SERVICE MANUAL SECTION

ELECTRICAL SYSTEM TROUBLESHOOTING GUIDE - 4100, 4300, 4400, 7300, 7400, 7500, 7600, 7700, 8500, 8600, ProStar Models Built After 03/01/2007

Model: 4100, 4300, 4400
Start Date: 03/01/2007

Model: 7300, 7400, 7500, 7600, 7700
Start Date: 03/01/2007

Model: 8500, 8600
Start Date: 03/01/2007

Model: ProStar
Start Date: 03/01/2007

S08303

11/15/2007

1. DESCRIPTION

The information is in this order:

- General Diagnostic Information
- Displaying Diagnostic Codes
- ABS
- Aftertreatment – DLB Software *before* November, 2007
- Aftertreatment – DLB Software November, 2007 and after
- Cruise Control
- Differential Lock
- Fifth Wheel Slide
- Fuel Transfer Pump System
- HVAC
- HVAC — ProStar Sleeper
- Load Shedding
- Power Divider Lock
- Remote Start/Stop (3200/4000/7000/CXT/RXT Models)
- Remote Start/Stop (ProStar)
- Suspension Dump
- Tire Pressure Monitoring System (TPMS)
- Tire Transmitter ID Programming
- Vehicle Information Display (ProStar)
- Windshield Wiper and Washer Pump

General Diagnostic Information

1. Cautions and Warnings

IMPORTANT: Read the following before starting any service procedures.

You must follow your company safety procedures when you service or repair equipment. Be sure to understand all of the procedures and instructions before you begin work on the unit.

International uses the following types of notations to give warning of possible safety problems and to give information that will prevent damage to the equipment being serviced or repaired.

A warning indicates procedures that must be followed exactly. Personal injury or possible death, along with damage to the vehicle, can occur if the procedure is not followed.

A caution indicates procedures that must be followed exactly. If the procedure is not followed, damage to equipment or components can occur.

NOTE: A note indicates an operation, procedure or instruction that is important for correct service.

Some procedures require the use of special tools for safe and correct service. Failure to use these special tools when required can cause injury to service personnel or damage to vehicle components.

2. High Voltage Circuits (Greater Than 50 Volts) on International Trucks and Buses

To avoid property damage, personal injury, or death, refer to the manufacturer's service information before working on any high voltage equipment. By definition, high voltage circuits and components contain voltage levels that may cause equipment damage, electrical shock, and/or electrocution if handled incorrectly.

Only a trained technician may perform service inside high voltage components. When working around or maintaining high voltage circuits, please seek high voltage training.

NOTE: The intent of this section is to provide some basic guidelines when working on or around International vehicles that are equipped with high voltage electrical equipment and

circuits. For specific instructions, maintenance, or service information on specific equipment or options, refer to the service manuals for the specified truck models and component(s). It is not the intent of this section to provide detailed service instructions for high voltage equipment and circuits.

High voltage systems require the maintainer to be familiar with two types of electrical systems.

DC (Direct Current)

Most DC systems on today's trucks use 12 volt negative ground. Some systems can store DC electricity in batteries with operating voltages as high as 600 volts DC.

AC (Alternating Current)

The main difference between AC and DC systems is that the voltage levels in DC systems remain constant while the voltage levels in AC systems are constantly changing. When measuring an AC system, it is important to know that the average voltage is zero, and that is why a voltmeter set to DC will not indicate the presence of an AC voltage when connected to an AC circuit.

High voltage can be lethal. Always refer to the manufacturer of the high voltage component when maintenance or repairs are needed. In most cases, diagnostics and repair are performed after the high voltage circuits are disabled. If working around or maintaining high voltage circuits, please seek high voltage training.

WARNING:

To avoid property damage, personal injury, or death, circuits must be checked using a voltmeter for the presence of both DC and AC voltages. A voltmeter set to DC will not indicate the presence of an AC voltage when connected to an AC circuit! Contacting an unknown AC or DC voltage may cause equipment damage, electrical shock, and/or electrocution.

2.1 Understanding High Voltage Equipment and Circuits on International Products

Some examples of high voltage equipment that can be encountered on products are as follows:

Auxiliary Power Units (APUs)

APUs are basically small diesel powered generator units that are integrated into the vehicle electrical system. APUs are utilized in combination with inverters and battery chargers. APUs are often set up to automatically start when the electrical management system deems it necessary to maintain battery charge or electrical demand requires it.

