated for too long, this fault becomes active. Troubleshoot for the marker interrupt switch stuck in the active position, or for the user holding it too long.	variable	variable
6928	7	Suspension proportioning — no pressure feedback	The suspension proportioning output circuit has been commanded ON, but air pressure is not detected at the pressure feedback switch. Troubleshoot for a suspension proportioning air solenoid fault, and for an air pressure switch open circuit fault.	variable	variable
6929	7	Suspension proportioning — pressure detected	The suspension proportioning output circuit is commanded OFF, but air pressure is detected at the pressure feedback switch. Troubleshoot for suspension proportioning air solenoid fault, and for air pressure switch short circuit fault.	variable	variable
6931	7	Suspension dump — no pressure feedback	The suspension dump output circuit has been commanded ON, but air pressure is not detected at the pressure feedback switch. Troubleshoot for suspension dump air solenoid fault, and for air pressure switch open circuit fault.	variable	variable
6932	7	Suspension dump — pressure detected	The suspension dump output circuit is commanded OFF, but air pressure is detected at the pressure feedback switch. Troubleshoot for suspension dump air solenoid fault, and for air pressure switch short circuit fault.	variable	variable
6944	6	Fuel water separator heater circuit — current above expected value	The BHM measures the current on this circuit. This fault indicates that the circuit is drawing more current than it is designed to supply, and possibly there is a wiring fault shorting this circuit to ground. Troubleshoot for a wiring fault shorting this circuit to ground, and for a short in the heater. Also check the Davco 382 fuel/water separator. The heater is wired directly to the CHM. The CHM cannot process the added current draw. If this is the case, install harness A06-65516-000 to remedy the current draw issue. See G06-65515-000. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	196	**CHM** C3, A

Bulkhead Module Fault Code Information

J1939 Fault Codes From Bulkhead Module (SA 33)					
SPN	**FMI**	**Fault Description**	**Diagnosis**	**Circuit**	**ECU Conn/ Pin**
6951	7	Fifth wheel slide — no pressure feedback	The fifth wheel slide output circuit has been commanded ON, but air pressure is not detected at the pressure feedback switch. Troubleshoot for a fifth wheel slide air solenoid fault, and for an air pressure switch open circuit fault.	variable	variable
6952	7	Fifth wheel slide — pressure detected	The fifth wheel slide output circuit is commanded OFF, but air pressure is detected at the pressure feedback switch. Troubleshoot for a fifth wheel slide air solenoid fault, and for an air pressure switch short circuit fault.	variable	variable
6954	7	End of frame air — no pressure feedback	The End of Frame air output circuit has been commanded ON, but air pressure is not detected at the pressure feedback switch. Troubleshoot for an End of Frame air solenoid fault, and for an air pressure switch open circuit fault.	variable	variable
6955	7	End of frame air — pressure detected	The End of Frame air output circuit is commanded OFF, but air pressure is detected at the pressure feedback switch. Troubleshoot for an End of Frame air solenoid fault, and for an air pressure switch short circuit fault.	variable	variable
6958	6	Brake air dryer circuit — current above expected value	The BHM measures the current on this circuit. This fault indicates that the circuit is drawing more current than it is designed to supply, and possibly there is a wiring fault shorting this circuit to ground. Use the schematic in module 84A to assist troubleshooting this circuit. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	94	**BHM** B4, M
6961	7	Axle lift # 1 — no pressure feedback	The axle lift 1 output circuit has been commanded ON, but air pressure is not detected at the pressure feedback switch. Troubleshoot for axle lift 1 air solenoid fault, and for air pressure switch open circuit fault.	variable	variable
6962	7	Axle lift # 1 — pressure detected	The axle lift 1 output circuit is commanded OFF, but air pressure is detected at the pressure feedback switch. Troubleshoot for axle lift 1 air solenoid fault, and for air pressure switch short circuit fault.	variable	variable
6965	4	BHM VBAT 5 input — voltage below expected value	The output circuits that are powered by VBAT5 will all be inoperative. Other fault codes may be present, but troubleshoot for this first. The fuse in the main PDM powering this circuit may be open. The root cause could be excessive loads on an output, or a short to ground in the VBAT5 supply to the BHM.	14H	**BHM** B1, J
6966	4	BHM VBAT 4 input — voltage below expected value	The output circuits that are powered by VBAT4 will all be inoperative. Other fault codes may be present, but troubleshoot for this first. The fuse in the main PDM powering this circuit may be open. The root cause could be excessive loads on an output, or a short to ground in the VBAT4 supply to the BHM.	14H	**BHM** B4, K
6967	4	BHM VBAT 3 input — voltage below expected value	The output circuits powered by VBAT3 will all be inoperative. Other fault codes may be present, but troubleshoot for this first. The fuse in the main PDM powering this circuit may be open. The root cause could be excessive loads on an output, or a short to ground in the VBAT3 supply to the BHM.	14H	**BHM** B1, N

Bulkhead Module Fault Code Information

J1939 Fault Codes From Bulkhead Module (SA 33)					
SPN	**FMI**	**Fault Description**	**Diagnosis**	**Circuit**	**ECU Conn/ Pin**
6968	4	BHM VBAT 2 input — voltage below expected value	The output circuits that are powered by VBAT2 will all be inoperative. Other fault codes may be present, but troubleshoot for this first. The fuse in the main PDM powering this circuit may be open. The root cause could be excessive loads on an output, or a short to ground in the VBAT2 supply to the BHM.	14H	**BHM** B4, G
6969	4	BHM VBAT 1 input — voltage below expected value	The output circuits that are powered by VBAT1 will all be inoperative. Other fault codes may be present, but troubleshoot for this first. The fuse in the main PDM powering this circuit may be open. The root cause could be excessive loads on an output, or a short to ground in the VBAT1 supply to the BHM.	14H	**BHM** B3, D
6970	5	Wiper high speed circuit — current below expected value	The BHM measures the current on this circuit when the windshield wipers are operating on high speed. This fault indicates the wiper motor high speed circuit is open, or the wiring between the BHM and the wiper motor is open circuit. Test for an open wiper motor and use the schematic in module 66B to assist troubleshooting the circuit.	318	**BHM** B3, F
6970	6	Wiper high speed circuit — current above expected value	The BHM measures the current on this circuit when the windshield wipers are operating on high speed. This fault indicates the wiper motor high speed circuit is short to ground, or the wiring between the BHM and the wiper motor is short to ground. Use the schematic in module 66B to assist troubleshooting the circuit.	318	**BHM** B3, F
6971	5	Wiper low speed circuit — current below expected value	The BHM measures the current on this circuit when the windshield wipers are operating on low speed. This fault indicates the wiper motor low speed circuit is open, or the wiring between the BHM and the wiper motor is open circuit. Test for an open wiper motor and use the schematic in module 66B to assist troubleshooting the circuit.	316	**BHM** B3, H
6971	6	Wiper low speed circuit — current above expected value	The BHM measures the current on this circuit when the windshield wipers are operating on low speed. This fault indicates the wiper motor low speed circuit is short to ground, or the wiring between the BHM and the wiper motor is short to ground. Use the schematic in module 66B to assist troubleshooting the circuit.	316	**BHM** B3, H
6972	19	Windshield wiper high speed switch — data error	The ICU is unable to broadcast a valid wiper high speed switch position to the BHM. Troubleshoot for a wiper switch fault or for loss of J1939 communication from the ICU.	—	**ICU** A2
6973	19	Windshield wiper low speed switch — data error	The ICU is unable to broadcast a valid wiper low speed switch position to the BHM. Troubleshoot for a wiper switch fault or for loss of J1939 communication from the ICU.	—	**ICU** A2
6974	19	Windshield wiper switch — data error	The ICU is unable to broadcast a valid wiper switch position to the BHM. Troubleshoot for a wiper switch fault or for loss of J1939 communication from the ICU.	—	**ICU** A2

Bulkhead Module Fault Code Information

J1939 Fault Codes From Bulkhead Module (SA 33)					
SPN	**FMI**	**Fault Description**	**Diagnosis**	**Circuit**	**ECU Conn/ Pin**
6976	5	Windshield washer pump circuit — current below expected value	The BHM measures the current on this circuit when the windshield washer pump is operating. This fault indicates the windshield washer pump is open circuit, or the wiring between the BHM and the windshield washer pump is open circuit. Test for an open washer pump and use the schematic in module 66B to assist troubleshooting the circuit.	320	**BHM** B3, G
6976	6	Windshield washer pump circuit — current above expected value	The BHM measures the current on this circuit when the windshield washer pump is operating. This fault indicates the windshield washer pump is short to ground, or the wiring between the BHM and the windshield washer pump is short to ground. Use the schematic in module 66B to assist troubleshooting the circuit. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	320	**BHM** B3, G
6977	19	Windshield washer switch — data error	The ICU is unable to broadcast a valid windshield washer switch position to the BHM. Troubleshoot for a washer switch fault or for loss of J1939 communication from the ICU.	—	**ICU** B7
6978	19	Right turn signal switch — data error	The ICU is unable to broadcast a valid turn signal switch position to the BHM. Troubleshoot for a turn signal switch fault or for loss of J1939 communication from the ICU.	—	**ICU** B6
6979	19	Left turn signal switch — data error	The ICU is unable to broadcast a valid turn signal switch position to the BHM. Troubleshoot for a turn signal switch fault, or for loss of J1939 communication from the ICU.	—	**ICU** B6
6980	5	Right stop/turn lamp — current below expected value	The BHM measures the current on this circuit when the lamp is commanded ON. This fault indicates the bulb is open, or the wiring between the BHM and the bulb is open circuit.	39R	**CHM** C1, L
6980	6	Right stop/turn lamp — current above expected value	The BHM measures the current on this circuit when the lamp is commanded ON. This fault indicates that the lamps connected to this circuit are drawing more current than the circuit is designed to supply, or there is a wiring fault shorting this circuit to ground. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	39R	**CHM** C1, L
6981	5	Left stop/turn lamp — current below expected value	The BHM measures the current on this circuit when the lamp is commanded ON. This fault indicates the bulb is open, or the wiring between the BHM and the bulb is open circuit.	39L	**CHM** C1, N
6981	6	Left stop/turn lamp — current above expected value	The BHM measures the current on this circuit when the lamp is commanded ON. This fault indicates that the lamps connected to this circuit are drawing more current than the circuit is designed to supply, or there is a wiring fault shorting this circuit to ground. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	39L	**CHM** C1, N

Bulkhead Module Fault Code Information

J1939 Fault Codes From Bulkhead Module (SA 33)					
SPN	**FMI**	**Fault Description**	**Diagnosis**	**Circuit**	**ECU Conn/ Pin**
6982	5	Wake up / ICU power output circuit — current below expected value	The BHM measures the current on this circuit when the wake up/ICU power output circuit is commanded ON. This fault indicates an open circuit.	81C	**BHM** B5, D
6982	6	Wake up / ICU power output circuit — current above expected value	The BHM measures the current on this circuit when the wake up/ICU power output is commanded ON. This fault indicates that the wake up/ICU power circuit is drawing more current than the circuit is designed to supply, and possibly there is a wiring fault shorting this circuit to ground. Some BHM configurations force this circuit off until the ignition switch is cycled.	81C	**BHM** B5, D
6983	5	Starter relay output — current below expected value	The BHM measures the current on this circuit when the starter output is commanded ON. This fault indicates the magnetic switch or the wiring between the BHM and the magnetic switch is open circuit.	472S	**BHM** B4, B
6983	6	Starter relay output — current above expected value	The BHM measures the current on this circuit when the starter output is commanded ON. This fault indicates that the magnetic switch circuit is drawing more current than the circuit is designed to supply and possibly there is a wiring fault shorting this circuit to ground. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	472S	**BHM** B4, B
6984	5	Ignition accessory output circuit — current below expected value	The BHM measures the current on this circuit when the accessory output is commanded ON. This fault indicates an open circuit. Use the vehicle schematics to determine what devices are powered by this circuit.	295A or 98	**BHM** B6,A9 or **BHM** B6,A10
6984	6	Ignition accessory output circuit — current above expected value	The BHM measures the current on this circuit when the accessory output is commanded ON. This fault indicates that the accessory circuit is drawing more current than the circuit is designed to supply, and possibly there is a wiring fault shorting this circuit to ground. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	295A or 98	**BHM** B6,A9 or B6,A10
6985	5	Ignition output circuit — current below expected value	The BHM measures the current on this circuit when the ignition output is commanded ON. This fault indicates an open circuit. Use the vehicle schematics to determine what devices are powered by this circuit.	439W+ 376C, 223A, 439A, 81C	**BHM** B1, F B1, P B2, L B2, K B6, A8
6985	6	Ignition output circuit — current above expected value	The BHM measures the current on this circuit when the ignition output is commanded ON. This fault indicates that the ignition circuit is drawing more current than the circuit is designed to supply, and possibly there is a wiring fault shorting this circuit to ground. Some BHM configurations force this circuit off until the ignition switch is cycled.	439W+ 376C, 223A, 439A, 81C	**BHM** B1, F B1, P B2, L B2, K B6, A8

Bulkhead Module Fault Code Information

<table>
<tr><th colspan="6">J1939 Fault Codes From Bulkhead Module (SA 33)</th></tr>
<tr><th>SPN</th><th>FMI</th><th>Fault Description</th><th>Diagnosis</th><th>Circuit</th><th>ECU Conn/ Pin</th></tr>
<tr><td>6985</td><td>7</td><td>The CHM ignition input circuit is not measuring the same state as the BHM ignition output circuit</td><td>The BHM ignition output circuit is ON and the CHM ignition input circuit is measuring OFF, or the opposite combination is occurring. This could indicate a combination of wiring faults in the ignition ON circuit to the CHM.</td><td>81C</td><td>CHM
C3, M
and
BHM
B6, A8</td></tr>
<tr><td>6986</td><td>7</td><td>Ignition switch circuits to BHM are in an invalid combination</td><td>The voltage on the 3 ignition-switch input circuits is expected to be a combination of the values shown below. This fault is active when any of the "Error" combinations occur. Troubleshoot for a wiring fault between the ignition switch and the BHM, or for a defective ignition switch.
<table>
<tr><th>ACC B6, A1</th><th>IGN B6, A3</th><th>Crank B6,A5</th><th>State</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>Off</td></tr>
<tr><td>12</td><td>0</td><td>0</td><td>Acc</td></tr>
<tr><td>0</td><td>12</td><td>0</td><td>Error</td></tr>
<tr><td>12</td><td>12</td><td>0</td><td>On</td></tr>
<tr><td>0</td><td>0</td><td>12</td><td>Error</td></tr>
<tr><td>12</td><td>0</td><td>12</td><td>Error</td></tr>
<tr><td>0</td><td>12</td><td>12</td><td>Crank</td></tr>
<tr><td>12</td><td>12</td><td>12</td><td>Error *</td></tr>
</table>
* Unless the truck has remote start, this is the remote crank signal.</td><td>52,15, 305, 306</td><td>BHM
B6, A1
B6, A3
B6, A5</td></tr>
<tr><td>6987</td><td>5</td><td>Tail lamp circuit — current below expected value</td><td>The BHM measures the current on this circuit when the tail lamp output is commanded ON. This fault indicates the tail lamp circuit from the BHM to the CHM, or the wiring between the CHM and the lights is open circuit.</td><td>23, 23A, 23C</td><td>BHM
B1, K
and
CHM
C1, D
C1, E
C1, F
C2, G
C3, P</td></tr>
<tr><td>6987</td><td>6</td><td>Tail lamp circuit — current above expected value</td><td>The BHM measures the current on this circuit when the tail lamp output is commanded ON. This fault indicates that the tail lamp circuit is drawing more current than it is designed to supply and possibly there is a wiring fault shorting this circuit to ground. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.</td><td>23, 23A, 23C</td><td>BHM
B1, K
and
CHM
C1, D
C1, E
C1, F
C2, G
C3, P</td></tr>
<tr><td>6988</td><td>5</td><td>Left low beam headlamp circuit — current below expected value</td><td>The BHM measures the current on this circuit when the headlamp output is commanded ON. This fault indicates the headlamp circuit or the wiring between the BHM and the lamp is open circuit.</td><td>20L</td><td>BHM
B1, R</td></tr>
</table>

Bulkhead Module Fault Code Information

J1939 Fault Codes From Bulkhead Module (SA 33)					
SPN	**FMI**	**Fault Description**	**Diagnosis**	**Circuit**	**ECU Conn/ Pin**
6988	6	Left low beam headlamp circuit — current above expected value	The BHM measures the current on this circuit when the headlamp output is commanded ON. This fault indicates that the headlamp circuit is drawing more current than it is designed to supply and possibly there is a wiring fault shorting this circuit to ground.	20L	**BHM** B1, R
6989	5	Right low beam headlamp circuit — current below expected value	The CHM measures the current on this circuit when the headlamp output is commanded ON. This fault indicates the headlamp circuit or the wiring between the CHM and the lamp is open circuit.	21L	**CHM** C3, L
6989	6	Right low beam headlamp circuit — current above expected value	The CHM measures the current on this circuit when the headlamp output is commanded ON. This fault indicates that the headlamp circuit is drawing more current than it is designed to supply and possibly there is a wiring fault shorting this circuit to ground.	21L	**CHM** C3, L
6990	5	Left high beam headlamp circuit — current below expected value	The BHM measures the current on this circuit when the headlamp output is commanded ON. This fault indicates the left high beam headlamp circuit or the wiring between the BHM and the lamp is open circuit.	20H	**BHM** B1, L
6990	6	Left high beam headlamp circuit — current above expected value	The BHM measures the current on this circuit when the headlamp output is commanded ON. This fault indicates that the left high beam headlamp circuit is drawing more current than it is designed to supply and possibly there is a wiring fault shorting this circuit to ground. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	20H	**BHM** B1, L
6991	5	Right high beam headlamp circuit — current below expected value	The CHM measures the current on this circuit when the headlamp output is commanded ON. This fault indicates the right high beam headlamp circuit or the wiring between the CHM and the lamp is open circuit.	21H	**CHM** C4, K
6991	6	Right high beam headlamp circuit — current above expected value	The CHM measures the current on this circuit when the headlamp output is commanded ON. This fault indicates that the right high beam headlamp circuit is drawing more current than it is designed to supply and possibly there is a wiring fault shorting this circuit to ground. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	21H	**CHM** C4, K
6992	19	High beam switch status — data not available	The BHM is not receiving valid data from the ICU for high beam switch status. Troubleshoot for a fault with the multifunction switch high and low beam circuits to the ICU.	473B	ICU B7
6993	7	Headlamp switch inputs to BHM are in an invalid combination	There are two headlamp ON circuits and one park lamp ON circuit from the headlight switch to the BHM. Both headlamp ON circuits must be at the same voltage. The park lamp circuit from the headlight switch can not be ON when the headlamp circuits are ON. This fault will be active when either of these two fault conditions are present. Troubleshoot for a headlight switch fault, and a wiring fault between the headlight switch and the BHM.	20, 21, 23F	**BHM** B6, B9 B6, B10, B6, B11

Bulkhead Module Fault Code Information

J1939 Fault Codes From Bulkhead Module (SA 33)					
SPN	**FMI**	**Fault Description**	**Diagnosis**	**Circuit**	**ECU Conn/ Pin**
6994	19	Hazard lamp switch — circuit out of range	The hazard lamp switch closes a circuit from BHM pin B6, B8 through a resistor in the switch unit to ground. Troubleshoot for a fault in the wiring or an error in the switch assembly.	38B	**BHM** B6, B8
6995	4	Electric horn — voltage below expected value	The BHM measures the current on this circuit when the horn is commanded ON. Troubleshoot for a short to ground in the wiring between the BHM and the horn. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	24	**BHM** B3, E
6995	5	Electric horn — current below expected value	The BHM measures the current on this circuit when the horn is commanded ON. Troubleshoot for high resistance or open circuit between the BHM and the horn.	24	**BHM** B3, E
6995	6	Electric horn — current above expected value	The BHM measures the current on this circuit when the horn is commanded ON. Troubleshoot for a short to ground in the wiring between the BHM and the horn. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	24	**BHM** B3, E
6996	5	Dome lamp switched power circuit — current below expected value	The BHM measures the current on the dome lamp circuit that is controlled by the door switches when the lamp output is commanded ON. This fault indicates the dome lamp bulb or the wiring between the BHM and the light is open circuit.	108D	**BHM** B5, B
6996	6	Dome lamp switched power circuit — current above expected value	The BHM measures the current on the dome lamp circuit that is controlled by the door switches when the lamp output is commanded ON. This fault indicates the dome lamp circuit is drawing more current than it is designed to supply and possibly there is a wiring fault shorting this circuit to ground. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	108D	**BHM** B5, B
6997	4	Cigar lighter circuit — voltage below expected value	The BHM measures the voltage on this circuit when the lighter output is powered ON. This fault indicates the lighter circuit is measuring lower voltage than the BHM expects. Troubleshoot for a short to ground or for too many accessories connected to this circuit. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	57	**BHM** B5, F
6997	5	Cigar lighter circuit — current below expected value	The BHM measures the current on this circuit . This fault indicates the lighter or the lighter circuit between the BHM and the lighter is high resistance or open circuit.	57	**BHM** B5, F
6997	6	Cigar lighter circuit — current above expected value	The BHM measures the current on this circuit when the lighter output is powered ON. This fault indicates the lighter circuit is drawing more current than the circuit is designed to supply. Troubleshoot for a short to ground or too many accessories connected to this circuit. Some BHM configurations force this circuit off until the ignition switch is cycled.	57	**BHM** B5, F

Bulkhead Module Fault Code Information

J1939 Fault Codes From Bulkhead Module (SA 33)					
SPN	FMI	Fault Description	Diagnosis	Circuit	ECU Conn/ Pin
6998	5	Smart switch battery power circuit — current below expected value.	The BHM measures the current on the smart switch power circuit. Troubleshoot for an open circuit between the BHM and the smart switches.	41	**BHM** B7, A12
6998	6	Dome lamp battery power circuit — current above expected value	The BHM measures the current on the dome lamp circuit that is powered by the BHM. This circuit is powered ON when the BHM is in awake state. This fault indicates the dome lamp circuit is drawing more current than it is designed to supply and possibly there is a wiring fault shorting this circuit to ground. Some BHM configurations force this circuit off until the ignition switch is cycled.	41	**BHM** B5, A
6999	5	Backup lamp circuit — current below expected value	The CHM measures the current on this circuit when the backup lamp output is commanded ON. This fault indicates the backup lamp circuit or the wiring between the CHM and the lamp is open circuit.	120B	**CHM** C1, A C1, H C1, J
6999	6	Backup lamp circuit — current above expected value	The CHM measures the current on this circuit when the backup lamp output is commanded ON. This fault indicates that the backup lamp circuit is drawing more current than it is designed to supply and possibly there is a wiring fault shorting this circuit to ground. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	120B	**CHM** C1, A C1, H C1, J
7000	4	Backlighting circuit — voltage below expected value	The BHM measures the current on this circuit when the backlighting is ON. Troubleshoot for a short to ground in the backlighting circuits. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	29A	**BHM** B5, H
7000	5	Backlighting circuit — current below expected value	The BHM measures the current on this circuit when the backlighting is ON. Troubleshoot for an open circuit in the backlighting wiring.	29A	**BHM** B5, H
7000	6	Backlighting circuit — current above expected value	The BHM measures the current on this circuit when the backlighting is ON. Troubleshoot for a short to ground in the backlighting circuits. The fault remains active until the ignition is turned ON when the fault is no longer present. Some BHM configurations force this circuit off until the ignition switch is cycled.	29A	**BHM** B5, H
524280	31	Component ID mismatch	The BHM is in a non-recoverable boot mode. Replace the BHM and contact the help desk to arrange for shipping this BHM to DTNA engineering.	—	—
524281	31	Application to parameters fail	Reflash the BHM — disconnect ServiceLink and cycle the ignition switch.	—	—
524282	12	Parameter data fails checksum	Reflash the BHM — disconnect servicelink and cycle the ignition switch.	—	—
524283	12	Application code fails checksum	Reflash the BHM — disconnect servicelink and cycle the ignition switch.	—	—

Bulkhead Module Fault Code Information

J1939 Fault Codes From Bulkhead Module (SA 33)					
SPN	**FMI**	**Fault Description**	**Diagnosis**	**Circuit**	**ECU Conn/ Pin**
524284	12	Boot block checksum fail	The BHM is in a non-recoverable boot mode. Replace the BHM.	—	—
524285	4	Boot hold line is active	The BHM is in a non-recoverable boot mode. Replace the BHM and contact the help desk to arrange for shipping this BHM to DTNA engineering.	—	—
524286	12	RAM test fails	The BHM is in a non-recoverable boot mode. Replace the BHM.	—	—

Table 1, J1939 Fault Codes From Bulkhead Module (SA 33)

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
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

Bulkhead Module Fault Code Information

J1587 SIDs for Bulkhead Module (BHM) MID 164		
SID	Description	Possible FMI
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
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

Bulkhead Module Fault Code Information

J1587 SIDs for Bulkhead Module (BHM) MID 164		
SID	Description	Possible FMI
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
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

Bulkhead Module Fault Code Information

J1587 SIDs for Bulkhead Module (BHM) MID 164		
SID	Description	Possible FMI
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 2, J1587 SIDs for Bulkhead Module (BHM) MID 164

Failure Mode Identifiers	
FMI	J1587 Description
00	Data valid but above normal operational range (engine overheating)
01	Data valid but below normal operational range (engine oil pressure too low)
02	Data erratic, intermittent, or incorrect
03	Voltage above normal or shorted high
04	Voltage below normal or shorted low
05	Current below normal or open circuit
06	Current above normal or grounded circuit
07	Mechanical system not responding properly
08	Abnormal frequency, pulse width, or period
09	Abnormal update rate
10	Abnormal rate of change
11	Failure mode not identifiable
12	Bad intelligent device or component
13	Out of Calibration
14	Special Instructions

Table 3, Failure Mode Identifiers

Contents

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**.

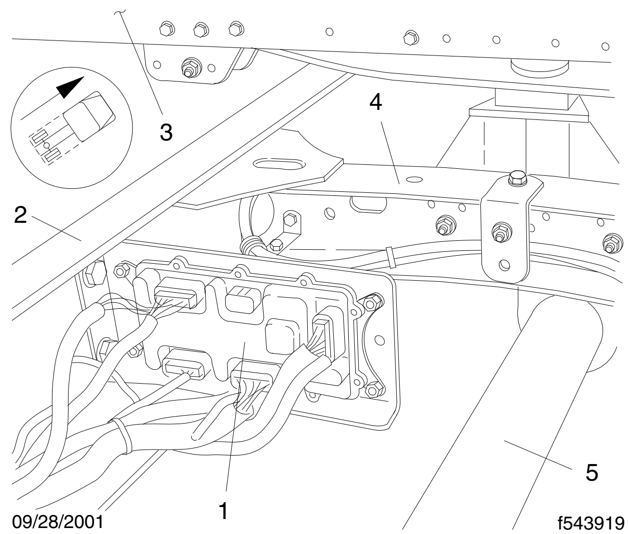
Both the standard CHM and full CHM are supported by one version of software.

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.

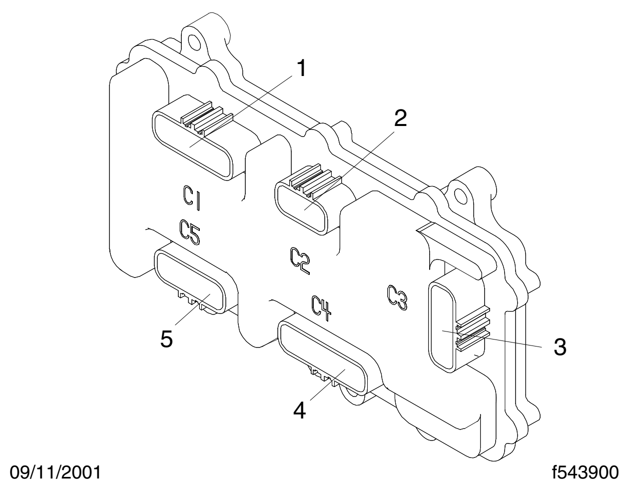
One of the following actions will cause the BHM, CHM, or ICU to go into an awake state:

- 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



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

The BHM, CHM, and ICU will enter a sleep state when they are no longer actively controlling any out-

General Information

puts 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.

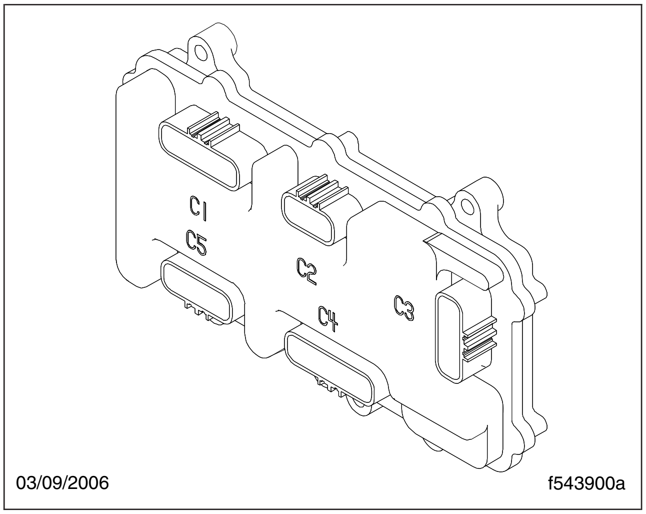


Fig. 3, Expansion Module Harness Connectors

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

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

Module Configuration and External Strapping IDs						
System Definition	Address ID Connections on Connector C4*				J1939 Source Address	J1587 MID
	A	B	C	D		
CHM	No Connections				71	249

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

Table 2, Module Configuration and External Strapping IDs

Chassis Module and Expansion Module Replacement

Replacement

IMPORTANT: It is rarely necessary to replace the Chassis Module (CHM) or the Expansion Module (EXM). Replacing the CHM or EXM should be the last resort to solving electrical problems, unless the module needs to be replaced due to physical damage. Follow troubleshooting procedures in **Section 54.12, Troubleshooting 300**, to solve electrical problems before replacing either the CHM or the EXM. If troubleshooting indicates a malfunction of either module, try reflashing the parameters and the software before replacing the module. Also check the external wiring.

See **Section 54.00, Subject 050**, for information about the M2 electrical system and **Section 54.00, Troubleshooting 300**, for information on troubleshooting the entire M2 electrical system.

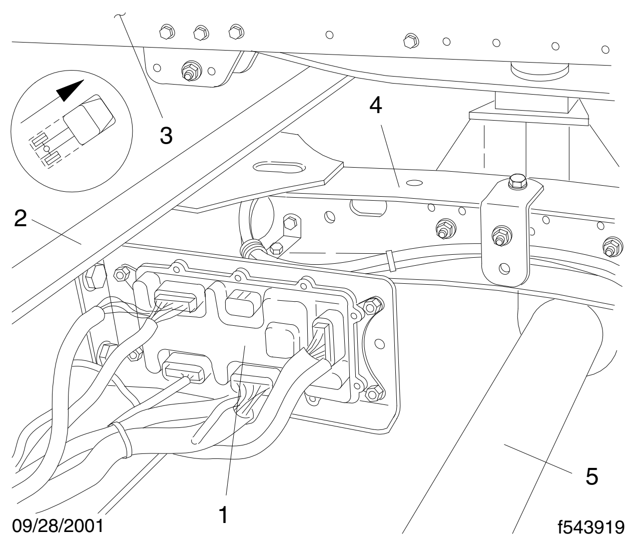
1. Disconnect the negative leads from the batteries or, if the vehicle is equipped with a battery disconnect switch, turn the switch to the off position.

NOTE: The Chassis Module is mounted on the left frame rail, aft of the cab. See **Fig. 1**. The EXM is mounted on the forward spring hanger bracket of the rear suspension.

2. Disconnect the harnesses at the harness connectors on the Chassis Module or Expansion Module. See **Fig. 2** or **Fig. 3**.

NOTE: The C2 and C5 connectors on the standard Chassis Module are sealed at the time of manufacture so that it is not possible to use these connectors. On a vehicle that has a full Chassis Module installed and no options on a particular connector (for example, a vehicle with air brakes but no trailer towing provision leaves the C2 connector empty), the connector will be installed and all the cavities on that connector will have sealing plugs.

NOTE: Before removing the Chassis Module from the mounting plate, note its orientation. Connector C3 is toward the center of the vehicle, and connectors C1 and C5 are toward the frame rail.



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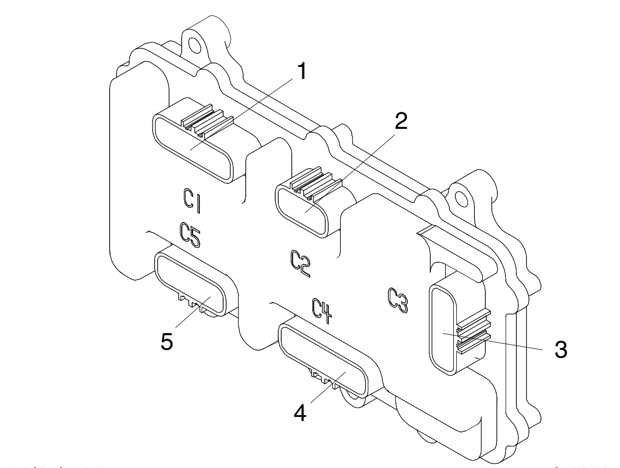
1. Chassis Module
2. Left Frame Rail
3. Cab Backwall
4. Crossmember
5. Driveline

Fig. 1, Chassis Module Installation



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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 Connectors

3. Remove the bolts and nuts that secure the Chassis Module or the Expansion Module, then remove the CHM or EXM.

Chassis Module and Expansion Module Replacement

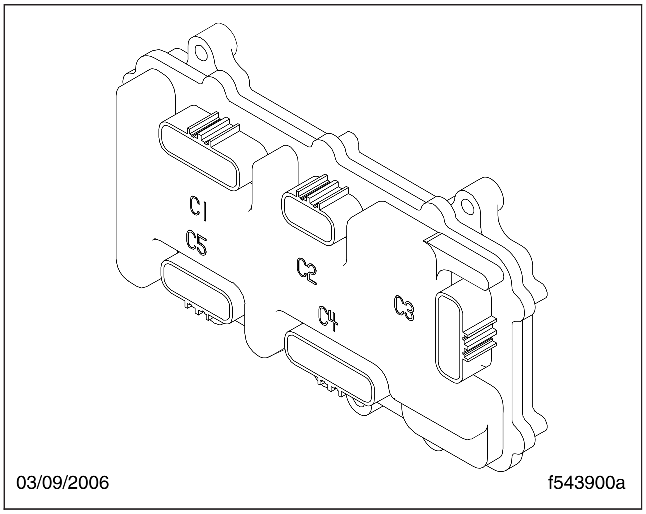


Fig. 3, Expansion Module Connectors

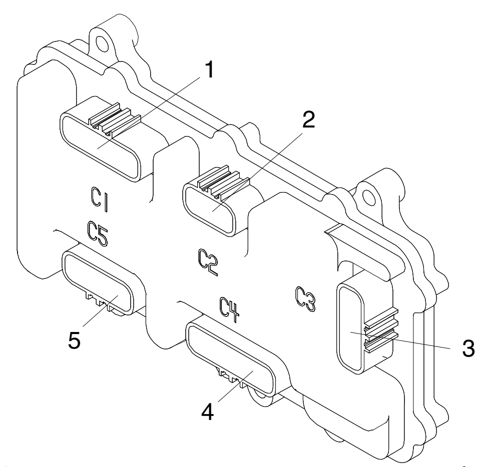
4. Properly orient the Chassis Module on its mounting plate. Using bolts and nuts, secure the CHM or EXM.
5. Connect the harnesses to the CHM or EXM.
6. Connect the batteries or turn the battery disconnect switch to on.
7. Check to make sure the electrical components work.

Chassis Module

See **Fig. 1** for an illustration of the Chassis Module (CHM).

See **Fig. 2** for an illustration of the CHM and EXM with pinout assignments and harness connectors.

See **Fig. 3** for a diagram of BHM and CHM outputs.



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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. 1, Chassis Module Harness Connectors

See **Fig. 4** for maximum allowable current load for the full Chassis Module output pins (part numbers 06-34530-XXX and 06-75158-000).

See **Fig. 5** for maximum allowable current load for the standard Chassis Module output pins (part number 06-42391-000).

NOTE: The power supply to the Bulkhead Module microprocessor is supplied from any of the five VBAT inputs (VBAT1, VBAT2, VBAT3, VBAT4, or VBAT5) through an internal diode network. The same is true for the Chassis Module with its input VBAT1, VBAT2, or VBAT3; VBAT4 on CHM 06-75158-000. In theory, if any one of the module's VBAT inputs is supplying power, the module will be functional.

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 CHM 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 CHM may be shortened.

Alternate Mounting Location of the CHM

On some M2 vehicles the CHM is factory installed under the cab instead of on the frame rail and behind the cab. This alternate location affects the wiring. See **Fig. 6**.

Example of How a Factory-installed Under-the-cab CHM Affects the Wiring

A vehicle with a factory-installed under-the-cab CHM and power takeoff (PTO) controls with an AMU/AAVA solenoid may be wired with circuit numbers 200 and 200E for the PTO AMU/AAVA solenoid as shown in **Fig. 6**. When these circuits become part of the jumper harness in the forward chassis harness, the circuit numbers change to 399F (or 481G) and 399G (or 481M) respectively.

In this example the remaining circuits contained in the jumper harness are unused. This may cause confusion since the G06-XXXXX-XXX wiring diagram for each individual function does not depict the additional wiring in the forward chassis harness or the circuit numbers when the CHM is mounted under the cab.

Expansion Module

See **Fig. 7** for an illustration of the Expansion Module (EXM).

See **Fig. 3** for an illustration of the CHM and EXM with pinout assignments and harness connectors.

Specifications

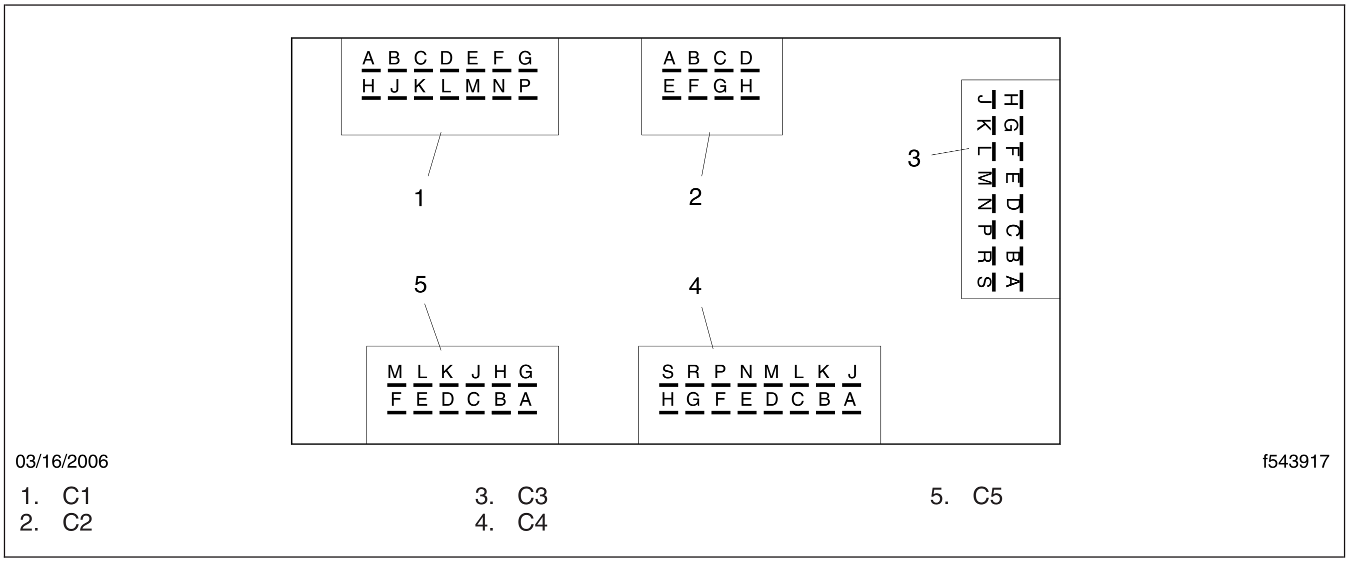


Fig. 2, Chassis Module and Expansion Module With Pinout Assignments and Harness Connectors

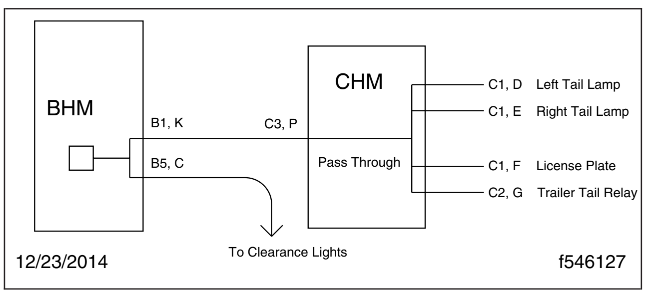


Fig. 3, BHM and CHM Outputs

See **Fig. 8** for maximum allowable current load for the Expansion Module output pins (part number 06-42399-000).

NOTE: Amperage listed is the maximum allowable amperage for each output circuit. When maximum allowable amperage is exceeded, the CHM may turn off the output.

When using ServiceLink® in Test Mode, the outputs will deliver more current than the maximum allowable current values shown. When testing, do not exceed the maximum combined values for more than a few seconds or the life of the output driver inside the module may be shortened.

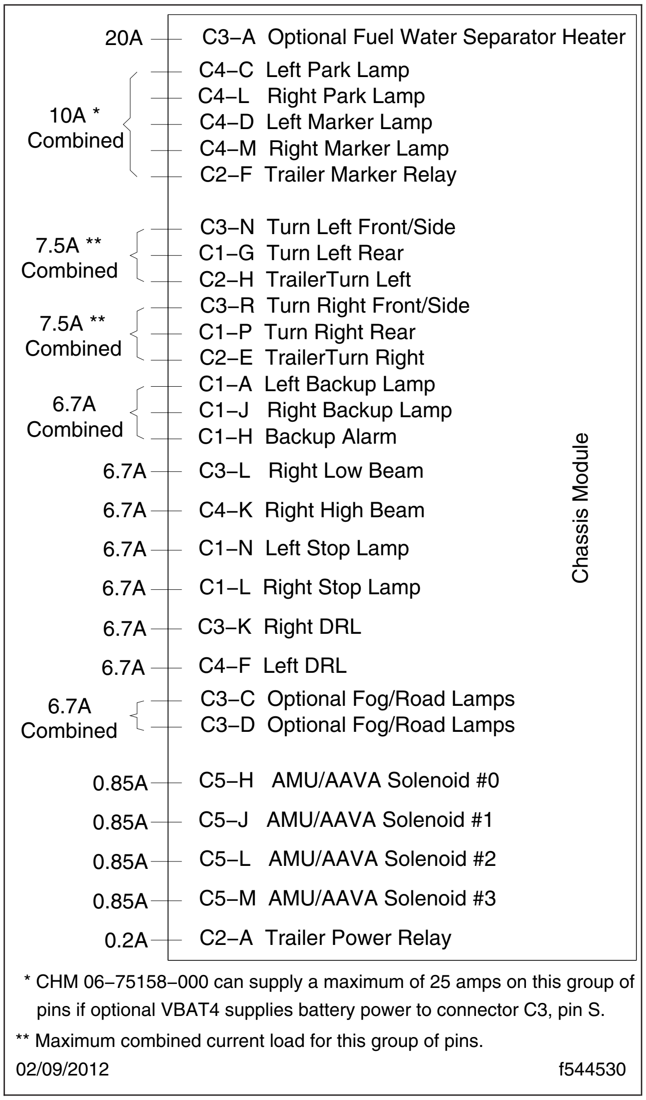


Fig. 4, Maximum Allowable Current Load for the Full Chassis Module Output Pins

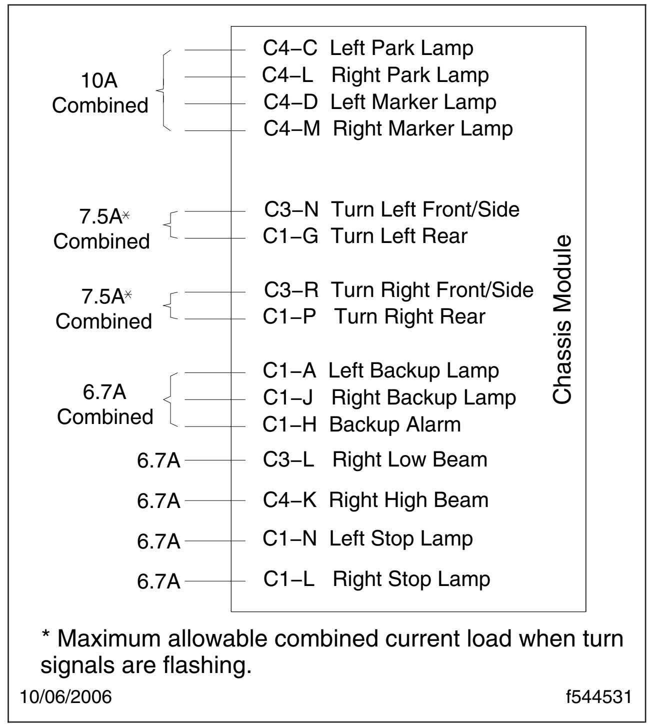
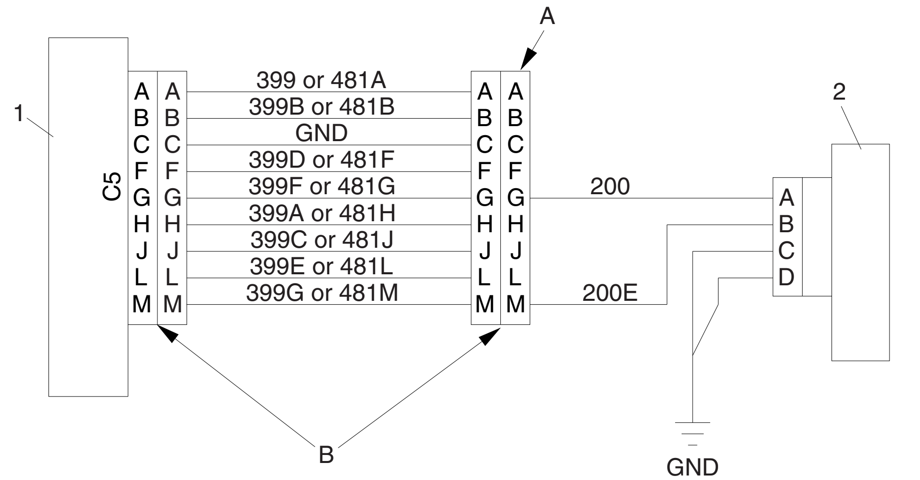


Fig. 5, Maximum Allowable Current Load for the Standard Chassis Module Output Pins (part number 06-42391-000)

Specifications



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A. This connector connects directly to the CHM C5 connector when the CHM is mounted on the frame rail, behind the cab. Check this connector for actual circuits used on the vehicle.
B. The jumper harness, which is part of the forward chassis harness, is present only when the CHM is mounted under the cab. The wires are numbered in either 399 series or 481 series depending on the harness manufacturer.

1. Chassis Module
2. Power Takeoff Solenoid

Fig. 6, Wiring Diagram of CHM Connector 5

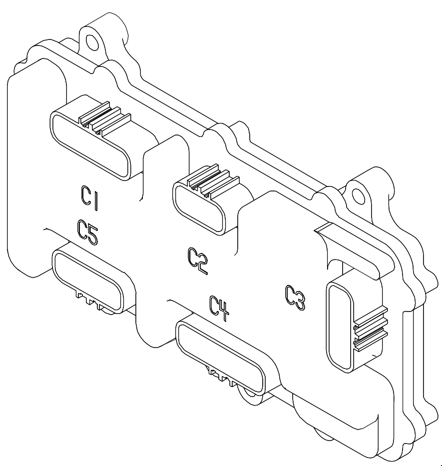

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Fig. 7, Expansion Module Harness Connectors

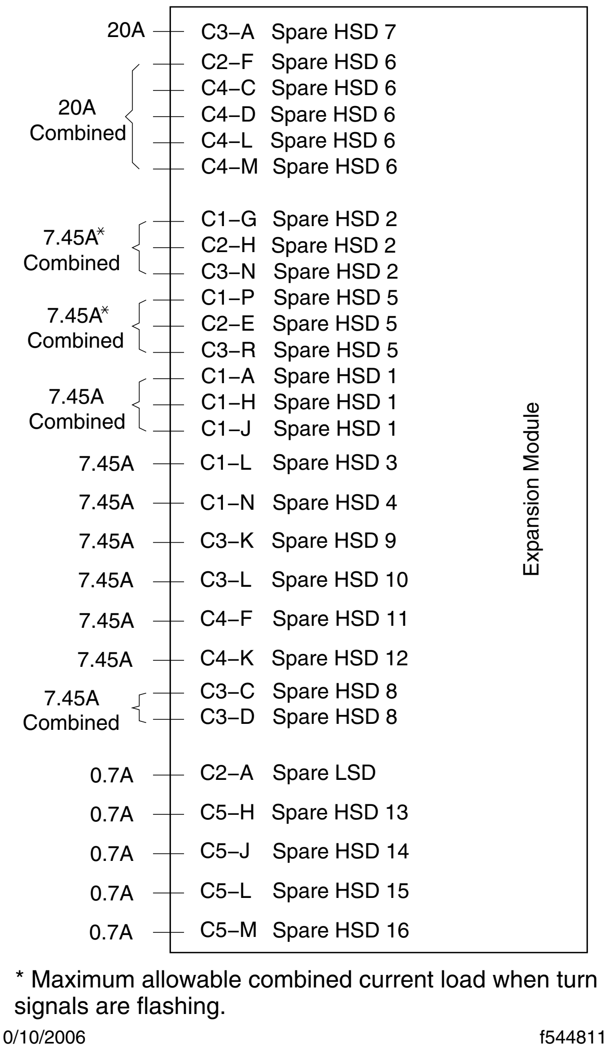


Fig. 8, Maximum Allowable Current Load for the Expansion Module Output Pins (part number 06-42399-000)

Taillight Harness Pinouts at Connector C1				
Connector and Pin Numbers	Signal Name	Signal Type	Full	Standard
C1-A	Left Backup Lamp	Digital Output	X	X
C1-D	Left Taillight Pass-Through	Pass-Through*	X	X
C1-E	Right Taillight Pass-Through	Pass-Through*	X	X
C1-F	License Plate Lamp Pass-Through	Pass-Through*	X	X
C1-G	Left Rear Turn Lamp Pass-Through	Digital Output	X	X
C1-H	Backup Alarm	Digital Output	X	X
C1-J	Right Backup Lamp	Digital Output	X	X

Specifications

Taillight Harness Pinouts at Connector C1				
Connector and Pin Numbers	Signal Name	Signal Type	Full	Standard
C1-L	Right Stop Lamp	Digital Output	X	X
C1-N	Left Stop Lamp	Digital Output	X	X
C1-P	Right Rear Turn Lamp	Digital Output	X	X

* This pin is sourced by pin C3-P.

Table 1, Taillight Harness Pinouts at Connector C1

Trailer Module Harness Pinouts at Connector C2				
Connector and Pin Numbers	Signal Name	Signal Type	Full	Standard
C2-A	Trailer Power Relay	Digital Output	X	—
C2-C	Ground	Power Ground	X	—
C2-D	Trailer Stop Lamp Relay Pass-Through	Pass-Through*	X	—
C2-E	Trailer Right Turn Lamp	Digital Output	X	—
C2-F	Trailer Marker Lamps Relay	Digital Output	X	—
C2-G	Trailer Taillight Relay Pass-Through	Pass-Through†	X	—
C2-H	Trailer Left Turn Lamp	Digital Output	X	—

* CHM C2-D is connected internally to CHM C3-G, which is the GROUND-activated input for the service brake.

† This pin is sourced by pin C3-P.

Table 2, Trailer Module Harness Pinouts at Connector C2

Forward Chassis Harness Pinouts at Connector C3				
Connector and Pin Numbers	Signal Name	Signal Type	Full	Standard
C3-A	Fuel/Water Separator Heater	Digital Output	X	—
C3-B	J1587– Datalink (not used on CHM 06-75158-000)	Datalink	X	X
C3-C	Fog/Road Lamps	Digital Output	X	—
C3-D	Fog/Road Lamps	Digital Output	X	—
C3-E	Low Air Pressure	Digital Input (active low)	X	X
C3-F	Park Brake	Digital Input (active low)	X	X
C3-G	Service Brake	Digital Input (active low)	X	X
C3-H	Ground	Power Ground	X	X
C3-J	Main Battery Power (VBAT2)	Power	X	X
C3-K	Right DRL	Digital Output	X	—
C3-L	Right Low Beam	Digital Output	X	X
C3-M	Ignition	Digital Input (active high)	X	X
C3-N	Left Front/Side Turn Lamp	Digital Output	X	X

Forward Chassis Harness Pinouts at Connector C3				
Connector and Pin Numbers	Signal Name	Signal Type	Full	Standard
C3-P	Taillight/License Plate Lamps Pass-Through	Pass-Through	X	X
C3-R	Right Front/Side Turn Lamp	Digital Output	X	X
C3-S	J1587+ Datalink or VBAT4 on CHM 06-75158-000	Datalink	X	X

Table 3, Forward Chassis Harness Pinouts at Connector C3

Forward Chassis Harness Pinouts at Connector C4				
Connector and Pin Numbers	Signal Name	Signal Type	Full	Standard
C4-A	Module Wake-Up Signal	Digital Input/Output	X	X
C4-B	Address Identification A	Analog Input	X	X
C4-C	Left Park Lamp	Digital Output	X	X
C4-D	Left Marker Lamp	Digital Output	X	X
C4-E	Address Identification C	Analog Input	X	X
C4-F	Left DRL	Digital Output	X	—
C4-G	J1939+ Datalink	Datalink	X	X
C4-H	Ground (address identification D)	Signal Ground	X	X
C4-J	Main Battery Power (VBAT3)	Power	X	—
C4-K	Right High Beam	Digital Output	X	X
C4-L	Right Park Lamp	Digital Output	X	X
C4-M	Right Marker Lamp	Digital Output	X	X
C4-N	Address Identification B	Analog Input	X	X
C4-P	Main Battery Power (VBAT1)	Power	X	X
C4-R	J1939– Datalink	Datalink	X	X
C4-S	Ground	Power Ground	X	X

Table 4, Forward Chassis Harness Pinouts at Connector C4

Connector C5 Air Controls				
Connector and Pin Numbers	Signal Name	Signal Type	Full	Standard
C5-A	Pressure Signal Analog Input 0	Digital Input (active low), Analog Input	X	—
C5-B	Pressure Signal Analog Input 1	Digital Input (active low), Analog Input	X	—
C5-C	Ground	Signal Ground	X	—
C5-F	Pressure Signal Analog Input 2	Digital Input (active low), Analog Input	X	—
C5-G	Pressure Signal Analog Input 3	Digital Input (active low), Analog Input	X	—
C5-H	Solenoid 0	Digital Output	X	—

Specifications

Connector C5 Air Controls				
Connector and Pin Numbers	Signal Name	Signal Type	Full	Standard
C5-J	Solenoid 1	Digital Output	X	—
C5-L	Solenoid 2	Digital Output	X	—
C5-M	Solenoid 3	Digital Output	X	—

Table 5, Connector C5 Air Controls

Power Supply Fuses and Associated Outputs for the Chassis Module				
CHM Power Input	CHM Power Input Pin	Fuse Supplying CHM Power Input	CHM Outputs Supplied	CHM Output Pin
Power In			Power Out	
VBAT1	C4.P	Fuse 19 (30A)	Right Low Beam	C3.L
			Turn Right Front/Side	C3.R
			Turn Right Rear	C1.P
			Right Stop Lamp	C1.L
			Left Stop Lamp	C1.N
			Right DRL	C3.K
			Fog/Road Lamps	C3.C/C3.D
			Trailer Turn Right	C2.E
VBAT2 VBAT4	C3.J	Fuse 17 (30A)	Left Park Lamp	C4.C
			Right Park Lamp	C4.L
			Left Marker Lamp	C4.D
			Right Marker Lamp	C4.M
			Trailer Marker Relay	C2.F
			Right High Beam	C4.K
			Left Backup Lamp	C1.A
			Right Backup Lamp	C1.J
			Backup Alarm	C1.H
			Turn Left Front/Side	C3.N
			Turn Left Rear	C1.G
			Left DRL	C4.F
			Trailer Turn Left	C2.H

Specifications

Power Supply Fuses and Associated Outputs for the Chassis Module				
CHM Power Input	**CHM Power Input Pin**	**Fuse Supplying CHM Power Input**	**CHM Outputs Supplied**	**CHM Output Pin**
Power In			**Power Out**	
VBAT3	C4.J	Fuse 13 (30A)	Fuel Water Separator Heater	C3.A
			Solenoid 0	C5.H
			Solenoid 1	C5.J
			Solenoid 2	C5.L
			Solenoid 3	C5.M

Table 6, Power Supply Fuses and Associated Outputs for the Chassis Module

Chassis Module Pass-Throughs		
CHM Input	**CHM Outputs Supplied**	**CHM Output Pin**
C3.P*	Left Taillight	C1.D
	Right Taillight	C1.E
	Trailer Taillight Relay	C2.G
	License Plate Lamp	C1.F

* CHM pin C3.P is supplied by BHM pin B1.K.

Table 7, Chassis Module Pass-Throughs

Pinouts at Connector C1		
Connector and Pin Numbers*	**Signal Name**	**Signal Type**
C1-A	Spare HSD 1†	7.45A Output (combined load, all pins)
C1-H		
C1-J		
C1-G	Spare HSD 2	
C2-H		
C3-N		
C1-L	Spare HSD 3	
C1-N	Spare HSD 4	
C1-P	Spare HSD 5	
C2-E		
C3-R		

* Connector and pin numbers in bold are from another connector.

† High Side Driver

Table 8, Pinouts at Connector C1

Pinouts at Connector C2		
Connector and Pin Numbers	**Signal Name**	**Signal Type**
C2-A	Spare LSD*	Output
C2-C	Ground	Ground
C2-D	See C3-G	—
C2-E	See C1-P	—
C2-F	Spare HSD 6†	20A Output
C2-H	See C1-G	—

* Low Side Driver

† High Side Driver

Table 9, Pinouts at Connector C2

Pinouts at Connector C3		
Connector and Pin Numbers	**Signal Name**	**Signal Type**
C3-A	Spare HSD 7*	20A Output
C3-B	J1587–	Datalink
C3-C	Spare HSD 8	7.45A Output
C3-D	See C3-C	—
C3-E	Spare Input 1	Digital (active low) Input
C3-F	Spare Input 2	Digital (active low) Input
C3-G	Spare Input 3	Digital (active low) Input
C3-H	Ground	Ground
C3-J	VBAT 2	Power
C3-K	Spare HSD 9	7.45A Output
C3-L	Spare HSD 10	7.45A Output

Specifications

Pinouts at Connector C3		
Connector and Pin Numbers	**Signal Name**	**Signal Type**
C3-M	Ignition	Digital (active high) Input
C3-N	See C1-G	—
C3-R	See C1-P	—
C3-S	J1587+	Datalink

* High Side Driver

Table 10, Pinouts at Connector C3

Pinouts at Connector C4		
Connector and Pin Numbers	**Signal Name**	**Signal Type**
C4-A	Module Wake-Up	Digital Input/Output
C4-B	Address Strapping A	Analog Input
C4-C	See C2-F	—
C4-D		
C4-E	Address Strapping C	Analog Input
C4-F	Spare HSD 11*	7.45A Output
C4-G	J1939+ Datalink	Datalink
C4-H	Address Strapping Ground	Signal Ground
C4-J	VBAT 3	Power
C4-K	Spare HSD 12	7.45A Output
C4-L	See C2-F	—
C4-M		
C4-N	Address Strapping B	Analog Input
C4-P	VBAT1	Power
C4-R	J1939– Datalink	Datalink
C4-S	Ground	Power Ground

* High Side Driver

Table 11, Pinouts at Connector C4

Pinouts at Connector C5		
Connector and Pin Numbers	**Signal Name**	**Signal Type**
C5-A	Spare Input 4	Digital (active low) Input
C5-B	Spare Input 5	
C5-F	Spare Input 6	
C5-G	Spare Input 7	
C5-H	Spare HSD 13*	0.7A Output
C5-J	Spare HSD 14	
C5-L	Spare HSD 15	
C5-M	Spare HSD 16	

* High Side Driver

Table 12, Pinouts at Connector C5

Contents

General Information

Smart switches are optional low-current switches that are connected to the Bulkhead Module (BHM) or to an optional Switch Expansion Module (SEM) on a Business Class® M2 vehicle. A smart switch is used to activate an optional feature on the vehicle. These features may include, but are not limited to:

- fog lights
- differential lock control
- interaxle lock control
- pusher and tag axle controls
- fifth wheel slide control
- PTO control
- split-shaft PTO and fire pump controls
- marker light interrupt control

A smart switch is similar in appearance to a high-current switch. A smart switch can be differentiated from a high-current switch by the part number that is marked on the side of the switch. Each smart switch has a base part number of A06-37217.

Another way to differentiate a smart switch from a high-current switch is to look at the electrical connector used on the switch. See **Fig. 1** and **Fig. 2** for illustrations of the connectors used on smart switches and high-current switches.

A smart switch is significantly different from a high-current switch. Unlike a high-current switch, the smart switch is designed to control very low currents, and will be damaged if it is connected to a high-current circuit. A smart switch has an internal printed circuit board which contains:

- A light-emitting diode (LED) for backlighting the switch when the headlights are turned on;
- A light-emitting diode (LED) that, when on solid, indicates the feature is activated and, when blinking, indicates an error condition.
- Two precision resistors that are used to create a unique switch identifier that allows the BHM to identify each switch that is connected;
- Three precision resistors that are used to indicate the position of the switch.

A small number of smart switches do not have an LED indicator. Instead, these switches have two LEDs for backlighting.

A smart switch does not function correctly without programming the BHM. Optional features are designed around specific smart switch part numbers, and a different smart switch number cannot be substituted.

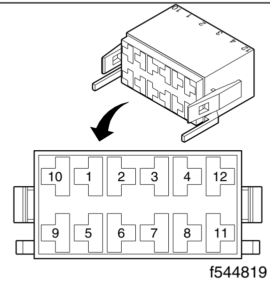


Fig. 1, Connector Used on a Smart Switch

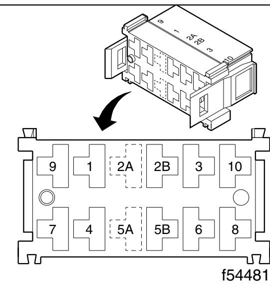


Fig. 2, Connector Used on a High-current Switch

Smart Switches Removal and Installation

Removal

1. Turn off the engine, apply the parking brakes, and chock the tires.
2. Remove the trim plate panel. For instructions, see **Section 60.08, Subject 100**.
3. Remove the gauge panel surrounding the smart switch you want to remove. For instructions, see **Section 60.08, Subject 100**.
4. Disconnect the electrical connector from the smart switch.
5. Remove the smart switch from the gauge panel.

Installation

1. Install a new smart switch in the gauge panel.
2. Connect the electrical connector to the smart switch.
3. Install the gauge panel. For instructions, see **Section 60.08, Subject 100**.
4. Install the trim plate panel. For instructions, see **Section 60.08, Subject 100**.
5. Remove the chocks from the tires.

Typical Smart Switch Faults

Smart switch faults must be diagnosed to determine if the smart switch itself is the cause of the problem. See **Table 1** for symptoms that might indicate a smart switch fault.

See **Table 2** for descriptions of smart switch faults.

Determining Which Smart Switches the Vehicle is Programmed to Use

Use the following instructions to determine which vehicle functions use a smart switch.

1. Log on to ServiceLink® and click on the BHM icon.
2. Click on the **Features** tab.
3. All of the reference parameters programmed into the Bulkhead Module (BHM) that use a smart switch have "(Smart Switch)" in the description of the reference parameter. See **Fig. 1**.

Smart Switch Faults						
J1587 Fault			J1939 Fault			Fault Description
MID	SID	FMI	SA	SPN	FMI	
164	022	07	33	6918	07	Missing Smart Switch
164	021	07	33	6919	07	Duplicate Smart Switch
164	020	07	33	6920	07	Extra Smart Switch
—	—	—	128	6914	04	Smart Switch VBAT Short to Ground
—	—	—	129	6914	04	Smart Switch VBAT Short to Ground
—	—	—	130	6914	04	Smart Switch VBAT Short to Ground
—	—	—	131	6914	04	Smart Switch VBAT Short to Ground

Table 1, Smart Switch Faults

Definition of Smart Switch Faults	
Problem	**Description**
Missing Smart Switch Fault	The BHM cannot detect a smart switch for a function that is programmed into the BHM by a reference parameter For example, no fog lamp switch, but a reference parameter for fog lamps is programmed into the BHM.
Duplicate Smart Switch Fault	The BHM has detected more than one smart switch for a particular function programmed into the BHM by a reference parameter. For example, two fog lamp smart switches are connected.
Extra Smart Switch Fault	The BHM detects a smart switch for a function that is not programmed into the BHM by a reference parameter. For example, a fog lamp switch is connected, but the vehicle is not programmed for fog lamps.
Smart Switch VBAT Short to Ground	The smart switch indicator and/or backlight drive circuit is overloaded. Only smart switches connected to a SEM report this fault.

Table 2, Definition of Smart Switch Faults

Currently Installed Features

Reference Parameter	Description
26–01017–001	With 7 Way Center Pin Ignition Supply
26–01019–001	With Marker Interrupt Switch (Smart Switch)
26–01020–014	With Combo Stop/Turn Lamps
26–01021–000	Without Fog or Road Lamps
26–01026–001	Dome Lamps
26–01030–000	Not Multiplexed, Transmission Wiring
26–01031–000	Not Multiplexed, Vehicle Interface Wiring
26–01032–003	PTO End of Frame Air Control, With Ignition Interlock (Smart Switch)
26–01034–000	With Brake Line Air Dryer
26–01038–000	Not Multiplexed, Window Power
26–01039–000	Windshield Washer, Without Fluid Level Sensor
26–01042–000	With HVAC, Not Multiplexed
26–01045–000	With Backup Alarm, Manual Transmission
26–01047–000	With Electric Horn
26–01052–000	Audio System, Not Multiplexed
26–01053–000	With Heated Mirrors (Smart Switch)

Refresh Features List | **Undo Last Changes** | **Display Wiring Instructions**

11/09/2005 f544680

Fig. 1, Currently Installed Features Screen

NOTE: Some reference parameter descriptions may indicate there is a smart switch even if the description indicates the vehicle is not programmed with that feature. An example is 26-01019-000, "Without Marker Interrupt Switch (Smart Switch)." Since a vehicle with this reference parameter is not programmed with the marker interrupt switch, there is no marker interrupt smart switch.

4. If the vehicle is equipped with a Switch Expansion Module, there will be an icon on the left-side menu of ServiceLink for that ECU. Click on that icon to display a separate tab for smart switches. This screen lists all smart switches connected to the SEM.

NOTE: Smart switches connected to the Bulkhead Module are not listed in the Switch Expansion Module smart switch screen.

5. To verify which smart switches are connected to the SEM, click the **Identify SEM** button in ServiceLink on the SEM Smart Switch screen. See **Fig. 2**. The smart switch indicator lights will blink for the switches connected to the SEM.

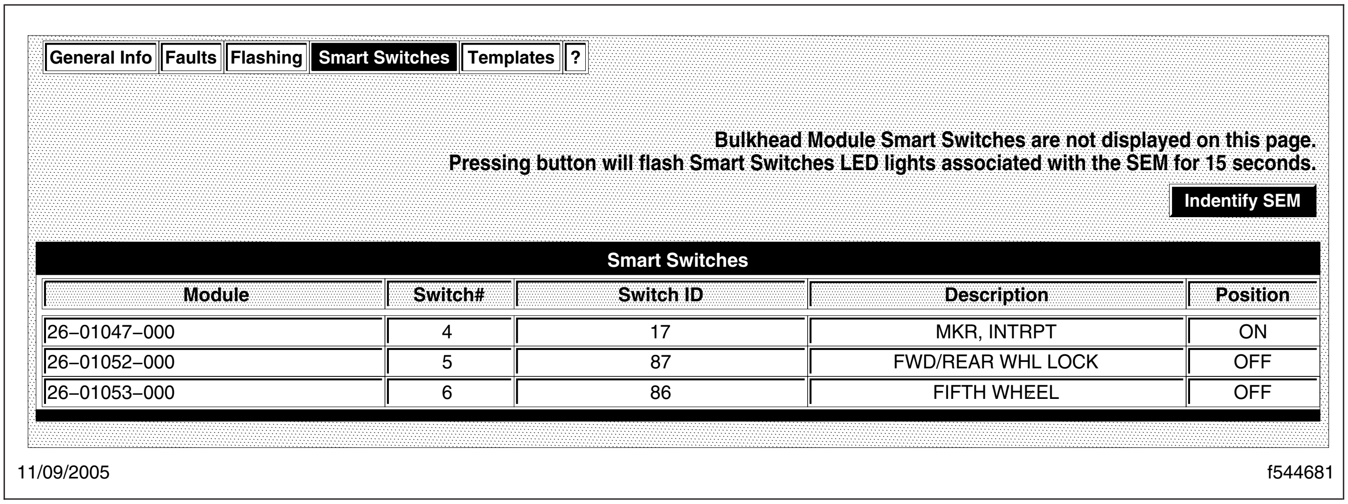
Troubleshooting Smart Switch Faults

Use the following instructions to troubleshoot the smart switch faults described in **Table 2**.

Missing Smart Switch Fault

The Missing Smart Switch fault occurs when a smart switch that the BHM is programmed to use is not found connected to one of the five BHM ports or one of the six SEM ports. Use the following steps to troubleshoot this fault.

1. Access the Features screen in ServiceLink to determine which smart switches the vehicle is



Smart Switches				
Module	Switch#	Switch ID	Description	Position
26–01047–000	4	17	MKR, INTRPT	ON
26–01052–000	5	87	FWD/REAR WHL LOCK	OFF
26–01053–000	6	86	FIFTH WHEEL	OFF

Fig. 2, SEM Smart Switch Screen

programmed to use. For instructions, see "Determining Which Smart Switches the Vehicle is Programmed to Use" in this subject.

2. Identify which smart switches the vehicle recognizes as being installed using one of the appropriate J1939 templates in ServiceLink (for either the BHM or the SEM).

NOTE: See the ServiceLink User's Guide under "Templates" for instructions on using the DataLink monitor templates. These templates provide the unique smart switch decimal value that indicates what smart switches the Bulkhead Module is programmed to use.

3. See the "Smart Switch Part Number, Function, and ID Number" table in **Specifications 400** to cross-reference the smart switch decimal value with the smart switch function. Compare this with the smart switches that were expected based on what features the Bulkhead Module was programmed to use.

4. Determine which smart switch is missing or not being correctly identified.

   A missing smart switch fault may occur due to one of the following conditions:

   - The smart switch is physically not connected.
   - There is a switch ID circuit wiring problem.
   - J1939 communication problems exist between an optional SEM and the BHM.
   - The switch ID resistors in the smart switch itself are faulty.

5. Remove the smart switch from the dash. Using the "Smart Switch Part Number, Function, and ID Number" table in **Specifications 400**, determine the values of ID resistors R1 and R2. Add the R1 and R2 values. Measure the resistance between pins 7 and 8 of the smart switch. If the measurement is within 1 percent of the added resistance value, the switch is okay.

Extra Smart Switch Fault

The Extra Smart Switch fault indicates that a smart switch that the vehicle is not programmed to utilize is found connected to one of the five BHM or six SEM smart switch ports. Use the following steps to troubleshoot this fault.

1. Access the Features screen in ServiceLink to determine which smart switches the vehicle is programmed to use. For instructions, see "Determining Which Smart Switches the Vehicle is Programmed to Use" in this subject.

2. Identify which smart switches the vehicle recognizes as being installed using one of the appropriate J1939 templates in ServiceLink (for either the BHM or the SEM).

NOTE: See the ServiceLink User's Guide under "Templates" for instructions on using DataLink monitor templates. These templates provide the unique smart switch ID number that indicates what smart switches the Bulkhead Module actually recognizes as being on the vehicle.

3. See the "Smart Switch Part Number, Function, and ID Number" table in **Specifications 400** to cross-reference the smart switch part number with the smart switch function. Compare this with the smart switches that were expected based on what features the Bulkhead Module was programmed to use.
4. Determine which smart switch is missing or not being correctly identified.

Duplicate Smart Switch Fault

The Duplicate Smart Switch fault indicates that there are two or more identical smart switches connected to either the BHM or SEM smart switch ports.

Determine which smart switches the vehicle is programmed to use. See the Features screen in ServiceLink to determine which smart switches the vehicle is programmed to use. For instructions, see "Determining Which Smart Switches the Vehicle is Programmed to Use" in this subject.

The switch function that is duplicated will be two or more smart switch ports that have the same smart switch ID number shown in the applicable template. The duplicate switch must be disconnected. See the ServiceLink User's Guide under "Templates" for instructions on using DataLink monitor templates.

Smart Switch VBAT Short to Ground Fault

The Smart Switch VBAT Short to Ground fault indicates a smart switch indicator and/or backlight drive circuit is overloaded. Only smart switches connected to a SEM will report this fault. Use the following steps to troubleshoot this fault.

1. Access ServiceLink to determine which smart switches are connected specifically to the SEM.
2. Click on the **Switch Expansion Module** icon on the left-side list of the ECUs.
3. Click on the **Smart Switch** tab. A list of all smart switches that are connected to the SEM will be displayed.
4. Click on the **Identify SEM** button in ServiceLink. This causes the smart switch indicator lights to blink.
5. Based on the descriptions of the switches connected to the SEM, look for the smart switch that is connected to the SEM, but has an indicator light that is not blinking.
6. Once the affected smart switch is identified, troubleshoot the switch and check the wiring for a short circuit.

The Switch Controlled Option Does Not Work

When a smart switch controlled option does not work when the smart switch is activated, the problem is likely due to one of the conditions described in **Table 3**.

If a function does not work and there are no active smart switch fault codes, then the following procedure will help determine if the smart switch itself or its wiring is the cause of the problem. If smart switch fault code(s) are active, troubleshoot them first.

To determine if the smart switch or its wiring is the cause of the multiplexed function not working, see **Table 4**.

Smart Switch Controlled Option Faults	
Problem	**Description**
Hardware problems	Main VBAT fuse that supplies the output pin is open.
	BHM, CHM, or EXM output driver circuit is overloaded; too much current will cause the output to shut off.
	Faulty BHM, CHM, or EXM output driver (internal BHM, CHM, or EXM problem).
Output problems	The output device is faulty. For example, the suspension dump AMU/AAVA solenoid valve is faulty.
	The output device wiring is faulty.
	Output is not wired to the correct output pin.
	If the output is connected to the CHM, there are possible J1939 communication problems between the BHM and CHM.
	If the output is connected to an EXM, there are possible J1939 communication problems between the BHM and EXM.
Input problems	Faulty smart switch.
	Faulty smart switch wiring.
	Other input conditions for the function to activate are not met. For example, the BHM does not sense that the park brake is set in order to activate the suspension dump valve.
	J1939 communication problems exist between the optional SEM and the BHM.
Software problems	The reference parameter is not compatible with vehicle options.
	The reference parameter has errors.

Table 3, Smart Switch Controlled Option Faults

Smart Switch Troubleshooting			
Step	**Test Procedure**	**Test Result**	**Action**
1	Are any smart switch faults active?	Yes	Troubleshoot faults as outlined in this subject.
		No	Go to **step 2**.

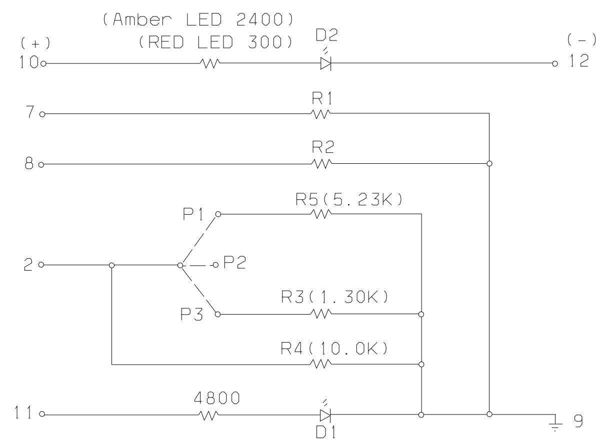
Troubleshooting

Smart Switch Troubleshooting			
Step	**Test Procedure**	**Test Result**	**Action**
2	Observe the smart switch indicator (if equipped) while attempting to operate the function with the switch. NOTE: If the switch does not have an indicator light, go to **step 3**.	Blinks steady	The function interlocks were met, but the BHM does not sense that the function actually engaged. For example, if a function uses an AMU/AAVA solenoid, the BHM may not be sensing that the function engaged through the AMU or air pressure switch. This could be caused by the AMU/AAVA solenoid not switching, a defective pressure switch, or a wiring fault. This does not indicate a problem with the smart switch.
		On, then quickly off	Some other condition is not met in order for the function to work. For example, if the function requires that the park brake be set in order for the function to operate, and the park brake is not set, then the function will not work. This does not indicate a problem with the smart switch.
		Off	Go to **step 3**.
		Switch does not have indicator	Go to **step 3**.
3	Using ServiceLink, access the BHM Features screen. Is there a reference parameter listed for the function, and does it indicate the use of a smart switch?	Yes	Go to **step 4**.
		No	The reference parameter for the function is not loaded into the BHM. Load the correct reference parameter using ServiceLink.
4	Find the part number on the smart switch for the function that is not working. Using the "Smart Switch Part Number, Function, and ID Number" table in **Specifications 400**, find the ID Number that corresponds to the part number of the switch. In ServiceLink, open the applicable smart switch template (either for the BHM, or SEM). Locate the column that has the smart switch ID that matches the ID Number in "Smart Switch Part Number, Function, and ID Number" table in **Specifications 400**. While observing the input or position status on the template, operate the switch through each position. There should be a change in either the voltage input, or position (depending on the template). Is there a change in switch position reflected in the template?	Yes	The problem is not with the smart switch or its wiring. The problem is either with the output to the function, or possibly a reference parameter problem.
		No	Go to **step 5**.

Smart Switch Troubleshooting			
Step	**Test Procedure**	**Test Result**	**Action**
5	Remove the smart switch. Check resistance between pins 2 and 9 for each switch position. Compare readings with the values specified in the "Switch Position Input Resistance, Pin 2 to Pin 9" table in **Specifications 400**. Are the resistance values within specifications?	Yes	Check wiring (circuit 474B) between pin 2 of the smart switch and the BHM. Repair as necessary.
		No	Replace the smart switch.

Table 4, Smart Switch Troubleshooting

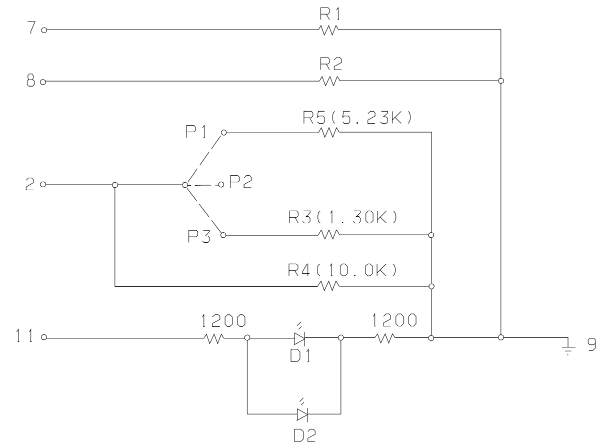
See **Fig. 1** for the wiring diagram of a two-position smart switch. See **Fig. 2** for the wiring diagram for a three-position smart switch.



08/27/2004 Ref. Dia. A06–37217 Chg. Ltr. K f544518

D2 Activation LED
R1 ID No. 1 Resistor
R2 ID No. 2 Resistor
R3 Switch Position No. 3 Resistor
R4 Switch Off Resistor (Same as switch position no. 2; only applies to switches with on/off/on pattern.)
R5 Switch Position No. 1 Resistor
D1 Backlighting LED

Fig. 1, Smart Switch Wiring, Circuit Diagram A



08/31/2004 Ref. Dia. A06–37217 Chg. Ltr. K f544519

R1 ID No. 1 Resistor
R2 ID No. 2 Resistor
R3 Switch Position No. 3 Resistor
R4 Switch Off Resistor (Same as switch position no. 2; only applies to switches with on/off/on pattern.)
R5 Switch Position No. 1 Resistor
D1 Backlighting LED
D2 Backlighting LED

Fig. 2, Smart Switch Wiring, Circuit Diagram B

Pinout for Circuit Diagram A Smart Switch		
Pin	**Circuit Number**	**Circuit Description**
2	474B	Switch Position Input
7	474C	Switch Function ID 1 Input
8	474D	Switch Function ID 2 Input
9	GND	Ground
10	14E	Indicator (+)
11	29A	Backlighting (+)
12	474A	Indicator (–)

Table 1, Pinout for Circuit Diagram A Smart Switch

Pinout for Circuit Diagram B Smart Switch		
Pin	**Circuit Number**	**Circuit Description**
2	474B	Switch Position Input

Specifications

Pinout for Circuit Diagram B Smart Switch		
Pin	**Circuit Number**	**Circuit Description**
7	474C	Switch Function ID 1 Input
8	474D	Switch Function ID 2 Input
9	GND	Ground
11	29A	Backlighting (+)

Table 2, Pinout for Circuit Diagram B Smart Switch

Switch Position Input Resistance, Pin 2 to Pin 9		
Lower Switch Position	**Mid Switch Position**	**Upper Switch Position**
1138 to 1162 ohms	9900 to 10,100 ohms	3400 to 3468 ohms

Table 3, Switch Position Input Resistance, Pin 2 to Pin 9

Smart Switch Part Number, Function, and ID Number					
Smart Switch Part Number	**Smart Switch Function**	**Circuit Diagram**	**Smart Switch ID Number**	**R1 Value in Ohms**	**R2 Value in Ohms**
A06-37217-000	Marker Interrupt	A	17	1020	1020
A06-37217-001	Engine Retarder	A	18	1020	1300
A06-37217-002	Mirror Heat	A	19	1020	1620
A06-37217-003	Utility Lamp	A	20	1020	2000
A06-37217-005	Fog Lamp	A	22	1020	2940
A06-37217-006	Rear Fog Lamp	A	23	1020	3570
A06-37217-007	Snowplow	A	24	1020	4320
A06-37217-008	Bunk Override	A	25	1020	5230
A06-37217-009	Engine Check	A	26	1020	6340
A06-37217-010	PTO	A	27	1020	7870
A06-37217-011	Transretarder	A	28	1020	10,000
A06-37217-012	Brake Check	A	33	1300	1020
A06-37217-013	Dome Lamp	A	34	1300	1300
A06-37217-014	Optional	A	35	1300	1620
A06-37217-015	Shutdown Override	A	36	1300	2000
A06-37217-016	Engine Fan	A	37	1300	2430
A06-37217-017	PTO	A	38	1300	2940
A06-37217-018	Transfer Case	A	39	1300	3570
A06-37217-019	Fuel Heater	A	40	1300	4320
A06-37217-020	Transfer Case	A	41	1300	5230
A06-37217-021	Spot Lamp	A	42	1300	6340
A06-37217-022	Advertising Light	A	43	1300	7870

Specifications

Smart Switch Part Number, Function, and ID Number					
Smart Switch Part Number	**Smart Switch Function**	**Circuit Diagram**	**Smart Switch ID Number**	**R1 Value in Ohms**	**R2 Value in Ohms**
A06-37217-023	Trailer Auxiliary	A	44	1300	10,000
A06-37217-024	Lift Axle	A	49	1620	1020
A06-37217-025	Air Unloader	A	50	1620	1300
A06-37217-026	Axle Shift	A	51	1620	1620
A06-37217-027	Beacon	A	52	1620	2000
A06-37217-028	Increment/Decrement	B	53	1620	2430
A06-37217-029	Bunk Control	A	54	1620	2940
A06-37217-030	Interaxle Lock	A	55	1620	3570
A06-37217-031	Forward Wheel Lock	A	56	1620	4320
A06-37217-032	Left Step	A	57	1620	5230
A06-37217-033	Right Step	A	58	1620	6340
A06-37217-034	Rear Wheel Lock	A	59	1620	7870
A06-37217-035	Auxiliary Transmission	A	60	1620	10,000
A06-37217-036	Suspension Dump	A	65	2000	1020
A06-37217-037	Fifth Wheel Slide	A	66	2000	1300
A06-37217-038	Alternate Flasher	A	67	2000	1620
A06-37217-039	DRL Override	A	68	2000	2000
A06-37217-040	Backup Alarm	A	69	2000	2430
A06-37217-041	Lift Axle 2	A	70	2000	2940
A06-37217-042	RPM Control	A	71	2000	3570
A06-37217-043	RPM+/RPM–	B	72	2000	4320
A06-37217-044	Center Wheel Lock	A	73	2000	5230
A06-37217-045	Interaxle Lock 2	A	74	2000	6340
A06-37217-046	Forward Wheel Lock	A	75	2000	7870
A06-37217-047	Transfer Case PTO	A	76	2000	10,000
A06-37217-048	Auxiliary Air	A	81	2430	1020
A06-37217-049	Auxiliary Air 2	A	82	2430	1300
A06-37217-050	Auxiliary Air 3	A	83	2430	1620
A06-37217-051	Auxiliary Air 4	A	84	2430	2000
A06-37217-052	Headlamp/Marker	B	—	—	—
A06-37217-053	Dimmer	B	—	—	—
A06-37217-056	Exhaust Brake	A	85	2430	2430
A06-37217-057	Electric/Air Horn	B	86	2430	2940
A06-37217-058	Front/Rear Wheel Lock	A	87	2430	3570
A06-37217-059	Interaxle Lock 1	A	88	2430	4320

Specifications

Smart Switch Part Number, Function, and ID Number					
Smart Switch Part Number	Smart Switch Function	Circuit Diagram	Smart Switch ID Number	R1 Value in Ohms	R2 Value in Ohms
A06-37217-060	Interaxle Lock 1 & 2	A	89	2430	6340
A06-37217-061	Forward Wheel Lock	A	90	2430	10,000
A06-37217-062	Rear Wheel Lock	A	91	2430	7870
A06-37217-063	Forward/Center Wheel Lock	A	92	2430	10,000
A06-37217-064	Center/Rear Wheel Lock	A	97	2940	1020
A06-37217-065	Rear Wheel Lock	A	98	2940	1300
A06-37217-066	Forward/Center/Rear Wheel Lock	A	99	2940	1620
A06-37217-067	All Wheel Drive	A	100	2940	2000
A06-37217-068	Lift Axle 1	A	101	2940	2430
A06-37217-069	Lift Axle 3	A	102	2940	2940
A06-37217-070	Auxiliary Axle 5	A	103	2940	3570
A06-37217-071	Fire Pump	A	104	2940	4320
A06-37217-073	Marker Interrupt	B	17	1020	1020
A06-37217-074	Engine Air Intake	A	105	2940	5230
A06-37217-077	Electric/Air Horn	A	86	2430	2940
A06-37217-078	Lift Axle	A	49	1620	1020
A06-37217-079	Lift Axle 1	A	101	2940	2430
A06-37217-080	Lift Axle 2	A	70	2000	2940
A06-37217-081	Lift Axle 3	A	102	2940	2940
A06-37217-084	Compartment Lamp	A	106	2940	6340
A06-37217-085	Right Compartment Lamp	A	107	2940	7870
A06-37217-086	Left Compartment Lamp	A	108	2940	10,000

Table 4, Smart Switch Part Number, Function, and ID Number

Contents

General Information

The multifunction turn signal switch is mounted on the left side of the steering column, just below the steering wheel. The switch controls the:

- turn signals
- windshield wipers and washers
- headlight dimmer/flash to pass
- hazard warning flasher

The switch uses a low-current resistive ladder network for the switch functions. Low-current switches allow the use of smaller diameter wires, while the resistive ladder network reduces the number of wires.

Each switch function corresponds to a resistive output. The resistive ladder output is connected to the instrumentation control unit (ICU3-M2) where the signals are processed and sent to the Bulkhead Module to actuate high-current devices such as the headlights, turn signals, and wiper motor.

The hazard switch is a traditional switch and is directly wired to the Bulkhead Module.

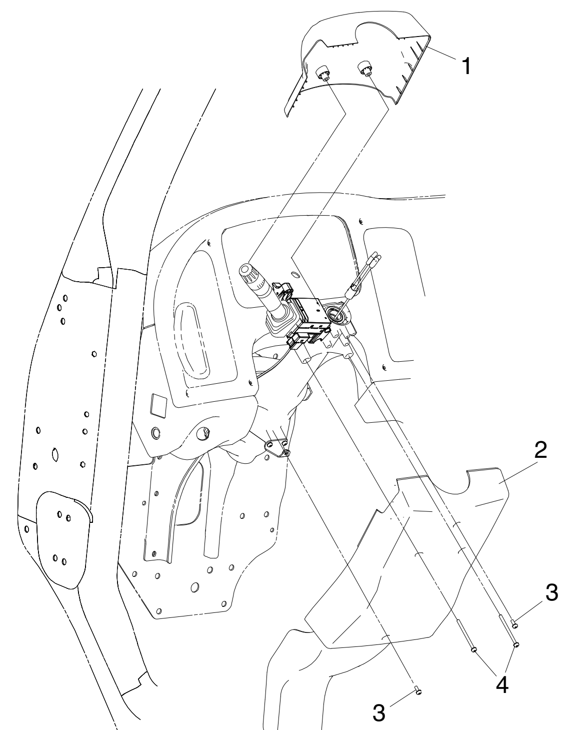
Multifunction Turn Signal Switch Removal and Installation

Removal

1. Disconnect the negative leads from the batteries.

NOTE: The multifunction turn signal switch is mounted on the left side of the steering column, just below the steering wheel.

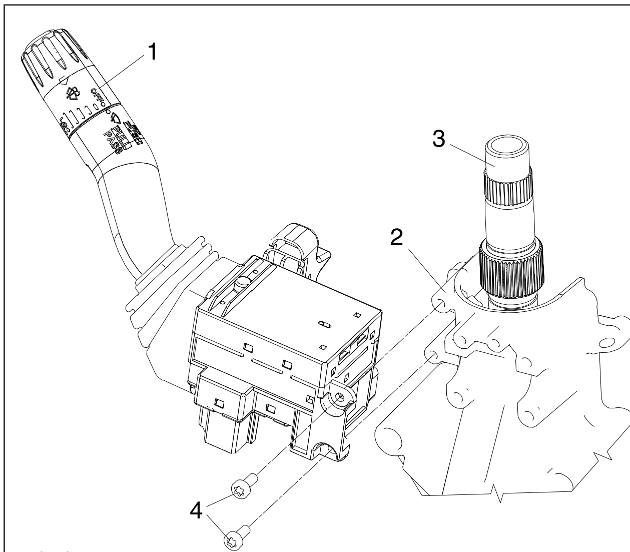
2. Remove the capscrews that attach the upper and lower clamshell covers to the steering column cover. See **Fig. 1**.



NOTE: Steering wheel shown removed for clarity.
1. Upper Clamshell Cover
2. Lower Clamshell Cover
3. 12-mm Long Capscrew
4. 70-mm Long Capscrew

Fig. 1, Clamshell Covers Installation

3. Remove the capscrews that attach the multifunction turn signal switch to the steering column cover. See **Fig. 2**.
4. Disconnect the two electrical harness connectors from the multifunction turn signal switch, then remove the switch.



1. Multifunction Turn Signal Switch
2. Steering Column Cover
3. Steering Column
4. 15-mm Long Capscrew

Fig. 2, Multifunction Turn Signal Switch Installation

Installation

1. Connect the two electrical harness connectors to the multifunction turn signal switch.
2. Properly orient the multifunction turn signal switch and use two capscrews to attach the switch to the steering column cover. Torque 7 lbf·ft (9 N·m).
3. Using four capscrews, attach the upper and lower clamshell covers to the steering column cover.
4. Connect the batteries.
5. Verify the operation of the switch functions.

Specifications

The tables below list the values for switch -002 (P/N A06-39656-002) and superceeding switch -003 (P/N A06-39656-003). See **Fig. 1** for a wiring diagram.

Multifunction Turn Signal Switch Resistor Values			
Description	**Resistor**	**Value in Ohms (Switch -002, P/N A06-39656-002)**	**Value in Ohms (Switch -003, P/N A06-39656-003)**
Pin 6 Wiper Off (normal position)	R1	24	12.7
Pin 6 Wiper Intermittent 1	R2	56	56
Pin 6 Wiper Intermittent 2	R3	100	100
Pin 6 Wiper Intermittent 3	R4	160	160
Pin 6 Wiper Intermittent 4	R5	240	240
Pin 6 Wiper Intermittent 5	R6	390	390
Pin 6 Wiper Low Speed	R7	680	680
Pin 6 Wiper High Speed	R8	1600	1600
Pin 5 Normal Position	R9	1500	1500
Pin 5 Windshield Washer	R10	300	300
Pin 5 High Beam/Flash High Beam	R11	180	180
Pin 4 Normal Position	R12	1500	1500
Pin 4 Left Turn Signal	R13	300	300
Pin 4 Right Turn Signal	R14	180	180

Table 1, Multifunction Turn Signal Resistor Values

Multifunction Turn Signal Switch Resistance Range Values			
Description	**Resistor**	**Resistance Range in Ohms (Switch -002, P/N A06-39656-002)**	**Resistance Range in Ohms (Switch -003, P/N A06-39656-003)**
Pin 6 Wiper Off (normal position)	R1	23.8 – 24.2	12.5 – 12.8
Pin 6 Wiper Intermittent 1	R2	55.4 – 56.6	55.4 – 56.6
Pin 6 Wiper Intermittent 2	R3	99.0 – 101.0	99.0 – 101.0
Pin 6 Wiper Intermittent 3	R4	158.4 – 161.6	158.4 – 161.6
Pin 6 Wiper Intermittent 4	R5	237.6 – 242.4	237.6 – 242.4
Pin 6 Wiper Intermittent 5	R6	386.1 – 393.9	386.1 – 393.9
Pin 6 Wiper Low Speed	R7	673.2 – 686.8	673.2 – 686.8
Pin 6 Wiper High Speed	R8	1584.0 – 1616.0	1584.0 – 1616.0
Pin 5 Normal Position	R9	1485.0 – 1515.0	1485.0 – 1515.0
Pin 5 Windshield Washer	R9 and R10 in parallel	247.5 – 252.5	297.0 – 303.0
Pin 5 High Beam/Flash High Beam	R9 and R11 in parallel	159.2 – 162.3	178.2 – 181.8
Pin 5 Washer and High Beam	R9, R10 and R11 in parallel	103.6 – 105.7	103.6 – 105.7
Pin 4 Normal Position	R12	1485.0 – 1515.0	1485.0 – 1515.0

Specifications

Multifunction Turn Signal Switch Resistance Range Values			
Description	Resistor	Resistance Range in Ohms (Switch -002, P/N A06-39656-002)	Resistance Range in Ohms (Switch -003, P/N A06-39656-003)
Pin 4 Left Turn Signal	R12 and R13 in parallel	247.5 – 252.5	297.0 – 303.0
Pin 4 Right Turn Signal	R12 and R14 in parallel	159.1 – 162.3	178.2 – 181.8

Table 2, Multifunction Turn Signal Switch Resistance Range Values

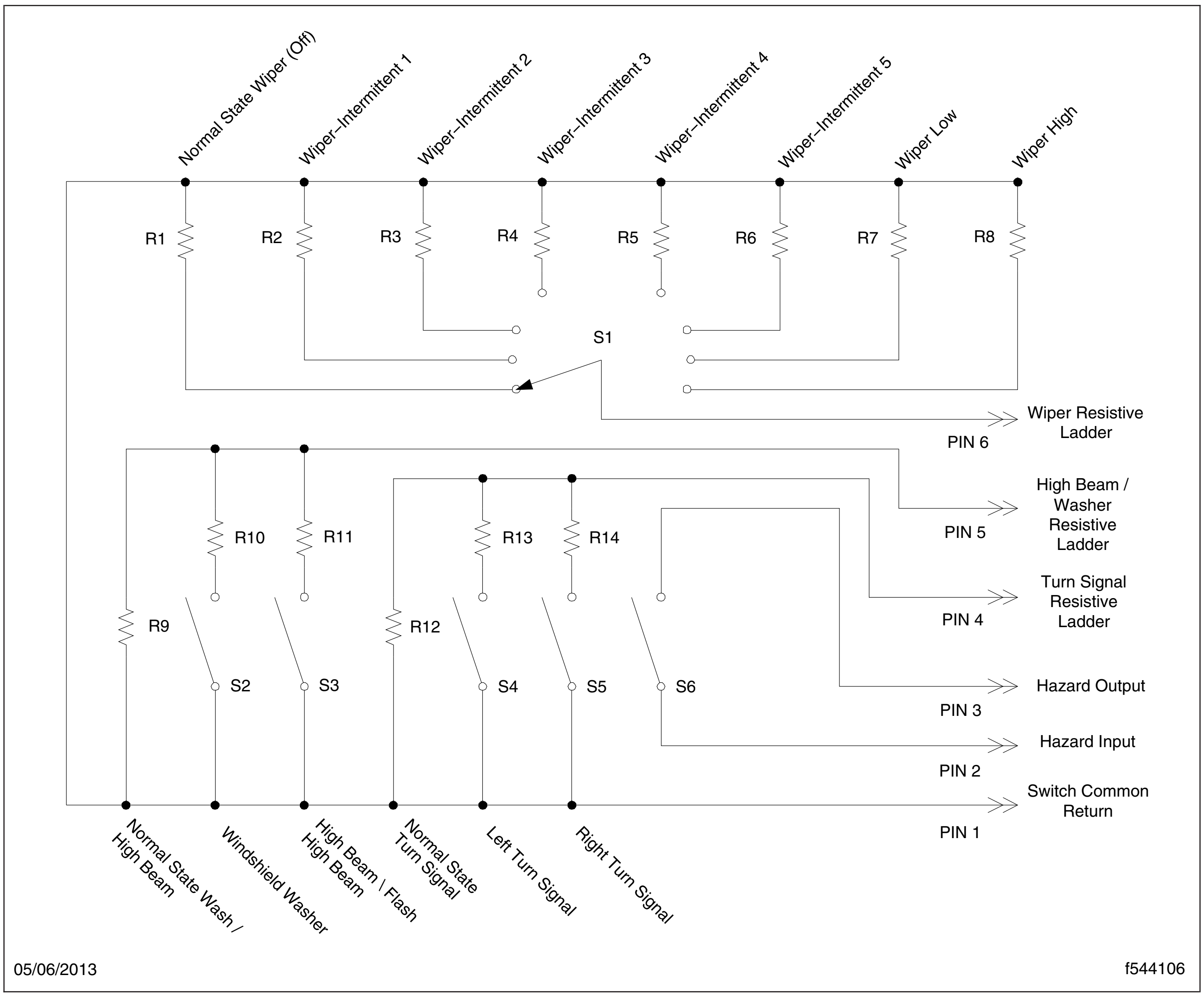


Fig. 1, Multifunction Turn Signal Switch Wiring Diagram

Contents

General Information

Background Information

A Switch Expansion Module (SEM) is used on a Business Class® M2 vehicle when more than five smart switches are installed on the vehicle. A Switch Expansion Module supports up to six smart switches.