NOTE: APU high voltage wiring may NOT be marked for easy identification as high voltage.

Shore Power

Shore power is a connection from a vehicle to an external 120 volt AC power source. The vehicle is equipped with an exterior receptacle that allows connection to an external "shore" power source.

NOTE: High voltage shore power wiring may NOT be marked for easy identification as high voltage.

Inverters

Inverters are electronic devices used to change DC (Direct Current) into AC (Alternating Current). Some inverters contain converters that also convert AC to DC for battery charging or running 12V equipment.

NOTE: High voltage wiring for inverters may NOT be marked for easy identification as high voltage.

Hybrid Electric Vehicles (HEVs)

HEVs combine internal combustion engines with high voltage batteries, electric motors, and inverters to offer higher fuel efficiency and lower emissions without compromising power, range, and convenient fueling of conventional vehicles. Regardless of the HEV design, high electrical voltages and currents are present.

NOTE: The industry standard for high voltage cables is for the cables to be ORANGE or covered in ORANGE CONDUIT.

If orange conduit is observed on a vehicle, please review the safety precautions for that system.

2.2 How to Identify High Voltage Circuits

High voltage circuits are not always connected with large wires. The best way to identify high voltage equipment or circuits is to be familiar with the equipment and circuit diagrams as well as to look for high voltage warning labels and orange conduit. **Inspect the vehicle for any equipment or circuits added after the truck was built (owner/operators may add high voltage components such as inverters or APUs).**

All electrical circuits associated with APUs, shore power, inverters, and HEVs should be considered high voltage. The standard for high voltage cabling on HEVs is orange. APUs, inverters, shore power, and cabin 110/120V outlet wiring may not indicate high voltage by visual inspection (they may not be marked and are NOT orange in color).

2.3 Servicing International Products

The following steps outline the appropriate method to follow to identify and address any maintenance or service on International products with factory-installed high voltage equipment.

- Complete related training prior to attempting to identify and service any high voltage system.

- Review the line-set ticket provided with the vehicle or from ISIS, and identify all high voltage components. Inspect the vehicle for any equipment or circuits added after the truck was built (owner/operators may add high voltage components such as inverters or APUs that could be live and powering circuits in the vehicle EVEN WITH THE IGN OFF AND THE BATTERIES DISCONNECTED).
- Refer to manufacturer's service publications for identified high voltage components.
- Physically locate high voltage components on the vehicle and disable them according to manufacturer's instructions (some components may require a waiting period or special procedures to discharge the voltage completely).

5. Use Best Work Practices (see below) when performing work on electrical systems.

2.4 Best Work Practices

To avoid personal injury or death, permit only trained responsible and capable persons to operate or maintain the equipment. Carelessly operating or neglecting maintenance despite the safe design of any vehicle and its high voltage equipment may result in personal injury or death.

The danger of injury through electrical shock is possible whenever electrical power is present. Most fatal injuries result from high-voltage exposure; however, people can sustain severe injuries from low voltage power if it has a high current flow.

- Be aware of ALL high voltage equipment on the vehicle; review line-set/build ticket and the owner and service manuals of high voltage equipment **BEFORE** starting any work.
- When working on this equipment, remain alert at all times. Never work on the equipment when physically or mentally fatigued, and never work alone near high voltage equipment.
- Always stand on an insulated, dry surface when working on any electrical circuit. Do not handle any kind of electrical device while standing in water, while barefoot, or while hands or feet are wet.
- Always work in an adequately illuminated area.
- Always use appropriate protective equipment: insulated gloves, rubber gloves, goggles/face shield, safety shoes, protective clothing, and insulated tools when working on electrical components/circuits of the vehicle.
- Never wear jewelry when working on this equipment. Jewelry can conduct electricity resulting in electric shock or burns and may get caught in moving components causing injury.
- When working on vehicles that have high voltage devices or equipment, use appropriate alerting techniques in plain view to warn people that may be in the general area and to prevent inadvertent activation of any disabled high voltage circuit(s) during service: safety signs, safety symbols, tags, barricades, cones, etc.

- Keep a fire extinguisher close by at all times. Extinguishers rated "ABC" by the National Fire Protection Association are appropriate for use on the electrical system. Make sure the extinguisher is properly charged and be familiar with its use. Consult the local fire department with any question pertaining to fire extinguishers.
- Ensure that the high voltage power, high voltage power generating equipment, and high voltage storage devices are disconnected, locked out, or otherwise disabled BEFORE working on or around the vehicle, its electrical circuits, or components. Unless disabled, Auxiliary Power Units (APUs) may start at any time without warning; when this occurs, the circuits associated with the APU become energized with potentially lethal high voltage. Some components may require a waiting period or special procedures to discharge the voltage completely.
- Use an appropriate electrical tester and procedures to confirm that the power is disconnected **BEFORE** performing any work on or near any high voltage components/circuits.
- Exercise caution around output circuits even when the input power is off. Parallel power sources and energy storage devices can still be dangerous. Be familiar with the high voltage equipment installed on the vehicle. Some systems contain high voltage condensers that may require time to discharge after power is removed.
- After disconnecting or exposing a high-voltage connector or terminal, insulate it immediately using insulation tape.
- After completion of any electrical work, **BEFORE** restoring the power, verify that parts and/ or tools are removed from the work area and that the fasteners are firmly tightened to the specified torque and the connectors are correctly connected.
- Voltage can be fatal at levels greater than 60 volts. High voltage can jump a larger air gap than low voltage. If contact is made with high voltage, it may not be possible to simply "let go".
- Towing a HEV with its drive wheels on the ground may cause the motor to generate electricity. Consult the operator's/owner's manual for proper towing procedures.
- If a high voltage fuse or circuit protection device trips, do not re-energize the circuit until it has been determined that the circuit is safe. See manufacturer's troubleshooting procedures before servicing a high voltage system.
- Reference OSHA Regulations as necessary and applicable.

3. Troubleshooting Information

3.1. Troubleshooting Basics

Before beginning any troubleshooting, there are several important steps to be taken:

1. **Gather information** by talking to the driver if possible. Try to determine the exact symptoms by gathering relevant information:

   a. What happened, and when?

   b. Under what conditions?

c. When did the symptoms begin?

d. What else occurred at that time?

2. **Verify the problem**. Is the complaint due to misunderstood customer selected parameters? Use an EST to review customer selected parameters.

3. **Check for and record any logged diagnostic trouble codes**. Diagnostic trouble codes may be viewed on the vehicle (if equipped) or using an electronic service tool, such as DLB. Refer to Displaying Diagnostic Trouble Codes or DLB level 1 user manual for more information.

   a. Do the logged codes correlate to probable causes?

   b. Were the codes logged about the same time as the symptoms appeared?

   c. Were the codes logged repeatedly?

   d. Are the logged codes related to other symptoms? Do they have a common cause?

4. **Ensure that the appropriate control modules are communicating properly before proceeding with troubleshooting.** A status window in Diamond Logic® Builder (DLB) indicates which available control modules are communicating on the SAE J1939 data link. A green checkbox ☑ = "communicating properly". A red ☒ indicates a module is not present on the data link (this could be due to the key switch not being in the ignition position. Refer to the DLB level 1 user manual for more information).

NOTE: Always diagnose any "loss of communication" codes first.

5. **Avoid preconceived ideas!** Eliminate any non-electrical causes for the problem first (contaminated fuel, clogged air filters, etc.).
6. Perform the following preliminary steps:

   a. Before performing any test on the electrical system, ensure that the vehicle batteries are **fully charged**. Performing tests with the batteries not fully charged can lead to misdiagnosis of a problem.

   b. Before beginning these test procedures, check any light or indicator lamp filaments that are suspected of being open (burned out). This is done to avoid unnecessary extensive circuit checks.

   c. Before beginning these test procedures, inspect all connectors for loose or damaged pins, wires, etc. and terminal corrosion. Refer to TEST EQUIPMENT AND CONNECTOR REPAIR section in Group 08 Electrical in the Master Service Manual.

   d. When the mechanic determines that a fuse is blown, while checking its condition, he is directed to locate the cause of the overload condition and to repair it. While no further instruction on this procedure is listed in the diagnostic tables, the common

procedure is as follows: isolate sections of the circuit by disconnecting connectors, and measure the resistance to ground to find the circuit that is shorted to ground. Then locate the damaged spot in the wire or connector and repair.

e. Diagnostics for circuits that are malfunctioning by sticking in the on position are generally not covered in detail. It is assumed that the mechanic knows to check for a malfunctioning switch, relay, or solenoid.