The function of the SEM is to:

- Read all smart switch IDs and positions;
- Transmit the smart switch IDs and position data on the J1939 datalink;
- Turn on the smart switch indicator lights when commanded to do so by the Bulkhead Module (BHM).

The SEM is a remote-mounted device on the M2 chassis. The SEM mounts to a bracket that is installed behind the gauge panel that is below the radio. See **Fig. 1**.

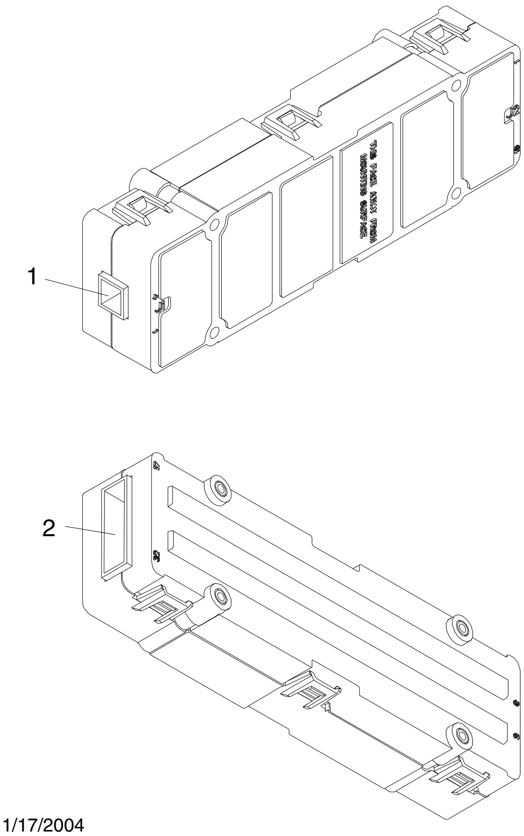
Smart switches are connected to the SEM using a harness connected to the J2 connector of the SEM.

The SEM communicates only over the J1939 datalink. It has no J1708/J1587 communication.

The SEM does not have any power output pins. Open power output pins must be available in a Chassis Module (CHM) or a Chassis Expansion Module (EXM) to control electrical devices, or another ECU that supports J1939 messages. This ECU must be able to receive J1939 commands in response to the activation of a smart switch.

If there are no open power output pins in the CHM or EXM, and there is no ECU that supports J1939 messages and receives commands in response to the activation of a smart switch, then the SEM is not required and it does not unlock any additional multiplexing capabilities.

In order to add an SEM, reference parameters must be available for programming the BHM.



1. J1 Connector
2. J2 Connector

Fig. 1, Switch Expansion Module

Replacement

1. Using ServiceLink®, take note of the icons that appear for the Switch Expansion Modules (SEM) on the vehicle.
2. Turn off the engine, apply the parking brakes, and chock the tires.
3. Disconnect the negative leads from the batteries.
4. Remove the trim plate panel from the dashboard. See **Fig. 1**. For instructions, see **Section 60.08, Subject 100**.
5. Disconnect the dome light switch at the right dash panel, then remove the right dash panel.
6. Remove the top cover from the dashboard.
7. Disconnect the connectors from each end of the SEM. See **Fig. 2**.

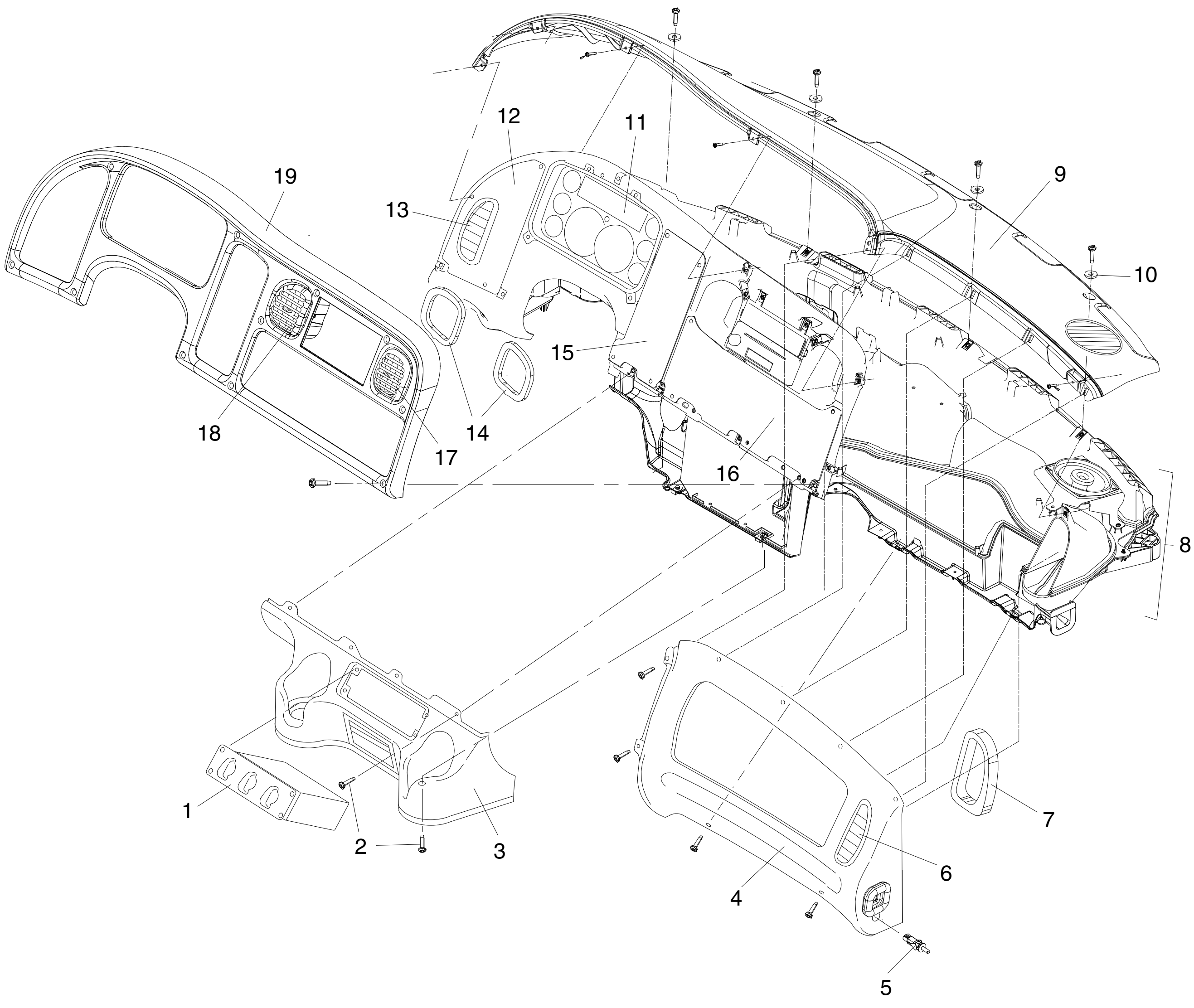
NOTE: If the vehicle has a Mercedes-Benz engine, a vehicle control unit (VCU) is mounted behind the right dash panel.

8. If the vehicle is equipped with a VCU, lift the VCU off the mounting bracket and set it down.
9. Remove the tie straps as necessary to remove the VCU wiring harness from the mounting clip, and to access the capscrews on the mounting bracket.
10. Remove the capscrews at the top and bottom of the mounting bracket, then remove the mounting bracket.
11. Remove the four capscrews that attach the SEM to the mounting bracket, and remove and discard the SEM.
12. Using four capscrews, attach a new SEM to the mounting bracket.
13. Using four capscrews, install the mounting bracket.
14. If the vehicle is equipped with a VCU, mount the VCU on the mounting bracket.
15. Use tie straps as necessary to secure the VCU wiring harness.
16. Connect the connectors to each end of the SEM.
17. Install the top cover on the dashboard. For instructions, see **Section 60.08, Subject 100**.
18. Install the right dash panel on the dashboard.
19. Install the trim plate panel on the dashboard.
20. Connect the batteries.
21. Using ServiceLink, take note of the icons that appear for the Switch Expansion Modules on the vehicle. If the SEM that was replaced did not appear in ServiceLink, then the new SEM will not appear in ServiceLink.

NOTE: To identify an SEM, go into the SEM icon in ServiceLink. Click on the **Smart Switches** tab and use the **Identify SEM** button to flash the indicator lights of the smart switches connected to that particular SEM. This makes it possible to locate the SEM and to see which smart switches are connected to which SEM.

22. Remove the chocks from the tires.

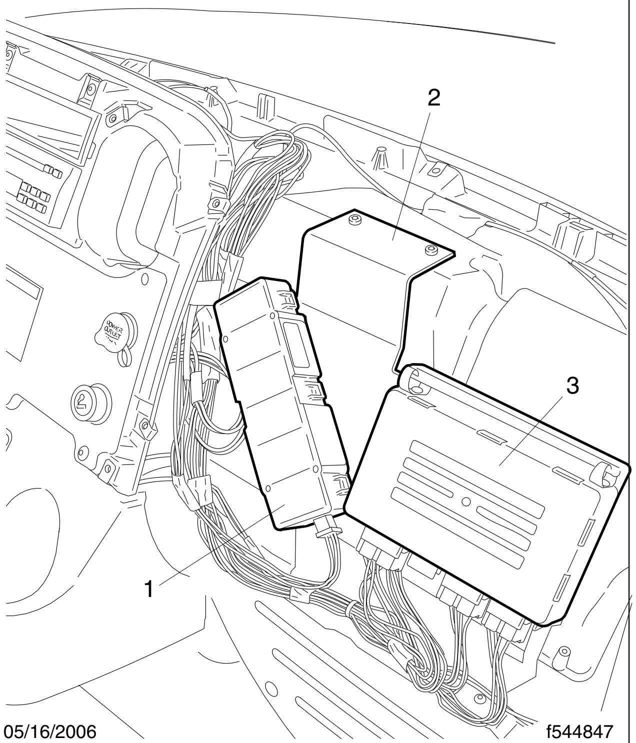
Switch Expansion Module Replacement



1. HVAC Control Panel
2. Torx® Capscrew
3. Cup Holder Panel
4. Right Dash Panel
5. Dome Light Switch
6. Right Window Outlet Louver
7. Duct Seal
8. Tray Assembly With HVAC Ducts
9. Top Cover
10. Washer
11. Instrument Cluster
12. Gauge Panel
13. Left Window Outlet Louver
14. Duct Seal
15. Switch Panel
16. Gauge Panel
17. Right Dash Outlet Louver
18. Left Dash Outlet Louver
19. Trim Plate Panel

Fig. 1, Dash Panels

Switch Expansion Module Replacement



1. Switch Expansion Module
2. Mounting Bracket
3. Vehicle Control Unit (vehicle with Mercedes-Benz engine only)

Fig. 2, Location of Switch Expansion Module

Installation

1. Turn off the engine, apply the parking brakes, and chock the tires.
2. Disconnect the negative leads from the batteries.
3. Remove the trim plate panel from the dashboard. See **Fig. 1**. For instructions, see **Section 60.08, Subject 100**.
4. Disconnect the dome light switch at the right dash panel, then remove the right dash panel.
5. Remove the top cover from the dashboard.

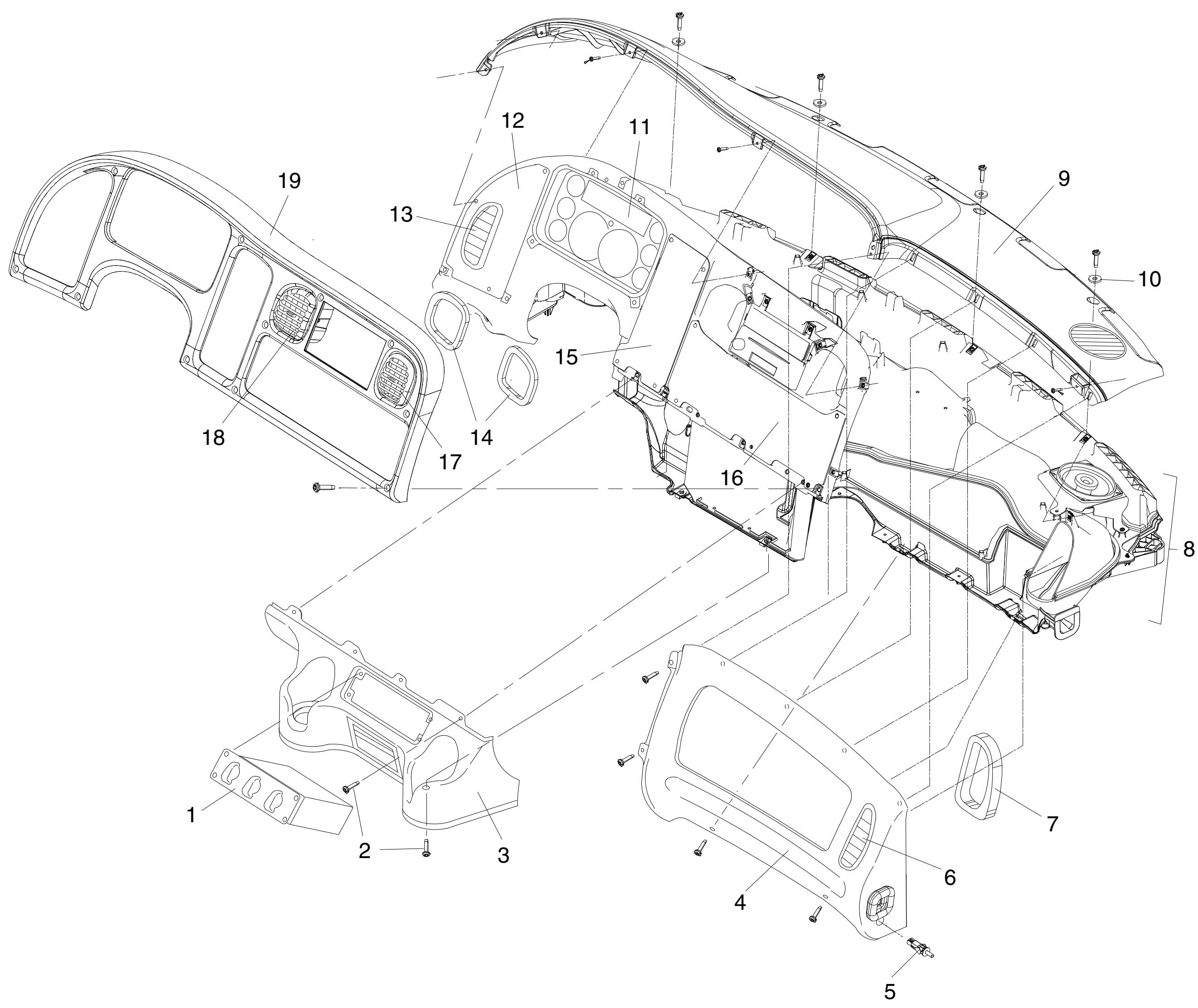
NOTE: If the vehicle has a Mercedes-Benz engine, a vehicle control unit (VCU) is mounted behind the right dash panel.

6. If the vehicle is equipped with a VCU, lift the VCU off the mounting bracket and set it down. See **Fig. 2**.
7. Remove the tie-straps as necessary to remove the VCU wiring harness from the mounting clip, and to access the capscrews on the mounting bracket.
8. Remove the capscrews at the top and bottom of the mounting bracket, then remove the mounting bracket.
9. For instructions on installing a smart switch, see **Section 54.14, Subject 100**.
10. Using four capscrews, install the Switch Expansion Module (SEM) to the mounting bracket.
11. Using four capscrews, install the mounting bracket.
12. If the vehicle is equipped with a VCU, mount the VCU on the mounting bracket.
13. Overlay the SEM wiring harness on the main cab harness. Connect one connector of the harness to the Bulkhead Module (BHM), one connector to the smart switch, and two connectors to the SEM.
14. Use tie-straps as necessary to secure the SEM harness to the main cab harness.
15. Use tie-straps as necessary to secure the VCU wiring harness.
16. Install the top cover on the dashboard. For instructions, see **Section 60.08, Subject 100**.
17. Install the right dash panel on the dashboard.
18. Install the trim plate panel on the dashboard.
19. Connect the batteries.
20. After installing an SEM, turn the ignition on and use ServiceLink® to connect to the vehicle. Notice that the newly installed SEM appears in ServiceLink as a new SEM icon in the left side bar. One of the following situations may be encountered.
    - If the serial number of the new SEM is lower than those already on the vehicle, it claims source address 128 and appears as SEM #1.
    - If the serial number of the new SEM is higher than those already on the vehicle, it appears as the next SEM in numeric order. For example, if there are two SEMs already on the vehicle appearing in ServiceLink as SEM #1 and SEM #2, the new SEM appears in ServiceLink as SEM #3.
    - If the serial number of the new SEM is between the serial numbers of SEMs already on the vehicle, the new SEM moves up the second SEM. The new SEM appears as SEM #2, and the SEM that was SEM #2 appears as SEM #3. Since SEM #1 still has the lowest serial number, it still appears as SEM #1.
    - If there are already three SEMs on the vehicle, the installation of a fourth SEM causes an **Invalid ECU (duplicate) – Unable to claim address** icon to appear in ServiceLink since no more than three SEMs can be installed on a vehicle. The fourth SEM should show a source address of 254.

NOTE: To identify an SEM, go into the SEM icon in ServiceLink. Click on the **Smart Switches** tab and use the **Identify SEM** button to flash the indicator lights of the smart switches connected to that particular SEM. This makes it possible to locate the SEM and to see which smart switches are connected to which SEM.

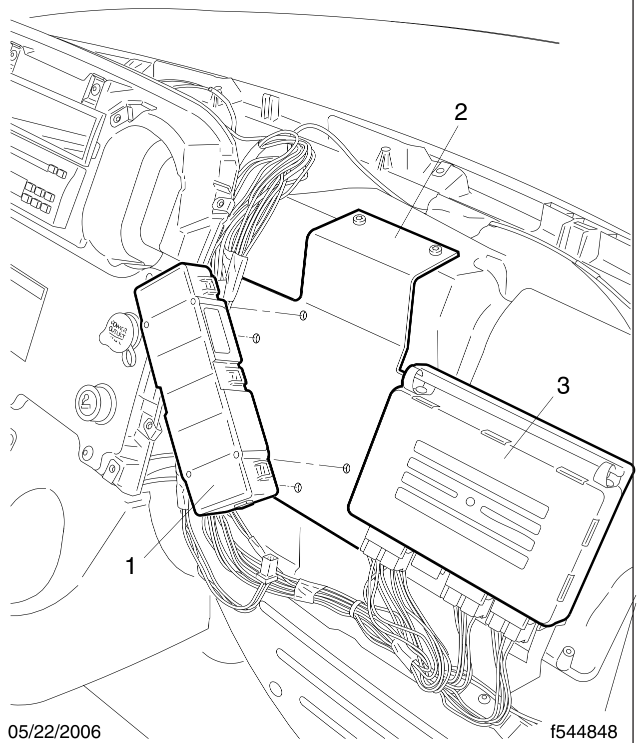
21. Remove the chocks from the tires.

Installation



1. HVAC Control Panel
2. Torx® Capscrew
3. Cup Holder Panel
4. Right Dash Panel
5. Dome Light Switch
6. Right Window Outlet Louver
7. Duct Seal
8. Tray Assembly With HVAC Ducts
9. Top Cover
10. Washer
11. Instrument Cluster
12. Gauge Panel
13. Left Window Outlet Louver
14. Duct Seal
15. Switch Panel
16. Gauge Panel
17. Right Dash Outlet Louver
18. Left Dash Outlet Louver
19. Trim Plate Panel

Fig. 1, Dash Panels



1. Mounting Bracket 2. Vehicle Control Unit

Fig. 2, Location of Switch Expansion Module

SEM J1939 Source Address Claiming Scheme

A Switch Expansion Module (SEM) on the J1939 datalink claims a J1939 source address. The source address (SA) identifies the module and can be viewed using ServiceLink®. See **Table 1** for a list of the SEM source addresses.

SEM J1939 Source Addresses	
Source Address	**SEM Number**
128	SEM #1
129	SEM #2
130	SEM #3

Table 1, SEM J1939 Source Addresses

Switch Expansion Modules on a vehicle are numbered SEM #1 through SEM #3 depending on the serial number of the SEM. The SEM with the lowest serial number, which is printed on the SEM housing, attempts to claim the lowest SEM source address, 128. Each additional SEM then claims a source address in similar fashion from low to high. The SEM with the next-highest serial number claims the next-highest source address, 129, and so on until all SEMs have claimed a source address.

NOTE: Although the Bulkhead Module (BHM) supports up to three Switch Expansion Modules, the SEM mounting bracket on the Business Class® M2 vehicle is designed for mounting only one SEM.

Once an SEM is installed and claims an address, it stores that as a preferred source address. Every time the vehicle is turned on after that, the SEM will attempt to reuse that preferred source address. This way, each SEM should appear in ServiceLink as the same SEM number (SEM #1 through SEM #3) each time ServiceLink is connected, regardless of whether an SEM is removed or whether the physical locations of the SEMs on the vehicle have changed. The only exception is when an SEM with a lower serial number is added.

If a new SEM is installed that has a serial number lower than those already on the vehicle, the new SEM will claim the lowest source address, 128, and bump up the source addresses of the other SEMs. The SEM that used to claim the source address of 128 must now claim 129, the SEM that used to claim 129 must now claim 130.

Invalid SEM

If a problem occurs while flashing the application code on an SEM, the SEM may not be able to claim one of the source addresses in **Table 1**. The SEM will appear in ServiceLink screens at source address 133 and with an icon labeled **Invalid SEM (Unresponsive)**. It will not report any make, model, or software ID. In this case, the technician can still access the **Flashing** tab and attempt to flash the SEM to recover it.

Locating the Correct SEM to Troubleshoot

To assist the technician in determining the specific SEM a given smart switch is connected to, ServiceLink has a **Smart Switches** tab located under the SEM icon. There the technician will find an **Identify SEM** button that can be used to briefly flash the indicator lights of a bank of smart switches connected to a specific SEM. This allows the technician to locate the correct SEM for troubleshooting smart switches.

Removing an SEM

1. Connect to the vehicle in ServiceLink and take note of the icons that appear for the SEMs connected to the vehicle.
2. Remove the SEM.
3. Reconnect to the vehicle in ServiceLink and take note of the icons that appear for the SEMs connected to the vehicle.
4. The icon for the removed SEM should be gone and none of the other SEMs still on the vehicle should change their order. For example, if there are three SEMs on a vehicle, appearing in ServiceLink as SEM #1, SEM #2, and SEM #3 and the second SEM is removed, on reconnecting to the vehicle in ServiceLink the icons for SEM #1 and SEM #3 still appear and the icon for SEM #2 is gone.

Fault Code Information

Fault Codes

NOTE: For troubleshooting procedures, see **Section 54.14, Subject 300**.

See **Table 2** for J1939 suspect parameter numbers (SPN) for Switch Expansion Module source addresses (SA) 128 through 130.

See **Table 3** for the failure mode identifiers (FMI) for J1939 datalink protocols.

J1939 Suspect Parameter Numbers for Switch Expansion Module Source Addresses 128 Through 130		
SPN	**J1939 Description**	**Possible FMI**
2033	No CAN communication from BHM	19
6914	Smart Switch VBatt Short to Ground	04

Table 2, J1939 Suspect Parameter Numbers for Switch Expansion Module Source Addresses 128 Through 130

Failure Mode Identifiers	
FMI	**J1939 Description**
19	Received network data in error
04	Voltage below normal or shorted low

Table 3, Failure Mode Identifiers

SEM Pinouts at J1 Connector			
Pin	**Signal Name**	**Type**	**Amps**
1	VBAT1 (unswitched power)	Power	1
2	System Wakeup	Bidirectional	—
3	System Ignition	Input	—
4	J1939– Datalink	Comm	—
5	GND	Ground	—
6	GND	Ground	—
7	GND	Ground	—
8	J1939+ Datalink	Comm	—

Table 1, SEM Pinout Definitions at Connector J1

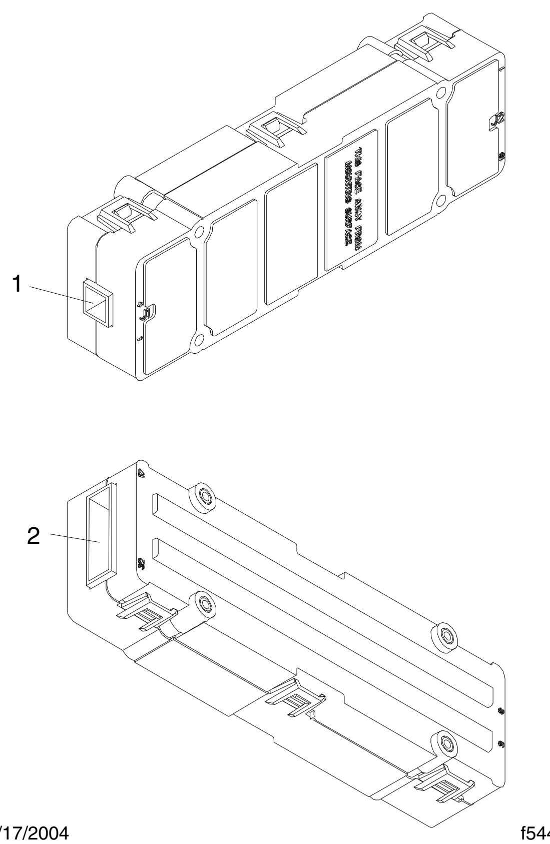
SEM Pinouts at J2 Connector			
Pin	**Signal Name**	**Type**	**Amps**
1	Smart Switch Ground	Signal Ground	—
2	SS5 Indicator	Smart Switch LED Drive	—
3	SS3 Indicator	Smart Switch LED Drive	—
4	SS1 Indicator	Smart Switch LED Drive	—
5	SS6 ID1	Smart Switch Analog Input	—
6	SS5 ID2	Smart Switch Analog Input	—
7	SS5 Switch Position	Smart Switch Analog Input	—
8	Smart Switch Backlight	Smart Switch Backlight	0.2
9	Smart Switch Vbat	Smart Switch Vbat	0.2
10	SS4 ID2	Smart Switch Analog Input	—
11	SS4 Switch Position	Smart Switch Analog Input	—
12	SS3 ID1	Smart Switch Analog Input	—
13	SS2 ID2	Smart Switch Analog Input	—
14	SS2 Switch Position	Smart Switch Analog Input	—
15	SS1 ID1	Smart Switch Analog Input	—
16	Smart Switch Ground	Signal Ground	—
17	Smart Switch Ground	Signal Ground	—
18	SS6 Indicator	Smart Switch LED Drive	—
19	SS4 Indicator	Smart Switch LED Drive	—
20	SS2 Indicator	Smart Switch LED Drive	—
21	SS6 ID2	Smart Switch Analog Input	—
22	SS6 Switch Position	Smart Switch Analog Input	—
23	SS5 ID1	Smart Switch Analog Input	—
24	Smart Switch Ground	Signal Ground	—
25	Smart Switch Ground	Signal Ground	—
26	SS4 ID1	Smart Switch Analog Input	—
27	SS3 ID2	Smart Switch Analog Input	—
28	SS3 Switch Position	Smart Switch Analog Input	—

Specifications

SEM Pinouts at J2 Connector			
Pin	Signal Name	Type	Amps
29	SS2 ID1	Smart Switch Analog Input	—
30	SS1 ID2	Smart Switch Analog Input	—
31	SS1 Switch Position	Smart Switch Analog Input	—
32	Smart Switch Ground	Signal Ground	—

Table 2, SEM Pinout Definitions at J2 Connector

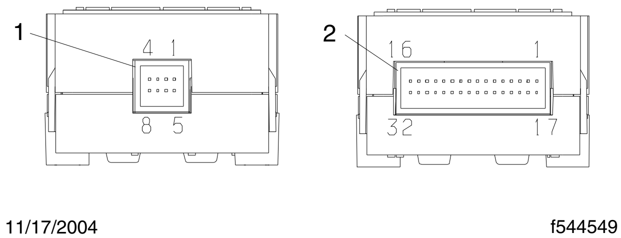
For an illustration of the SEM, see **Fig. 1**. For an end view of the module connectors, see **Fig. 2**.



11/17/2004 f544550

1. J1 Connector
2. J2 Connector

Fig. 1, Switch Expansion Module



11/17/2004 f544549

1. J1 Connector
2. J2 Connector

Fig. 2, End Views of the Switch Expansion Module

Contents

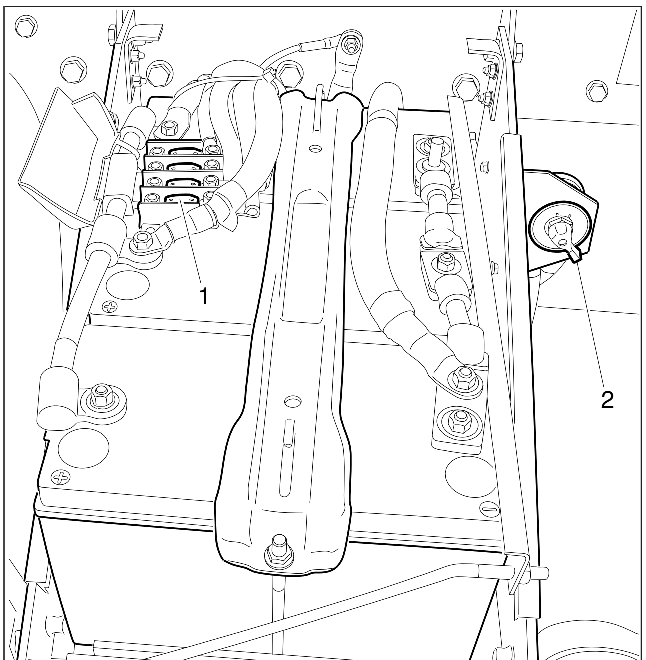
General Information

MEGA Fuse Junction Block

Vehicles have a MEGA fuse junction block (MFJB) inside the battery box to distribute and fuse some of the power circuits.

Typical circuits protected by the MEGA fuses in EPA07 and earlier vehicles are the main PDM, the powertrain PDM, and the trailer/chassis PDM. The alternator and starter are connected directly to the batteries. See **Fig. 1** for a typical battery box mounted MFJB.

EPA10 vehicles use the battery box mounted MFJB to protect the power circuits feeding the chassis PDM and other optional PDMs.



11/23/2010 f545703

1. MEGA Fuses
2. Battery Cutoff Switch

Fig. 1, Typical EPA07 Battery Box

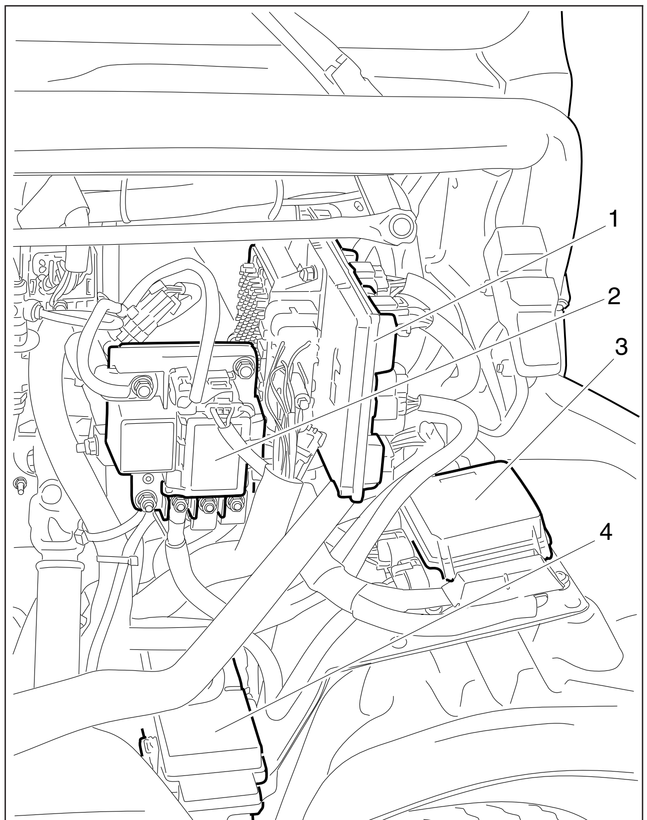
Powernet Distribution Box (PNDB)

EPA10 vehicles incorporate the powernet distribution box (PNDB) to distribute and fuse battery power to many of the vehicle loads. An optional cab load disconnect switch (CLDS) is available to disconnect selected circuits. The CLDS may be located on the chassis near the battery box or mounted so that it is operated from inside the cab. There is an LED in the CLDS that will illuminate when power is on. The LED will flash when certain faults are detected.

Some vehicles have an auxiliary PNDB in addition to the primary PNDB. If the vehicle is equipped with a CLDS, it controls both. An additional LED status indicator is in the CLDS on dual PNDB systems.

NOTE: See **Fig. 6** for the auxiliary PNDB.

The primary PNDB is located on the engine side of the front wall near the steering shaft. See **Fig. 2** for the location of the primary PNDB and other EPA10 engine compartment power distribution modules.



11/24/2010 f545704

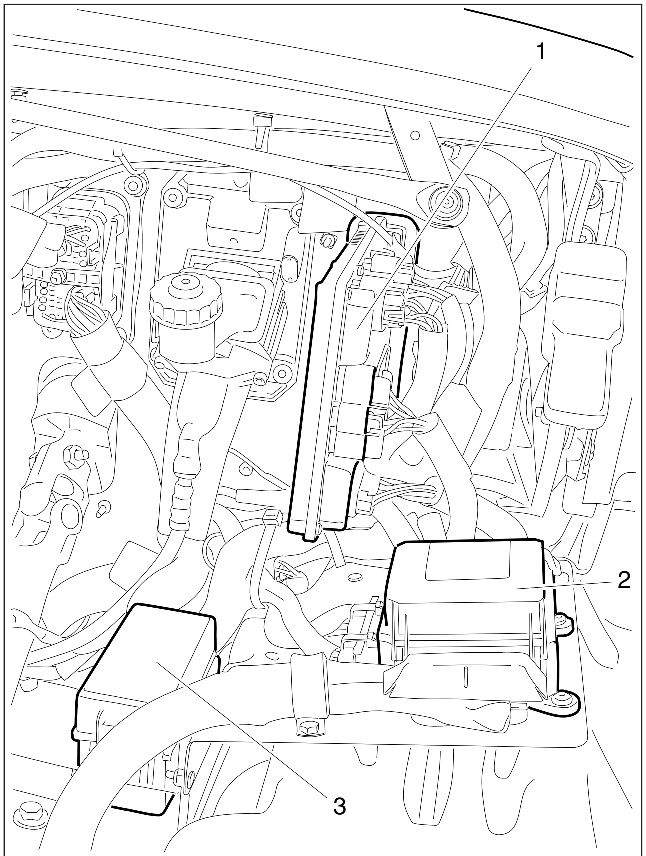
1. Bulkhead Module
2. PNDB
3. Main PDM
4. Powertrain PDM

Fig. 2, EPA10 Power Distribution Modules

General Information

Main Power Distribution Module

The main PDM is located on the driver side inner fender in the engine compartment. Power for most cab and many chassis functions are protected by fuses in the main PDM. Most vehicles have spare fuse circuits in the main PDM that can be used for customer installed options. A map of fuses to output connectors for the circuits in the main PDM is shown in **Subject 130**. See **Fig. 3** for EPA07 engine compartment power distribution modules.



1. Bulkhead Module
2. Main PDM
3. Powertrain PDM

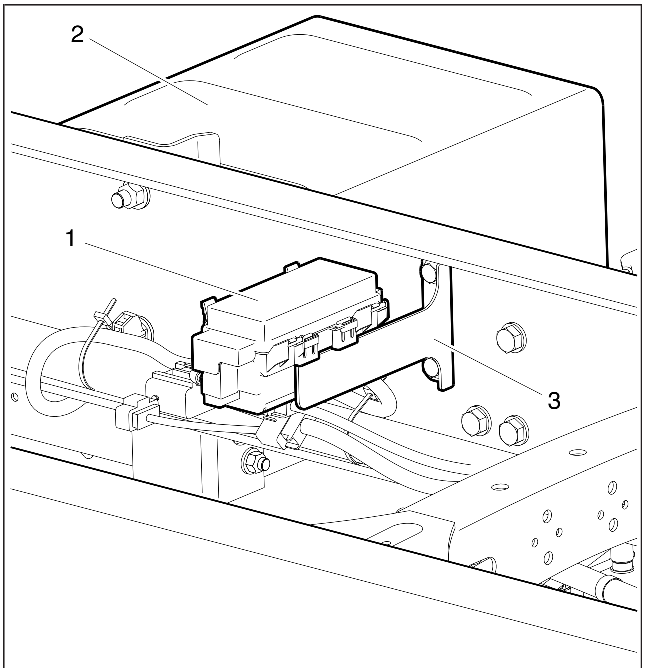
Fig. 3, Typical EPA07 Power Distribution Modules

Powertrain Power Distribution Module

Vehicles built for EPA07 and later use a powertrain PDM to protect circuits to the engine, transmission, and exhaust after treatment systems. The powertrain PDM is located inside the engine compartment on a bracket near the main PDM on the drivers side inner fender.

Chassis Power Distribution Module

The chassis power distribution module switches power to operate air valves for the axles, fifth wheel, suspension, PTO, and other air controlled devices on vehicles manufactured before chassis module 4.1 was released and with an auxiliary air valve assembly (AAVA). The chassis PDM is in an enclosed housing and located beneath or behind the cab on a bracket attached to the frame rails. See **Fig. 4**.



1. Chassis PDM
2. Battery Box
3. Mounting Bracket

Fig. 4, Chassis PDM on Early AAVA Vehicle

Trailer Power Distribution Module

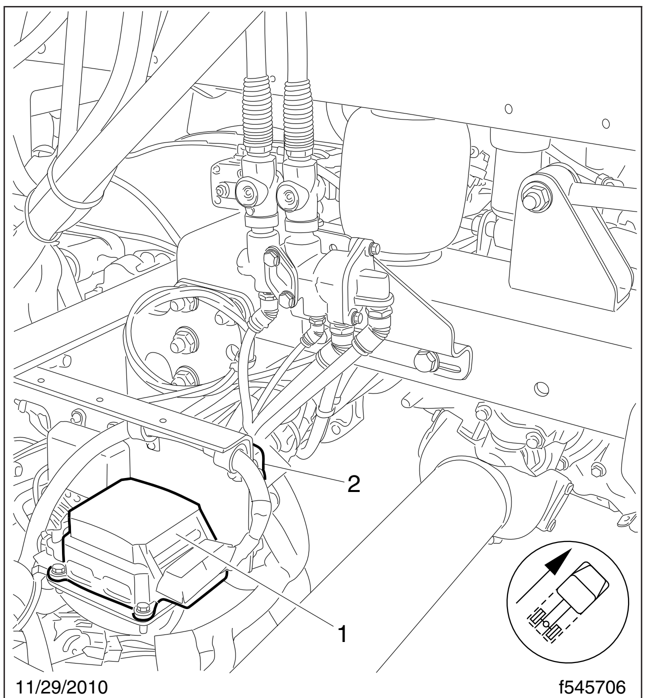
The trailer PDM fuses and supplies power for trailer lighting. The CHM controls the inputs to this PDM. The trailer PDM has traditionally been located on a bracket mounted to the frame below and behind the cab. In 2010, the trailer PDM has been relocated to inside the cab on the drivers side behind the seat. See **Fig. 5** for a typical EPA07 and earlier trailer PDM. See **Fig. 6** for a typical EPA10 in-cab trailer PDM.

For more information on the trailer PDM, refer to **Section 54.29** in this manual.

Body Lighting Power Distribution Module

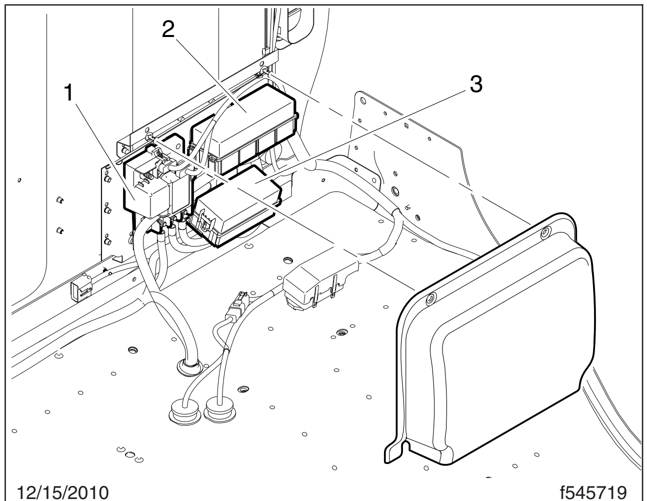
The body lighting PDM supplies higher amperage power for exterior lighting in addition to ignition and battery power for options installed by the truck equipment manufacturer. The body lighting PDM has traditionally been located on a bracket mounted to the frame below and behind the cab. In 2010, the body lighting PDM has been relocated to inside the cab on the drivers side behind the seat on the back wall or the floor. See **Fig. 6** for a typical EPA10 in-cab body lighting PDM installation.

For more information on the body lighting PDM, refer to **Section 54.35** in this manual.



1. Trailer PDM
2. Chassis Module

Fig. 5, EPA07 Trailer PDM (deck plate removed)



1. PNDB
2. Trailer PDM
3. Body Lighting PDM

Fig. 6, EPA10 In-Cab PDM Installation

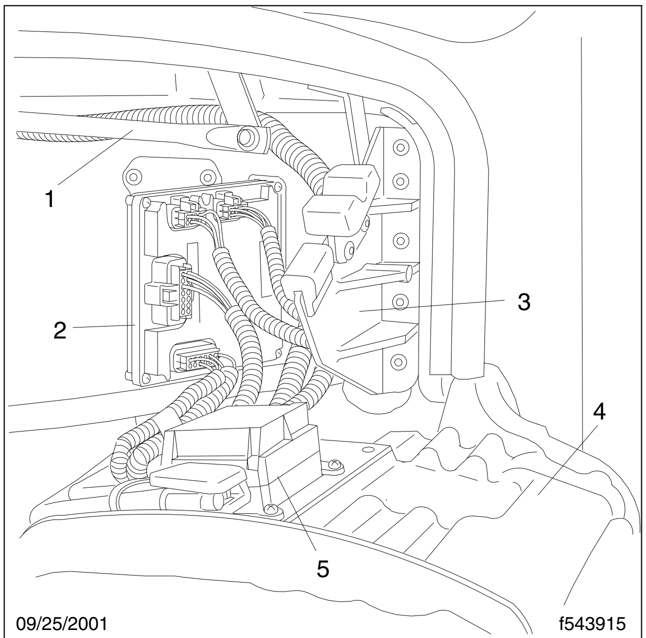
Main Power Distribution Module Removal and Installation

Removal

1. Disconnect the negative leads from the batteries.

NOTE: The main power distribution module (PDM) is mounted in the engine compartment on the left front inner fender. See **Fig. 1**.

2. Remove the nuts and washers that attach the battery cables to the power studs, then remove the battery power cables from the PDM. See **Fig. 2**.



1. Wiper Linkage
2. Bulkhead Module
3. Hood Support Bracket
4. Quarter Fender
5. Main Power Distribution Module

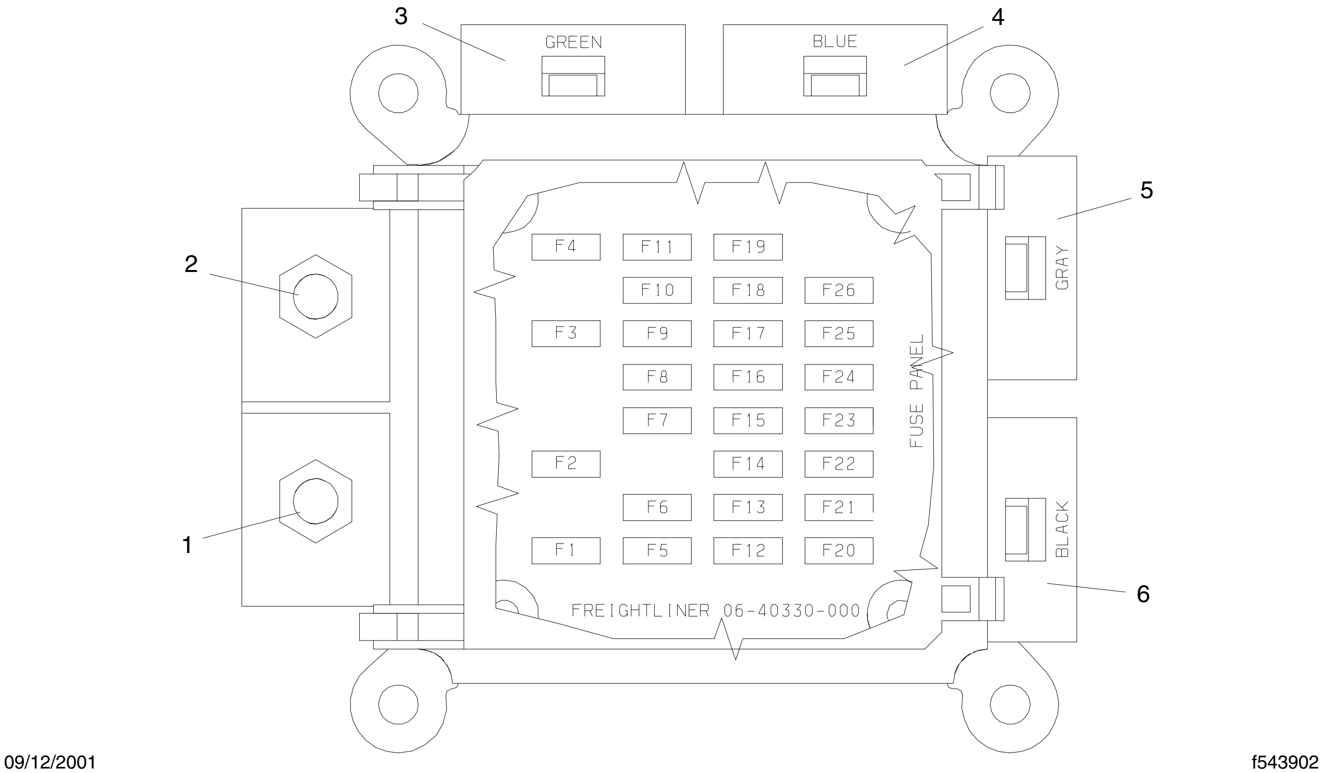
Fig. 1, Main Power Distribution Module Installation

3. Remove the four harness connectors (green, blue, gray, and black) from the PDM.
4. Remove the four Torx® capscrews that attach the PDM to the inner fender, then remove the PDM.

Installation

1. Properly orient the PDM and attach it to the quarter fender using four Torx capscrews.
2. Connect the four harness connectors to the PDM.
3. Using nuts and washers, attach the battery power ring connectors to the power studs.
4. Connect the batteries or tun the battery disconnect switch to on.
5. Verify operation of electrical components.

Main Power Distribution Module Removal and Installation



1. Battery Power to 125-Amp MEGA® Fuse 2
2. Battery Power to 125-Amp MEGA Fuse 1
3. Engine Harness Connector (green)
4. Forward Chassis Harness Connector (blue)
5. Forward Chassis Harness Connector (gray)
6. Frontwall Harness Connector (black)

Fig. 2, Main PDM Fuse Panel Layout and Connections

EPA07 Powertrain PDM

Removal

1. Disconnect the negative leads from the batteries.

NOTE: The powertrain power distribution module (PDM) is mounted in the engine compartment next to the left front inner fender. See **Fig. 1**.

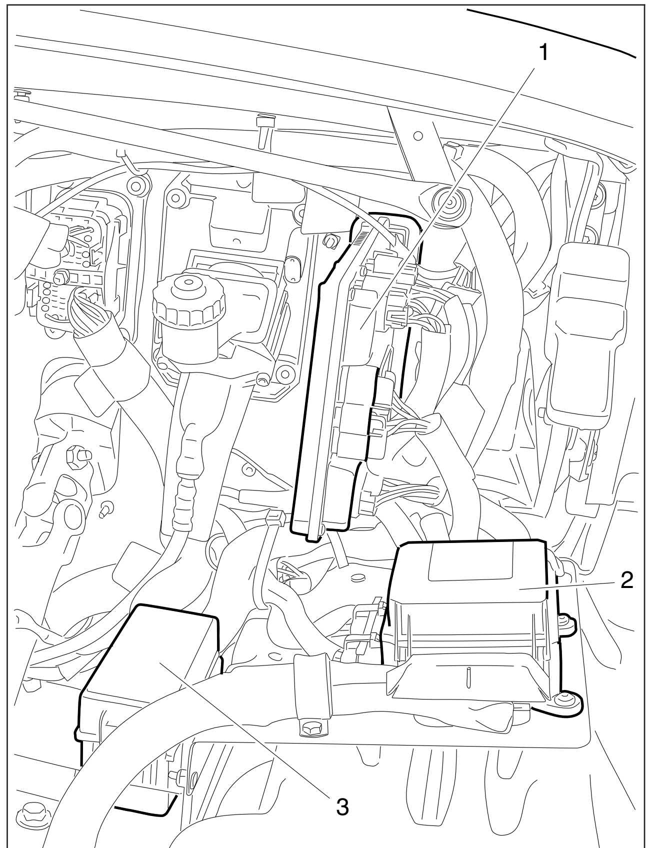
2. Using a screwdriver, release the support tabs that secure the PDM to the mounting bracket. See **Fig. 2**. Remove the PDM from the bracket.
3. Remove the top cover from the PDM.
4. Remove the fuses and relays from the top of the PDM, noting the location of each fuse and relay before removal.
5. Remove the terminal locks. See **Fig. 3**.
6. Release the bottom cover using the tab on the end of the PDM where the wires exit. The cover will hinge open.
7. Mark each wire for reassembly.
8. Remove the wires under the PDM by pressing each terminal lock with a pick tool. See **Fig. 4**.
9. Remove the PDM from the vehicle.

Installation

1. Attach all wires to the bottom of the PDM. The terminals will click into place when inserted correctly.

NOTE: If the terminals are inserted backward, the lock will not press into place.

2. Install the terminal locks.
3. Install the fuses and relays, using the locations noted earlier.
4. Install the bottom cover.
5. Position the PDM on the mounting bracket, and push down until the support tabs snap into place.
6. Install the PDM top cover. Use a wire tie to secure the cover, if necessary.
7. Connect the batteries.



1. Bulkhead Module
2. Main PDM
3. Powertrain PDM

Fig. 1, Power Distribution Modules (EPA07 shown)

EPA10 Powertrain PDM

Removal

1. Disconnect the batteries at the negative terminals.
2. Insert a small flat screwdriver into the openings between the mounting bracket and the side of the PDM, then release the tabs. See **Fig. 2**.
3. Open the cover and remove the two retaining clips. See **Fig. 5**.
4. Lift the PDM block assembly out from the housing. The power feed circuits can be disconnected from the bus when the block assembly is about half way out of the housing.

Powertrain PDM Removal and Installation

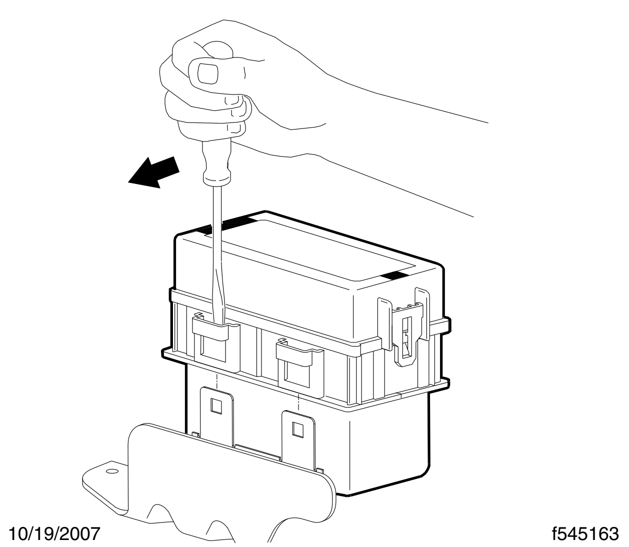

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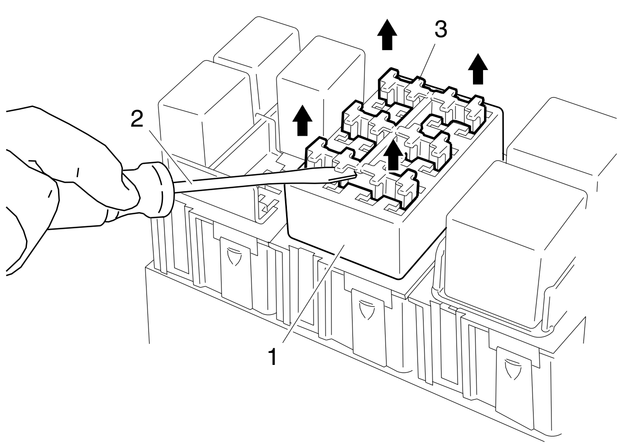
Fig. 2, PDM Removal

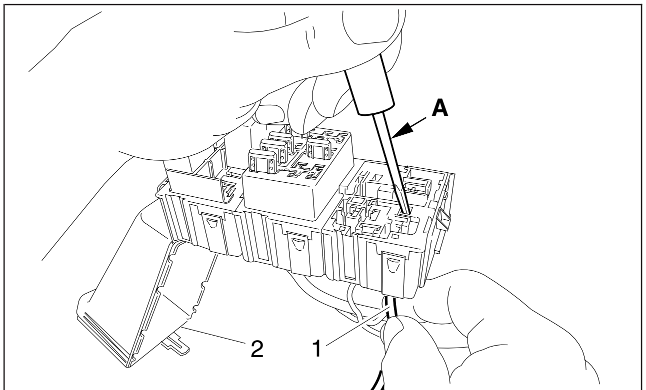


01/14/2008 f545189

1. Terminal Housing
2. Flat-Tip Screwdriver
3. Terminal Locks

Fig. 3, Removing the Terminal Locks

5. Identify the positions and values of the fuses and relays, then remove them.
6. Lift the terminal locks up and out of the PDM. See **Fig. 3**.
7. Label all the wires before removing them from the PDM. Remove the wires.
8. Use a Delphi pick tool to release the tab on the terminal then remove it from the bottom side.



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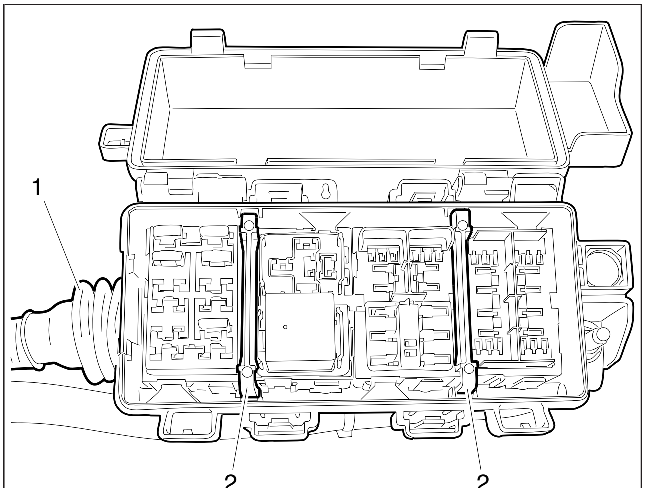
A. Press each terminal lock with the pick tool to remove.

Fig. 4, Removing the Wire with a Pick Tool



08/18/2010 f545684

1. Connector Boot
2. Retaining Clips

Fig. 5, EPA10 PDM

9. Remove the PDM from the vehicle.

Installation

1. Insert each circuit into the bottom of the PDM block assembly. If the terminal is backward, the lock will not seat into place. See **Fig. 6**.
2. Install the terminal locks and the fuses and relays, as previously noted.

Powertrain PDM Removal and Installation

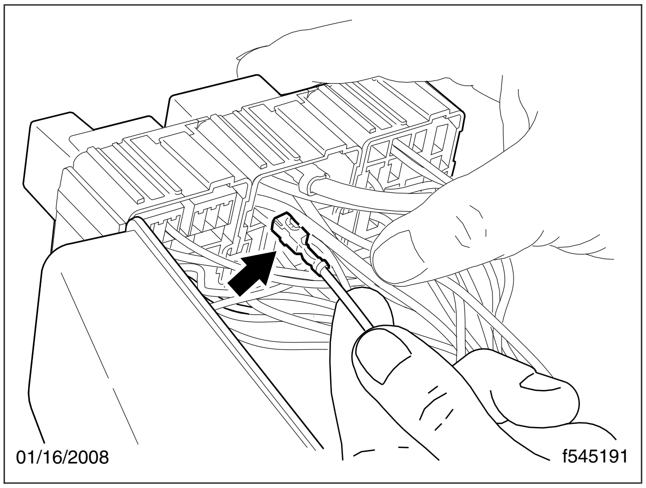
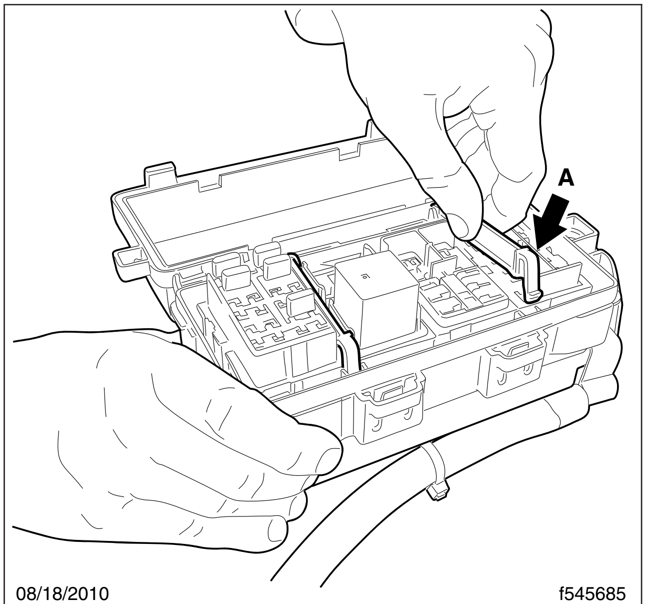


Fig. 6, Inserting Circuits in to the PDM

3. Place the PDM block assembly into the housing, and connect the power feed circuits to the buss bar.
4. Gently squeeze the PDM housing and install the two retaining clips. See **Fig. 7**.
5. Close the PDM cover.



A. Squeeze the housing of the PDM when installing the retaining clips.

Fig. 7, Installing the Retaining Clips

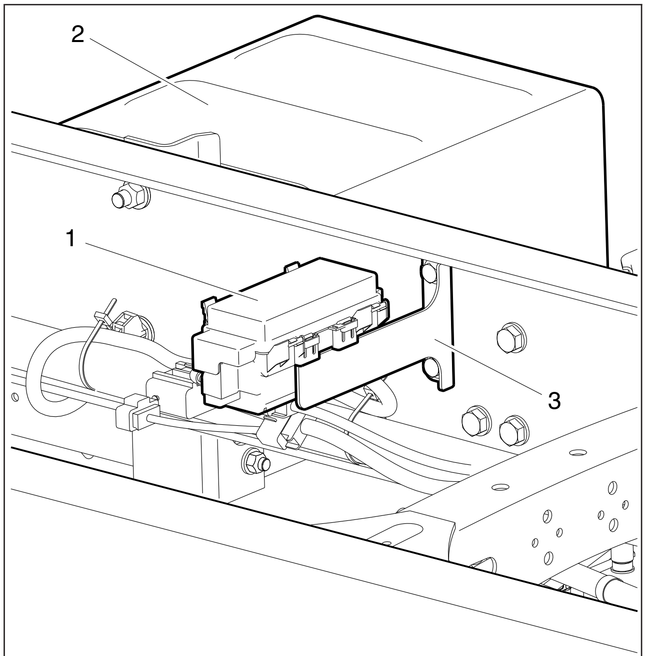
6. Install the PDM housing onto the bracket, if it was removed.
7. Connect the batteries and close the hood.

Chassis PDM Removal and Installation

Removal

The Chassis PDM is located underneath or behind the cab, near the battery box. See **Fig. 1**.

1. Disconnect the batteries at the negative terminals.
2. Open the cover and remove the two retaining clips. See **Fig. 1**.



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1. Chassis PDM
2. Battery Box
3. Mounting Bracket

Fig. 1, Chassis PDM

3. Lift the PDM block assembly out from the housing. The power feed circuits can be disconnected from the bus when the block assembly is about half way out of the housing.
4. Identify the positions and values of the fuses and relays, then remove them.
5. Lift the terminal locks up and out of the PDM.
6. Label all the wires before removing them from the PDM. Remove the wires.
7. Remove the PDM from the vehicle.

Installation

1. Insert each circuit into the bottom of the PDM block assembly. If the terminal is backward, the lock will not seat into place.
2. Install the terminal locks and the fuses and relays, as previously noted.
3. Place the PDM block assembly into the housing, and connect the power feed circuits to the buss bar.
4. Gently squeeze the PDM housing and install the two retaining clips.
5. Close the PDM cover.
6. Install the PDM housing onto the bracket, if it was removed.
7. Connect the batteries.

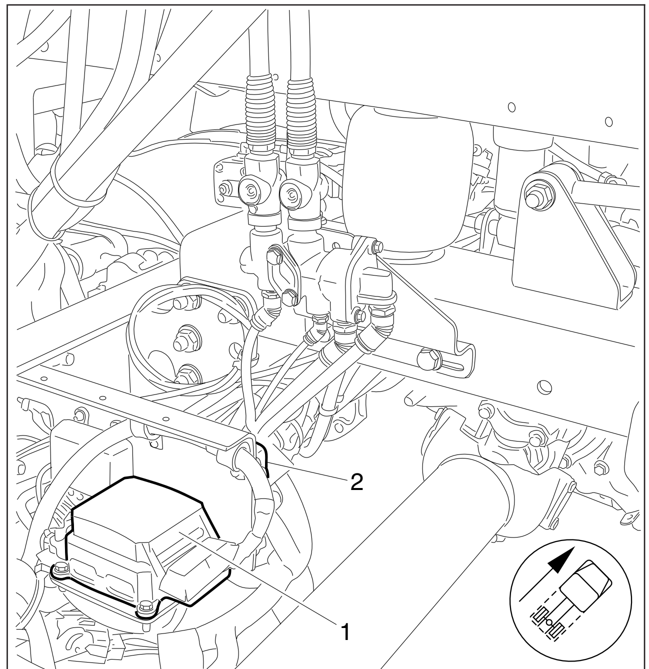
Trailer PDM Removal and Installation (EPA07 and earlier)

Removal

1. Turn off the engine, apply the parking brakes, and chock the tires.
2. Disconnect the negative leads from the batteries.

NOTE: The trailer power distribution module is mounted in between the frame rails, on a bracket. See **Fig. 1**.

3. Remove the nut and washer that attach the positive lead to the trailer PDM battery power stud. Then remove the positive lead. See **Fig. 2**.
4. Disconnect the electrical connectors from the trailer PDM.
5. Remove the nuts and washers that attach the trailer PDM to the mounting bracket, then remove the PDM.



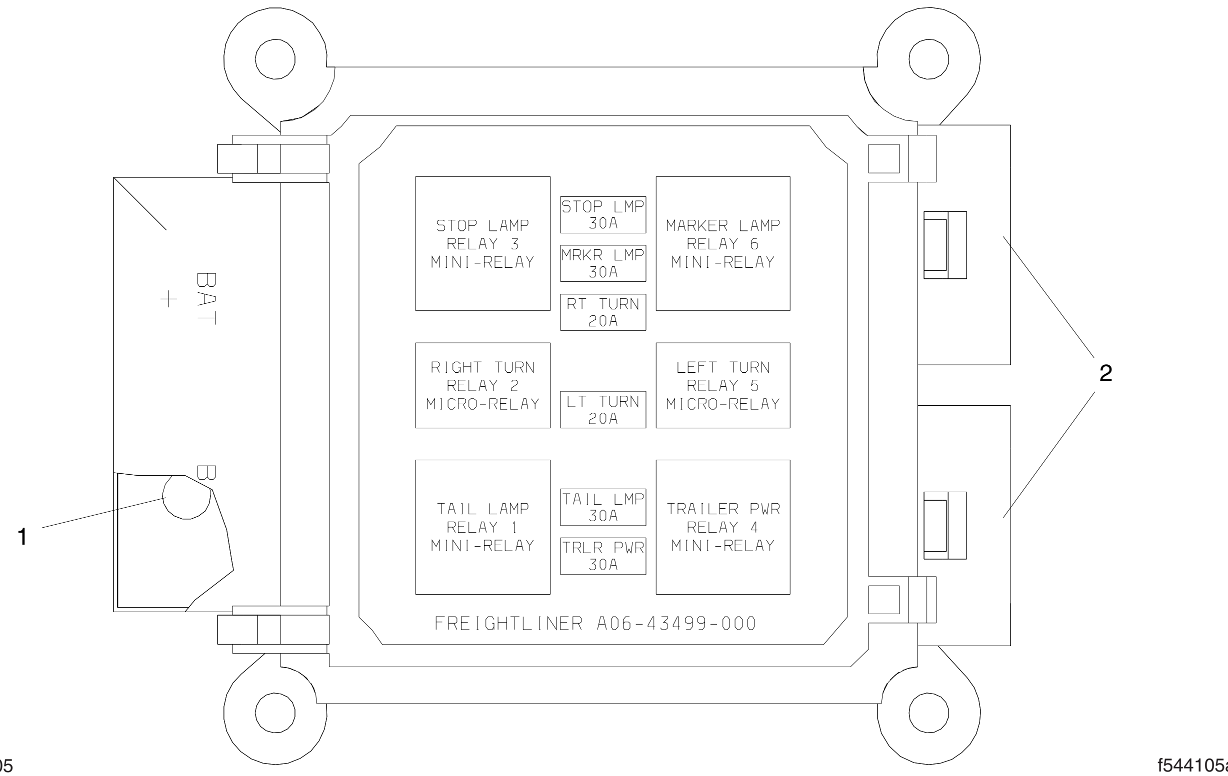
1. Trailer PDM
2. Chassis Module

Fig. 1, Typical EPA07 Trailer PDM (deck plate removed)

Installation

1. Using nuts and washers, attach the PDM to the mounting bracket.
2. Attach the electrical connectors to the trailer PDM.
3. Using a nut and washer, install the positive lead on the trailer PDM battery power stud. Torque the nut 11 to 13 lbf·ft (15 to 18 N·m). Apply dielectric red enamel to protect the power connection.
4. Connect the batteries.
5. Remove the chocks from the tires.

Trailer PDM Removal and Installation (EPA07 and earlier)



1. Battery Power Stud
2. Electrical Connector

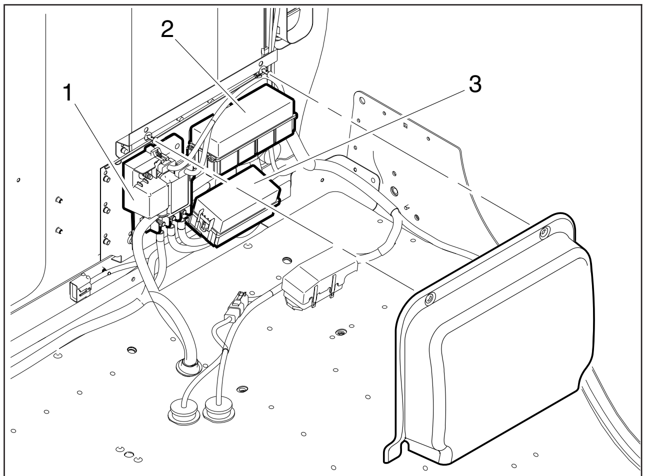
Fig. 2, Trailer PDM Fuse Panel Layout

EPA10 Body Lighting PDM Removal and Installation

The Body Lighting PDM is located behind the driver's seat.

Removal

1. Disconnect the batteries at the negative terminals.
2. Remove the cover of the PDM modules housing.
3. Open the cover of the Body Lighting PDM and remove the two retaining clips. See **Fig. 1**.



1. Auxiliary PNDB
2. Trailer PDM
3. Body Lighting PDM

Fig. 1, Power Distribution Modules (EPA10 shown)

4. Lift the PDM block assembly out from the housing. The power feed circuits can be disconnected from the bus when the block assembly is about half way out of the housing.
5. Identify the positions and values of the fuses and relays, then remove them.
6. Lift the terminal locks up and out of the PDM.
7. Label all the wires before removing them from the PDM. Remove the wires.
8. Remove the PDM from the vehicle.

Installation

1. Insert each circuit into the bottom of the PDM block assembly. If the terminal is backward, the lock will not seat into place.
2. Install the terminal locks and the fuses and relays, as previously noted.
3. Place the PDM block assembly into the housing, and connect the power feed circuits to the buss bar.
4. Gently squeeze the PDM housing and install the two retaining clips.
5. Close the PDM cover.
6. Install the PDM housing onto the bracket, if it was removed.
7. Connect the batteries.

Powernet Distribution Box Removal and Installation

Removal

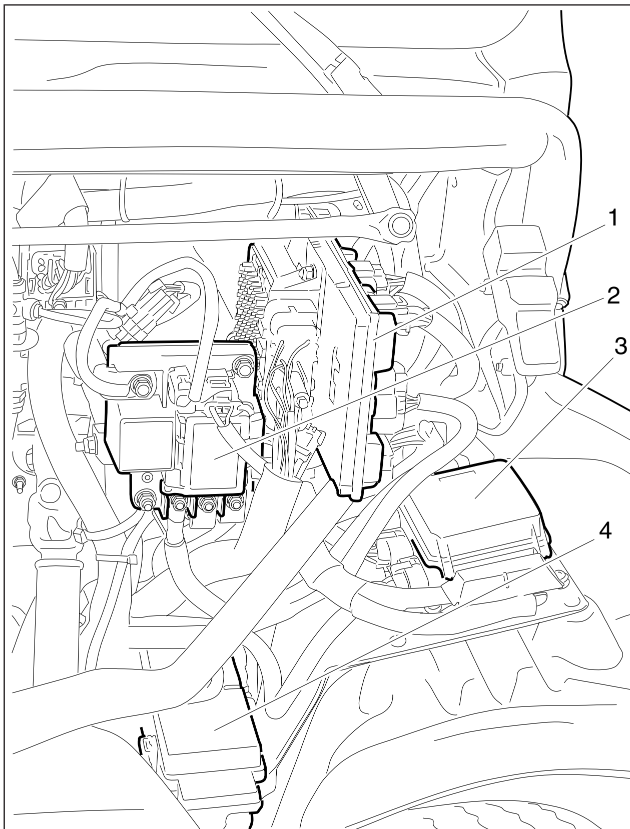
1. Disconnect all batteries. If the vehicle is equipped with an auxiliary battery bank, disconnect these batteries as well.
2. Open the hood.

NOTE: The powernet distribution box (PNDB) is located on the cab frontwall, next to the bulkhead module. See **Fig. 1**.

3. Disconnect the battery and power cables from the PNDB. See **Fig. 2**.
4. Disconnect the cab load disconnect switch (CLDS) connecter, if equipped.

IMPORTANT: Inspect the keep-alive and CLDS connectors and make sure that the plugs are in unused connector cavities. Install plugs to seal the connector if any are missing.

5. Disconnect the keep-alive circuit connector from the PNDB.
    5.1 Using a flat-head screwdriver, push the red locking tab up.
    5.2 Press and release the tab, then remove the connector.
6. Remove the two mounting nuts.
7. Remove the PNDB from the vehicle.



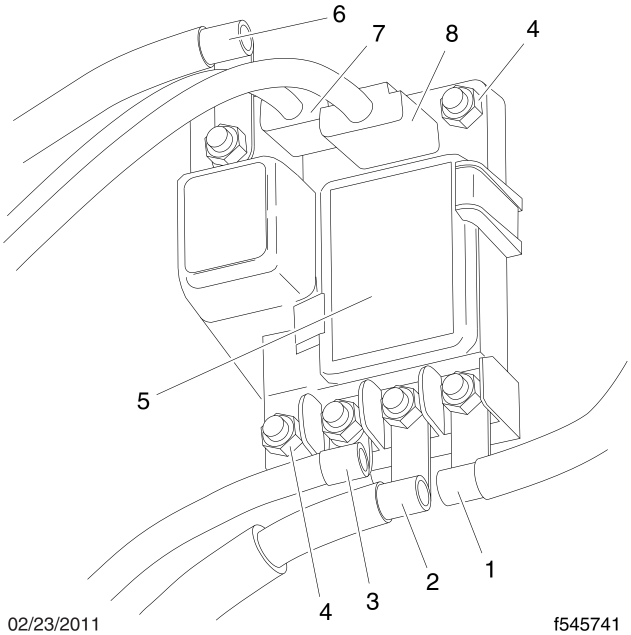
1. Bulkhead Module
2. PNDB
3. Main PDM
4. Powertrain PDM

Fig. 1, Power Distribution Modules (EPA10 shown)

Installation

1. Position the PNDB on the frontwall, and attach the two mounting nuts.
2. Connect the battery and power cables.
3. Attach the keep-alive circuit connector and the CLDS connector.
4. Connect the batteries.
5. Close the hood.

Powernet Distribution Box Removal and Installation



1. Main PDM Power (circuit 1)
2. Main PDM Power (circuit 2)
3. Powertrain PDM Power
4. Mounting Nut
5. Fuse Cover
6. Power (B+)
7. Disconnect Switch (CLDS) Connector
8. Keep-Alive Circuit Connector

Fig. 2, Powernet Distribution Box

Troubleshooting

MEGA Fuses

MEGA fuses must be measured using a voltmeter when in the circuit or with an ohm meter when out of the circuit to determine if they are open. There is no visual method of determining continuity. See **Fig. 1**.

In 2008, the type of MEGA fuses changed from Bussman to Littelfuse. The Littelfuse is staked and addresses the intermittently open circuit fault that may occur with the Bussman fuse. When MEGA fuses are replaced, be certain that stainless steel nuts and washers are used. Cover the connections in the battery box liberally with dielectric grease.

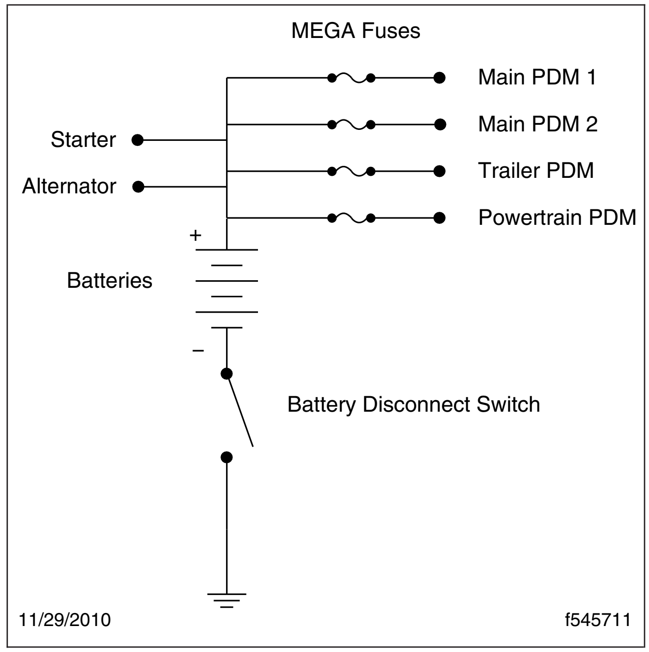


Fig. 1, Typical EPA07 and Earlier In-Battery Box MEGA Fuse Schematic

PNDB

Each powernet distribution box (PNDB) on the vehicle provides up to 4 low amperage circuits (30 amp and less), and up to three high amperage circuits through midi fuses. The fuses are located behind a cover on the face of the PNDB. On vehicles equipped with a cab load disconnect switch (CLDS), the high amperage circuits are switched on and off with the CLDS. The low amperage circuits are always live. Vehicles may have one or two PNDBs and both are connected to the same CLDS.

When the CLDS is in the on position, an LED on the switch, and another on the PNDB, will be illuminated. When there is an error condition with the PNDB system, the LED on the PNDB and CLDS may flash. A flashing LED indicates an error. An LED that remains on when the switch is off or no LED when the switch is on also indicates an error condition.

To test for open fuses, use conventional troubleshooting methods. The LED's in the PNDB and switch are not affected by open fuses or the circuits they connect.

See **Table 1** to troubleshoot a switched PNDB system

See **Table 2** to diagnose a blinking PNDB LED.

PNDB and CLDS Troubleshooting			
Step	**Test Procedure**	**Test Result**	**Action**
1	Check the power cables on the PNDB for proper torque. Open the cover and inspect the MIDI fuse fastener torque and for discoloration caused by excessive heat.	Loose fasteners or heat discoloration.	Determine if the fasteners can be properly torqued or if the PNDB needs replacement. Repair or replace as required.
		All OK	Go to step 2.

Troubleshooting

PNDB and CLDS Troubleshooting			
Step	**Test Procedure**	**Test Result**	**Action**
2	Does the LED on the PNDB flash in a constant pattern when the CLDS is switched to the OFF or ON position or does the LED on the PNDB just randomly flicker?	Constant Repeating Flashing Pattern	Troubleshoot and repair any wiring faults on circuits 425D, 425F, or circuit 425G between the CLDS and the PNDB. If there is no wiring fault, replace the CLDS.
		Random flickering.	Replace the PNDB.
		No	Go to step 3.
3	Measure for ground on PNDB connector 1, pins 1 and 6. If either of these pins are not populated with a wire disregard measuring the unpopulated pin. Is ground present in the wiring harness supplying these pins?	Yes	Measure the voltage on PNDB connector X1, pin 4. If pin 4 is at about 11 volts then troubleshoot and repair for a wiring fault in circuits 425D, 425F, 425G between the CLDS and the PNDB and for a open or short circuit in the CLDS. If there is no wiring or switch fault, replace the PNDB.
		No	Repair an open ground circuit to the PNDB.

Table 1, PNDB and CLDS Troubleshooting

NOTE: If there is a 12-volt backfeed on any of the output studs and the PNDB is in an OFF state, then the PNDB will not turn on. This is because the PNDB monitors the output, and if any voltage is present, the PNDB thinks the bi-stable relay is on.

PNDB LED Blinking		
LED Behavior	**Problem**	**Action**
LED blinks 3 times fast.	Pin 4 is disconnected, cut, or is showing an open circuit due to high resistance.	Verify the integrity of all connections, and verify that there is no corrosion. Perform a continuity test between all terminal connections. If all connections are good, and the continuity tests pass, replace the PNDB.
	CLDS pin 1 is disconnected, cut, or is showing an open circuit due to high resistance.	
	The CLDS connector or the PNDB control connector is not fully mated.	
Main LED is off. Auxiliary light is ON, and auxiliary PNDB is ON.	PNDB pin 5 is disconnected, cut, or is showing an open circuit due to high resistance.	
	Switch pin 1 of 4 is disconnected.	
The LED double blinks.	The PNDB fails to turn ON after 5 attempts.	Low voltage can cause this issue. If the voltage is normal, then the PNDB is no longer operational. Replace the PNDB.
	The PNDB fails to turn OFF after 5 attempts.	

Table 2, PNDB LED Blinking

See **Fig. 2**, **Fig. 3**, **Fig. 4**, and **Fig. 5** for illustrations of the connectors with pin identification.

See **Table 3** for primary PNDB and CLDS connector and pin functions.

NOTE: PNDB connector X2 is not part of the switching and control system. See **Table 4** for information on the function of PNDB connector X2.

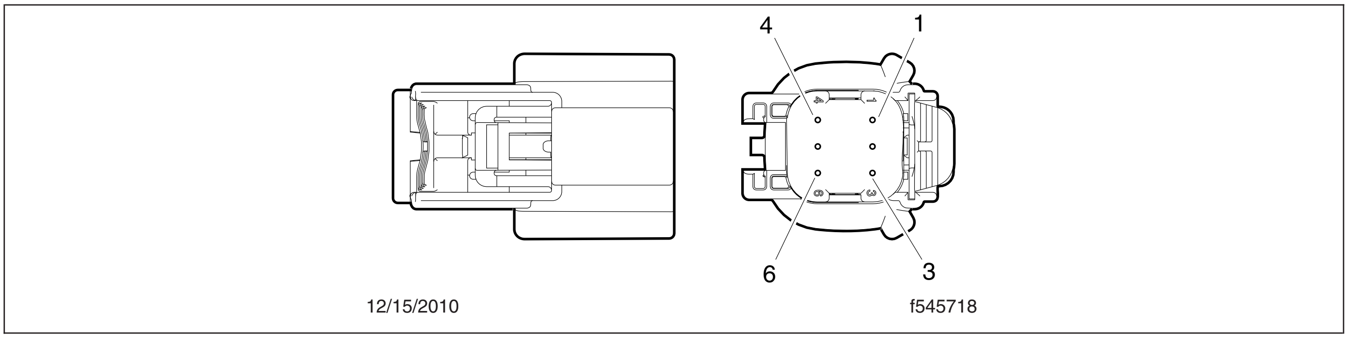


Fig. 2, Wire Insertion View of PNDB Connector X1

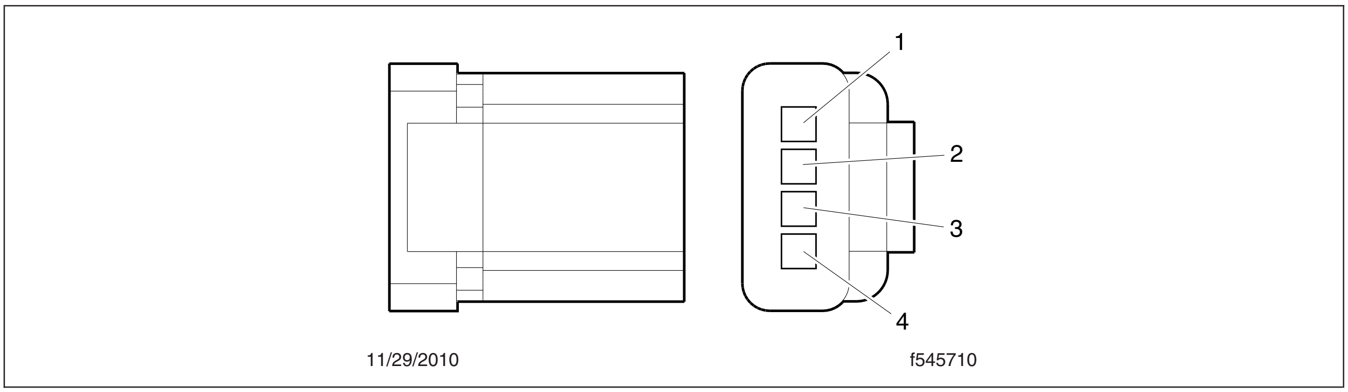


Fig. 3, Wire Insertion View of PNDB Connector X2

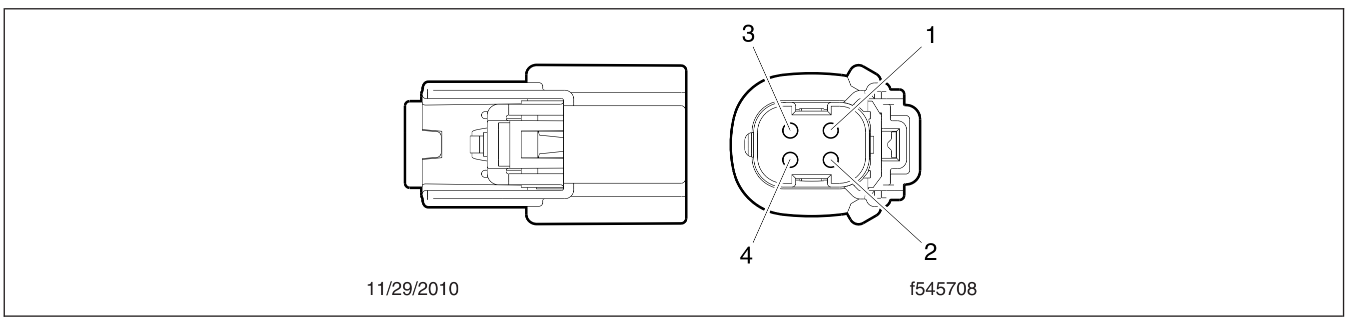


Fig. 4, Wire Insertion View of CLDS Connector X1

Troubleshooting

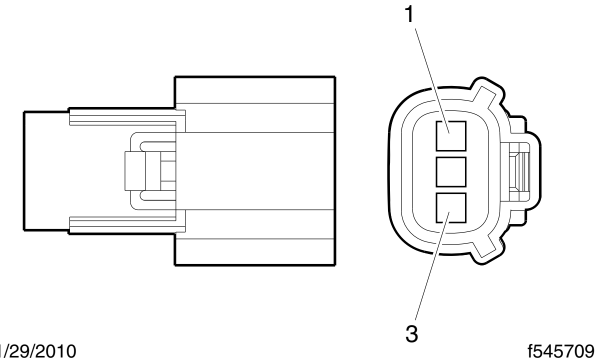


Fig. 5, Wire Insertion View of CLDS Connector X2

Primary PNDB and CLDS Connector and Pin Functions			
Device	**Connector, Pin**	**Voltage**	**Function**
Primary PNDB	X1, 1	0	Ground
	X1, 2	0	Off Signal – Always at ground.
	X1, 3	0 – ON	LED Indicator – PNDB drives this low when the switch is on.
	X1, 4	11	On Signal – Approximately 11 volts.
	X1, 5	11 – ON 0 – OFF	Control Signal – Approximately 11 volts when CLDS is on. At ground when off.
	X1, 6	0	Not used or ground circuit connecting to aux PNDB.
CLDS	X1, 1	11	On Signal – Approximately 11 volts.
	X1, 2	11 – ON 0 – OFF	Control Signal – Approximately 11 volts. when CLDS is on. At ground when off.
	X1, 3	0 – ON	LED Indicator – PNDB drives this low when switch is on.
	X1, 4	0	Off Signal – Always at ground.
	X2, 1	11 – ON 0 – OFF	Control Signal – Approximately 11 volts when CLDS is on. At ground when off.
	X2, 2	0	Off Signal – Always at ground.
	X2, 3	0 – ON	LED Indicator – PNDB drives this low when the switch is on.
Auxiliary PNDB	X1, 1	0	Ground
	X1, 2	0	Off Signal – Always at ground.
	X1, 3	0 – ON	LED Indicator – PNDB drives this low when the switch is on.
	X1, 4	X	Not used.
	X1, 5	11 – ON 0 – OFF	Control Signal – At approximately 11 volts when CLDS is on. At ground when off.
	X1, 6	0	Not used, or ground.

Table 3, PNDB and CLDS Connector and Pin Functions

See Fig. 6 for a schematic of the dual PNDB system with the cab load disconnect switch option.

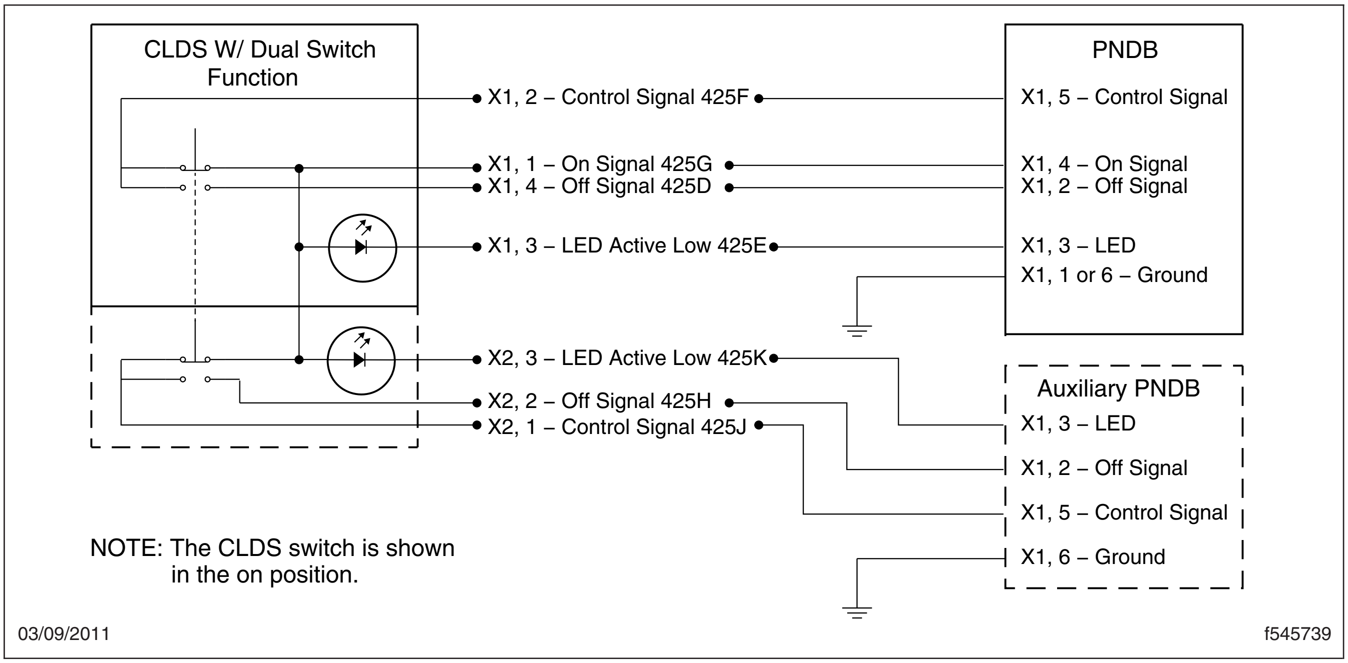


Fig. 6, Primary and Auxiliary PNDB with CLDS Option

Primary PNDB Fuses and Functions					
Fuse	Amperage	Function	Circuit	Connector/Pin	Module
ATC – A	30	ACM (After Treatment Module)	439	X2/1	28F
ATC – B	—	—	—	X2/2	—
ATC – C	5	Radio and Clock	295B	X2/3	74D
ATC – D	5	Alternator Remote Sense	125E	X2/4	12C
MIDI – 1	175	Powertrain PDM	439	1	283
MIDI – 2	125	Main PDM 1	14E	2	285
MIDI – 3	125	Main PDM 2	14E	3	285

Table 4, Primary PNDB Fuses and Functions

Main PDM

Main PDM Circuit Mapping		
Fuse	Connector, Pin	Power Source
F1	Green, A	1
F2	Green, B	1
F3	Green, H	2

Main PDM Circuit Mapping		
Fuse	**Connector, Pin**	**Power Source**
F4	Green, G	2
F5	Black, D	1
F6	Black, C	1
F7	Gray, F	1
F8	Green, C	2
F9	Green, D	2
F10	Blue, G Green, F	2
F11	Blue, H	2
F12	Black, H	1
F13	Gray, E	1
F14	Black, B	1
F15	Black, A	2
F16	Blue, A	2
F17	Blue, C	2
F18	Blue, B	2
F19	Gray, G	2
F20	Black, E	1
F21	Black, F	1
F22	Black, G	1
F23	Gray, H Blue, E	1
F24	Gray, D	1
F25	Gray, C	2
F26	Gray, A Gray, B Blue, D	2

Table 5, Main PDM Circuit Mapping

Powertrain PDM

Engine, transmission, and exhaust after treatment systems are powered through the powertrain PDM.

The circuits that populate this PDM will vary depending on vehicle option content.

EPA07 PTPDM			
Position	**Rating**	**Description**	**Module**
F1	10A	Electric Fan	283

EPA07 PTPDM			
Position	**Rating**	**Description**	**Module**
F2	5A	Transmission ECU Ignition	34B
F3	20A	Fuel Heater/MAF Sensor	28F
F4	20A	Fuel Heater/ICD Power	28F
F5	See Label	Engine Ignition	283
F6	See Label	VNT/ATD or Lockout Sol/Fuel Sender	—
F7	15A	LVD/Remote Sense	—
F8	See Label	Engine ECU Battery Power	283
F9	See Label	CPC/Engine ECU Battery Power	283
F10	See Label	Trans Batt Power	34B
F11	20A	Trans Batt Power	34B
F12	See Label	Trans Batt Power/EMP Air Pump	34B
R1	15A	START ENABLE	34B
R2	15A	MEIIR or Lockout Sol (Crank)	34B
R3	15A	CHECK TRANS/HYD BRAKES	34B/863
R4	See Label	Electric Fan/HEST Lamp or Lockout Sol (Run)	—
R5	See Label	STARTER/Electric Fan	156
R6	70A	Engine Ignition Power	283

Table 6, EPA07 PTPDM

EPA10 PTPDM			
Position	**Rating**	**Description**	**Module**
F1	30A	ECM/MCM, BAT	283
F2	10A	CPC, BAT	283
F3	10A or 30A	TCU, BAT	34B
F4	25A	COOLANT PUMP BAT	34B
F5	30A	BATTERY FAN, BAT	34B
F6	20A	DEF LINE HEATERS, BAT	28F
F7	10A	TCU/IGN or COOLANT PUMP, IGN	34B
F8	—	SPARE	—
F9	20A	ENG/SCR NOX SENSOR, IGN	28F
F10	5A or 15A	ECM, CPC, MCM, ACM – IGN	283
F11	10A	ELECTRIC FAN, IGN	276
F12	5A	DCU, IGN	28F
F13	50A	ECA/BAT	34B
F14	30A	HCM, BAT	34B

EPA10 PTPDM			
Position	Rating	Description	Module
F15	25A	HEAT EXCHANGER FAN,BAT	34B
R1	MINI	PTO #2 or BATTERY FAN	885/34B
R2	75A	IGN	283
R3	MICRO	AUTO NEUTRAL or COOLANT PUMP	877/34B
R4	MICRO	DEF LINE HEAT	28328F
R5	MICRO	PTO/MEIIR OR 12V CRANK	885/34B
R6	MICRO	ELECTRIC FAN	276
R7	MICRO	NEUTRAL INTERLOCK	87K
R8	MICRO	START ENABLE (TRANS)	34B

Table 7, EPA10 PTPDM

Chassis PDM

Vehicles with the AAVA have a chassis power distribution module. This PDM contains the fuses and relays that drive the air solenoids in the AAVA.