3.1.1. Read “Feature Functions”

The Feature Functions section will list all interlock conditions for proper operation (interlock conditions not met is a major cause of mis-diagnosed problems). By studying the circuit diagram and the electrical operation, enough information about circuit operation should be learned to narrow the cause of the problem to one component or portion of the circuit.

3.1.2. Check The Circuit Diagram

Refer to the circuit diagram for possible clues to the problem. Location and identification of circuit components may give some idea of where the problem is located.

The circuit diagrams are designed to make it easy to identify common points in circuits. This can help narrow the problem to a specific area. For example, if several circuits fail at the same time, check for a common power source or common ground connection. If part of a circuit fails, check the connections between the part that works and the part that doesn't work.

For example, if the low-beam headlights work, but both high-beam lights and the high-beam indicator do not work, then the power and ground paths must be good.

Since the dimmer switch is the component that switches the power to the high-beam headlights, it is the most likely cause of failure.

3.1.3. Check For Cause Of The Problem

Certain feature descriptions provide diagnostic charts for many of the common faults that may occur. Refer to these charts in each section. Follow the procedures in the chart until the cause of the problem is located.

If the particular symptom found in the problem circuit is not covered by a diagnostic chart, refer to the general electrical troubleshooting information provided under Electrical Test Equipment below.

3.1.4. Make The Repair

Repair the problem circuit as directed in the diagnostic charts.

3.1.5. Verify The Repair is Complete

Operate the system and check that the repair has removed all symptoms, and also that the repair has not caused any new symptoms.

4. Electrical Test Equipment

4.1. EZ-TECH® Electronic Service Tool (EST)

The EZ-Tech® EST is a rugged laptop computer capable of running various software programs to perform vehicle diagnostics.

The EZ-Tech is connected to the vehicle diagnostic connector through an interface connector.

Once connected, the software on the EZ-Tech can be used to monitor certain vehicle parameters, list active and inactive diagnostic trouble codes, and in some cases override inputs and outputs of electrical controllers.

The Diamond Logic® Builder (DLB) software can be used to diagnose the body controller. DLB software must be used to reprogram or restore programming to the electrical system controller. Refer to the DLB level 1 user manual for detailed instructions.

Other software programs are available for other electrical systems on the vehicle.

4.2. International Electrical System Tester by Midtronics®

The International Electrical System Tester provides complete multi-meter functionality with scope mode to produce the ultimate electrical diagnostic tool.

Diagnostics are simplified through the icon-based user interface, large back-lit graphic display, alphanumeric keypad, arrow key scrolling and hot keys.

Features of this tool include:

- Identify battery defects even at an extremely low voltage (discharged battery)
  - Tests battery packs (2-5 batteries) and individual batteries
  - Tests conventional, deep cycle, and AGM batteries
  - Eliminate charge and retest with 'during charge test' algorithms
- Performs charging and cranking system tests
- Custom voltage drop/circuit resistance tests for starting and charging circuits
- Removable cable sets, expansion ports and additional custom expansion capabilities available
- Custom encrypted battery failure warranty code
- Tamper-proof date stamp. Dealer ID number is stored in memory
- Export results wirelessly via IRDA receiver to EZ Tech or desktop PC
- Custom printout PC software for EZ-Tech® or desktop PC
- Data display via serial connection to EZ-Tech® for remote tech support
  - Output tester display to EZ-Tech® remote desktop
- Field updateable via EZ-Tech® and/or SD memory card slot
- Current load measurement (inductive 1A to 700A range)

- Multiple Language- English, Spanish, French-Canadian language selection in software

4.3. Body Controller Breakout Box

CAUTION:

Always use the breakout box whenever possible to perform tests. Attempting to make measurements directly on connector pins can damage the pins and may cause incorrect readings.

The Body Controller breakout box allows the technician to check Body Controller inputs and outputs. It should also be used when taking measurements on Body Controller connectors. This will prevent damaging connector cavities with test probes.

The breakout box can be connected to the Body Controller connectors in the engine compartment or the connectors in the cab.

The breakout box can be used to provide pinouts to a single connector (out of circuit), to test individual wires for shorts or opens, to test output signals from the Body Controller, or to test input circuits to the Body Controller.

The breakout box can also be connected in circuit to allow technicians to monitor signals with the Body Controller in operation.

4.4. Fluke 88 Digital Multi-Meter (DMM) (ZTSE4357)

CAUTION:

When probing connectors, always take care not to cause damage by forcing probe tips into cavities. Use the appropriate tip adapters to prevent damage. Expanded cavities will cause increased circuit resistance.

The Fluke 88 Digital Multi-meter (DMM) is the meter recommended by International Truck and Engine Corporation and discussions of meter use in this manual will refer to this meter. The International Electrical System Tester by Midtronics® can be used as an alternate multi-meter.

The Fluke 88 Multi-Meter is a digital meter, and is recommended because it uses very little current when performing tests. Digital meters have high impedance (resistance), 10 Megohms, and thus do not damage components or give misleading readings.

CAUTION:

Some of the devices in an electronic control system are not capable of carrying any appreciable amount of current. Therefore the test equipment used to troubleshoot an electronic system must be especially designed not to damage any part of it. Because most analog meters use too much current to test an electronic control system, it is

recommended that they not be used, unless specified. The use of any kind of battery-powered test light, unless specified, is not recommended when troubleshooting an electronic circuit, since it could also damage an electronic control circuit.

4.5. Jumper Wires and Test Leads

4.5.1. Jumper Wires

CAUTION:

Always take care not to cause damage by forcing probe tips into connector cavities when using jumpers and test leads. Use the appropriate tip adapters to prevent damage. Expanded cavities will cause increased circuit resistance and potential open circuits. Always use the breakout box whenever possible.

In addition, jumpers should be appropriately fused to prevent inadvertent damage to sensitive components due to higher than anticipated currents, especially if the jumper is mistakenly connected to the wrong point.

Jumper wires allow "jumping" across a suspected open or break in a circuit.

If the circuit (Refer to Jumpers in Circuits) works properly with the jumper wire in place, but does not work when the jumper wire is removed, the circuit has an open spot.

A circuit without any opens or breaks has continuity (is continuous) and a DMM can be used to measure the continuity (resistance of a few ohms) of the circuit with the battery removed.

Jumper wires are fitted with several types of tips or ends. It will be helpful to have several jumper wires available with different tips.

If bypassing the switch with a jumper wire causes the light to illuminate, but closing the switch does not, it indicates the switch has failed.

If, when the switch is closed, the light does not illuminate, and "jumpering" the switch doesn't cause the light to operate, but "jumpering" the light to ground causes the light to operate, then there is an open in the ground circuit.

The jumper wire can be used to check for open relay contacts, wire breaks, poor ground connections, etc.

4.5.2. Test Leads

CAUTION:

When probing connectors, always take care not to damage them by forcing probe tips into cavities. Use the appropriate tip adapters to prevent damage. Expanded cavities will cause increased circuit resistance.

NEVER insert the test meter probe tip into connectors where the probe tip will expand the terminal. Expanded terminals will cause increased circuit resistance.

Construct test leads using a mating terminal, a short lead and an alligator clip. Insert the mating terminal into the connector and attach the alligator clip to the meter lead.

4.6. Ohm's Law

Ohm's Law is a formula (I = E / R) describing the relationship of voltage (E), current (I) and resistance (R). If any two of the values are known for a given circuit, the missing value can be found by substituting the known values in amperes, volts or ohms and solving for the missing value.

A complete review of Ohm's Law and its usage can be found in S08293.

4.7. Voltmeter

Voltage is an electrical pressure or force that pushes the current through a circuit. The pressure is measured in Volts and the symbol V (as in 12V) is used in the circuit diagrams. The letter "E" is also used for voltage and stands for Electromotive Force. Voltage can be compared to the pressure necessary to push water through a metering valve.

Low voltage to a lamp will cause the lamp to glow dimly. This can be caused by low source voltage (battery discharged or low alternator output), or by high circuit resistance in the circuit due to a poor connection. The resistance of the poor connection or poor ground acts as an additional load in the circuit, causing less voltage to be available to push current through the load device. Before making any meter measurements, it is important to briefly review the relationship between voltage, current, and resistance (Ohms Law).