EPA10 Chassis PDM			
Position	Relay	Description	Module
F1, 5A	R1 Micro	Lift Axle #1	87F
F2, 5A	R2 Micro	Axle Lock #1	87B
F3, 5A	R3 Micro	Inter Axle Diff	87A
F4, 5A	R4 Micro	Axle Shift	87C
F5, 5A	R5 Micro	Fifth Wheel	87E
F6, 5A	R6 Micro	Optional Air Solenoid	87G
F7, 5A	R7 Micro	Air Horn	264
F8, 5A	R8 Micro	Air Suspension Dump	87D
F9, 5A	R9 Micro	Axle Lock #2	87B
F10, 5A	R10 Micro	Auto Park Brake	877
F11, 5A	R11 Micro	PTO Pump #1	885
F12, 5A	R12 Micro	PTO Pump #2	885

Table 8, EPA10 Chassis PDM

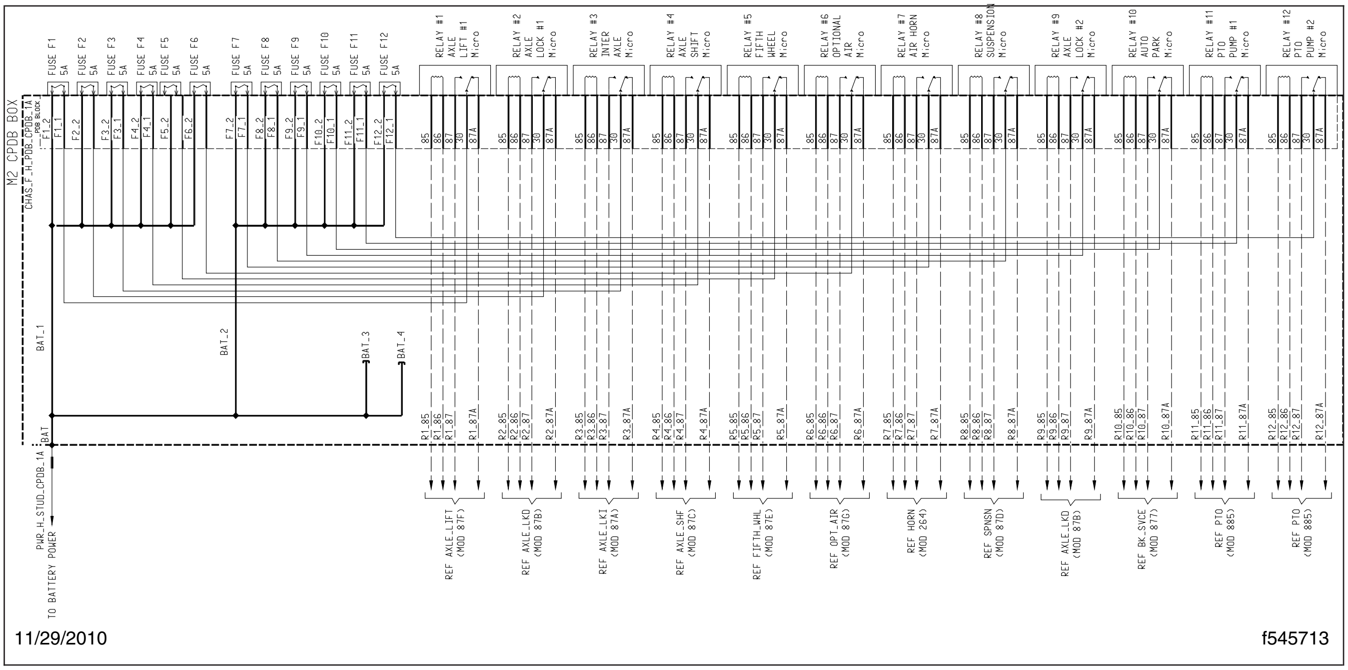
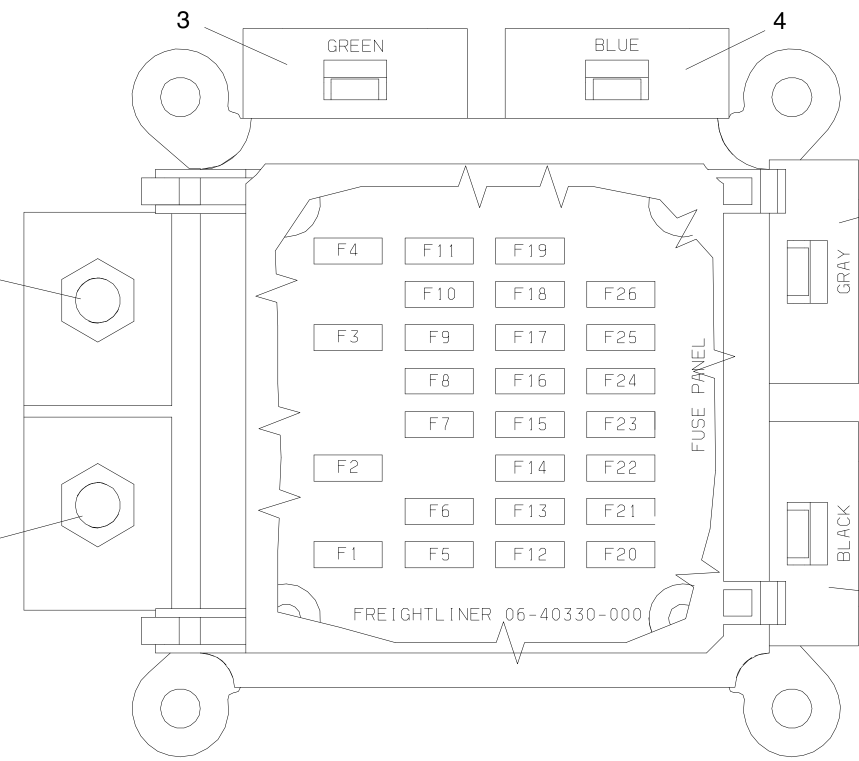


Fig. 7, Chassis PDM Schematic

Main PDM Specifications

See Fig. 1 for an illustration of the main PDM fuse panel layout and connections.



1. Battery Power to 125-Amp MEGA Fuse 2
2. Battery Power to 125-Amp MEGA Fuse 1
3. Engine Harness Connector (green)
4. Forward Chassis Harness Connector (blue)
5. Forward Chassis Harness Connector (gray)
6. Frontwall Harness Connector (black)

Fig. 1, Main PDM Fuse Panel Layout and Connections

Fuse Specifications*				
Fuse Location	**Primary Function**	**Fuse Rating**	**Secondary Function**	**Fuse Rating**
F1	Vehicle Control Unit (MBE only)	10A	Spare	—
F2	Blower Motor	30A	—	—
F3	Engine ECU (MBE or Caterpillar C7 and C9)	20A	Engine ECU (Caterpillar 3126, C11, C13, C15 ACERT, and Cummins ISC)	30A
F4	Engine ECU (Caterpillar 2004 EPA)	20A	Transmission ECU	30A
F5	Ignition Switch	5A	—	—
F6	Hydromax Relay (hydraulic ABS)	30A	—	—

Specifications

Fuse Specifications*				
Fuse Location	Primary Function	Fuse Rating	Secondary Function	Fuse Rating
F7	Bulkhead Module	30A	—	—
F8	ICU3-M2	10A	—	—
F9	Automatic Transmission ECU	10A	Eaton AutoShift Transmission ECU	30A†
F10	Spare	—	—	—
F11	Spare	—	—	—
F12	Radio/Diagnostic	20A	—	—
F13	Chassis Module	30A	—	—
F14	Spare	—	—	—
F15	Bulkhead Module	30A	—	—
F16	ABS ECU (pneumatic)	15A	ABS ECU (hydraulic)	25A
F17	Chassis Module	30A	—	—
F18	Bulkhead Module	30A	—	—
F19	Chassis Module	30A	—	—
F20	Bulkhead Module	30A	—	—
F21	Spare	—	—	—
F22	Bulkhead Module	30A	—	—
F23	Spare	—	—	—
F24	Hydraulic Pump and Motor (hydraulic ABS)	25A	Spare	—
F25	Spare	—	—	—
F26	Spare	—	—	—

* Spare fuse locations may be used for additional options such as power windows and power door locks.

† The fuse rating for an AGS transmission is 20A.

Table 1, Fuse Specifications

Specifications

MEGA® Fuse and the Corresponding PDM Fuses It Protects	
MEGA Fuse	**PDM Fuse**
1	F1
	F2
	F5
	F6
	F7
	F12
	F13
	F14
	F20
	F21
	F22
	F23
	F24
2	F3
	F4
	F8
	F9
	F10
	F11
	F15
	F16
	F17
	F18
	F19
	F25
	F26

Table 2, MEGA Fuse and the Corresponding PDM Fuses It Protects

PDM Fuses and the Corresponding PDM Output Pins	
PDM Fuse	**Output Connector and Terminal**
F1	Green A
F2	Green B
F3	Green H
F4	Green G
F5	Black D
F6	Black C
F7	Gray F
F8	Green C
F9	Green D
F10	Blue G
	Green F
F11	Blue H
F12	Black H
F13	Gray E
F14	Black B
F15	Black A
F16	Blue A
F17	Blue C
F18	Blue B
F19	Gray G
F20	Gray E
F21	Black F
F22	Black G
F23	Gray H
	Blue E
F24	Gray D
F25	Gray C
F26	Gray A
	Gray B
	Blue D

Table 3, PDM Fuses and the Corresponding PDM Output Pins

Contents

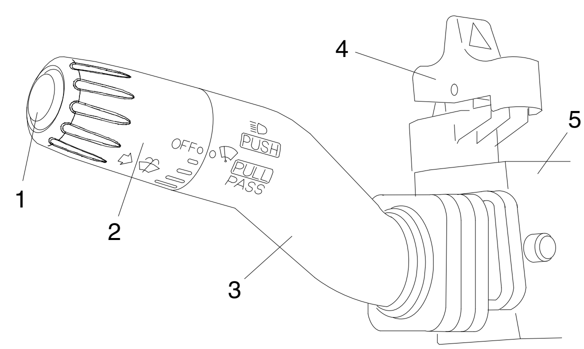
Description

The instrumentation control unit (ICU) monitors wiper control dial and washer switch position information from the multifunction turn signal switch and sends this information via J1939 messages to the Bulkhead Module (BHM). The BHM takes these messages from the ICU and uses the information to control the windshield wiper motor and the washer pump motor.

Wiper Control Dial

The wiper control dial at the end of the multifunction turn signal switch controls the operation of the wiper. See **Fig. 1**. There are two steady-speed settings, LO and HI, and five delay settings. The delay settings are indicated by five lines of various lengths on the wiper control dial. The longer the length of the line, the shorter the delay between wipes.

Rotate the wiper control dial away from you to turn the wipers on. When the wipers are on, rotate the wiper control dial toward you to turn the wipers off. See **Fig. 2**.



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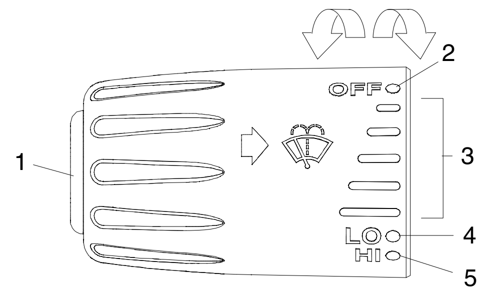
1. Washer Button
2. Wiper Control Dial
3. Turn Signal Lever
4. Hazard Flasher
5. Multifunction Turn Signal Switch Module

Fig. 1, Multifunction Turn Signal Switch

See **Specifications 400** for wiper control dial input/output signals sent to the ICU.



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1. Washer Button
2. Wiper Off Position
3. Wiper Delay Positions
4. Low-speed Wiper Position
5. High-speed Wiper Position

Fig. 2, Wiper/Washer Controls

Wiper Motor

The wiper motor is a two-speed motor that runs the wipers at low speed or high speed. For the five intermittent positions, the wipers are pulsed at low speed. There is a short time delay between pulses that varies in duration according to the position of the wiper control dial.

The BHM controls the wiper motor speed by monitoring three J1939 messages that are received from the ICU. The three messages are:

- wiper on/off message
- wiper low message
- wiper high message

When one of the intermittent speeds is selected, the ICU controls the timing of the wipers by pulsing the wiper on/off and wiper low messages. See **Specifications 400** for the I/O conditions of the wiper motor operation.

The BHM also monitors the wiper motor wiring and is capable of detecting a short circuit. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and can be viewed through ServiceLink®. See **Troubleshooting 300** for possible wiper motor fault conditions.

General Information

Washer Pump

The washer pump is operated by a button at the end of the multifunction turn signal switch. To operate the washer, press the button in and hold it in for the length of wash you want. See **Table 1** for a description of the available wash cycles. Unless the wiper control dial is in the high position, wiping triggered by the wash button is done at low speed.

The BHM monitors the washer pump motor wiring and is capable of detecting a short circuit. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and can be viewed through ServiceLink. See **Troubleshooting 300** for possible washer pump fault conditions.

Washer Fluid Level

If the vehicle is equipped with an optional washer fluid level switch, the BHM will monitor the level of the washer fluid in the fluid reservoir and send this information to the ICU via a J1939 message. When the BHM sees ground at the washer fluid level input, it sends a J1939 message to the ICU indicating low washer fluid. The ICU then illuminates the low washer fluid indicator. If the washer fluid level input is unavailable or in error, the BHM will assume the washer fluid level is low.

Washer Cycles	
Cycle Activation Requirements	**Cycle Description**
Wash button is pressed less than 0.5 second.	Single dry wipe, commonly called a mist wipe.
Wash button is pressed from 0.5 to 1.0 second.	Short wash with three wipes.
Wash button is pressed more than 1.0 second.	Wash continues until the button is released.

Table 1, Washer Cycles

Fault Codes

The reference parameters that program the Bulkhead Module (BHM) determine whether a fault code will broadcast for any wiper/washer system fault. Even if the BHM detects a wiper/washer system fault, a fault code may not be transmitted. If the BHM is programmed to transmit wiper/washer system fault codes, they can be viewed through ServiceLink®. Fault messages may be transmitted on the J1939 datalink, the J1708 datalink, or both.

Wiper Control Dial

Table 1 displays wiper control dial message combinations that create a fault.

Wiper Motor

Table 2 displays how the BHM handles wiper motor faults.

Washer Pump

Table 3 displays how the BHM handles washer pump faults.

Wiper Control Dial Fault Conditions			
J1939 Wiper Control Dial Messages			Action Taken by the BHM
Wiper On/Off	Wiper Low	Wiper High	
Off	On	Off	BHM may transmit a J1939 and/or a J1708 fault message.
On	Off	Off	BHM may transmit a J1939 and/or a J1708 fault message.
On	On	On	BHM may transmit a J1939 and/or a J1708 fault message.
Off	On	On	BHM may transmit a J1939 and/or a J1708 fault message.
Off	Off	On	BHM may transmit a J1939 and/or a J1708 fault message.

Table 1, Wiper Control Dial Fault Conditions

Wiper Motor Fault Conditions	
Description of Fault	Action Taken by the BHM
Ignition switch is in error.	BHM will assume the ignition switch is on, and may transmit a fault message on the J1939 and/or J1708 datalinks.
Wiper commutator switch is unavailable or in error.	BHM will assume the wiper commutator switch is in the park position.
J1939 wiper on/off message from the instrumentation control unit (ICU) is unavailable or in error.	BHM may transmit a J1939 and/or a J1708 fault message.
J1939 wiper low message from the ICU is unavailable or in error.	BHM may transmit a J1939 and/or a J1708 fault message.
J1939 wiper high message from the ICU is unavailable or in error.	BHM may transmit a J1939 and/or a J1708 fault message.
Contradictory J1939 messaging between the ICU and BHM.	BHM may transmit a J1939 and/or a J1708 fault message.
ICU sends an error indicator in any of the J1939 wiper messages to the BHM.	BHM may transmit a J1939 and/or a J1708 fault message.
BHM fails to receive any five consecutive J1939 wiper messages from the ICU.	BHM may transmit a J1939 and/or a J1708 fault message.

Troubleshooting

Wiper Motor Fault Conditions	
Description of Fault	**Action Taken by the BHM**
Short in the wiper motor wiring.	BHM may transmit a J1939 and/or a J1708 fault message.

Table 2, Wiper Motor Fault Conditions

Washer Pump Fault Conditions	
Description of Fault	**Action Taken by the BHM**
J1939 washer pump message from the ICU is unavailable or in error.	BHM assumes the J1939 washer pump message is off.
ICU sends an error indicator in the J1939 washer pump message to the BHM.	BHM may transmit a J1939 and/or a J1708 fault message.
BHM fails to receive five consecutive J1939 washer pump messages from the ICU.	BHM may transmit a J1939 and/or a J1708 fault message.
Short in the washer pump motor wiring.	BHM may transmit a J1939 and/or a J1708 fault message.

Table 3, Washer Pump Fault Conditions

Description

The instrumentation control unit (ICU) monitors windshield wiper control dial and washer switch position information from the multifunction turn signal switch and sends this information via J1939 messages to the Bulkhead Module (BHM). The BHM takes these messages from the ICU and uses the information to control the windshield wiper motor and the washer pump motor. See **Fig. 1** for a diagram of the major components used in the operation of the wiper/washer system.

Input and Output Conditions

The wiper motor has a low speed, a high speed, and five intermittent speeds. The BHM controls the wiper motor speed by monitoring three J1939 messages that it receives from the ICU. The three messages are:

- wiper on/off message
- wiper low message
- wiper high message

When one of the intermittent speeds is selected at the multifunction turn signal switch, the ICU controls the timing of the wipers by pulsing the J1939 wiper on/off and the J1939 wiper low messages.

Table 1 displays the wiper control dial inputs to the ICU and the J1939 message outputs.

Table 2 displays the wiper motor inputs to the BHM and how the BHM reacts to these inputs.

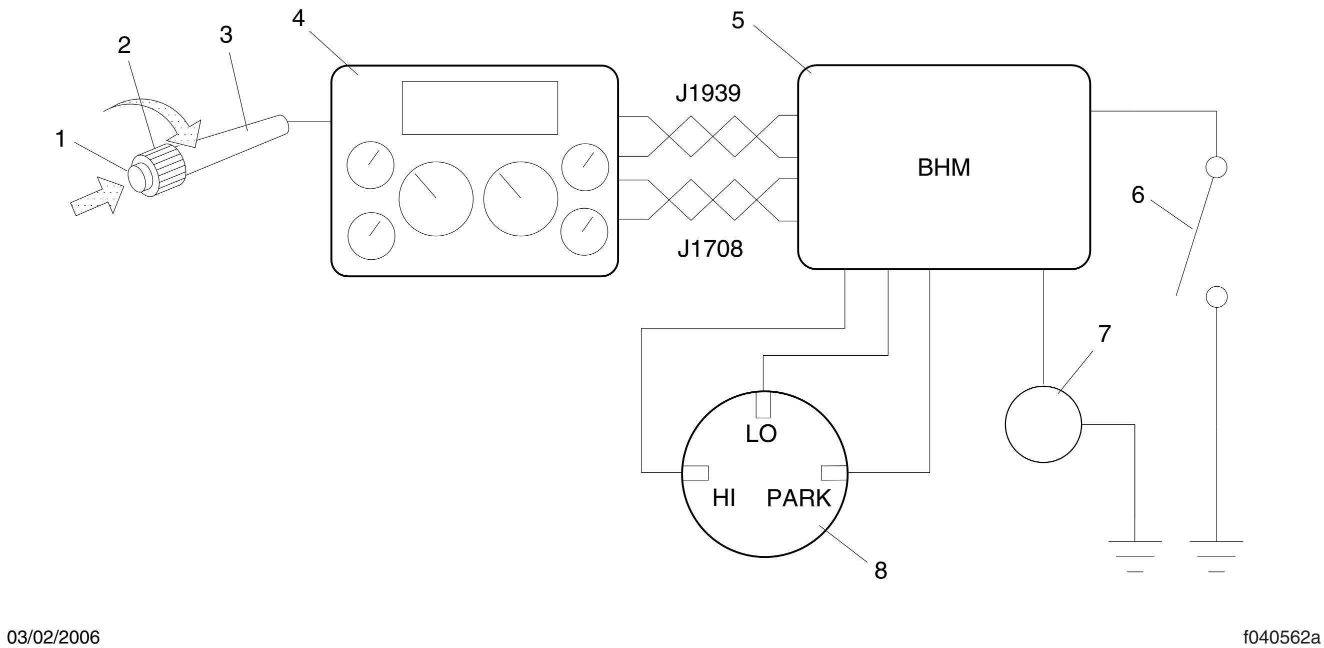
Wiring Diagram

Figure 2 shows a wiring diagram for a typical Business Class® M2 wiper/washer system. BHM pin identification and circuit colors shown on this diagram may not be representative of every vehicle.

Wiper Control Dial Input/Output Conditions				
Inputs to ICU		**Outputs from ICU**		
Wiper Control Dial Position	**Wiper Operation Timing**	**J1939 Wiper On/Off Message**	**J1939 Wiper Low Message**	**J1939 Wiper High Message**
OFF	Wiper off	Off	Off	Off
Intermittent 1	Wipe every 17 seconds	Pulsed on	Pulsed on	Off
Intermittent 2	Wipe every 12 seconds	Pulsed on	Pulsed on	Off
Intermittent 3	Wipe every 8 seconds	Pulsed on	Pulsed on	Off
Intermittent 4	Wipe every 5 seconds	Pulsed on	Pulsed on	Off
Intermittent 5	Wipe every 3 seconds	Pulsed on	Pulsed on	Off
LO	Wiper low speed	On	On	Off
HI	Wiper high speed	On	Off	On

Table 1, Wiper Control Dial Input/Output Conditions

Specifications



1. Washer Switch
2. Wiper Control Dial
3. Multifunction Turn Signal Switch
4. Instrumentation Control Unit
5. Bulkhead Module
6. Washer Fluid Level Sensor
7. Washer Pump
8. Wiper Motor

Fig. 1, Wiper/Washer System

Wiper Motor Input/Output Conditions				
Inputs to BHM				Output from BHM
Ignition Switch Position	J1939 Wiper On/Off Message	J1939 Wiper Low Message	J1939 Wiper High Message	Wiper Motor Speed
Start/Off	On/Off	On/Off	On/Off	Off
On/Acc	Off	Off	Off	Off
On/Acc	On	On	Off	Low
On/Acc	Off	On	Off	Low*
On/Acc	On	Off	Off	Low*
On/Acc	On	Off	On	High
On/Acc	On	On	On	High*
On/Acc	Off	On	On	High*
On/Acc	Off	Off	On	High*

* This is an error condition. See Specifications 300, for more information concerning fault conditions.

Table 2, Wiper Motor Input/Output Conditions

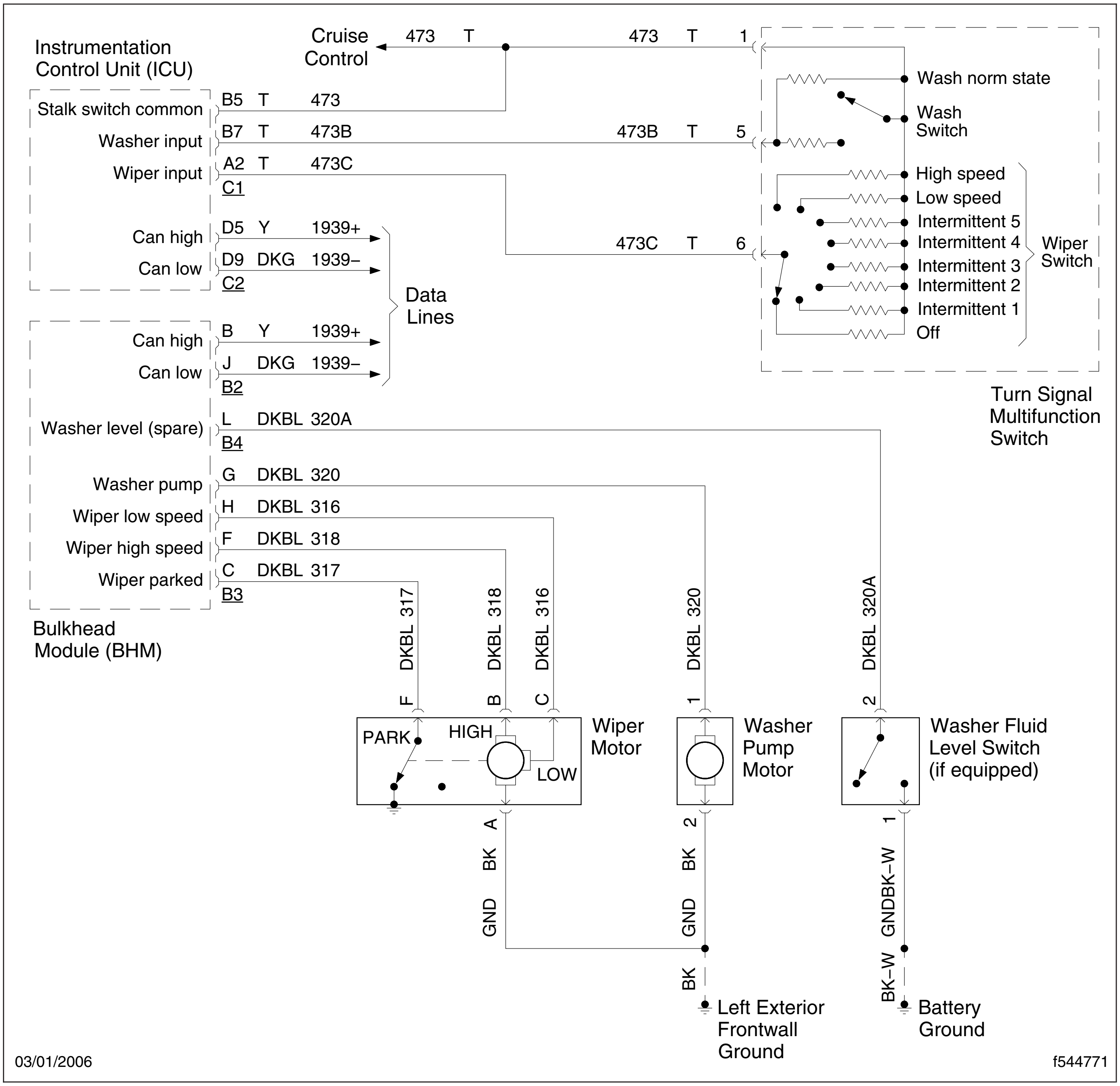
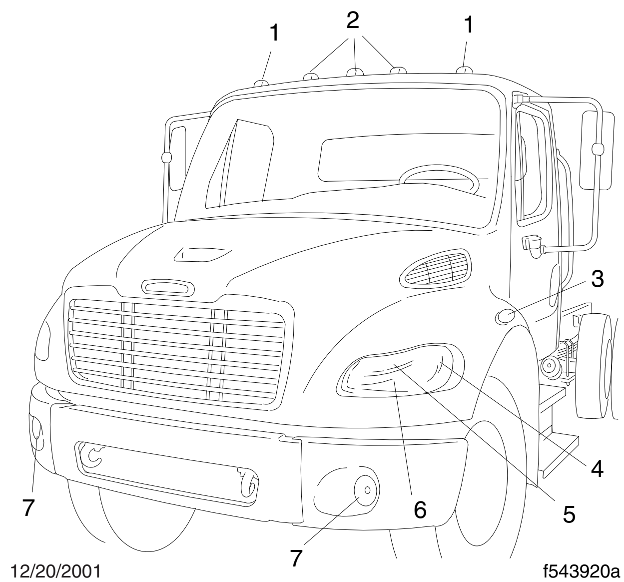


Fig. 2, Wiper/Washer Wiring Diagram

Contents

See **Fig. 1** for the locations of the forward exterior lights on a typical Business Class® M2 vehicle.



1. Clearance Light
2. Identification Light
3. Side Marker/Turn Signal Light
4. Park/Turn Signal Light
5. Headlight, Low Beam
6. Headlight, High Beam
7. Fog Light (optional)

Fig. 1, Forward Exterior Lights, All Models Except M2 106V

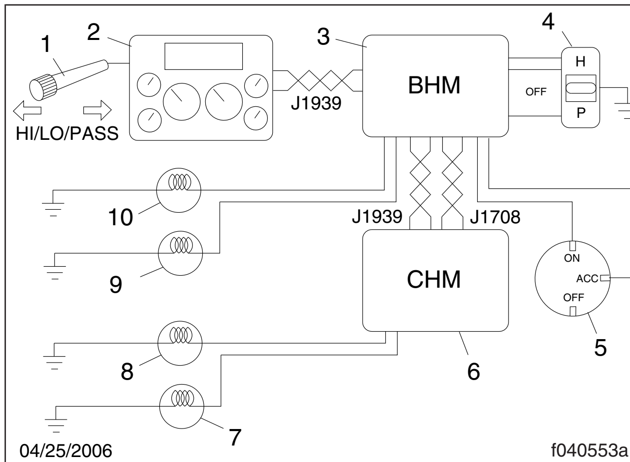
Headlight System

The Bulkhead Module (BHM) takes inputs from the multifunction turn signal switch via a J1939 message from the instrumentation control unit (ICU) as well as the combination headlight/parking light switch, and uses the information to control the headlights. See **Fig. 2**.

Headlight Switch Function

The headlight switch on the dash panel has three positions: off, park (parking lights), and on (headlights). The Bulkhead Module (BHM) continuously monitors the position of the headlight switch and broadcasts this information on the J1939 datalink.

There are three circuits that run from the headlight switch to the BHM. One is for the parking lights, the other two are for the headlights. Either of the two headlight circuits running from the switch to the BHM can activate the headlights. The double circuits act as a fail-safe and allow the headlights to work even if one of the two wires is damaged or disconnected. See **Fig. 2**.



1. Multifunction Turn Signal Switch
2. Instrumentation Control Unit
3. Bulkhead Module
4. Headlight Switch
5. Ignition Switch
6. Chassis Module
7. Right Headlight, Low Beam
8. Right Headlight, High Beam
9. Left Headlight, High Beam
10. Left Headlight, Low Beam

Fig. 2, Headlight System Function

The BHM monitors the headlight switch wiring and is capable of detecting error conditions in the headlight switch circuits. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink®.

Headlight Assemblies

There are two headlight assemblies available for a Business Class M2 vehicle:

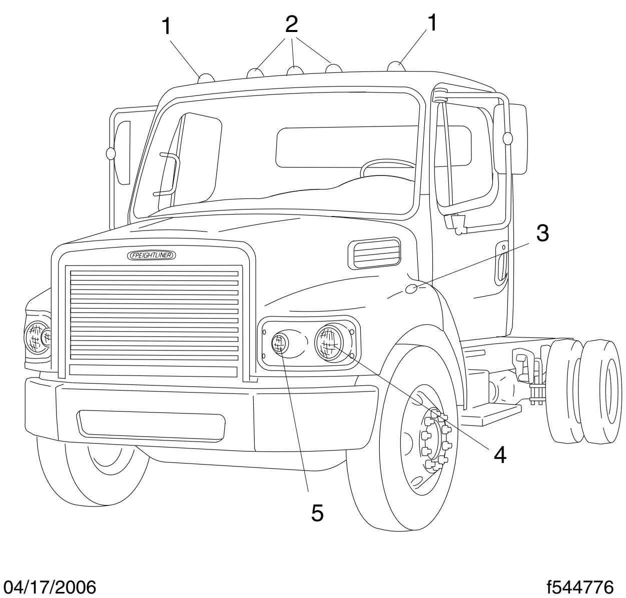
- composite headlights
- sealed-beam headlights

Composite headlights are installed on all models except M2 106V. Sealed-beam headlights are only installed on the M2 106V.

General Information

See **Fig. 1** for the locations of the forward exterior lights on a vehicle with composite headlights.

See **Fig. 3** for the locations of the forward exterior lights on a vehicle with sealed-beam headlights.



1. Clearance Light
2. Identification Light
3. Side Marker/Turn Signal Light
4. Headlight
5. Park/Turn Signal Light

Fig. 3, Forward Exterior Lights, M2 106V Only

A composite headlight assembly provides separate access to the low-beam bulb and high-beam bulb. The separate bulb connections of a composite headlight permit individual bulb replacement.

A sealed-beam headlight is an enclosed light assembly that is replaced as a single unit. The individual bulbs within the sealed-beam headlight are not replaceable.

The forward chassis harness supplies the headlights via an 8-pin connector. Depending on the type of headlight assembly, short wiring connections are made from the 8-pin connector to the headlight. A composite headlight has two separate electrical connections, one at each bulb of the headlight. A sealed-beam headlight has a single electrical connection at the rear of the headlight unit.

High Beams Function

The Bulkhead Module (BHM) continually monitors the position of the headlight switch and the position of the multifunction turn signal switch to determine if the headlights should be on low beams or high beams. The instrumentation control unit (ICU) transmits the multifunction turn signal switch position information to the BHM via a J1939 message. When the headlight switch is on and high beam or PASS is selected at the multifunction turn signal switch, the BHM activates the left high beam and sends a J1939 message to the Chassis Module (CHM) instructing it to activate the right high beam. High beams operate only with the ignition on.

The BHM is capable of detecting shorted circuits in the left high beam wiring and the right high beam wiring on the CHM. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink. See **Fig. 2**.

Low Beams Function

The Bulkhead Module (BHM) continually monitors the position of the headlight switch and the position of the multifunction turn signal switch to determine if the headlights should be on low beams or high beams. The instrumentation control unit (ICU) transmits the multifunction turn signal switch position information to the BHM via a J1939 message. When the headlight switch is on and low beam is selected at the multifunction turn signal switch, the BHM activates the left low beam and sends a J1939 message to the Chassis Module (CHM) instructing it to activate the right low beam.

NOTE: If the CHM does not see J1939 messages from the BHM, the right low beam is activated. If the BHM fails, the left low beam is activated.

The BHM is capable of detecting shorted circuits in the left low beam wiring and the right low beam wiring on the CHM. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink. See **Fig. 2**.

Daytime Running Lights

All Business Class M2 vehicles can be equipped with daytime running lights (DRL). Daytime running lights are required on vehicles domiciled in Canada. The customer can also request DRL.

IMPORTANT: When adding daytime running lights to a vehicle that was built without DRL, you must follow the "Adding a Feature" procedure in **Section 54.00, Subject 110**. Adding or changing a reference parameter without following this procedure may have legal consequences for the vehicle owner, which may include fines and having vehicles placed out of service. The regulations in the Federal Motor Vehicle Safety Standards (FMVSS) and Canadian Motor Vehicle Safety Standards (CMVSS) control the illumination intensity of daytime running lights and the required marking of lights used as DRL. Some jurisdictions enforce these regulations during vehicle inspections.

The daytime running lights use either the low-beam headlights or the front turn signal lights, depending on the type of vehicle. On an M2 106V vehicle, the low-beam headlights are used as the daytime running lights. On all other M2 vehicles, the front turn signal lights are used as the daytime running lights. DRL functionality is programmed to the BHM whether the low-beam headlights or the front turn signal lights are used.

See **Subject 500** for DRL reference parameters and descriptions.

NOTE: A vehicle that uses the low-beam headlights as the DRL cannot be converted to the front turn signal lights as the DRL. The front turn signal lights do not meet the legal requirements for lamp identification for use as DRL.

A vehicle that uses the front turn signal lights as the DRL cannot be converted to the low-beam headlights as the DRL. The headlights will not provide the legally-required illumination intensity.

DRL Using Low-beam Headlights

On an M2 106V vehicle with daytime running lights, the pulse-width-modulated (PWM) DRL is only supported by BHM part number 06-49824-002 (software version 6.40 or higher). Since the CHM controls the right low beam, the CHM must be part number 06-34530-004 to possess PWM capabilities. PMW low-beam DRL is used on an M2 106V vehicle.

Low-beam DRL is activated with the headlight switch off, the ignition on, and the park brake released. When these conditions are met, the BHM activates the left low beam and sends a J1939 message to the CHM instructing it to activate the right low beam.

When operating as daytime running lights, the low-beam headlights are pulse-width modulated at approximately 85 percent. This is recognized as a voltage supply to the low beams at a reading lower than battery voltage. If the headlight switch is turned on, full battery voltage is supplied to the low beams.

DRL Using Turn Signal Lights

On a Business Class M2 vehicle with daytime running lights using turn signal lights, the front turn signals are powered by separate output pins on the CHM. A jumper harness must be installed to connect the DRL outputs directly to the front turn signal circuits. The DRL outputs of the CHM continuously illuminate the front turn signals when the ignition is on, the headlight switch is off, and the turn signals are not active. If the turn signal switch is activated when the DRL is on, the CHM turns on and off the DRL output to the appropriate turn signal.

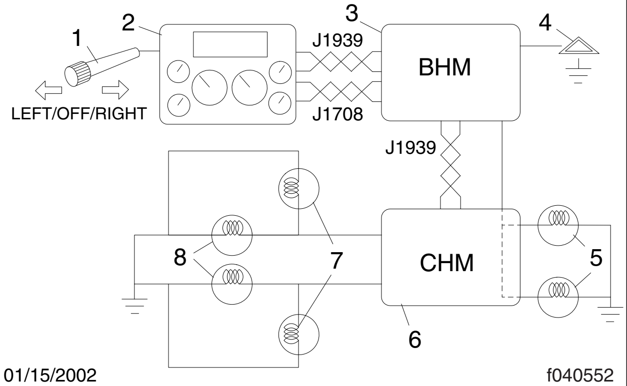
Turn Signal Lights Function

The Bulkhead Module (BHM) uses J1939 message inputs from the instrumentation control unit (ICU) to instruct the Chassis Module (CHM) to activate the turn signals. The ICU monitors the position of the multifunction turn signal switch. When the ICU sees that the driver has activated this switch, it sends a J1939 message to the BHM. The BHM then checks whether the hazard switch has been activated. If the hazard switch has not been activated, the BHM sends a J1939 message to the CHM instructing it to illuminate the turn signal lights. See **Fig. 4**.

Exterior bulbs that provide turn signal identification often contain dual filaments in order to provide other vehicle lighting such as park lights or marker lights. Exterior turn signals on a typical M2 are:

- park/turn signal lights at the front of the vehicle
- side marker/turn signal lights on the front fenders
- taillights at the rear of the vehicle
- raised fender lights (optional) viewable from the front and side of the vehicle

General Information



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1. Multifunction Turn Signal Switch
2. Instrumentation Control Unit
3. Bulkhead Module
4. Hazard Switch
5. Rear Turn Signal Lights
6. Chassis Module
7. Side Turn Signal Lights
8. Front Turn Signal Lights

Fig. 4, Turn Signal Lights Function

The CHM switches power on and off to all forward turn signals. The BHM operates the rear turn signals by sending pulsed power through the CHM to the taillights. The BHM is capable of detecting short circuits in the turn signal wiring. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink.

Hazard Lights Function

Hazard lights are used to warn other drivers of emergency situations. The same bulbs that are used for the turn signals are also used for the hazard lights. The BHM activates these lights based on the position of the hazard and multifunction turn signal switches. The BHM monitors the hazard switch directly. The instrumentation control unit (ICU) transmits the multifunction turn signal switch position information to the BHM via a J1939 message. When the hazard switch is on and neither the right-turn nor the left-turn signal is selected at the multifunction turn signal switch, the BHM sends a J1939 message to the CHM instructing it to activate all the forward lighting turn signals. The BHM activates the right-turn and left-turn signal lights at the rear of the vehicle by sending power through the CHM and to the lights.

NOTE: The CHM will activate the hazard lights in the event the BHM loses communication with the CHM on the J1939 datalink.

The BHM is capable of detecting short circuits in the right-turn and left-turn signal light wiring. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink. See **Fig. 4**.

Marker Lights Function

A marker light is any light that indicates the presence of the vehicle to other drivers. This includes parking lights, taillights, marker lights, identification lights, and clearance lights. See **Fig. 1** for forward maker light locations.

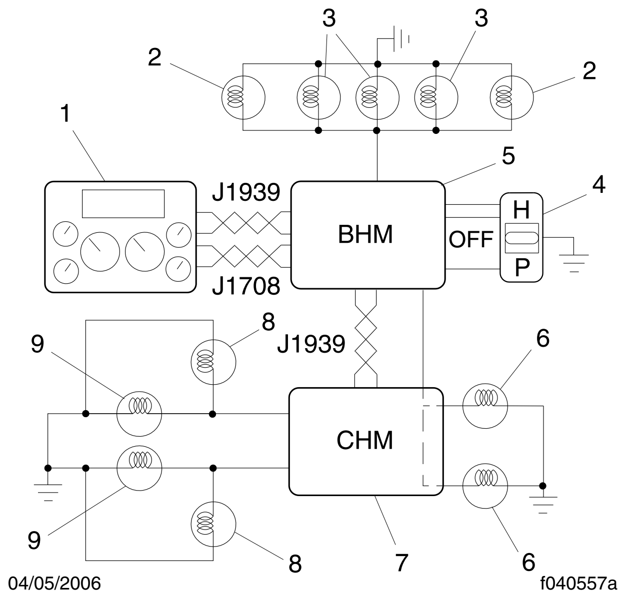
The Bulkhead Module (BHM) continually monitors the position of the headlight switch. When it sees that the operator has selected either headlights or parking lights, the BHM does several things. It sends power directly to the identification lights and clearance lights that are mounted on the cab roof. It also sends power through the Chassis Module (CHM) to the taillights. Finally, the BHM sends a J1939 message to the CHM instructing it to turn on the side marker lights and park lights.

The BHM is capable of detecting shorted wires in the marker light circuits. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink. See **Fig. 5**.

Variations on Marker Light Function

Marker lights may be programmed or adapted for functionality that differs from the headlight switch. Some common variations of marker light functionality are:

- battery-operated clearance lights
- clearance lights, identification lights, and taillights that are on at all times
- clearance lights and identification lights controlled by a marker interrupt switch
- marker lights turn off when the ignition is turned off



1. Instrumentation Control Unit
2. Clearance Light (top of cab)
3. Identification Lights (top of cab)
4. Headlight Switch
5. Bulkhead Module
6. Taillights
7. Chassis Module
8. Side Marker Lights (side of hood)
9. Park Lights (front of hood)

Fig. 5, Marker Lights Function

See **Subject 500** for the reference parameters required to program alternate marker light functionality. Some parameter programming requires no installation of additional features, while other parameters may require additional wiring.

When a customer requests battery-operated clearance lights, a different harness is used for the clearance and identification lights. The clearance lights are connected directly to the battery splice pack in the vehicle dash, while the identification lights are connected to the BHM.

Vehicles equipped with battery-operated clearance lights are equipped with a battery disconnect switch. The disconnect switch must be turned to the off position to turn off the clearance lights.

Vehicles equipped with marker lights that are programmed to be on at all times are equipped with a battery disconnect switch. These marker lights are turned off by placing the battery disconnect switch to the off position.

The marker interrupt switch turns on the identification lights, front park lights, side marker lights, and taillights when the headlight switch is in the off position. This switch turns off these lights when the headlight switch is in either the park or on positions. The interrupt switch can also be programmed for use with marker lights that are on with the ignition off.

Fog Lights Function

Fog lights are available as an optional feature on a Business Class M2 vehicle. Fog lights may only be activated if the ignition switch is on and the headlight high beams are off.

The BHM continually monitors the position of the ignition switch, multifunction turn signal switch, and the dash-mounted fog light switch. The fog light switch is a two-position latching smart switch that delivers signals directly to the BHM. If the fog light switch is on and the BHM has determined that the other requirements are met, the BHM sends a J1939 message to the CHM instructing it to turn on the fog lights. The CHM fog light outputs are at pins C and D of CHM connector C3.

The BHM is capable of detecting shorted wires in the fog lights circuits. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink. See **Fig. 6**.

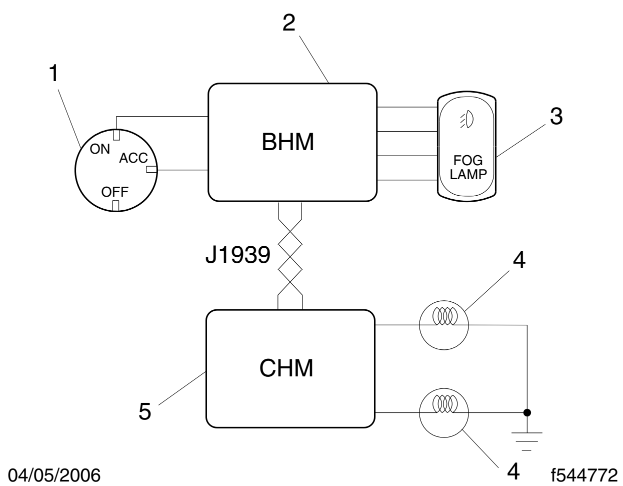
Snowplow Lights Provision

A provision for installation of snowplow lights is an optional feature on a Business Class M2 vehicle. Freightliner does not install snowplow lights or mounting hardware for the lights, only the provision for customer-installed snowplow lights.

A snowplow installed on a vehicle may block the standard vehicle headlights. When this situation occurs, the snowplow light provision allows the customer to install an auxiliary set of headlights and additional park/turn signal lights above the snowplow.

IMPORTANT: The customer installing the snowplow lights is responsible for complying with the regulations regarding snowplow lights and daytime running lights (DRL) functionality in the Federal Motor Vehicle Safety Standards

General Information



1. Ignition Switch
2. Bulkhead Module
3. Fog Light Switch
4. Fog Lights
5. Chassis Module

Fig. 6, Fog Lights Function

(FMVSS) and the Canadian Motor Vehicle Safety Standards (CMVSS).

When an M2 vehicle is equipped with the snowplow lights provision, the following electrical components are already installed on the vehicle:

- dash-mounted PLOW LAMP switch (snowplow light switch)
- snowplow light harness
- upper control module and lower control module mounted in the left, front wheel well

The snowplow lights can only be turned on when the ignition switch is on and the standard headlights are on.

WARNING

When a vehicle is equipped with snowplow light provision but snowplow lights are not installed, turning the PLOW LAMP switch on turns off both the standard headlights and the daytime running lights using low-beam headlights (M2 106V). Do not turn the PLOW LAMP switch on when snowplow lights are not installed. Doing so could cause an accident resulting in serious personal injury or property damage.

Snowplow Lights Function

The Bulkhead Module (BHM) monitors the position of the snowplow light switch. The snowplow light switch is a two-position, latching smart switch that delivers signals directly to the BHM.

When the snowplow light switch is on and the BHM has determined that the other requirements are met, the BHM sends a message on the J1939 datalink to the Chassis Module (CHM) instructing it to signal the upper and lower control modules to switch the headlight output from the standard headlights to the auxiliary headlight connector. The CHM snowplow lights control output is at pin C of the CHM C3 connector. See **Fig. 7**.

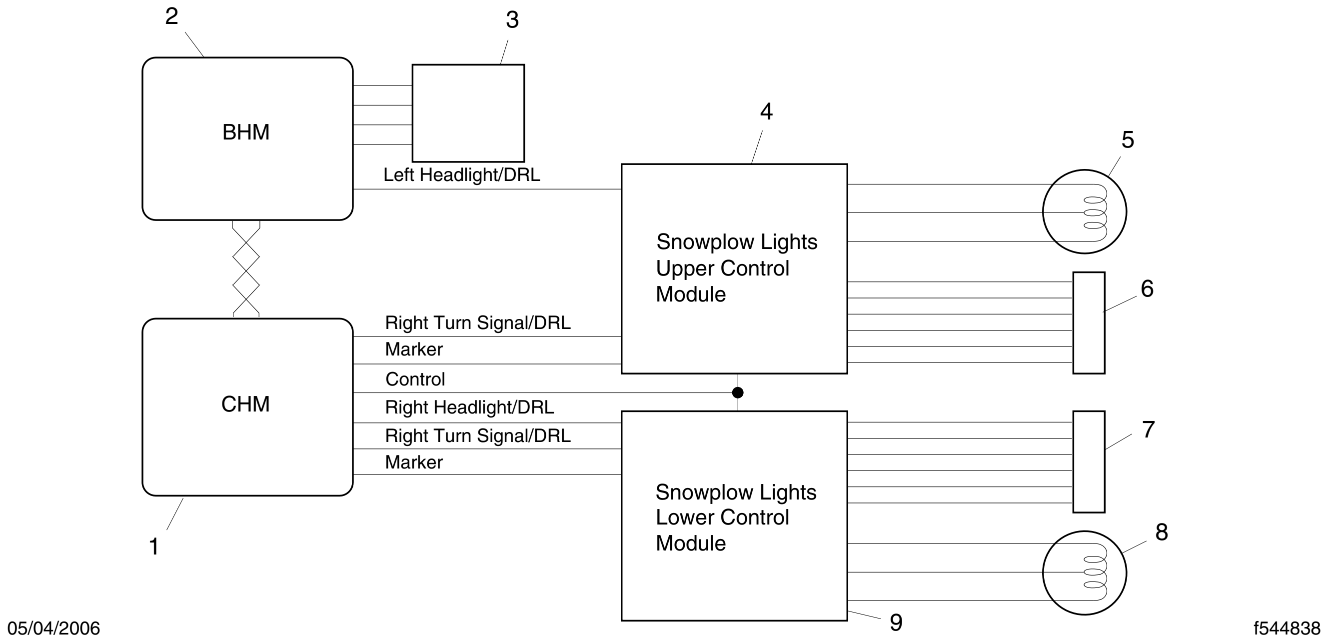
The low beams and high beams work with both the standard and auxiliary headlights. The same system of daytime running lights that is used on the standard headlights, whether using the turn signals or the low-beam headlights (M2 106V), is used on the snowplow lights. The DRL system used on the M2 106V vehicle is also known as pulse-width-modulated DRL.

The snowplow light harness overlays the main chassis harness between the headlights and the CHM. The standard lighting circuits are intercepted at the connectors behind the headlights and rerouted through the upper and lower control modules, then back to the headlights.

A vehicle with a composite, standard headlight uses a different version of the snowplow light harness than a vehicle model M2 106V with a sealed-beam, standard headlight.

The two snowplow light connectors are located behind the headlights, one on each side. In addition to the switch headlight output, the snowplow light connectors provide the appropriate turn signal and marker lights, which are always active.

NOTE: The upper control module, which controls the right snowplow lights, and the lower control module, which controls the left snowplow lights, are identical. Both control modules have two 6-pin connectors—one black and one yellow. Make sure that the connectors are paired correctly since the snowplow light harness is not color coded. The snowplow light harness has labels that indicate which connector each branch is intended to connect to. One branch is



1. Chassis Module
2. Bulkhead Module
3. Snowplow Lights Switch
4. Upper Control Module for Right Snowplow Lights
5. Right Low- and High-beam Headlights
6. Right Snowplow Light Connector
7. Left Snowplow Light Connector
8. Left Low- and High-beam Headlights
9. Lower Control Module for Left Snowplow Lights

Fig. 7, Snowplow Lights Function

longer that the other branch. The longer branch is connected to the upper control module.

Headlights, All Models

The headlight connectors on the main chassis harness are connected to the snowplow lights harness instead of the headlights. The low beam, high beam, and headlights common circuits are rerouted through the snowplow light harness to the upper and lower control modules. The control modules switch the signal between the standard headlights and the snowplow light connector, and all of these circuits route back to the appropriate connectors behind the headlights.

The headlight connectors on the snowplow light harness connect to the headlights while the snowplow lights circuits terminate at the snowplow light connector. Note that the snowplow headlight common circuits are switched by the upper and lower control modules, while the ground circuits at the snowplow connector are not.

Control, All Models

The control signal for the snowplow lights comes from the Chassis Module, normally from pin C of the C3 connector. This output is usually associated with fog lights; therefore, a vehicle cannot be equipped with both fog lights and a snowplow lights provision. The return for the upper and lower control module relays is spliced from the headlight common form the associated module.

Turn Signal Lights, All Models Except M2 106V

When the vehicle is equipped with daytime running lights, the DRL overlay connector connects to the turn signal connector on the snowplow light harness. When the vehicle is not equipped with DRL, the turn signal connector of the main harness connects to the turn signal connector on the snowplow light harness. The turn signal circuits are spliced to return to the DRL connectors on the main chassis harness and to the upper and lower control modules for rerouting to the snowplow light connectors.

Park Lights, All Models Except M2 106V

The park lights circuit is picked up from the trailer output connection (C2) of the Chassis Module. Since this circuit is also required for trailer wiring when the vehicle has a towing provision, the circuit is spliced from a short jumper section in to which the trailer wiring can be connected. This circuit is provided to both the upper and lower control modules and from there to the snowplow light connectors.

Turn Signal and Park Lights, M2 106V Only

The turn signal/park light connectors on the main chassis harness are connected to the snowplow light harness instead of the turn signal/park lights. These circuits are spliced with one path continuing to the normal turn signal/park light connections, and the other path routed through the upper and lower control modules to the snowplow light connectors.

Before checking or adjusting the headlight aim, do the following:

- Remove any large amounts of mud or ice from the underside of the fenders.
- Check the springs for sagging or broken leaves.
- Check the suspension for proper function of the leveling mechanism. On cabs with air suspensions, make sure that the height is properly adjusted.
- Check for damage to the hood and hinge assembly. Repair as necessary.
- Clean the headlight lenses.
- With the vehicle unloaded, check that the tires are inflated to the recommended air pressure.

Headlight Aim Checking

1. Park the vehicle on a level surface 25 ft (7.6 m) from a screen or wall that can be used for aiming the headlights. Shut down the engine, apply the parking brakes, and chock the front tires. See **Fig. 1**.

NOTE: The low-beam headlight is the top bulb in the dual-beam assembly.

2. On each headlight, find the bulb center. See **Fig. 2**.
3. Measure the distance from the ground to the center of each low-beam bulb and note those distances.
4. On the screen or wall 25 ft (7.6 m) away, make the appropriate markings directly across from each headlight and at the same height as measured for the headlight.
5. Turn on the headlights to the low-beam setting. See **Fig. 3** for the ideal and acceptable patterns for both headlights.
    - If either or both headlights do not aim into the inner edges of the centerline, follow the adjusting procedure below.
    - If both headlights come close to the inside of each headlight centerline as shown, no further work is needed. Turn off the headlights and remove the chocks from the front tires.

Adjusting Composite Headlights

1. Lift the flap over the rear end of the headlight bucket to expose the two plastic adjusting knobs on each headlight. See **Fig. 4**.

NOTE: Horizontal aim should not be adjusted in the field.

2. With the vehicle parked 25 ft (7.6 m) from the screen or wall, put the headlights on low beams and turn both adjusting knobs the same amount as needed to adjust the lights until the beam pattern meets the acceptable standard in **Fig. 3**.

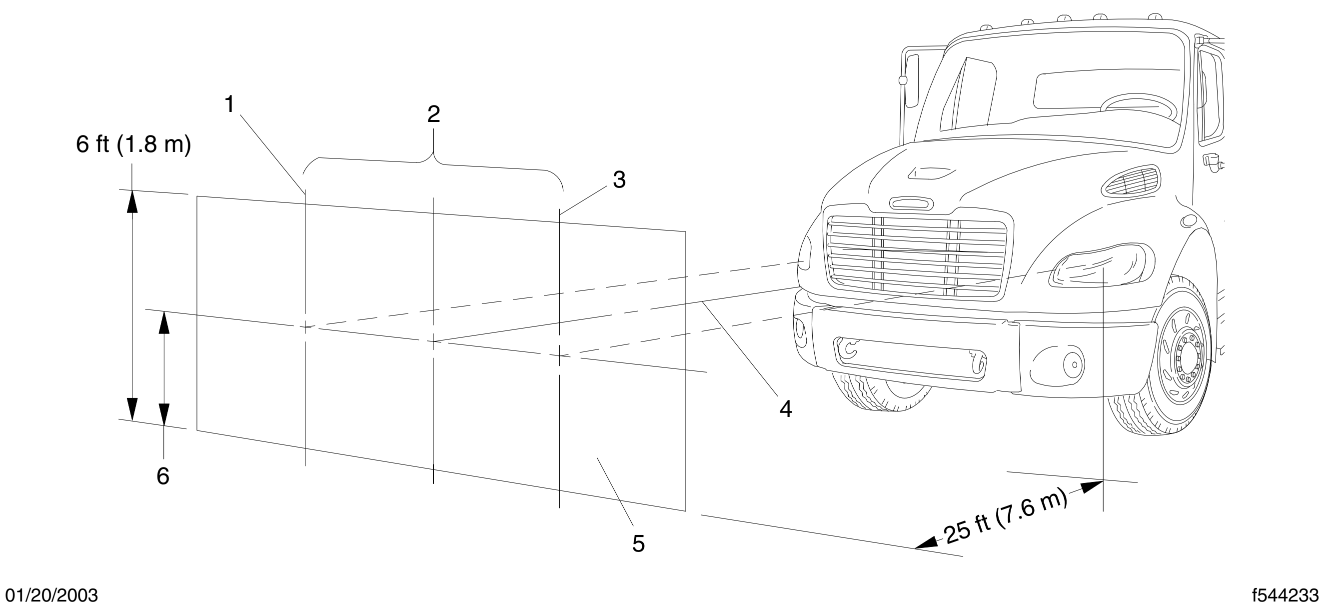
NOTE: Blocking off each light is not necessary, but it can help to present a clearer beam pattern.

3. Remove the chocks from the front tires.

Adjusting Sealed-beam Headlights

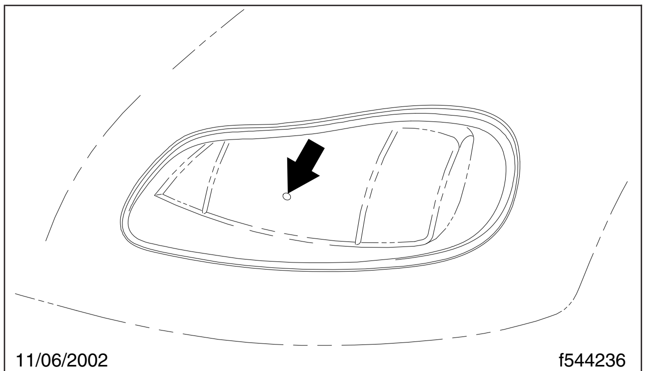
1. Park the vehicle on a level surface 25 ft (7.6 m) from a screen or wall that can be used for aiming the headlights. Shut down the engine, apply the parking brakes, turn on the headlight low beams, and chock the front tires
2. Locate the headlight adjusting screws that are accessible through the front of the headlight bezel. See **Fig. 5**.
3. Use a screwdriver to adjust the headlight beam position as necessary to achieve the acceptable standard shown in **Fig. 3**.
4. Remove the chocks from the front tires.

Headlight Aim Checking and Adjusting



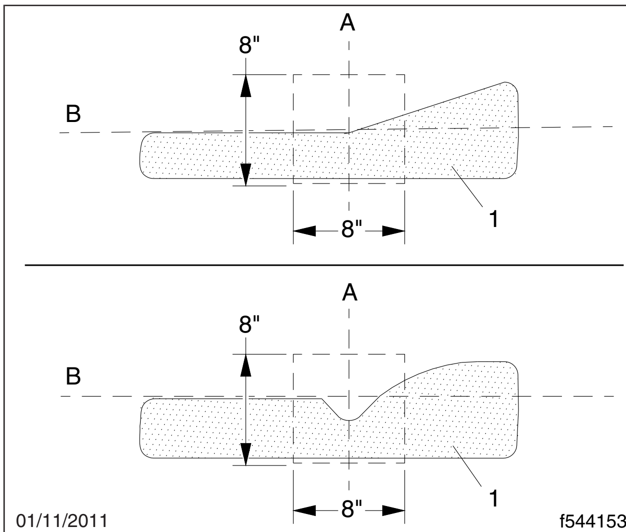
1. Vertical Centerline of Right Headlight
2. Distance Between Headlights
3. Vertical Centerline of Left Headlight
4. Projected Vehicle Centerline
5. Screen or Wall
6. Height of Lamp Centers

Fig. 1, Headlight Aiming Screen or Wall



NOTE: Measure beam height from the ground to the small dot roughly in the center of the headlight lens.

Fig. 2, Headlight Beam Height Adjusting Dot

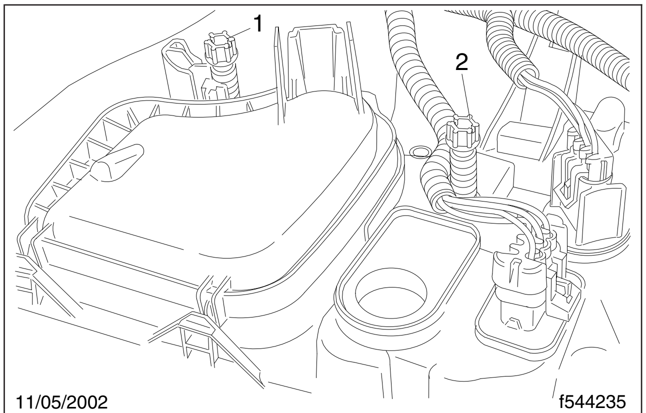


NOTE: The top view shows the ideal beam pattern; the bottom view shows an acceptable standard.

A. Vertical Centerline
B. Horizontal Centerline

1. Bright Area

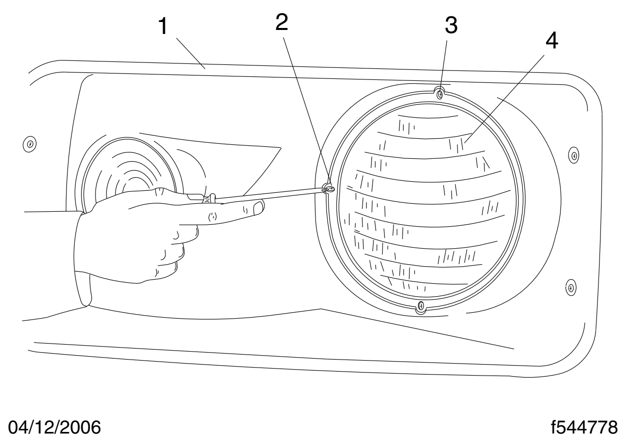
Fig. 3, Headlight Beam Pattern



NOTE: The right side headlight bucket is shown. The left side is opposite.

1. Inboard Adjusting Knob
2. Outboard Adjusting Knob

Fig. 4, Headlight Adjusting Knobs



1. Headlight Bezel
2. Horizontal Adjusting Screw
3. Vertical Adjusting Screw
4. Headlight

Fig. 5, Sealed-beam Headlight Adjusting

Before working on the vehicle, park it on a level surface and shut down the engine. Set the parking brake and chock the front and rear tires.

NOTE: Use gloves or a clean cloth or paper towel when handling halogen bulbs; do not handle them with bare hands. Oil from the skin causes overheating and rapid blowout. If bulbs are handled accidentally, use a cotton swab dipped in rubbing alcohol to remove oil.

NOTE: There are two types of headlights used on Business Class® M2 vehicles. Most M2 vehicles have composite headlights. The M2 106V vocational chassis has sealed-beam headlights. When replacing headlights and bulbs, use the correct replacement procedure for the type of headlight on the vehicle.

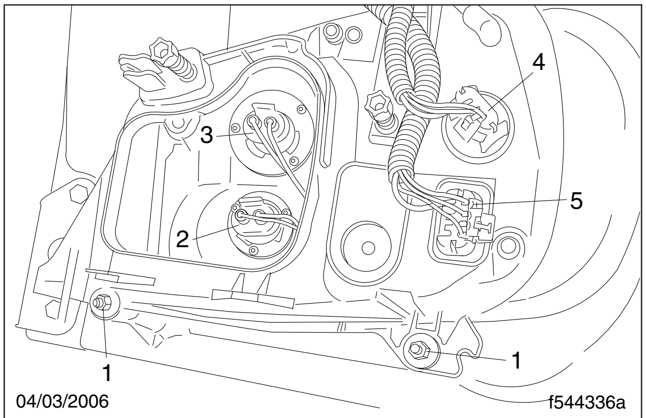
Composite Headlights

Headlight and Park/Turn Signal Light Assembly Replacement

1. Open the hood.
2. Secure the headlight splash guard out of the way.
3. Disconnect the headlight and park/turn signal light electrical connectors and cut any tie-straps that may be holding them to the headlight bucket assembly.
4. Remove the nuts from the two lower mounting adjustment studs. See **Fig. 1**.
5. Remove the Torx® capscrew from the upper mounting bracket.
6. Remove the headlight assembly.
7. Place a new assembly on the mounting studs and install the two nuts and washers.

NOTE: Before installing the new assembly, verify that the lower mounting adjustments on the new assembly are set the same as the old assembly.

8. Install the upper mounting capscrew.
9. Connect the two electrical connectors.
10. Verify the proper operation of the lights.



1. Lower Mounting Adjustment Nut
2. High Beam Socket
3. Low Beam Socket
4. Park/Turn Socket and Connector Assembly
5. Headlight Connector

Fig. 1, Headlight Bucket (rear view)

11. Return the headlight splash guard to its original operating position.

Headlight Bulb Replacement

1. Open the hood.
2. Remove the inner headlight cover by pressing the tab at the top and pulling out.
3. Disconnect the headlight connector. See **Fig. 1**.
4. Twist the high beam or low beam socket assembly 1/8 of a turn counterclockwise to remove it from the headlight bucket assembly and access the bulb.
5. Protecting the bulb with gloves or a cloth, unplug it from the socket. The bottom bulb in the assembly is the high beam lamp; the top bulb in the assembly is the low beam lamp.
6. Line up the bulb tabs and insert a new bulb into the socket then twist it 1/8 of a turn clockwise to secure it.
7. Connect the headlight connector.
8. Replace the inner headlight cover and snap it into place.
9. Close the hood.
10. Verify proper operation of the lights.

Exterior Lights Replacement

11. Check and adjust the headlight aim as described in **Subject 100**.

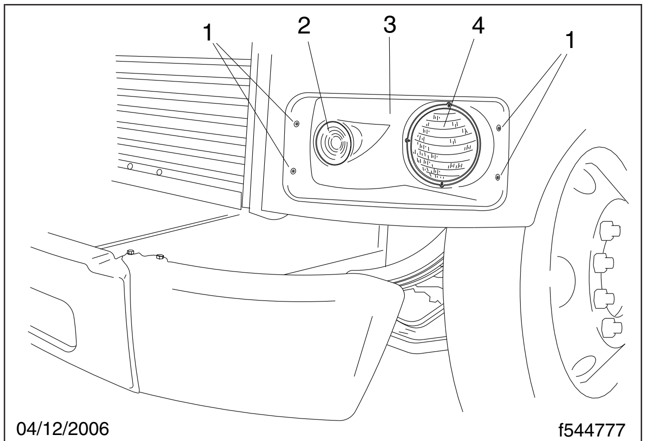
Front Park/Turn Bulb Replacement

1. Open the hood.
2. Twist the park/turn connector and socket assembly 1/8 turn counterclockwise and remove it from the headlight bucket. See **Fig. 1**.
3. Protecting the bulb with gloves or a cloth, pull the bulb straight out from the socket.
4. To provide corrosion protection, coat the base of the new bulb with dielectric grease. For approved lubricants, see **Specifications 400**.
5. Push the new bulb straight into the socket.
6. Place the connector and socket assembly in the headlight bucket and twist it 1/8 turn clockwise to lock it in place.
7. Verify proper operation of the lights.

Sealed-Beam Headlights

Headlight Replacement

1. Remove the four screws that attach the headlight bezel to the fender. See **Fig. 2**.



1. Bezel Retaining Screw
2. Park/Turn Signal Light
3. Headlight Bezel
4. Headlight

Fig. 2, Sealed-Beam Headlight Assembly

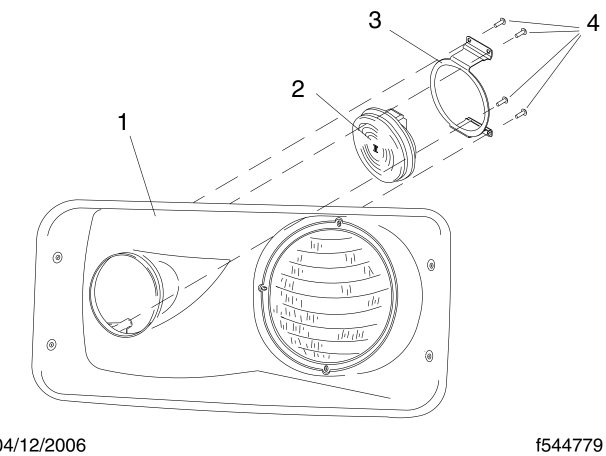
2. Remove the headlight bezel and disconnect the park/turn signal light electrical connector at the rear of the bezel.

NOTE: Do not turn the headlight adjustment screws. These screws are used for beam adjustment only; they do not secure the headlight retaining ring.

3. Remove the screws that secure the headlight retaining ring, then remove the retaining ring.
4. Ease the headlight from the housing to expose the electrical connector at the back of the light.
5. Disconnect the wiring connector from the headlight.
6. Check the wiring connector for corrosion and integrity. Clean and/or repair as needed.
7. Coat the prongs (connector terminals) of the new headlight with dielectric grease to help prevent corrosion. For approved lubricants, see **Specifications 400**.
8. Firmly seat the wiring connector onto the prongs of the new headlight.
9. Place the headlight in the headlight housing and position the light properly.
10. Place the retaining ring over the headlight and install the screws that secure the headlight.
11. Verify proper operation of the headlights.
12. Connect the park/turn signal light electrical connector.
13. Place the headlight bezel in the proper position and install the four screws.
14. Check and adjust the headlight aim as described in **Subject 100**.

Front Park/Turn Signal Light Replacement

1. Remove the four screws that attach the headlight bezel to the fender. See **Fig. 2**.
2. Disconnect the park/turn signal light electrical connector at the rear of the bezel.
3. Remove the four screws that attach the park/turn signal light retainer to the back of the headlight bezel. See **Fig. 3**.
4. Remove the park/turn signal light.



1. Headlight Bezel
2. Park/Turn Signal Light
3. Park/Turn Signal Light Retainer
4. Retainer Screw

Fig. 3, Sealed-Beam Park/Turn Signal Light

5. To provide corrosion protection, coat the electrical connection of the new light with dielectric grease. For approved lubricants, see **Specifications 400**.
6. Position the new park/turn signal light in the headlight bezel.
7. Place the retainer over the park/turn signal light and install the screws that secure the light to the bezel.
8. Connect the park/turn signal light electrical connector.
9. Verify proper operation of the lights.
10. Place the headlight bezel in the proper position and install the four screws.

Cab Clearance and Identification Light Assembly Replacement

1. Access the mounting nuts and electrical connections from inside the cab.
   1.1 Remove the left and right overhead map pockets to access the outer two lights.
   1.2 Remove the center console/dome light assembly or headliner to access the center three lights.
2. Disconnect the connector.
3. Remove the two mounting nuts and remove the light assembly.
4. Install a new clearance light. Tighten the two nuts to 60 lbf·in (677 N·cm).
5. Seal the hole with silicon sealant.
6. Connect the connector.
7. Replace the headliner or center console/dome lamp and/or map pockets.

Cab Clearance and Identification Light Bulb Replacement

1. From outside the cab, remove the capscrew that attaches the clearance light lens to the base.
2. Lift the lens cover at the rear with a screwdriver, and slide the cover forward off the locking tab.
3. Pull the bulb straight out to remove it.
4. To provide corrosion protection, coat the base of the new bulb with dielectric grease.

   For approved electrical terminal lubricants, see **Specifications 400**.
5. Plug in the new bulb and test for proper operation.
6. Install the lens on the base, making sure that it is fully seated.
7. Secure the clearance light in place with the capscrew.

IMPORTANT: Do not overtighten the capscrew or damage to the lens may occur.

Front Side Marker/Turn Signal Light Assembly Replacement

1. Open the hood.
2. If the harness is being replaced, cut the two tie-straps securing it at the molded splash guard.

3. Twist the marker/turn signal light connector 1/8 turn counterclockwise to disconnect the connector and harness.
4. Remove the two capscrews that attach the lens to the fender.
5. Remove the marker/turn signal light lens.
6. Using two capscrews, install a new marker/turn signal light lens on the fender.

IMPORTANT: Do not overtighten the capscrews or damage to the lens may occur.

7. Install a new harness, if required, and connect the electrical connector and bulb socket. Twist it clockwise 1/8 turn to secure.
8. If a new harness was installed, secure it to the molded plastic inner wheel well shroud using two tie-straps at the openings. Secure the tie-straps to the connector.

Front Side Marker/Turn Signal Light Bulb Replacement

1. Open the hood.
2. Twist the connector 1/8 turn counterclockwise to unplug the connector and bulb socket.
3. Pull the bulb straight out of the socket to remove it. Push a new bulb straight into the socket to replace it.
4. Insert the connector and bulbs into the lens assembly and turn 1/8 turn clockwise to secure.

Parameter Programming

When adding or changing a feature on a Business Class® M2 vehicle, you must use ServiceLink® to update the programming on the vehicle.

IMPORTANT: When adding daytime running lights (DRL) to an M2 vehicle that was built without DRL, you **must** follow the "Adding a Feature" procedure in **Section 54.00**. Adding or changing reference parameters without following this procedure may result in serious legal consequences for the vehicle owner, which may include fines and having the vehicle placed out of service. The regulations in the Federal Motor Vehicle Safety Standards (FMVSS) and Canadian Motor Vehicle Safety Standards (CMVSS) control the intensity of illumination of DRL lamps and the required marking of lamps used as DRL. Some jurisdictions enforce these regulations during vehicle inspections.

Version 6.10 Daytime Running Lights

For M2 vehicles with software version 6.10, the reference parameter programs both DRL and the stop/turn light functionality. The only DRL available for version 6.10 is turn signal DRL. Turn-signal DRL is available on all M2 chassis except the M2 106V vocational chassis.

Version 6.40 Daytime Running Lights

DRL for software versions 6.40 or higher may be turn-signal DRL or headlight low-beam DRL. Low-beam DRL is a pulse-width modulated (PWM) signal at 85 percent duty cycle. Low-beam DRL is used on the M2 106V vocational chassis. The reference parameters program only the DRL functionality.

Reference Parameters for Marker Lights

A marker light is any light that indicates the presence of the vehicle to other drivers. This includes parking lights, taillights, marker lights, identification lights, and clearance lights.

See **Table 1** for the reference parameters for marker light functionality.

Reference Parameters for Marker Lights		
Parameter	**Description**	**Functionality**
26-01019-000	Without marker interrupt switch	No marker interrupt switch, the marker lights turn on with the headlight switch.
26-01019-001	With marker interrupt switch	The marker lights turn on with the headlight switch, a momentary interrupt switch turns the marker lights off as long as the switch is held.
26-01019-003	Without marker interrupt switch, with constant on marker lights	No marker interrupt switch, the marker lights are on at all times. The battery disconnect switch is used to turn off the lights.
26-01019-004	With marker interrupt switch, marker lights on with ignition off	The marker lights are on when the ignition is off or when the headlight switch is turned on. A momentary interrupt switch turns off the marker lights when headlight switch is on.
26-01019-005	Without marker interrupt switch, with constant on marker lights	No marker interrupt switch, the marker lights are on at all times. The battery disconnect switch is used to turn off the lights.
26-01019-006	Without marker interrupt switch, marker lights off with ignition off	No marker interrupt switch, the marker lights are turned off when the ignition is turned off. The headlight switch controls the marker lights for all other conditions.

Table 1, Reference Parameters for Marker Lights

IMPORTANT: Use ServiceLink® to troubleshoot the M2 electrical system. For specific circuit and pin information for how the vehicle is wired, go to the Configuration screen in ServiceLink and select the specific function in which you are interested.

To troubleshoot specific inputs and outputs of this system, go to the Templates screen in ServiceLink and select the template for the function in which you are interested.

Headlight Switch Function

Input and Output Conditions

See **Table 1** for the Bulkhead Module (BHM) responses to the headlight switch input/output conditions.

Fault Conditions

See **Table 2** for the headlight switch circuit conditions that will create a fault. In these conditions, the BHM assumes the headlight switch status is on. The reference parameters that program the BHM determine whether or not a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted.

If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on the J1939 and/or the J1708 data links until the ignition switch is turned off.

Headlight Switch Input/Output Conditions					
Headlight Switch Inputs to BHM			Outputs from BHM		
Park Lights Signal	Headlight On 1 Signal	Headlight On 2 Signal	Headlight Switch Status	J1939 Headlight On/Off Message	J1939 Headlight Park Message
Open	Open	Open	Off	Off	Off
Closed	Open	Open	Park	Off	On
Open	Closed	Open	On	On	On
Open	Open	Closed	On	On	On
Open	Closed	Closed	On	On	On
Closed	Open	Closed	On*	On	On
Closed	Closed	Open	On*	On	On
Closed	Closed	Closed	On*	On	On

* These are error conditions. For more information see "Fault Conditions."

Table 1, Headlight Switch Input/Output Conditions

Headlight Switch Fault Conditions			
Description of Fault			Action Taken by BHM
Park Lights Signal	Headlight On 1 Signal	Headlight On 2 Signal	
Closed	Closed	Open	BHM may transmit a J1939 and/or a J1708 fault message.
Closed	Open	Closed	BHM may transmit a J1939 and/or a J1708 fault message.
Closed	Closed	Closed	BHM may transmit a J1939 and/or a J1708 fault message.

Table 2, Headlight Switch Fault Conditions

Troubleshooting

Headlight High Beams Function

Input and Output Conditions

See **Table 3** for the Bulkhead Module (BHM) responses to the headlight high beams input/output conditions.

Fault Conditions

See **Table 4** for the headlight high beams fault conditions and the resulting actions of the BHM. The reference parameters that program the BHM determine whether or not a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted.

If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on the J1939 and/or the J1708 data links until the ignition switch is turned off.

NOTE: The Flash-To-Pass function of the high beams only operates when the ignition is on and the high beam switch is in the low beam position.

Headlight High Beams Input/Output Conditions				
Inputs to BHM			Outputs from BHM	
Ignition Switch Position	Headlight Switch Position	High Beam Switch Position*	Left High Beam	Right High Beam†
On	On	High Beam/PASS	On	On
On	On	Low Beam	Off	Off
On	Off	High Beam/PASS	Off	Off
Off	On	High Beam/PASS	Off	Off

* Part of the multifunction turn signal switch

† Via J1939 message to the CHM

Table 3, Headlight High Beams Input/Output Conditions

Headlight High Beams Fault Conditions	
Description of Fault	Action Taken by BHM
Headlight switch is in error.	BHM will assume the headlight switch is on, and may transmit a fault message on the J1939 and/or J1708 data links.
Position of multifunction turn signal switch is unavailable or in error.	BHM will assume the multifunction turn signal switch position is low.
BHM fails to receive five consecutive J1939 multifunction turn signal switch position messages from the ICU.	BHM may transmit a J1939 and/or a J1708 fault message.
BHM receives a J1939 multifunction turn signal switch error message from the ICU.	BHM may transmit a J1939 and/or a J1708 fault message.
Left high beam wiring shorted.	BHM may transmit a J1939 and/or a J1708 fault message.
Right high beam wiring shorted.	BHM may transmit a J1939 and/or a J1708 fault message.

Table 4, Headlight High Beams Fault Conditions

Headlight Low Beams Function

Input and Output Conditions

See **Table 5** for the Bulkhead Module (BHM) responses to the headlight low beams input/output conditions.

Fault Conditions

See **Table 6** for the headlight low beams fault conditions and the resulting actions of the BHM. The reference parameters that program the BHM determine whether or not a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted.

If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on the J1939 and/or the J1708 data links until the ignition switch is turned off.

NOTE: If the CHM does not see J1939 messages from the BHM, the right low beam is activated. If the BHM fails, the left low beam is activated.

Turn Signal Lights Function

Input and Output Conditions

See **Table 7** for the Instrumentation Control Unit (ICU) turn signal lights input/output conditions.

See **Table 8** for the Bulkhead Module (BHM) responses to the turn signal lights system input/output conditions.

Fault Conditions

See **Table 9** for the turn signal lights fault conditions and the resulting actions of the BHM. The reference parameters that program the BHM determine whether or not a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted.

If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on the J1939 and/or the J1708 data links until the ignition switch is turned off.

Headlight Low Beams Input/Output Conditions			
Inputs to BHM		Outputs from BHM	
Headlight Switch Position	High Beam Switch Position*	Left Low Beam	Right Low Beam†
On	Low Beam	On	On
On	High Beam/PASS	On	On
Off	High Beam/PASS	Off	Off

* Part of the multifunction turn signal switch

† Via J1939 message to the CHM

Table 5, Headlight Low Beams Input/Output Conditions

Headlight Low Beams Fault Conditions	
Description of Fault	Action Taken by BHM
Headlight switch is in error.	BHM will assume the headlight switch is on, and may transmit a fault message on the J1939 and/or J1708 data links.
Position of multifunction turn signal switch is unavailable or in error.	BHM will assume the multifunction turn signal switch position is low.
BHM fails to receive five consecutive J1939 multifunction turn signal switch position messages from the ICU.	BHM may transmit a J1939 and/or a J1708 fault message.

Troubleshooting

Headlight Low Beams Fault Conditions	
Description of Fault	**Action Taken by BHM**
BHM receives a J1939 multifunction turn signal switch error message from the ICU.	BHM may transmit a J1939 and/or a J1708 fault message.
Left low beam wiring shorted.	BHM may transmit a J1939 and/or a J1708 fault message.
Right low beam wiring shorted.	BHM may transmit a J1939 and/or a J1708 fault message.

Table 6, Headlight Low Beams Fault Conditions

ICU Turn Signal Lights Input/Output Conditions		
Input to ICU	**Outputs from ICU**	
Multifunction Turn Signal Switch Position	**J1939 Right Turn Message**	**J1939 Left Turn Message**
Left Turn	Off	On
Right Turn	On	Off
Off	Off	Off

Table 7, ICU Turn Signal Lights Input/Output Conditions

Turn Signal Lights System Input/Output Conditions				
Inputs to BHM			**Outputs from BHM**	
J1939 Left Turn Message	**J1939 Right Turn Message**	**Hazard Switch Position**	**Left Turn and Stop Lights**	**Right Turn and Stop Lights**
Off	On	Off	Activated	Deactivated
On	Off	Off	Deactivated	Activated
Off	Off	On	Activated	Activated

Table 8, Turn Signal Lights System Input/Output Conditions

Turn Signal Lights Fault Conditions	
Description of Fault	**Action Taken by BHM**
Left turn switch position is unavailable or in error.	BHM will assume the J1939 left turn switch position is off.
Right turn switch position is unavailable or in error.	BHM will assume the J1939 right turn switch position is off.
Hazard switch position is unavailable or in error.	BHM will assume the hazard switch is on.
ICU sends an error indicator in the J1939 left turn switch position message.	BHM may transmit a J1939 and/or a J1708 fault message.
ICU sends an error indicator in the J1939 right turn switch position message.	BHM may transmit a J1939 and/or a J1708 fault message.
BHM fails to receive five consecutive left turn switch messages from the ICU.	BHM may transmit a J1939 and/or a J1708 fault message.
BHM fails to receive five consecutive right turn switch messages from the ICU.	BHM may transmit a J1939 and/or a J1708 fault message.
Left turn signal lights wiring shorted.	BHM may transmit a J1939 and/or a J1708 fault message.

Turn Signal Lights Fault Conditions	
Description of Fault	**Action Taken by BHM**
Right turn signal lights wiring shorted.	BHM may transmit a J1939 and/or a J1708 fault message.

Table 9, Turn Signal Lights Fault Conditions

Hazard Lights Function

Input and Output Conditions

See **Table 10** for the instrumentation control unit turn signal lights input/output conditions.

See **Table 11** for the BHM responses to the hazard lights system input/output conditions.

Fault Conditions

See **Table 12** for the hazard lights fault conditions and the resulting actions of the BHM. The reference parameters that program the BHM determine whether or not a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted.

If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on the J1939 and/or the J1708 data links until the ignition switch is turned off.

Marker Lights Function

Input and Output Conditions

See **Table 13** for the Bulkhead Module (BHM) responses to the marker lights input/output conditions. The marker interrupt switch is optional. If the vehicle does not have a marker interrupt switch, the BHM operates in the same way as if the vehicle has a marker switch that is open (off) all the time.

Fault Conditions

See **Table 14** for the marker lights fault conditions and the resulting actions of the Bulkhead Module (BHM). The reference parameters that program the BHM determine whether or not a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted.

If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on the J1939 and/or the J1708 data links until the headlight switch is turned to off.

Fog Lights Function

Input and Output Conditions

See **Table 15** for the Bulkhead Module (BHM) responses to the fog lights input/output conditions.

Snowplow Lights Provision

Input and Output Conditions

See **Table 16** for the Bulkhead (BHM) responses to the snowplow light input/output conditions.

Fault Conditions

See **Table 17** for the snowplow lights fault conditions and the resulting actions of the BHM. The reference parameters that program the BHM determine whether or not a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted.

If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on the J1939 and/or the J1708 datalinks until the ignition switch is turned off.

Effect of the Snowplow Lights Provision on Forward Lighting System Troubleshooting

Identification of faults in the forward lighting system can proceed normally when the snowplow lights provision is installed and operating correctly. However, problems with the snowplow light control modules and incorrect connections to the snowplow light harness cannot be identified through the J1939 or J1708 datalinks.

Troubleshooting

A bad snowplow light control module or improper connections can result in one or more lamps not illuminating when directed by the BHM, or in having one or more lamps driven by the incorrect signal. Other indications specifically associated with incorrect connections of the M2 106V snowplow light harness include relay chatter in one of the snowplow light control modules or a fault message indicating the park light and/or low-beam output is shorted.

Troubleshooting headlight, turn signal light, and park light operation when the snowplow light provision is present is facilitated by having snowplow lights installed; however, it is possible to do all checks with a digital multimeter to check the snowplow light connector pins instead.

ICU Turn Signal Lights Input/Output Conditions		
Input to ICU	**Outputs from ICU**	
Multifunction Turn Signal Switch Position	**J1939 Right-Turn Message**	**J1939 Left-Turn Message**
Left Turn	Off	On
Right Turn	On	Off
Off	Off	Off

Table 10, ICU Turn Signal Lights Input/Output Conditions

Hazard Lights System Input/Output Conditions				
Inputs to BHM			**Outputs from BHM**	
Hazard Switch Position	**J1939 Left Turn Message**	**J1939 Right Turn Message**	**Left-Turn and Stop Lights***	**Right-Turn and Stop Lights***
Off	Off	On	Deactivated	Activated
Off	On	Off	Activated	Deactivated
On	Off	Off	Activated	Activated

* For combination stop/turn lamps. For separate stop and turn lamps, only the turn lamps will be activated.

Table 11, Hazard Lights System Input/Output Conditions

Hazard Lights Fault Conditions	
Description of Fault	**Action Taken by BHM**
Left turn switch position is unavailable or in error.	BHM will assume the left turn switch position is off, and may transmit a fault message on the J1939 and/or J1708 data links.
Right turn switch position is unavailable or in error.	BHM will assume the right turn switch position is off, and may transmit a fault message on the J1939 and/or J1708 data links.
ICU sends a left turn switch error message to the BHM.	BHM may transmit a J1939 and/or a J1708 fault message.
ICU sends a right turn switch error message to the BHM.	BHM may transmit a J1939 and/or a J1708 fault message.
BHM fails to receive five consecutive left turn switch messages from the ICU.	BHM may transmit a J1939 and/or a J1708 fault message.
BHM fails to receive five consecutive right turn switch messages from the ICU.	BHM may transmit a J1939 and/or a J1708 fault message.
Left turn/stop lamp wiring shorted.	BHM may transmit a J1939 and/or a J1708 fault message.

Hazard Lights Fault Conditions	
Description of Fault	**Action Taken by BHM**
Right turn/stop lamp wiring shorted.	BHM may transmit a J1939 and/or a J1708 fault message.

Table 12, Hazard Lights Fault Conditions

Marker Lights Input/Output Conditions			
Inputs to BHM		**Outputs from BHM**	
Headlight Switch	**Marker Interrupt Switch**	**Park, Marker, License Plate Lights**	**Taillights, Identification Lights**
Park	Off	Activated	Activated
Park	On	Deactivated	Deactivated
On	Off	Activated	Activated
On	On	Deactivated	Deactivated
Off	Off	Deactivated	Deactivated
Off	On	Activated	Activated

Table 13, Marker Lights Input/Output Conditions

Marker Lights Fault Conditions	
Description of Fault	**Action Taken by BHM**
Status or position of the headlight switch is in error.	BHM assumes the headlight switch is on, and may transmit a fault message on the J1939 and/or J1708 data links.
Status or position of the marker interrupt switch is unavailable or in error.	BHM assumes that the marker interrupt switch is off, and may transmit a fault message on the J1939 and/or J1708 data links.
Any marker light output wiring is shorted.	BHM may transmit a J1939 and/or a J1708 fault message.

Table 14, Marker Lights Fault Conditions

Fog Lights Input/Output Conditions				
Inputs to BHM			**Outputs**	
Ignition Switch Position	**J1939 High Beam Status from ICU**	**Fog Light Switch**	**J1939 message from BHM to CHM**	**Fog Lights**
Off	Off	On	Deactivate	Off
On	On	On	Deactivate	Off
On	Off	On	Activate	On

Table 15, Fog Lights Input/Output Conditions

Snowplow Lights Input/Output Conditions		
Inputs to BHM		**Outputs from BHM**
Snowplow Lights Signal	**Headlight Switch Position**	**Snowplow Lights J1939 Message**
Open	On	Off

Troubleshooting

Snowplow Lights Input/Output Conditions		
Inputs to BHM		Outputs from BHM
Snowplow Lights Signal	Headlight Switch Position	Snowplow Lights J1939 Message
Closed	On	On
Open	Off	Off
Closed	Off	Off

Table 16, Snowplow Lights Input/Output Conditions

Snowplow Lights Fault Conditions	
Description of Fault	Action Taken by BHM
Snowplow light switch is in error.	BHM will assume the snowplow light switch is off, and may transmit a fault message on the J1939 and/or J1708 datalinks.
Headlight switch is in error.	BHM will assume the headlight switch is on, and may transit a fault message on the J1939 and /or J1708 datalinks.

Table 17, Snowplow Lights Fault Conditions

Approved Electrical Lubricants	
Manufacturer	**Lubricant**
Standard Oil Co.	White Vaseline
Shell Oil Co.	No. 71032; No. 71306
Texaco, Inc.	No. 955
Quaker State	No. NYK-77

Table 1, Approved Electrical Lubricants

Replacement Bulb Part Numbers		
Description	**Part Number**	**Amps**
Composite Headlight, Low Beam	9006	4.30
Composite Headlight, High Beam	9005	5.08
Front Park/Turn Signal Light	3157	2.23
Clearance and Identification Lights	193	0.33 (14.0 design volts)
Front Side Marker/Turn Signal Light	194	0.27 (14.0 design volts)

Table 2, Replacement Bulb Part Numbers

Wiring Diagrams

IMPORTANT: The following wiring diagrams provide circuit details for the forward lighting electrical system of a typical Business Class® M2 vehicle. These details may not correspond to every vehicle.

See **Fig. 1** for wiring details of the control inputs for a typical M2 vehicle forward exterior lighting system.

See **Fig. 2** for wiring details of the control outputs for a typical M2 vehicle forward exterior lighting system.

See **Fig. 3** for a wiring diagram of the optional fog lights.

See **Fig. 4** for a wiring diagram of the optional snowplow lights provision.

Circuit Identification

See **Table 3** for a connector face view and pinout chart of the headlight connectors on the forward chassis harness for all models except the M2 106V.

See **Table 4** for a connector face view and pinout chart of the headlight connectors on the forward chassis harness for the M2 106V model only.

See **Table 5** for a connector face view and pinout chart of the park/turn signal light connectors on the forward chassis harness.

See **Table 6** for a connector face view and pinout chart of the side marker/turn signal light connectors on the forward chassis harness.

See **Table 7** for a connector face view and pinout chart of the snowplow light connectors on the snowplow light harness.