4.7.1. Measuring Voltage

In electrical diagnosis, the voltmeter is used to answer:

- Is voltage present?
- What is the voltage reading?
- What is the voltage drop across a load device?

When using a voltmeter to determine if voltage is present to power a device, connect the positive meter lead to input connection of the device (positive side) and connect the negative meter lead to good vehicle ground. A good ground would be any metallic bracket, body panel, or fastener that is free of paint, rust or corrosion, and is connected to the frame, engine, or body.

To check the voltage drop across a load device, connect the positive lead of the voltmeter to the positive side of the device and the negative meter lead to the negative side of the device. With the device operating, measure the voltage drop across the device.

4.8. Ammeter

An ammeter is used to measure current flow (amperage) in a circuit. Amperes are units of electron flow, which indicate how many electrons are passing through the circuit. Ohms Law indicates that current flow in a circuit is equal to the circuit voltage divided by total circuit resistance. Since amps (I) is the current in the circuit, increasing voltage also increases the current level (amps). Also, any decrease in resistance (ohms) will increase current flow (amps).

At normal operating voltage, most circuits have a characteristic amount of current flow, referred to as current draw. Current draw can be measured with an ammeter. Referring to a specified current draw rating for a component (electrical device), measuring the current flow in the circuit, and comparing the two (the rated versus the actual measured) can provide valuable diagnostic information.

4.8.1. Measuring Amperage

An ammeter is connected in series with the load, switches, resistors, etc. This causes all of the current to flow through the meter. The meter will measure current flow only when the circuit is powered and operating. Before measuring current flow, we need to know approximately how much current will be present to properly connect the meter. The DMM is fused to measure up 10 amps using the 10A connection point. The Midtronics® tester can be used If measurements of higher amperage are required.

Never attempt a voltage measurement with the test probe lead in the current jack (10A or 300mA). Meter damage or personal injury may result!

Always make sure the power is off before cutting, soldering or removing a circuit component to insert the DMM for current measurements. Even small amounts of current can be dangerous.

Excessive current draw means that more current is flowing in a circuit than the fuse and circuit were designed for. Excessive current will open fuses and circuit breakers. Excessive current draw can also quickly discharge batteries. An ammeter is useful to help diagnose these conditions.

On the other hand, there are times reduced current draw will cause a device (electric window motor for example) to operate poorly. Remember increased circuit resistance causes lower current to be available to the device. Loose or corroded connections can frequently cause this problem.

4.9. Ohmmeter

The ohmmeter is used to measure resistance (ohms) in a circuit. Like the ammeter and voltmeter, there are both analog and digital meters available. It is recommended that the digital meter (Fluke 88 DMM) be used.

CAUTION:

Some of the devices in an electronic control system are not capable of carrying any appreciable amount of current. Therefore the test equipment used to troubleshoot an electronic system must be especially designed not to damage any part of it. Because most analog meters use too much current to test an electronic control system, it is recommended that they not be used, unless specified. The use of any kind of battery-powered test light may not be recommended when troubleshooting an electronic circuit, since it, too, could damage an electronic control circuit.

CAUTION:

The ohmmeter can only be used on circuits where power has been removed. The meter contains its own low voltage power supply and the power from 12-volt systems may damage the meter.

Ohmmeters use a small battery to supply the voltage and current which flow through the circuit being tested. The voltage of the meter battery and the amount of current flow in the circuit are used with Ohms Law, and the meter calculates the circuit resistance which is displayed by the meter. With the Fluke 88 DMM, range selection and meter adjustment are not necessary.

4.9.1.1. Measuring Resistance

Resistance measurements determine:

1. Resistance of a load
2. Resistance of conductors
3. Value of resistors
4. Operation of variable resistors.

To measure the resistance of a component or a circuit, power must first be removed from the circuit.

The component or circuit that is to be measured must be isolated from all other components or circuits so that meter current (from probe to probe) only flows through the desired circuit or component or the reading will not be accurate.

To measure the load, one connector to the load should be removed. It is not always apparent when a component must be isolated in such a manner, so it is usually a good practice to isolate the circuit or component by physically disconnecting one circuit.