Specifications

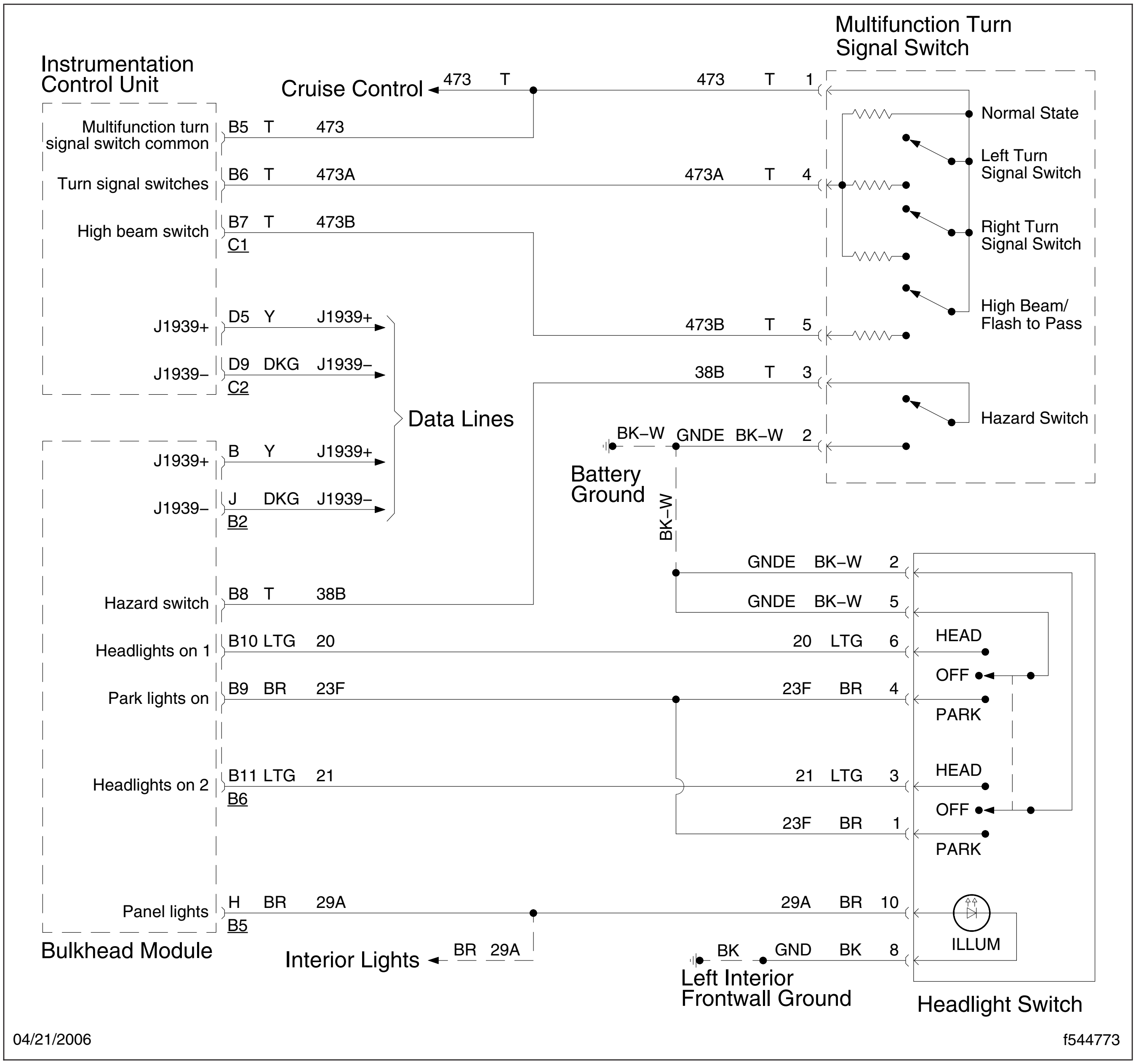


Fig. 1, Forward Exterior Lighting Inputs

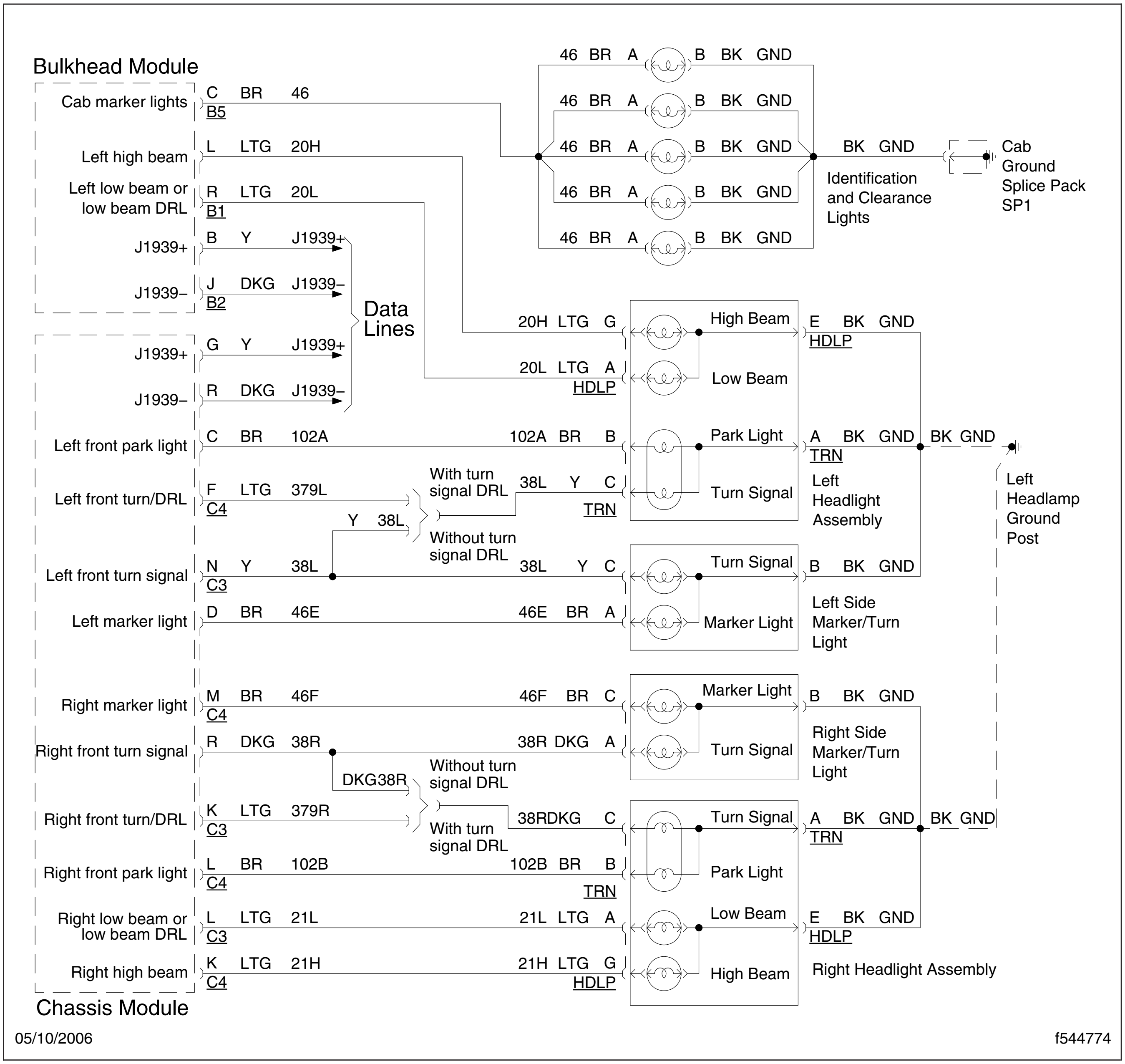


Fig. 2, Forward Exterior Lighting Outputs

Specifications

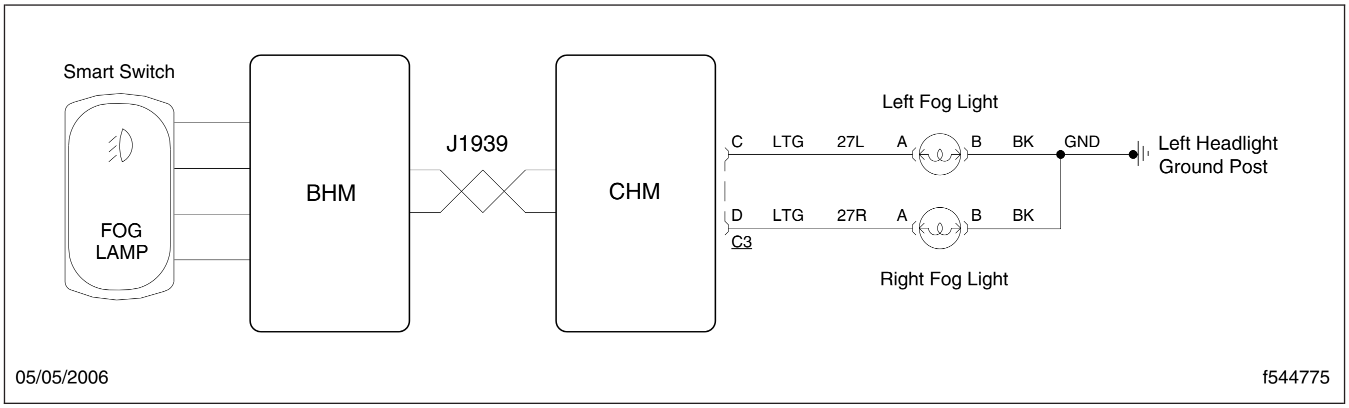


Fig. 3, Fog Lights Wiring Diagram

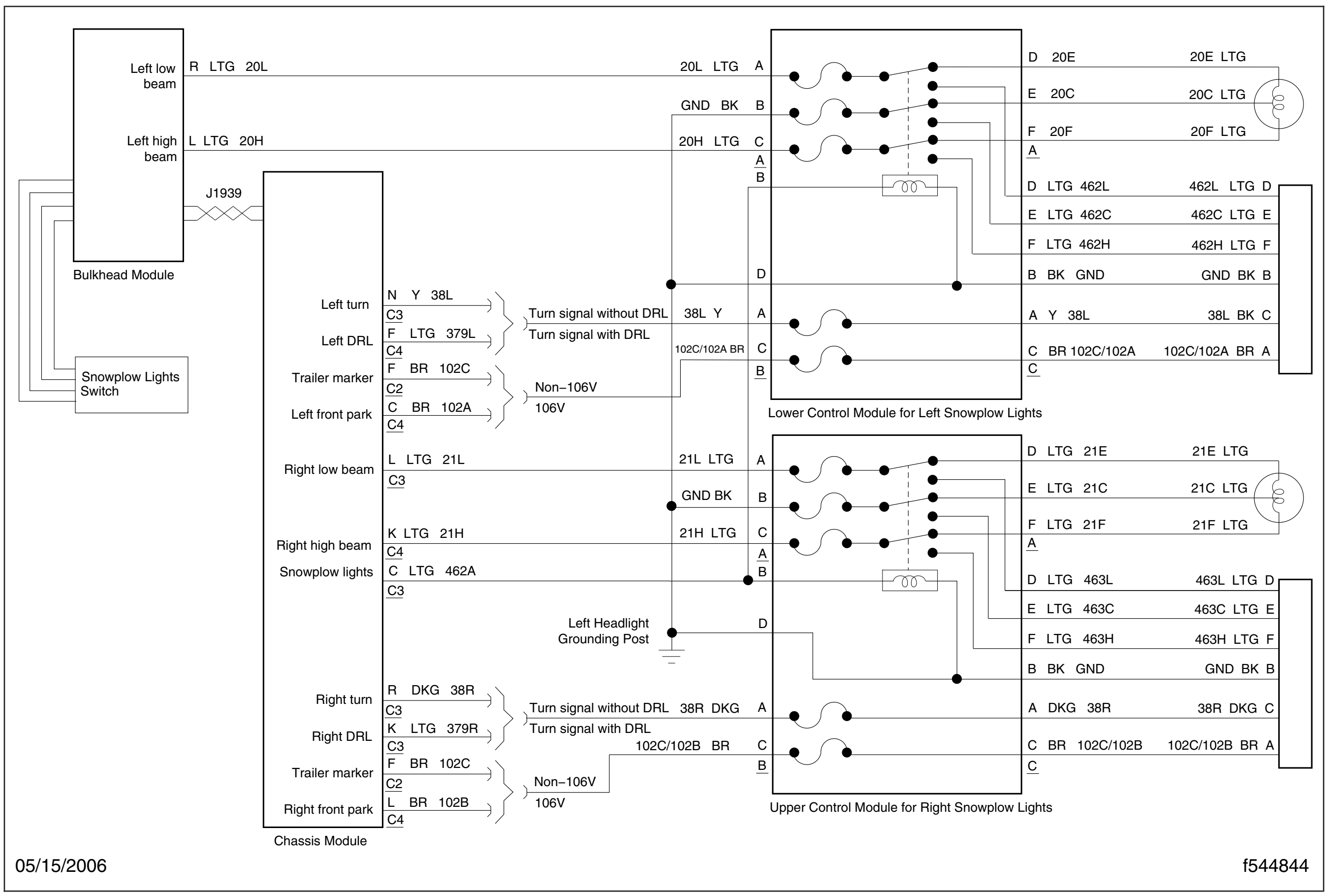


Fig. 4, Snowplow Lights Provision Wiring Diagram

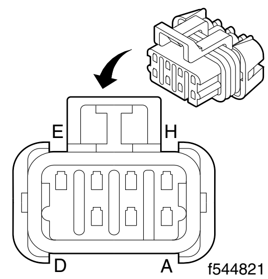
Forward Chassis Harness Headlight Connectors (all models except M2 106V)					
Connector Pin	Signal Name	Left Headlight		Right Headlight	
		Circuit Number	Circuit Color	Circuit Number	Circuit Color
					
A	Low Beam	20L	LTG	21L	LTG
B	—	—	—	—	—
C	—	—	—	—	—
D	—	—	—	—	—
E	Ground	GND	BK	GND	BK
F	—	—	—	—	—
G	High Beam	20H	LTG	21H	LTG
H	—	—	—	—	—

Table 3, Forward Chassis Harness Headlight Connectors (all models except M2 106V)

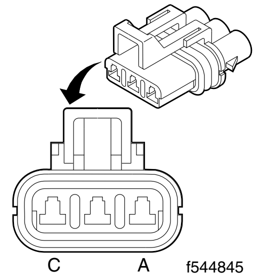
Forward Chassis Harness Headlight Connectors (M2 106V only)					
Connector Pin	Signal Name	Left Headlight		Right Headlight	
		Circuit Number	Circuit Color	Circuit Number	Circuit Color
					
A	Low Beam	20L	LTG	21L	LTG
B	Ground	GND	BK	GND	BK
C	High Beam	20H	LTG	21H	LTG

Table 4, Forward Chassis Harness Headlight Connectors (M2 106V only)

Specifications

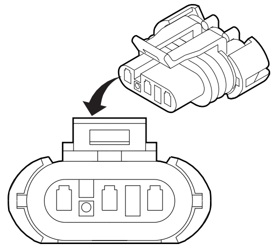
Forward Chassis Harness Park/Turn Signal Light Connectors					
Connector Pin	Signal Name	Left Park/Turn Signal Light		Right Park/Turn Signal Light	
		Circuit Number	Circuit Color	Circuit Number	Circuit Color
					
A	Ground	GND	BK	GND	BK
B	Park Light	102A	BR	102B	BR
C	Turn Signal	38L	Y	38R	DKG

Table 5, Forward Chassis Harness Park/Turn Signal Light Connectors

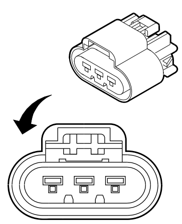
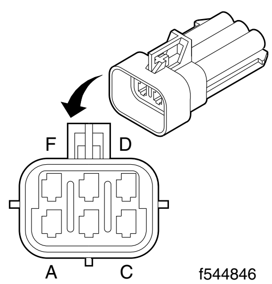
Forward Chassis Harness Side Marker/Turn Signal Light Connectors					
Connector Pin	Signal Name	Left Side Marker/Turn Signal Light		Right Side Marker/Turn Signal Light	
		Circuit Number	Circuit Color	Circuit Number	Circuit Color
					
A	Marker Light	46E	BR	46F	BR
B	Ground	GND	BK	GND	BK
C	Turn Signal	38L	Y	38R	DKG

Table 6, Forward Chassis Harness Side Marker/Turn Signal Light Connectors

Snowplow Light Connectors					
Connector Pin	Signal Name	Left Side Connector		Right Side Connector	
		Circuit Number	Circuit Color	Circuit Number	Circuit Color
					
A	Park Light	102C/102A*	BR	102C/102B*	BR
B	Ground	GND	BK	GND	BK
C	Turn Signal	38L	Y	38R	DKG
D	Auxiliary Low Beam	462L	LTG	463L	LTG
E	Auxiliary Headlight Ground	462C	LTG	463C	LTG
F	Auxiliary High Beam	462H	LTG	463H	LTG

* 102A and 102B are for model M2 106V only. 102C is for all other models.

Table 7, Snowplow Light Connectors

Contents

Rear Lighting

Typical rear lighting on a Business Class® M2 vehicle includes:

- stop lights
- turn signal lights
- license plate light
- backup light(s)
- taillights/park lights

All rear-lighting outputs come from the Chassis Module (CHM) via connector C1. The taillights and license lights are directly supplied by the Bulkhead Module (BHM) via a CHM pass-through; the same output controls the cab clearance and identification lights and the front park lights. See **Section 54.27** for more information on forward lighting.

All other rear lights are controlled by the CHM. An aft chassis harness normally connects at CHM connector C1 and routes the rear-lighting circuits along the frame rail toward the rear of the vehicle.

On an M2 vehicle there are two electrical designs for the stop and turn signal lights:

- combination stop/turn signal lights
- separate stop/turn signal lights

Combination Stop/Turn Signal Lights

Combination stop/turn signal lights use a single high-intensity filament of a taillight bulb for stop illumination and turn signal light indication. The CHM controls the high-intensity filament with a single output, making the output a combination of stop and turn signal lights functions.

When a vehicle is programmed for combination stop/turn signals, the circuit function operates so that the brake lights are overridden when the hazard lights and/or turn signal lights are on.

Factory-installed rear lights are only provided if a vehicle is ordered with combination stop/turn signal lights; however, the lights can be omitted by requesting a wiring-only provision. Rear lights are either integral taillights or individual light connections.

Integral taillights are enclosed lighting assemblies that contain all the rear lights and lighting circuitry.

The integral taillights mount on brackets at the rear of each frame rail. Positioning of the brackets can allow for taillight mounting inside the frame rail, outside the frame rail, or below the frame rail.

The aft chassis harness connects directly to the left integral taillight via a 5-pin connector. Inside the left taillight, circuits are wired to the individual bulbs, and circuits for the right taillight are wired to a second 5-pin connector on the left taillight housing. A taillight jumper harness that routes along the rear crossmember connects the left taillight to the right taillight and transfers the necessary right lighting signals. See **Fig. 1**.

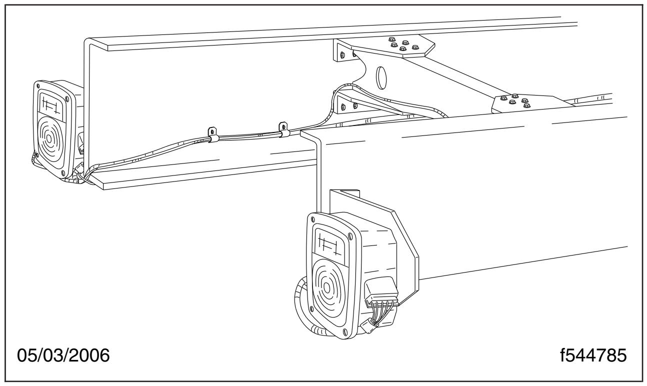


Fig. 1, Integral Taillights

Individual rear lights are usually mounted along the rear-closing crossmember. A rear-lighting harness connects to the 5-pin aft chassis connector. The rear-lighting harness routes circuits to all the individual rear-light connections. Some common harness configurations for individual rear lights are:

- rear lights with a center backup and license lights
- rear lights with dual backup lights
- rear lights that utilize the taillight jumper

Separate Stop/Turn Signal Lights

A vehicle may be ordered or reprogrammed for separate stop/turn signal light functionality. An M2 vehicle ordered with separate stop/turn signal light functionality is equipped with only a rear-lighting electrical harness; no rear lights are provided.

General Information

Separate stop/turn signal light functionality provides for individual stop and turn signal lights by programming the vehicle to use stop-only outputs and turn-signal-light-only outputs from the CHM. Each output is to feed the high-intensity filament of an individual rear light.

The harness that is included with separate stop/turn signal light programming connects to CHM connector C1 and routes along the frame rail toward the rear of the vehicle. The harness terminates with a sealed 7-pin connector that contains the rear-lighting outputs for customer adaptation.

Stop Lights

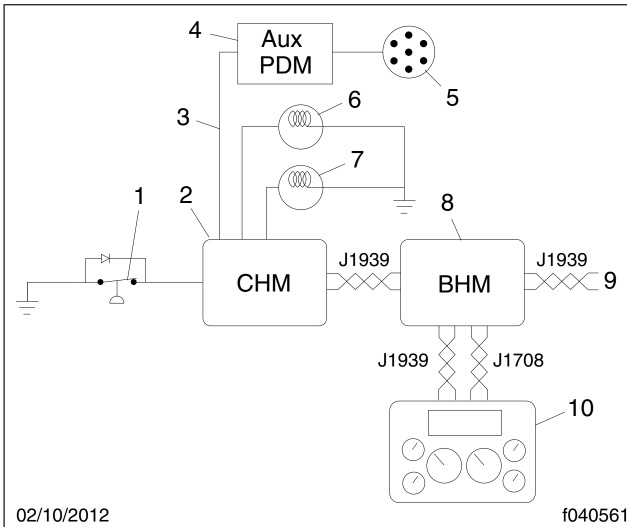
The M2 multiplexing system activates the stop lights when the service brake switch input on the CHM is grounded. The system also sends a J1939 cruise control/vehicle speed (CC/VS) message indicating that the driver is depressing the service brake. The CHM service brake switch input is connected to a switch or relay that is located in the service brake system.

When the service brake switch grounds the CHM input, the CHM immediately supplies power to the brake lights. This is a fail-safe feature that allows the stop lights to function even if the BHM or CHM microprocessors fail.

On a vehicle equipped with trailer electrical connections, the service brake switch also provides a fail-safe ground to the trailer stop light relay via a circuit board trace in the CHM.

With the service brake switch input grounded, the CHM sends a J1939 message to the BHM indicating that the stop lights are activated. If the BHM is not awake when this message is sent, the message wakes up the BHM. After receiving the CHM message, the BHM takes over the operation of the stop lights. The BHM communicates that the driver is depressing the service brake by broadcasting a service brake status message (part of the CC/VS message) over the J1939 datalink for other ECUs to use.

On AAVA vehicles, the stop light pressure switch is located in the application air line, in the center of the dash. On air management unit (AMU) vehicles, the stop light switch is integral to the AMU pressure switch "A." When the service brake is depressed, air pressure is applied at pressure switch "A." The stop light switch closes between 2 and 5 psi (13 and 34 kPa). See **Fig. 2**.

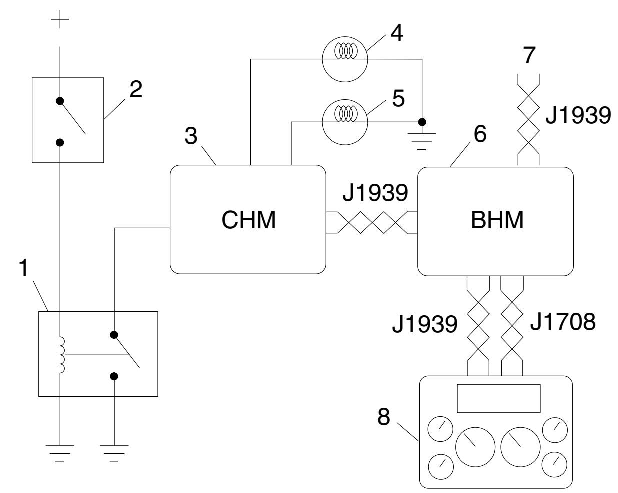


1. Stop Light Pressure Switch
2. Chassis Module
3. Trailer Stop Light Relay Signal
4. Auxiliary Power Distribution Module
5. 7-Way Trailer Receptacle
6. Right Stop Light
7. Left Stop Light
8. Bulkhead Module
9. General Datalink Broadcast
10. Instrumentation Control Unit

Fig. 2, Air Brakes Stop Lights Function

On vehicles equipped with hydraulic brakes, the service brake switch input on the CHM is connected to a relay instead of a switch. The relay is controlled by a switch that is mounted to the service brake arm. The stop light relay is mounted in the dash above the base of the steering column. Depressing the service brake closes the stop light switch. The closed stop light switch passes power from a battery-power dash splice pack to the coil of the stop light relay. The relay energizes and supplies a ground signal to the CHM service brake switch input through the closed contacts of the relay. See **Fig. 3**.

For combination and separate stop/turn signal light functionality, the CHM delivers the stop light outputs from pins L and N of CHM connector C1. With combination stop/turn signal lights, the factory-installed lighting draws 2.1 amps of current, leaving 5.35 amps available for additional lights. With separate stop/turn signal lights, the outputs at pin L and N are



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1. Stop Light Relay
2. Stop Light Switch
3. Chassis Module
4. Right Stop Light
5. Left Stop Light
6. Bulkhead Module
7. General Datalink Broadcast
8. Instrumentation Control Unit

Fig. 3, Hydraulic Brakes Stop Lights Function

stop-only signals. Since no rear lighting is installed for separate stop/turn signal light functionality, 7.45 amps is available for the left and right stop-only outputs.

The BHM is capable of detecting short circuits in the stop light wiring to the CHM. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink®.

Backup Lights

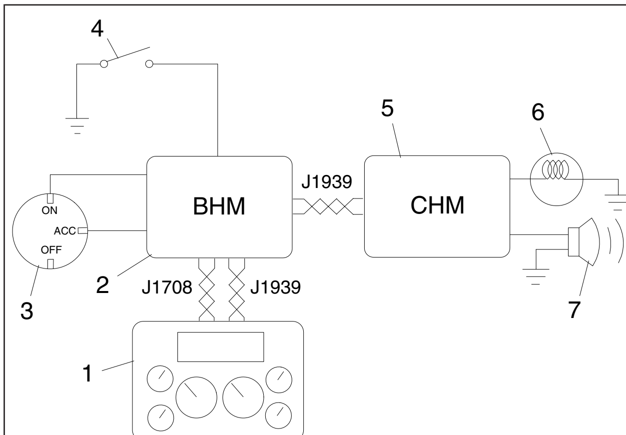
The backup function provides a visual and optional audio warning to anyone standing behind a vehicle that is backing up. When the transmission is placed into reverse gear, the BHM sends a J1939 message to the CHM activating the backup light(s) and optional audible backup alarm. The backup lights and optional audible backup alarm receive power from a single CHM electronic driver, but connect at three different pins on the CHM connector C1. The maximum combined current capacity for all three pins is 7.45A. See **Table 1**.

CHM Backup Lights Outputs	
Circuit Description	**Pin Location On CHM Connector C1**
Left Backup Light	A
Backup Alarm	H
Right Backup Light	J

Table 1, CHM Backup Lights Outputs

The BHM is capable of detecting short circuits in the backup lights/alarm wiring on the CHM. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink.

A vehicle with a manual transmission activates the backup lights/alarm differently than a vehicle with either an automatic or automated mechanical (AMT) transmission. A manual transmission uses a standard backup switch to tell the BHM when the transmission is in reverse. See **Fig. 4**.



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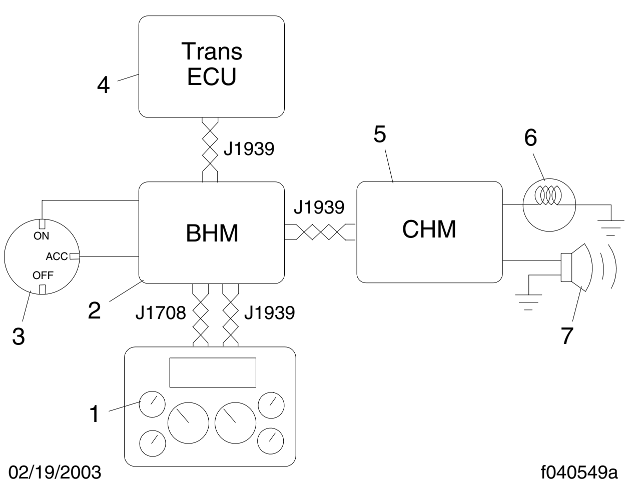
1. Instrumentation Control Unit
2. Bulkhead Module
3. Ignition Switch
4. Backup Switch
5. Chassis Module
6. Backup Lights
7. Optional Backup Alarm

Fig. 4, Backup Lights Function on a Vehicle With Manual Transmission

An automatic or AMT transmission sends a J1939 message to the BHM when the transmission is placed into reverse gear. See **Fig. 5**.

See **Table 2** for BHM backup function according to the type of transmission.

General Information



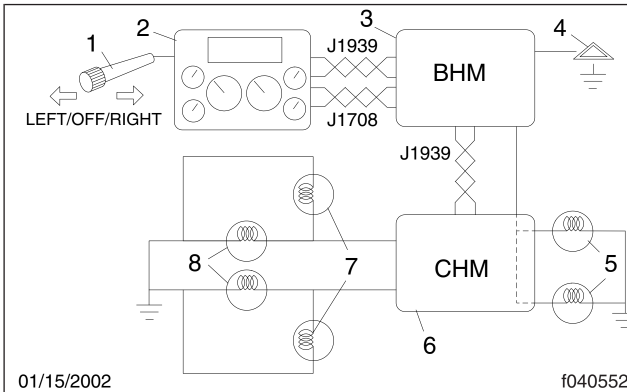
1. Instrumentation Control Unit
2. Bulkhead Module
3. Ignition Switch
4. Transmission ECU
5. Chassis Module
6. Backup Lights
7. Optional Backup Alarm

Fig. 5, Backup Lights Function on a Vehicle With Automatic or AMT Transmission

Turn Signal Lights

The BHM uses J1939 message inputs from the instrumentation control unit (ICU) to instruct the CHM to activate the turn signal lights. The ICU monitors the position of the multifunction turn signal switch. When the ICU senses that the driver has activated this switch, it sends a J1939 message to the BHM. The BHM then checks whether the hazard switch has been activated. If the hazard switch has not been activated, the BHM sends a J1939 message to the CHM instructing it to illuminate the turn signal lights. See **Fig. 6**.

The CHM operates the rear turn signal lights by pulsing the power to the taillights. With combination stop/turn signal lights, the CHM delivers power for the turn signal lights on the same outputs (pins L and N of CHM connector C1) as used for the the stop lights. The turn signal lights take priority over the stop lights. If a vehicle is braking while the multifunction turn signal switch is in a turn position, the appropriate stop/turn signal light pulses for turn signal lights while the opposing stop/turn signal light illuminates for braking.



1. Multifunction Turn Signal Switch
2. Instrumentation Control Unit
3. Bulkhead Module
4. Hazard Switch
5. Rear Turn Signal Lights
6. Chassis Module
7. Side Turn Signal Lights
8. Front Turn Signal Lights

Fig. 6, Turn Signal Lights Function

With separate stop/turn signal lights, the power for the stop lights is provided at pins L and N of CHM connector C1. The power for the separate turn signal lights is now provided at pins P and G of CHM connector C1.

With combination stop/turn signal lights, the factory-installed lighting draws 2.1 amps of current, leaving 5.35 amps available for additional lights. With separate stop/turn signal lights, the outputs at pins P and G are connected with several other possible turn signal light outputs, such as:

- front turn signal lights
- side turn signal lights
- trailer turn signal lights (if equipped)

The total current draw for all combined turn signal lighting can reach 4.1 amps. If a vehicle is not equipped with a high-current lighting interface option, this leaves only 3.35 amps for any additional turn signal lighting. Without the high-current lighting option, LED lights are recommended for any additional turn signal lights.

The BHM is capable of detecting short circuits in the turn signal wiring. Faults discovered by the BHM may be reported on the J1939 and/or J1708 data links and may be viewed through ServiceLink.

Turn Signal Daytime Running Lights

M2 chassis can be programmed to use the front turn signal lights as daytime running lights (DRL). The reference parameter used for programming the functionality of the rear stop/turn signal lights (combination or separate) also programs the DRL function of the front turn signal lights for chassis with BHM software version 6.10. See **Subject 120** for stop/turn signal light and turn DRL reference parameters and descriptions.

Hazard Lights

The operation, description, and function of the hazard lights are covered in "Forward Lighting Systems," **Section 54.27**.

Marker Lights

The operation, description, and function of the marker lights and taillights are covered in "Forward Lighting Systems," **Section 54.27**.

Backup Lights Function		
Transmission Type	**Input to BHM**	**BHM Conclusion**
Manual Transmission	Backup switch is closed.	Transmission is in reverse.
Automatic or AMT Transmissions	J1939 message from transmission indicates either: • Current Gear = Reverse • Selected Gear = Reverse • Gear Range = R	Transmission is in reverse.

Table 2, Backup Lights Function

Before working on the vehicle, park it on a level surface and shut down the engine. Set the parking brake and chock the front and rear tires.

Stop Light and Taillight Assembly Replacement

1. 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.
2. Disconnect the electrical connectors to the taillight assembly.

NOTE: There are two connectors on the left taillight assembly and one connector on the right taillight assembly.

3. Remove the three nuts that attach the taillight assembly to the mounting bracket and remove the taillight assembly from the mounting bracket.
4. If the new taillight assembly did not come supplied with bulbs, follow the steps in "Stop Light and Taillight Bulb Replacement."
5. Place a new taillight assembly on the mounting bracket and secure the three nuts.
6. Connect the connectors.
7. Connect the negative leads to the batteries or, if the vehicle is equipped with a battery disconnect switch, turn the switch to the on position.
8. Verify the proper operation of the lights.
9. Remove the chocks from the tires.

Stop Light and Taillight Bulb Replacement

1. Remove the four capscrews that attach the lens to the housing.
2. Press the bulb in and turn it counterclockwise to release it from the socket.
3. To provide corrosion protection, coat the base of the new bulb with dielectric grease. For approved electrical terminal lubricants, see the applicable table in **Specifications 400**.
4. Install the new bulb, pressing and turning 1/8 turn clockwise to lock it. Test the bulb for proper operation.
5. Install the lens on the housing. Fasten it in place with capscrews.

IMPORTANT: Do not overtighten the capscrews or damage to the lens may occur.

6. Remove the chocks from the tires.

Separate Stop/Turn Signal Lights Conversion

The default rear lighting configuration for a Business Class® M2 vehicle is combination stop/turn signal lights. Combination stop/turn signal lights use the same bulb filament for stop light and turn signal light illumination.

ServiceLink® is required for conversion of combination stop/turn signal lights to separate stop/turn signal lights, and for conversion of separate stop/turn signal lights to combination stop/turn signal lights.

In a combination stop/turn signal lights to separate stop/turn signal lights conversion, the two existing Chassis Module (CHM) outputs for the combination stop/turn signal lights will become the stop light outputs. Two other outputs on the CHM will provide the signal for the new turn signal lights. The new turn signal light outputs will need circuits routed to the rear turn signal lights.

Converting Combination to Separate Stop/Turn Signal Lights

1. Shut down the engine, apply the parking brakes, and chock the tires.
2. Gather the necessary parts:
   - 2 Packard GT280 female terminals (15304717, 15304720, or equivalent for 16/14 AWG)
   - 2 Packard GT280 cable seals (15366067 or equivalent)
   - Appropriate wiring for connecting additional lighting
3. 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.
4. Cut new wires to the required length to reach the left- and right-rear turn signal lights. Be sure to have enough length for routing the wires and installing cable terminals.
5. Crimp a terminal and terminal seal to one end of each of the wires.
6. Locate and disconnect connector C1 of the CHM. See **Fig. 1**.
7. Remove the seals from cavities G and P of CHM connector C1.

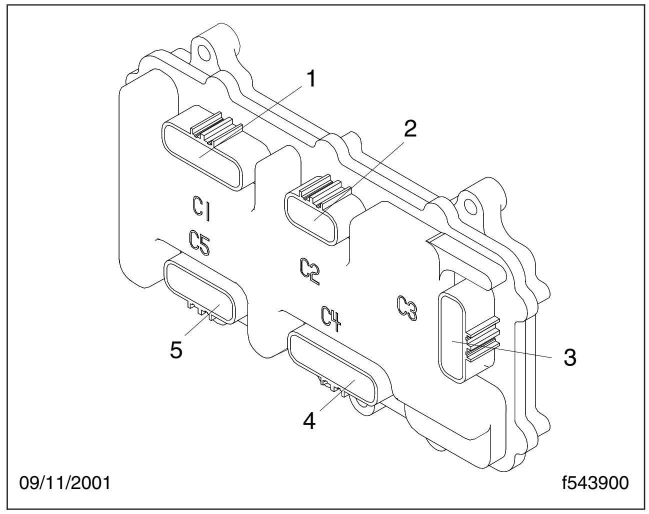


Fig. 1, Chassis Module Connector Identification

8. Install the wire for the left turn signal light into cavity G. Make sure the terminal is fully seated.
9. Install the wire for the right turn signal light into cavity P. Make sure the terminal is fully seated.
10. Route the new turn signal light wires to the rear of the truck. Use a split loom to protect the wires and tie-strap the loom to the existing harness where appropriate.
11. Connect wires to the rear turn signal lights.
12. Connect the negative leads to the batteries or, if the vehicle is equipped with a battery disconnect switch, turn the switch to the on position.

IMPORTANT: When converting a vehicle from combination stop/turn signal lights to separate stop/turn signal lights, you must follow the conversion information in **Table 1** exactly. Using a different reference parameter may result in incorrect operation of either the rear lights or daytime running lights (DRL) and may have legal consequences for the vehicle owner, which may include fines and having vehicles placed out of service. The regulations in the Federal Motor Vehicle Safety Standards (FMVSS) and Canadian Motor Vehicle Safety Standards (CMVSS) control rear lighting and DRL functionality. Some jurisdictions enforce these regulations during vehicle inspections.

13. Using ServiceLink, apply the appropriate reference parameter to the vehicle. See **Table 1**.

Separate Stop/Turn Signal Lights Conversion

14. Verify the proper operation of the lights.
15. Remove the chocks from the tires.

Converting Separate to Combination Stop/Turn Signal Lights

1. Shut down the engine, apply the parking brakes, and chock the tires.
2. Locate the existing turn signal wires where they terminate at the rear turn signal lights.
    - 2.1 Cut the wires.
    - 2.2 Apply heat shrink to the chassis side of the wires to seal the wire.
    - 2.3 Tuck the wires in to the harness loom.
3. Locate the existing stop light wires where they terminate at the stop lights.
    - 3.1 Route the wires as needed to the new combination stop/turn signal lights.
    - 3.2 Use convoluted tubing to protect the wires, and use tie-straps to secure the wires to the existing harness.

   NOTE: If the total current draw for the combination stop/turn signal light circuit on either side will exceed 6.7 amps, install relays.

IMPORTANT: When converting a vehicle from separate stop/turn signal lights to combination stop/turn signal lights, you must follow the conversion information in **Table 2** exactly. Using a different reference parameter may result in incorrect operation of either the rear lights or daytime running lights (DRL) and may have legal consequences for the vehicle owner, which may include fines and having vehicles placed out of service. The regulations in the Federal Motor Vehicle Safety Standards (FMVSS) and Canadian Motor Vehicle Safety Standards (CMVSS) control rear lighting and DRL functionality. Some jurisdictions enforce these regulations during vehicle inspections.

4. Using ServiceLink, apply the appropriate reference parameter to the vehicle. See **Table 2**.
5. Verify the correct operation of the lighting.
6. Remove the chocks from the tires.

Reference Parameters for a Conversion from Combination to Separate Stop/Turn Signal Lights	
Existing Parameter	**New Parameter**
26-01020-000 or 26-01020-010	26-01020-004 or 26-01020-009
26-01020-001	26-01020-003
26-01020-006	26-01020-007
26-01020-012	26-01020-013

Table 1, Reference Parameters for a Conversion from Combination to Separate Stop/Turn Signal Lights

Reference Parameters for a Conversion from Separate to Combination Stop/Turn Signal Lights	
Existing Parameter	**New Parameter**
26-01020-004 or 26-01020-009	26-01020-000 or 26-01020-010
26-01020-003	26-01020-001
26-01020-007	26-01020-006
26-01020-013	26-01020-012
26-01020-015	26-01020-014

Table 2, Reference Parameters for a Conversion from Separate to Combination Stop/Turn Signal Lights

Parameter Programming

When adding or changing a feature on a Business Class® M2 vehicle, you must use ServiceLink® to update the programming on the vehicle.

IMPORTANT: When converting a vehicle from combination stop/turn signal lights to separate stop/turn signal lights, or from separate stop/turn signal lights to combination stop/turn signal lights, you must follow the conversion information in **Subject 110** exactly. Using a different reference parameter may result in incorrect operation of either the rear lights or daytime running lights (DRL) and may have legal consequences for the vehicle owner, which may include fines and having vehicles placed out of service. The regulations in the Federal Motor Vehicle Safety Standards (FMVSS) and Canadian Motor Vehicle Safety Standards (CMVSS) control rear lighting and DRL functionality. Some jurisdictions enforce these regulations during vehicle inspections.

See **Table 1** for stop/turn signal light reference parameters. The turn signals of a vehicle may be programmed to provide DRL.

Stop/Turn Signal Light Reference Parameters	
Parameter	**Description**
26-01020-000	Combination stop/turn signal
26-01020-001	Combination stop/turn signal with DRL
26-01020-002	Combination stop/turn signal
26-01020-003	Separate stop/turn signal with DRL
26-01020-004	Separate stop/turn signal
26-01020-006	Combination stop/turn signal with DRL
26-01020-007	Separate stop/turn signal with DRL
26-01020-009	Separate stop/turn signal
26-01020-010	Combination stop/turn signal
26-01020-011	Combination stop/turn signal
26-01020-012	Combination stop/turn signal with DRL
26-01020-013	Separate stop/turn signal with DRL
26-01020-014	Combination stop
26-01020-015	Separate stop
26-01020-018	Combination stop/turn signal with DRL, front side marker and taillight on with DRL

Table 1, Stop/Turn Signal Light Reference Parameters

IMPORTANT: The following is a general description of how the rear lighting electrical system of a Business Class® M2 vehicle works. ServiceLink® is the diagnostic tool for troubleshooting the M2 electrical system. For specific circuit and pin information on how the vehicle is wired, go to the Configuration screen in ServiceLink and select the specific function in which you are interested. To troubleshoot specific inputs and outputs of this system, go to the Templates screen in ServiceLink and select the template for the function in which you are interested.

Turn Signal Lights

Input/output conditions and fault conditions for turn signal lights are covered in "Forward Lighting Systems," Section 54.27. For troubleshooting procedures, see **Section 54.27, Subject 300**.

Hazard Lights

Input/output conditions and fault conditions for hazard lights are covered in "Forward Lighting Systems," Section 54.27. For troubleshooting procedures, see **Section 54.27, Subject 300**.

Marker Lights

Input/output conditions and fault conditions for marker lights are covered in "Forward Lighting Systems," Section 54.27. For troubleshooting procedures, see **Section 54.27, Subject 300**.

Stop Lights

Input and Output Conditions

See **Table 1** for the Bulkhead Module (BHM) responses to the stop lights input/output conditions.

The service brake switch directly controls the trailer stop light relay. The stop light switch input pin is connected with a circuit board trace directly to the trailer stop light relay pin in the Chassis Module (CHM).

Fault Conditions

See **Table 2** for the stop lights fault conditions that create faults. The reference parameters that program the BHM determine whether a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted. If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on the J1939 and/or the J1708 datalinks until the service brake switch is open.

Diagnostics for a Vehicle With Air Brakes

On air management unit (AMU) vehicles, pressure switch module "A" of the AMU contains internal pressure switches to monitor various functions. The internal pressure switches for part number 12-18205-XXX have a diode wired in parallel with each switch. Internal pressure switches for part number A12-19776-XXX do not have diodes in parallel with the switch.

One of the pressure switches of module "A" is the stop light switch. The stop light switch monitors pressure in the service brake system. Its main purpose is to control the stop lights. This switch closes at approximately 3.5 ±1.5 psi (24 ±10 kPa). See **Table 3** for testing of the stop light switch.

On auxiliary air valve assembly (AAVA) vehicles, there are two service brake pressure switches located in the center of the dash.

Stop Lights Input/Output Conditions			
Input to BHM from CHM	Outputs from BHM		
Service Brake Switch	J1939 Service Brake Message	Left Stop Light	Right Stop Light
Closed	Depressed	Activated	Activated
Open	Released	Deactivated	Deactivated

Table 1, Stop Lights Input/Output Conditions

Troubleshooting

Stop Lights Fault Conditions	
Description of Fault	**Action Taken by BHM**
Left stop light wiring is shorted.	BHM may transmit a J1939 and/or a J1708 fault message.
Right stop light wiring is shorted.	BHM may transmit a J1939 and/or a J1708 fault message.

Table 2, Stop Lights Fault Conditions

Stop Lights Switch Tests for a Vehicle With Air Brakes NOTE: If any test fails, the Pressure Switch Module A is defective and must be replaced.				
Test	**Conditions**	**Test Point**	**Good Result**	**If Test Fails:**
Stop Light Ground Circuit	Key off, engine off. Battery disconnected. Pressure switch "A" 6-way connector disconnected.	Resistance Check: Measured between pin D (harness side) and the negative battery terminal.	Less than 1 ohm.	Check ground circuit wiring.
Stop Light Switch Diode Applies to part number 12-18205-XXX. For all other part numbers, skip this test.	Key off, engine off. Drain air tanks. Pressure switch "A" 6-way connector disconnected.	Resistance Check (or diode test if meter is capable): Measured between pin C and D (switch side). Then reverse test leads and check again.	With the leads connected one way, the meter should read resistance (value not important). When the leads are reversed, the reading should be infinite or OL. NOTE: If the result is 0 ohms both ways, either the diode is shorted or the pressure switch is stuck closed. If the result was OL both ways, the diode is open.	Faulty Pressure Switch "A."

Stop Lights Switch Tests for a Vehicle With Air Brakes				
NOTE: If any test fails, the Pressure Switch Module A is defective and must be replaced.				
Test	**Conditions**	**Test Point**	**Good Result**	**If Test Fails:**
Stop Light Switch	Key off, engine off. Pressure switch "A" 6-way connector disconnected. Drain air tanks. Disconnect one of the APP ports on the face of the module and connect a regulated air supply setup to the port. Using the setup, close Valve "A" and Valve "B." Back the regulator screw off so that the downstream pressure is zero. Connect shop air to the test apparatus. Open Valve "A." Apply 10 psi (69 kPa) to the APP port by adjusting the pressure regulator. This should cause the stop light pressure switch to close.	Resistance Check: Measured between pins C and D (switch side). Then reverse test leads and check again.	Less than 1 ohm (test leads both ways). NOTE: If the resistance is more than 1 ohm either way, then the stop light switch is not closing between 2 and 5 psi (13 and 34 kPa).	Faulty Pressure Switch "A."

Table 3, Stop Lights Switch Tests for a Vehicle With Air Brakes

Backup Lights

Input and Output Conditions

See **Table 4** for the BHM responses to the backup lights input/output conditions.

Backup Lights Input/Output Conditions		
Inputs to BHM		**Output from BHM**
Ignition Switch	**Transmission Status**	**Backup Lights/Alarm***
On/Acc	Reverse	On
On/Acc	Not Reverse	Off
Off	Reverse	Off
Off	Not Reverse	Off

* Via J1939 message to the CHM

Table 4, Backup Lights Input/Output Conditions

Fault Conditions

See **Table 5** for the backup lights system conditions that will create a fault. The reference parameters that program the BHM determine whether a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted. If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on the J1939 and/or the J1708 datalinks until the ignition switch is turned off.

On a vehicle with an automatic transmission, the BHM has **additional** J1939 fault messages that may be broadcast. Any J1939 fault message may be transmitted until the ignition switch is turned off. See **Table 6**.

Troubleshooting

Backup Lights System Fault Conditions	
Description of Fault	**Action Taken by BHM**
Ignition switch status is in error.	BHM will assume the ignition switch is in the on position and may transmit a fault message on the J1939 and/or J1708 datalinks.
Backup lights/alarm wiring shorted.	BHM may transmit a J1939 and/or a J1708 fault message.

Table 5, Backup Lights System Fault Conditions

Backup Lights System Fault Conditions for a Vehicle With an Automatic Transmission or Automated Mechanical Transmission (AMT)	
Description of Fault	**Action Taken by BHM**
BHM fails to receive five consecutive J1939 messages from the transmission ECU.	BHM may transmit a J1939 fault message and assume the transmission is in reverse.
Transmission ECU sends an error indicator in the J1939 message to the BHM.	BHM may transmit a J1939 fault message and assume the transmission is in reverse.

Table 6, Backup Lights System Fault Conditions for a Vehicle With an Automatic Transmission or Automated Mechanical Transmission (AMT)

Approved Electrical Lubricants	
Manufacturer	**Lubricant**
Standard Oil Co.	White Vaseline
Shell Oil Co.	No. 71032; No. 71306
Texaco, Inc.	No. 955
Quaker State	No. NYK-77

Table 1, Approved Electrical Lubricants

Replacement Bulb Part Numbers	
Description	**Part Number**
Stop/Turn Signal/Park Light	1157
Backup Light	1156

Table 2, Replacement Bulb Part Numbers

Wiring Diagrams

IMPORTANT: The following wiring diagrams provide circuit details for the rear lighting of a typical Business Class® M2 vehicle. These details may not correspond to every vehicle. ServiceLink® is the diagnostic tool for troubleshooting the M2 electrical system. For specific circuit and pin information on how the vehicle is wired, go to the Configuration screen in ServiceLink and select the specific function in which you are interested. To troubleshoot specific inputs and outputs of this system, go to the Templates screen in ServiceLink and select the template for the function in which you are interested.

See **Fig. 1** for wiring details of the control inputs for the rear lights of a typical M2 vehicle.

Combination Stop/Turn Signal Lights

See **Fig. 2** for wiring details of the control outputs for integrated rear lights.

See **Fig. 3** for wiring details of the control outputs for individual rear lights.

Separate Stop/Turn Signal Lights

If an order for a vehicle includes separate stop/turn signal lights functionality, the vehicle is not equipped with rear lights. Only a harness connection that supplies the lighting outputs is provided. See **Fig. 4** for wiring details of the control outputs at the rear lighting connection.

Circuit Identification

See **Table 3** for a connector face view and pinout chart of the CHM Connector C1.

See **Table 4** for a connector face view and pinout chart of the aft chassis harness rear light connector for vehicles with combination stop/turn signal lights.

See **Table 5** for a connector face view and pinout chart of the aft chassis harness rear light connector for vehicles with separate stop/turn signal lights.

Specifications

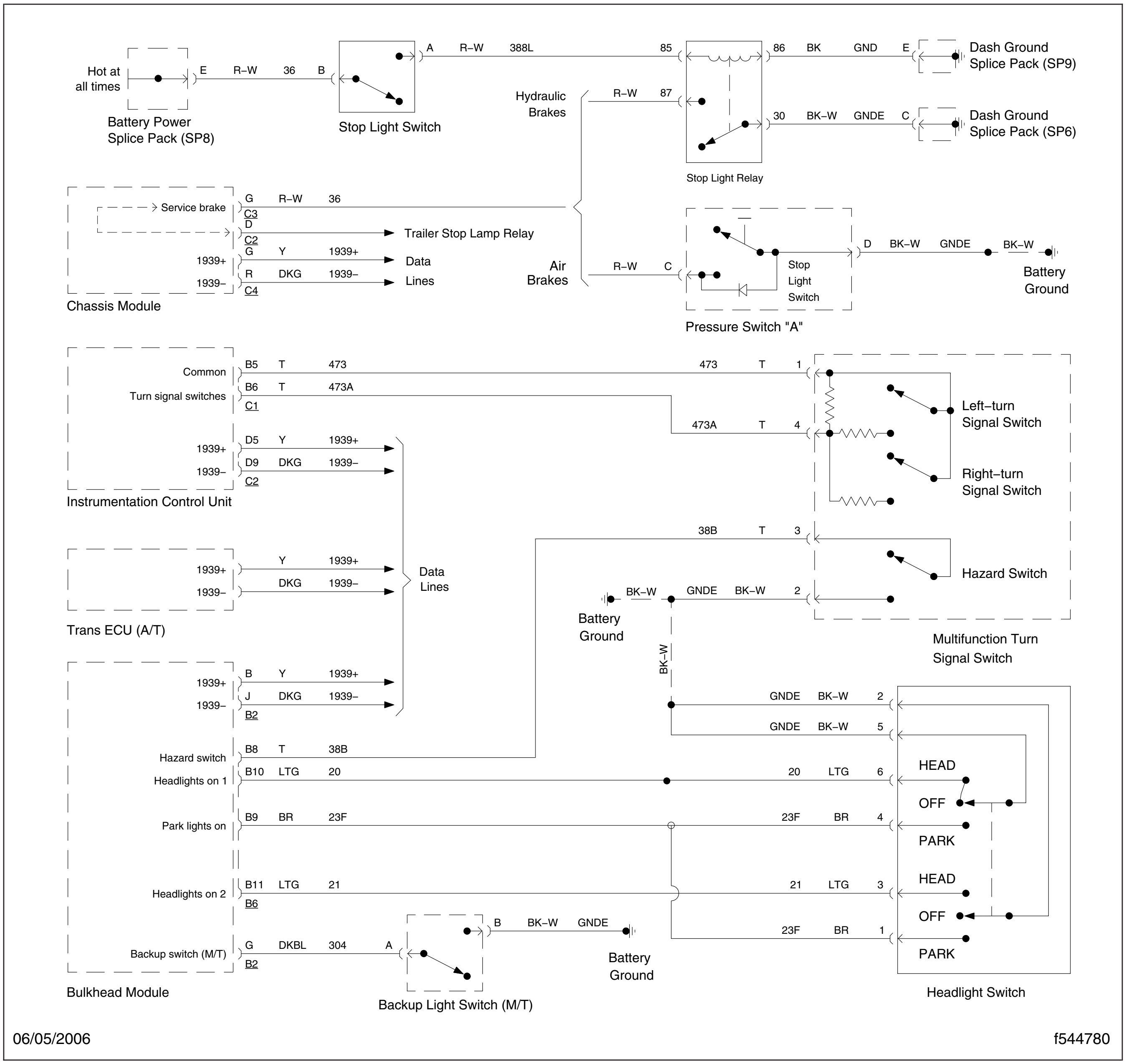


Fig. 1, Rear Exterior Lighting Inputs

Specifications

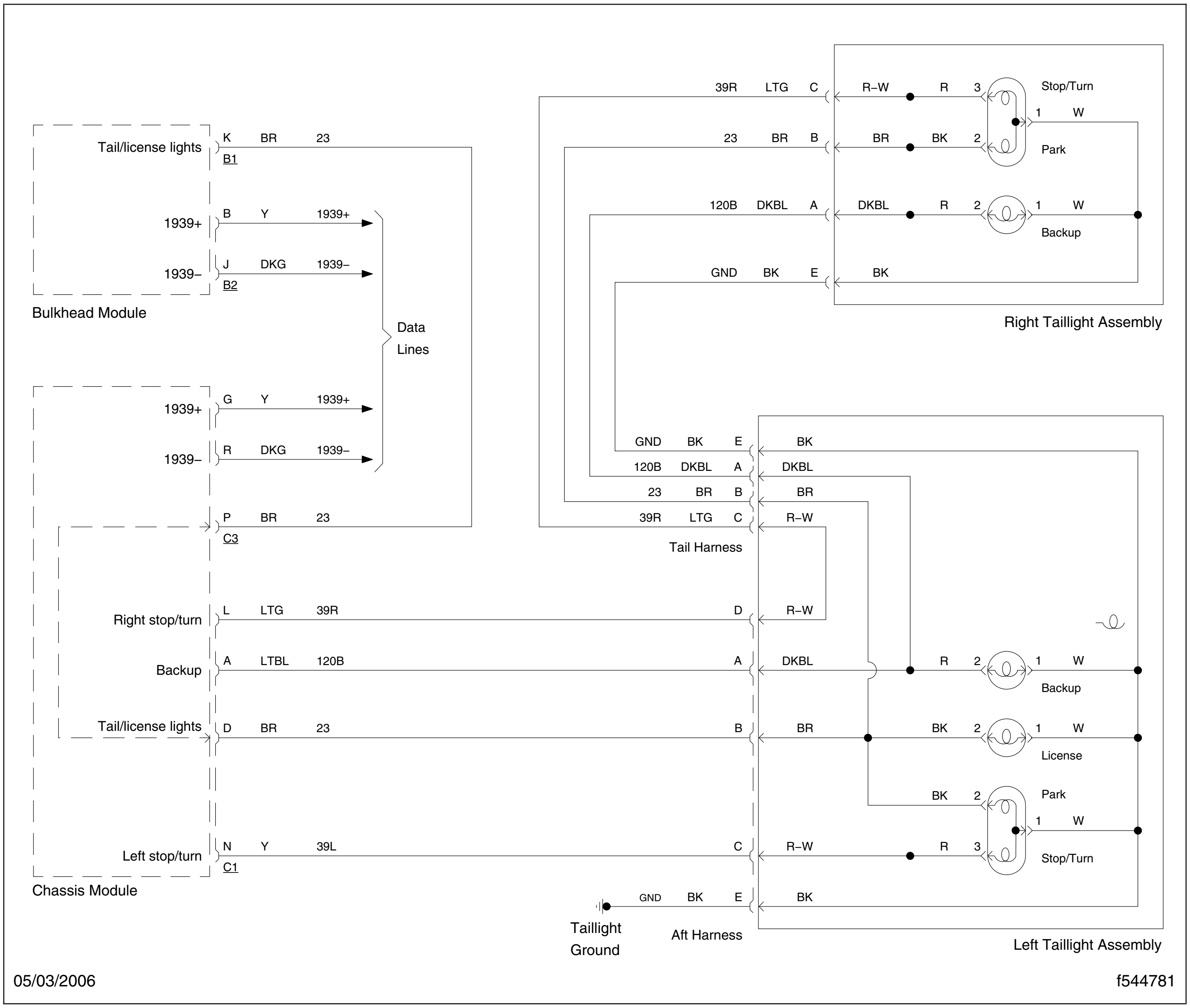


Fig. 2, Lighting Outputs for Integrated Rear Lights (combination stop/turn signal)

Specifications

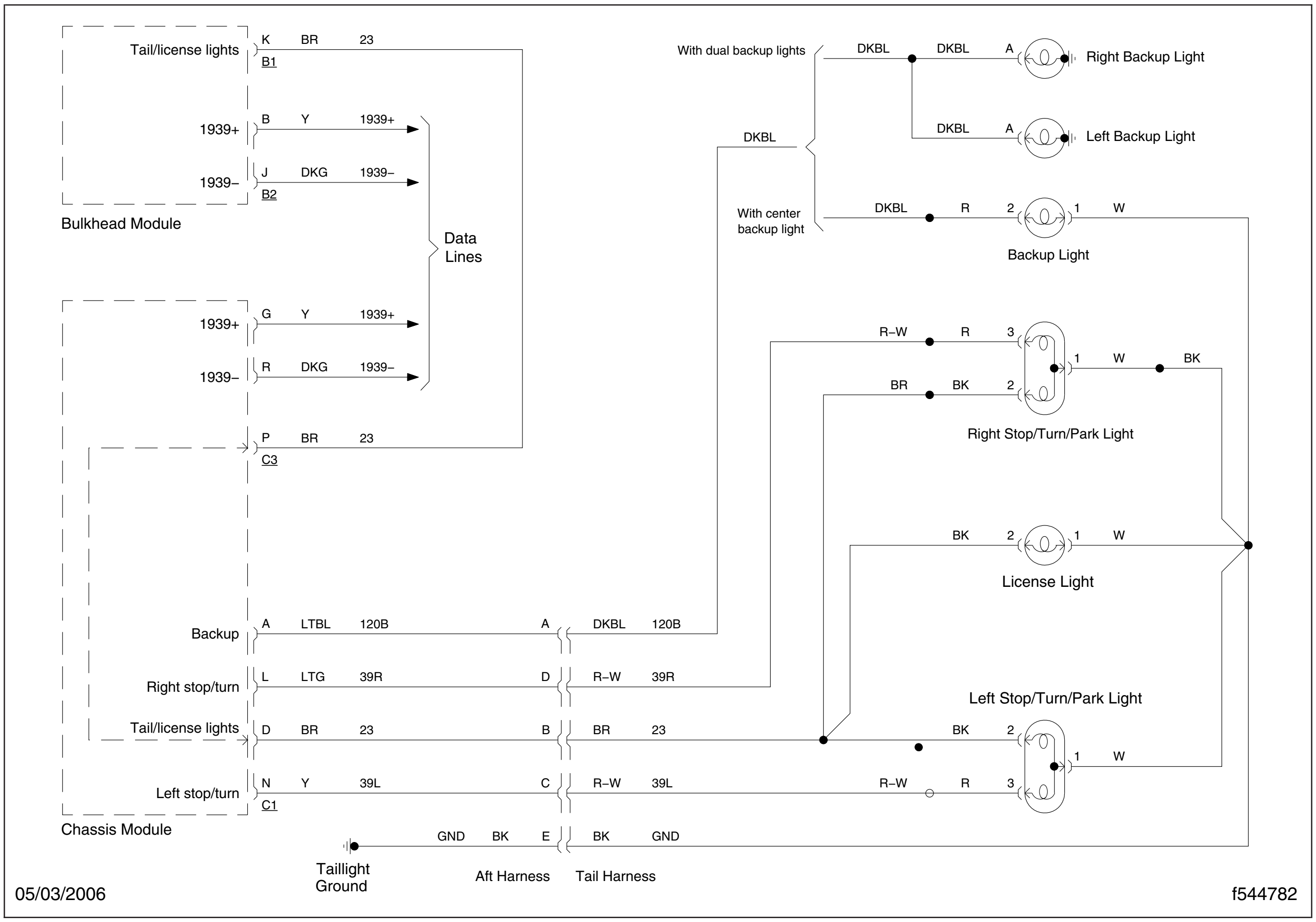


Fig. 3, Lighting Outputs for Individual Rear Lights (combination stop/turn signal)

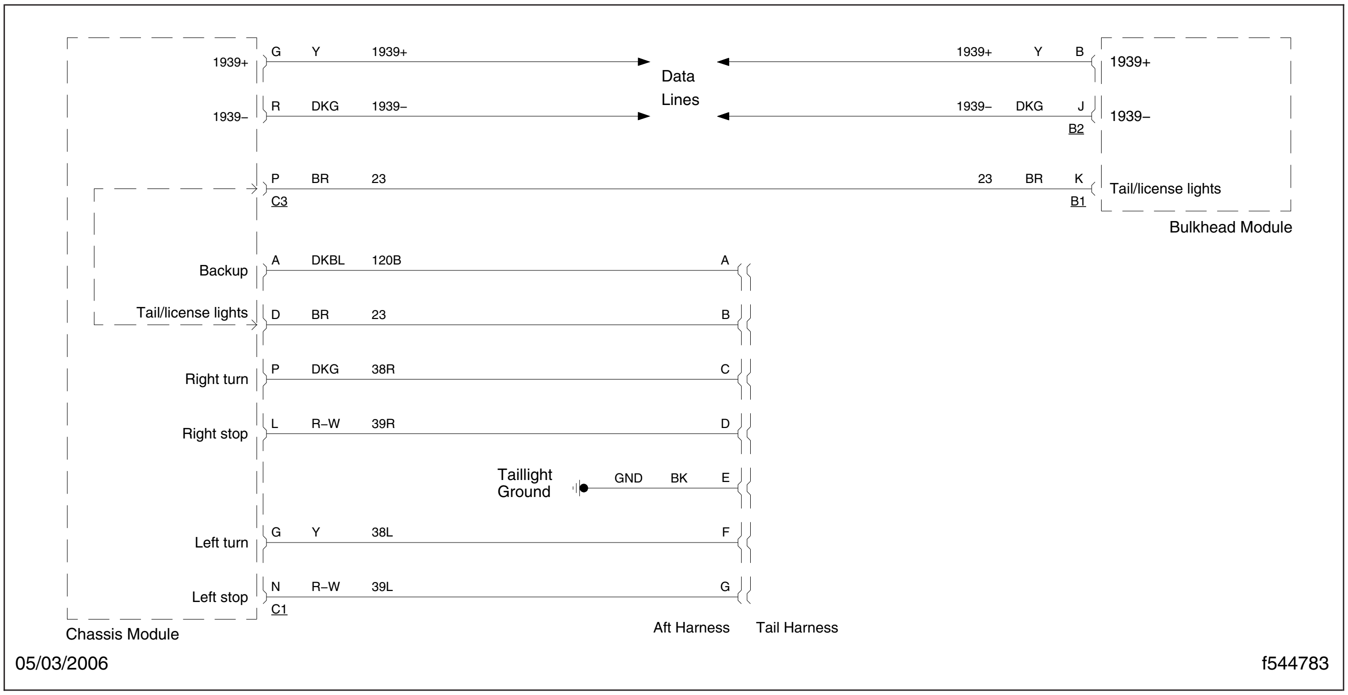
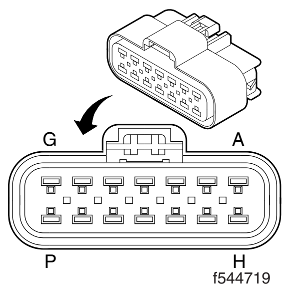


Fig. 4, Rear Lighting Connection (separate stop/turn signal)

Pinouts at CHM Connector C1

Connector Pin	Signal Name	Signal Type	Circuit Color	Circuit Number	Current Capacity
					
C1-A	Left Backup Light (combination stop/turn signal)	Digital Output	LTBL	120B	7.45A*
C1-A	Left Backup Light (separate stop/turn signal)	Digital Output	DKBL	120B	7.45A*
C1-B	—	—	T	OPTA	—
C1-C	—	—	T	OPTB	—
C1-D	Left Taillight Pass-Through	Pass-Through	BR	23	1.0A†
C1-E	Right Taillight Pass-Through	Pass-Through	BR	23A	1.0A†
C1-F	License Plate Light	Digital Output	BR	23C	1.0A†
C1-G	Left Rear Turn Signal Light (separate stop/turn signal)	Digital Output	Y	38L	7.45A‡
C1-H	Backup Alarm	Digital Output	DKBL	120B	7.45A*

Specifications

Pinouts at CHM Connector C1					
Connector Pin	**Signal Name**	**Signal Type**	**Circuit Color**	**Circuit Number**	**Current Capacity**
C1-J	Right Backup Light	Digital Output	DKBL	120B	7.45A[*]
C1-K	—	—	T	OPTC	—
C1-L	Right Stop Light (combination stop/turn signal)	Digital Output	LTG	39R	7.45A
C1-L	Right Stop Light (separate stop/turn signal)	Digital Output	R-W	39R	7.45A
C1-M	—	—	T	OPTD	—
C1-N	Left Stop/Turn Signal Light (combination stop/turn signal)	Digital Output	Y	39L	7.45A
C1-N	Left Stop Light (separate stop/turn signal)	Digital Output	R-W	39L	7.45A
C1-P	Right Rear Turn Signal Light (separate stop/turn signal)	Digital Output	DKG	38R	7.45A[§]

[*] Pins C1-A, C1-H, and C1-J are fed from the same CHM circuit board trace. The maximum combined current capacity for all three pins is 7.45A.

[†] Pins C1-D, C1-E, and C1-F are fed from the same CHM circuit board trace. The maximum combined current capacity for all three pins is 1A.

[‡] Pins C1-G, C2-H, and C3-N are fed by the same CHM circuit board trace. The maximum combined current capacity for all three pins is 7.45A.

[§] Pins C1-P, C2-E, and C3-R are fed by the same CHM circuit board trace. The maximum combined current capacity for all three pins is 7.45A.

Table 3, Pinouts at CHM Connector C1

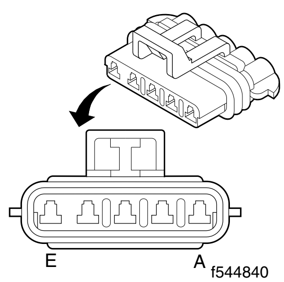
Rear Light Connector (combination stop/turn signal)				
Connector Pin	**Signal Name**	**Signal Type**	**Circuit Color**	**Circuit Number**
				
A	Backup Light	Output	LTBL	120B
B	Taillights and License Light	Output	BR	23
C	Left Stop/Turn Signal Light	Output	Y	39L
D	Right Stop/Turn Signal Light	Output	LTG	39R
E	Ground	Ground	BK	GND

Table 4, Rear Light Connector (combination stop/turn signal)

Specifications

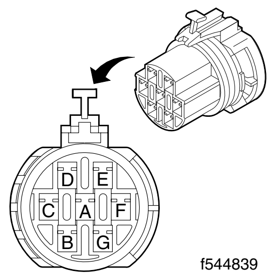
Rear Light Connector (separate stop/turn signal)				
Connector Pin	Signal Name	Signal Type	Circuit Color	Circuit Number
				
A	Backup Light	Output	DKBL	120B
B	Taillights and License Light	Output	BR	23
C	Right Turn Signal Light	Output	DKG	38R
D	Right Stop Light	Output	R-W	39R
E	Ground	Ground	BK	GND
F	Left Turn Signal Light	Output	Y	38L
G	Left Stop Light	Output	R-W	39L

Table 5, Rear Light Connector (separate stop/turn signal)

Contents

Introduction

The Business Class® M2 is available in several vehicle configurations. When an M2 vehicle is used as a tractor to pull a trailer, or as a truck to tow a piece of equipment, electrical connections are required between the vehicle and the trailer or the equipment.

Semitrailers and full trailers that are equipped with pneumatic brakes and used in North America or South America are generally equipped with an electrical cable that terminates in a 7-way connector that is defined in SAE J560 standard, *Primary and Auxiliary Seven Conductor Electrical Connector for Truck-Trailer Jumper Cable*. In some cases, a trailer used in North America is equipped with two electrical cables; one will be an SAE J560 connector and the other will be an ISO 3731 connector.

The harnesses and components that are used to provide an SAE J560 connector on a tractor or truck are nearly identical, regardless of the country of domicile of the vehicle. Most of the **component** variation is contained in the single-piece J560 connector, and if equipped, in the ISO 3731 connector that is installed on the tractor—the J560 connector and the ISO 3731 connector may be a straight connector or a 90-degree connector, and the cable may contain a signal filter that is related to the TRAILER ABS warning light. **Operational** variation is contained in the reference parameters that are used to control the functionality of the center pin of the J560 connector.

Overview

Trailer wiring requires the use of a full-feature Chassis Module (CHM). The CHM provides the necessary digital outputs, such as lighting and trailer power condition, via a wiring harness to the trailer power distribution module (PDM). The trailer PDM is usually mounted on the left frame rail aft of the cab, or on a rear crossmember at the end of the frame rail. Direct battery power is supplied to the trailer PDM via an independent connection to a 150 amp Battery MEGA® Fuse. The trailer PDM contains fuses and relays to enable high current outputs via a wiring harness to the trailer connector. It is possible to adapt trailer connector placement and mounting methods to better suit vehicle configuration or the preference of the body builder. Trailer PDM outputs include:

- taillights
- marker lights
- stop lights
- turn lights
- trailer power

If electrical trailer provisions are to include a trailer antilock braking system (ABS), the harness between the trailer PDM and trailer connector is adapted with a power line carrier (PLC) filter to permit communication of the trailer ABS warning signal on the trailer power circuit. The PLC filter is usually mounted alongside the trailer PDM.

Components

If electrical trailer provisions need to be added, visit a local Freightliner dealer to request a bill of material. Be prepared to provide the dealer with the vehicle identification number (VIN) and a sales option code (if known) for the desired feature. The bill of material provides a complete parts list that is tailored to the configuration and dimension of the vehicle.

The following is a list of some necessary components for establishing proper trailer electrical provisions:

- reference parameter (programs the new feature)
- upgraded CHM (full-feature Chassis Module required)
- trailer PDM with mounting hardware and bracket
- trailer connector J560 with mounting hardware and bracket
- harness between the CHM and the trailer PDM
- harness between the trailer PDM and the trailer connector
- power cable between the battery and the trailer PDM
- 150 amp Battery MEGA Fuse

The J560 center pin functionality must be programmed into the Bulkhead Module (BHM) of the truck. Use ServiceLink® to add the reference parameter if this feature is added to a vehicle that is already in service.

General Information

Installation or Replacement Guidelines

When installing or replacing any part of the electrical trailering system, follow these guidelines:

- Make ground connections at factory-provided ground stud locations whenever possible. If there is not a ground stud available, it will be necessary to add a bolt or self-threading fastener to connect the ground lugs to the frame rail.
- Route all wiring so that it will not be exposed to harmful conditions such as, moving parts, excessive heat, chafing, or saturation with oil or grease.
- Secure and protect all electrical components. Use appropriate mounting and installation techniques such as, retaining clips, harness protection, and correct hardware.
- Be sure to clean all paint, dielectric enamel, and road grime from the ground stud or frame before connecting the new ground leads. After the connections are secured, use a dielectric enamel on the ground connections to protect against corrosion.
- Removal of electrical components for an extended period of operation requires proper weatherproofing to avoid system damage and electrical faults.

Removal

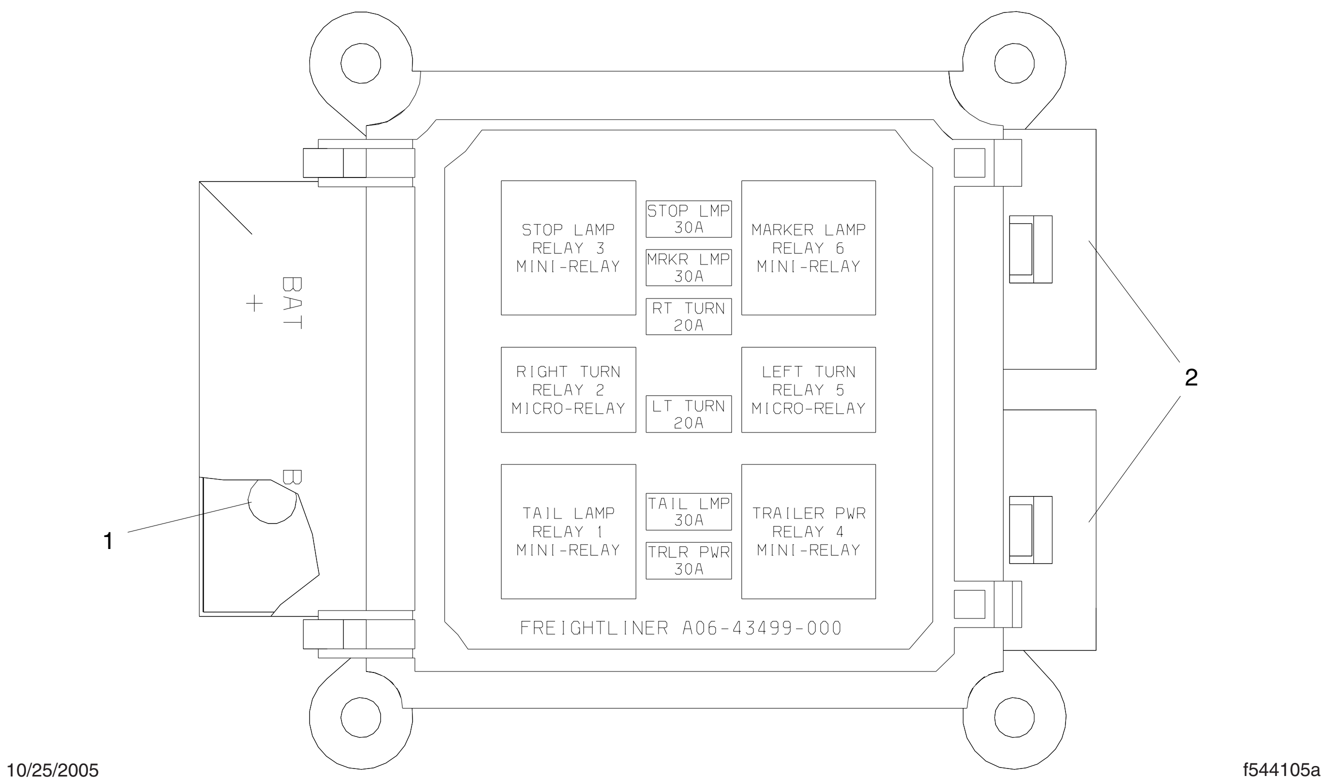
1. Turn off the engine, apply the parking brakes, and chock the tires.
2. Disconnect the negative leads from the batteries or, if the vehicle is equipped with a battery disconnect switch, turn the switch to the off position.

NOTE: The trailer power distribution module (PDM) is mounted on the left frame rail aft of the cab, or on a crossmember at the end of the frame rail.

3. Remove the capscrews that attach the metal cover on the PDM to the mounting plate, then remove the cover.
4. Remove the nut and washer that attach the positive lead to the trailer PDM battery power stud. Then remove the positive lead. See **Fig. 1**.
5. Disconnect the electrical connectors from the trailer PDM. See **Fig. 1**.
6. Remove the nuts and washers that attach the trailer PDM to the mounting bracket, then remove the PDM. See **Fig. 2** and **Fig. 3**.

Installation

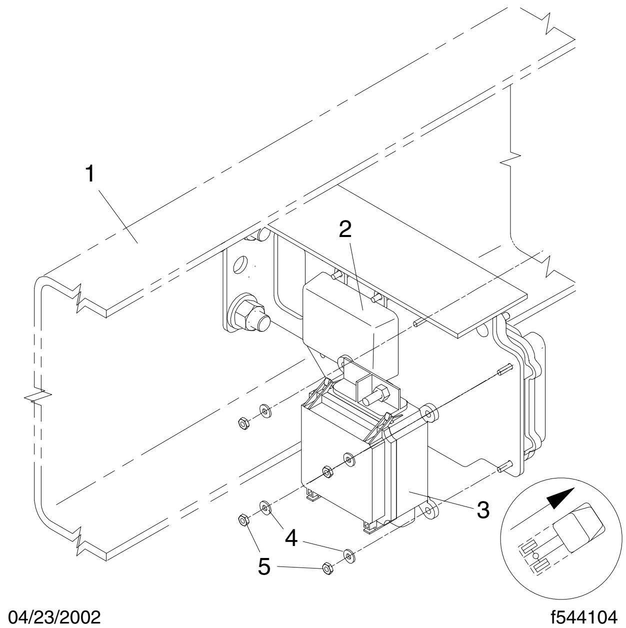
1. Using nuts and washers, attach the PDM to the mounting bracket.
2. Attach the electrical connectors to the trailer PDM.



1. Battery Power Stud
2. Electrical Connector

Fig. 1, Trailer PDM Fuse Panel Layout

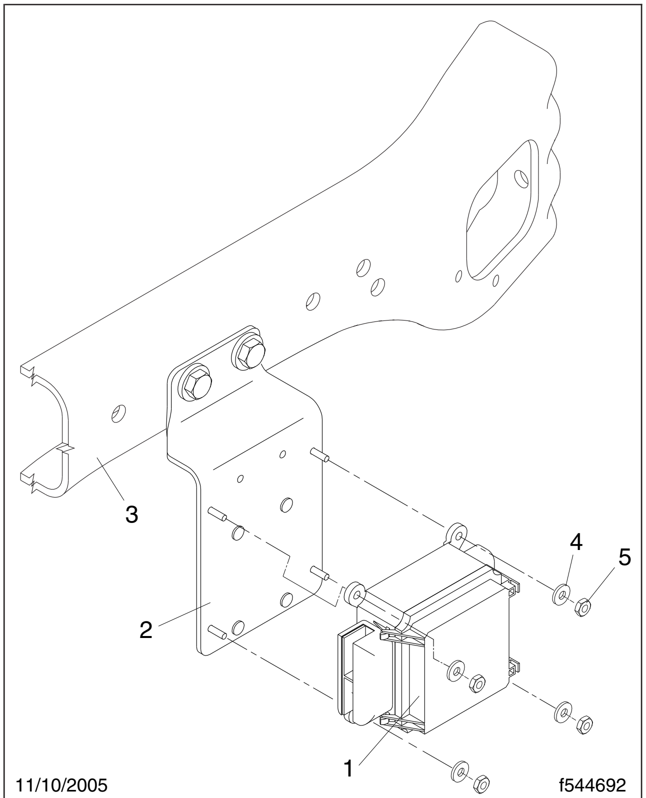
PDM Removal and Installation



1. Left Frame Rail
2. PLC Filter
3. Trailer PDM
4. #10 Washer
5. 10-24 Nut

Fig. 2, Trailer PDM Aft-of-Cab Installation

3. Using a nut and washer, install the positive lead on the trailer PDM battery power stud. Torque the nut 11 to 13 lbf·ft (15 to 18 N·m).
4. Using capscrews, attach the metal cover (that protects the PDM) to the mounting plate.
5. Connect the batteries or turn the battery disconnect switch to on.
6. Verify the operation of the trailer electrical components.
7. Remove the chocks from the tires.



1. Trailer PDM
2. Mounting Bracket
3. Crossmember
4. #10 Washer
5. 10-24 Nut

Fig. 3, Trailer PDM End-of-Frame Installation

Parameter Programming

When adding or changing a trailer feature on the M2, you must use ServiceLink® to update the programming on the vehicle.

1. Establish a connection to ServiceLink.
2. Select the J1939 **Bulkhead Module** icon on the left side of the screen.
3. Select the **Features** menu.
4. Enter the appropriate reference parameter for the feature that is being programmed.
5. Click on **Add to List**.
6. Click on **Apply Changes**.

Troubleshooting

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

Electrical Troubleshooting	
Description of Fault	**Possible Cause**
Stop lights on at all times.	Battery MEGA® Fuse that supplies the trailer power distribution module (PDM) is open or missing.
Trailer connector center pin (pin 7) is not providing desired power condition.	Incorrect Reference Parameter.
Intermittent or no electrical trailer operation at all outputs.	Loss of connection. Check trailer PDM electrical connections and ground.
No operation on single output.	Trailer PDM components are inoperable. Check PDM fuse (blown) and relay (stuck) for that output.
Intermittent or no operation on single output.	Loose terminal connection(s), damaged wire. Trace the suspect circuit.

Table 1, Electrical Troubleshooting

Trailer Connector Testing

Make sure that the center pin is operating according to the programmed reference parameter. See **Specifications 400**.

Verify that all trailer lighting signals are operating properly. Test the taillights, marker lights, stop lights, parking lights, and turn lights.

Trailer Electrical System Wiring Diagram

See **Fig. 1** for a wiring diagram of the trailer electrical system with only a J560 connector.

See **Fig. 2** for a wiring diagram of the trailer electrical system with both J560 and ISO 3731 connectors.

Trailer Electrical System I/O Diagram

For an overview of the input and output signals of the trailer electrical system, see **Fig. 3**.

Reference Parameters

Several configurations of trailer wiring are available and are mainly defined by the function and use of the trailer connector center pin. Each configuration is provided a unique ServiceLink® reference parameter for programming the proper trailer wiring usage and center pin operation. For a list of possible trailer reference parameters and the corresponding descriptions, see **Table 1**.

Circuit Identification

Chassis Module

For Chassis Module (CHM) connector identification, see **Fig. 4**. For a connector face view and pinout chart of the CHM C2 connector, see **Table 2**.

Trailer PDM

For trailer power distribution module (PDM) layout and identification of electrical connections, see **Subject 100**. For a connector face view and pinout chart of the trailer module harness PDM connector, see **Table 3**. For a connector face view and pinout chart of the trailer connector harness PDM connector, see **Table 4**.

Trailer Connector

For a connector face view and pinout chart of the trailer connector harness at J560 connector, see **Table 5**. For a connector face view and pinout chart of the trailer connector harness at ISO 3731 connector, see **Table 6**.

Specifications

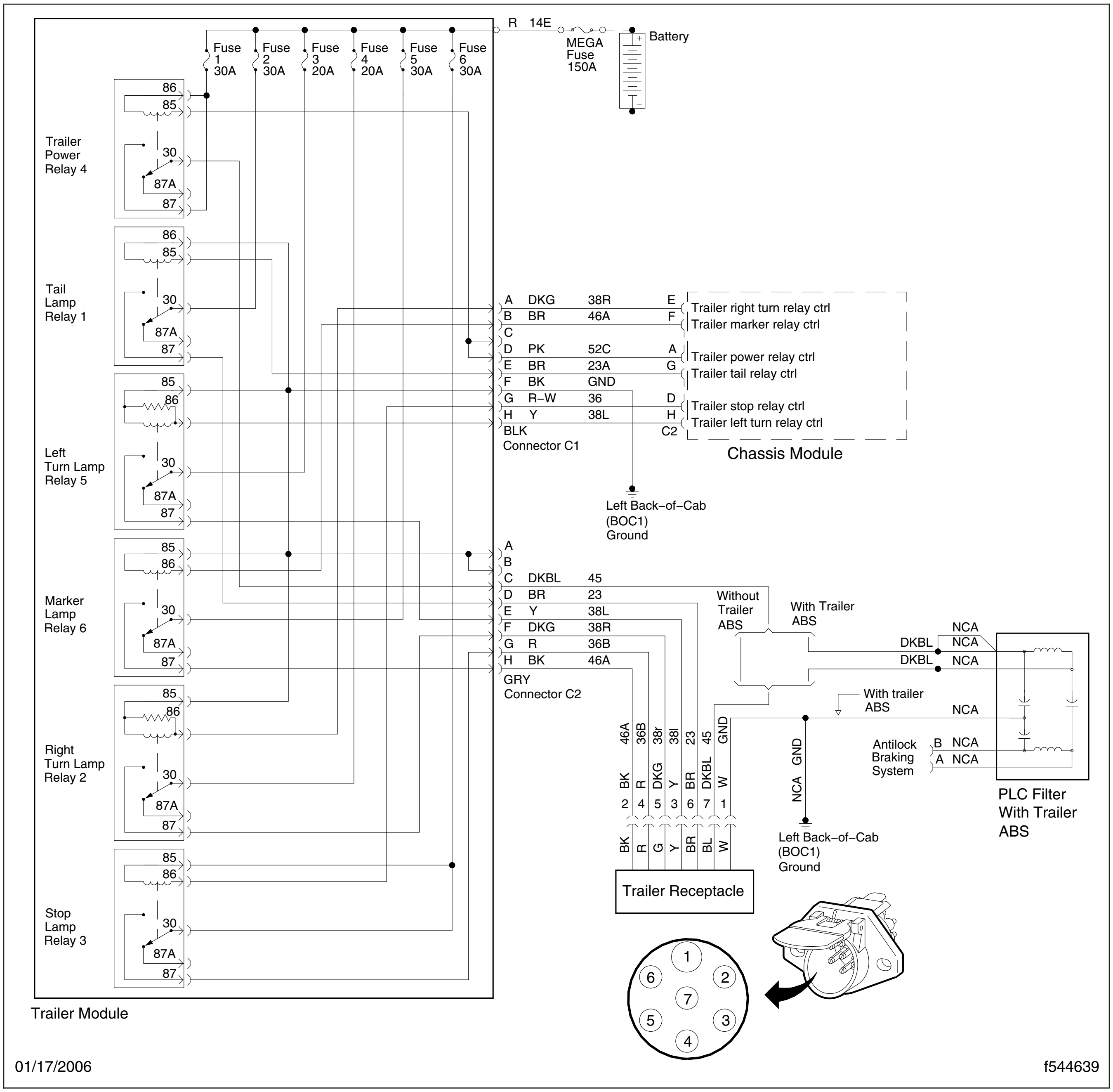


Fig. 1, Wiring Diagram of the Trailer Electrical System With Only a J560 Connector (primary receptacle)

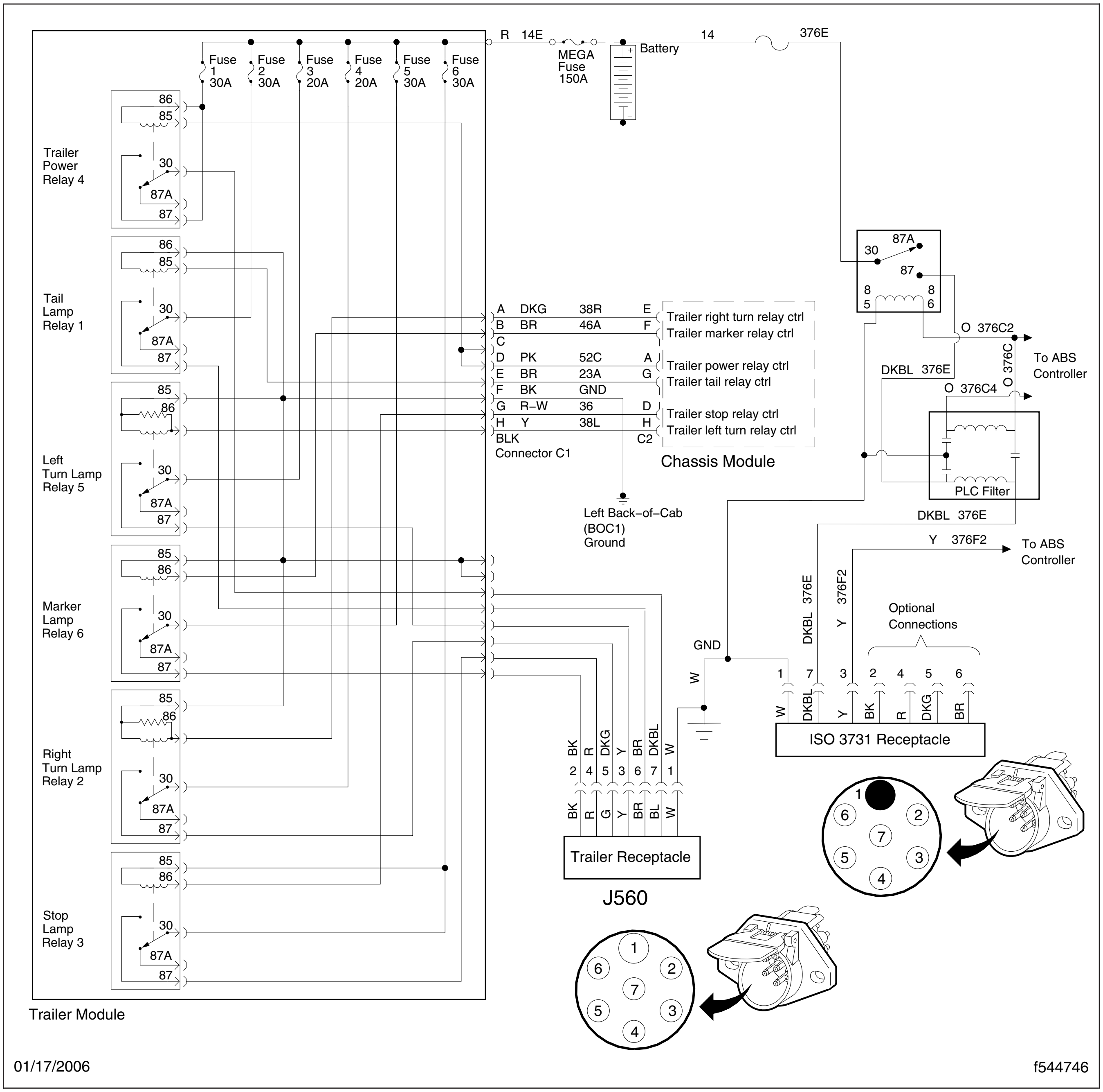
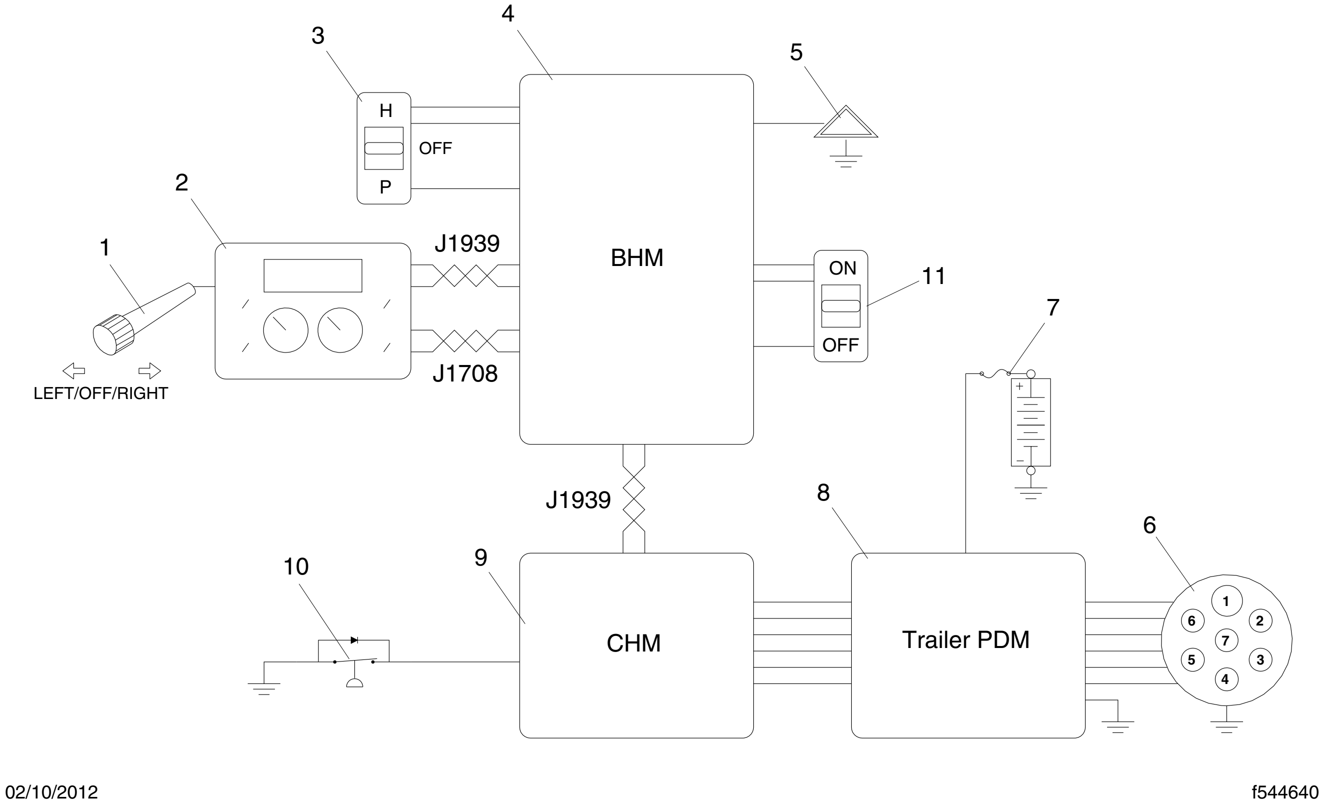


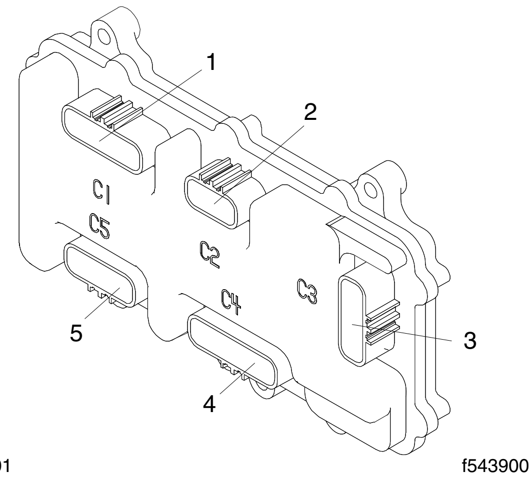
Fig. 2, Wiring Diagram of the Trailer Electrical System With Both J560 and ISO 3731 Connectors (primary and secondary receptacles)

Specifications



1. Multifunction Turn Signal Switch
2. Instrumentation Control Unit
3. Headlight Switch
4. Bulkhead Module
5. Hazard Switch
6. Trailer Connector
7. Battery MEGA® Fuse
8. Trailer Power Distribution Module
9. Full-feature Chassis Module
10. Brake Switch
11. Trailer Connector Center Pin Control Switch (optional parameter dependant)

Fig. 3, Trailer Electrical System I/O Diagram



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

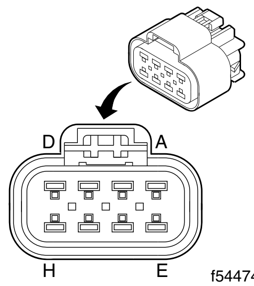
Fig. 4, Chassis Module Connector Identification

Trailer Reference Parameters		
Reference Parameter	**Description**	**Additional Information**
26-01017-000	Without 7-Way Center Pin Ignition Supply	No trailering
26-01017-001	With 7-Way Center Pin Ignition Supply	Provides +12 volts at the center pin (pin 7) of the trailer connector with ignition ON via PDM Fuse 1 (30A) with PDM relay 4 (trailer power) active.
26-01017-002	Switch-controlled 7-Way Center Pin (Smart Sw ID#44)	Provides for a dash switch that turns on/off the center pin power. +12 volts at the center pin (pin 7) of the trailer connector with dash switch ON via PDM Fuse 1 (30A) with PDM relay 4 (trailer power) active.
26-01017-004	Trailer Center Pin ON With Reverse Lights	Non-U.S. option, export feature. Provide reverse output at center pin.

Table 1, Trailer Reference Parameters

Specifications

Trailer Module Harness Pinouts at CHM Connector C2



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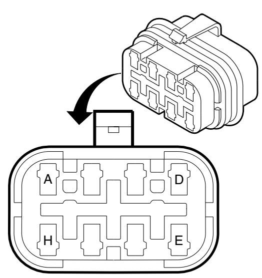
Connector Pin	Signal Name	Signal Type	Circuit Color	Circuit Number
C2-A	Trailer Power Relay Control	Digital Output	PK	52C
C2-B	—	—	—	—
C2-C	—	—	—	—
C2-D	Trailer Stop Light Relay Control Pass-through	Pass-through	R-W	36
C2-E	Trailer Right Turn Light Relay Control	Digital Output	DKG	38RT
C2-F	Trailer Marker Light Relay Control	Digital Output	BR	46A
C2-G	Trailer Taillight Relay Control Pass-through	Pass-through	BR	23A
C2-H	Trailer Left Turn Light Relay Control	Digital Output	Y	38LT

Table 2, Trailer Module Harness Pinouts at CHM Connector C2

Trailer Module Harness Pinouts at PDM Connector C1



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Connector Pin	Signal Name	Signal Type	Circuit Color	Circuit Number
A	Trailer Right Turn Light Relay Control	Digital Input	DKG	38RT
B	Trailer Marker Light Relay Control	Digital Input	BR	46A
C	—	—	—	—
D	Trailer Power Relay Control	Digital Input	PK	52C
E	Trailer Taillight Relay Control	Digital Input	BR	23A
F	Ground	Ground	BK	GND

Trailer Module Harness Pinouts at PDM Connector C1				
Connector Pin	**Signal Name**	**Signal Type**	**Circuit Color**	**Circuit Number**
G	Trailer Stop Light Relay Control	Digital Input	R-W	36
H	Trailer Left Turn Light Relay Control	Digital Input	Y	38LT

Table 3, Trailer Module Harness Pinouts at PDM Connector C1

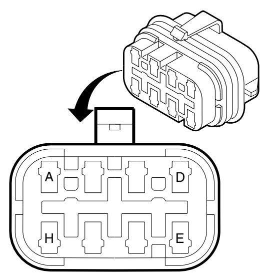
Trailer Connector Harness Pinouts at PDM Connector C2				
Connector Pin	**Signal Name**	**Signal Type**	**Circuit Color**	**Circuit Number**
 f544739				
A	—	—	—	—
B	—	—	—	—
C	Trailer Power Output	+12V via PDM Fuse 1 (30A) with PDM relay 4 (trailer power) active.	DKBL	45
D	Trailer Taillight Output	+12V via PDM Fuse 2 (30A) with PDM relay 1 (taillight) active.	BR	23
E	Trailer Left Turn Light Output	+12V via PDM Fuse 3 (20A) with PDM relay 5 (left turn) active.	Y	38L
F	Trailer Right Turn Light Output	+12V via PDM Fuse 4 (20A) with PDM relay 2 (right turn) active.	DKG	38R
G	Trailer Stop Light Output	+12V via PDM Fuse 6 (30A) with PDM relay 3 (stop light) active.	R	36B
H	Trailer Marker Light Output	+12V via PDM Fuse 5 (30A) with PDM relay 6 (marker light) active.	BK	46A

Table 4, Trailer Connector Harness Pinouts at PDM Connector C2

Specifications

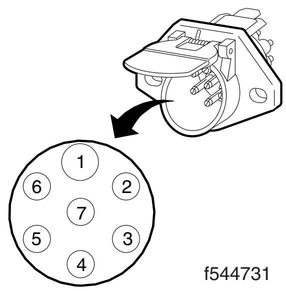
Trailer Connector Harness Pinouts at J560 Connector				
Connector Pin	**Signal Name**	**Signal Type**	**Circuit Color**	**Current Capacity**
				
1	Ground	Ground	W	20A
2	Trailer Marker Light	+12V via PDM Fuse 5 (30A) with PDM relay 6 (marker light) active.	BK	30A
3	Trailer Left Turn Light	+12V via PDM Fuse 3 (20A) with PDM relay 5 (left turn) active.	Y	20A
4	Trailer Stop Light	+12V via PDM Fuse 6 (30A) with PDM relay 3 (stop light) active.	R	30A
5	Trailer Right Turn Light	+12V via PDM Fuse 4 (20A) with PDM relay 2 (right turn) active.	G	20A
6	Trailer Taillight	+12V via PDM Fuse 2 (30A) with PDM relay 1 (taillight) active.	BR	30A
7	Trailer Power	+12V via PDM Fuse 1 (30A) with PDM relay 4 (trailer power) active.	BL	30A

Table 5, Trailer Connector Harness Pinouts at J560 Connector

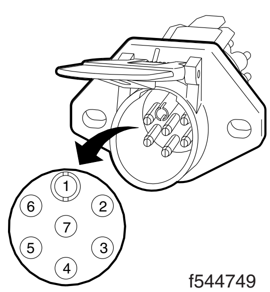
Trailer Connector Harness Pinouts at ISO 3731 Connector				
Connector Pin	**Current**	**Signal Name**	**Signal Type**	**Color**
				
1	30A	Ground	Ground	W
3	0.5A	Trailer ABS Lamp	+12V through relay controlled by tractor ABS	Y
7	20A	Trailer Power	+12V through relay controlled by tractor ABS	DKBL

Table 6, Trailer Connector Harness Pinouts at ISO 3731 Connector

Contents

Introduction

Interior lighting on a Business Class® M2 vehicle includes backlighting and courtesy lighting. Backlighting is the illumination of the instrumentation control unit and most of the switch legends.

The Bulkhead Module (BHM) controls the backlighting using a pulse-width modulated (PWM) signal. Pulse-width modulation is a method of controlling the percentage of time that the DC voltage is enabled. For example, a signal that is 80 percent modulated has the signal on 80 percent of the time, or 0.8 seconds for every second.

Courtesy lighting, or entrance lighting, is interior lighting that is turned on by opening a door on the vehicle. Most courtesy lights can also be turned on manually to provide dome/reading lights; however, there are optional door courtesy lights that only provide entrance lighting.

Backlighting

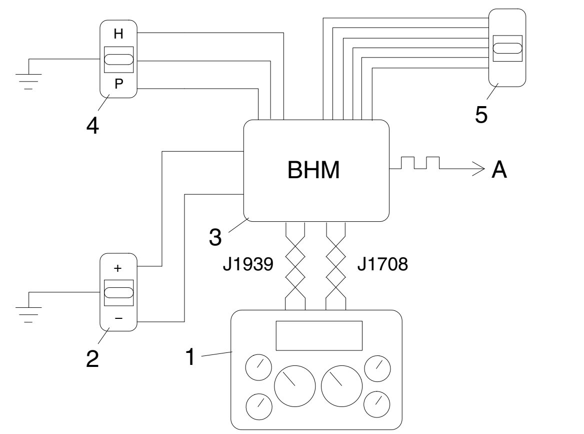
The backlighting function illuminates the dash display and numerous control switches throughout the vehicle cab. Backlighting power is provided to components that include, but are not limited to the:

- instrumentation control unit
- HVAC control panel
- headlight switch
- smart switches
- cruise control switches
- power door lock/window/mirror switches
- transmission dash shifter

Instead of controlling the level of backlighting with a rheostat (the common method for many Freightliner vehicles), the backlighting functionality in the Business Class M2 is controlled by a pulse-width modulated signal from the BHM. Backlighting voltage to the components can vary between 10 and 90 percent of battery voltage.

PWM does not adjust the voltage strength, it controls the percentage of time that the DC voltage is enabled. A multimeter capable of measuring duty cycle will read a voltage of 12 volts (nominal); a multimeter set to the DC range will read a voltage that is less than 12 volts.

The panel light increase/decrease switch is a two-position, momentary switch that controls the intensity of the backlighting. When the driver pushes the upper part of the switch, labeled INCR+, a ground circuit to the BHM is completed, indicating a request to increase the backlighting. When the driver pushes the lower part of the switch, labeled DECR–, a different pin at the BHM is grounded, indicating a request to decrease the backlighting. See **Fig. 1**.



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A. Pulse-width Modulated Signal (illumination feed)

1. Instrumentation Control Unit
2. Dimmer Switch
3. Bulkhead Module
4. Headlight Switch
5. Marker Light Interrupt Switch

Fig. 1, Backlighting Function

Backlighting is active with the headlight switch in either the on or park positions, or if the marker interrupt switch is toggled while the headlight switch is in the off position.

The BHM monitors the backlighting voltage output and is capable of detecting a short circuit when the backlighting output is active. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink®.

Courtesy Lighting

Courtesy lights include:

- dome lights
- reading/map lights

General Information

- door entrance lights
- overhead console lights

The number and location of the courtesy lights varies depending on cab configuration and vehicle options. Courtesy lighting variations range from day cabs with one-switch activation (driver door) of a dome light assembly, to crew cabs with four-switch activation of the dome lights, reading lights, and optional door courtesy lights.

The BHM is capable of detecting shorted circuits in the courtesy lights wiring. Faults discovered by the BHM may be reported on the J1939 and/or J1708 datalinks and may be viewed through ServiceLink.

Dome Lights

Dome lights are installed on all cabs. The basic dome light has a clear lens and is installed above the rear window. On cabs with an overhead console, there is an optional lighting assembly that contains two dome lights and two reading lights. Additional dome lights located in the headliner are available on crew cabs and extended cabs.

A dome light can be turned on by opening a door or pressing the switch on the dome light. There are two separate power circuits coming from the BHM to the dome light assembly. One circuit from pin A of BHM connector B5 has power at all times and is used to turn the light on when the driver presses the switch on the dome light. The other circuit from pin B of BHM connector B5 is powered when a door is opened. See **Fig. 2**.

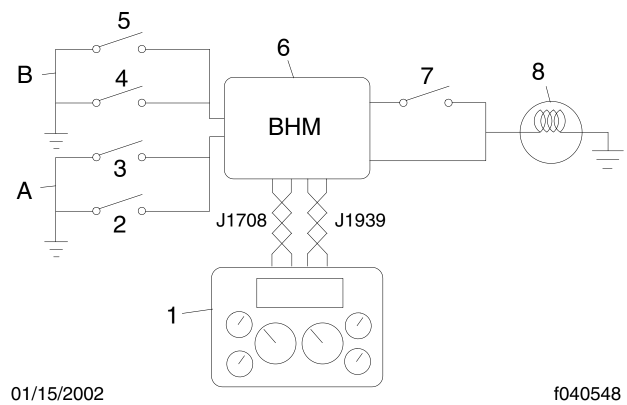
The number and location of door pin switches that activate the dome light(s) vary with cab configuration and vehicle options. On day cabs and extended cabs, the driver door switch is standard and the passenger side door switch is optional. On crew cabs, all four door switches are standard.

Reading/Map Lights

Reading lights are clear lights that are available with:

- The optional lighting assembly on a cab with an overhead console;
- A crew cab that has optional dome/reading light assemblies.

In the overhead console lighting assembly, the reading lights are located on either side of the overhead console next to the dome lights. The reading lights in



A. Passenger Side B. Driver Side

1. Instrumentation Control Unit
2. Rear Door Switch
3. Front Door Switch
4. Rear Door Switch
5. Front Door Switch
6. Bulkhead Module
7. Dome Light Switch
8. Dome Lamp Bulb

Fig. 2, Dome Light Function

this assembly are nonreplaceable light-emitting diode (LED) modules.

Map lights are red lights that are available instead of the clear reading lights in the overhead console.

Door Entrance Lights

Door entrance lights are located on the inner door panels. These lights are only activated when a door is opened and can not be turned on manually. The door entrance lights provide additional interior lighting when getting in and out of the vehicle.

Most cab configurations utilize the dome light output at pin B of BHM connector B5 to activate the door courtesy lights; however, there are a few crew cab configurations where the Chassis Module (CHM) is used to activate the door entrance lights to remove some of the current load from the BHM output. For these configurations, the BHM sends datalink messages to the CHM requesting courtesy light activation. The CHM output at pin C of CHM connector C3 powers the door entrance lights.

Current Capacity

For cab configurations where the BHM powers many courtesy lights, it is necessary to be aware that exceeding the current capacity of a BHM output results in the BHM shutdown of that output. If adding additional interior lights to a vehicle, do not exceed the current capacity of control module output. See **Table 1** for identification of possible courtesy light outputs and the current capacity of those outputs.

Courtesy Light Outputs				
Module	**Pin**	**Connector**	**Function**	**Current Capacity**
BHM	A	B5	Dome lights battery power	6.7A*
BHM	B	B5	Dome lights and optional door courtesy lights switched power	6.7A
CHM	C	C3	Door courtesy lights (unused fog light output)	6.7A†

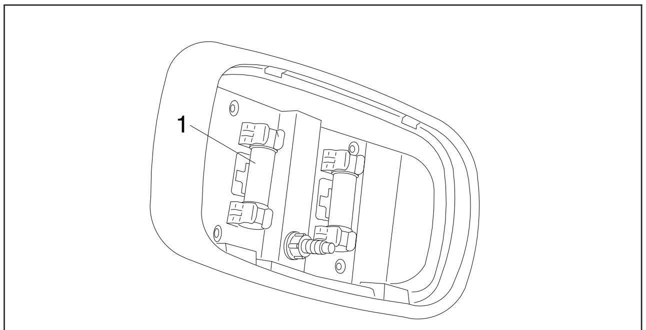
* Pins B5-A and B7-A12 (smart switch battery power) are fed from the same BHM circuit board trace. The maximum combined current capacity for both pins is 6.7A.

† Pins C3-C and C3-D (optional fog light) are fed from the same CHM circuit board trace. The maximum combined current capacity for both pins is 6.7A.

Table 1, Courtesy Light Outputs

Cab Rear Dome Light Bulb Replacement

1. Remove the lens using a flat-blade screwdriver to release the two tabs on the bottom of the lens. Then gently pry the lens from the bottom of the housing.
2. Remove the two bulbs from the lock clips by pulling them straight out. See **Fig. 1**.



1. Bulb

Fig. 1, Cab Rear Dome Light

3. Press new bulbs into the lock clips.
4. Insert the two tabs on the lens into the slots in the top of the housing, then push the bottom of the lens into place, locking the tabs.

Cab Rear Dome Light Assembly Replacement

1. Remove the lens using a flat-blade screwdriver to release the two tabs on the bottom of the lens. Then gently pry the lens from the bottom of the housing.
2. Insert the screwdriver into the lower slots in the housing to release the two spring clips, then remove the assembly from the headliner.
3. Disconnect the electrical connector.
4. Connect the electrical connector of the new assembly.
5. Align the tabs on the top edge of the new assembly and press the lower edge of the assembly into place until the locking tabs click into place.

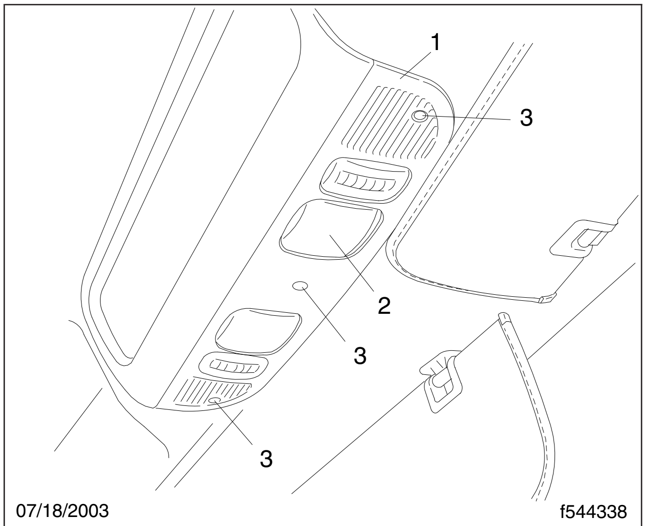
Overhead Console Map/ Reading Light Assembly Bulb Replacement

NOTE: The bulbs are replaceable in the inner larger lights only. The smaller lights use nonreplaceable LEDs.

1. Using a flat-blade screwdriver, release the tab by pushing on the edge of the lens that is indented. Then gently pry the lens from the housing.
2. Remove the bulb from the lock clip by pulling it straight out.
3. Press a new bulb into the lock clip.
4. Insert the tab on the lens into the slots in the housing, then push the lens into place, locking the tabs.

Overhead Console Map/ Reading Light Assembly Replacement

1. Remove the three Torx® capscrews that hold the center overhead panel in place. See **Fig. 2**.



1. Center Overhead Panel
2. Reading Light With Replaceable Bulb
3. Torx Capscrew

Fig. 2, Overhead Panel With Map/Reading Lights

Interior Lights Replacement

2. Lower the assembly and disconnect the connector to the light assembly.
3. Remove the four capscrews that attach the light assembly to the panel, and remove the light assembly.
4. Using capscrews, install a new light assembly on the panel.
5. Connect the connector to the light assembly.
6. Using capscrews, install the center overhead panel.

IMPORTANT: ServiceLink® is the diagnostic tool for troubleshooting the M2 electrical system. For specific circuit and pin information on how the vehicle is wired, go to the Configuration screen in ServiceLink and select the specific function in which you are interested. To troubleshoot specific inputs and outputs of this system, go to the Templates screen in ServiceLink and select the template for the function in which you are interested.

Backlighting

Input and Output Conditions

See **Table 1** for the Bulkhead Module (BHM) responses to the backlighting input/output conditions.

Fault Conditions

See **Table 2** for the backlighting conditions that will create a fault. The reference parameters that program the BHM determine whether or not a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted. If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on the J1939 and/or the J1708 datalinks until both the headlight switch and the marker interrupt switch are turned off.

Dome Light Fault Conditions

See **Table 3** for the dome light conditions that will create a fault. The reference parameters that program the BHM determine whether or not a fault code is broadcast. Therefore, even if the BHM detects a fault, a fault code may not be transmitted. If the BHM is programmed to transmit fault codes, they can be viewed through ServiceLink. Fault messages may be transmitted on the J1939 and/or the J1708 datalinks until the ignition switch is turned off.

Backlighting Input/Output Conditions				
Inputs to BHM		Outputs from BHM		
Headlight Switch	Marker Interrupt Switch	Backlight Status	Illumination	Percent Battery Voltage Output
On/Park	Off	On	Dependent on dimmer switch position (range dim to bright).	Dependent on dimmer switch position (range 10 to 90%).
Off	On	On	Bright	100%
On/Park	On	Off	Off	0%
Off	Off	Off	Off	0%

Table 1, Backlighting Input/Output Conditions

Backlighting Fault Conditions		
Failed Component or Circuit	Description of Fault	Action Taken by BHM
Backlight dimmer switch	BHM sees panel light increase and panel light decrease simultaneously.	BHM may transmit a J1939 and/or a J1708 fault message.
Headlight switch	Headlight switch is in error.	BHM will assume the headlight switch is on.
Marker interrupt switch	Marker interrupt switch is in error.	BHM will assume the marker interrupt switch is off and may transmit a fault message on the J1939 and/or J1708 datalinks.

Troubleshooting

Backlighting Fault Conditions		
Failed Component or Circuit	**Description of Fault**	**Action Taken by BHM**
Backlighting power output	Backlighting power wiring is shorted.	BHM may transmit a J1939 and/or a J1708 fault message.

Table 2, Backlighting Fault Conditions

Dome Light Fault Conditions	
Description of Fault	**Action Taken by BHM**
Dome light power (hot at all times) wiring is shorted.	BHM may transmit a J1939 and/or a J1708 fault message.
Dome light switched (hot with door switch closed) wiring is shorted.	BHM may transmit a J1939 and/or a J1708 fault message.

Table 3, Dome Light Fault Conditions

Wiring Diagrams

IMPORTANT: The following wiring diagrams show typical interior lighting configurations available for a Business Class® M2 vehicle. The circuit details shown may not correspond to every vehicle. ServiceLink® is the diagnostic tool for troubleshooting the M2 electrical system. For specific circuit and pin information on how the vehicle is wired, go to the Configuration screen in ServiceLink and select the specific function in which you are interested. To troubleshoot specific inputs and outputs of this system, go to the Templates screen in ServiceLink and select the template for the function in which you are interested.

Backlighting

See **Fig. 1** and **Fig. 2** for backlighting wiring diagrams showing dimmer controls and instrument illumination.

Courtesy Lights

The number and location of courtesy lights are dependent on the vehicle configuration and vehicle options.

Day Cabs and Extended Cabs

See **Fig. 3** for a wiring diagram of the courtesy lights for a cab with a single rear dome light.

See **Fig. 4** for a wiring diagram of the courtesy lights for a cab with the optional lighting assembly in the overhead console.

Crew Cabs

Courtesy light door switches are standard on a crew cab. The courtesy lights are activated by opening any of the four vehicle doors. See **Fig. 5** for a wiring diagram of the door switches.

There are many interior lighting configurations available for crew cab vehicles. The Bulkhead Module (BHM) outputs that drive the interior lights have a limited load capacity. As supplied interior lighting increases, sometimes it is necessary to feed the door courtesy lights from an unused Chassis Module (CHM) output to prevent BHM output overload.

Typical examples of crew cab courtesy light configurations include:

- Two dome lights and optional door entrance lights. See **Fig. 6**.
- An overhead console, four dome lights, and optional front door entrance lights. See **Fig. 7**.
- An overhead console, four dome lights, and CHM-controlled door entrance lights. See **Fig. 8**.

Specifications

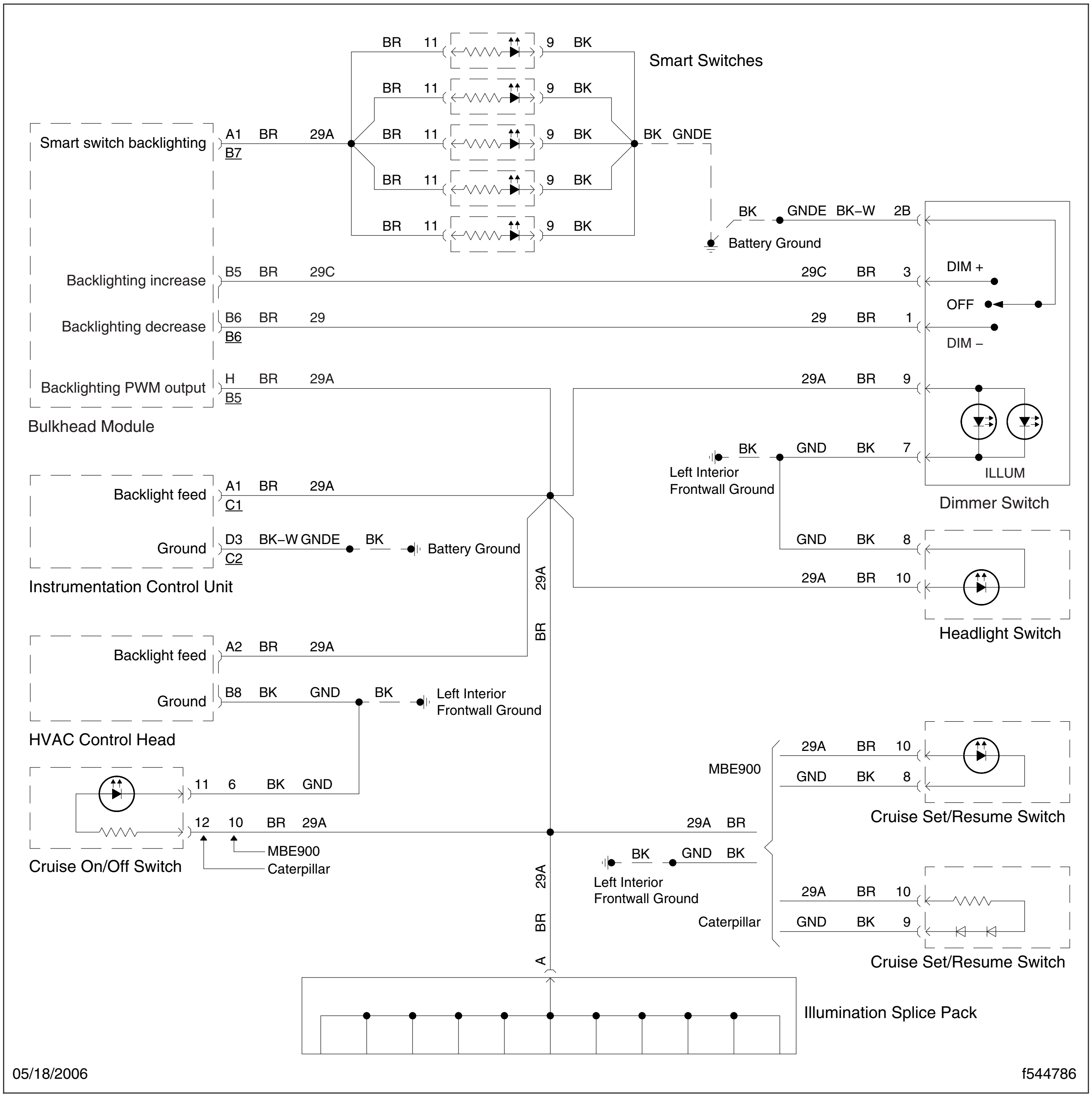


Fig. 1, Backlighting Dimmer Controls

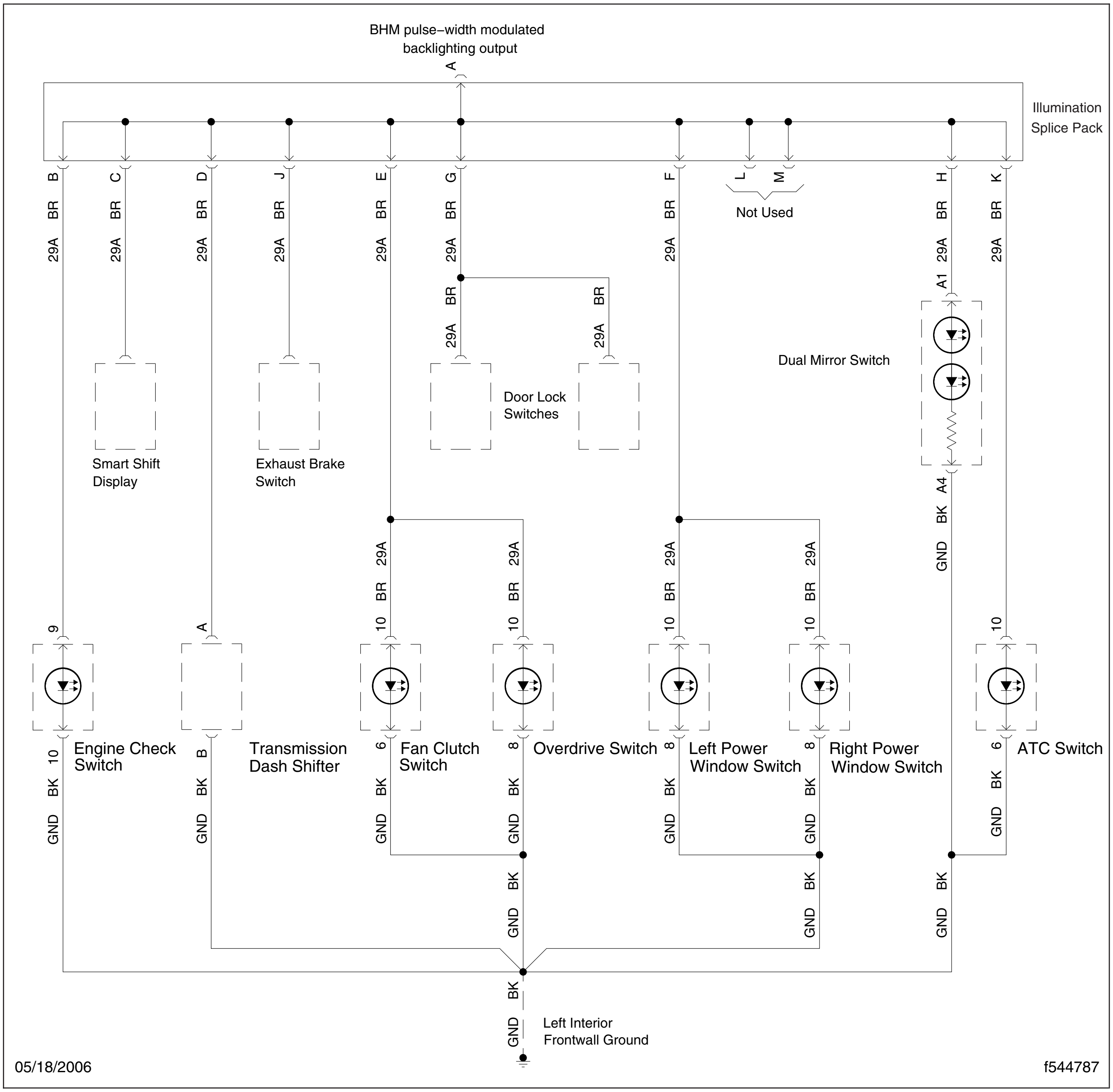


Fig. 2, Backlighting

Specifications

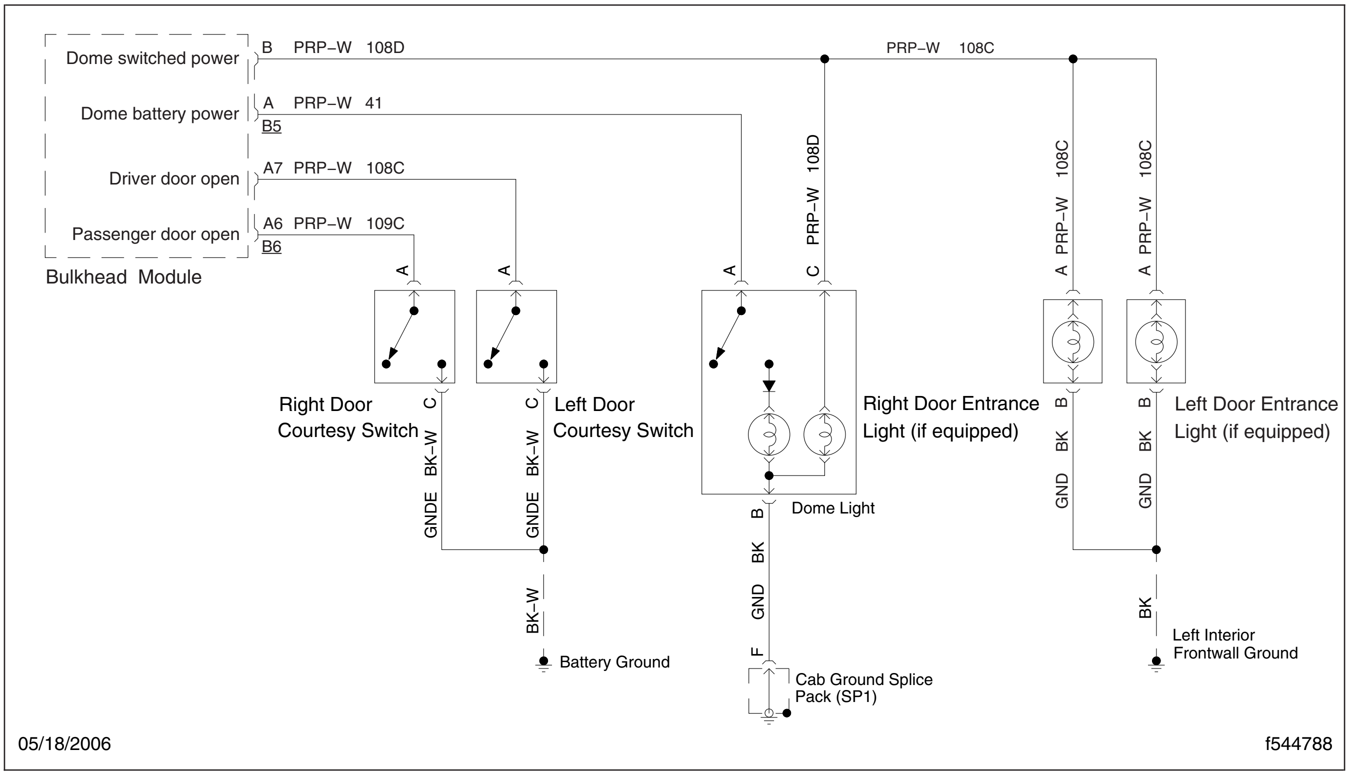


Fig. 3, Single Rear Dome Light

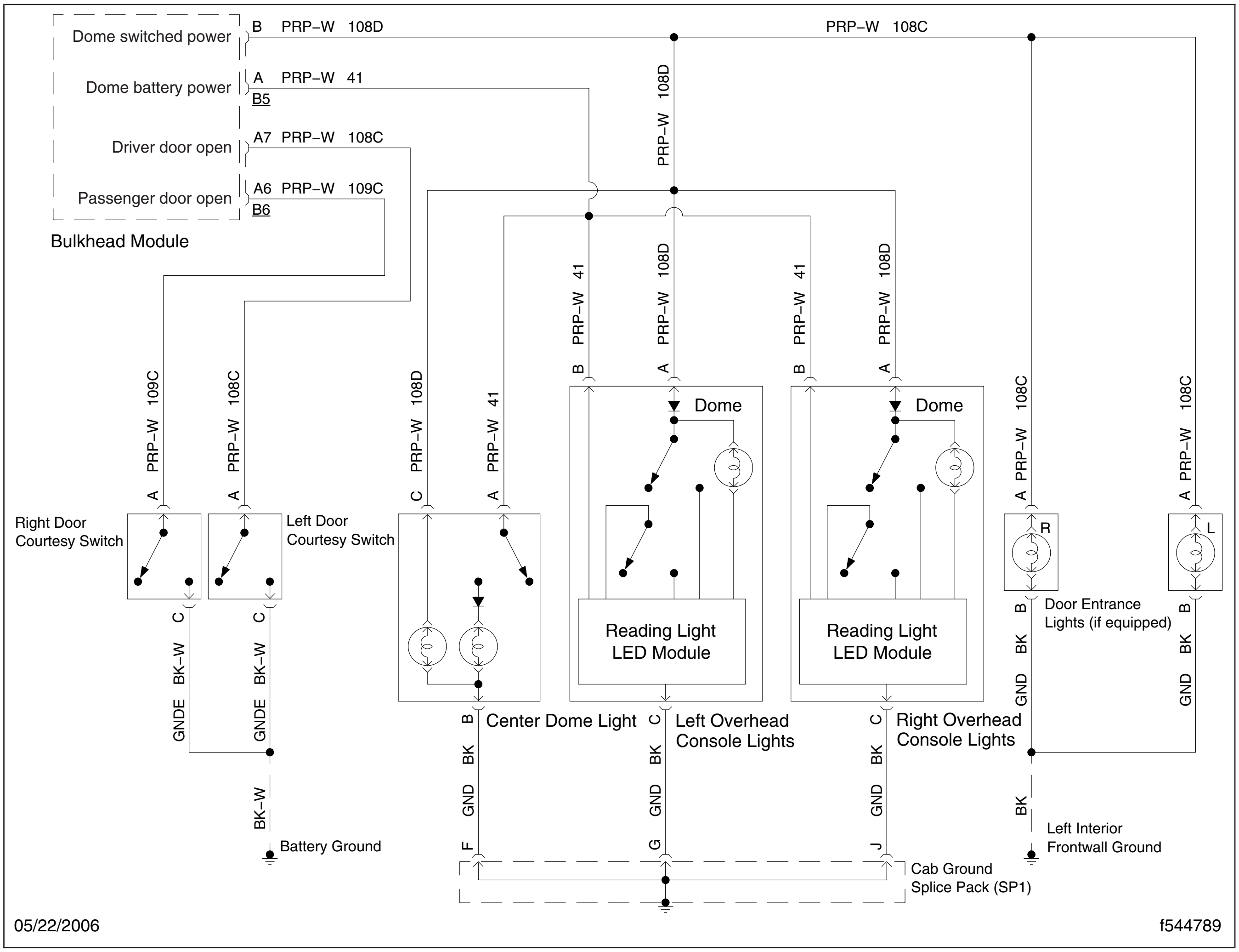


Fig. 4, Overhead Console

Specifications

Fig. 5, Crew Cab Door Switches

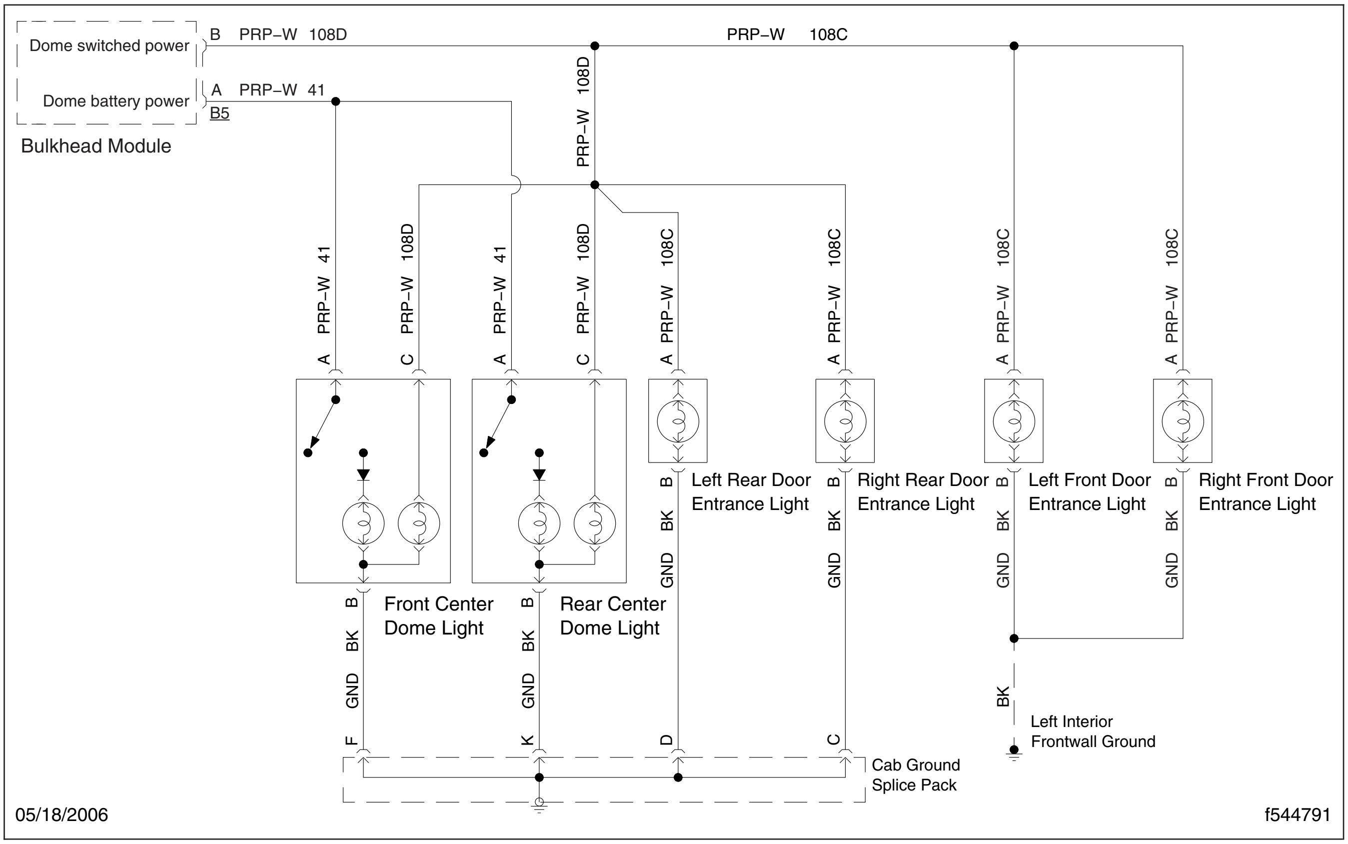


Fig. 6, Two Dome Lights

Specifications

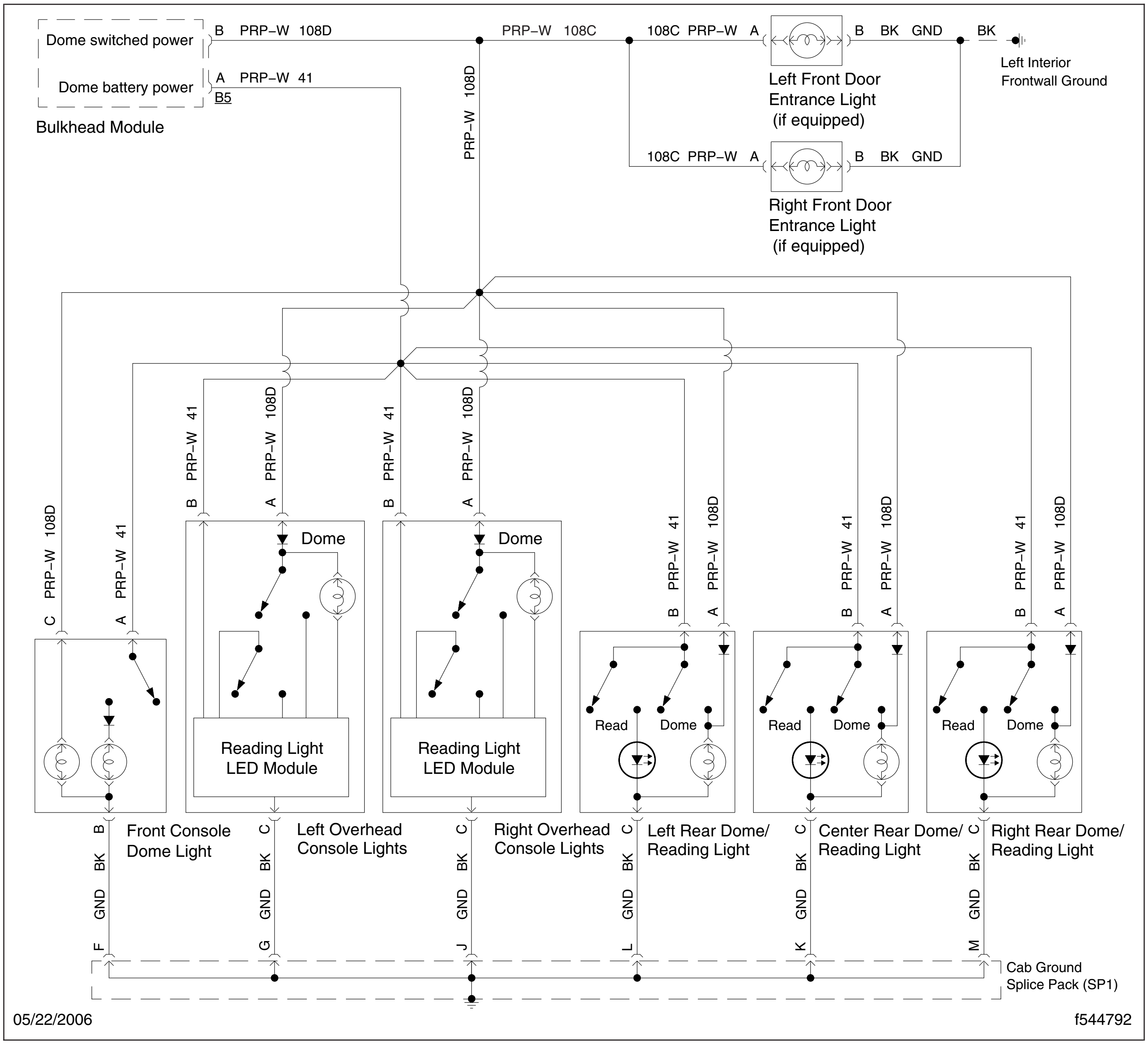


Fig. 7, Six Dome Lights with Optional Front Entrance Lights

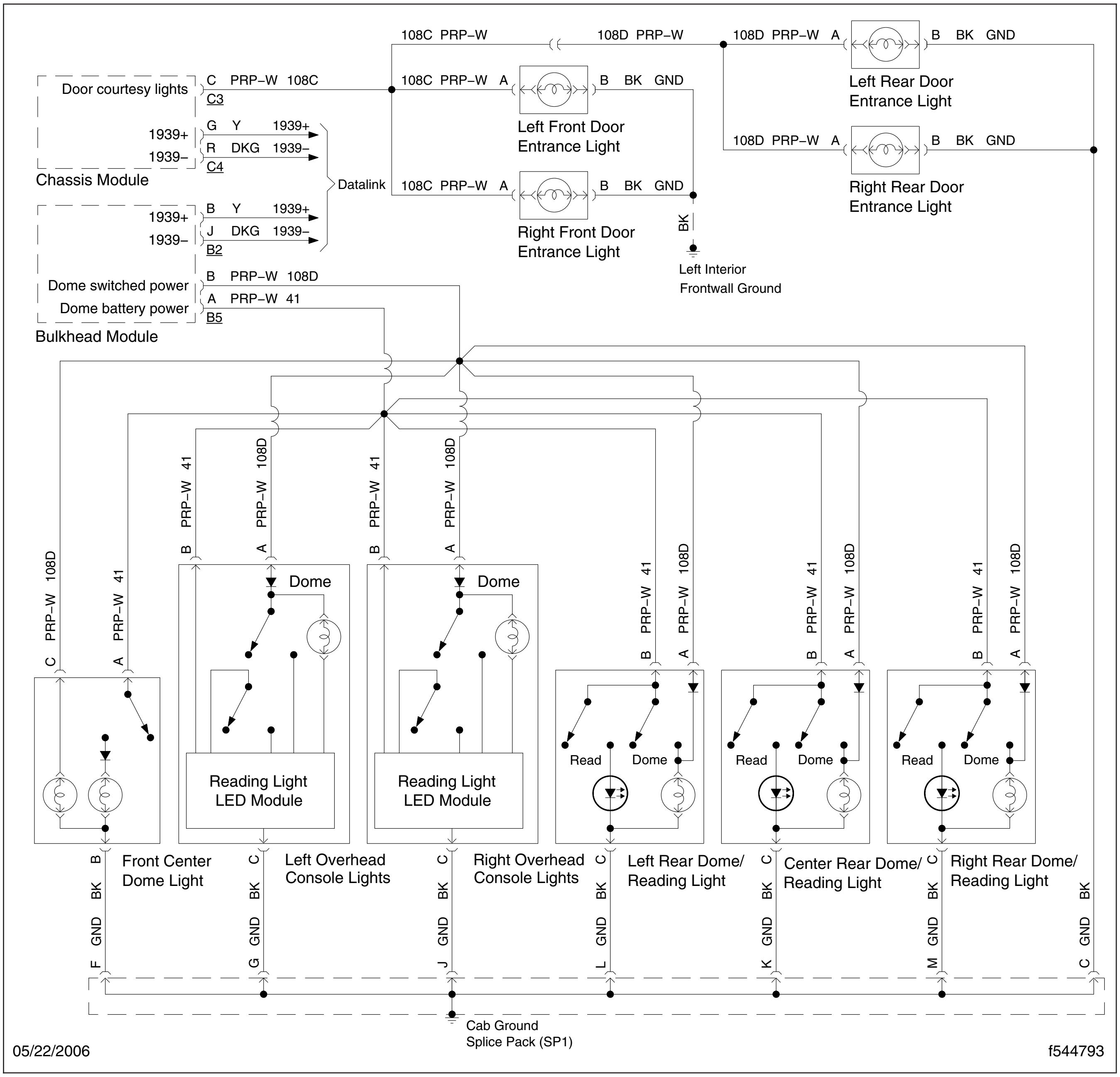


Fig. 8, Six Dome Lights with Four Entrance Lights

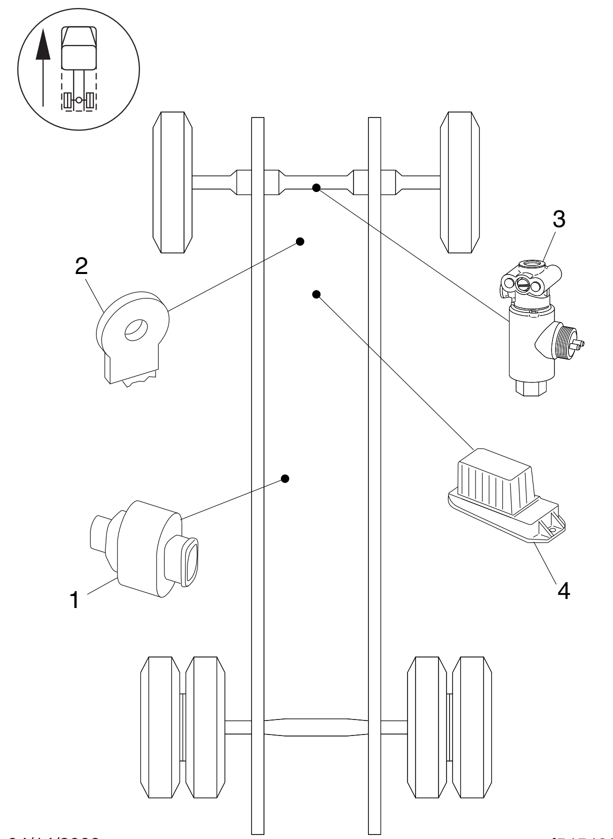
Contents

General Information

The Roll Stability Control (RSC) system is an electronic system that passively monitors wheel speed and lateral acceleration. The system controls drive axle and trailer axle braking while decreasing engine torque and applying engine retarder (if equipped) in emergency roll over situations. As a result, the driver has full control over the vehicle until the ABS Electronic Control Unit (ECU) detects a potential rollover, and intervenes accordingly.

When active, tractor rear brakes are applied using the ATC solenoid valve while the trailer brakes are applied by the RSC solenoid valve. This is the same process used for the ATC, that is connected between the pneumatic brake system foot valve and the rear relay brake valve. The RSC valve is connected between the foot valve and the tractor protection valve. In normal operation, the roll stability control valve is inactive and allows control of the trailer brakes from the foot valve. If a rollover is about to occur, the valve opens the air supply from the secondary air tank to the tractor protection valve, that activates the trailer brakes. See **Fig. 1**.

The Electronic Stability Control (ESC) system is an RSC system that offers the additional capability of complete directional stability (yaw control) in oversteer and understeer conditions, such as the ability to reduce the likelihood of drift-out or jackknife. The ESC system includes an additional solenoid valve for front axle braking, a brake pressure sensor, a Steering Angle Sensor (SAS), and an Electronic Stability Control ECU (ESC module) with an integrated yaw rate sensor. The additional sensors allow the ECU to determine where the driver is attempting to steer the vehicle and how much brake demand is required in order to more precisely control the vehicle in an emergency situation. The additional front solenoid valve allows for individual wheel braking on the steering axle to provide yaw control.



1. Brake Demand Pressure Sensor
2. Steering Angle Sensor
3. Front Axle Solenoid Valve
4. ESC Module

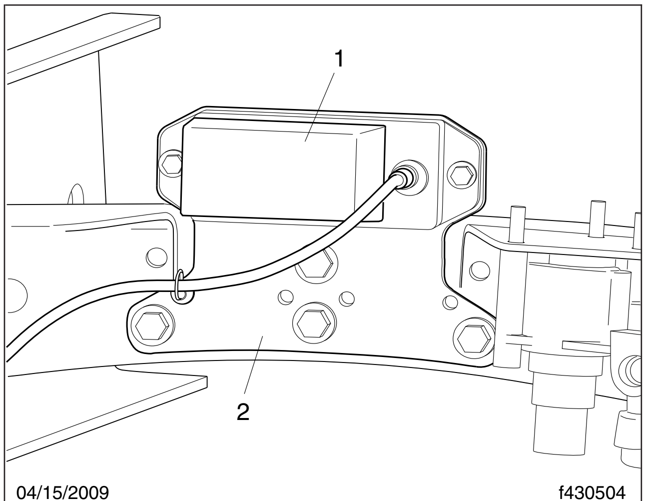
Fig. 1, Electronic Stability Control Components

Electronic Stability Control Module

The ECU is mounted under the cab on the crossmember located behind the transmission. See **Fig. 2** and **Fig. 3**.

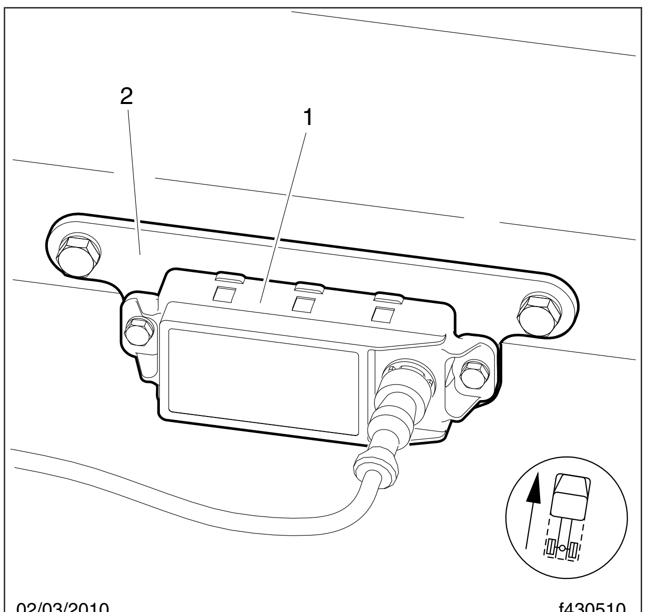
The ESC module has two sensors: an accelerometer and a yaw rate sensor. An accelerometer is used to measure lateral acceleration. During cornering, lateral acceleration causes a force directed at the vehicles center of gravity, and if high enough, can cause a vehicle to roll. The yaw rate sensor provides rotational sensing that can be used to detect and help prevent vehicle spinout or jackknife. The ESC module has one 4-pin connector that is used to communicate with the ABS ECU.

General Information



1. ESC Module
2. Mounting Bracket

Fig. 2, Electronic Stability Control Module, Extended Cab Mounting



1. ESC Module
2. Mounting Bracket

Fig. 3, Electronic Stability Control Module, Day Cab Mounting

ESC Module Removal and Installation

Removal

1. Shut down the engine and chock the tires.
2. Disconnect the electrical connector.
    2.1 Turn the collar on the connector counter-clockwise until it stops.
    2.2 Disconnect the connector.
3. Remove the two screws from each side of the ESC module.
4. Remove the ESC module.

Installation

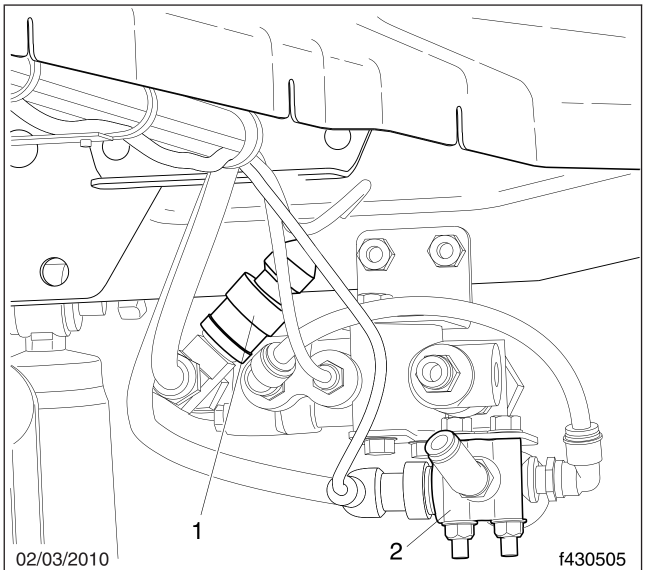
1. Position the ESC module on the crossmember and install two screws and nuts. Tighten the screws 16 lbf·ft (22 N·m).
2. Connect the electrical connector.
3. Initialize the new ESC module. Refer to the Meritor WABCO End of Line (EOL) procedure for the initialization process. The procedure can be found in the latest version of the Meritor WABCO Maintenance Manual (MM-0112). This document is available at the **Meritor WABCO website**.

NOTE: For complete instructions for using TOOLBOX software, refer to the ArvinMeritor "TOOLBOX User's Manual, TP-99102."

RSC Valve Removal and Installation

Removal

1. Shut down the engine and chock the tires.
2. Release the pressure from the air reservoirs.
3. Disconnect the electrical connector from the roll stability control (RSC) valve. See **Fig. 1**.



1. Brake Demand Pressure Sensor
2. Roll Stability Control Valve

Fig. 1, Pressure Sensor (mounted on trailer protection valve)

   3.1 Turn the collar on the connector counterclockwise until it stops.

   3.2 Disconnect the connector.

4. Disconnect the air lines.
5. Remove the two mounting screws and nuts.
6. Remove the RSC valve.

Installation

1. Position the RSC valve on the crossmember and install two mounting screws and nuts. Tighten the screws 13 lbf·ft (18 N·m).
2. Connect the air lines.
3. Connect the electrical connector to the RSC valve. Hand-tighten only.
4. Verify operation of the RSC valve.

   4.1 Connect the blue gladhand to a 50 cubic inch (819 cubic cm) air tank.

   4.2 Start the vehicle and allow the air reservoirs to fully charge.

   4.3 Shut down the engine.

   4.4 Turn the ignition to ON. Verify that the ATC/RSC/ESC indicator lamp operates correctly.

   4.5 Activate the RSC valve using the Meritor WABCO PC Diagnostics tool, TOOLBOX.

   4.6 Check for air leaks at the RSC valve. If the RSC valve leaks, make the necessary repairs.

   4.7 If the RSC valve fails to cycle, turn off the ignition and make sure the electrical connections are tight. Turn the ignition switch on and check the valve again. If the RSC valve still fails to cycle, check for fault codes.

Front Solenoid Valve Removal and Installation

Removal

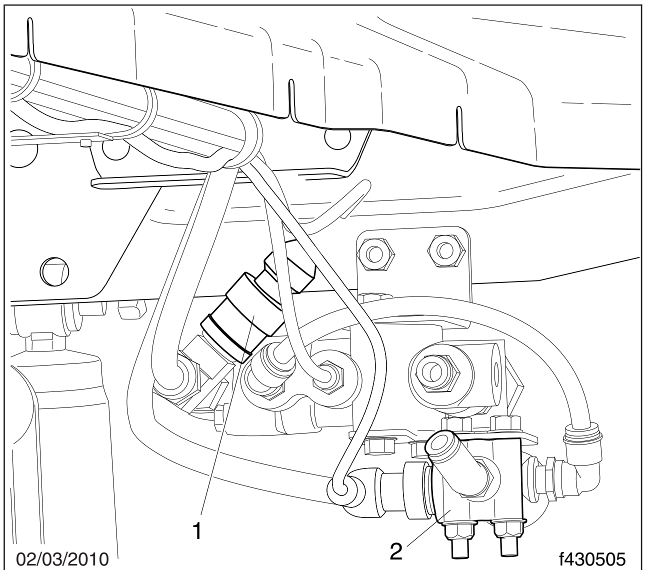
1. Shut down the engine and chock the tires.
2. Release the pressure from the air reservoirs.
3. Disconnect the electrical connector from the front solenoid valve.
   - 3.1 Turn the collar on the connector counterclockwise until it stops.
   - 3.2 Disconnect the connector.
4. Disconnect the air lines.
5. Remove the two mounting screws and nuts.
6. Remove the front solenoid valve.

Installation

1. Mount the new solenoid valve and install the two screws and nuts. Tighten the nuts to 8 lbf·ft (11 N·m).
2. Connect the air lines to the front solenoid valve.
3. Connect the electrical connector to the front solenoid valve. Hand-tighten only.
4. Verify the operation of the solenoid valve.
   - 4.1 Start the vehicle and allow the air reservoirs to fully charge.
   - 4.2 Shut down the engine.
   - 4.3 Apply the brakes and check for air leaks at the front solenoid valve.
   - 4.4 Turn the ignition to ON. Verify that the ATC/RSC/ESC indicator lamp operates correctly.
   - 4.5 Activate the front solenoid valve using the Meritor WABCO PC Diagnostics tool, TOOLBOX.
   - 4.6 Check for air leaks at the front solenoid valve. If valve leaks, make necessary repairs.
   - 4.7 If front solenoid valve fails to cycle, turn off the ignition and make sure the electrical connections are tight. Then, turn the ignition switch on and check the valve again. If the front solenoid valve still fails to cycle, check for fault codes.

Removal

1. Shut down the engine and chock the tires.
2. Release the pressure from the air reservoirs.
3. Disconnect the wiring from the pressure sensor. See **Fig. 1**.



1. Brake Demand Pressure Sensor
2. Roll Stability Control Valve

Fig. 1, Pressure Sensor

   3.1 Turn the flange on the connector counterclockwise until it stops.

   3.2 Disconnect the connector.

4. Disconnect the pressure sensor.

Installation

1. Install the new air pressure sensor. Make sure that the pressure sensor is secured; the connector end should be higher than the threaded end to prevent freezing water from disabling the sensor.
2. Connect the electrical connector to the pressure sensor. Hand-tighten only.
3. Verify operation of the pressure sensor.

   3.1 Connect the blue gladhand to a 50 cubic inch (819 cubic cm) air tank.

   3.2 Start the engine and allow the air reservoirs to fully charge.

   3.3 Shut down the engine.

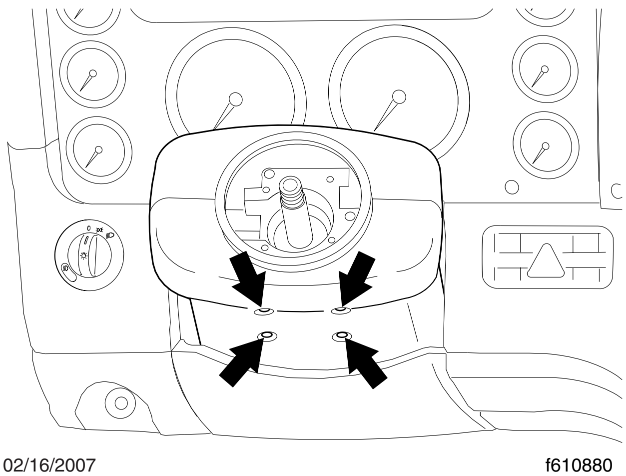
   3.4 Apply the brakes and check the pressure sensor fitting for leaks.

   3.5 Test drive the vehicle to verify that the ATC/RSC/ESC indicator lamp operates correctly.

Steering Angle Sensor Removal and Installation

Removal

1. Shut down the engine and chock the tires.
2. Remove the knee bolster panel, located below the steering column. Remove the four fasteners. See Fig. 1.



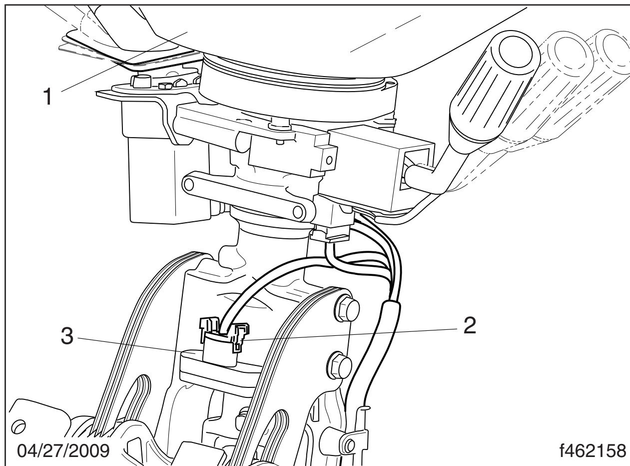
A. Steering wheel not shown for clarity.

Fig. 1, Lower Steering Column Cover Fasteners

3. Remove the steering column.
   - 3.1 Remove the pinch bolt and nut from the upper end yoke on the steering column shaft. Discard the pinch bolt and nut.
   - 3.2 Slide the upper-end yoke off the splines on steering column shaft.
4. Remove the 7-pin connector from the steering angle sensor. See Fig. 2.
5. Remove the 3 screws (two upper, one lower) holding the steering angle sensor to the steering column. See Fig. 3. Discard the 3 T20 screws and remove the steering angle sensor.

Installation

1. Apply a small amount of grease to the tab in the middle of the steering angle sensor opening, and to the groove of the steering shaft.
2. Place the new steering angle sensor on the steering shaft, making sure to align the guide pin on the steering angle sensor into the grooved slot on the steering shaft. Make sure the steering angle sensor is facing the same direction as originally installed.

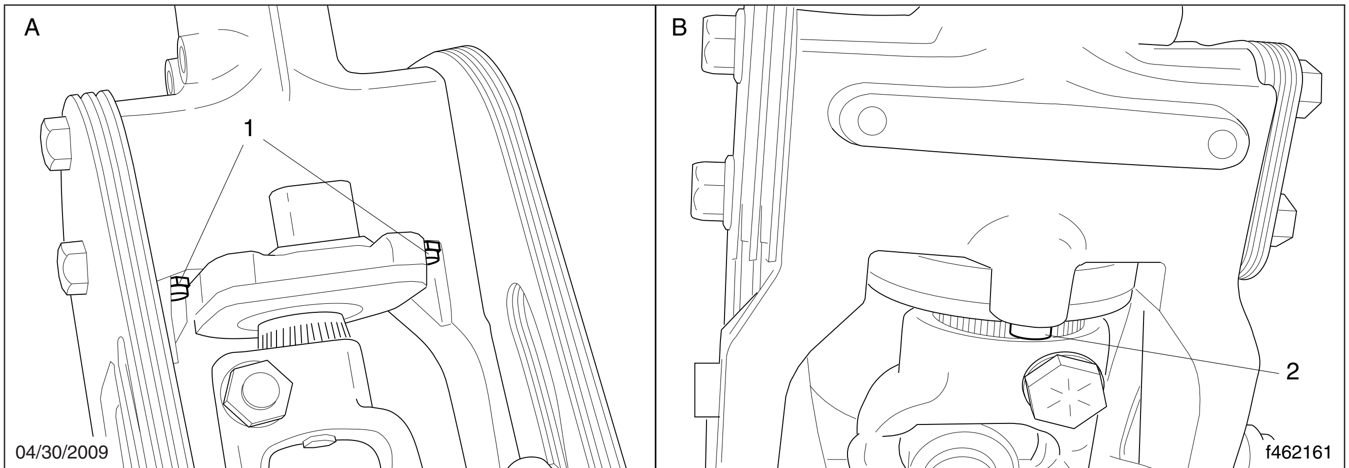


1. Steering Column
2. 7-Pin Connector
3. Steering Angle Sensor

Fig. 2, Steering Column Assenmbly

3. Secure the steering angle sensor onto the steering column using three new T20 screws.
4. Using a new pinch bolt and nut, attach the upper end yoke to the steering column shaft. Tighten the bolt 30 to 35 lbf·ft (41 to 47 N·m).
5. Connect the 7-pin connector onto the new steering angle sensor.
6. Install the steering column.
   - 6.1 Slide the upper-end yoke on to the splines on steering column shaft.
   - 6.2 Install the pinch bolt and nut on the upper end yoke on the steering column shaft.
7. Install the knee bolster. Tighten the four screws 26 to 34 lbf·in (295 to 385 N·cm).
8. Install the steering column upper and lower covers. Tighten the screws 26 to 34 lbf·in (295 to 385 N·cm).
9. Initialize the ESC module. Refer to the Meritor WABCO End of Line (EOL) procedure for the initialization process. In addition, when the steering angle sensor is replaced, it is important that the sensor is re-calibrated. These procedures can be found in the latest version of the Meritor

Steering Angle Sensor Removal and Installation



A. Steering Angle Sensor, Front
B. Steering Angle Sensor, Back

1. Upper Mounting Screws
2. Lower Mounting Screw

Fig. 3, Steering Angle Sensor

WABCO Maintenance Manual (MM-0112). This document is available at the **Meritor WABCO website**.

NOTE: For complete instructions for using TOOLBOX software, refer to the ArvinMeritor "TOOLBOX User's Manual, TP-99102."

Solenoid Valve Tests

1. **Test the voltage on the affected solenoid valve connector.**
   1.1 Disconnect the 4-pin connector from the solenoid valve.
   1.2 Switch the ignition to the ON position
   1.3 Measure the voltage between all pins in the solenoid connector and a good ground.

   Is voltage present on any pin?

   YES → Check the wiring for a short to power. Repair as necessary.

   NO → Go to test 2.
2. **Measure the voltage between all pins in the solenoid connector and +12V power.**

   Is voltage present on any pin?

   YES → The wire shorted to ground. Repair as necessary.

   NO → Go to test 3.
3. **Measure the resistance between pins 1 and 2 on the solenoid valve.**

   Is the resistance between 7 and 14 ohms?

   YES → Go to test 4.

   NO → Clean the electrical contacts on the solenoid and test again. If the resistance is still not correct, replace the solenoid valve.
4. **Measure the resistance of the solenoid valve through the wiring to the ABS ECU.**

   Is the resistance between 7 and 14 ohms?

   YES → Check for other electrical faults. The ABS ECU or the solenoid valve may be faulty.

   NO → Clean the electrical contacts and check wiring between the ABS ECU and solenoid valve. Repair as necessary. If the resistance is still not correct, replace the solenoid valve.

Fault Codes

Fault Codes						
MID	**SID**	**FMI**	**Fault Description**	**Test**	**Result**	**Action**
136	88	1	ESC – Initialization Not Complete	—	—	Important: Refer to Meritor WABCO's End of Line (EOL) procedure for the initialization process. This procedure can be found in Meritor WABCO's Maintenance Manual MM-0112. This document is available through Meritor WABCO or their website.
136	88	2	ESC – System Configuration	—	—	The ESC module is not compatible with the ABS ECU. Contact OEM or Meritor WABCO for ECU combinations.

Troubleshooting

Fault Codes						
MID	**SID**	**FMI**	**Fault Description**	**Test**	**Result**	**Action**
136	88	5	ESC – CAN Datalink Loss	Remove the 4-pin connector from the ESC Module. Turn the ignition ON. Measure the voltage between pins 1 and 2 of the 4-pin connector.	Voltage	Verify fault. Check ESC Module wiring for intermittent connection. Check for open connection on ESC Module and insure it is tight and clear of debris/corrosion. Repair as necessary. If fault persists, ESC module or ABS ECU may be faulty.
					No Voltage.	Check wiring in circuit 376A from ESC Module to ABS ECU unit. Repair as necessary.
136	88	9	ESC – CAN Datalink Incorrect or Missing	Remove the 4-pin connector from the ESC Module. Measure the resistance between pins 3 and 4 on the 4-pin connector.	Resistance is approximately 90 ohms.	Verify fault. Check ESC Module wiring for intermitent connection and insure it is tight and clear of debris/corrosion. Repair as necessary. Measure the resistance from the ABS ECU X4 18-pin connector and insure approximate 90 ohms is measured. If fault persists, ESC module or ABS ECU may be faulty.
					Resistance is much less or much greater than 90 ohms.	Check wiring between the ESC Module and ABS ECU. Repair as necessary. If fault persists, the ESC Module or ABS ECU may be faulty.
136	88	12	ESC – Internal Fault	Check the ESC Module and its mounting location. Verify that the ESC module is mounted horizontally and properly secured to the cross member. Check the 4-pin connector on the ESC Module and insure it is tight and clear of debris and corrosion. Check the wiring between the ESC module and the ABS ECU.	—	Verify fault. Clear code from ECU memory. Check for other fault codes that may have occurred with this fault, as this could indicate faulty wiring or poor connection at ESC module. If fault persists, the ESC module may be faulty.

Fault Codes						
MID	**SID**	**FMI**	**Fault Description**	**Test**	**Result**	**Action**
136	88	13	ESC – Initialization Required	—	—	Important: Refer to Meritor WABCO's End of Line (EOL) procedure for the initialization process. This procedure can be found in Meritor WABCO's Maintenance Manual MM-0112. This document is available through Meritor WABCO or their website.
136	88	14	ESC – Module Mounting Fault	Check the ESC Module and its mounting location. Verify the ESC module is mounted horizontally and properly secured to the crossmember. Check the 4-pin connector on the ESC Module and insure it is tight and clear of debris and corrosion. Check wiring between the ESC module and the ABS ECU.	—	Verify fault. Clear code from ECU memory. If fault persists, the ESC module may be faulty.
136	89	1, 2, 7 or 8	SAS – Steering Angle Sensor various faults	—	—	Visually check the installation of the steering sensor and mount to ensure it is properly seated. If any vehicle work related to the steering system has been performed, the SAS must be calibrated and the ESC module initialized. Refer to Meritor WABCO's End of Line (EOL) procedure for the initialization process. This procedure can be found in Meritor WABCO's Maintenance Manual MM-0112. This document is available through Meritor WABCO or their website.

Troubleshooting

Fault Codes						
MID	**SID**	**FMI**	**Fault Description**	**Test**	**Result**	**Action**
136	89	9	SAS – Commutation Fault	Remove the 7-pin connector from the Steering Angle Sensor. Measure the resistance between pins 3 and 4 of the 7-pin connector.	Resistance is approximately 90 ohms.	Verify fault. Check Steering Angle Sensor wiring. Check for open connection between the ABS ECU and Steering angle sensor. Ensure connection is tight and clear of debri/corrosion. Repair as necessary. If fault persists, the SAS or ABS ECU may be faulty.
					Resistance is much less or much greater than 90 ohms.	Check wiring between the SAS and ABS ECU. Repair as necessary. If fault persists, the SAS Sensor or ABS ECU may be faulty.
136	89	12	SAS – Sensor Defective	Disconnect the 7-pin connector from the steering angle sensor. Turn ignition ON. Measure the voltage between pins 1 and 2 of the 7-pin connector.	Voltage	Check Steering Angle Sensor wiring. Check for intermitent connection between the ABS ECU and Steering angle sensor. Ensure conenction is tight and clear of debri/corrosion. If fault persists, the ABS ECU may be faulty.
					No Voltage.	Check the wiring in circuit 576A between the SAS and the ABS ECU. Repair as necessary.
136	89	13	SAS – Not Calibrated	—	—	Refer to Meritor WABCO's SAS calibration procedure. This procedure can be found in Meritor WABCO's Maintenance Manual MM-0112. This document is available through Meritor WABCO or their website.
136	89	14	SAS – Internal Fault	—	—	Check SAS and its mounting location. Verify the SAS is securely mounted and the connector is free of debris and corrosion. SAS may be faulty.
136	16	5	BLS/Pressure Sensor	Disconnect the 18-pin X4 connector from the ABS ECU. Measure the voltage between pin 8 of the 18-pin (X4) connector and ground.	Voltage.	Wire shorted to power, check wiring and repair as necessary.
					No voltage.	Open circuit or shorted to ground. Check wiring and repair as necessary.

Fault Codes						
MID	SID	FMI	Fault Description	Test	Result	Action
136	19	2	Front Axle Brake Valve – Open	Disconnect connector X4 from the ABS ECU. Measure the resistance between pins 16 and 13 of the 18-pin (X4) connector.	Open circuit, or high resistance.	Check Front solenoid valve wiring for corrosion or open connection. Repair as necessary. If fault persists, replace the front solenoid valve.
					Resistance is 7-14 ohms.	Correct resistance is measured. Check wiring for intermitent connection. Repair as necessary. If Front valve passes test, ABS ECU may be faulty.
136	19	5	Trailer Brake Valve (RSC) Open	Disconnect connector X3 from the ABS ECU. Measure the resistance between pins 13 and 8 of the 15-pin (X3) connector.	Open circuit, or high resistance.	Check RSC valve wiring for corrosion or open connection. Repair as necessary. If fault persists, replace the RSC valve.
					Resistance is 7-14 ohms.	Correct resistance is measured. Check wiring for intermitent connection. Repair as necessary. If RSC valve passes test, ABS ECU may be faulty.
136	19	12	SAS and ESC Module – Shorted to Ground	Disconnect connector X4 from the ABS ECU. Measure the resistance between pin 7 of the 18-pin (X4) connector and ground.	Low Resistance	Wire shorted to ground, check wiring and repair as necessary.
					High Resistance	Verify fault. Check for intermitent fault in circuit 376A or open circuit. If fault persists, ABS ECU may be faulty.
136	55	3	Brake Pressure Sensor – Shorted to Battery	Disconnect the 4-pin connector from the Brake Pressure Sensor. Measure the resistance between pin 3 of the 4-pin connector and power.	Low Resistance	Wire shorted to power, check wiring and repair as necessary.
					High Resistance	Verify fault. Check for intermitent fault in circuit 402. If fault persists, sensor may be faulty.
136	55	5	Brake Pressure Sensor – Open or shorted to ground.	Disconnect the 4-pin connector from the Brake Pressure Sensor. Measure the resistance between pin 2 of the 4-pin connector and ground.	Low Resistance	Wire shorted to ground, check wiring and repair as necessary.
					High Resistance	Verify fault. Check for intermitent fault in ground circuit or open circuit. If fault persists, sensor may be faulty.

Table 1, Fault Codes

General Information

Smartplex is a configurable system that allows a common set of electronic components to manage different options in various vehicle configurations. Smartplex allows the customer to select the switches needed for the vehicle, then configure the output circuits for specific functions.

Smartplex allows up to 24 switches and indicators in the overhead console, and 6 hardwired input circuits, to control twelve 20-amp output circuits and ten 6.7-amp output circuits. See **Fig. 1**. Any combination of smart switches and hardwire input circuits can be configured to operate the output circuits that are wired to customer interface connector 1A, and customer interface connector 2A. The configuration is programmable with ServiceLink using parameters that can be accessed using the "Parameter Search Tool".

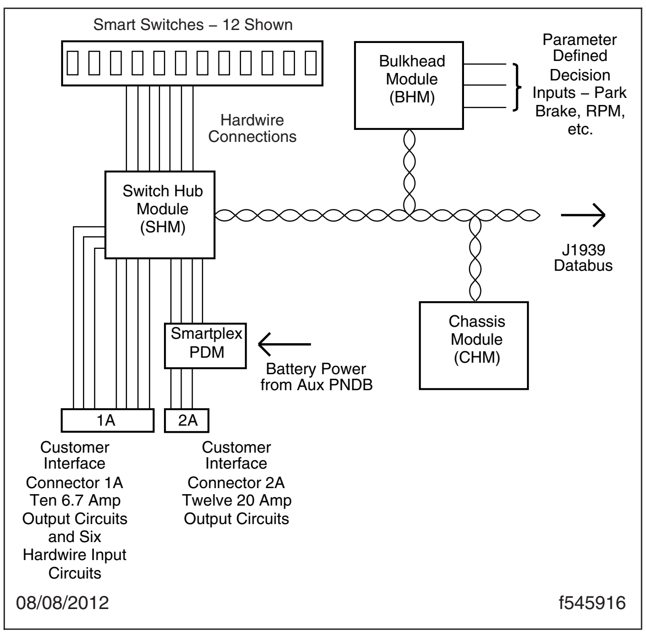


Fig. 1, Smartplex System Diagram

Smartplex performs operations that would otherwise require large bundles of wire and multiple sensors for the same function. **Fig. 2** details the order in which Smartplex evaluates inputs and controls outputs.

Parameter Configuration

The parameters used to configure Smartplex are verified by using the "Parameter Search Tool." See **Fig. 3**. The search tool is available to authorized users on *AccessFreightliner*.

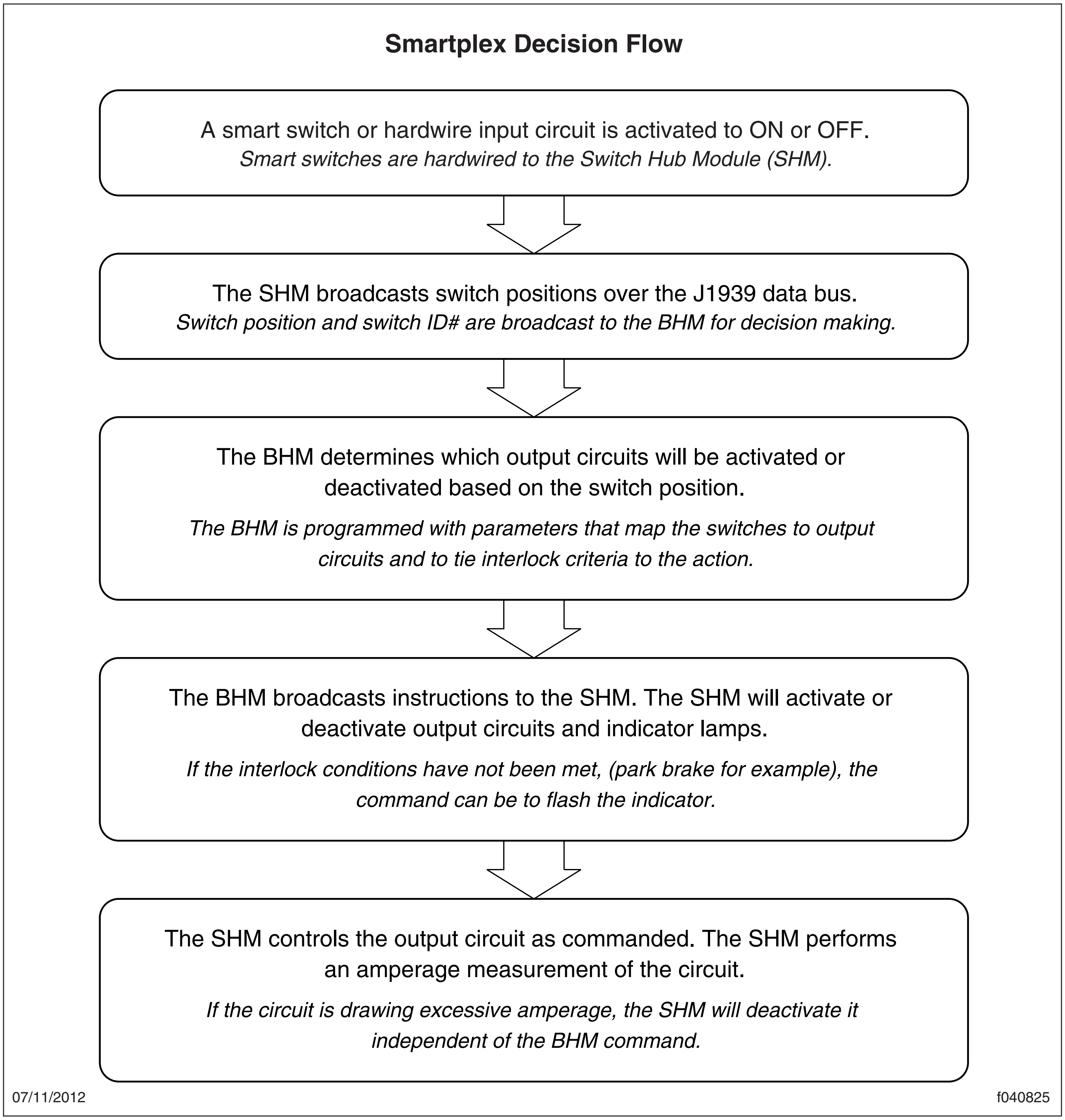


Fig. 2, Smartplex Decision Flow

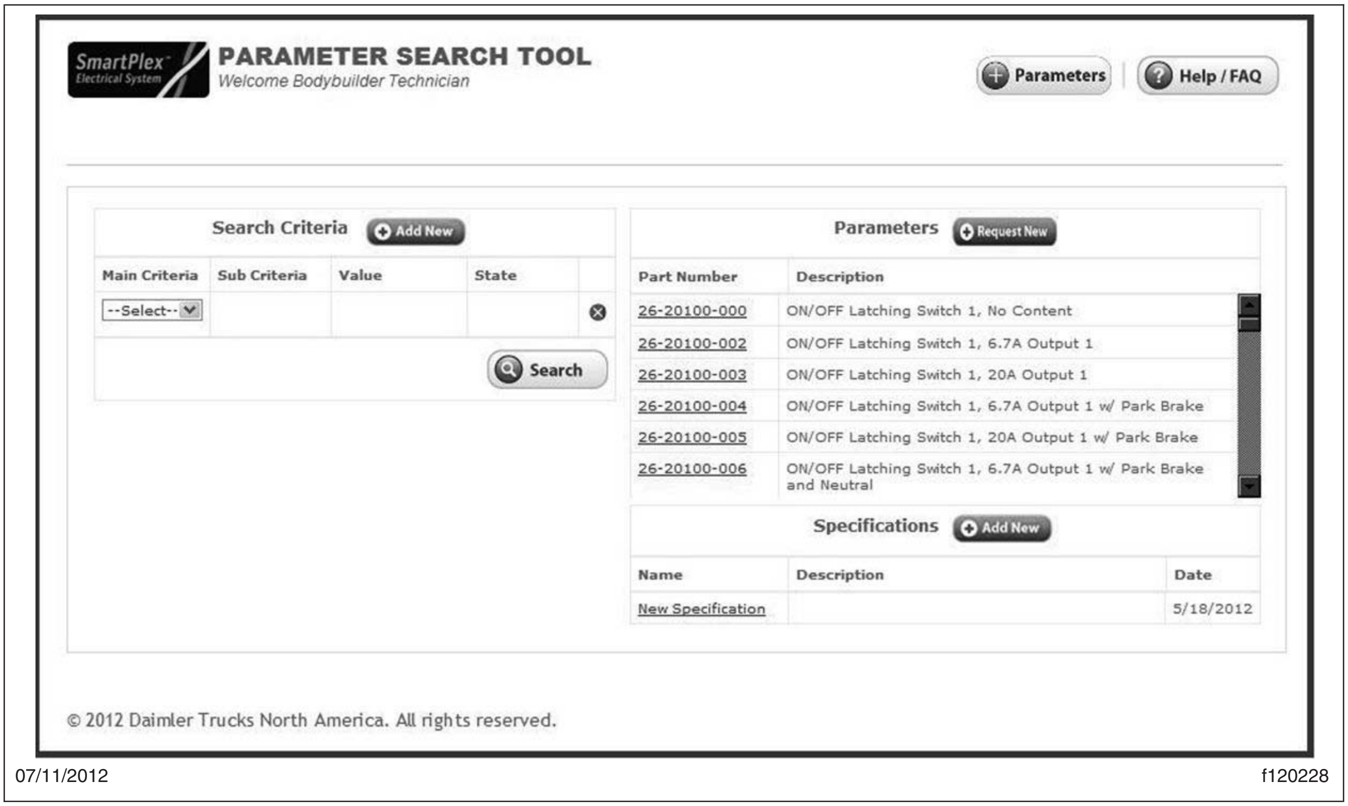


Fig. 3, Parameter Search Tool

Contents

Switch Hub Module

Removal

1. Remove the center smart switch panel in the overhead console. See **Fig. 1**.

   NOTE: The center trim panel and the map/reading light panel can be removed from the overhead console as a single unit.

   1.1 Remove the five screws that secure the center trim panel and the map/reading light panel to the overhead console. See **Fig. 1**, refs. 4 and 6.

   1.2 Slide the panel to the right until the locking tabs release, then pull it from the overhead console.

   1.3 Remove the four screws that secure the smart switch panel, then remove the panel. See **Fig. 1**, ref. 2.

NOTE: The switch hub module is attached to the mounting bracket with hook and loop tape.

2. Gently lift the switch hub module from the mounting bracket, then remove it from the vehicle.
3. Remove the connectors from the switch hub module. See **Fig. 2**.

Installation

1. Install the connectors on the switch hub module.
2. Install the switch hub module on the mounting bracket and ensure that it is secure.
3. Install the center smart switch panel and secure it with the four mounting screws. Tighten the screws securely.
4. Position the center trim panel and map/reading light panel assembly on the overhead console, then slide it to the left until it engages with the locking tabs. Install the five mounting screws, then tighten them securely.

Smart Switches

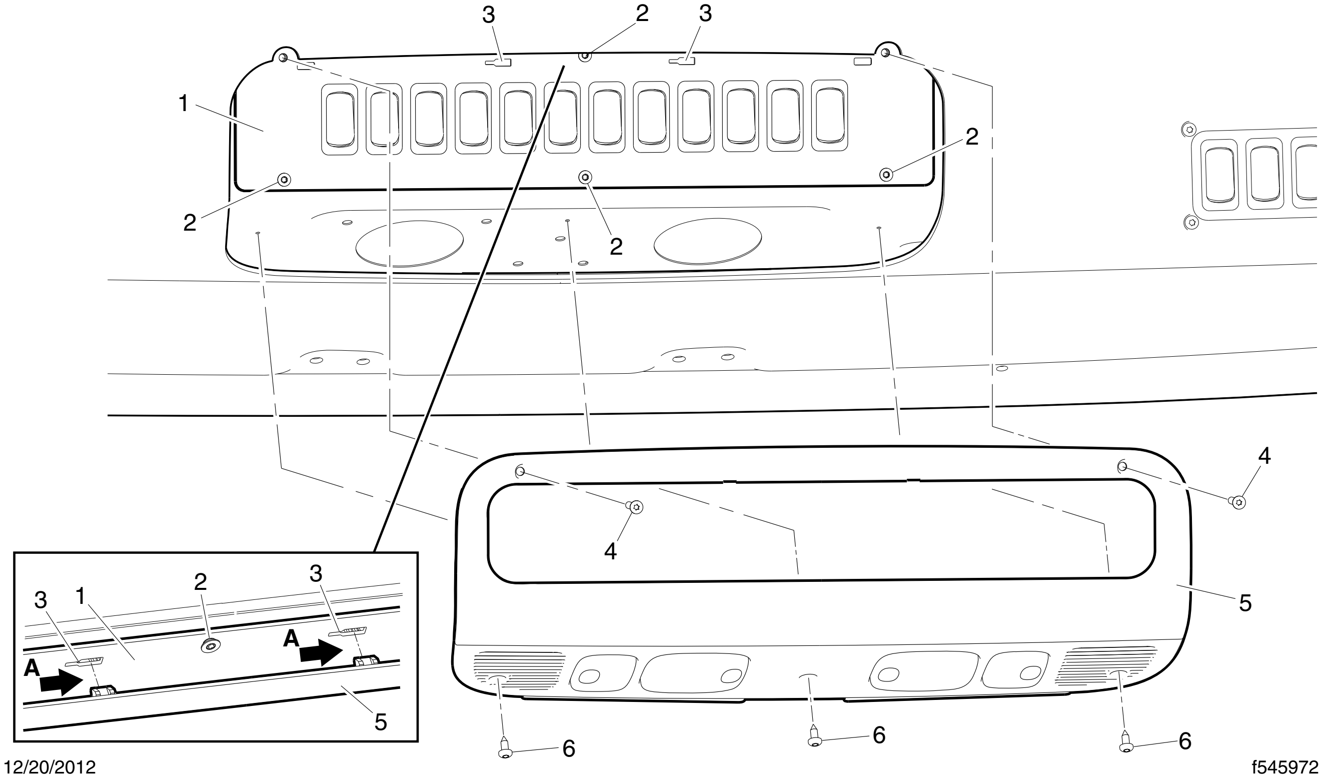
Removal

1. Remove the fascia panel. See **Fig. 3**.
2. Remove the mounting plate.
3. Squeeze the tab on both sides of the smart switch.
4. Remove the switch.

Installation

1. Install the new smart switch.
2. Install the mounting plate.
3. Position the fascia panel on the mounting plate, then install the screws.
4. Tighten the screws securely.

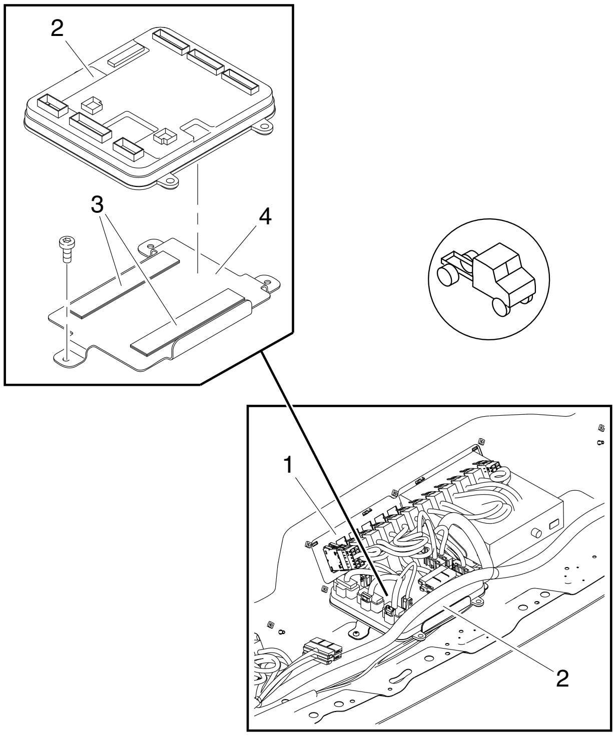
Removal and Installation



A. The trim panel *must* be slid to the right before it will release from the overhead console.

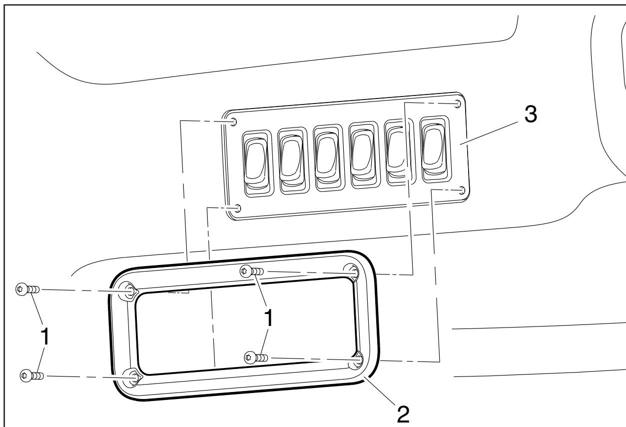
1. Center Smart Switch Panel
2. Smart Switch Plate Screws
3. Center Trim Panel Locking Slots
4. Center Trim Panel Mounting Screws
5. Center Overhead Console Trim Panel
6. Map/Reading Light Panel Mounting Screws

Fig. 1, Center Overhead Console Assembly



1. Center Smart Switch Panel (connector side)
2. Switch Hub Module
3. Hook and Loop Tape
4. Mounting Bracket

Fig. 2, Switch Hub Module Installation in the Headliner, Overhead View (roof not shown for clarity)



1. Mounting Screws
2. Fascia Panel
3. Mounting Plate

Fig. 3, Smart Switch Assembly

Troubleshooting

ServiceLink makes two templates available to troubleshoot the Smartplex system:

- The "Smartplex Switches" template monitors switch operation and identifies the unique ID of each smart switch. The switch hub module (SHM) and bulkhead module (BHM) use the ID to electronically map the switch to the output circuit it controls. This template also allows the user to force the indicator in the switch on and off.
- The "Smartplex Outputs" template determines if the SHM output circuit is commanded ON or OFF by the BHM and the SHM. This template allows the user to force the output circuit on and off, and also displays indicators for the six hardwire switch inputs to the SHM.
- Both templates display ignition voltage and the power supply status to the SHM.

The SHM is capable of generating J1939 fault codes for specific failures. **Table 1** identifies these fault codes.

Fault Codes from SHM Source Address 49			
SPN	**FMI**	**Description**	**Troubleshooting**
2033	19	No J1939 Communication with the BHM	Connect ServiceLink to see if the BHM shows up as an ECU on the left hand sidebar. Continue by using the troubleshooting instructions in the BHM manual.
6914	4	Smart Switch Battery Supply Power – Out of Range, Low	Disconnect SHM connectors J5, J6, and J7 one at a time to narrow down which bank of switches the short is occurring in. Pin 26 in each of these 3 connectors is the smart switch power supply circuit.
524283	12	SHM Software Memory Fail	Flash the SHM with the appropriate version of software.
524285	4	SHM is in Boot Mode	Use ServiceLink to flash the SHM with the appropriate version of software. If flashing does not correct this fault, replace the SHM.
524286	12	SHM Memory Fail	Replace the SHM.

Table 1, Fault Codes from SHM Source Address 49

Refer to **Table 2** for a list of procedures for diagnosing problems with the Smartplex system.

Smartplex Symptom Based Troubleshooting	
Symptom	**Remedy**
No smart Switches or Outputs Operate	Table 3
"Missing Smart Switch", or "Extra Smart Switch", or "Duplicate Smart Switch"	Table 4
ServiceLink Reports a Circuit-to-Pin Error	Table 5
One Smartplex Switch or Output Does Not Operate	Table 6
None of The 20-Amp Smartplex Outputs are Operating	Table 7
A Smart Switch Indicator Does Not Illuminate but The Output Works	Table 8
The Smart Switch Backlighting Does Not Illuminate	Table 9

Table 2, Smartplex Symptom Based Troubleshooting

Troubleshooting

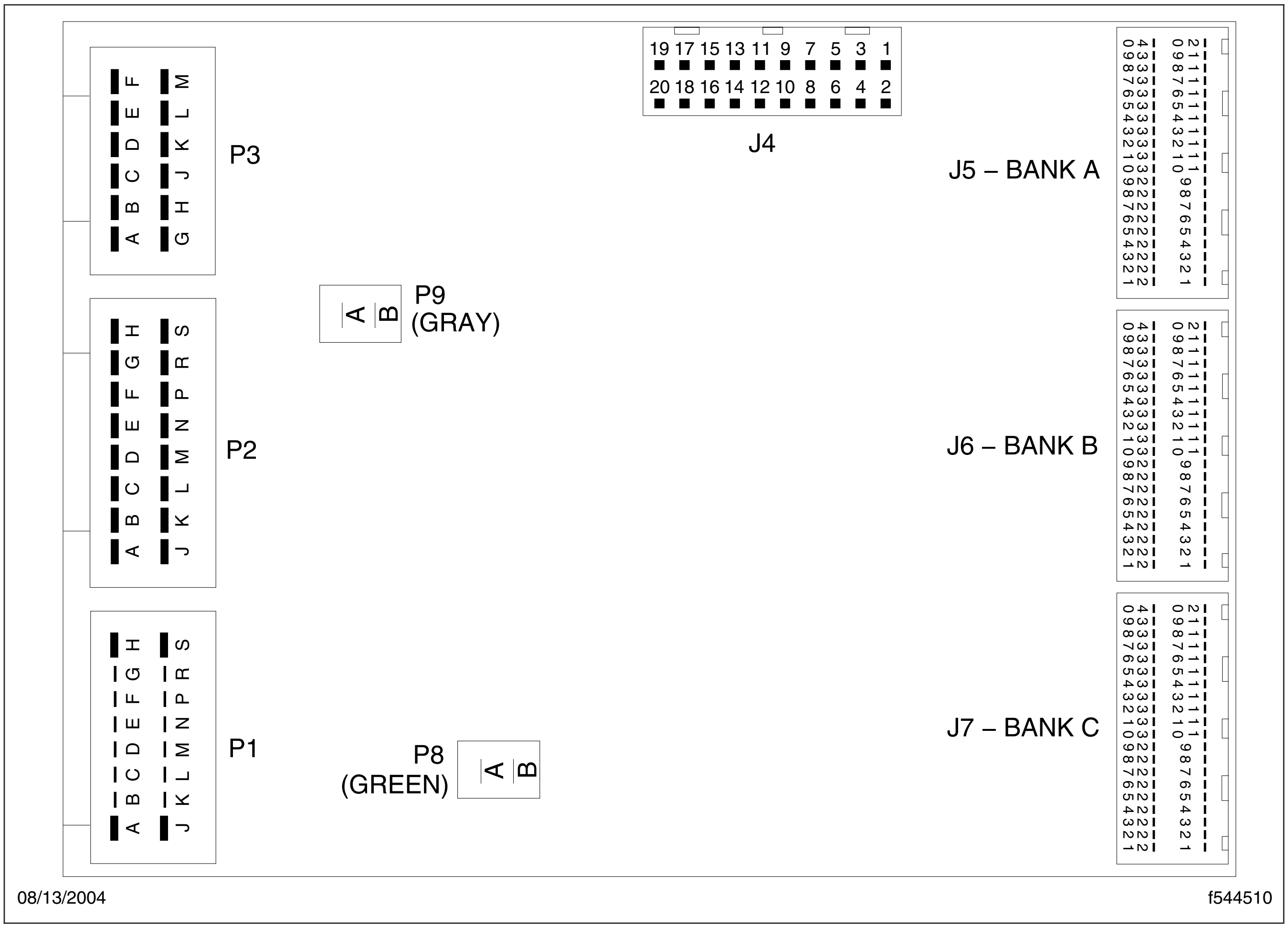


Fig. 1, Switch Hub Module Connector Pin Out

No Smart Switches or Outputs Operate			
Step	**Test**	**Result**	**Action**
1	Open ServiceLink and click on the"Switches" template, then observe the power indicators on the top row. Is power present on all 3 SHM power source circuits?	Yes	Go to step 2.
		No	If all the indicators have yellow triangles over their display, there is no data communication with the SHM. Troubleshoot for a J1939 data bus fault. Use the J1939 Datalink template to see which devices are communicating. If power is not present, access the SHM and troubleshoot for a wiring fault on the circuits that are not indicating battery voltage.

No Smart Switches or Outputs Operate			
Step	**Test**	**Result**	**Action**
2	Is the power to the smart switches indicator showing that power is ON?	Yes	Click on the “Enter Test Mode” button then click the ON button for a smart switch that is equipped with an indicator lamp. (Not all switches have an indicator.) The template will not show that the indicator has been turned on, but the indicator in the smart switch will illuminate if the SHM is operating. If the indicator did not illuminate, replace the SHM, otherwise continue with step 3.
		No	Troubleshoot for a wiring fault in each of the three smart switches wiring bundles for a short to ground. Repair as required.
3	Click the "Exit Test Mode" button. Operate a smart switch that is indicating a valid ID number. Does the "State" display change appropriately?	Yes	The SHM switch position sensing appears to be working correctly. Close the Smartplex Switches template and open the Smartplex Outputs template. The “BHM Command Status” indicator shows the message the BHM is sending to the SHM for output control. The “SHM Output Status” shows what the SHM is doing with the BHM command. If the SHM Output Status is not operating the outputs according to the BHM command, replace the SHM. If the outputs are operating correctly, measure voltage for outputs that are ON at the Smartplex PDM and at the customer interface connectors. Repair the customer installed wiring. If the BHM Command Status indicators have yellow triangles, there is a problem with the BHM – continue with step 4.
		No	Troubleshoot for a wiring fault in the wiring bundles connecting the smart switches. If there are no wiring faults, replace the SHM.
4	Do the BHM status indicators show yellow triangles?	Yes	The BHM is not communicating over the J1939 data bus. Use the J1939 Datalink template to determine which devices are not communicating, including the BHM to help locate a databus fault. Check power to the BHM. Use the BHM troubleshooting instructions in the BHM troubleshooting manual.
		No	The BHM parameters mapping the switches to the outputs may not be programmed for the vehicle. Use the "Parameter Search Tool" to verify the parameter configuration and ServiceLink to flash the intended parameters.

Table 3, No Smart Switches or Outputs Operate

Troubleshooting

"Missing Smart Switch", or "Extra Smart Switch", or "Duplicate Smart Switch"			
Step	**Test**	**Result**	**Action**
This troubleshooting section is for diagnosing problems with SHM smart switches that are located in the overhead console. The smart switches that are wired to the SHM are managed by parameters in the BHM. The BHM parameters tie the smart switch to an electrical action. When a switch is not present but a parameter is programmed for it, or a switch is present with no programmed parameter, ServiceLink indicates this condition. Smart switches are also connected directly to the BHM, and are also used in SEMs (switch expansion modules).			
1	Is the fault for a missing, duplicate, or extra smart switch?	Missing	Go to step 2.
		Duplicate	Go to step 3.
		Extra	Go to step 4.
2	This fault becomes active if there is a missing indicator. Open ServiceLink. Click on the "Bulkhead Module" icon, then click the "Configuration" tab. When the screen opens, click on the "Check for Missing Smart Switches" button. The missing switch will appear on a blue row in the dialog box. Record the switch ID number and the parameter number (RPN). Close the dialog box, then select the "Features" tab and scroll down the list to locate the parameter number. The description for this parameter identifies the switch type, position, and the output it controls. If this parameter is for an indicator, its label will be described. Is a switch or indicator with this description physically present in the overhead console?	Yes	Open the "Switches" template and view the switch ID number. It should be 768, indicating there is a fault with the switch or the wiring between the SHM and the switch. Repair the wiring or replace the switch, as appropriate.
		No	This fault may be due to switches that are intended to be connected directly to the BHM, or are used in a SEM. BHM and SEM switch troubleshooting is covered in the applicable workshop manual section. The parameter for the switch identifies the switch and the operation of this function. If this switch is intended for the vehicle, add the switch identified by the parameter. If the switch is not wanted on this vehicle, change the parameter to "no content". Typically, this can be done by changing the last 3 digits of the parameter to -000.
3	Click the "Switches" template. Look at the switch IDs and find the switches that are shown twice. Does the "Switches" template show two switches with the same ID number?	Yes	Remove the duplicate switch and watch the switch ID number on the template transition to a high number, such as 792 and then to 768.
		No	If there are no duplicate switches shown on this template, the duplicate switch could be in the dash. Unplug each dash smart switch for 15 seconds. When the duplicate switch is unplugged, the active fault will clear on the ServiceLink "Faults" screen after 15 seconds.

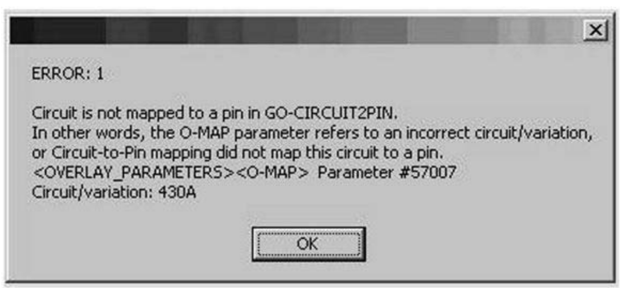
<table>
<tr><th colspan="4">"Missing Smart Switch", or "Extra Smart Switch", or "Duplicate Smart Switch"</th></tr>
<tr><th>Step</th><th>Test</th><th>Result</th><th>Action</th></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Click on the "Bulkhead Module" icon, then click the "Configuration" tab. When the screen opens, click on the "Check for Missing Smart Switches" button. Any extra switches will appear on rows that are colored tan. Record the switch ID number, then open the "Smartplex" switches template. If the extra switch is a Smartplex switch in the overhead console, the template will show its ID number and position.

Does the template show a switch with this switch ID number?</td><td>Yes</td><td>If the switch is intended to be used in this vehicle, determine the correct parameter to program into the BHM. Use the "Parameter Search Tool" to identify the desired parameter. Program this parameter to the BHM using ServiceLink.

If the switch is not necessary for the vehicle, remove it and place a close-out cover in the opening.</td></tr>
<tr><td>No</td><td>The extra switch is not connected to the Smartplex SHM. It may be located on the vehicle dash connected directly to the BHM, or is in a SEM.</td></tr>
</table>

Table 4, "Missing Smart Switch", or "Extra Smart Switch", or "Duplicate Smart Switch"

<table>
<tr><th colspan="4">ServiceLink Reports a Circuit-to-Pin Error</th></tr>
<tr><th>Step</th><th>Test</th><th>Result</th><th>Action</th></tr>
<tr><td colspan="4">When opening any of the ServiceLink Configuration tabs, the error dialog appears:



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This condition indicates a mismatch with the parameters that are recorded in the Freightliner mainframe data and the parameters that the vehicle is capable of supporting.</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Click on the 'Bulkhead Module" icon, then click the "Configuration" tab.

Does the error dialog shown above pop up?</td><td>Yes</td><td>Investigate the parameter and circuit number noted in the error message dialog box. If the circuit is for a parameter that was generated using the "Parameter Search Tool", use ServiceLink to remove the parameter. If the error is still present, contact the Dealer Help Desk. If there is no error, the problem was likely caused by creating a parameter incompatibility with the "Parameter Search Tool."</td></tr>
<tr><td>No</td><td>If there is an error dialog box present indicating an error with “hex file generation from PrePar” present, there is a mainframe parameter mismatch. Contact the Dealer Help Desk.</td></tr>
</table>

Table 5, ServiceLink Reports a Circuit-to-Pin Error

Troubleshooting

One Smartplex Switch or Output Does Not Operate			
Step	**Test**	**Result**	**Action**
1	Open ServiceLink and click on the "Switches" template and slowly cycle the switch through its positions. Is the switch state changing as expected?	Yes	Note the switch ID number for this switch. Click on the "Info" button at the top of the switches template. When the text file opens, scroll down to the crossover information section. Note the switch ID number, and record the parameter base number. Continue with step 2.
		No	The switch or the wiring between the SHM and the switch is at fault. Troubleshoot the wiring for a fault before replacing the switch.
2	Close the "Switches" template and click on the BHM icon, then click the "Features" tab. Scroll down the features list to locate the parameter number recorded from step 1. The output controlled by this switch is listed, along with any interlock conditions. Note this information, then open the "Outputs" template. If there are no outputs defined for this parameter, no physical output is expected to activate. Are all the interlock conditions for this output met?	Yes	Go to step 3.
		No	Troubleshoot for a fault with the interlock circuit, after insuring that the vehicle is in a condition where the interlocks are met.
3	Open the "Outputs" template. Slowly cycle the switch. Does the BHM command status indicator on the template activate correctly to the switch state?	Yes	Go to step 4.
		No	If all the interlock conditions are met, there is a parameter programming problem for this switch/output. Use the "Parameter Search Tool" to locate the correct parameter, then use ServiceLink to apply the parameter.
4	Is the output on customer interface connector 1A or 2A?	Connector 1A	If connector 1A of the SHM output status indicator shows **OFF** or **Error**, the circuit is using more than the 6.7 amp capacity. The circuit may have a short, or it may need to be remapped to one of the 20-amp outputs on connector 2A. If the SHM output status is **ON**, measure the voltage for this output at the customer interface connector. If battery voltage is present, the fault is downstream of the Smartplex system and is with the body equipment. Otherwise, troubleshoot for a wiring fault between the SHM and the customer interface connector.
		Connector 2A	Measure the voltage for this output at the customer interface connector. If battery voltage is present, the fault is downstream of the Smartplex system and is with the body equipment. If there is no voltage at the connector, troubleshoot for a fault in the wiring between the SHM and the Smartplex body builder PDM, or for a fuse and relay fault in the Smartplex body builder PDM.

Table 6, One Smartplex Switch or Output Does Not Operate

None of The 20-Amp Smartplex Outputs are Operating			
Step	**Test**	**Result**	**Action**
1	Open the "Outputs" template and observe the indicators for the 0.5-amp outputs driving 20-amp relays. Does the SHM output status show that any of the outputs are ON?	Yes	Check the battery supply power to the Smartplex PDM that is located under the access panel behind the drivers seat. Check the PDM for corrosion or damage. Locate and repair any wiring fault.
		No	Turn on a smart switch that is configured for one of these outputs, then follow the "Yes" instructions above.

Table 7, None of The 20-Amp Smartplex Outputs are Operating

A Smart Switch Indicator Does Not Illuminate but The Output Works			
Step	**Test**	**Result**	**Action**
1	Open the "Switches" template and observe the indicator on the template and the one on the switch. Change the switch from OFF to ON. Does the template indicator status show ON or OFF?	ON	The indicator bulb in the switch is open circuit, or there is a wiring fault between the SHM and the switch. Troubleshoot for a wiring fault in the indicator circuit and repair as appropriate. Otherwise, replace the smart switch.
		OFF	Click on the "Enter Test Mode" button on the switches template. Click the ON button next to the switch indicator. The indicator on the template does not come on in test mode, but the lamp in the switch will illuminate if the switch is equipped with an indicator lamp. If the switch does not illuminate it is not equipped with an indicator.

Table 8, A Smart Switch Indicator Does Not Illuminate but The Output Works

The Smart Switch Backlighting Does Not Illuminate			
Step	**Test**	**Result**	**Action**
1	Open the "Smartplex Switches" template and observe the backlighting indicator on the top row of the template. With the vehicle running lamps turned ON, and the backlighting intensity turned at maximum, does the indicator show the backlighting is ON, OFF, or ERR/NA?	ON	Troubleshoot for a wiring fault in the backlighting circuits from SHM connectors J5, J6, and J7 that are inoperative.
		OFF	The backlighting is not being commanded ON by the bulkhead module. The bulkhead module commands the SHM to turn backlighting ON with J1939 messaging.
		ERR/NA	The SHM has detected an over amperage, or under amperage condition for the backlighting circuit. Troubleshoot for a wiring fault with all the backlighting circuits from SHM connectors J5, J6, and J7. Disconnect each of these connectors one at a time to isolate the group of smart switches that has the fault.

Table 9, The Smart Switch Backlighting Does Not Illuminate

Contents

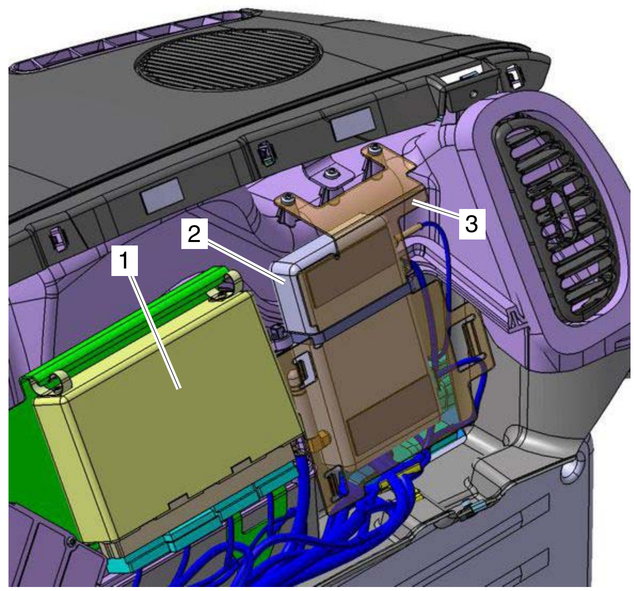
General Information

The Virtual Technician (VT) generates diagnostic information to aid the Detroit® Customer Support Center and the technician in diagnosing complex engine control issues. The system creates log files, captures fault codes, and sends alert messages and other advanced diagnostic information to the Detroit Customer Support Center. The VT utilizes GPS position, GSM (cellular telephone) communication, and a J1939 connection for databus monitoring. Virtual Technician does not require any driver input to function.

The Virtual Technician is located behind the dash on the passenger side of the vehicle. See **Fig. 1** for vehicles with a flat dash and **Fig. 2** for vehicles with a wing dash. The VT can safely be removed from the mount while remaining wired into the vehicle for visual diagnostic purposes.

There are three modes of operation for the Virtual Technician:

- **Registration Mode**: The vehicle identification number (VIN), engine serial number, and GPS ID are gathered at the manufacturing facility in this mode. Registration mode also occurs when a new unit is installed at the dealership.
- **Normal Operation Mode**: This mode occurs after electronic registration of the unit. In this mode, the VT gathers fault codes, snapshot data files, and GPS data. This mode monitors the databus for general information and fault codes. Transmission of this information to Detroit® generally occurs within 4 minutes of collection depending on GSM network availability. Normal mode also allows for over-the-air updates of VT firmware.
- **Dormant Mode**: In dormant mode, activity and data usage is minimized or eliminated. This mode is activated only by remote modification of the firmware settings by the CSC. This may occur if the VT subscription ends.



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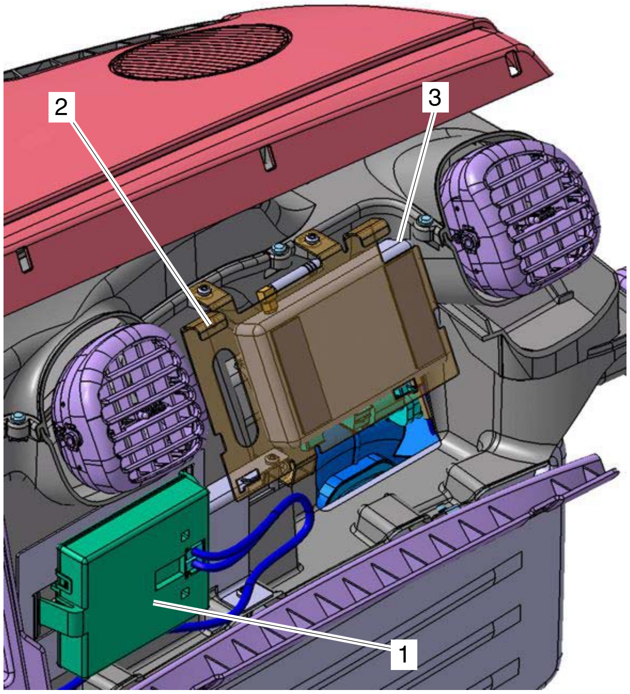
1. Common Powertrain Controller
2. Virtual Technician
3. Mounting Bracket

Fig. 1, Virtual Technician, Flat Dash Installation

General Information



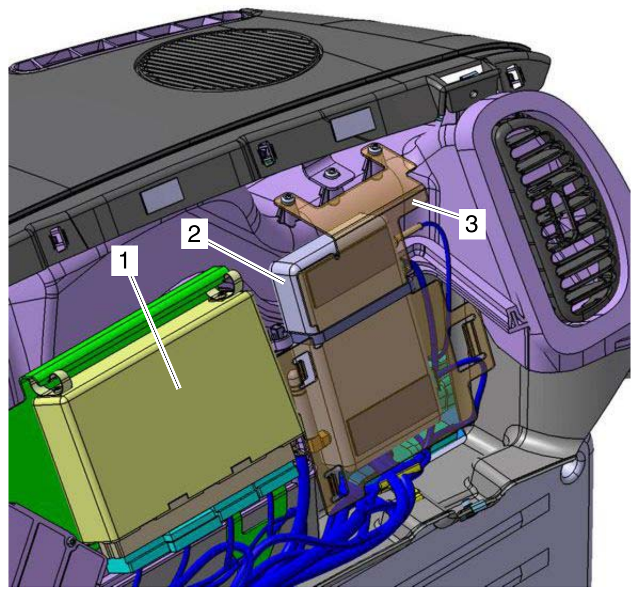
1. Gateway Module
2. Mounting Bracket
3. Virtual Technician

Fig. 2, Virtual Technician, Wing Dash Installation

Virtual Technician Removal and Installation

Removal

1. Park the vehicle and shut down the engine.
2. Remove the passenger-side dash.
3. Remove the Virtual Technician mounting bracket to view LEDs for diagnostic information. See **Fig. 1** and **Fig. 2**. The LEDs are located on the left side of the VT.
4. Refer to **Troubleshooting, 300** for diagnostic information. If the Virtual Technician needs to be replaced, call the *Detroit® Customer Support Center*.
5. Disconnect the 4-pin and 10-pin connectors to the VT.
6. Disconnect the GPS antenna cable.
7. Remove the VT from the vehicle.



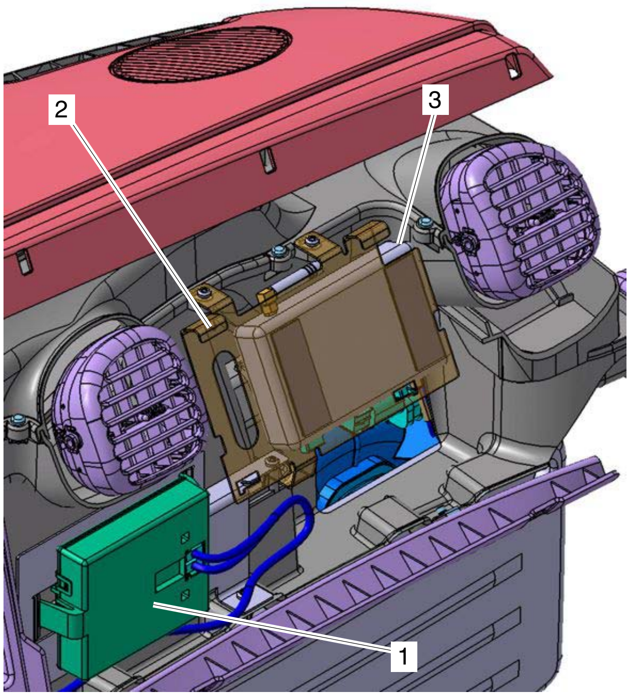
1. Common Powertrain Controller
2. Virtual Technician
3. Mounting Bracket

Fig. 1, Virtual Technician, Flat Dash Installation

Installation

1. Record the Virtual Technician GPS ID number that is located on the back of the unit.
2. Connect the 4-pin and 10-pin connectors to the new VT.
3. Screw on the GPS antenna cable to the threaded GPS connection.
4. Position the new Virtual Technician in the vehicle.
5. Install the mounting bracket.
6. Install the passenger-side dash panel.
7. Verify the operation of the VT.
   7.1 Start the vehicle and drive to an open area, at least 40 feet (12 meters) away from any buildings. Park the vehicle and keep the ignition in the ON position. Apply the parking brake.
   7.2 Call the *Detroit® Customer Support Center*. Make sure to have the vehicle serial number and the Virtual Technician GPS ID available so that the new VT can be registered.

Virtual Technician Removal and Installation



1. Gateway Module
2. Mounting Bracket
3. Virtual Technician

Fig. 2, Virtual Technician, Wing Dash Installation

Replacement

NOTE: Before removing the GPS antenna, call the *Detroit® Customer Support Center* for diagnosis of the problem and instructions for repair.

1. Park the vehicle, shut down the engine, and set the parking brake. Chock the tires.
2. Remove the passenger-side lower kick panel.
3. Remove the A-pillar outer panel.
4. Disconnect the antenna pigtail from the antenna cable.
5. Loosen the nut securing the antenna to the passenger-side cowl, and remove the antenna.
6. Remove the rubber grommet and pigtail from the cab.
7. Mount the new antenna to the cowl and tighten the mounting nut.
8. Run the new pigtail into the cab, and secure the attached rubber grommet over the insertion hole.
9. Connect the antenna pigtail to the antenna cable.
10. Install the passenger-side lower kick panel.

Diagnostic Overview

All testing of the GPS and cellular reception must be done outside, and at a distance of at least 40 feet (12 meters) from any buildings. This ensures adequate GPS signal strength and good cellular reception.

Diagnosing Virtual Technician requires access to the unit to view the LEDs. The LEDs provide diagnostic information needed by the technician and the CSC (Customer Support Center). To access the unit, refer to **Subject 100**. To diagnose the unit, turn the ignition to the ON position.

There are seven LEDs visible on the VT ECU and five on the VT HU. If no LEDs light up with the ignition ON, diagnose supplied power and ground to the unit. See **Table 1** and **Fig. 1** or **Fig. 2**.

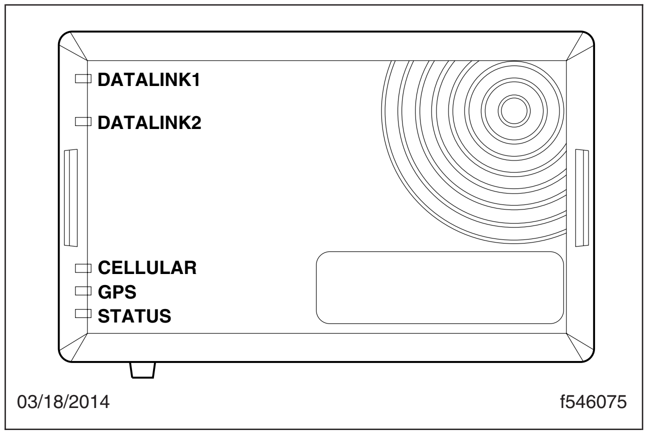


Fig. 2, Virtual Technician HU

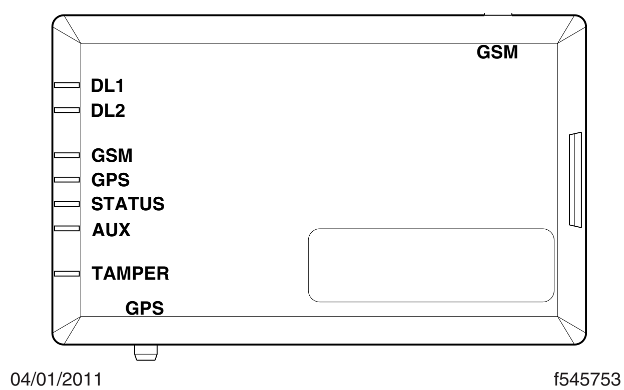


Fig. 1, Virtual Technician ECU

Diagnostic LEDs			
Name	**Color**	**Function**	**Action**
DL1	Red	**Red Blink (1Hz)**: J1708 connectivity (disabled). No J1708 activity detected (device is awake). Device is not wired for J1708 connectivity.	Red is the normal and expected state.
DL2	Red and Green	**Red Blink (1Hz)**: J1939 connectivity. No J1939 activity detected (device is awake). **Green Blink (1Hz)**: J1939 activity detected (device is awake) .	Green blink is expected, if LED is blinking red diagnose J1939 connectivity issue at the terminals.

Troubleshooting

Diagnostic LEDs			
Name	**Color**	**Function**	**Action**
GSM	Green	**Solid**: GPS connection successful. **One Blink**: Initializing. **Two Blinks**: Acquiring time zone information. **Three Blinks**: Attempting to make a GPS connection.	Solid is expected – if otherwise call the Customer Support Center for further instruction. NOTE: The VT must be in a 2G network service area.
GPS	Green	**Solid**: Satellites acquired. **One Blink**: Acquiring satellites.	Refer to J1939 Fault codes if a problem is suspected.
Status	Green	**Solid**: Engine running. **One Blink**: Engine not running; no data to send. **Two Blinks**: Data is available to be sent. **Four Blinks**: GPS storage log is full.	Refer to J1939 Fault codes if a problem is suspected.
AUX	Red	**Solid**: GSM Modem Comm. Error, or panic line is active. **Two Blinks**: Not Used. **Three Blinks**: GSM modem is not starting up. **Four Blinks**: SIM Card read error. **Five Blinks**: GSM CTS (clear-to-send) line is active.	Refer to J1939 Fault codes if a problem is suspected.
Tamper	Red	Disabled	N/A

Table 1, Diagnostic LEDs

Fault Codes

NOTE: The VT source address (SA) is usually 74. Due to the addition of other telematics devices, SA 74 may be taken by another ECU. In this case the VT will be assigned another source address. To reset the VT back to address 74, the 4-pin power connector must be disconnected for 5 seconds then connected.

Fault Codes				
Fault	**SPN**	**FMI**	**Details**	**Action**
Sim Card Error	524283	11	Installed SIM Card cannot be read.	Contact CSC/ Replace VT

Fault Codes				
Fault	**SPN**	**FMI**	**Details**	**Action**
GPS Shorted	524286	4	Center lead shorted to ground or cable ground.	Check the antenna cable; replace GPS antenna if necessary
GPS Not Connected	524286	5	Antenna open or cut.	Attach GPS antenna. Replace antenna if wiring damaged
NAND Full	524285	0	Full	Contact CSC/ Replace VT
NAND ++Checksum Error	524285	2	Error	Contact CSC/ Replace VT
NAND I/O Error	524285	11	Cannot read/write.	Contact CSC/ Replace VT
uSD Full	524284	0	Full	Contact CSC/ Replace VT
uSD Checksum Error	524284	2	Read/write error	Contact CSC/ Replace VT
uSD I/O Error (micro SD)	524284	11	Cannot read/write – not present	Contact CSC/ Replace VT
RTC Error (real time clock)	524282	11	VTECU RTC out of range	Contact CSC/ Replace VT

Table 2, Fault Codes

Virtual Technician Connector Reference

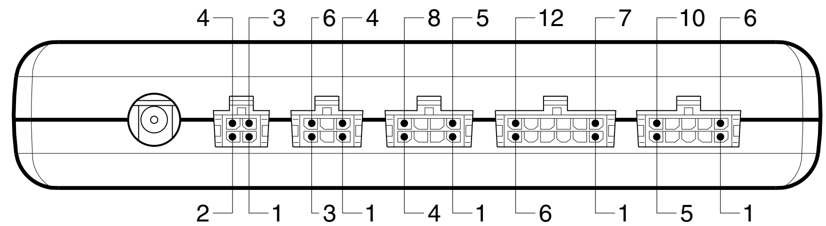


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Fig. 1, Connector Reference, Virtual Technician ECU

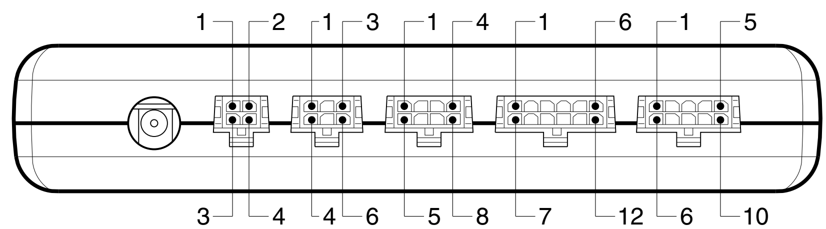

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Fig. 2, Connector Reference, Virtual Technician HU

Power Connector						
Connector	**Pin**	**Name**	**Type**	**Minimum**	**Maximum**	**Notes**
4-Pin	1	Power	Input	8 VDC	30 VDC	Requires External Fuse
	2	Ignition	Input	0 VDC	30 VDC	Requires External Fuse 0 VDC = Logic 0 1.8 VDC = Logic 1
	3	Ground	—	0 VDC	0 VDC	—
	4	—	—	—	—	—

Table 1, Power Connector

Specifications

Vehicle Communication Connector		
Connector	Pin	Name
10-Pin	1	J1939 –H
	2	NC
	3	—
	4	NC
	5	NC
	6	J1939 –L
	7	NC
	8	NC
	9	NC
	10	NC

Table 2, Vehicle Communication Connector

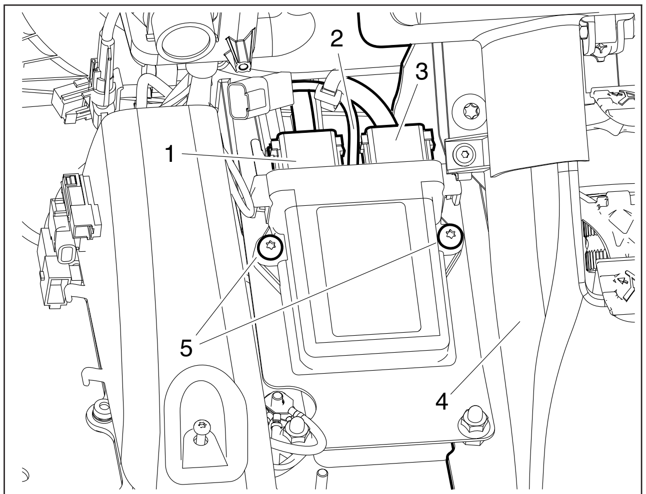
Contents

General Information

The occupant restraint indicator works in conjunction with a vehicle data recorder (VDR) to indicate passenger location and safety equipment operation in the vehicle. The indicator provides audible and visual warnings if the driver or passengers are seated without the seatbelt fastened.

The display shows a green icon when the seat is occupied and the seatbelt is buckled. The icon flashes red and a beep sounds if the seat is occupied and the seatbelt is not buckled. The VDR system retains occupant data for 30 days.

The occupant restraint system is self-contained and uses J1939 vehicle data. The VDR is located under the dash, on the left-hand side of the steering column. See **Fig. 1**. The display is located on the center dash. See **Fig. 2**. The precise location of the VDR may vary depending on vehicle configuration.



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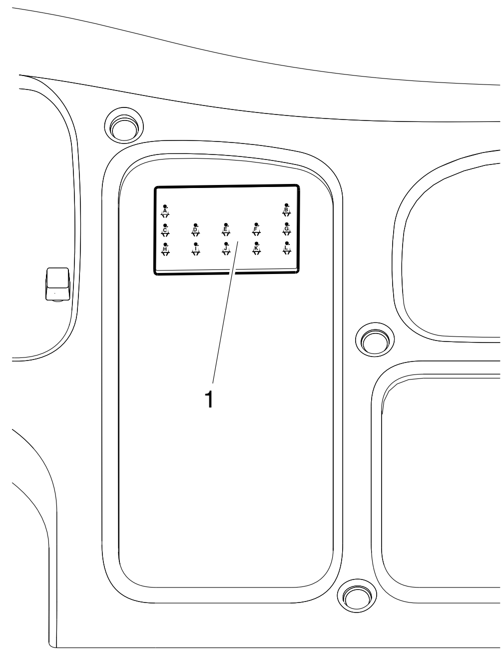
1. Connector B
2. USB Port (Deutsch connector)
3. Connector A
4. Steering Column (for reference)
5. Mounting Bolts

Fig. 1, Occupancy Detection ECU



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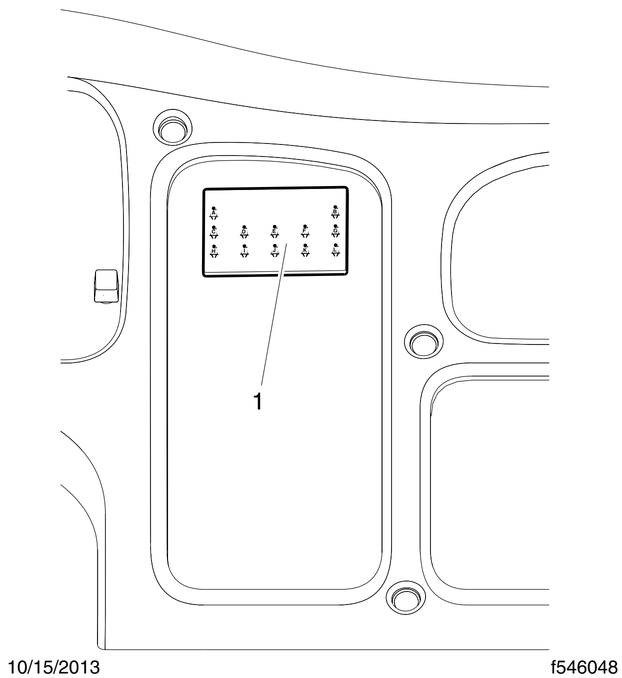
1. Dash Display

Fig. 2, Occupancy Detection Display

Seat Belt Occupancy Display Replacement

1. Park the vehicle, shut down the engine, and set the parking brake. Chock the tires.
2. Remove the four fasteners from the center gauge panel, and tilt it forward. See **Fig. 1**.
3. Remove the connector from the back of the display.



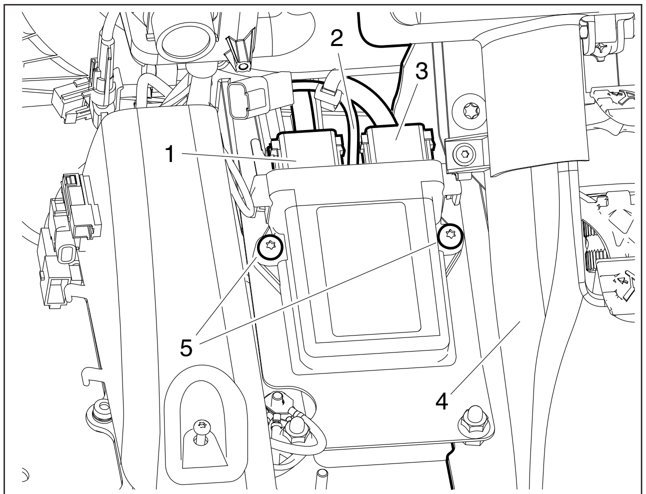
1. Dash Display

Fig. 1, Occupancy Detection Display

4. Remove the two mounting nuts that secure the display to the gauge panel, then remove the display.
5. Position a new display on the center gauge panel and install the two mounting nuts. Tighten the nuts securely.
6. Attach the connector to the back of the display.
7. Tilt the center gauge panel back and install the four fasteners. Securely tighten the fasteners.
8. Verify the operation of the new display.

Replacement

1. Park the vehicle, shut down the engine, and set the parking brake. Chock the tires.
2. Disconnect connector A, connector B, and the USB connector from the vehicle data recorder (VDR). See **Fig. 1**.
3. Remove the two fasteners from the VDR mounting bracket.
4. Lift the VDR out of the vehicle.
5. Position the new VDR in the vehicle, then install the two fasteners. Tighten the fasteners securely.
6. Connect connector A, connector B, and the USB connector.
7. Verify the operation of the VDR.



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1. Connector B
2. USB Port (Deutsch connector)
3. Connector A
4. Steering Column (for reference)
5. Mounting Bolts

Fig. 1, Occupancy Detection ECU

Troubleshooting Overview

Troubleshoot the system when the occupant display indicator displays incorrect information. See **Fig. 1**.

The vehicle data recorder (VDR) is located below the driver-side dash, next to the steering column. See **Fig. 2** and **Fig. 3**.

Vehicle Data Recorder (VDR) Troubleshooting

Use the steps in **Table 1** if the seat occupancy display is not operating properly.

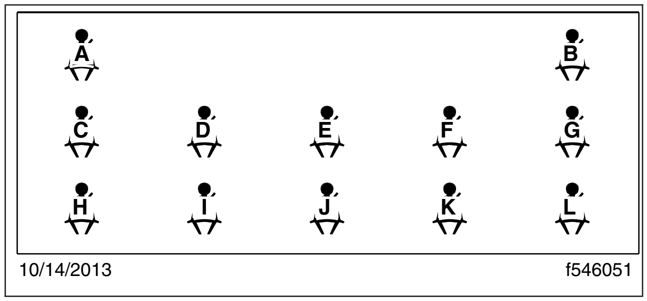


Fig. 1, Occupant Display Indicator

Refer to **Specifications 400** for a schematic of the system.

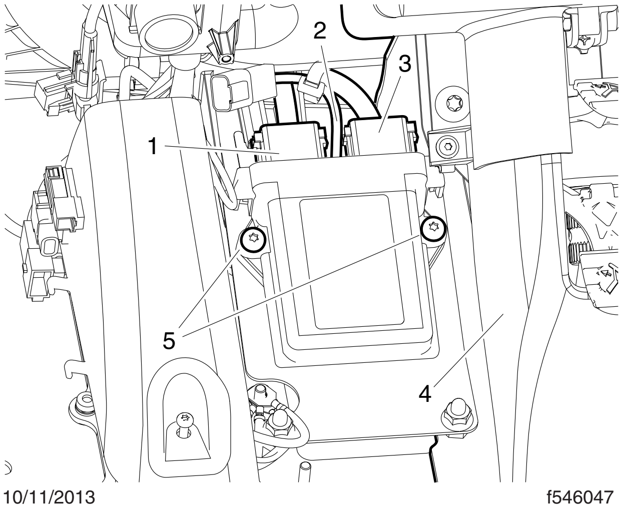
Step	Test	Result	Action
1	Test Connector A on the VDR. See **Fig. 2**, ref. 1. Using a multimeter, verify that the VDR reads +12 volts at wire 442, pin 10. Is the voltage +12 at wire 442, pin 10?	Yes	Go to test 2.
		No	Check for broken or bent terminals, or a broken wire. If the connector is damaged, replace it and repeat the test.
2	Test Connector B. See **Fig. 2**, ref. 3. Disconnect the connector, and test the voltage at the pin that corresponds with the affected seat(s). Using a multimeter, verify that the pin reads +12 volts. Is the voltage +12 at the affected pin(s)?	Yes	Continue with test 3.
		No	Check for broken or bent terminals, or a broken wire. If the connector is bad, replace it and repeat the test.
3	Test the jumper connectors. Are the terminals and the wire intact?	Yes	Continue with the tests in "Occupancy Detection Switch Troubleshooting."
		No	Check for broken or bent terminals, or a broken wire. If the connector is bad, replace it.

Table 1, Vehicle Data Recorder (VDR) Troubleshooting

Occupancy Detection Switch Troubleshooting

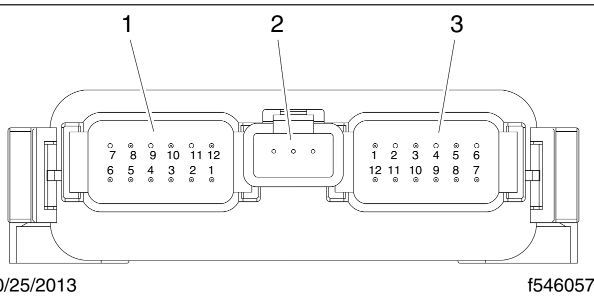
1. Perform a resistance test on the fuse. Locate wire 442, pin 10 on connector A. See **Fig. 3**. If the fuse is blown, replace the fuse then test the operation of the seat switches.
2. Check for a broken or loose switch behind each affected seat location. See **Fig. 4** for switch locations. Refer to **Table 2** for the first row of connectors, and **Table 3** for the second row of connectors.
3. Disconnect one switch at a time to verify operation of the corresponding indicator light on the occupant display indicator. See **Fig. 1**. Perform a continuity test on each switch using a multimeter. Touch one probe to the black wire terminal and the other probe to the tan and white wire. If there is no continuity, replace the switch.
4. If the VDR module does not operate normally after performing these tests, replace the module.

Troubleshooting



1. Connector B
2. USB Port (Deutsch connector)
3. Connector A
4. Steering Column (for reference)
5. Mounting Bolts

Fig. 2, VDR Module



1. Connector A
2. Deutsch Receptacle Housing
3. Connector B

Fig. 3, VDR Module Connector Interface

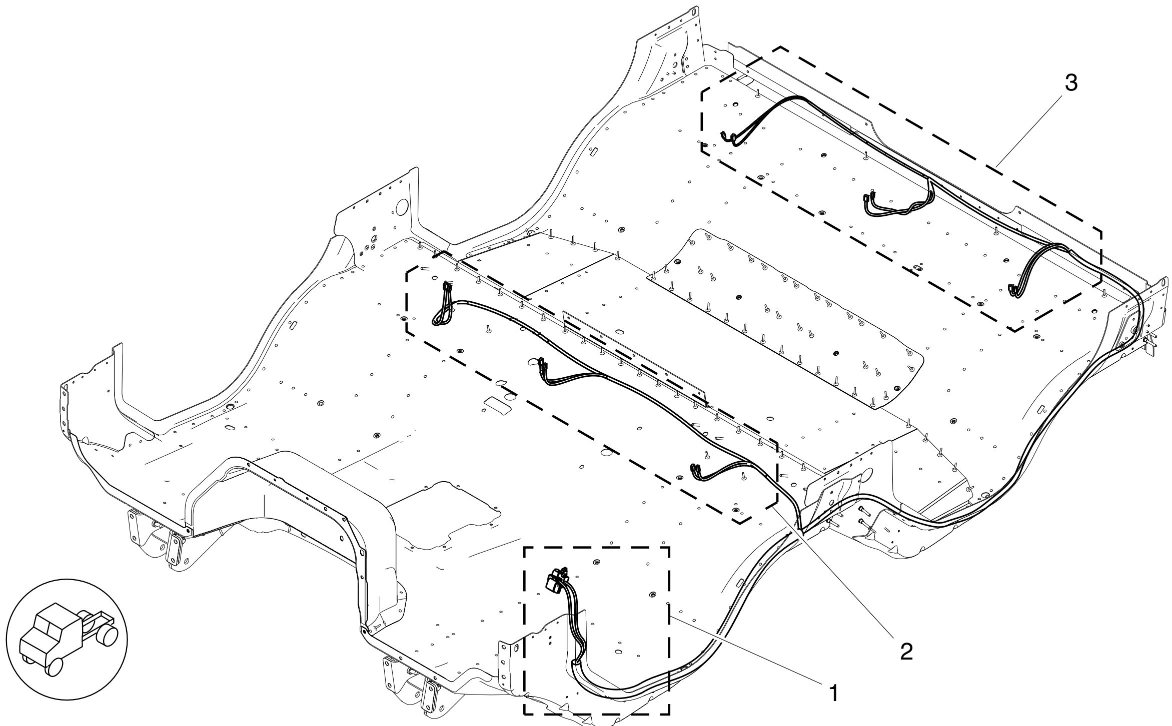
Seatbelt Switches, First Row	
Switch	**Pin**
204B	1
204C	2
204G	6
432E	12
432F	11
432K	7

Table 2, Seatbelt Switches, First Row

Seatbelt Switches, Second Row	
Switch	**Pin**
204D	3
204E	4
204F	5
432G	10
432H	9
432J	8

Table 3, Seatbelt Switches, Second Row

Troubleshooting



1. Vehicle Data Recorder
2. Switches 204B through 432K (right to left)
3. Switches 204D through 432J (right to left)

Fig. 4, Seat Occupancy Switch Locations

Specifications

See Fig. 1 for wiring diagram of the VDR module and the seat indicator display unit.

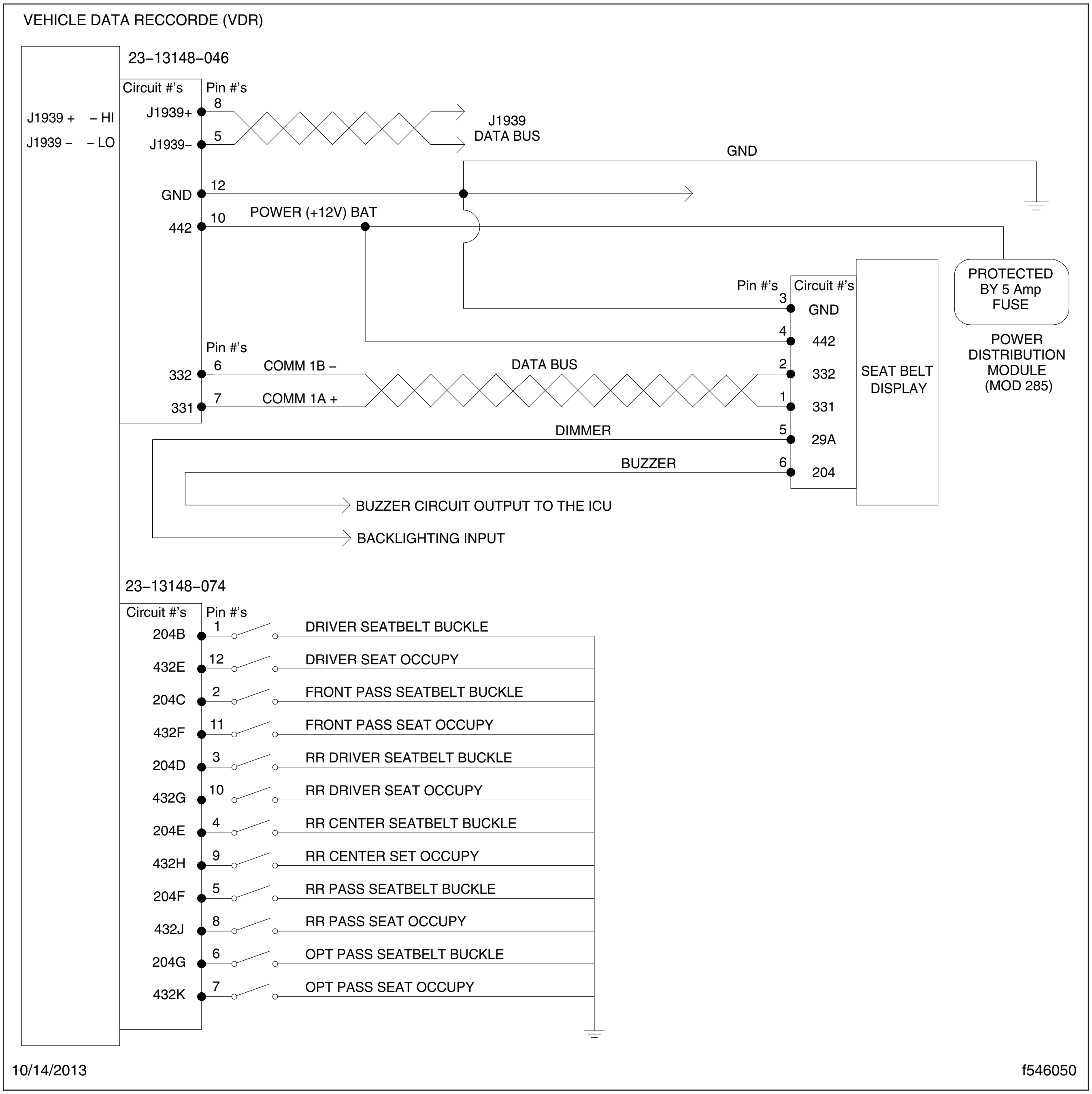


Fig. 1, VDR Module and Indicator Display Unit Wiring

Contents

Introduction

Lighting interface harnesses are used to provide a Business Class® M2 with additional lighting connections. Designed lighting interface harnesses discussed in this section include:

- high current
- low current
- additional marker lights

High-current and low-current interface harnesses provide multiple CHM-controlled lighting outputs such as taillights, stop lights, turn lights, and backup lights. Some vehicles that come equipped with additional marker light interface harnesses provide either a marker light 2-pin jumper harness or a customer access junction block with a marker light feed. When a vehicle is not equipped with a preinstalled marker light interface harness, additional marker lights can be supplied by a splice connection.

Overview

Many of the lighting interface harnesses provide signals that receive current protection from Chassis Module (CHM) outputs. The CHM will shut down outputs that exceed their maximum current capacity. When adding additional lighting to a vehicle, be sure to identify all loads of the same function that draw their current protection from the CHM. Make sure that the combined load from like sources does not exceed the maximum current capacity for any CHM output. Keep in mind that you need to consider the factory-installed lighting that remains on the vehicle. For circuit information, including current capabilities, see **Subject 400**.

If body marker lights are the only lights being added, tie the lights in to the vehicle electrical system using a jumper, a junction block, or a splice. See "Marker Light Jumper," "Marker Light Junction Block," and "Marker Light Splice" in this subject for more information.

Install an inline fuse to allow the technician to separate the marker lights when troubleshooting is required. To determine the fuse rating:

1. Add the steady-state current draw of the lighting load.
2. Select a standard fuse rating that is between 10 and 20 percent greater than the steady-state current draw. If there is not a standard fuse available in this range, use the next closest standard value up to the 10-amp limit.

High-Current Lighting Interface

The high-current interface harness is a 19-pin customer connector that provides 20-amp lighting outputs. The interface harness is located at the back of the cab or at the rear of the frame rail. High-current lighting is made possible by equipping the vehicle with a taillight power distribution module (PDM). The taillight PDM is usually mounted on the left frame rail aft of the cab, or on a rear crossmember at the end of the frame rail. The PDM contains relays and fuses for each lighting output. Direct battery power is supplied to the taillight PDM fuses via a cable connection to a 150-amp MEGA® Fuse. The CHM sends digital outputs to control the PDM lighting relays. The energized relays deliver 20-amp fuse-protected lighting outputs to the high-current interface harness. Taillight PDM outputs include:

- taillights
- backup lights
- stop lights
- turn lights

Low-Current Lighting Interface

The low-current interface harness terminates in a 12-pin connector that provides access to CHM-protected lighting outputs. The interface harness connector can be located in the engine compartment, at the back of the cab, or at the rear of the frame rail. The low-current interface harness provides the following lighting circuits:

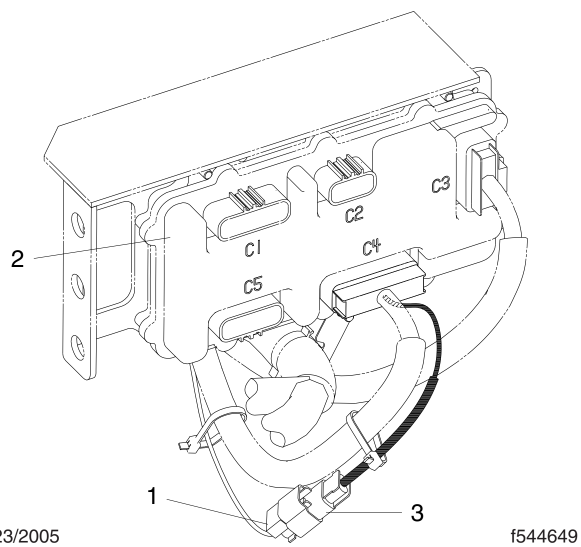
- taillights
- backup lights
- stop lights
- turn lights

The low-current interface harness is suitable for limited load applications such as additional LED lighting. Since the interface harness outputs are splices from existing circuits, CHM maximum current loads can not be exceeded. Most of the CHM lighting outputs provide a maximum current load of 6.7 amps, with the exception of the taillight outputs which provide a combined maximum current load of 1 amp. Current loads for each output include lighting connected to the interface harness plus all factory-installed lighting of the same function that is not permanently removed during body installation.

Marker Light Jumper Harness

The optional marker light jumper harness establishes a connection at pin M of the CHM connector C4. See **Fig. 1**. The harness provides additional marker light feeds via a 2-pin connector usually located near the CHM. The 2-pin connector supplies marker light outputs at both pins. The CHM output that provides the marker light feed to the junction block has a maximum combined current load of 10 amps. Marker lamp connections made to the the jumper harness should include an appropriately sized inline fuse for further circuit protection.

If the vehicle is not equipped with a marker light jumper harness, a harness can be installed by a Freightliner dealer.



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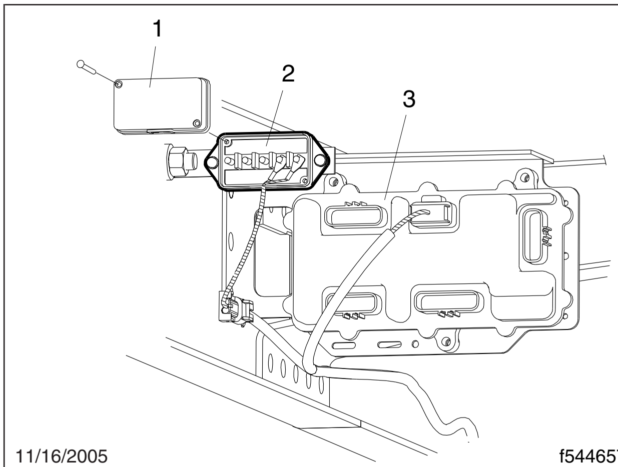
1. Body Builder Marker Light Connection
2. Chassis Module
3. Jumper Harness

Fig. 1, Marker Light Jumper Harness

Marker Light Junction Block

Some vehicles are equipped with a customer access junction block that is usually located on the frame rail near the CHM. See **Fig. 2**. This feature provides a 5-post quick connection point to support easy customer access. For one post, the junction block feed comes from a dash-mounted optional switch that provides 15-amp fused power. See **Section 54.40** for more information on connecting to the junction block. On another post, the junction block is provided a marker light feed from the CHM. The CHM output that provides the marker light feed to the junction block has a maximum combined current load of 10 amps. When establishing additional marker lamp connections to the the junction block, install an appropriately sized inline fuse for further circuit protection.



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

Fig. 2, Junction Block

Marker Light Splice

The marker light splice requires making a splice connection on the existing marker light circuit, located at pin M of the CHM connector C4. The new spliced feed should be equipped with an appropriately sized inline fuse. Do not exceed a combined load of 10 amps at pin M of CHM connector C4.

Components

If electrical lighting interface harnesses need to be added to a vehicle, visit a local Freightliner dealer to request a bill of material. Be prepared to provide the dealer with the vehicle identification number (VIN) and a sales option code (if known) for the desired feature. The bill of material provides a complete parts list that is tailored to the configuration and dimension of the vehicle.

The following components are necessary for creating a high-current lighting interface harness:

- taillight PDM with mounting hardware and bracket
- high-current interface harness
- harness between the CHM and the taillight PDM
- harness between the taillight PDM and the interface connector
- power cable between the battery and the taillight PDM
- 150-amp MEGA Fuse

Installation or Replacement Guidelines

When installing or replacing any part of an electrical system, follow these guidelines:

- Make ground connections at factory-provided ground stud locations whenever possible. If there is no ground stud available, it will be necessary to add a bolt or self-threading fastener to connect the ground lugs to the frame rail.
- Route all wiring so that it will not be exposed to harmful conditions such as moving parts, excessive heat, chafing, or saturation with oil or grease.
- Secure and protect all electrical components. Use appropriate mounting and installation techniques such as retaining clips, harness protection, and correct hardware.
- Be sure to clean all paint, dielectric enamel, and road grime from the ground stud or frame before connecting the new ground leads. After the connections are secured, use a dielectric enamel on the ground connections to protect against corrosion.
- Removal of electrical components for an extended period of operation requires proper weatherproofing to avoid system damage and electrical faults.

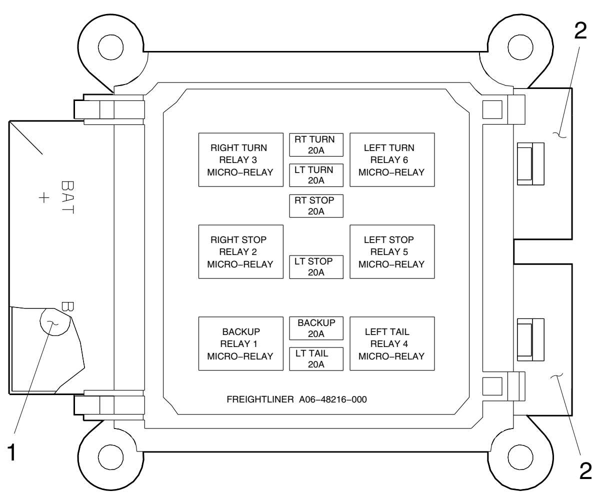
Taillight PDM Removal and Installation

Removal

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.

NOTE: The taillight power distribution module (PDM) can be mounted on the left frame rail aft of the cab, or on a crossmember at the end of the frame rail. If a vehicle is equipped with both a taillight PDM and trailer PDM, the taillight PDM is always mounted in the left frame rail aft of the cab.

3. Remove the nut and washer that attach the positive lead to the taillight PDM battery power stud, and remove the positive lead. See **Fig. 1**.
4. Disconnect the electrical connectors from the taillight PDM. See **Fig. 1**.
5. Remove the nuts and washers that attach the PDM to the mounting bracket, and remove the PDM. See **Fig. 2**.



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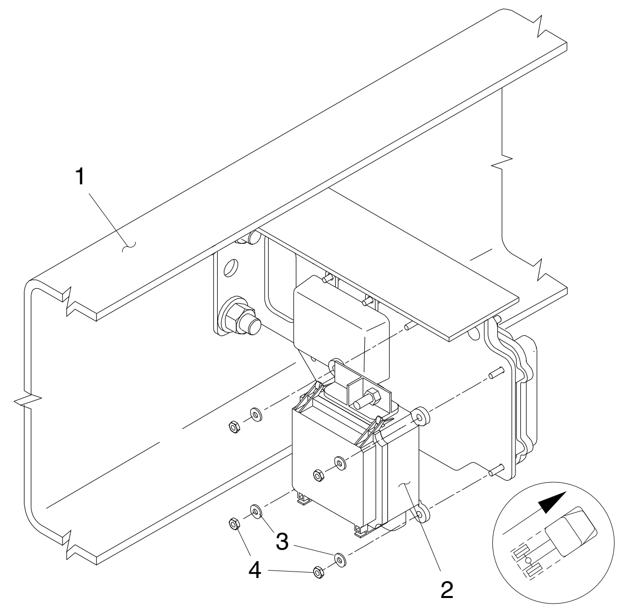
1. Battery Power Stud
2. Electrical Connector

Fig. 1, Taillight PDM Fuse Panel Layout



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1. Left Frame Rail
2. Taillight PDM
3. #10 Washer
4. 10-24 Nut

Fig. 2, Taillight PDM Installation

Installation

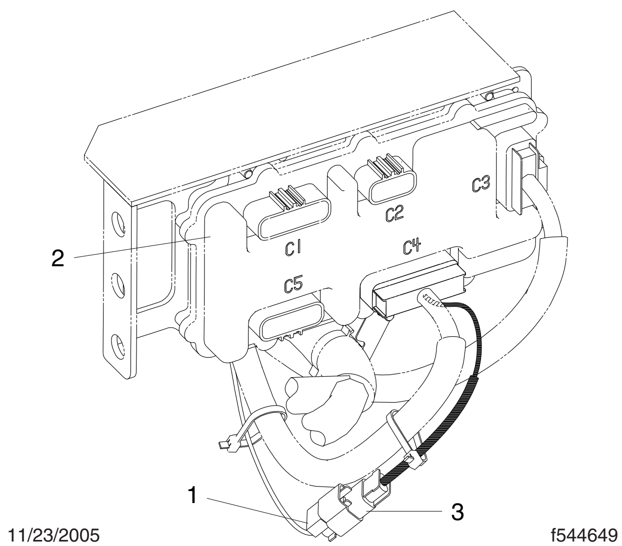
1. Using nuts and washers, install the taillight PDM on the mounting bracket.
2. Attach the electrical connectors to the taillight PDM.
3. Using a nut and washer, install the positive lead on the taillight PDM battery power stud. Torque the nut 11 to 13 lbf·ft (15 to 18 N·m).
4. Connect the batteries or turn the battery disconnect switch to on.
5. Verify the operation of the electrical components.
6. Remove the chocks from the tires.

Marker Light Jumper Harness for a Vehicle With an Optional Factory-Installed Harness

1. Turn off the engine, apply the parking brakes, and chock the tires.
2. Disconnect the negative leads from the batteries.

NOTE: The Chassis Module (CHM) is located on a bracket behind the back-of-cab crossmember (standard location) or underneath the cab on the driver side. For CHM location and connector identification, see **Subject 400**.

3. Find marker light jumper harness A06-53321-000. See **Fig. 1**. The harness is inserted at pin M of the CHM electrical connector C4.



1. Body Builder Marker Light Connector
2. Chassis Module
3. Jumper Harness

Fig. 1, Marker Light Jumper Harness

4. Remove the seal plug from cavity B of the 2-pin connector of the marker light jumper harness and connect jumper harness A06-19868-074 to the cavity.
5. Splice additional marker lights to the blunt cut wire of harness A06-19868-074 using solder and heat shrink tubing.

IMPORTANT: The combined maximum allowable load at the chassis module **must not exceed 10 amps**. The A06-19868-074 harness includes a 7.5 amp inline fuse to ensure that the total load for the circuit does not exceed the maximum allowable 10 amps, including the existing connected load, which is normally 0.7 amps. If greater amperage is required, use the blunt-cut wire to trigger a relay with the power source coming from a separate fused battery supply.

6. Properly install and route the marker light circuit.
7. Connect the batteries.
8. Verify the operation of the marker lights.
9. Remove the chocks from the tires.

Marker Light Jumper Harness for a Vehicle Without an Optional Factory-Installed Harness

NOTE: When adding marker lights to a vehicle without a factory-installed optional harness, jumper harnesses A06-53321-000 and A06-19868-074 are required.

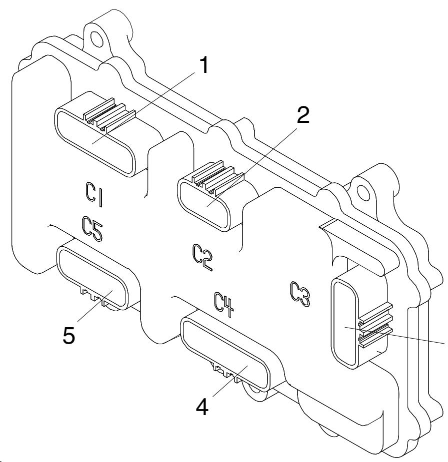
1. Turn off the engine, apply the parking brakes, and chock the tires.
2. Disconnect the negative leads from the batteries.

NOTE: The Chassis Module (CHM) is located on a bracket behind the back-of-cab crossmember (standard location) or underneath the cab on the driver side. For CHM location and connector identification, see **Subject 400**.

3. Disconnect the forward chassis harness from position C4 of the CHM. See **Fig. 2**.
4. Remove circuit 46F (BR, right marker lamp) from cavity M of the forward chassis harness. See **Fig. 3** and **Fig. 4**.
5. Connect the single connector end of jumper harness A06-19868-073 into cavity M of the forward chassis harness. See **Fig. 5**.
6. Connect the forward chassis harness to position C4 of the CHM.

Marker Light Connections

7. Connect circuit 46F to cavity A of the 2-pin connector of jumper harness A06-19868-073.
8. Remove the seal plug from cavity B of the 2-pin connector of jumper harness A06-19868-073, and connect jumper harness A06-19868-074 to the cavity. See **Fig. 5** and **Fig. 6**.
9. Splice additional marker lights to the blunt-cut wire of harness A06-19868-074 using solder and heat-shrink tubing.



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

Fig. 2, Chassis Module Connections

IMPORTANT: The combined maximum allowable load at the chassis module must not exceed 10 amps. The A06-19868-074 harness includes an inline fuse to ensure that the total load for the circuit doesn't exceed the maximum allowable 10 amps including the existing connected load which is normally 0.7 amps. If greater amperage is required, use the blunt-cut wire to trigger a relay with the power source coming from a separate fused battery supply.

10. Properly install and route the marker light circuit.
11. Connect the batteries.
12. Verify the operation of the marker lights.
13. Remove the chocks from the tires.

Marker Light Junction Block

1. Turn off the engine, apply the parking brakes, and chock the tires.
2. Disconnect the negative leads from the batteries.

NOTE: The Chassis Module (CHM) is located on a bracket behind the back-of-cab crossmember (standard location) or underneath the cab on the driver side. For CHM location and connector identification, see **Subject 400**.

3. Find the junction block attached to the frame rail near the CHM. See **Fig. 6**.
4. Remove the capscrews that attach the junction block cover to the junction block, and remove the cover. Then find the marker light feed at the yellow wire.
5. Using an appropriate ring terminal, connect the marker light circuit to the junction block.

IMPORTANT: The combined maximum allowable load at the chassis module **must not exceed 10 amps**.

6. Use an appropriately sized inline fuse to provide proper circuit protection to the marker light circuit.
7. Properly install and route the marker light circuit.
8. Using capscrews, attach the junction block cover to the junction block.
9. Connect the batteries.
10. Verify the operation of the marker lights.
11. Remove the chocks from the tires.

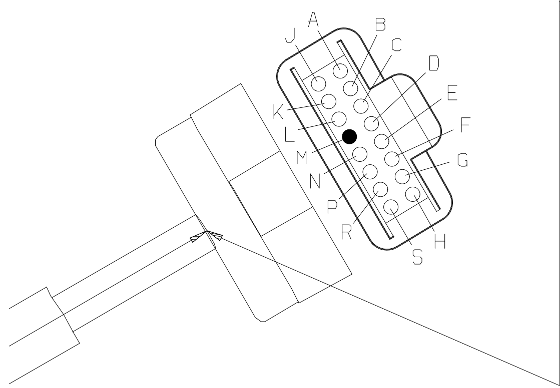
Marker Light Splice

1. Turn off the engine, apply the parking brakes, and chock the tires.
2. Disconnect the negative leads from the batteries.

NOTE: The Chassis Module (CHM) is located on a bracket behind the back-of-cab crossmember (standard location) or underneath the cab on the driver side. For CHM location and connector identification, see **Subject 400**.

3. Find pin M of the CHM electrical connector C4.

Marker Light Connections



IDENTIFR :FWD_CHAS_H_CHM_C4C	
PART NUMB:PAC15326666	
ETN IDNUM	CIRCUIT_NUMBER
A	14E # 1101 (R)
B	481 # 1206 (BK-W)
C	102A # 1303 (BR)
D	46E # 1303 (BR)
E	481 # 1206 (BK-W)
G	1939+ # 1603 (Y)
J	14G # 1101 (R)
K	21H # 1301 (LTG)
L	103 # 1303 (BR)
M	46F # 1303 (BR)
P	14G # 1101 (R)
R	1939- # 1603 (DKG)
S	GNDE # 1206 (BK-W)

10/11/2002 f544150

NOTE: Cavities I, O, and Q are skipped to avoid confusion with the numbers 1 and 0. Connector end view is shown from the wire insertion end.

Fig. 3, Typical Forward Chassis Harness at Position C4

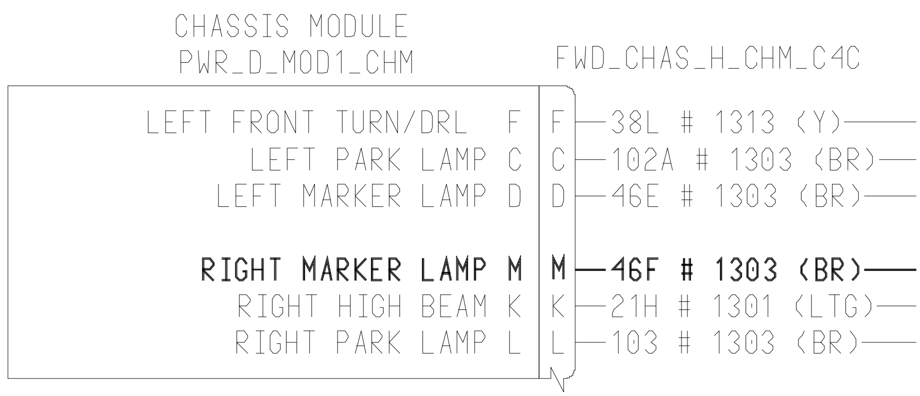


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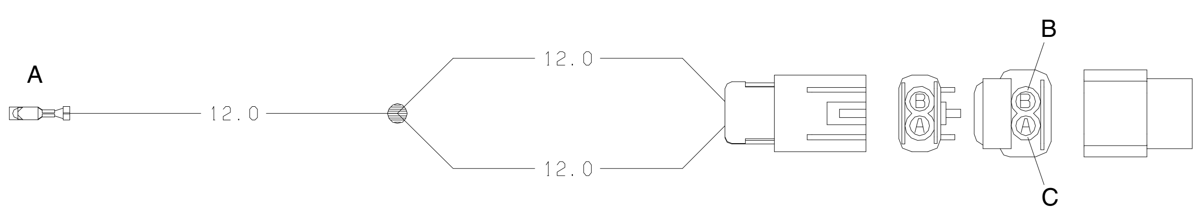
Fig. 4, Exterior Lighting Schematic at Chassis Module Connection C4



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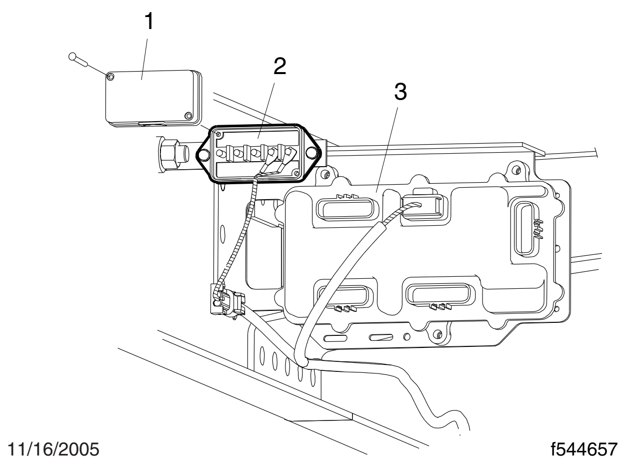
NOTE: Dimensions are in inches. Connector end view is shown from the wire insertion end.

A. Connect to cavity M of the forward chassis harness at position C4 of the Chassis Module.
B. Connect to harness A06-19868-074.
C. Connect to circuit 46F.

Fig. 5, Jumper Harness A06-19868-073

Marker Light Connections



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

Fig. 6, Junction Block Location

4. Pull back the wire loom to expose a sufficient length of circuit 46F to allow for splicing.
5. Splice within 6 to 8 inches (150 to 200 mm) of the CHM using appropriate waterproof methods.

IMPORTANT: The maximum allowable load from the vehicle chassis marker lights, combined with the added load of the body marker lights, **must not exceed 10 amps**.

6. Use an appropriately sized inline fuse to provide proper circuit protection to the marker light circuit.
7. Properly install and route the marker light circuit.

   Using electrical tape, wrap the harness bundle at least 2 inches (51 mm) on both sides of the splice connection, and wrap the added circuit at least 2 inches (51 mm) beyond the splice point to protect the marker light circuit. To reduce the chance of abrasion, cut a small notch in the wire loom where the added circuit leaves the loom. Install the wire loom over the harness bundle.
8. Connect the batteries.
9. Verify the operation of the marker lights.
10. Remove the chocks from the tires.

Stop Light Function

The stop light function of the high-current interface harness and the low-current lighting interface harness depends on the programming of the vehicle. Combination stop and turn lights are standard on M2 vehicles; however, it is possible to program the BHM (bulkhead module) for separate stop and turn lights. See **Table 1**.

To determine the stop lamp configuration presently programmed on a vehicle:

- Observe the lights in operation;
- Obtain the sales data-code description for the taillights from the dealer;
- Or use ServiceLink® to view the rear lighting reference parameter that begins with 26-01020.

When adding or changing a feature on the M2, you must use ServiceLink to update the programming on the vehicle. See **Section 54.28**, "Rear Lighting and Turn Signal Systems," for information on programming the functions of the stop and turn signal lights.

Stop Light Function			
Interface Type	**Pin Location**	**Programmed for Combination Stop and Turn Lights**	**Programmed for Separate Stop and Turn Lights**
Low Current	7	Right Stop/Turn Light	Right Stop Light
Low Current	8	Left Stop/Turn Light	Left Stop Light
High Current	10	Right Stop/Turn Light	Right Stop Light
High Current	18	Left Stop/Turn Light	Left Stop Light

Table 1, Stop Light Function

Troubleshooting

Electrical Troubleshooting		
Option	**Description of Fault**	**Possible Cause**
High Current	No outputs	MEGA® Fuse that supplies the PDM is open or missing.
High Current	No operation on a single output	PDM components are inoperable. Check the PDM fuse (blown) and relay (stuck) for that output.
Low Current, Additional Marker Lights	No operation on a single output	CHM may have disabled the output due to an overloaded circuit. Make sure that the collective load does not surpass the maximum current capacity for that circuit.
All	Intermittent or no operation at all outputs	Loss of connection. Check electrical connectors to make sure they are properly connected. For the high-current interface, check the ground connection.
All	Intermittent or no operation on a single output	Trace the suspect circuit and look for a loose terminal connection or damaged wire.
Additional Marker Lights	Intermittent or no operation	Check to see if the inline fuse is open (blown). Check the additional marker light connection point for proper installation.

Table 1, Electrical Troubleshooting

Current Capabilities

The high-current lighting interface harness supplies 20-amp circuit protection on all outputs. The Chassis Module (CHM) controls relays located in the taillight power distribution module (PDM). The PDM also contains fuses to provide the 20-amp circuit protection when the relays are activated. Battery power to the taillight PDM fuses is supplied from one of the MEGA® Fuses.

The low-current lighting interface harness provides outputs that are essentially splices from existing CHM lighting signals. The low-current interface harness provides for limited load applications such as additional LED (light-emitting diode) lighting. Since the interface outputs are splices from existing circuits, CHM maximum current loads can not be exceeded. Most of the CHM lighting outputs support a maximum current load of 7.45 amps, with the exception of the taillight outputs which support a combined maximum current load of 1 amp. When determining the total combined current load for any output, include the new lighting connected to the interface as well as all preexisting lighting of the same function that came factory-installed and is not permanently removed during body installation.

Additional marker light connections are powered by a CHM output. Do not exceed a maximum combined current load of 10 amps for a CHM marker lights output. When installing any additional marker lights, include an inline fuse with a rating equal to, or slightly higher than, the added lighting load. In no instance should the inline fuse exceed 10 amps.

Lighting Interface Wiring Diagrams

For a wiring diagram of the original design for the high-current interface harness A06-44608, see **Fig. 1**.

For a wiring diagram of the new design for the high-current interface harness A06-48218, see **Fig. 2**.

For a wiring diagram of the low-current interface harness A06-44388, see **Fig. 3**.

For a wiring diagram of the additional marker lights, see **Fig. 4**.

Circuit Identification

Chassis Module

The Chassis Module (CHM) may be located on a bracket behind the back-of-cab crossmember (standard location), or underneath the cab on the driver's side. For the back-of-cab CHM location, see **Fig. 5**. For CHM connector identification, see **Fig. 6**.

The high-current and low-current interface harnesses receive CHM lighting outputs via CHM connector C1. For a connector face view and pinout chart of the CHM C1 connector, see **Table 1**.

The marker light jumper harness is inserted at pin M of the CHM connector C4. For a connector face view of the CHM C4 connector and pin M identification, see **Table 2**.

The marker light junction block connection is made at pin F of the CHM connector C2. For a connector face view of the CHM C2 connector and pin F identification, see **Table 3**.

Taillight PDM

The taillight power distribution module (PDM) contains the necessary components to supply a high-current lighting interface harness. For taillight PDM layout and identification of electrical connections, see **Subject 100**.

For a connector face view and pinout chart of the taillight module harness PDM connector C2, see **Table 4**.

For a connector face view and pinout chart of the lighting interface harness PDM connector C8, see **Table 5**.

Lighting Interface

For a connector face view and pinout chart of the original design for the high-current lighting interface harness A06-44608, see **Table 6**.

For a connector face view and pinout chart of the new design for the high-current lighting interface harness A06-48218, see **Table 7**.

For a connector face view and pinout chart of the low-current lighting interface harness A06-44388, see **Table 8**.

Specifications

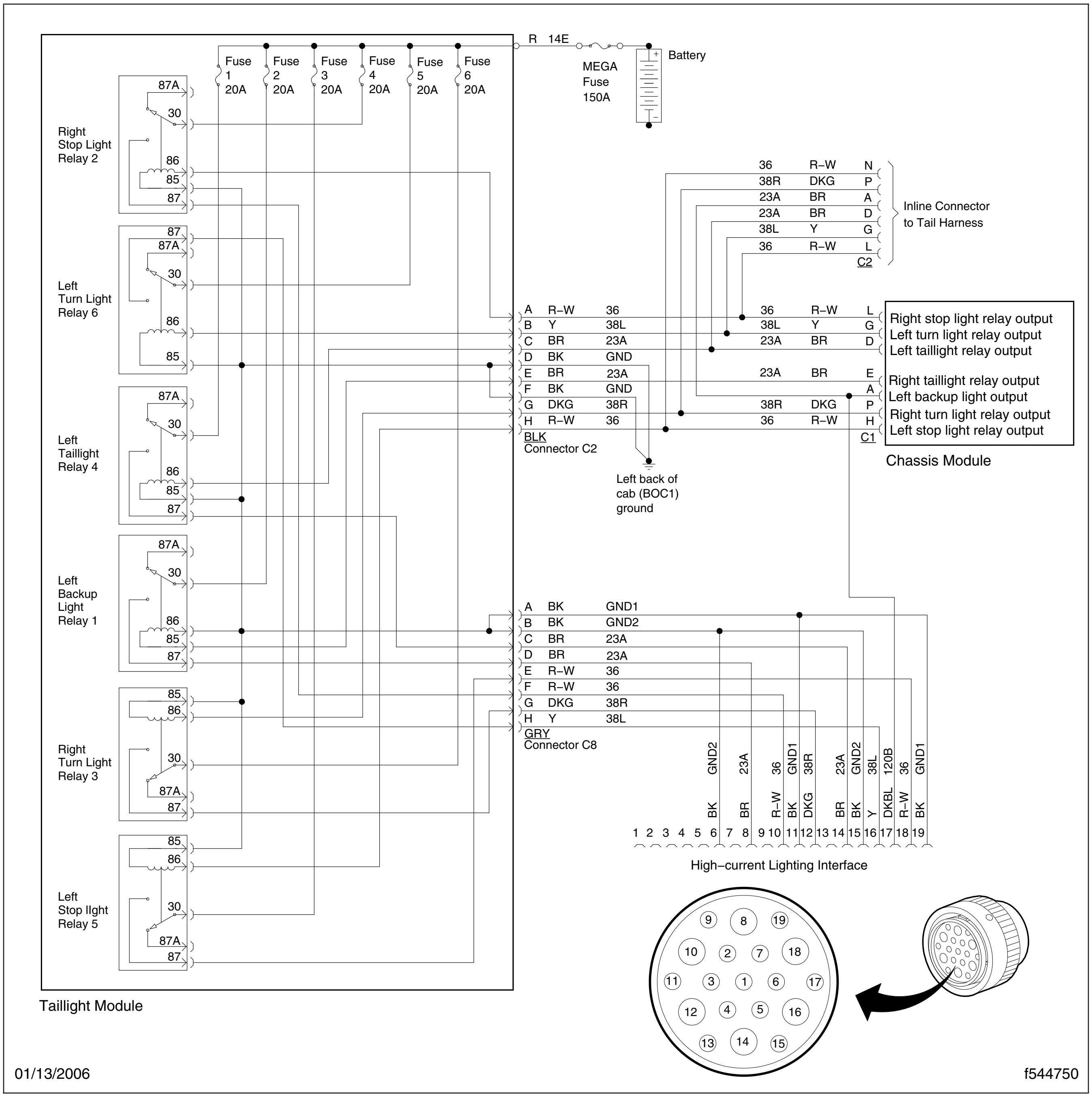


Fig. 1, Wiring Diagram of the Original Design for the High-Current Interface Harness A06-44608

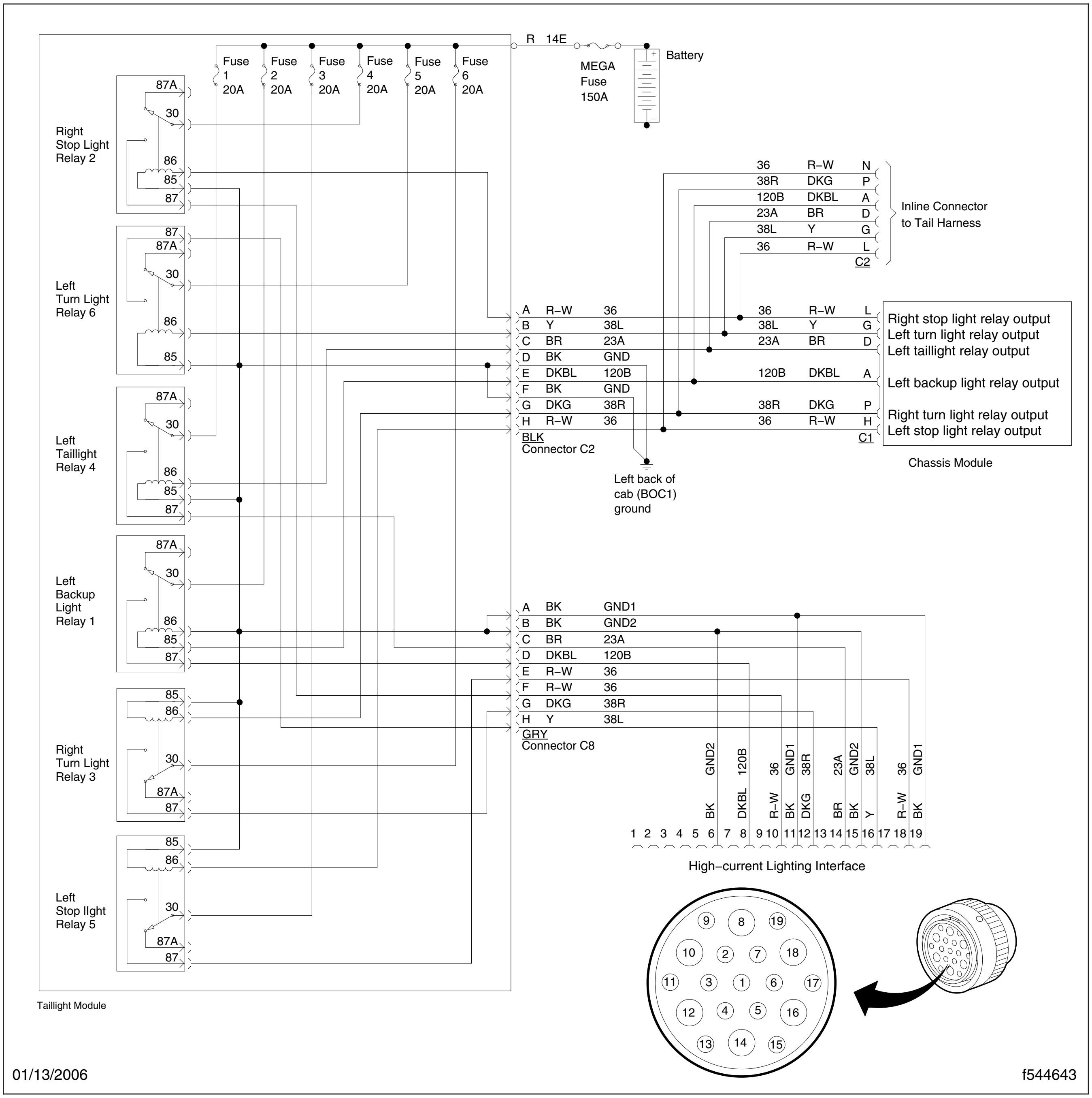


Fig. 2, Wiring Diagram of the New Design for the High-Current Interface Harness A06-48218

Specifications

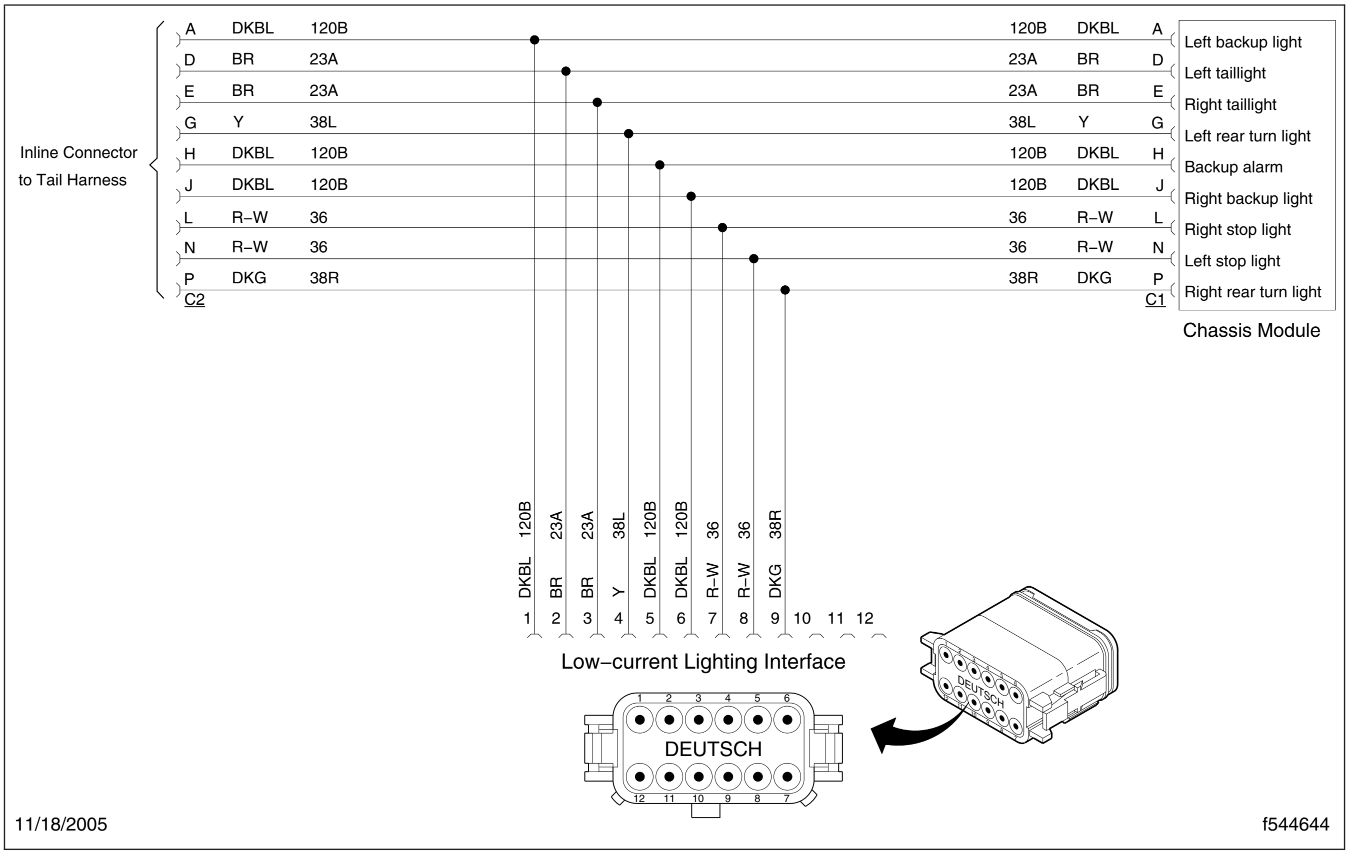


Fig. 3, Wiring Diagram of the Low-Current Interface Harness A06-44388

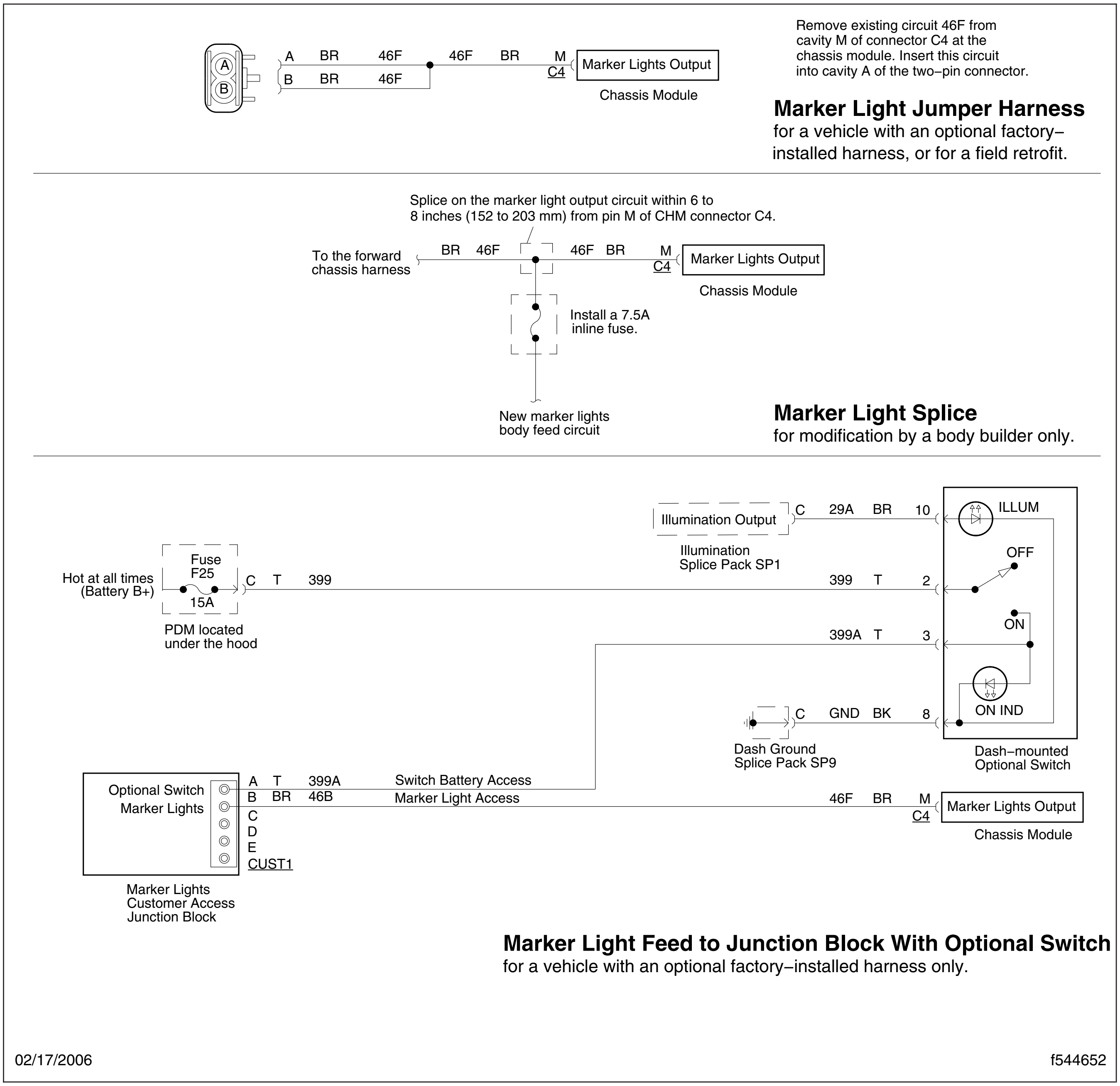
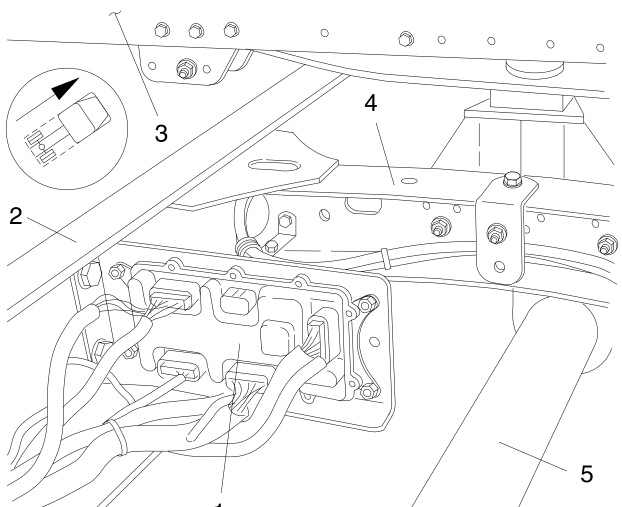


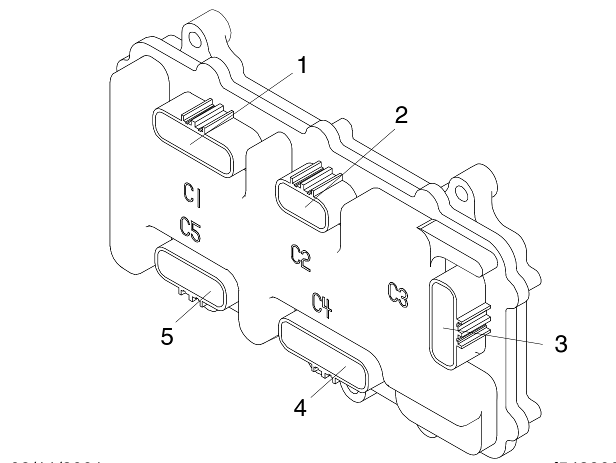
Fig. 4, Additional Marker Light Wiring Diagram

Specifications



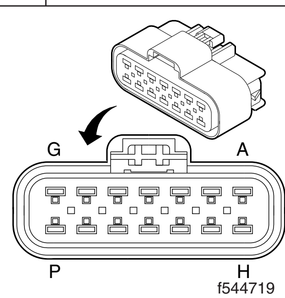
1. Chassis Module
2. Left Frame Rail
3. Cab Backwall
4. Crossmember
5. Driveline

Fig. 5, Back-of-Cab Chassis Module Location



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

Fig. 6, Chassis Module Connector Identification

Lighting Interface Harness Pinouts at CHM Connector C1					
Connector Pin	**Signal Name**	**Signal Type**	**Circuit Color**	**Circuit Number**	**Current Capacity**
					
C1-A	Left Backup Light	Digital Output	DKBL	120B	7.45A*
C1-B	—	—	T	OPTA	—
C1-C	—	—	T	OPTB	—
C1-D	Left Taillight Pass-Through	Pass-Through	BR	23A	1.0A†
C1-E	Right Taillight Pass-Through	Pass-Through	BR	23A	1.0A†
C1-F	License Plate Light	Digital Output	BR	23C	1.0A†
C1-G	Left Rear Turn Light	Digital Output	Y	38L	7.45A‡
C1-H	Backup Alarm	Digital Output	DKBL	120B	7.45A*

Specifications

Lighting Interface Harness Pinouts at CHM Connector C1					
Connector Pin	Signal Name	Signal Type	Circuit Color	Circuit Number	Current Capacity
C1-J	Right Backup Light	Digital Output	DKBL	120B	7.45A[*]
C1-K	—	—	T	OPTC	—
C1-L	Right Stop Light	Digital Output	R-W	36	7.45A
C1-M	—	—	T	OPTD	—
C1-N	Left Stop Light	Digital Output	R-W	36	7.45A
C1-P	Right Rear Turn Light	Digital Output	DKG	38R	7.45A[§]

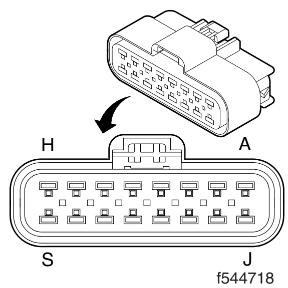
[*] Pins C1-A, C1-H, and C1-J are fed from the same CHM circuit board trace. The maximum combined current capacity for all three pins is 7.45A.

[†] Pins C1-D, C1-E, and C1-F are fed from the same CHM circuit board trace. The maximum combined current capacity for all three pins is 1A.

[‡] Pins C1-G, C2-H, and C3-N are fed by the same CHM circuit board trace. The maximum combined current capacity for all three pins is 7.45A.

[§] Pins C1-P, C2-E, and C3-R are fed by the same CHM circuit board trace. The maximum combined current capacity for all three pins is 7.45A.

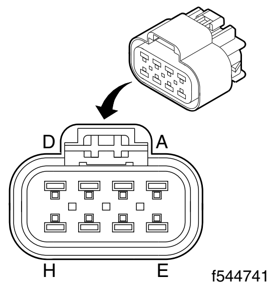
Table 1, Lighting Interface Harness Pinouts at CHM Connector C1

Marker Light Jumper Harness Connection at CHM C4					
Connector Pin	Signal Name	Signal Type	Circuit Color	Circuit Number	Current Capacity
					
C4-M	Right Marker Light	Digital Output	BR	46F	10A[*]

[*] Pins C4-M, C4-C, C4-D, C4-L, and C2-F are fed by the same CHM circuit board trace. The maximum combined current capacity for all five pins is 10A.

Table 2, Marker Light Jumper Harness Connection at CHM C4

Specifications

Marker Light Junction Block Connection at CHM C2					
Connector Pin	Signal Name	Signal Type	Circuit Color	Circuit Number	Current Capacity
					
C2-F	Trailer Marker Light Control	Digital Output	BR	46A	10A*

* Pins C2-F, C4-C, C4-D, C4-L, and C4-M are fed by the same CHM circuit board trace. The maximum combined current capacity for all five pins is 10A.

Table 3, Marker Light Junction Block Connection at CHM C2

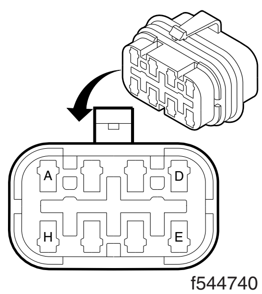
High-Current Taillight Module PDM Harness Connector C2				
Connector Pin	Signal Name	Signal Type	Circuit Color	Circuit Number
				
A	Right Stop Light Relay Control	Digital Input	R-W	36
B	Left Turn Light Relay Control	Digital Input	Y	38L
C	Left Taillight Relay Control	Digital Input	BR	23A
D	Ground	Ground	BK	GND
E	Backup Light Relay Control	Digital Input	DKBL	120B
F	Ground	Ground	BK	GND
G	Right Turn Light Relay Control	Digital Input	DKG	38R
H	Left Stop Light Relay Control	Digital Input	R-W	36

Table 4, High-Current Taillight Module PDM Harness Connector C2

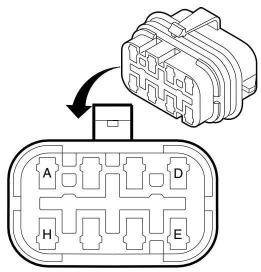
High-Current Lighting Interface PDM Harness Connector C8				
Connector Pin	**Signal Name**	**Signal Type**	**Circuit Color**	**Circuit Number**
		 f544739		
A	Ground	Ground	BK	GND 1
B	Ground	Ground	BK	GND 2
C	Left Taillight	+12V via PDM Fuse 1 (20A) with relay 4 (left taillight) active.	BR	23A
D	Backup Light	+12V via PDM Fuse 2 (20A) with relay 1 (backup light) active.	DKBL	120B
E	Left Stop Light	+12V via PDM Fuse 3 (20A) with relay 5 (left stop light) active.	R-W	36
F	Right Stop Light	+12V via PDM Fuse 4 (20A) with relay 2 (right stop light) active.	R-W	36
G	Right Turn Light	+12V via PDM Fuse 6 (20A) with relay 3 (right turn light) active.	DKG	38R
H	Left Turn Light	+12V via PDM Fuse 5 (20A) with relay 6 (left turn light) active.	Y	38L

Table 5, High-Current Lighting Interface PDM Harness Connector C8

Specifications

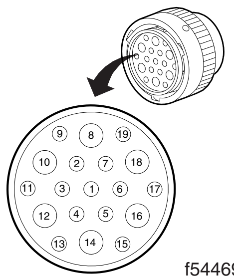
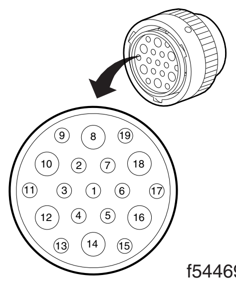
High-Current Lighting Interface Harness A06-44608					
Connector Pin	Signal Name	Signal Type	Circuit Color	Circuit Number	Current Capacity
 f544691					
1	—	—	—	—	—
2	—	—	—	—	—
3	—	—	—	—	—
4	—	—	—	—	—
5	—	—	—	—	—
6	Ground	Ground	BK	GND 2	—
7	—	—	—	—	—
8	Right Taillight	+12V via PDM Fuse 1 (20A) with relay 1 (right taillight) active.	BR	23A	20A
9	—	—	—	—	—
10	Right Stop Light	+12V via PDM Fuse 4 (20A) with relay 2 (right stop or stop/turn light) active.	R-W	36	20A
11	Ground	Ground	BK	GND 1	—
12	Right Stop Light or Right Stop/ Turn Light	+12V via PDM Fuse 6 (20A) with relay 3 (right turn light) active.	DKG	38R	20A
13	—	—	—	—	—
14	Left Taillight	+12V via PDM Fuse 1 (20A) with relay 4 (left taillight) active.	BR	23A	20A
15	Ground	Ground	BK	GND 2	—
16	Left Stop Light or Left Stop/ Turn Light	+12V via PDM Fuse 5 (20A) with relay 6 (left turn light) active.	Y	38L	20A
17	Backup Light	+12V via CHM.	DKBL	120B	7.45A
18	Left Stop Light	+12V via PDM Fuse 3 (20A) with relay 5 (left stop or stop/ turn light) active.	R-W	36	20A
19	Ground	Ground	BK	GND 1	—

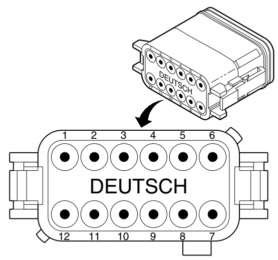
Table 6, High-Current Lighting Interface Harness A06-44608

High-Current Lighting Interface Harness A06-48218					
Connector Pin	**Signal Name**	**Signal Type**	**Circuit Color**	**Circuit Number**	**Current Capacity**
 f544691					
1	—	—	—	—	—
2	—	—	—	—	—
3	—	—	—	—	—
4	—	—	—	—	—
5	—	—	—	—	—
6	Ground	Ground	BK	GND 2	—
7	—	—	—	—	—
8*	Backup Light	+12V via PDM Fuse 2 (20A) with relay 1 (backup light) active.	DKBL	120B	20A
9	—	—	—	—	—
10	Right Stop Light	+12V via PDM Fuse 4 (20A) with relay 2 (right stop light) active.	R-W	36	20A
11	Ground	Ground	BK	GND 1	—
12	Right Stop Light or Right Stop/ Turn Light	+12V via PDM Fuse 6 (20A) with relay 3 (right stop or stop/turn light) active.	DKG	38R	20A
13	—	—	—	—	—
14	Left Taillight	+12V via PDM Fuse 1 (20A) with relay 4 (left taillight) active.	BR	23A	20A
15	Ground	Ground	BK	GND 2	—
16	Left Stop Light or Left Stop/ Turn Light	+12V via PDM Fuse 5 (20A) with relay 6 (left turn light) active.	Y	38L	20A
17	—	—	—	—	—
18	Left Stop Light	+12V via PDM Fuse 3 (20A) with relay 5 (left stop or stop/ turn light) active.	R-W	36	20A
19	Ground	Ground	BK	GND 1	—

* Some early harnesses have pin 8 located in pin 17.

Table 7, High-Current Lighting Interface Harness A06-48218

Specifications

Low-Current Lighting Interface Harness A06-44388					
Connector Pin	Signal Name	Signal Type	Circuit Color	Circuit Number	Current Capacity
 f544697					
1	Left Backup Light	Digital Output	DKBL	120B	7.45A*
2	Left Taillight	Digital Output	BR	23A	1.0A
3	Right Taillight	Digital Output	BR	23A	1.0A
4	Left Turn Light	Digital Output	Y	38L	7.45A
5	Backup Alarm	Digital Output	DKBL	120B	7.45A*
6	Right Backup Light	Digital Output	DKBL	120B	7.45A*
7	Right Stop Light or Right Stop/Turn Light	Digital Output	R-W	36	6.7A
8	Left Stop Light or Left Stop/Turn Light	Digital Output	R-W	36	6.7A
9	Right Turn Light	Digital Output	DKG	38R	7.45A
10	—	—	—	—	—
11	—	—	—	—	—
12	—	—	—	—	—

* This pin is fed by CHM pins 1, 5, and 6. The maximum combined current capacity for all three pins is 7.45A.

Table 8, Low-Current Lighting Interface Harness A06-44388

Deutsch HDP Series Size 12 Terminals			
Terminal Type	AWG	Freightliner Part Number	Deutsch Part Number
Stamped and Formed	12/14	DUF1060120166	1060-12-0166
Solid	12/14	DUF046020412141	0460-204-12141

Table 9, Deutsch HDP Series Size 12 Terminals

Deutsch DT and HDP Series Size 16 Terminals			
Terminal Type	AWG	Freightliner Part Number	Deutsch Part Number
Stamped and Formed	16/18	DUF1060160122PS	1060-16-0122
	14/16	DUF1060140122PS	1060-14-0122
	14/16/18	DUF1060160722	1060-16-0722

Deutsch DT and HDP Series Size 16 Terminals			
Terminal Type	**AWG**	**Freightliner Part Number**	**Deutsch Part Number**
Solid	16/18	DUF046020216141	0460-202-16141
	14/16	DUF046021516141	0460-215-16141

Table 10, Deutsch DT and HDP Series Size 16 Terminals

Contents

Background Information

Freightliner provides an engine interface harness when an rpm control system is needed for optional body builder features and PTO (power takeoff) applications. The optional features provided by this harness include:

- fast idle
- increment/decrement
- multiple fixed speeds
- variable rpm

The body builder must install circuits and switches for the rpm control system that is required.

To determine if a vehicle is equipped with an engine interface harness, look for a black, 12-pin Deutsch DT Series connector located on the engine side of the frontwall, behind the cab inside the left frame rail, or at the rear of the vehicle inside the left frame rail.

Fast Idle

An on/off switch controls the fast idle.

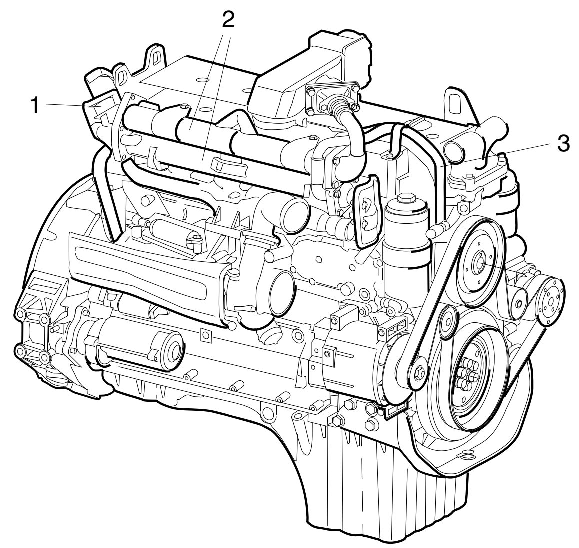
Increment/Decrement

The cruise control set and resume switches, or an increment/decrement switch located outside the cab, controls increment/decrement.

Although Cummins engines do not currently support the use of the cruise control set and resume switches for increment/decrement engine rpm control, they do support the use of an external increment/decrement switch.

On a vehicle with a Mercedes-Benz engine using multiplexed cruise control switches, an external increment/decrement switch cannot be added unless the cruise control switches are converted to wired switches. Vehicles with a 2004 EPA Mercedes-Benz engine have multiplexed cruise control switches. An engine with an EGR is a 2004 EPA engine. Check the engine to determine if it has exhaust gas recirculation (EGR). See **Fig. 1** and **Fig. 2** for some of the EGR components on an MBE900 and MBE4000 engine.

See **Subject 100** for instructions on how to hardwire the multiplexed cruise control switches in order to add an external increment/decrement switch.



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1. EGR Rotary Valve
2. EGR Cooler
3. EGR Cooler Coolant Supply

Fig. 1, MBE900 Engine With EGR

Multiple Fixed Speeds

On a vehicle with a Mercedes-Benz or Cummins engine, an on/off switch controls the multiple fixed speeds feature for PTO applications. When only one fixed speed is used, then the functionality is fast idle.

Press the on/off switch to the on position to attain fixed speed 1. Press the on/off switch on/off/on to attain fixed speed 2. Press the on/off switch on/off/on/off/on to attain fixed speed 3.

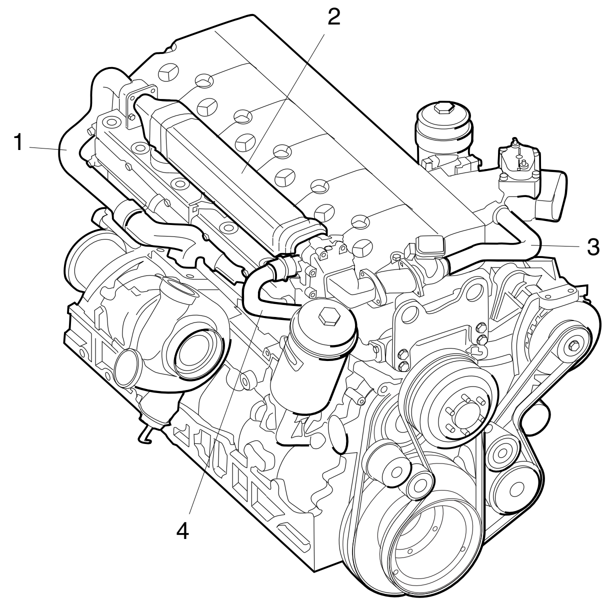
On a vehicle with a Caterpillar engine, one or two additional on/off switches control fixed speeds.

The rpm control switch must be in the on position before additional fixed speeds can be used. The rpm control switch can be programmed so that it controls a fixed speed when it is turned on. Refer to Caterpillar's service tools and documentation for more information.

Variable RPM

The remote throttle position sensor (TPS) controls the variable rpm through the use of a remote foot

General Information



1. EGR Hot Pipe
2. EGR Cooler
3. EGR Delivery Pipe
4. EGR Cooler Coolant Return

Fig. 2, MBE4000 Engine With EGR

pedal, a rotary hand throttle, or an electronic rpm control system, such as a Class1 governor. All engines support the variable rpm feature. Variable rpm is typically used on fire trucks and vacuum trucks.

Refer to the engine manufacturer's technical documentation to determine the electrical characteristics and component specifications for a variable rpm control.

Installation of an Engine Interface

When an rpm control system is needed for optional body builder features and PTO (power takeoff) applications, order an engine interface harness from a Freightliner dealer. The Freightliner dealer can install the interface harness directly to the engine control module (ECM), and do the programming. For instructions on adding a feature, see **Section 54.00, Subject 110**.

The body builder has the option of using documentation available from the engine manufacturer to install the circuits needed for the rpm control system.

Programming the Engine

Use the engine manufacturer's service software to program the settings needed for rpm control.

Engine Cruise Control Harness Installation

Installation

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. Remove the dash surround bezel, passenger-side dash cover, dash top cover, center dash panel, and left-side auxiliary control panel. See **Section 60.08** for removal instructions.
4. Disconnect the cruise control switches from the main dash electronic control unit (ECU) harness.
5. Remove the cruise control switches from the dash panel.
   5.1 From behind the dash panel, depress the clips that hold the switch in place.
   5.2 With the clips depressed, push the switch out through the front of the dash panel.
   5.3 Repeat these substeps for the other switch.
6. Tape the dash harness connectors so they do not rattle.

NOTE: The connectors will not be used again, but there is no need to remove them.

7. Install the new cruise control switches in the dash panel by pushing them in from the front of the dash panel until they click into place. See **Table 1** for part numbers of the cruise control switches and the engine cruise control harness.

Parts Required		
Description	**Part Number**	**Qty.**
On-Off Cruise Control Switch	A06-30769-011	1
Set-Resume Cruise Control Switch	A06-30769-012	1
Cruise Control Harness	A06-47841-000	1

Table 1, Parts Required

8. Connect the engine cruise control harness (A06-47841-000) to the cruise control switches, and route the harness over the main dash ECU harness. See **Fig. 1**.

IMPORTANT: Check the pin locations to verify the proper location.

9. Connect wires 440G to any open cavity on splice pack 13. See **Fig. 2** for a wiring diagram for a vehicle without an optional access connector for the engine control module (ECM); see **Fig. 3** for a wiring diagram for a vehicle with an optional access connector for the ECM (sales codes 148-014 through 148-046).

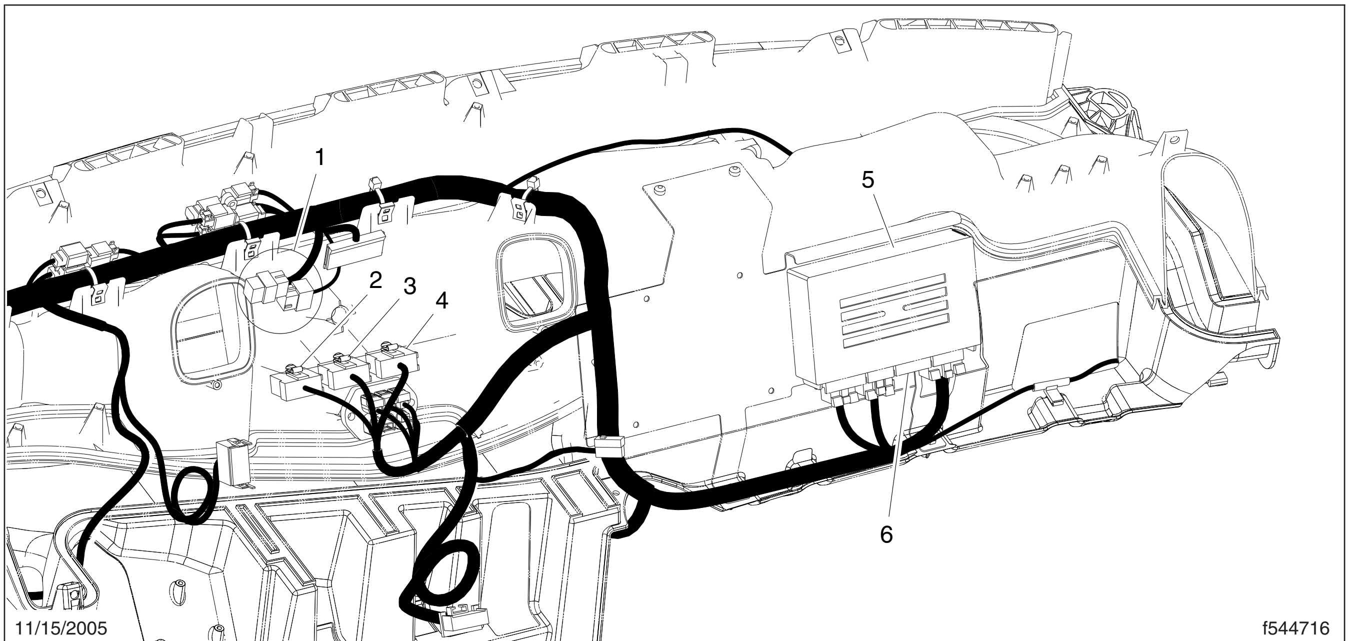
NOTE: The cavity locations may vary based on the vehicle configuration.

10. Connect wire 81C to any open cavity on splice pack 12A.
11. Connect wire 1204 GND to any open cavity on splice pack 9.
12. Connect wire 29A to any open cavity on splice pack 1.
13. On a vehicle without an optional access connector for the ECM, connect wire 440E to pin 4 of connector VC3 on the dash ECU harness. See **Fig. 2**.
    13.1 Connect wire 440F to pin 5 of connector VC3 on the dash ECU harness.
    13.2 Connect wire 440D to pin 6 of connector VC3 on the dash ECU harness.
14. On a vehicle with an optional access connector for the ECM, locate the 6-pin connector near the vehicle control unit (VCU). The 6-pin connector has an empty mating connector with wires 439U, 439A, and 439B. See **Fig. 3**.

    NOTE: There may be additional wires depending on the vehicle configuration.

    14.1 Unplug the mating connector and insert wire 440D in cavity 1, 440E in cavity 2, and 440F in cavity 3.
    14.2 Plug the mating connector into the vehicle-side 6-pin connector.
15. Install the dash panels. See **Section 60.08** for installation instructions.
16. Connect the batteries or turn the battery disconnect switch to on.
17. Using a Minidiag or DDDL, set the following parameters so that the cruise control switches will

Engine Cruise Control Harness Installation



1. Splice Pack 13
2. Splice Pack 1
3. Splice Pack 9
4. Splice Pack 12A
5. Dash Electronic Control Unit
6. VC3 18-pin Connector

Fig. 1, Main Dash ECU Harness Routing

work and to configure the rpm settings in power takeoff (PTO) mode.

17.1 Set parameter 11311 to zero (Cruise Switch On, Hardwired, or J1939 will be displayed).

17.2 Set parameter 11312 to zero (Set/Coast and Resume/Accel, Hardwired, or J1939 will be displayed).

17.3 Set parameter 11313 to zero (Cruise Pause, Hardwired, or J1939 will be displayed).

18. Set the following parameters as needed.

18.1 Program 10702 to the MAXIMUM RPM for PTO mode; this is the highest speed that the Cruise Control Resume input will reach.

18.2 Program 10703 to the MINIMUM RPM for PTO mode; this is the lowest speed that the Cruise Control Set input will reach.

18.3 Program 10709 to the speed desired (if different on initial startup) for the Cruise Control Set switch. The setting needs to be at least equal to or greater than 10703, and less than or equal to 10702.

18.4 Program 10712 to the speed desired (if different on initial startup) for the Cruise Control Resume switch input. The setting needs to be at least equal to or greater than 10703, and less than or equal to 10702.

18.5 10715 is the ramp rate and it should be adjusted to 250 rpm/second.

19. Verify that the cruise and engine PTO function correctly.

20. Remove the chocks from the tires.

Engine Cruise Control Harness Installation

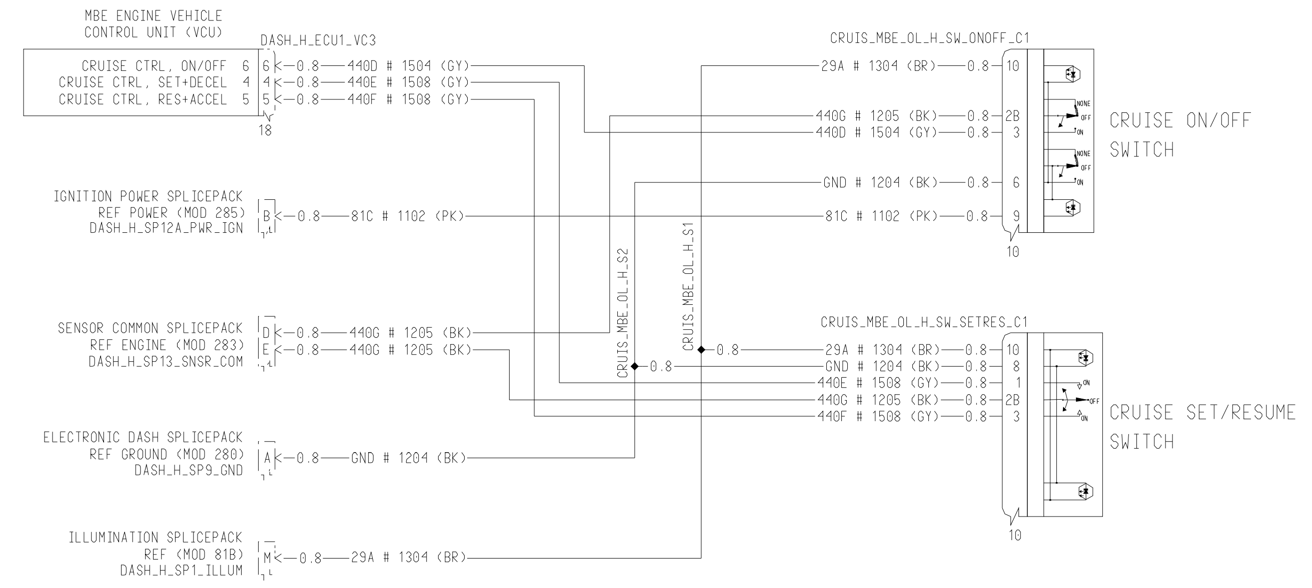


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Fig. 2, Engine Cruise Control Harness Wiring Diagram for a Vehicle Without an Optional Access Connector for the ECM

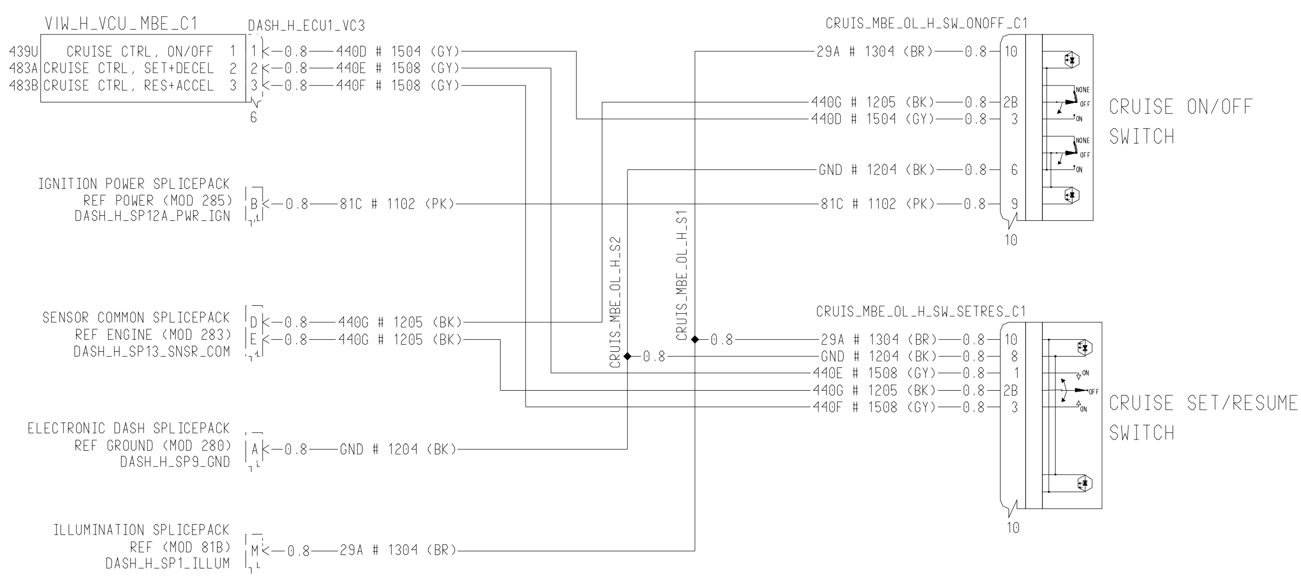

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Fig. 3, Engine Cruise Control Harness Wiring Diagram for a Vehicle With an Optional Access Connector for the ECM

Troubleshooting

When troubleshooting the engine interface harness, use the engine manufacturer's diagnostic literature for problems that cannot be traced to the Freightliner engine interface harness or to the wiring installed by a body builder.

Engine Interface Harness Troubleshooting	
Symptom	**Diagnosis**
The remote PTO on/off circuit is not functioning.	Check that the pins are seated correctly in the Deutsch connector.
	Check the functionality of interlocks.
The remote increment/decrement feature is not functioning.	For a Mercedes-Benz engine with 2004 EPA specifications, perform the installation procedure in **Subject 100** if necessary.
	Check that the pins are seated correctly in the DT-series Deutsch connector.
	Make sure that all interlock conditions are met before operation.
	For a Caterpillar engine, check the engine programming.
The remote throttle system is not functioning.	Make sure that the engine has been programmed correctly for the remote throttle.
	Check that the pins are seated correctly in the DT-series Deutsch connector.
	Make sure all interlock conditions are met before operation.

Table 1, Engine Interface Harness Troubleshooting

Wiring Schematics

See Fig. 1 for a typical wiring schematic for the engine interface harness for a vehicle with a Mercedes-Benz engine.

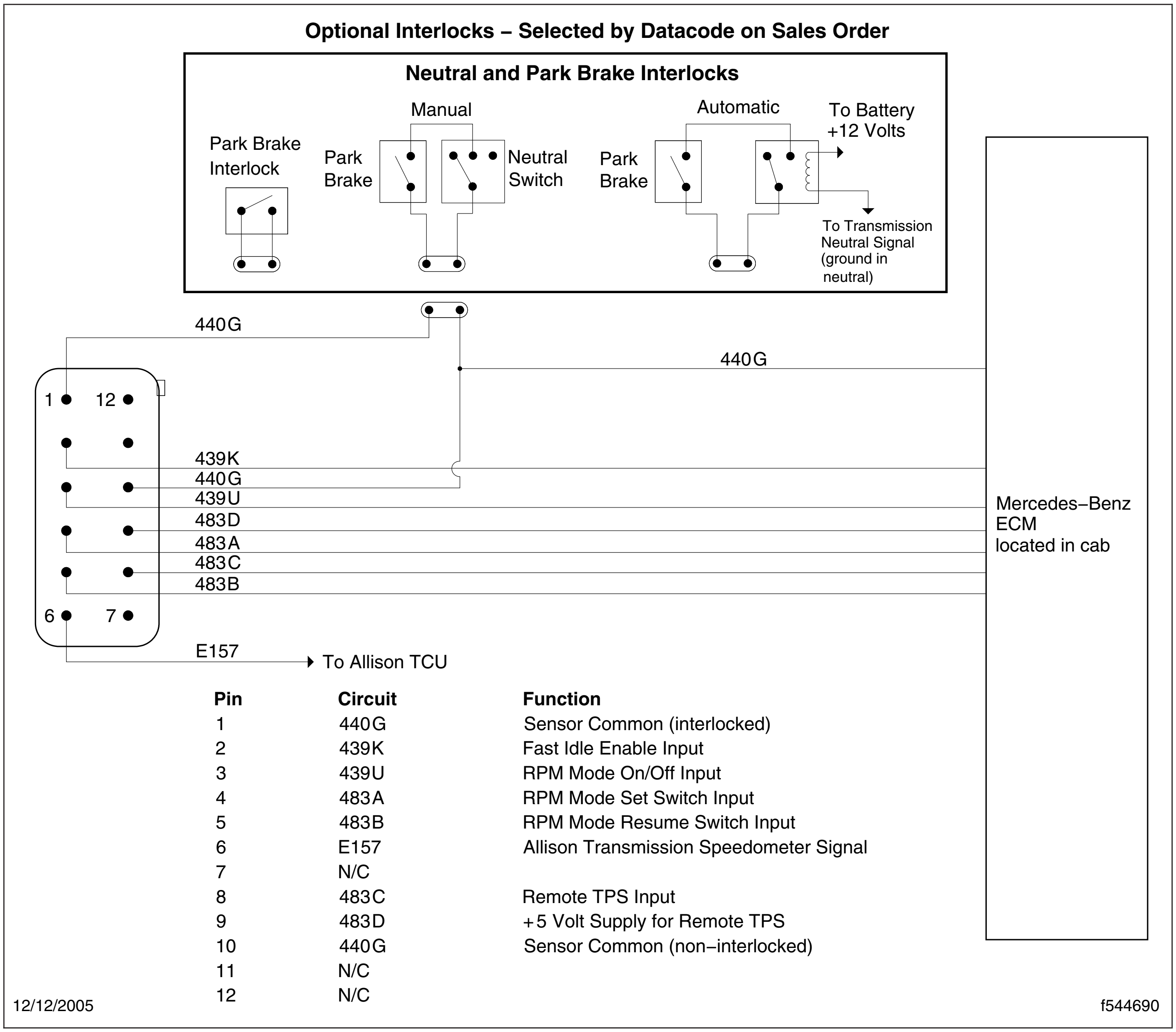
See Fig. 2 for a typical wiring schematic for the engine interface harness for a vehicle with a Caterpillar engine.

See Fig. 3 for a typical wiring schematic for the engine interface harness for a vehicle with a Cummins engine.

Deutsch DT Series Terminals			
Terminals	**Freightliner Part Number**	**Deutsch Part Number**	**AWG**
Stamped and Formed Terminals	DUF1060160122PS	1060-16-0122	16/18
	DUF1060140122PS	1060-14-0122	14/16
Solid Terminals	DUF046020216141	0460-202-16141	16/18
	DUF046021516141	0460-215-16141	14/16

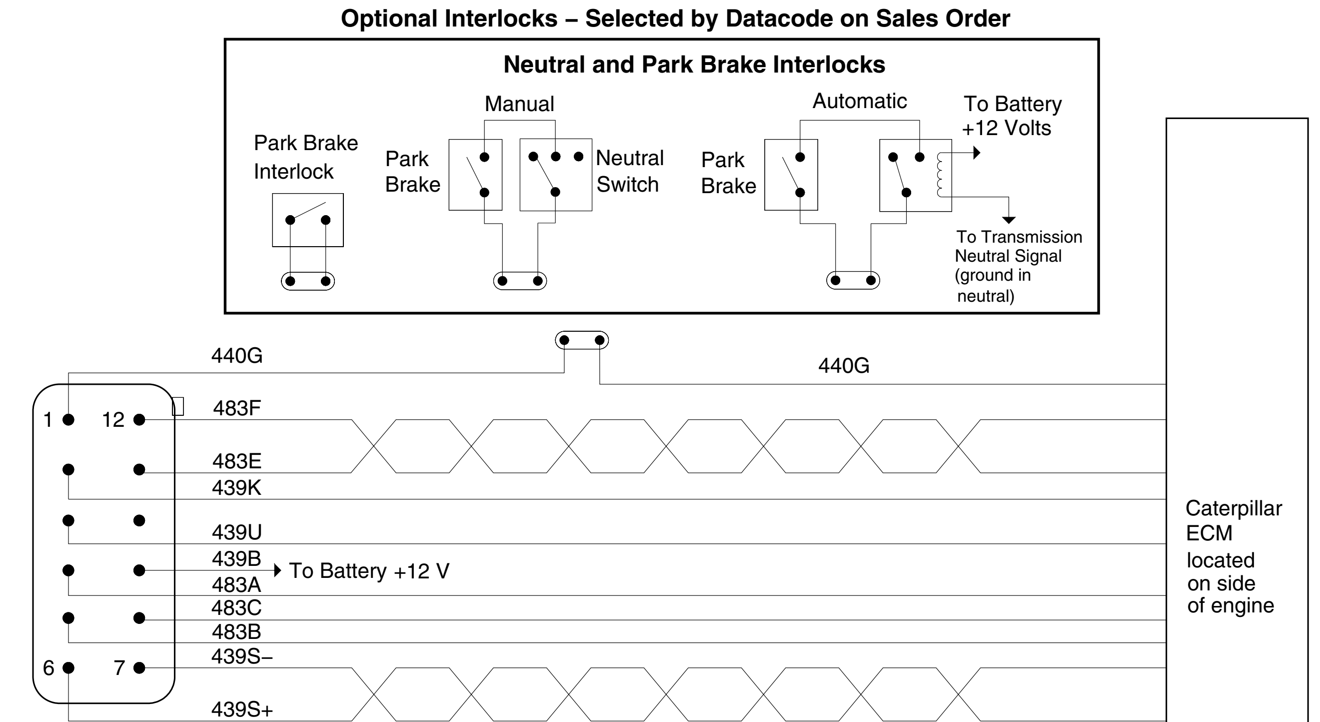
Table 1, Deutsch DT Series Terminals

Specifications



Pin	Circuit	Function
1	440G	Sensor Common (interlocked)
2	439K	Fast Idle Enable Input
3	439U	RPM Mode On/Off Input
4	483A	RPM Mode Set Switch Input
5	483B	RPM Mode Resume Switch Input
6	E157	Allison Transmission Speedometer Signal
7	N/C	
8	483C	Remote TPS Input
9	483D	+5 Volt Supply for Remote TPS
10	440G	Sensor Common (non–interlocked)
11	N/C	
12	N/C	

Fig. 1, Typical Wiring Schematic for the Engine Interface Harness for a Mercedes-Benz Engine



Pin	Circuit	Function
1	440G	Sensor Common
2	439K	Fast Idle Enable Input
3	439U	RPM Mode On/Off Input
4	483A	RPM Mode Set Switch Input
5	483B	RPM Mode Resume Switch Input
6	439S+	Speedometer + Signal
7	439S–	Speedometer – Signal
8	483C	Remote TPS Input
9	439B	+12 Volt Supply for Remote TPS
10	N/C	
11	483E	Tachometer + Signal
12	483F	Tachometer – Signal

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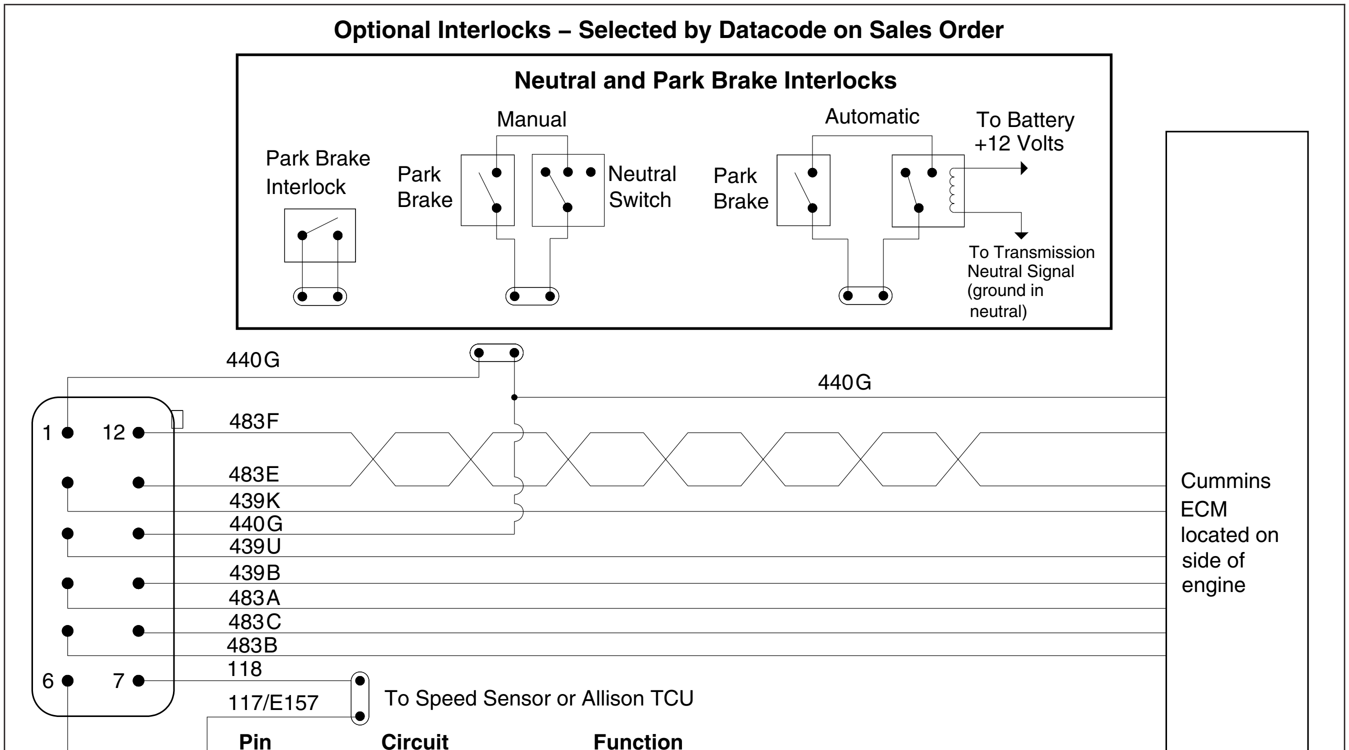
Fig. 2, Typical Wiring Schematic for the Engine Interface Harness for a Caterpillar Engine

Specifications



Pin	Circuit	Function
1	440G	Sensor Common
2	439K	Fast Idle Enable Input
3	439U	RPM Mode On/Off Input
4	483A	RPM Mode Set Switch Input
5	483B	RPM Mode Resume Switch Input
6	117/E157	Speedometer + Signal (manual/Allison)
7	118	Speedometer −˘Signal (manual only)
8	483C	Remote TPS Input
9	439B	+12 Volt Supply for Remote TPS
10	440G	Sensor Common (non−interlocked)
11	483E	Tachometer + Signal
12	483F	Tachometer Ground Signal

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Fig. 3, Typical Wiring Schematic for the Engine Interface Harness for a Cummins Engine

Contents

Background Information

Allison electronically controlled transmissions may be equipped with an optional transmission interface harness for customization by the body builder. The interface harness provides the vehicle interface wiring (VIW) connector to body builders for use in tying in to the transmission electronics for their specific application. The transmission interface harness provides for one type of VIW connector that is documented in the Allison transmission engineering documentation.

The transmission interface harness provides the VIW connection for the current generation of 1000/2000 Series or 3000/4000 Series electronic controls, depending on the transmission that is installed in the vehicle. The transmission interface harness provides most of the optional I/O circuits, and the speedometer signal, in a connector that can be used by the body builder.

See **Specifications 400** for wiring diagrams of the Allison Transmission® 1000/2000 Series and 3000/4000 Series VIW Connector.

Adding a Feature

Vehicle With a Transmission Interface Harness

On a vehicle equipped with a transmission interface harness, use the appropriate Deutsch DT Series pin terminal listed in **Table 1**. The terminal can be ordered from a Freightliner dealer. It may also be available through an Allison authorized service dealer.

Vehicle Without a Transmission Interface Harness

On a vehicle without a transmission interface harness, it is possible to wire in the individual circuits that are needed for a specific application. Currently, the Allison transmission control unit uses a Delphi Micro-Pack sealed, female terminal, part number PAC12084912. The terminal can be ordered from a Freightliner dealer. It may also be available through an Allison authorized service dealer.

CAUTION

Be extremely careful when installing the terminals in the connector. The terminals are very small and may get bent if not handled with care.

IMPORTANT: Before removing the cavity plugs from the connector, identify the cavities that will be used for the specific application.

It is highly recommended that you use Freightliner's wiring schematics when installing a feature on a vehicle without a transmission interface harness.

When adding a transmission interface harness to a vehicle, use the following instructions to add a feature to the vehicle.

1. Using the *Freightliner Business Class® M2 Data Book*, select the applicable data code that applies to the requested add-on feature.
2. Contact Freightliner Body Builder Technical Support at 503-745-6822 Monday through Friday, 6 A.M. to 3:30 P.M. Pacific time, and tell the representative the last six digits of the vehicle serial number and the data code requested. The representative will advise of the availability of the feature.

Deutsch DT Series Terminals			
Terminals	**Freightliner Part Number**	**Deutsch Part Number**	**AWG**
Stamped and Formed Terminals	DUF1060 16 0122	1060-16-0122	16/18
	DUF1060 14 0122	1060-14-0122	14/16
Solid Terminals	DUF046020216141	0460-202-16141	16/18
	DUF046021516141	0460-215-16141	14/16

Table 1, Deutsch DT Series Terminals

Troubleshooting

See the Allison *Troubleshooting Manual* for troubleshooting procedures.

Troubleshooting is dependent on the calibration that is programmed in to the transmission control unit (TCU). To determine the TCU calibration, obtain information from the 343 module data code on the vehicle sales order, or use Allison's diagnostic software, Allison DOC.

Specifications

See **Fig. 1** for a wiring diagram of the Allison Transmission® 1000/2000 Series VIW Connector.

See **Fig. 2** for a wiring diagram of the Allison Transmission® 3000/4000 Series VIW Connector.

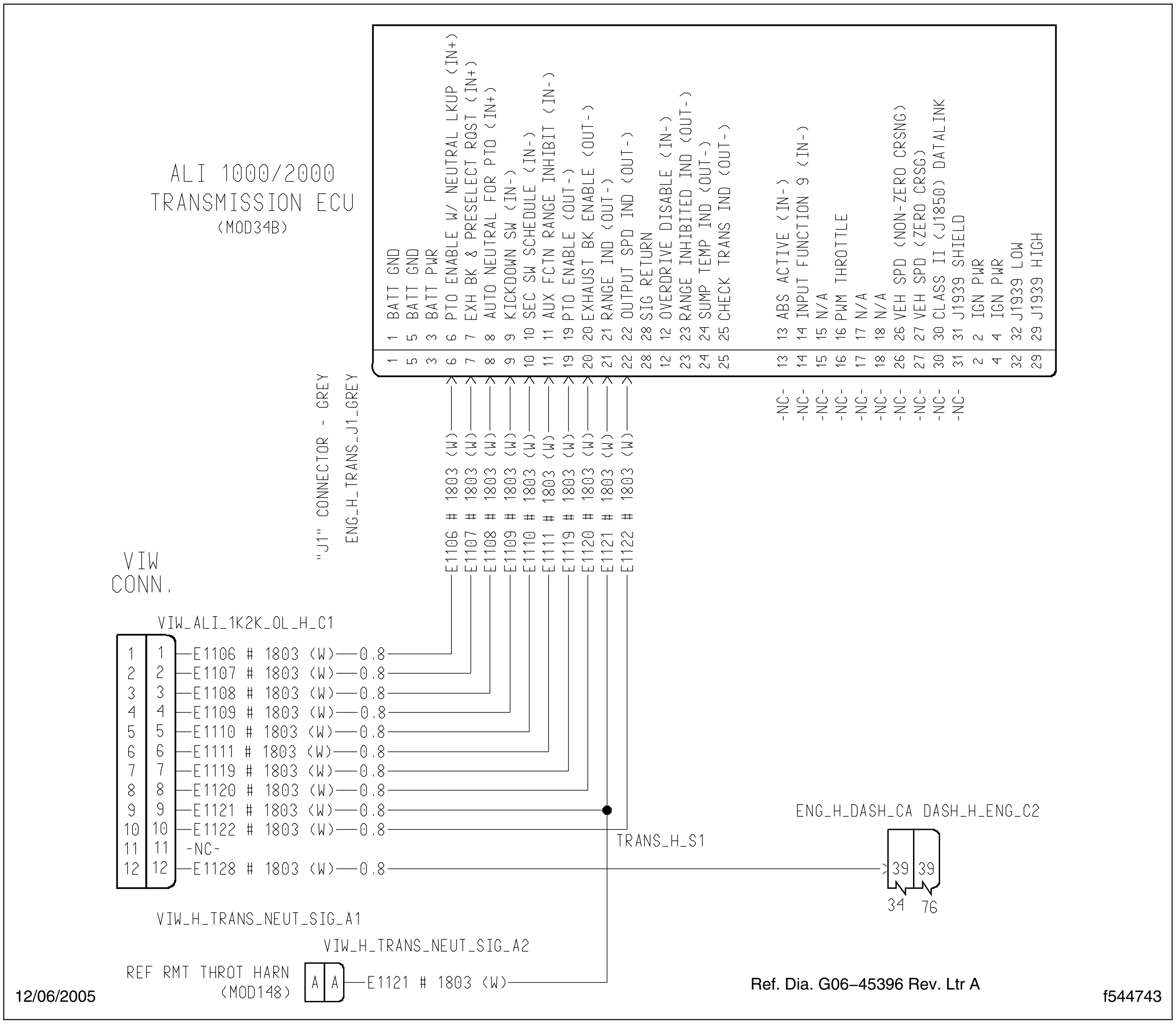


Fig. 1, Allison Transmission 1000/2000 Series VIW Connector Wiring Diagram

Specifications

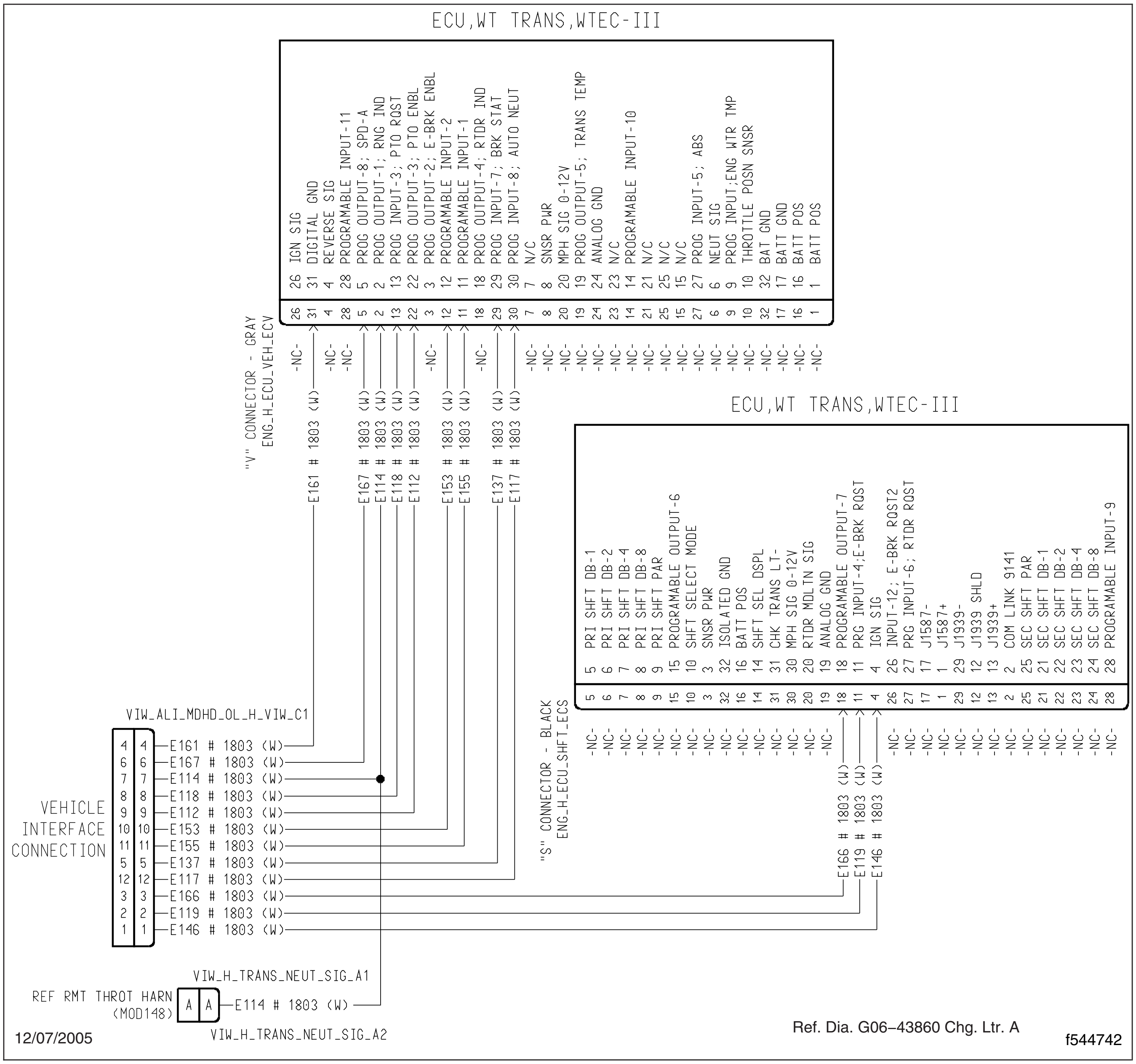


Fig. 2, Allison Transmission 3000/4000 Series VIW Connector Wiring Diagram

Contents

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®.

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. Then open the "AMU Solenoids Circuits" or "AAVA Solenoids Circuits" in the appropriate Datalink Monitor template. Make sure the vehicle has full air pressure. Turn the ignition on. 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.** 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. Attempt to turn the PTO solenoid on using the **ON** button on the template. NOTE: When done, exit Test Mode. 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. 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.** 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. Check the solenoid pressure switch. See **Section 42.19.** Check if air line is connected to solenoid. If the above items are OK, replace CHM.

Troubleshooting

PTO Function Electrical Diagnosis			
Test No.	Test Procedure	Test Result	Action
4	In ServiceLink, open the "PTO Interlocks" Datalink Monitor template. Using **Table 4**, determine which PTO interlocks are used based on the PTO reference parameter programmed in to the BHM. Engage the PTO using the switch in the dash. 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. If amperage is OK, check for mechanical problem.
5	In ServiceLink, open the "Chassis Module Battery Inputs" Datalink Monitor template. Is Battery Power Feed No. 3 at approximately battery voltage?	Yes	The problem may be in the PTO solenoid output circuit. Make sure the PTO is wired to the correct CHM output pin per the ServiceLink CHM Configuration screen. 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. 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. Check the solenoid. See **Section 42.19.** 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. 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

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. Then open the "AMU Solenoids Circuits" or "AAVA Solenoids Circuits" in the appropriate Datalink Monitor template. Make sure the vehicle has full air pressure. Turn the ignition on. 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.** 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. Attempt to turn the fire pump control solenoids on one at a time using the **ON** buttons on the template. NOTE: When done, exit Test Mode. NOTE: If operating normally, one solenoid should exhaust air when turned on, the other will exhaust air when turned off. 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. For the solenoid that is not working, make sure it is wired to the correct CHM output pins per the ServiceLink CHM Configuration screen. Check the solenoid output circuit from the CHM to the solenoid, including the solenoid coil ground circuit, for opens. 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. Check the solenoid. See **Section 42.19.** If all of the above is OK, replace the CHM.

Troubleshooting

<table>
<tr><th colspan="4">Fire Pump Controls Function Electrical Diagnosis</th></tr>
<tr><th>Test No.</th><th>Test Procedure</th><th>Test Result</th><th>Action</th></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Make sure the vehicle has full air pressure. Turn the ignition on.

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.

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.

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?</td><td>Yes</td><td>Go to test no. 4.</td></tr>
<tr><td>No</td><td>For the solenoid that does not change pressure switch status:
• Check solenoid pressure switch feedback circuit.
• Check the solenoid pressure switch. See Section 42.19.
• Check the air lines.

If the above items are OK, replace CHM.</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">In ServiceLink, open the "Fire Pump Interlocks" Datalink Monitor template.

Using Table 5, determine which fire pump interlocks are used based on the reference parameter programmed into the BHM.

Engage the fire pump using the switch in the dash.

Do any of the necessary interlocks drop out when the fire pump solenoids drop out?</td><td>Yes</td><td>Determine the cause for interlock drop out and repair as necessary.</td></tr>
<tr><td>No</td><td>Check both fire pump solenoid output circuits for amperage. If either exceeds 0.85A, make necessary repair or modification.

If amperage is OK, check for mechanical problem.</td></tr>
</table>

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. 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. Make sure the fire pump solenoids are wired to the correct CHM output pins per the ServiceLink CHM Configuration screen. Check both fire pump solenoid output circuits from the CHM to the solenoids, including the solenoid coil ground circuit, for opens. 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. Check the solenoid(s). See **Section 42.19.** 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. 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. NOTE: Be sure to open the correct template for the BHM software version on the vehicle. Look at each of the five BHM outputs: SS1 ID#, SS2 ID#, SS3 ID#, SS4 ID#, and SS5 ID#. If diagnosing the PTO, are any of the five SSn ID#s equal to 38? 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.**

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. Look at each of the six SEM to BHM outputs: SS1 ID#, SS2 ID#, SS3 ID#, SS4 ID#, SS5 ID#, and SS6 ID#. If diagnosing the PTO, are any of the five SSn ID#s equal to 38? 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: • Check if PTO or PUMP smart switch is installed and connected. • Check smart switch wiring. • Check the smart switch. • 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. If using the Smart Switches template, look for a change under the "BHM Inputs" heading in the input voltage for the smart switch. 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. 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: • Check smart switch wiring. • Check the smart switch. • If the smart switch is installed in SEM, check SEM.

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: • If testing the PTO controls, open the "PTO Interlocks" template. • If testing fire pump controls, open the "Fire Pump Interlocks" template. 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. 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. 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

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. Check the following: • Air system • Pressure feedback circuit including the ground. • 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. Check the following: • Air system • Pressure feedback circuit including the ground. • Solenoid–pressure switch may be stuck.

Table 6, PTO and Fire Pump Control J1587 Fault Codes

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. Check the following: • Air system • Pressure feedback circuit including the ground. • 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. Check the following: • Air system • Pressure feedback circuit including the ground. • Solenoid–pressure switch may be stuck.

Table 7, PTO and Fire Pump Control J1939 Fault Codes

Troubleshooting

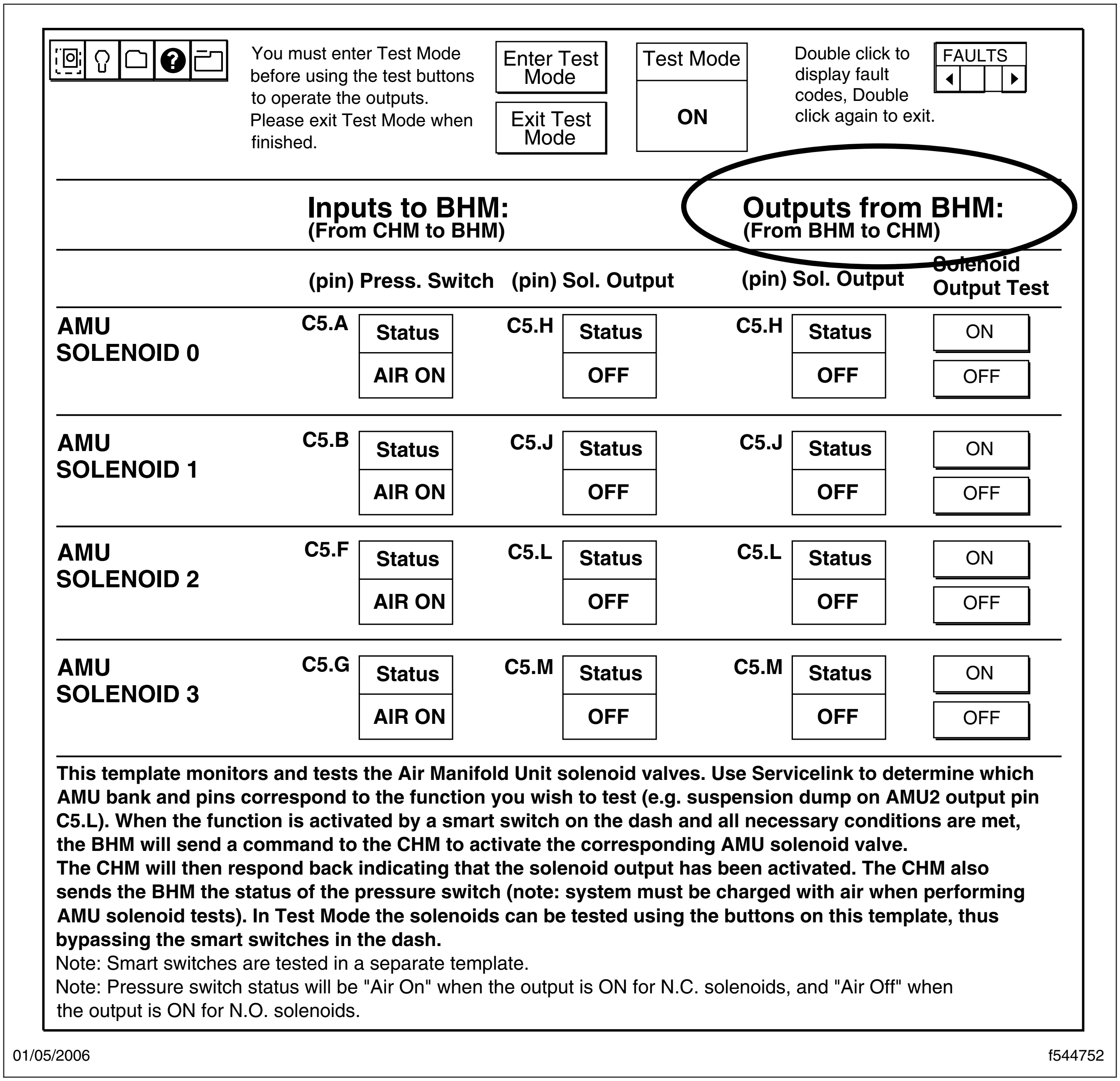


Fig. 1, AMU Solenoids Template, Outputs from BHM

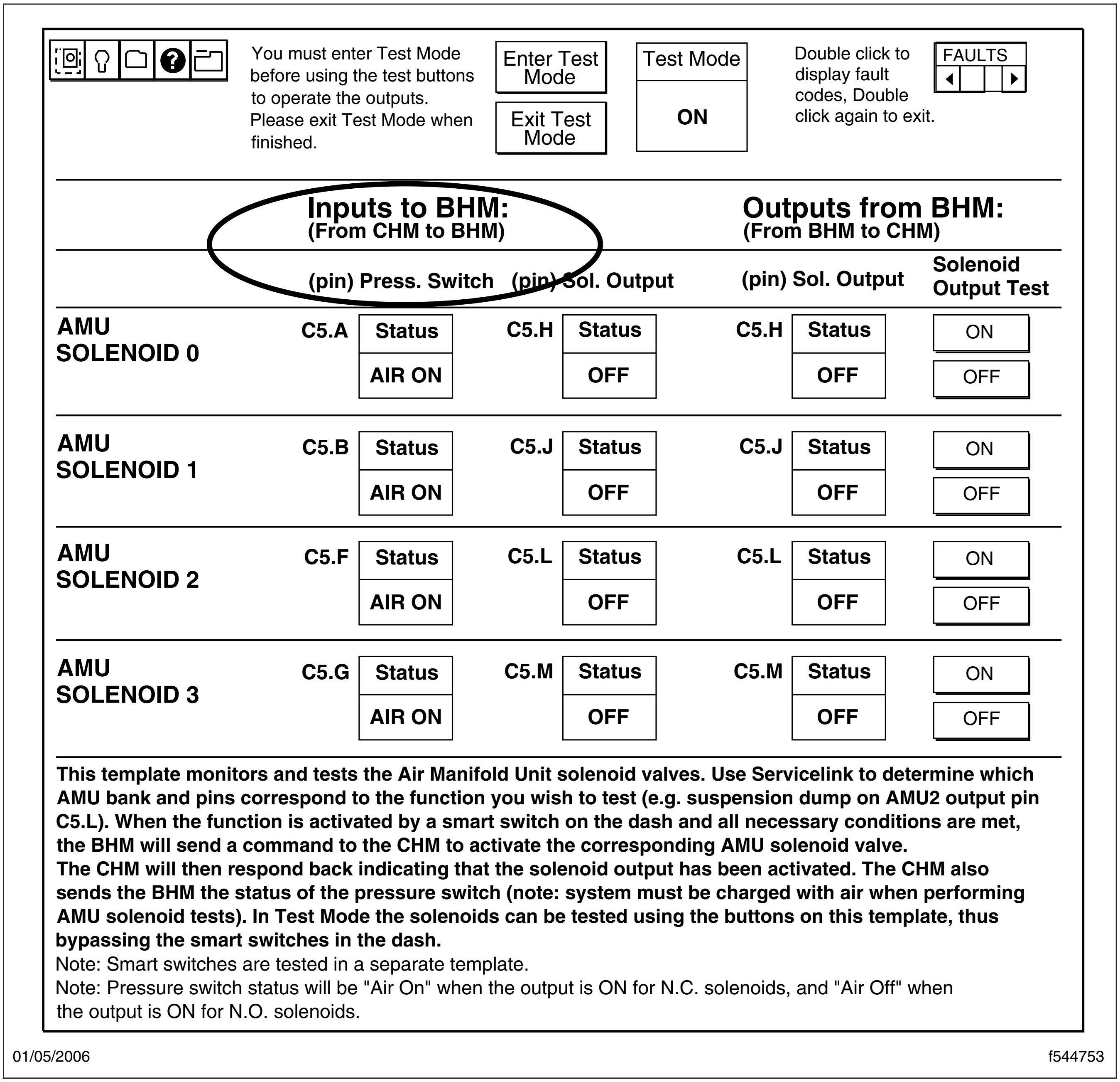


Fig. 2, AMU Solenoids Template, Pressure Switch Status

Troubleshooting

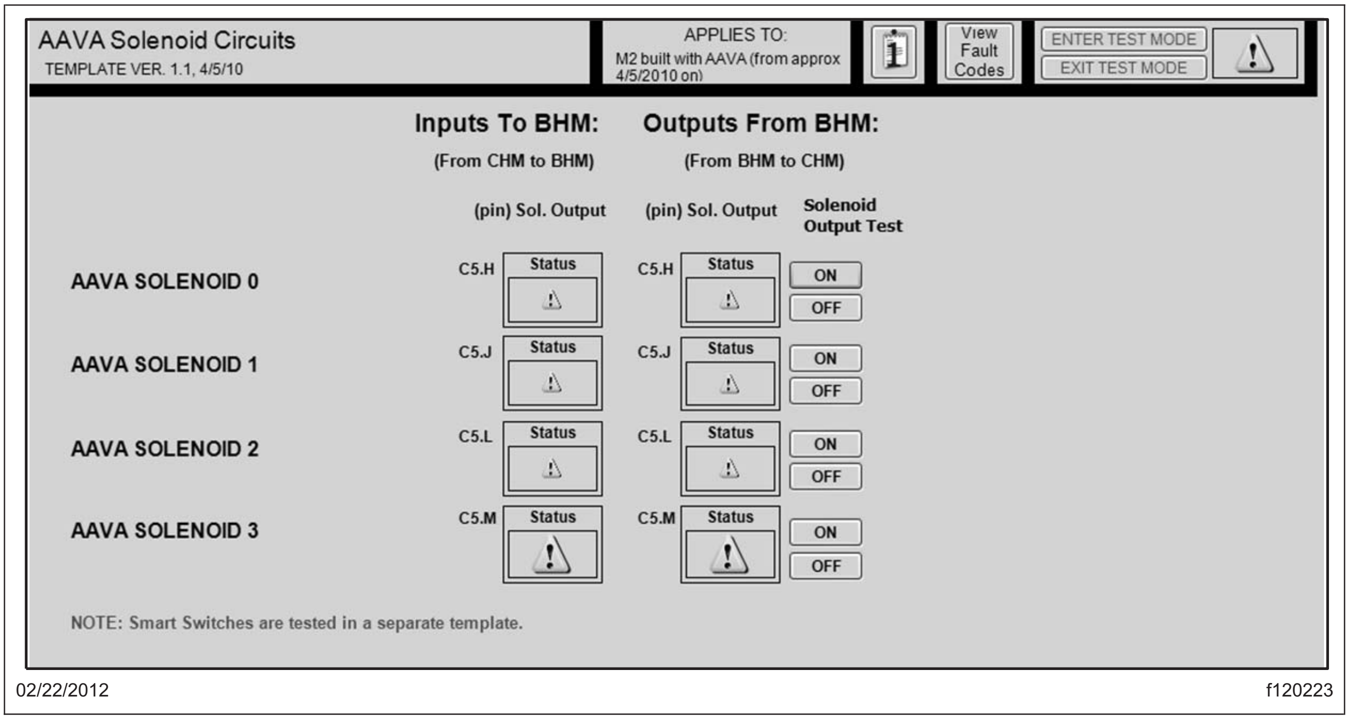


Fig. 3, AAVA Solenoids Template, Outputs from BHM

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.

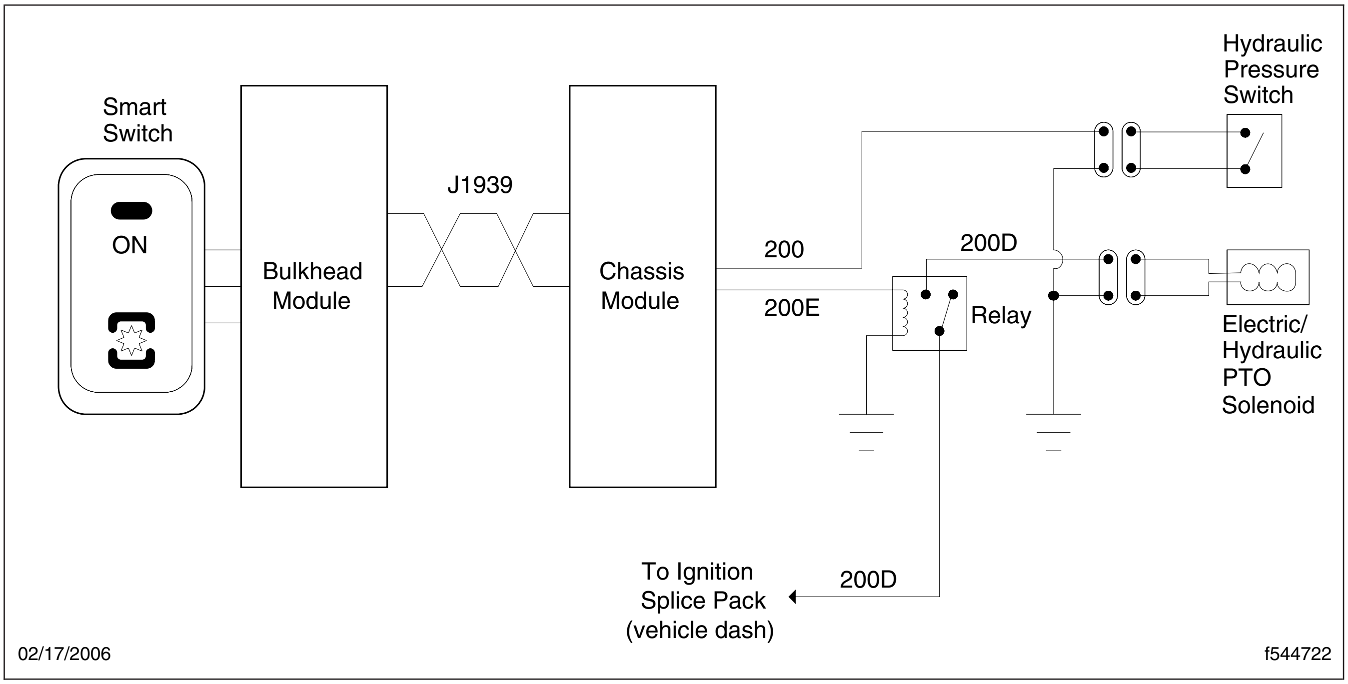
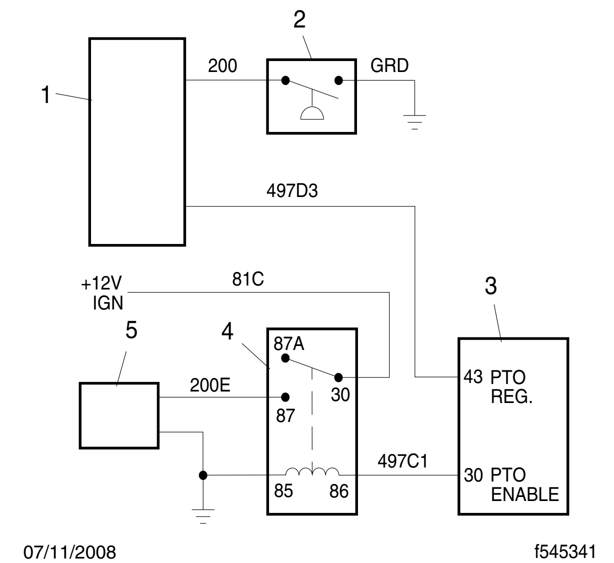


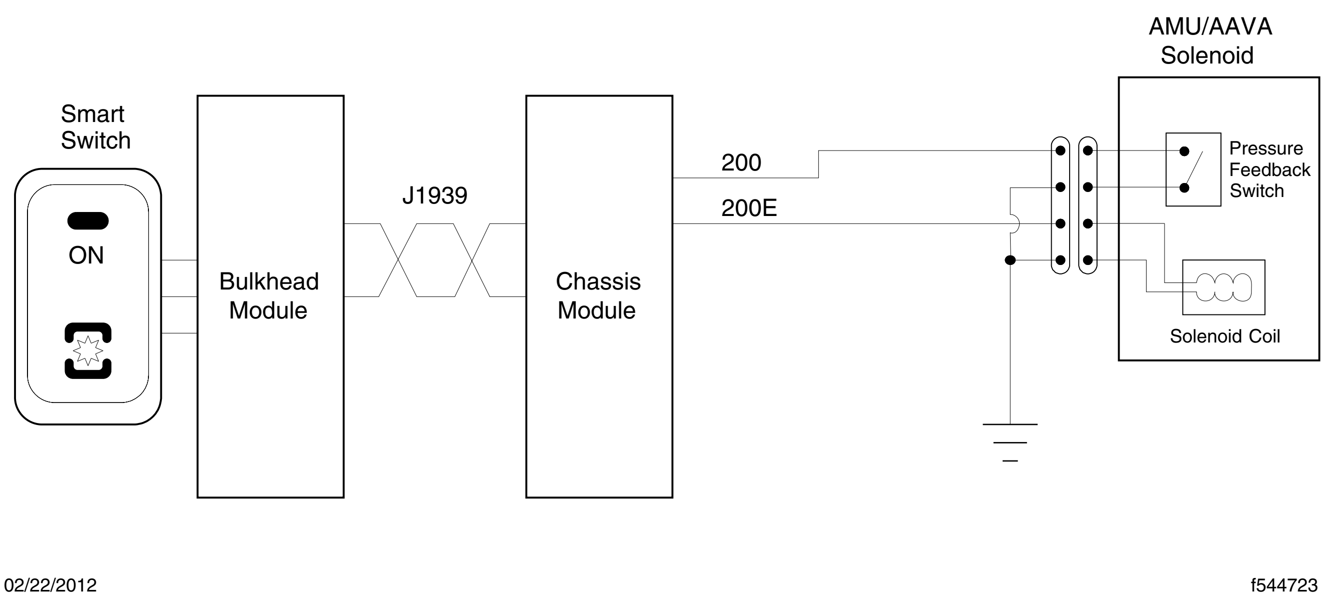
Fig. 1, Typical Wiring Diagram of an Allison Hydraulic PTO

Specifications



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

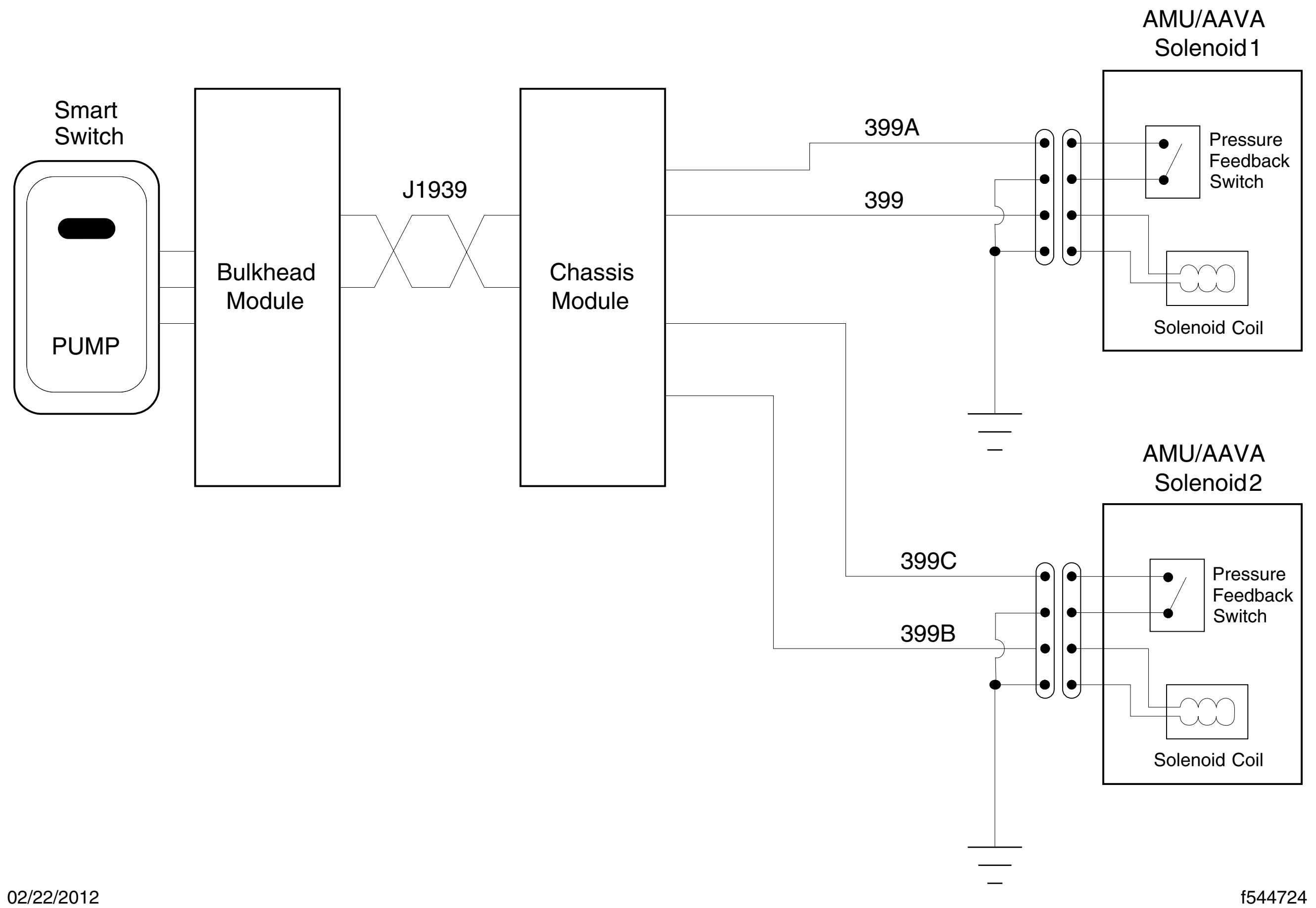
Fig. 2, Typical Wiring Diagram of an Allison Hydraulic PTO with 4th Generation TCU



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

Specifications



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

Contents

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**.

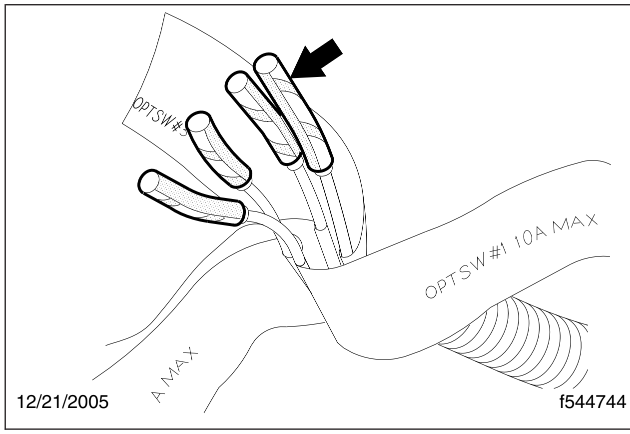


Fig. 1, Blunt-cut End

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

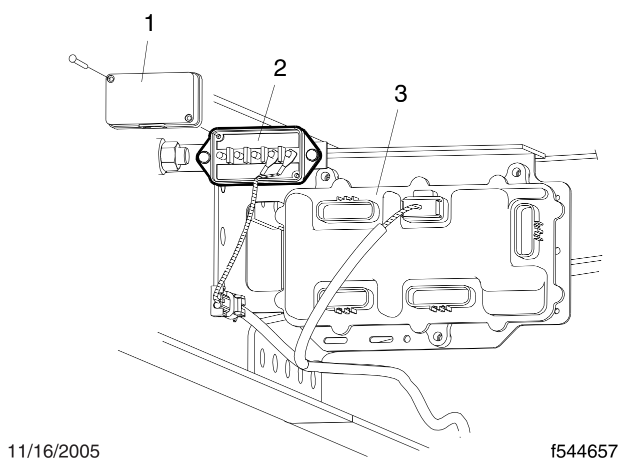
General Information

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

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.

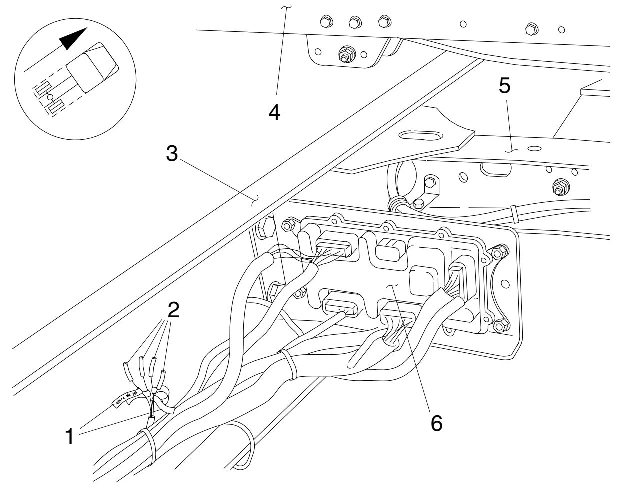
Connecting to One Switch Without a Junction Block or Multiple Switches

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.

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.

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

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.

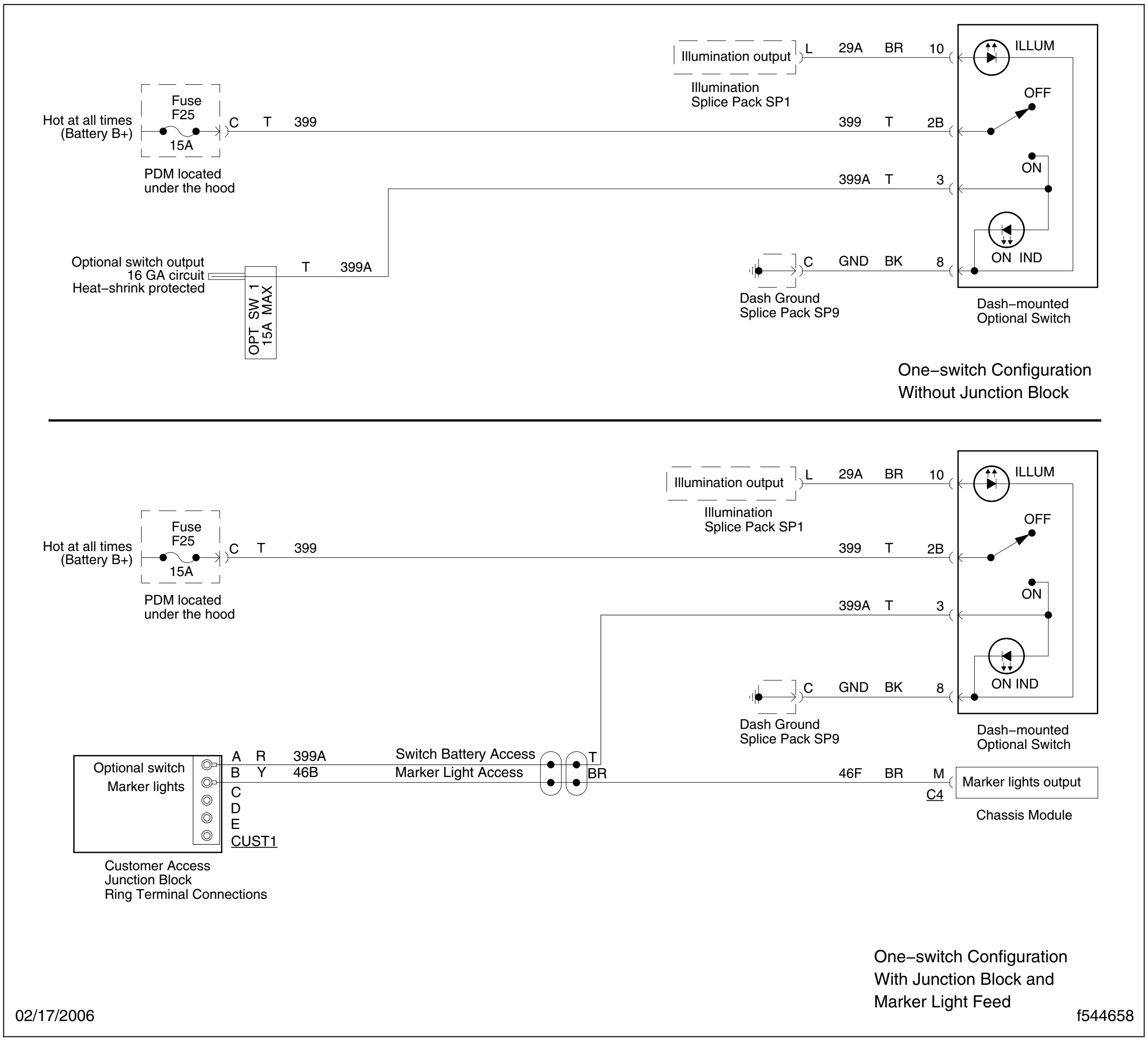


Fig. 1, One-Switch Configuration Wiring Diagram

Specifications

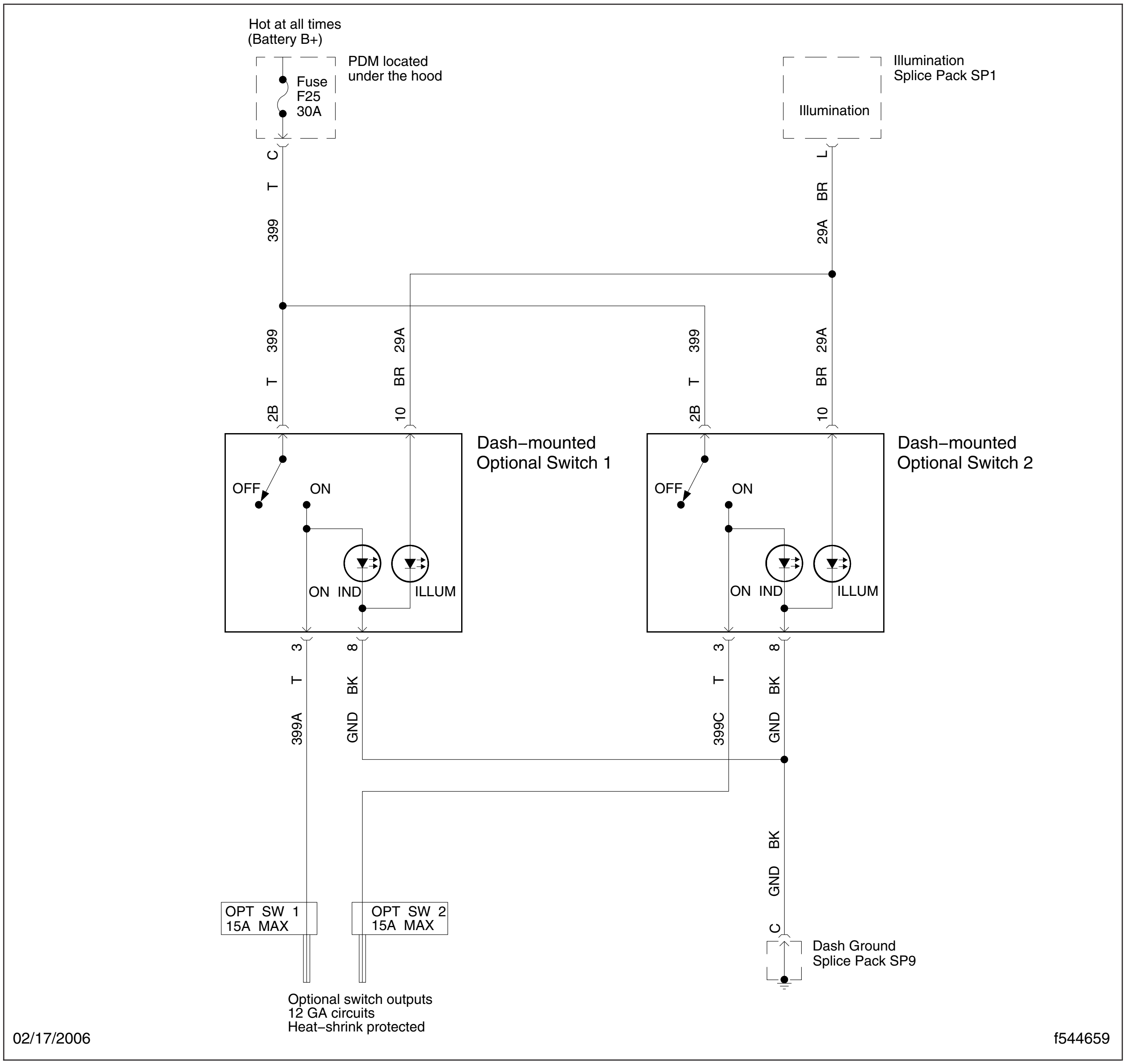


Fig. 2, Two-Switch Configuration Wiring Diagram

Specifications

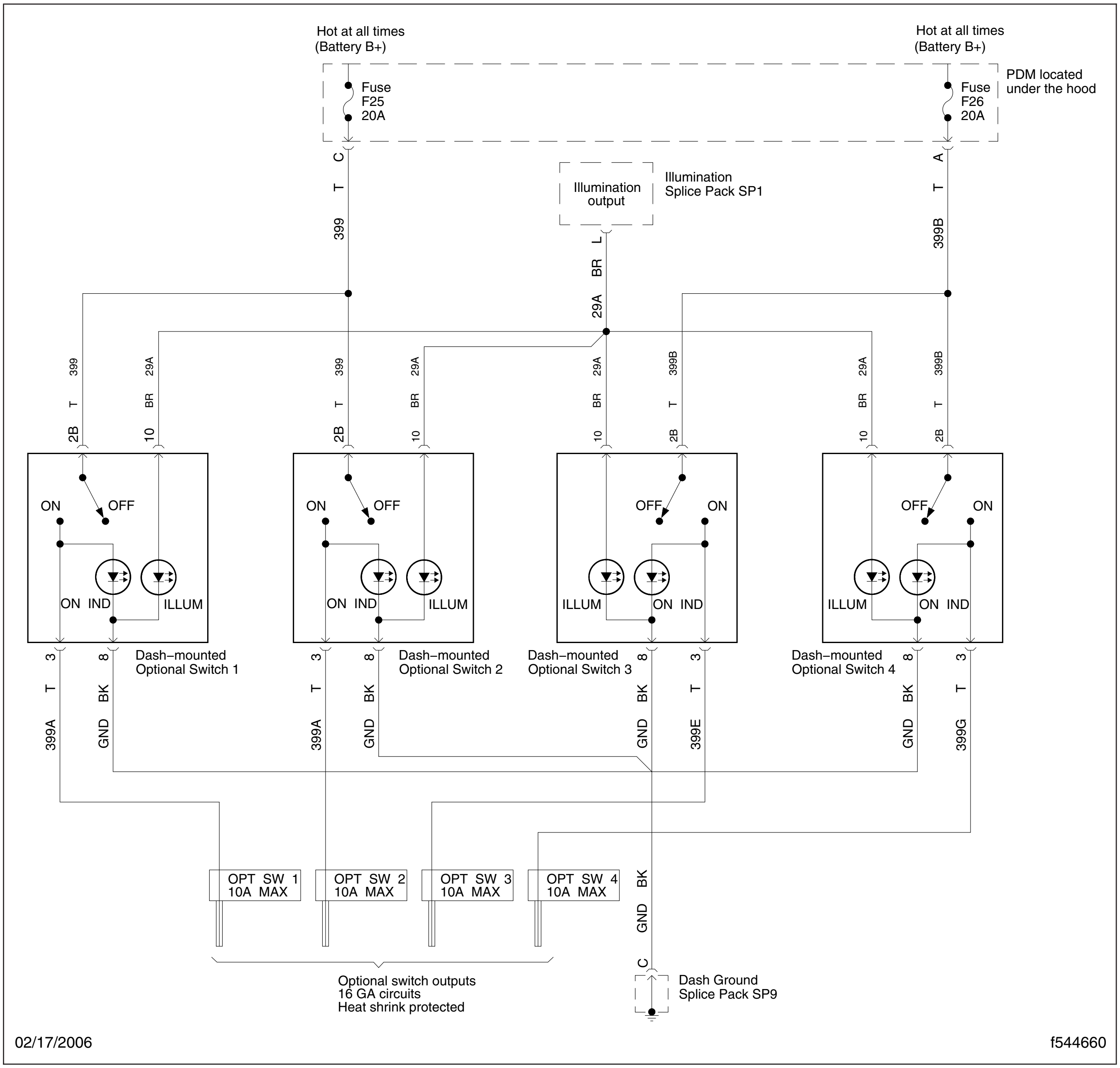


Fig. 3, Four-Switch Configuration Wiring Diagram

Specifications

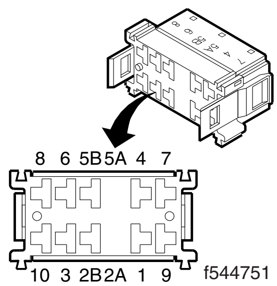
Optional Switch Connector				
Connector Pin	Signal Name	Signal Type	Circuit Color	Circuit Number
				
1	—	—	—	—
2B	Fused Battery Power	Input	T	399 for optional switches 1 and 2. 399B for optional switches 3 and 4.
3	Optional Switch Output	Output	T	399A for optional switch 1. 399C for optional switch 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

Contents

Subject	Subject Number

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.

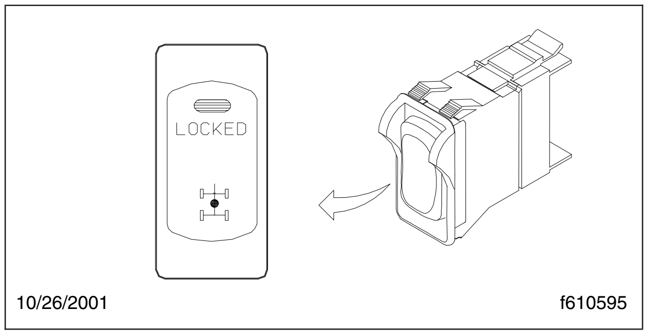


Fig. 1, Interaxle Lock Switch

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 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.

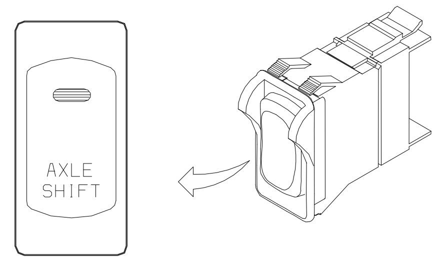


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Fig. 2, Axle Shift Switch

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

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.

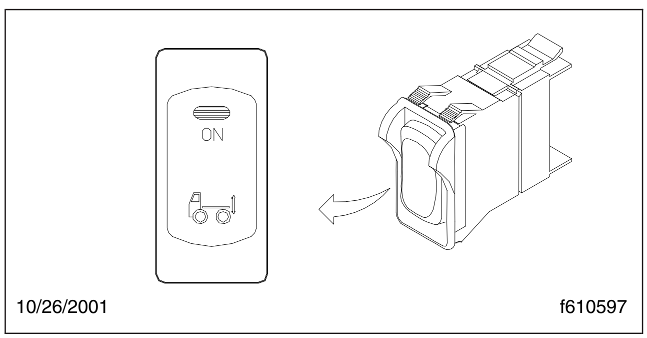


Fig. 3, Suspension Dump Switch

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

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).

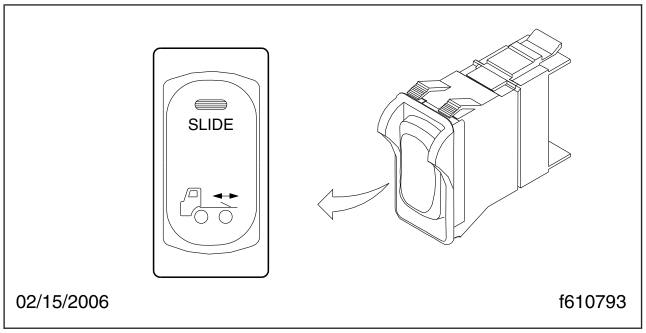
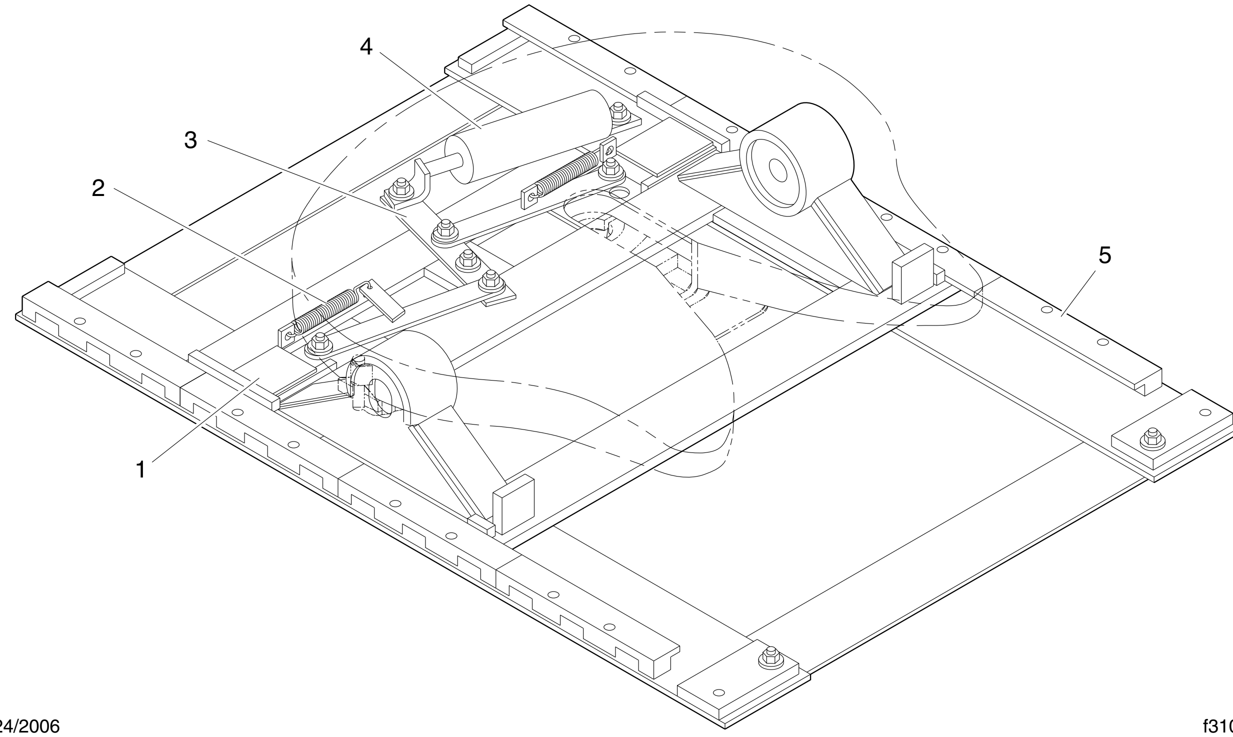


Fig. 4, Fifth Wheel Slide Switch

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



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 the axle is able to properly self-steer while reversing, the axle does not need to be raised.

Tag/Pusher Axle Lift Controls

There are many different control designs for tag and pusher axles. The tag or pusher axle type mainly determines the control design; however, other features on the vehicle may influence the design. Control similarities between all tag and pusher axles include:

- multiplexed electronics
- latching control switch
- reverse gear sense
- minimum of two AMU/AAVA solenoids
- four air bags (two at each axle end)

An M2 axle lift requires a minimum of two AMU/AAVA solenoids; some axle controls use three or four solenoids. Since the CHM has a limited number of designated AMU/AAVA outputs, the control design may use spare (unused) CHM outputs. If spare outputs are available, the CHM is programmed to use those outputs to power the necessary AMU/AAVA solenoids. Spare CHM outputs, often incorporated into axle lift controls, include: fog light outputs, backup light outputs, or daytime running lights (DRL) outputs on non-Canadian-domiciled vehicles.

Sometimes there are not enough spare CHM outputs to individually power each AMU/AAVA solenoid. For this circumstance, one of the Chassis Control Module's designated AMU outputs is wired so that the output controls a relay instead of a solenoid. This relay receives ignition power from a dash splice pack. The relay then supplies power to the AMU solenoids that operate the axle lift.

Tag and Pusher Axle Operation

With the engine running and the vehicle speed below 5 mph (8 km/h), a tag or pusher axle can be activated (lowered) using a latching, two-position smart switch. If the vehicle is turned off and restarted, a latching switch makes sure that the axle returns to the last selected position. Pressing the axle lift switch causes the CHM to send the appropriate signals to operate the AMU/AAVA controls. See **Fig. 6**.

Basic tag and pusher controls use two solenoids to supply air to the axle air bags. One solenoid is normally open, while the other is normally closed. At each end of the axle is a set of air bags. The sole-

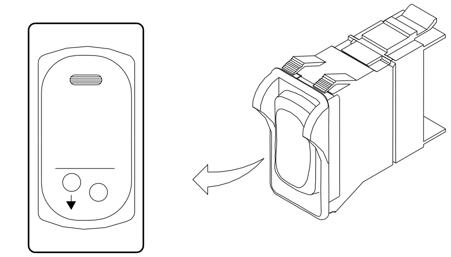


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Fig. 6, Axle Lift Switch

noids fill one bag and vent the other to raise the axle. To lower the axle, the CHM sends signals to the AMU/AAVA solenoids and reverses the air flow.

Some axles use only a single solenoid to control the axle air bags. For this setup, the second solenoid is a normally open lock solenoid that operates a double check valve located in the air supply line to the tag or pusher axle. This valve keeps the axle lift in the last selected state when the engine is turned off. The lock solenoid receives power through a BHM-supplied splice pack.

Lock solenoids are present in many of the control designs. Without a lock solenoid, the axle lift controls send the tag or pusher axle into a nonpowered state whenever the engine is turned off. The nonpowered state is the position that the axle is in with the switch off, which is usually the raised position.

Reverse caster axles use four solenoids in their control setup. Two solenoids control the air supply to the axle air bags for raising or lowering. The third solenoid is a lock solenoid to keep the axle in position even if the engine is turned off. The fourth solenoid supplies air to a cylinder that controls the axle caster angle. The CHM receives transmission status signals via the J1939 data lines and uses this information to determine if the vehicle is traveling in a forward or reverse direction. Changes in vehicle direction result in corresponding changes in the caster angle of the axle.

Feedback from the tag/pusher axle air circuit is required for correct operation of tag and pusher axle controls. Feedback is provided by a ground input to the CHM. The ground input is delivered when a pressure switch is activated within the normally closed AMU solenoid. On AAVA-equipped vehicles, the pressure switch is in the air line. A grounded feedback circuit from the closed pressure switch indicates that air pressure is present in the lines feeding the air bags that lower the axle. A grounded feedback circuit means the tag or pusher axle is lowered.

Differential Lock

The differential lock is available on a vehicle with a single-drive axle or tandem axle. For a vehicle with a tandem axle, it is possible to have a differential lock for both axles or for only one axle. When the differential lock is activated, the clutch collar locks the axle differential case, gearing, and shafts together. A differential lock improves traction in slippery conditions by spinning the wheels of the axle at the same speed.

To prevent interaxle lock damage, the differential lock should only be activated when the vehicle is stopped or moving slowly at low throttle.

On some vehicles, differential lock activation is only possible when the vehicle is in the low speed range. On these vehicles, shifting out of the low speed range will deactivate the differential lock.

Differential Lock Controls

Differential lock controls discussed in this section describe multiplexed controls and do not cover nonmultiplexed factory-installed all-wheel drive.

With the engine running, the differential lock can be activated using a momentary, two-position smart switch. Press the upper half of the differential lock switch to activate the differential lock. Press the upper half of the differential lock switch again to deactivate the differential lock. See **Fig. 7**. If the differential lock is activated and the engine is then turned off, the differential lock will deactivate.

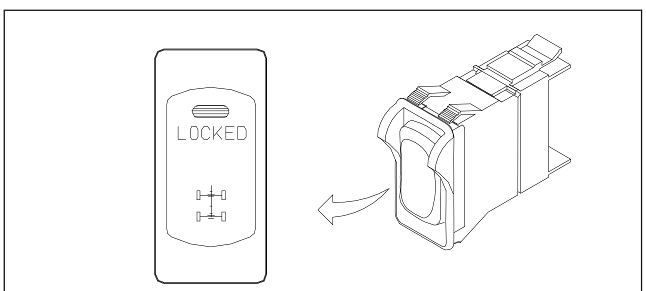


Fig. 7, Differential Lock Switch

When the differential lock 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 supplies pressurized air to the axle differential housing. The air sent to the housing applies a lock to the differential, causing all wheels on that axle to spin at the same speed.

Feedback to the CHM is required for correct operation of the differential lock. Each drive axle with a differential lock has an axle switch that provides CHM feedback. When an axle differential locks, the axle switch closes and completes a ground circuit to the CHM. The CHM uses the feedback signal(s) to determine if the differential lock is functioning properly or if there is a malfunction; the axle switch does not confirm the differential lock switch selection.

For a vehicle with a tandem axle, there are several differential lock control designs available:

- a differential lock on only one drive axle (**Fig. 8** or **Fig. 9**)
- one switch to control the differential locks on both axles (**Fig. 10**)
- two switches, each of which controls the differential lock for one axle (**Fig. 8** and **Fig. 10**)

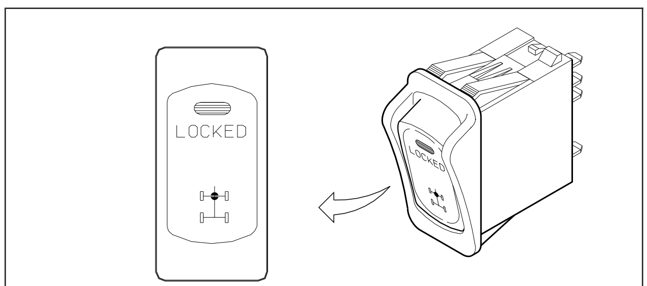


Fig. 8, Differential Lock on Forward-drive Axle of a Tandem Axle

General Information

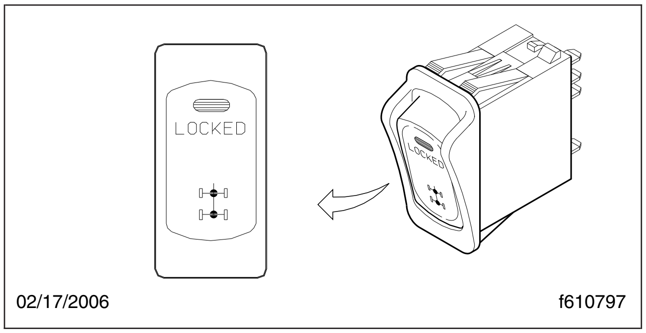


Fig. 9, Differential Locks on Both Axles

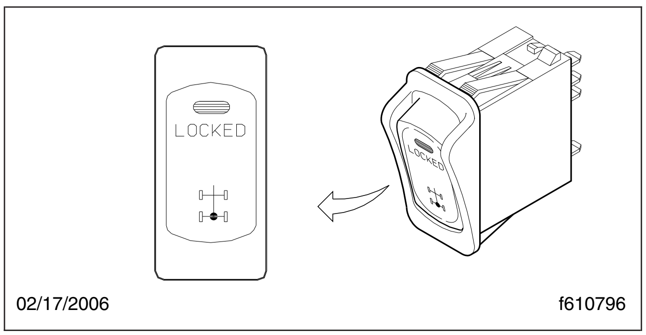


Fig. 10, Differential Lock on Rear-drive Axle of a Tandem Axle or Single-drive Axle

Interaxle Lock

For electrical troubleshooting of the interaxle lock, see **Table 1**.

Interaxle Lock Troubleshooting		
Symptom	**Possible Cause**	**Check For**
Blinking indicator on the interaxle lock switch.	No feedback.	Damaged feedback circuit.
Interaxle lock may engage then drop out, or not engage at all.	Insufficient air pressure.	If air pressure gauge indicates sufficient pressure, there may be a kink or restriction in the air lines.
	Defective air management unit (AMU)/auxiliary air valve assembly (AAVA) solenoid.	Remove the air line from the forward rear axle differential and turn on the switch. If no air, replace the solenoid.
	Wiring fault in the circuit feedback switch.	Inspect grounds. Clean or repair as needed.
	Defective electrical connection to the AMU/AAVA solenoid.	Inspect connector and pins. Straighten bent pins and make sure that electrical connections are properly seated.

Table 1, Interaxle Lock Troubleshooting

Axle Shift

For electrical troubleshooting of the axle shift, see Table 1.

Axle Shift Troubleshooting		
Symptom	**Possible Cause**	**Check For**
Blinking indicator on the axle shift switch.	No feedback.	Damaged feedback circuit.
Axle high range may engage then drop out, or not engage at all.	Insufficient air pressure.	If air pressure gauge indicates sufficient pressure, there may be a kink or restriction in the air lines.
	Defective air management unit (AMU)/auxiliary air valve assembly (AAVA) solenoid.	Remove the air line from the gear housing and set switch to high range position. If air is not heard from the air line, replace the solenoid.
	The electrical connection to the AMU/AAVA solenoid is defective.	Inspect connector and pins. Straighten bent pins and make sure that electrical connections are properly seated.
	Wiring fault in the axle position feedback circuit.	For multiplexed controls, a ground signal from axle switch circuit indicates low gear range to the Chassis Module (CHM). Make sure that the axle switch circuit is not shorted to ground.
	Defective ground to solenoid or feedback switch.	Inspect grounds. Clean or repair as needed.

Table 1, Axle Shift Troubleshooting

Suspension Dump

For electrical troubleshooting of the suspension dump, see Table 1.

Suspension Dump Troubleshooting		
Symptom	**Possible Cause**	**Check For**
Blinking indicator on the suspension dump switch.	No feedback.	Damaged feedback circuit.
Suspension does not dump with ignition on.	Defective air management unit (AMU)/auxiliary air valve assembly (AAVA) solenoid.	Remove the air line from the rear air suspension and trigger suspension dump. If air still present, replace the solenoid.
	Wiring fault in the feedback switch circuit.	Inspect grounds. Clean or repair as needed.
	Defective electrical connection to the AMU/AAVA solenoid.	Inspect connector and pins. Straighten bent pins and make sure that electrical connections are properly seated.

Table 1, Suspension Dump Troubleshooting

Fifth Wheel Slide

For electrical troubleshooting of the fifth wheel slide, see **Table 1**.

Fifth Wheel Slide Troubleshooting		
Symptom	**Possible Cause**	**Check For**
Blinking indicator on the fifth wheel slide switch.	No feedback.	Damaged feedback circuit.
Fifth wheel slide may engage then drop out, or not engage at all.	Insufficient air pressure.	If air pressure gauge indicates sufficient pressure, there may be a kink or restriction in the air lines.
	Defective air management unit (AMU)/auxiliary air valve assembly (AAVA) solenoid.	Remove the air line from the fifth wheel slide release cylinder and turn on the switch. If no air, replace the solenoid.
	Wiring fault in the feedback switch circuit.	Inspect grounds. Clean or repair as needed.
	The electrical connection to the AMU/AAVA solenoid is defective.	Inspect connector and pins. Straighten bent pins and make sure that electrical connections are properly seated.

Table 1, Fifth Wheel Slide Troubleshooting

Tag/Pusher Axle Lift

For electrical troubleshooting of the tag/pusher axle lift, see Table 1.

Tag/Pusher Axle Lift Troubleshooting		
Symptom	**Possible Cause**	**Check For**
Blinking indicator on the axle lift switch.	No feedback.	Damaged feedback circuit.
Reverse caster axle not responding.	Insufficient air pressure.	If air pressure gauge indicates sufficient pressure, there may be a kink or restriction in the air line to the caster cylinder.
	Defective air management unit (AMU)/auxiliary air valve assembly (AAVA) solenoid.	Remove the air line from the caster angle cylinder. See if air is present when vehicle is placed in reverse. If no air, replace the suspect solenoid.
	Defective reverse caster air cylinder.	If the air supply at the reverse caster cylinder proves good, replace the cylinder.
Axle lift may engage then drop out, or not engage at all.	Insufficient air pressure.	If air pressure gauge indicates sufficient pressure, there may be a kink or restriction in the air lines.
	Defective AMU/AAVA solenoid.	Remove the air line from one of the axle lift air bags. Test that air supply is controlled by axle lift switch. Repeat for all axle air bags. If air supply at air bag is not properly responding to the switch requests, replace the suspect solenoid.
	Wiring fault to the pressure feedback switch circuit.	Inspect grounds. Clean or repair as needed.
	The electrical connection to the AMU/AAVA solenoid is defective.	Inspect connector and pins. Straighten bent pins and make sure that electrical connections are properly seated.
	Wiring fault in the ground to solenoid or pressure switch circuit.	Inspect grounds. Clean or repair as needed.

Table 1, Tag/Pusher Axle Lift Troubleshooting

Differential Lock

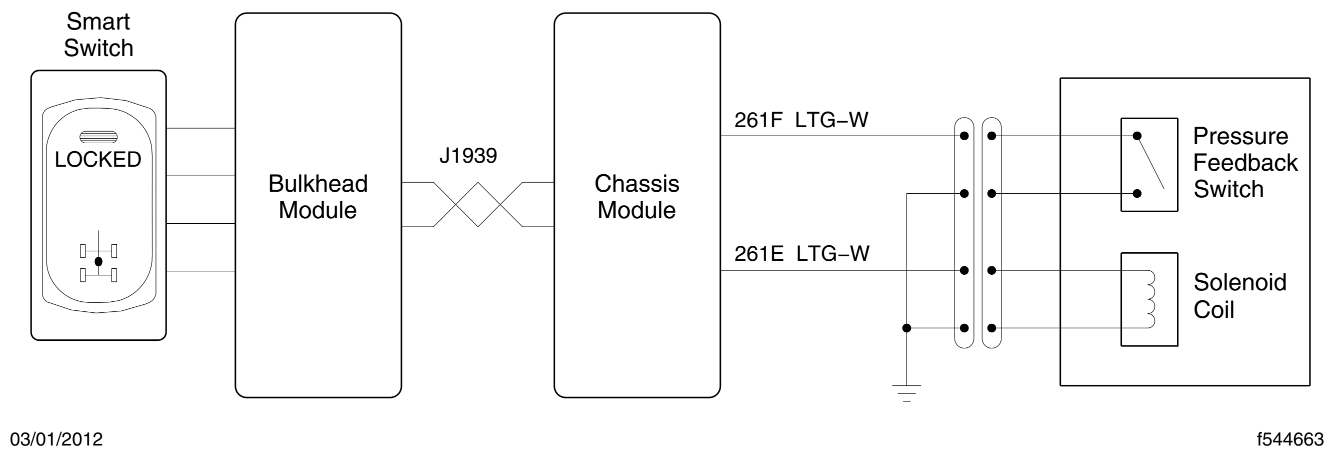
For electrical troubleshooting of the differential lock, see **Table 1**.

Differential Lock Troubleshooting		
Symptom	**Possible Cause**	**Check For**
Blinking indicator on the differential lock switch.	No feedback.	Damaged feedback circuit. Axle lock switch is not activated (closed) or is disconnected.
Differential lock may engage then drop out, or not engage at all.	Insufficient air pressure.	If air pressure gauge indicates sufficient pressure, there may be a kink or restriction in the air lines.
	Defective air management unit (AMU)/auxiliary air valve assembly (AAVA) solenoid.	Remove the air line from the differential housing and turn on the switch. If no air, replace the solenoid.
	Wiring fault in the axle position feedback circuit.	A ground signal from axle switch circuit indicates that the differential lock is activated. Make sure that the axle switch circuit is not shorted to ground.
	Defective electrical connection to the AMU/AAVA solenoid.	Inspect connector and pins. Straighten bent pins and make sure that electrical connections are properly seated.
	The ground to solenoid or pressure switch circuit is defective.	Inspect grounds. Clean or repair as needed.

Table 1, Differential Lock Troubleshooting

Interaxle Lock

For a wiring diagram of the interaxle lock, see **Fig. 1**.



NOTES:

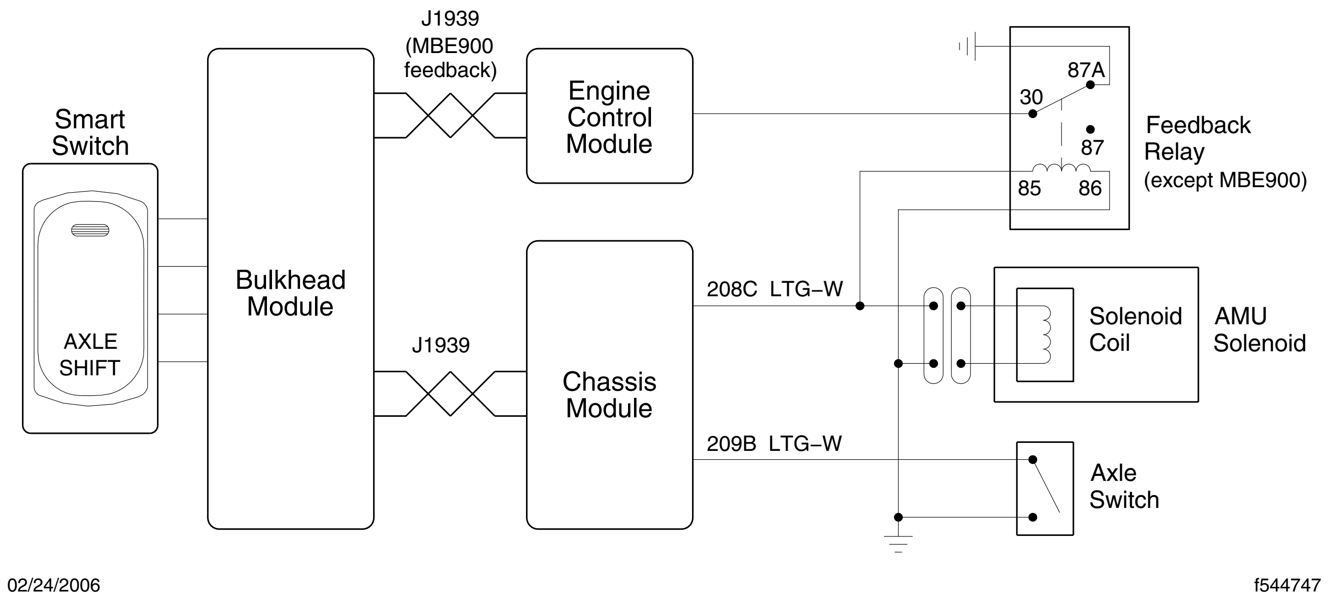
- Interaxle lock is active when the air solenoid is powered, allowing air to flow to the actuator.
- The pressure feedback switch closes when air pressure reaches about 12 to 28 psi (83 to 193 kPa).

Fig. 1, Interaxle Lock Wiring Diagram

Axle Shift

For a wiring diagram of the axle shift with multiplexed controls, see **Fig. 1**.

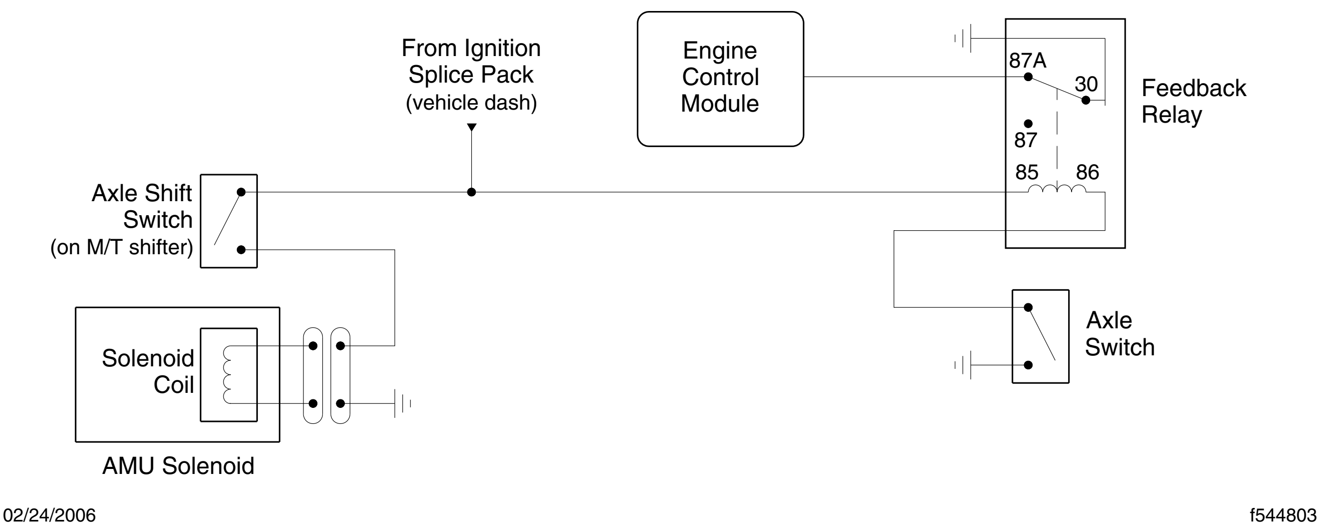
For a wiring diagram of the axle shift with nonmultiplexed controls, see **Fig. 2**.



NOTE: Multiplexed axle shift uses an air management unit (AMU) solenoid that provides air when power is applied by the CHM to the solenoid coil (normally closed).

Fig. 1, Wiring Diagram of Axle Shift With Multiplexed Controls

Axle Shift Specifications

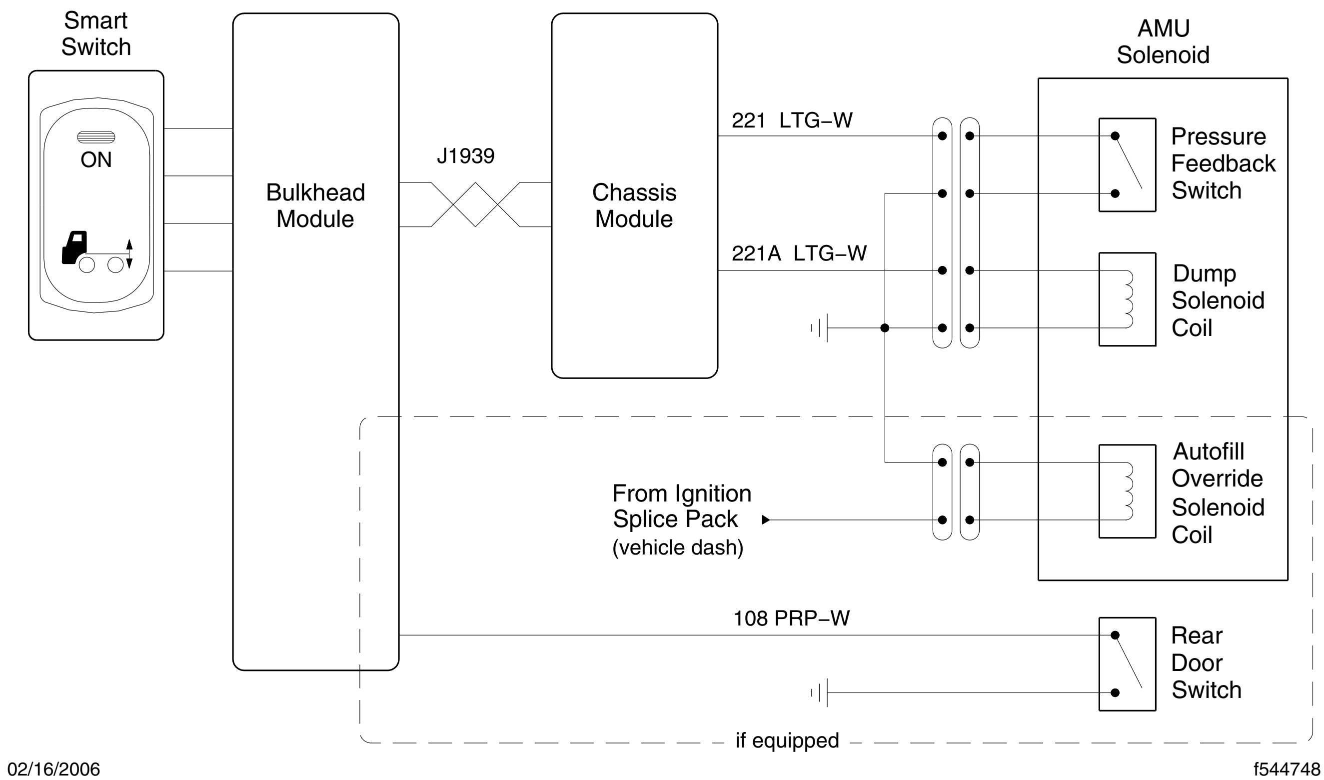


NOTE: Nonmultiplexed axle shift uses an air management unit solenoid that provides air when power is applied by the axle shift control switch to the solenoid coil (normally closed).

Fig. 2, Wiring Diagram of Axle Shift With Nonmultiplexed Controls (MT only)

Suspension Dump

For a wiring diagram of the suspension dump, see **Fig. 1**.



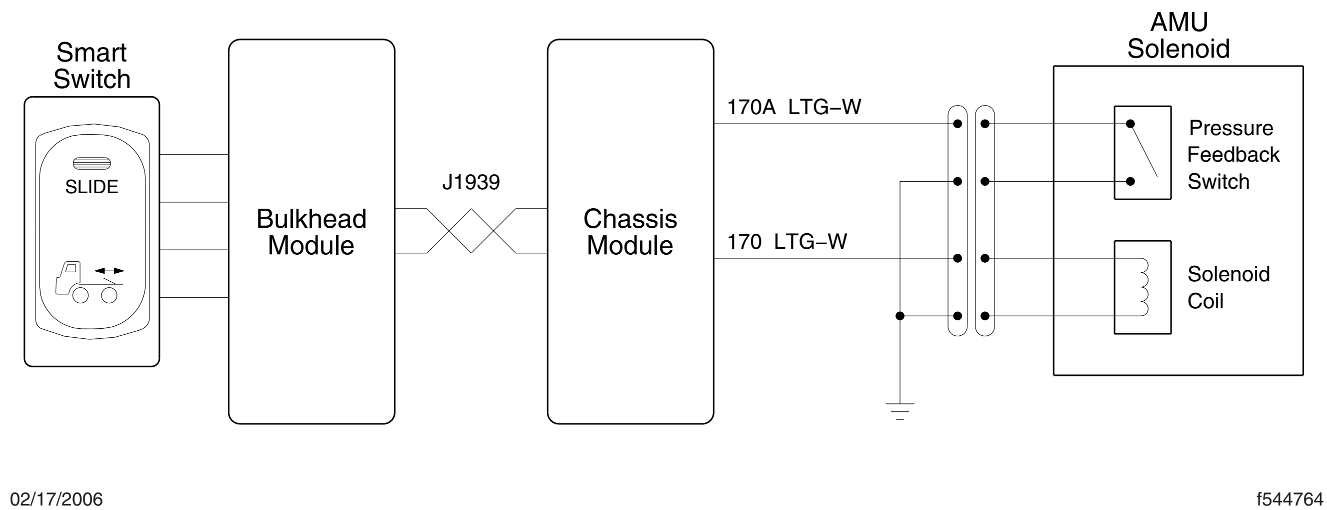
NOTES:

- Suspension dump uses an air management unit (AMU) 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).
- The autofill override solenoid receives ignition power with the engine running and is normally open.

Fig. 1, Suspension Dump Wiring Diagram

Fifth Wheel Slide

For a wiring diagram of the fifth wheel slide, see **Fig. 1**.



NOTES:

- Fifth wheel slide uses an air management unit (AMU) 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. 1, Fifth Wheel Slide Wiring Diagram

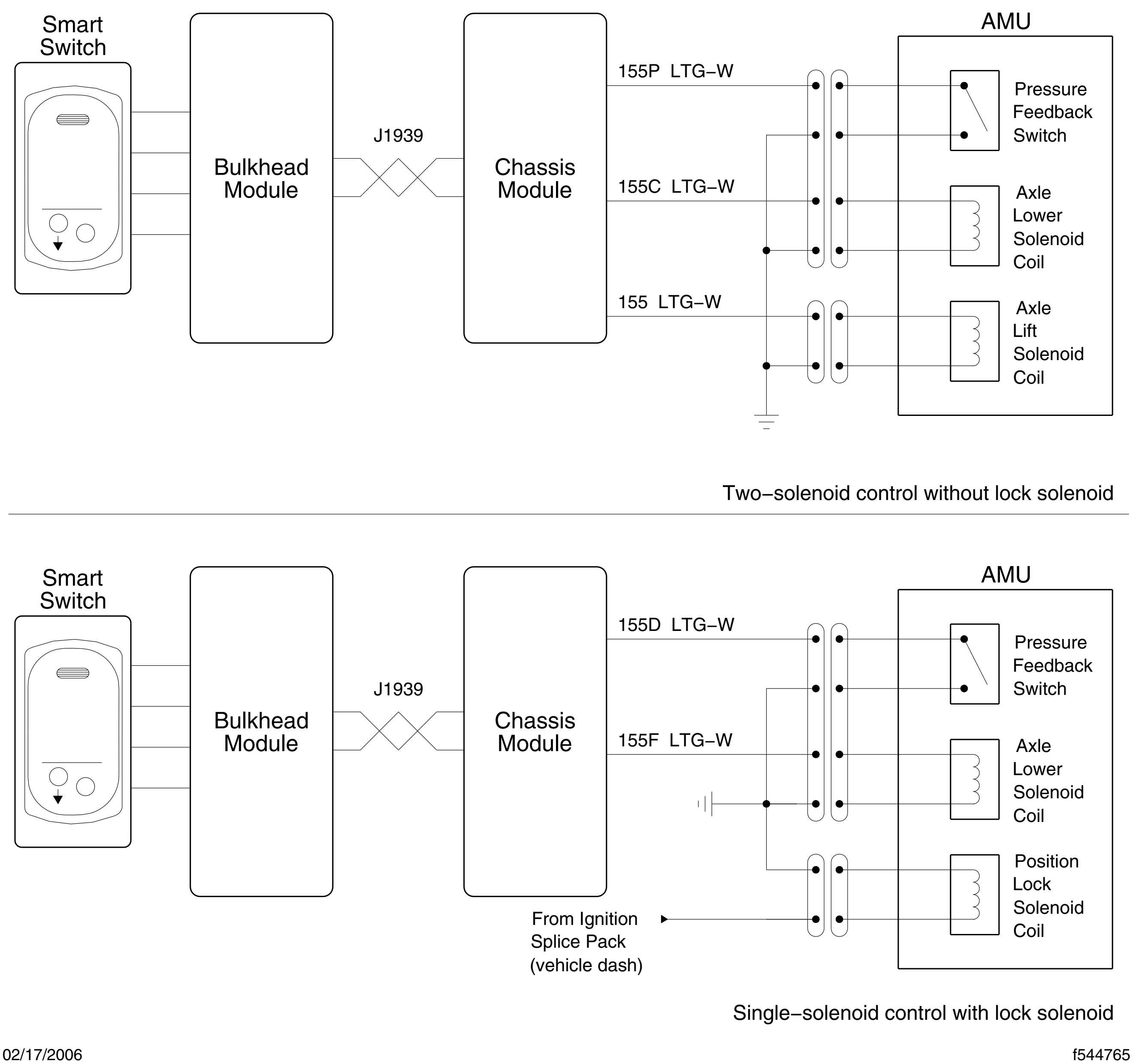
Tag/Pusher Axle Lift

For a wiring diagram of two-solenoid axle lift, see **Fig. 1**.

For a wiring diagram of a three-solenoid axle lift, see **Fig. 2**.

For a wiring diagram of a four-solenoid axle lift with reverse caster, see **Fig. 3**.

Tag/Pusher Axle Lift Specifications

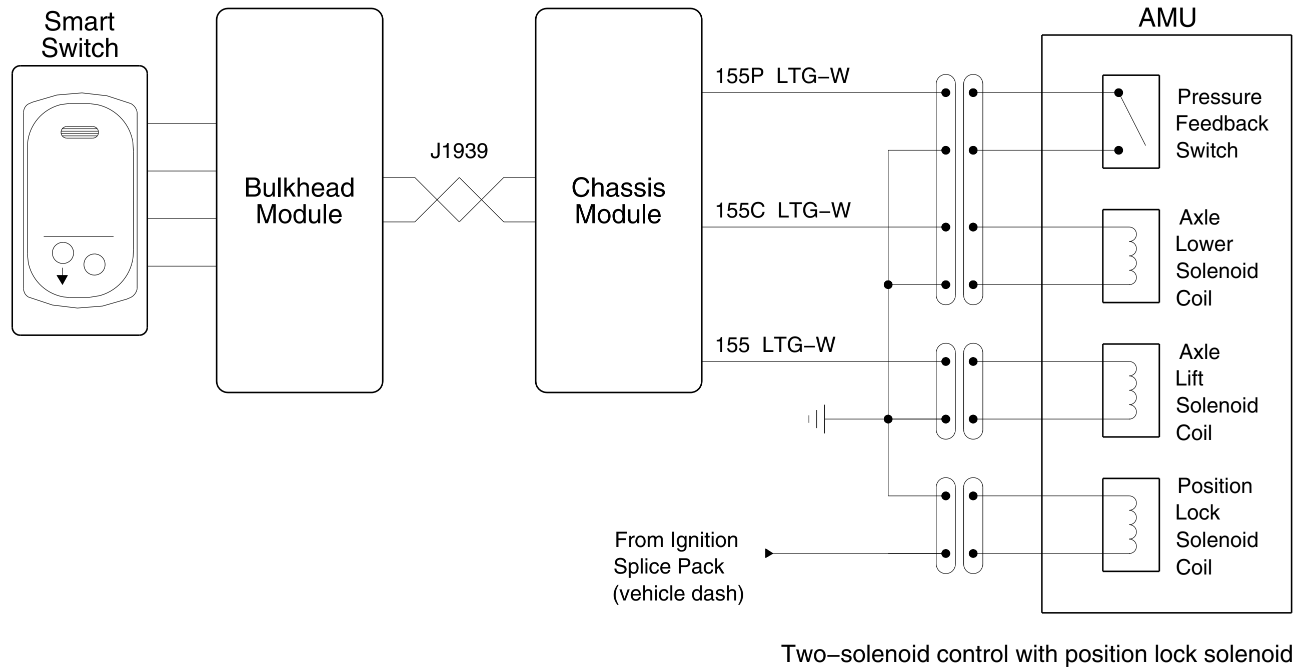


NOTES:

- The pressure switch is located in the normally closed axle lower solenoid and closes when the air pressure reaches about 12 to 28 psi (83 to 193 kPa).
- The lock solenoid receives ignition power with the engine running and is normally open.

Fig. 1, Two-Solenoid Axle Lift Wiring Diagram

Tag/Pusher Axle Lift Specifications

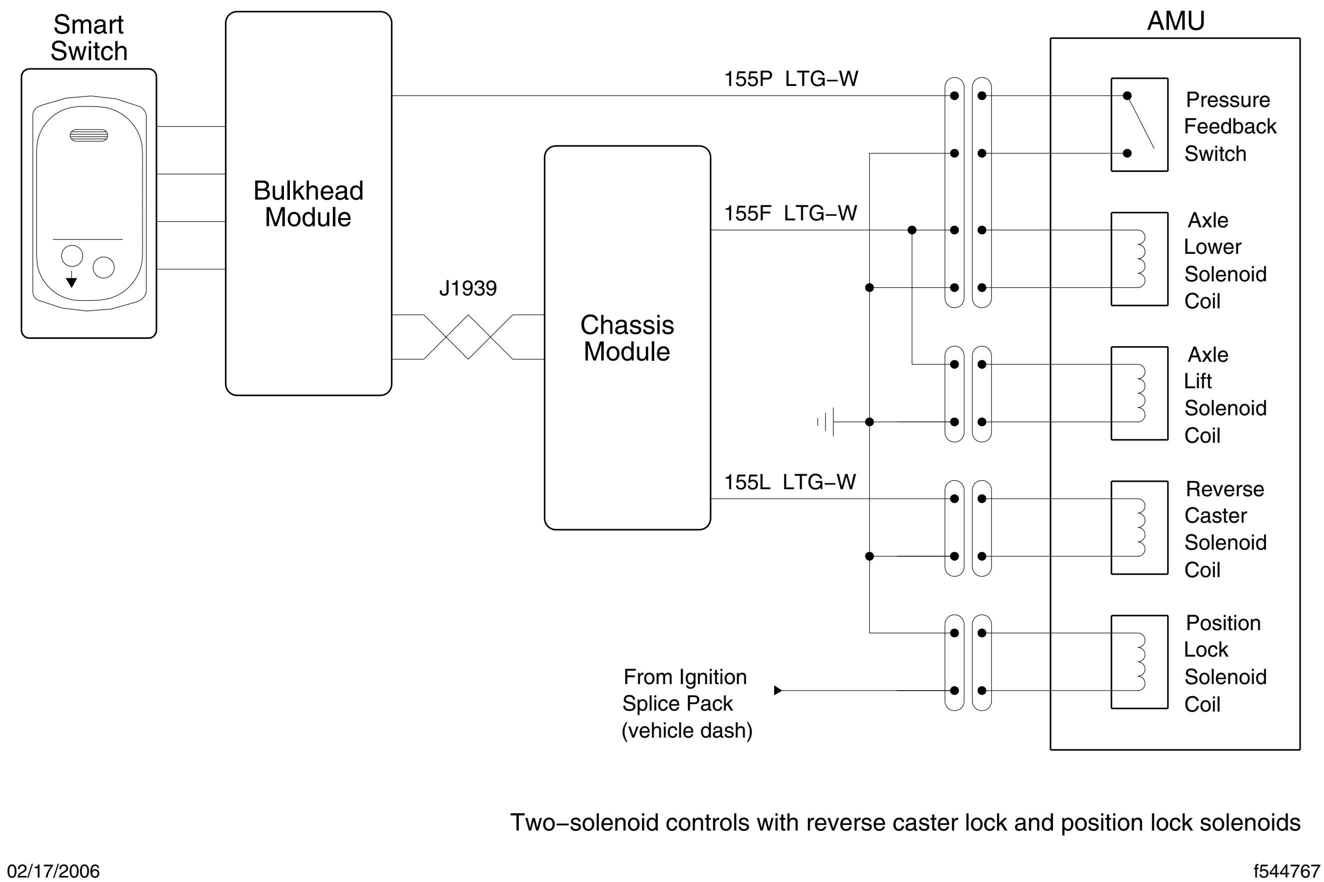


NOTES:

- The pressure switch is located in the normally closed axle lower solenoid and closes when the air pressure reaches about 12 to 28 psi (83 to 193 kPa).
- The lock solenoid receives ignition power with the engine running and is normally open.

Fig. 2, Three-Solenoid Axle Lift Wiring Diagram

Tag/Pusher Axle Lift Specifications



NOTES:

- The pressure switch is located in the normally closed axle lower solenoid and closes when the air pressure reaches about 12 to 28 psi (83 to 193 kPa).
- The lock solenoid receives ignition power with the engine running and is normally open.
- The reverse caster solenoid allows the axle to remain lowered when the vehicle is shifted into reverse.

Fig. 3, Four-Solenoid Axle Lift with Reverse Caster Wiring Diagram

Differential Lock

For a wiring diagram of single-drive axle differential lock, see **Fig. 1**.

For a wiring diagram of a one-switch tandem-axle differential lock, see **Fig. 2**.

For a wiring diagram of a two-switch tandem-axle differential lock, see **Fig. 3**.

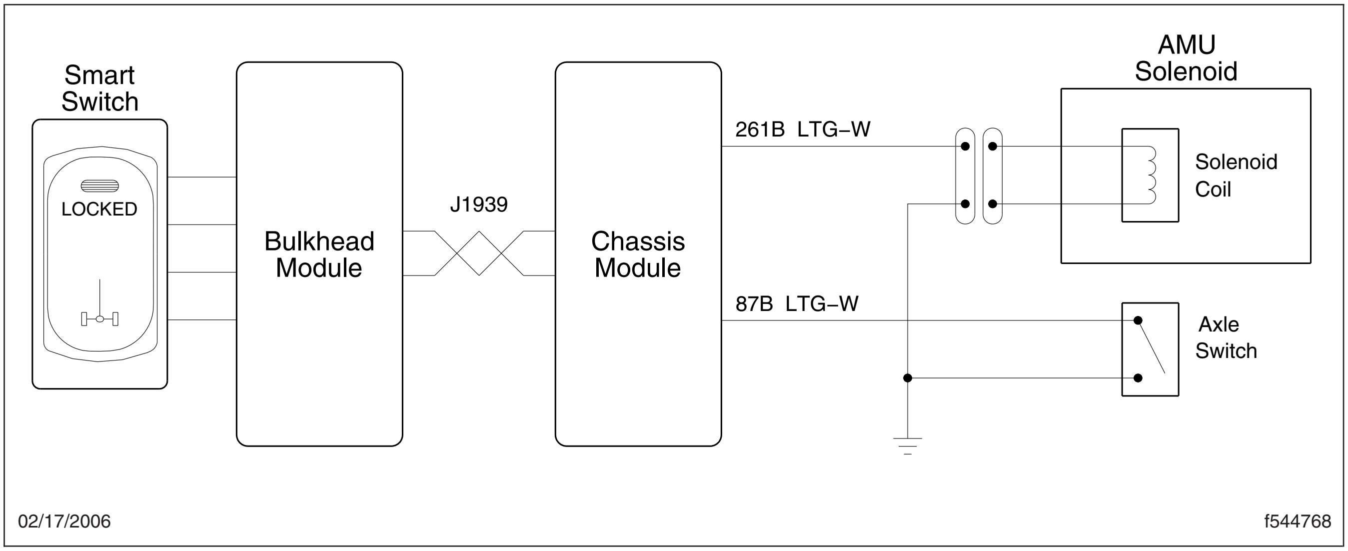


Fig. 1, Single-Drive Axle Differential Lock Wiring Diagram

Differential Lock Specifications

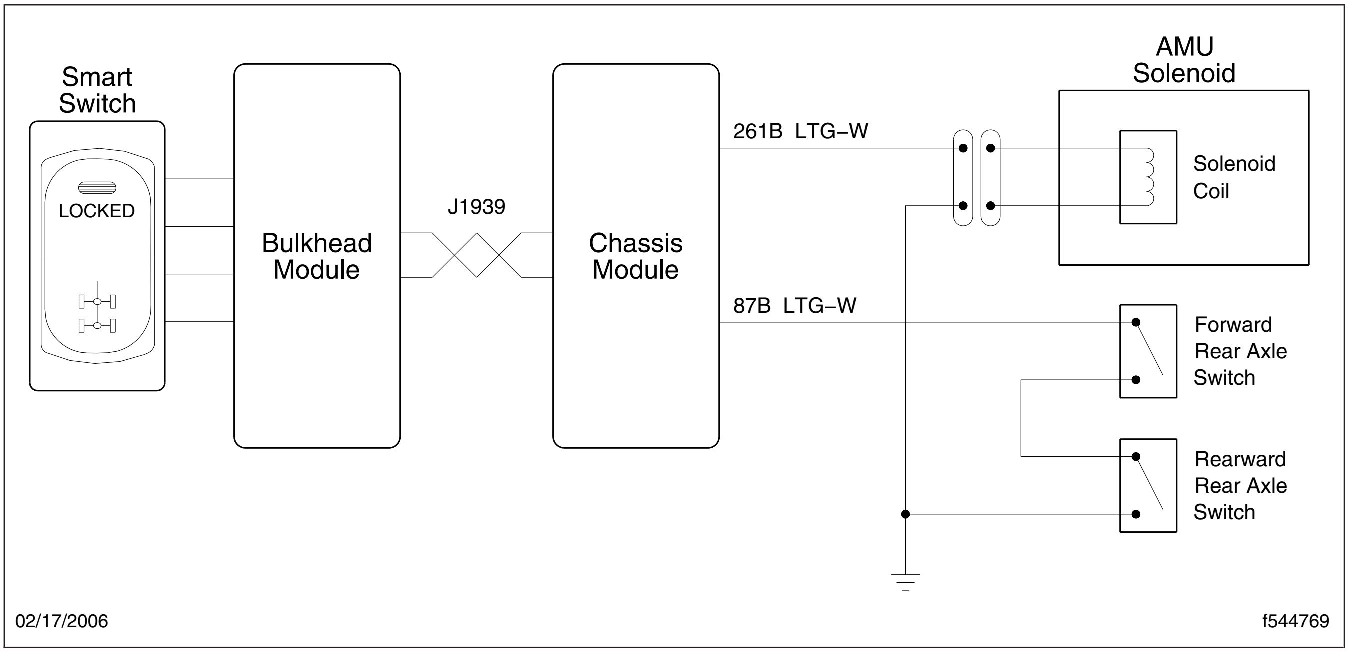


Fig. 2, One-Switch Tandem-Axle Differential Lock Wiring Diagram

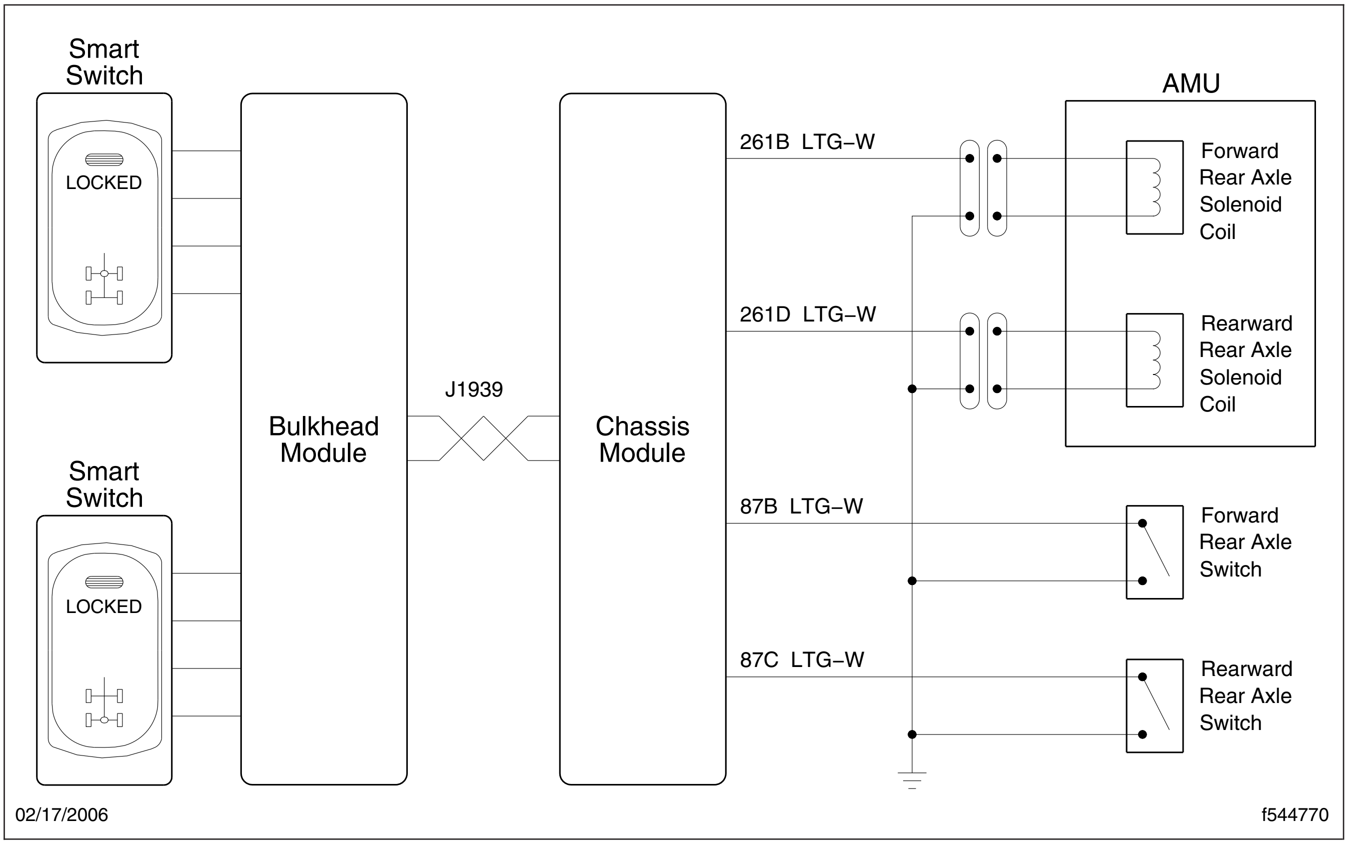


Fig. 3, Two-Switch Tandem-Axle Differential Lock Wiring Diagram

Contents

General Information

Introduction

A Business Class® M2 vehicle may be equipped with all-wheel drive (AWD). AWD delivers drive power to the front drive axle by engaging a front drive shaft that is connected to the transfer case. With AWD active, all front and rear wheels are used to provide drive power to the ground and greatly increase traction.

The electronic controls for AWD are not multiplexed. AWD is a stand-alone system that does not use datalink communications to operate and monitor the AWD system. The AWD system is engaged when an air solenoid is activated by the ABS controller. The air solenoid is a module of the AMU or a solenoid in the AAVA system.

The AWD controls may include:

- Activation of the transfer case ranges (low or high);
- Activation of the differential lock (with single rear axle);
- Activation of the interaxle lock (with tandem rear axles);
- Illumination of instrumentation control unit (ICU) indicators;
- Operational logic provided by the antilock brakes system ECU;
- Operation of AWD AMU/AAVA solenoids;
- Activation of AWD.

All-Wheel Drive

All-wheel drive engages the front drive shaft from the transfer case for all-wheel drive operation. With the engine running, AWD can be activated using a latching, two-position switch on the dash panel.

Pressing the upper half of the AWD switch engages the front drive axle. The switch LED illuminates when the switch is pressed for activation. Pressing the lower half of the AWD switch deactivates AWD.

NOTE: The controls are not multiplexed. If the AWD switch is left in the on position and the ignition key is turned off then back on, AWD will engage as long as all the interlock conditions are met.

AWD switch signals are wired directly to the antilock brakes system (ABS) ECU. Upon switch activation, the ABS ECU uses internal programmed logic to determine if AWD may be activated.

For AWD activation, the ABS ECU transmits a low-current output to a normally closed antilock brake AWD AMU or AAVA solenoid. The energized solenoid opens and supplies compressed air to the transfer case input port for the front driveshaft clutch. The air sent to the transfer case applies a lock to the forward drive shaft causing driveline power to be delivered to the front axle. With the forward axle engaged, a switch on the transfer case closes and sends a signal to the ICU to turn on the AWD indicator. See **Fig. 1**.

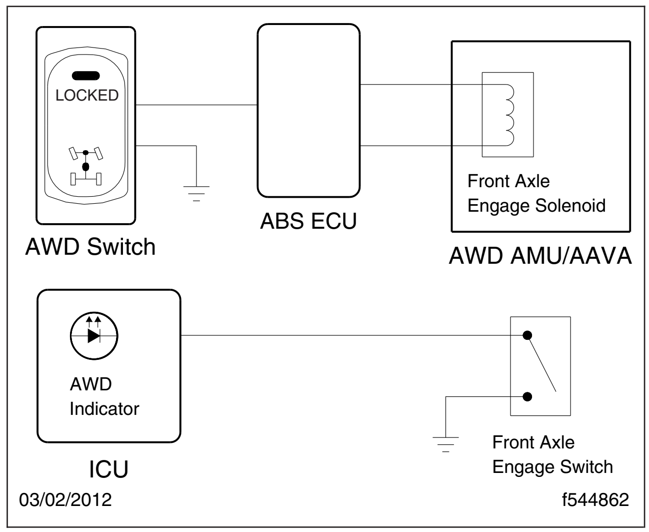


Fig. 1, AWD Function

The ABS ECU may restrict AWD activation to prevent excessive wear on the transfer case and other driveline components. Situations such as high engine speeds or variations between individual wheel speeds may prevent activation of AWD.

NOTE: Operating the vehicle with AWD activated under normal driving conditions increases driveline and tire wear. Use AWD when improved traction is needed.

Differential Lock

When a vehicle is equipped with a single rear drive axle, the differential lock controls are part of the AWD wiring. As part of the AWD wiring, the differential lock controls are not multiplexed.

When a vehicle is equipped with a tandem drive axle, the differential lock controls are multiplexed and therefore independent of the AWD wiring. See **Section 54.40** for information on multiplexed differential lock controls.

When the differential lock is activated using nonmultiplexed controls, the clutch collar locks the axle differential case, gearing, and shafts together. A differential lock improves traction in slippery conditions by spinning the wheels of the rear axle at the same speed.

With the engine running, the differential lock can be activated using a latching, two-position differential lock switch on the dash panel. When the upper half of the differential lock switch is pressed, a signal is sent from the switch to the ABS ECU requesting that the differential lock be activated. The switch LED illuminates when the switch is pressed for activation. When the lower half of the differential lock switch is pressed, the differential lock is deactivated.

NOTE: The controls are not multiplexed. If the differential lock switch is left in the on position and the ignition key is turned off then back on, the differential lock will engage as long as all the interlock conditions are met.

The differential lock switch is wired directly to the ABS ECU. Upon switch activation, the ABS ECU uses internal programmed logic to determine if the differential lock may be activated. For activation, the ABS ECU transmits a low-current output to a normally closed AWD AMU/AAVA solenoid. The energized solenoid opens and supplies compressed air to the differential housing. The air sent to the housing applies a lock to the differential, causing both axle shafts to spin at the same speed. With the differential lock engaged, a differential lock switch closes and sends a signal to the ICU to turn on the differential lock indicator. See **Fig. 2**.

Interaxle Lock

The interaxle lock is available with the AWD controls on a vehicle with tandem drive axles. When activated, the interaxle differential is locked. This essentially makes the driveshaft a solid connection between both the rear axles. Power entering the forward axle is transmitted straight through to the

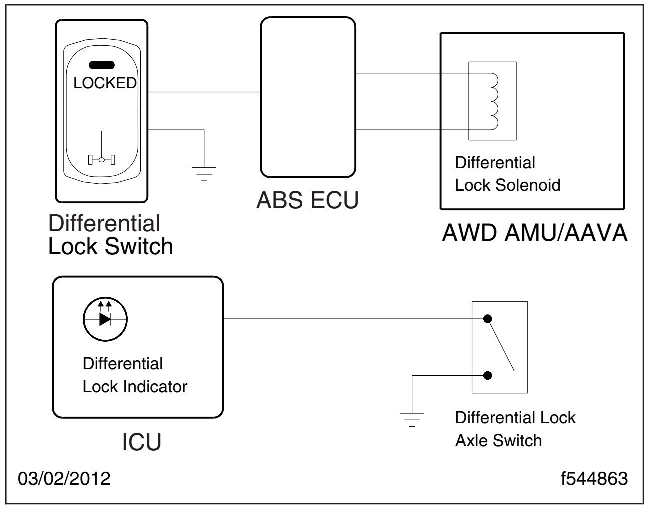


Fig. 2, Differential Lock Function

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. With the interaxle lock activated, both rear drive axles spin equally and improve traction in slippery conditions by turning all the rear wheels at the same speed.

With the engine running, the interaxle lock can be activated using a latching, two-position interaxle lock switch on the dash panel. By pressing the upper half of the interaxle lock switch, a signal is sent from the switch to the ABS ECU requesting that the interaxle lock be activated. The switch LED and an ICU indicator illuminate when the switch is activated. Pressing the lower half of the interaxle lock switch deactivates the differential lock.

NOTE: The controls are not multiplexed. If the interaxle lock switch is left in the on position and the ignition key is turned off then back on, the interaxle lock will engage as long as all the interlock conditions are met.

The interaxle lock switch is wired directly to the ABS ECU. For activation, the ABS ECU transmits a low-current output to a normally closed AWD AMU/AAVA solenoid. The energized 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. See **Fig. 3**.

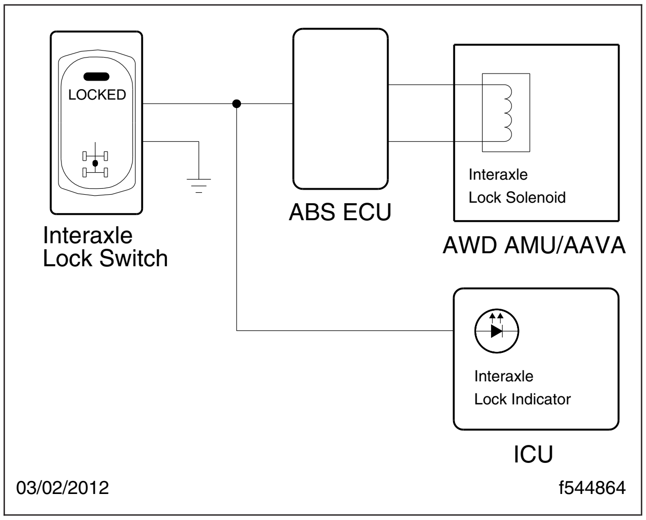


Fig. 3, Interaxle Lock Function

Transfer Case Range

The AWD system includes controls for the selection and activation of the transfer case speed range. These controls are not multiplexed. Electronic signals from the transfer case range switch activate relays in the auxiliary power distribution module (PDM). The relays control AWD AMU/AAVA solenoids that supply pressurized air to the transfer case to engage the selected range.

The auxiliary PDM is located under the top cover of the dashboard. On a vehicle with a winged dashboard, the auxiliary PDM is located in the center of the dashboard. On a vehicle with a flat dashboard, the auxiliary dashboard is located on the left side of the dashboard. The auxiliary PDM has a cover with a label on it. The part number of the label is 24-01410-003. See **Section 60.08, Subject 100** for dash panel removal and installation procedures.

The control relays in the auxiliary PDM include:

- ignition power supply relay
- low-range relay
- low-range interlock relay
- high-range relay
- high-range interlock relay

To prevent transfer case and driveline damage, range selection or range changes may only be made when the parking brake is applied. The controls for range selection use a dual contact parking brake pressure switch. The two sets of contacts within this pressure switch control activation of the transfer case range relays and transfer case range interlock relays.

Parking Brake Pressure Switch

On a Business Class M2 vehicle with AWD there is a parking brake pressure switch in the AWD AMU or in the park brake air line on AAVA equipped vehicles. The parking brake pressure switch has two sets of contacts that sense parking brake pressure as follows:

- Switch 1 is normally closed at 0 psi and opens when the air pressure reaches 70 to 84 psi (483 to 579 kPa).
- Switch 2 is normally open at 0 psi and closes when the air pressure reaches 2 to 5 psi (14 to 34 kPa).

NOTE: Air pressure of 0 psi at the parking brake AWD AMU/AAVA switch means that the parking brake is applied.

Parking Brake Applied

The circuits (493R and 493P) connected at switch 1 of the parking brake pressure switch control the transfer case range relays. When the parking brake is applied, there is 0 psi at switch 1 and the switch remains normally closed. With the engine on and switch 1 closed, all the coils of the transfer case relays are grounded, meaning the relays are energized. According to the selected position of the transfer case range switch, power is supplied from the range switch through the corresponding transfer case relay to the appropriate range solenoid. The activated solenoid supplies air to the transfer case to engage the selected range.

The circuits (GND and 493T) connected at switch 2 of the parking brake pressure switch control the transfer case range interlock relays. When the parking brake is applied, there is 0 psi at switch 2 and the switch remains normally open. With the engine on and switch 2 open, all the coils of the transfer case interlock relays are not grounded, meaning the relays are de-energized.

Parking Brake Released

When the parking brake is released, the pressure at the parking brake pressure switch will rise to the high pressure of the parking brake pneumatic circuit. The two switch contacts of the parking brake pressure switch function independently from one another and are activated at different parking brake pressures. See **Table 1** for the circuit function of the parking brake pressure switches in the AMU/AAVA.

As parking brake pressure increases to 2 to 5 psi (14 to 34 kPa), the normally open switch 2 closes and connects circuits GND and 493T. With switch 2 closed, all the coils of the transfer case interlock relays are provided a ground, meaning the relays are energized. According to the selected position of the transfer case range switch, power is supplied from the range switch through the corresponding transfer case and transfer case interlock relays to the appropriate range solenoid. The interlock relays ensure that when there is active pressure in the parking brake pneumatic circuit, the transfer case cannot be shifted out of the selected range.

As parking brake pressure reaches 70 to 84 psi (483 to 579 kPa), the normally closed switch 1 opens and deactivates the transfer case relays. Above these pressures, power is still supplied to the selected AWD solenoid via the activated interlock relay. No transfer case range shifts are allowed until the interlock relays are deactivated. Deactivation of the interlock relays occurs only when the parking brake is applied and the pressure at the parking brake switch returns to 0 psi.

Transfer Case High Range

With the parking brake applied and 0 psi at the parking brake pressure switch, the normally closed switch 1 of the parking brake pressure switch energizes the high-range relay in the auxiliary PDM. Selecting the high-range position on the transfer case range switch sends power through the closed contacts of the high-range relay to the high-range solenoid and the high-range interlock relay. The powered high-range solenoid sends compressed air to the transfer case housing shifting the transfer case into high range. See **Fig. 4**.

When the parking brake is released, the pressure of the parking brake pneumatic circuit will rise. As parking brake pressure reaches 2 to 5 psi (14 to 34 kPa), the normally open switch 2 closes and energizes the transfer case high-range interlock relay. Now the high-range solenoid is receiving power from both the high-range relay and the high-range interlock relay. The high-range interlock relay prevents the transfer case from being shifted out of high-range while there is active pressure in the parking brake pneumatic circuit.

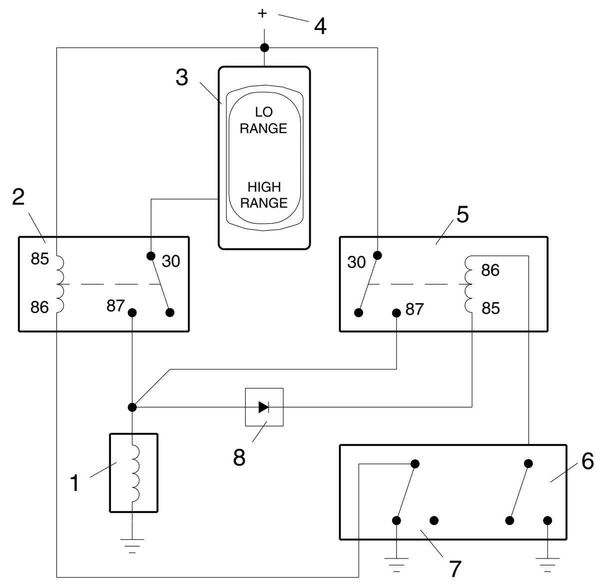
As parking brake pressure increases to 70 to 84 psi (483 to 579 kPa), the normally closed switch 1 opens and deactivates the transfer case high-range relay. At this pressure, the high-range solenoid is powered only by the high-range interlock relay. The transfer case will remain locked in high range until the parking brake is applied and the pressure at the parking brake switch returns to 0 psi.

Applying the parking brake decreases the pressure of the parking brake pneumatic circuit. As pressure falls to 70 to 84 psi (483 to 579 kPa), the high-range relay is energized. The high-range solenoid is now receiving power from both the high-range relay and the high-range interlock relay. When the pressure decreases to 2 to 5 psi (14 to 34 kPa), switch 2 will open and de-energize the high-range interlock relay.

Parking Brake Pressure Switch Circuit Function			
Pin	**Circuit**	**Switch Connection**	**Function**
A	493R	Switch 1 (normally closed)	Switch 1 is closed from 0 psi through approximately 70 to 84 psi (483 to 579 kPa). When closed, switch 1 connects circuits 493R and 493P. This activates all the coils of the transfer case range relays. Above 70 to 84 psi (483 to 579 kPa), switch 1 opens and the transfer case range relays are deactivated.
B	493P	Switch 1 (normally closed)	
C	GND	Switch 2 (normally open)	Switch 2 is open from 0 psi through approximately 2 to 5 psi (14 to 34 kPa). When open, switch 2 deactivates all the coils of the transfer case range interlock relays. Above 2 to 5 psi (14 to 34 kPa), switch 2 closes and connects circuits GND and 493T. This activates the transfer case range interlock relays and locks the transfer case into the selected range.
D	493T	Switch 2 (normally open)	

Table 1, Parking Brake Pressure Switch Circuit Function

After the high-range interlock relay is de-energized, the transfer case may be shifted to low range. Range changes can only occur when the parking brake is applied and the transmission is in neutral.



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1. High-Range Solenoid
2. High-Range Relay in Auxiliary PDM
3. Transfer Case Range Switch
4. Ignition Feed from Ignition Relay in Auxiliary PDM
5. High-Range Interlock Relay in Auxiliary PDM
6. Normally Open Switch 2 (part of the parking brake pressure switch)
7. Normally Closed Switch 1 (part of the parking brake pressure switch)
8. High-Range Interlock Diode

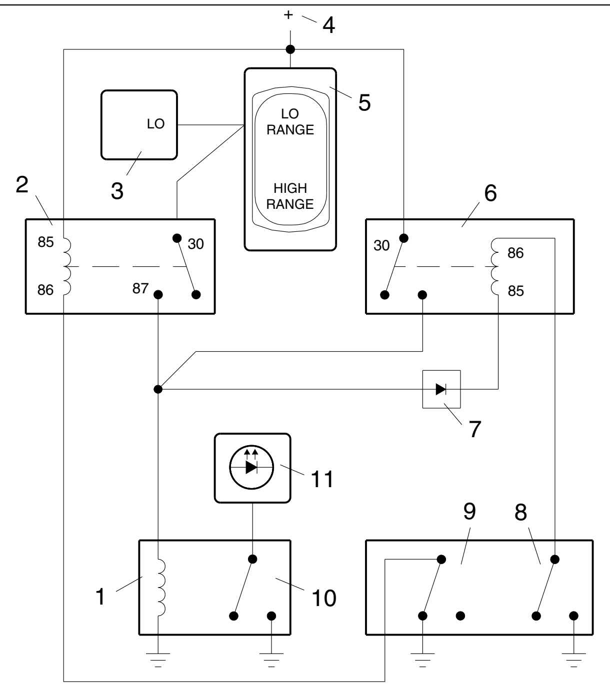
Fig. 4, High-Range Function

Transfer Case Low Range

With the parking brake applied and 0 psi at the parking brake pressure switch, the normally closed switch 1 of the parking brake pressure switch energizes the low-range relay in the auxiliary PDM. Selecting the low-range position on the transfer case range switch:

- Delivers a low-range signal to the engine ECU;
- Sends power to the low-range solenoid;
- Sends power to the low-range interlock relay in the auxiliary PDM.

The powered low-range solenoid sends compressed air to the transfer case housing shifting the transfer case into low range. A normally closed pressure switch inside the low-range solenoid opens when the solenoid is delivering air pressure. The solenoid pressure switch sends a signal that illuminates a low-range indicator on the ICU. See **Fig. 5**.



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1. Low-Range Solenoid
2. Low-Range Relay in Auxiliary PDM
3. Engine ECU (low-range notification)
4. Ignition Feed from Ignition Relay in Auxiliary PDM
5. Transfer Case Range Switch
6. Low-Range Interlock Relay in Auxiliary PDM
7. Low-Range Interlock Diode
8. Normally Open Switch 2 (part of the parking brake pressure switch)
9. Normally Closed Switch 1 (part of the parking brake pressure switch)
10. Low-Range Solenoid Pressure Switch
11. Low-Range Indicator in ICU

Fig. 5, Low-Range Function

The transfer case range switch provides the engine ECU notification that the transfer case is in low range. A low-range signal (ground input) is delivered via a circuit wired from the transfer case range switch directly to the engine ECU.

General Information

When the parking brake is released, the pressure of the parking brake pneumatic circuit will rise. As parking brake pressure reaches 2 to 5 psi (14 to 34 kPa), the normally open switch 2 closes and energizes the transfer case low-range interlock relay. Now the low-range solenoid is receiving power from both the low-range relay and the low-range interlock relay. The low-range interlock relay prevents the transfer case from being shifted out of low range while there is active pressure in the parking brake pneumatic circuit.

As increasing parking brake pressure reaches 70 to 84 psi (483 to 579 kPa), the normally closed switch 1 opens and deactivates the transfer case low-range relay. At this pressure, the low-range solenoid is powered only by the low-range interlock relay. The transfer case will remain locked in low range until the parking brake is applied and the pressure at the parking brake switch returns to 0 psi.

Applying the parking brake decreases the pressure of the parking brake pneumatic circuit. As pressure falls to 70 to 84 psi (483 to 579 kPa), the low-range relay is energized. The low-range solenoid is now receiving power from both the low-range relay and the low-range interlock relay. When the pressure decreases to 2 to 5 psi (14 to 34 kPa), switch 2 will open and de-energize the low-range interlock relay.

After the low-range interlock relay is de-energized, the transfer case may be shifted to high-range. Range changes can only occur when the parking brake is applied and the transmission is in neutral.

Troubleshooting

IMPORTANT: A Business Class® M2 vehicle with optional all-wheel drive (AWD) has nonmultiplexed electronic controls for the transfer case functions. The following troubleshooting procedures are for nonmultiplexed transfer case controls. These controls do not use datalink communications to operate and monitor the transfer case functions. Only use this troubleshooting section if your vehicle is equipped with AWD.

See **Table 1** for electrical troubleshooting of the all-wheel drive.

See **Table 2** for electrical troubleshooting of the driver-controlled differential lock on an AWD vehicle with a single rear axle.

See **Table 3** for electrical troubleshooting of the inter-axle lock on an AWD vehicle with dual rear axles.

See **Table 4** for electrical troubleshooting of the transfer case range.

All-Wheel-Drive Troubleshooting		
Symptom	**Possible Cause**	**Check For**
No illumination of the AWD indicator on the instrumentation control unit (ICU).	Bad feedback circuit	Check the front axle engage switch. If the switch is functioning properly, check the circuit from the switch to ground and the circuit from the switch to the ICU.
AWD may engage then drop out, or not engage at all.	Insufficient air pressure	If an air pressure gauge indicates sufficient pressure, there may be a kink or restriction in the air lines.
	Bad electrical connection to the AWD air management unit (AMU)	Inspect the connector and connector pins. Straighten bent pins and make sure that the electrical connections are properly seated.
	Bad solenoid in the AWD AMU	Remove the air line from the transfer case for the front drive shaft lock. If no air, replace the solenoid.
	No signal from the AWD switch	Check the circuits of the AWD switch. Check the circuit from the switch to ground and the circuit from the switch to the ABS ECU.
	Antilock brakes system (ABS) ECU malfunction	The front axle engage solenoid is controlled by the ABS ECU. Make sure that all criteria for AWD activation are met and that the ABS ECU is functioning properly.

Table 1, All-Wheel-Drive Troubleshooting

Driver-controlled Differential Lock Troubleshooting for an AWD Vehicle With a Single Rear Axle		
Symptom	**Possible Cause**	**Check For**
No illumination of the differential lock indicator on the ICU.	Bad feedback circuit	Check the differential lock axle switch. If the switch is functioning properly, check the circuit from the switch to ground and the circuit from the switch to the ICU.

Troubleshooting

Driver-controlled Differential Lock Troubleshooting for an AWD Vehicle With a Single Rear Axle		
Symptom	**Possible Cause**	**Check For**
Differential lock (nonmultiplexed) may engage then drop out, or not engage at all.	Insufficient air pressure	If an air pressure gauge indicates sufficient pressure, there may be a kink or restriction in the air lines.
	Bad electrical connection to the AWD AMU	Inspect the connector and connector pins. Straighten bent pins and make sure that the electrical connections are properly seated.
	Bad solenoid in the AWD AMU	Remove the air line from the differential housing and turn on the switch. If no air, replace the solenoid.
	No signal from the differential lock switch	Check the circuits of the differential lock switch. Check the circuit from the switch to ground and the circuit from the switch to the ABS ECU.
	ABS ECU malfunction	The differential lock solenoid is controlled by the ABS ECU. Make sure that the ABS ECU is functioning properly.

Table 2, Driver-controlled Differential Lock Troubleshooting for an AWD Vehicle With a Single Rear Axle

Interaxle Lock Troubleshooting for an AWD Vehicle With Dual Rear Axles		
Symptom	**Possible Cause**	**Check For**
No illumination of the interaxle lock indicator on the ICU.	Bad interaxle lock switch circuit	Check the ground circuit from the interaxle lock switch.
Interaxle lock (nonmultiplexed) may engage then drop out, or not engage at all.	Insufficient air pressure	If an air pressure gauge indicates sufficient pressure, there may be a kink or restriction in the air lines.
	Bad electrical connection to the AWD AMU	Inspect the connector and connector pins. Straighten bent pins and make sure that the electrical connections are properly seated.
	Bad solenoid in the AWD AMU	Remove the air line from the forward rear axle differential and turn on the switch. If no air, replace the solenoid.
	No signal from the interaxle lock switch	Check the circuits of the interaxle lock. Check the circuit from the switch to ground and the circuit from the switch to the ABS ECU.
	ABS ECU malfunction	The interaxle lock solenoid is controlled by the ABS ECU. Make sure that the ABS ECU is functioning properly.

Table 3, Interaxle Lock Troubleshooting for an AWD Vehicle With Dual Rear Axles

Transfer Case Range Troubleshooting		
Symptom	**Possible Cause**	**Check For**
No illumination of the low-range indicator on the ICU.	Bad feedback circuit	Make sure that the pressure switch inside the low-range solenoid is operating properly.

Troubleshooting

Transfer Case Range Troubleshooting		
Symptom	**Possible Cause**	**Check For**
Selected transfer case range (nonmultiplexed) may engage then drop out, or not engage at all.	Insufficient air pressure	If an air pressure gauge indicates sufficient pressure, there may be a kink or restriction in the air lines.
	Bad solenoid in the AWD AMU	Remove the air line of the suspect solenoid from the transfer case and turn on the switch. If no air, replace the solenoid.
	Bad relay in the auxiliary PDM	Check function of suspect relays. For each range there is a range relay and a range interlock relay. Make sure both relays are operational.
	Bad electrical connection(s)	Check the circuitry of the AWD system. Look for loose, damaged, or improperly seated components.
	Bad parking brake pressure switch in AWD AMU	Check the parking brake pressure switch for correct operation. Pins A and B are for the normally closed switch 1 that opens at 70 to 84 psi (483 to 579 kPa). Pins C and D are for the normally open switch 2 that closes at 2 to 5 psi (14 to 34 kPa).
Engine ECU not receiving low-range notification.	Bad feedback circuit	Check the feedback circuit. For vehicles without a transfer-case-mounted PTO, feedback is provided by a single circuit from the transfer case switch to the engine ECU. With a transfer-case-mounted PTO, feedback is provided by a low-range engine ECU relay in the auxiliary PDM.

Table 4, Transfer Case Range Troubleshooting

Wiring Diagrams

IMPORTANT: A Business Class® M2 vehicle with optional all-wheel drive (AWD) has nonmultiplexed electronic controls for the transfer case functions. The following wiring diagrams are for nonmultiplexed transfer case controls. These controls do not use datalink communications to operate and monitor the transfer case functions. Only use these wiring diagrams if your vehicle is equipped with AWD.

See **Fig. 1** for a wiring diagram of all-wheel drive.

See **Fig. 2** for a wiring diagram of the driver-controlled differential lock on an AWD vehicle with a single rear axle.

See **Fig. 3** for a wiring diagram of the interaxle lock on an AWD vehicle with dual rear axles.

See **Fig. 4** for a wiring diagram of the transfer case power.

See **Fig. 5** for a wiring diagram of the transfer case low range.

See **Fig. 6** for a wiring diagram of the transfer case high range.

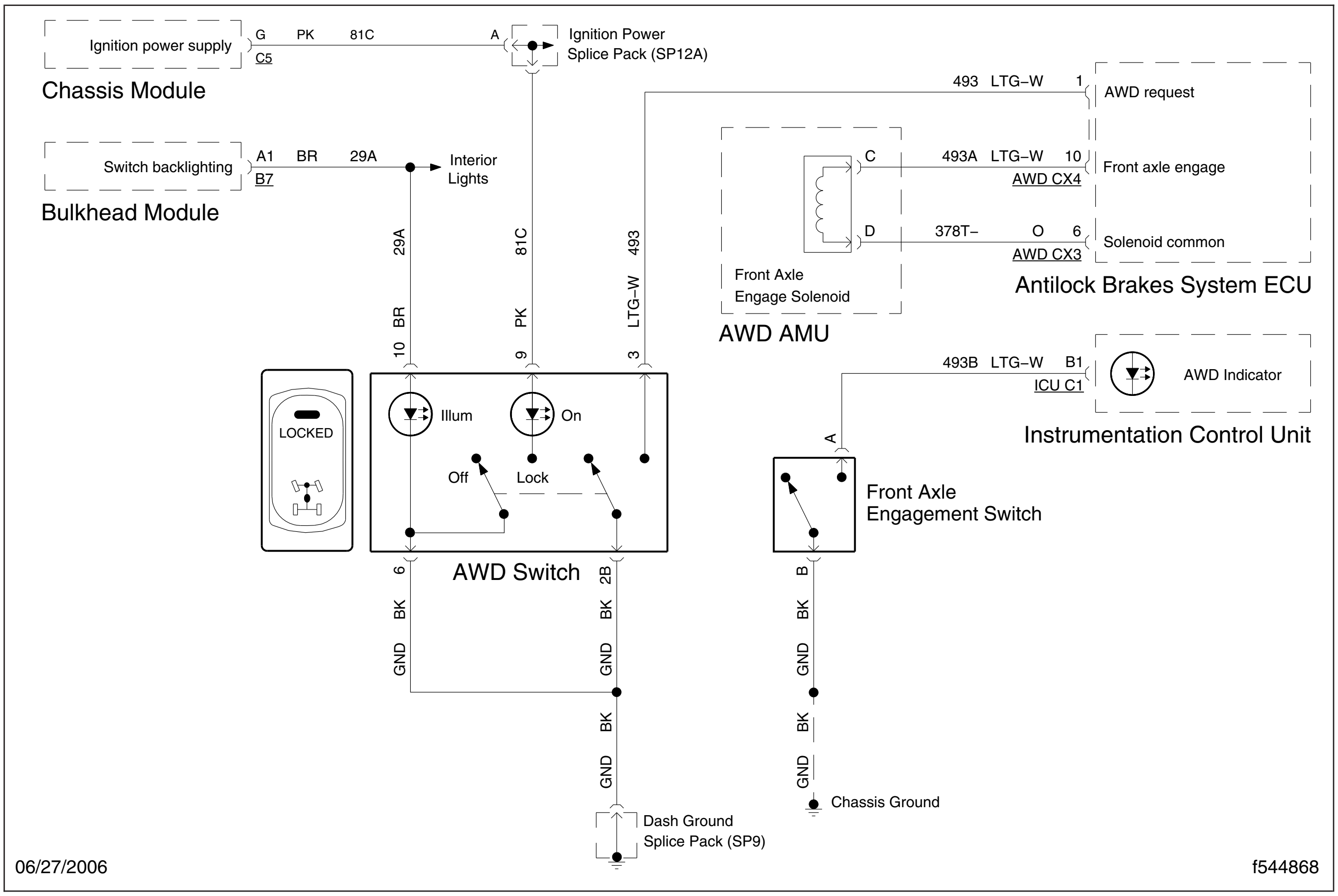

Fig. 1, AWD Wiring Diagram

Specifications

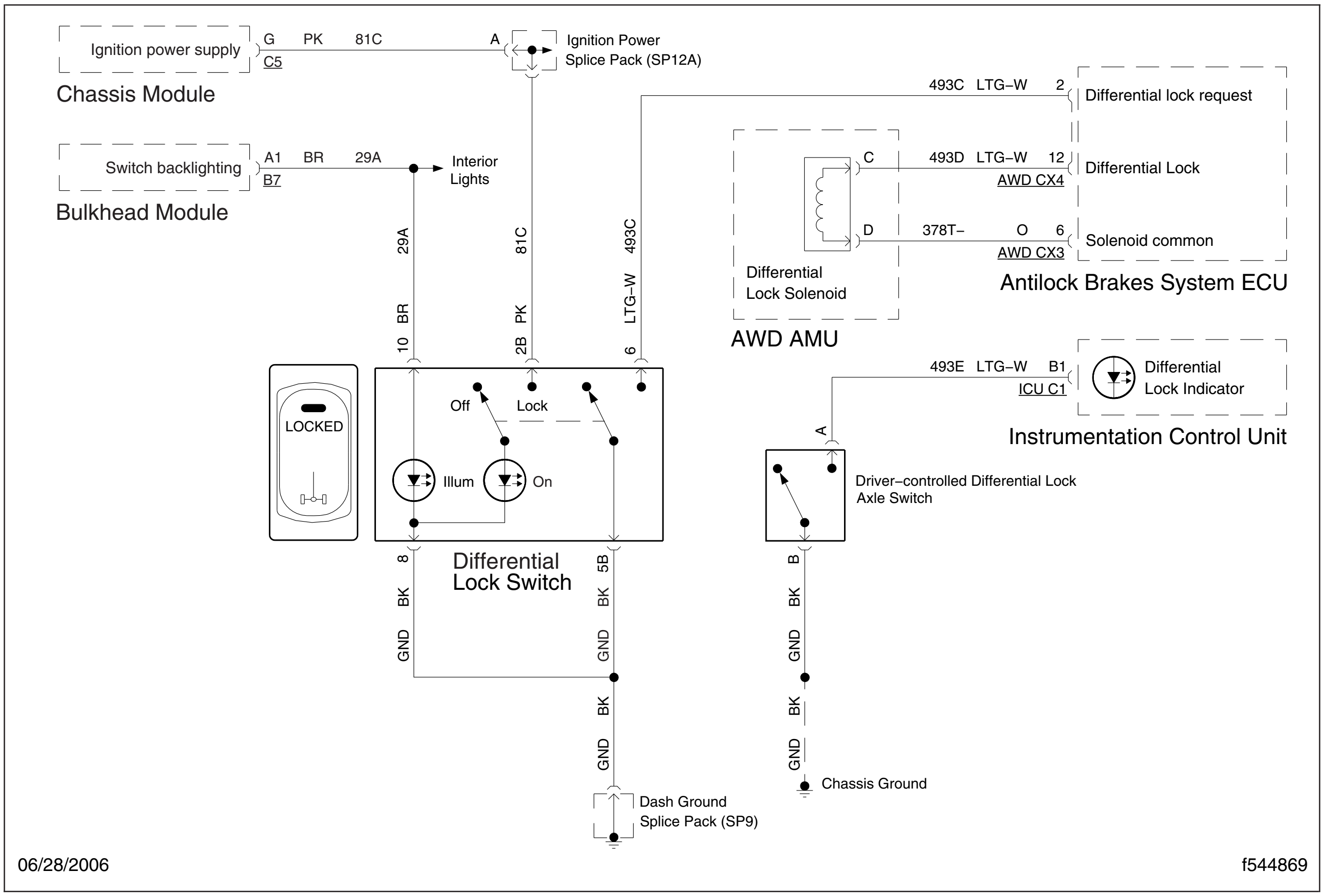

Fig. 2, Driver-Controlled Differential Lock Wiring Diagram for an AWD Vehicle With a Single Rear Axle

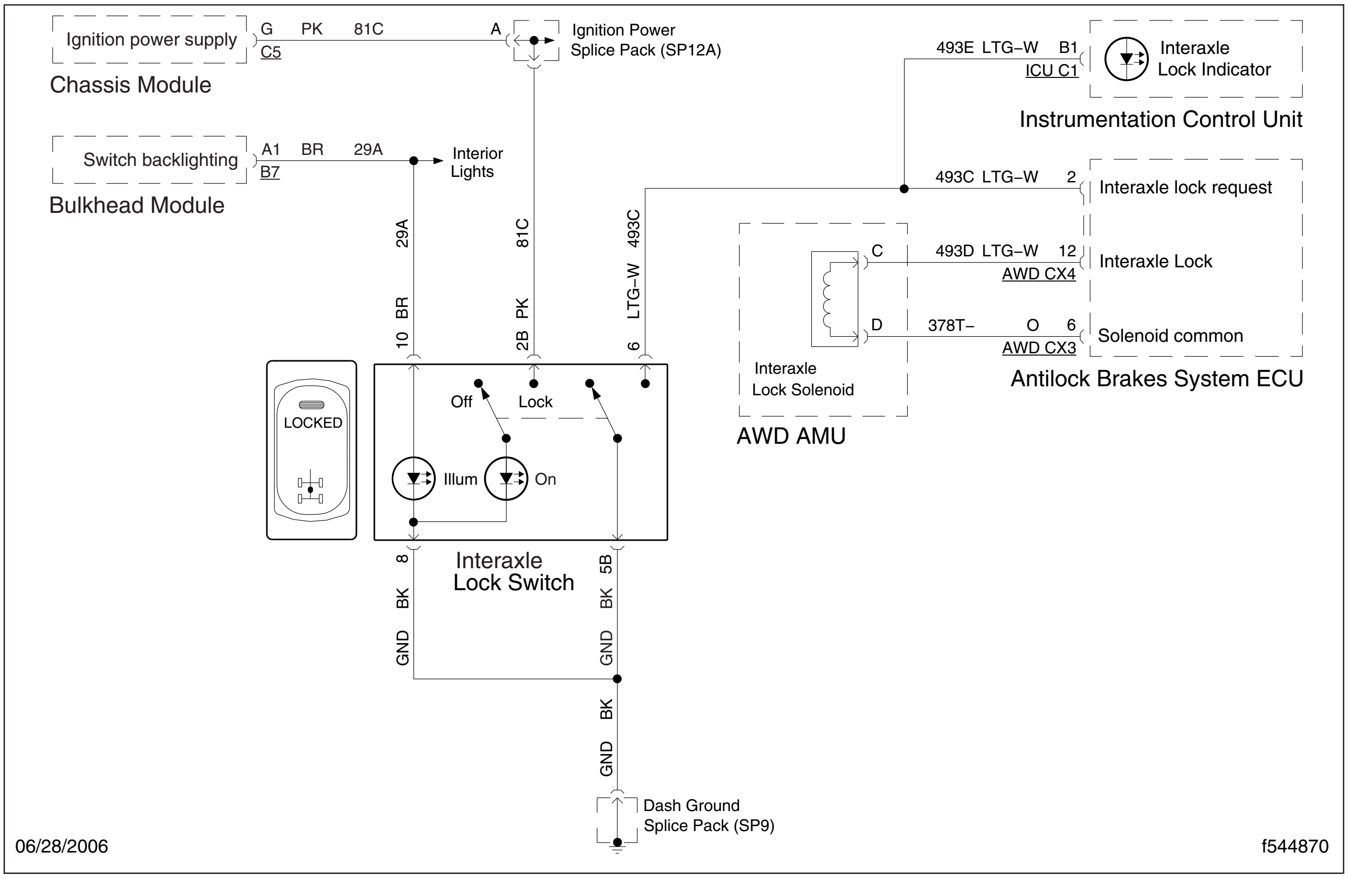

Fig. 3, Interaxle Lock Wiring Diagram for an AWD Vehicle With Dual Rear Axles

Specifications

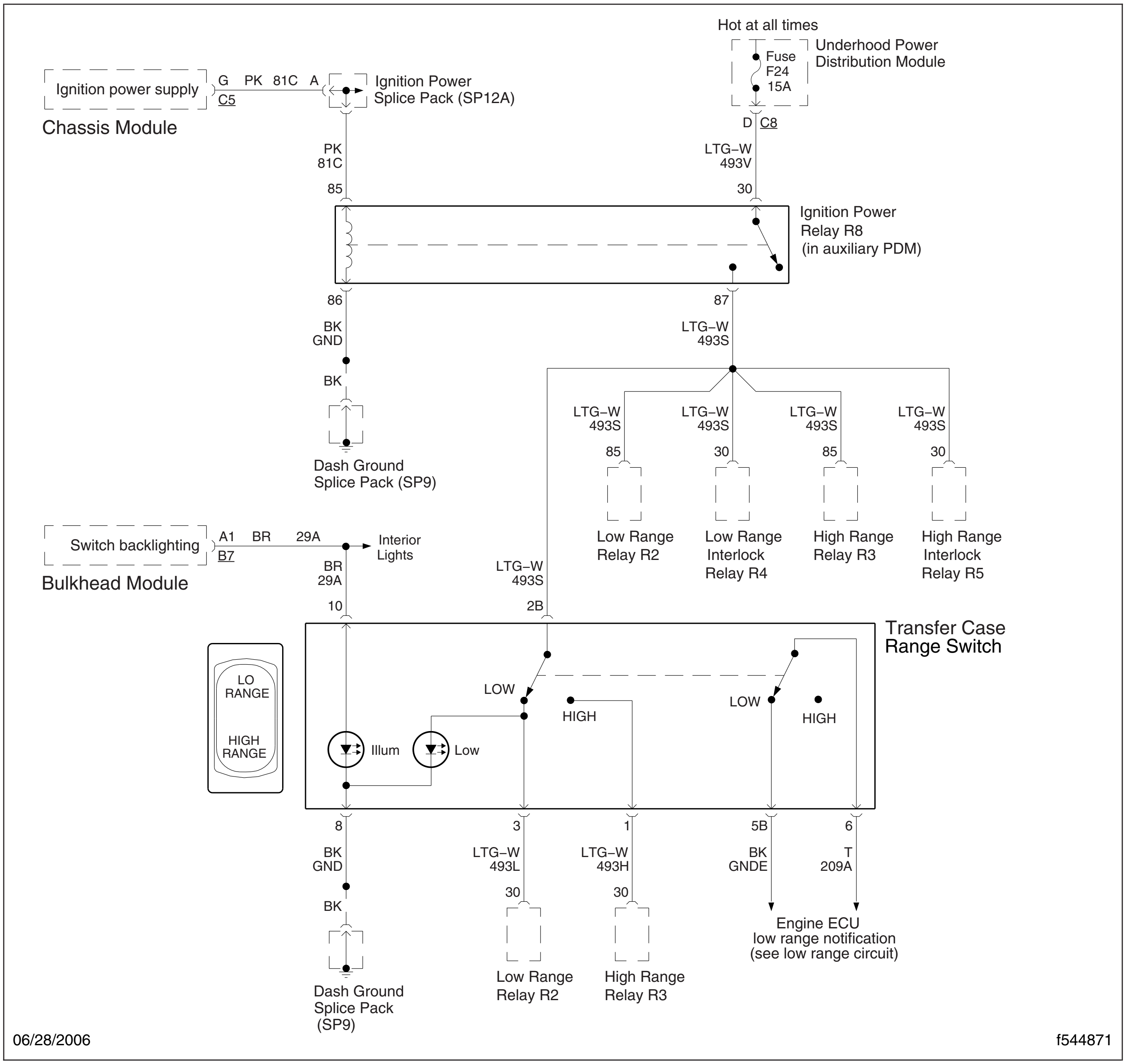

Fig. 4, Transfer Case Power Wiring Diagram

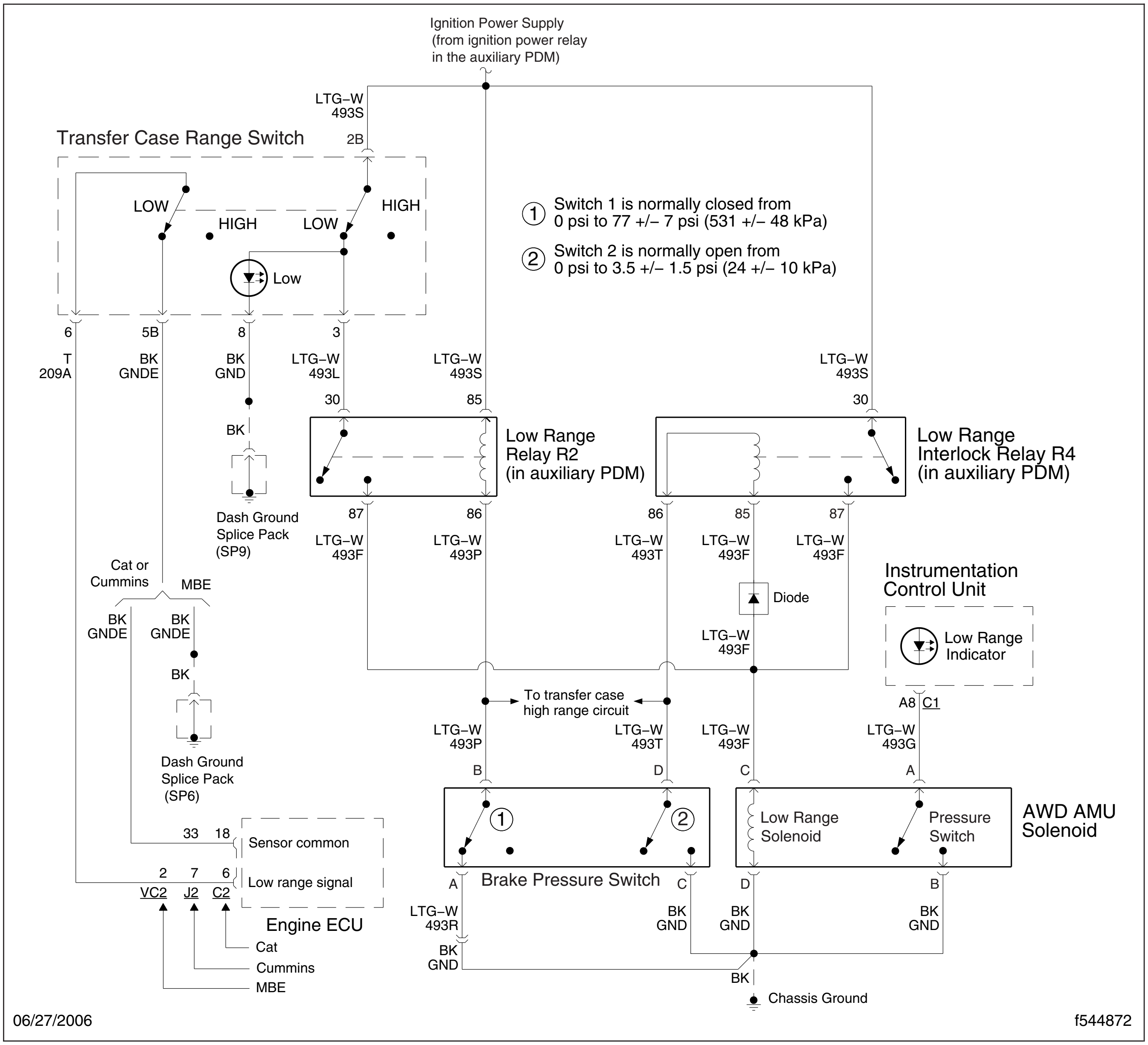

Fig. 5, Transfer Case Low-Range Wiring Diagram

Specifications

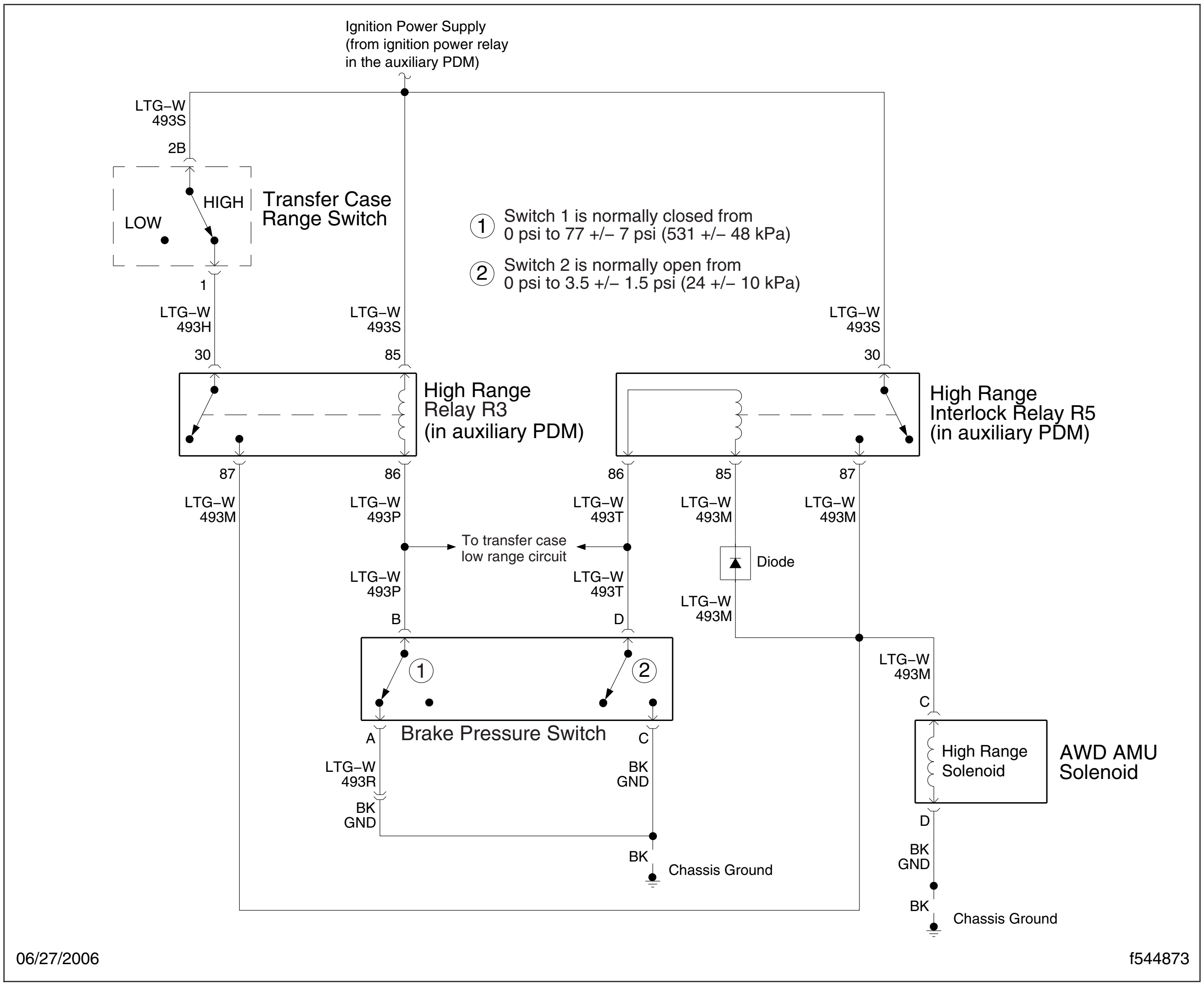

Fig. 6, Transfer Case High-Range Wiring Diagram