The ohmmeter leads are then placed across the component or circuit and the resistance will be displayed in ohms. When checking a sensor or variable resistor such as fuel level gauge, heating the element or moving the arm should move the meter through a range of resistance that can be compared to a specification.

4.9.1.2. Checking For Open Circuits

Electrical circuits can be checked for opens using an ohmmeter. The circuit must first be disconnected from the power supply. The circuit to be checked must also be isolated from other circuits. Connect the meter to the open ends of the circuit. A high reading (infinity) indicates there is an open in the circuit. A near zero reading is an indication of a continuous circuit.

4.9.1.3. Checking For Short Circuits

Checks for short circuits are made in a similar manner to that used to check for open circuits, except that the circuit to be checked must be isolated from both the power source and the ground point.

Connecting the ohmmeter between an isolated circuit and a good ground point will allow checking the circuit for a short to ground. A short to ground will be indicated by a near zero reading, while a circuit not shorted to ground will cause the meter to read very high (near infinity). With the Fluke 88 DMM, an open circuit will read "OL" on the meter display.

5. Vehicle Configuration

A line set ticket will identify the features in which each vehicle is equipped. The line set ticket is placed into each vehicle when the vehicle is built. This type of vehicle information can also be found on ISIS. Vehicle configurations can be obtained by navigating to the “Vehicle Information” section on ISIS and entering the vehicle identification number (VIN), which can be found on the vehicle door pillar.

6. Bench Testing Relays

International circuits use suppressed relays for controlling power to load devices. The suppression feature (an internal circuit in parallel with the relay coil) prevents voltage spikes from damaging electronic components in the vehicle. **These relays must be replaced with approved International parts.** The part number and relay circuit diagram are embossed on the relay body. The terminals are numbered on the relay in the same manner as in the circuit diagrams.

6.1. Relay Test Procedure

1. With relay removed, measure resistance between terminals 30 and 87A. If resistance is less than 5 ohms, go to Step 2; otherwise replace the relay.
2. Measure resistance between terminals 30 and 87. If resistance is 100K ohms or more, go to Step 3; otherwise replace the relay.
3. Using 12V battery source and test leads, connect (+) lead to terminal 85 and (-) lead to terminal 86. If relay energizes with an audible click sound, go to Step 4; otherwise replace the relay.
4. While relay is energized, measure resistance between terminals 30 and 87. If resistance is less than 5 ohms, go to Step 5; otherwise replace the relay.
5. While the relay is energized, measure resistance between terminals 30 and 87A. If resistance is 100K ohms or more, the relay is good; otherwise replace relay.

7. Circuit Breakers

7.1. TYPE I

Type I circuit breakers will automatically reset after a circuit overload has occurred.

The headlight and windshield wiper output circuits from the Body Controller will act like Type I circuit breakers.

7.2. TYPE III

Type III circuit breakers must be manually reset after a circuit overload has occurred.

The 20 amp and 10 amp output circuits from the Body Controller, except the headlight and windshield wiper outputs will act like Type III circuit breakers. The Body Controller will reset these circuits when the feature is turned off.

1. Displaying Diagnostic Trouble Codes

The ability to display diagnostic trouble codes (DTC) is an optional feature. Codes may be displayed on either the gauge cluster or an optional vehicle information display (VID). **The vehicle must be equipped with the option to display codes in both cases.** Codes will not be displayed on the gauge cluster if the vehicle is equipped with the VID.

1.1. Vehicles Equipped with Option to Display Codes

1.1.1. Displaying Codes on the Gauge Cluster (Non-VID equipped vehicles)

To display codes on vehicles not equipped with a VID:

1. Set the parking brake
2. Turn the key switch to the ACCESORY position to view only previously active codes. Turn the key switch to the IGNITION position to view both active and previously active codes.
3. Momentarily press the Cruise "ON" switch and the Cruise "Resume" switch at the same time.

A gauge sweep will be performed on the gauges. The gauge cluster will then display the following information for 5 seconds:

Software Rev: XXX
Hardware Rev: XXX
Active Faults: XXX
Total Faults: XXX

NOTE: The gauge cluster will only display “Software Rev” and “Hardware Rev” for 5 seconds followed by the message “Diagnostic Trouble Codes are not available” if the vehicle is not equipped with the option to display codes.

If faults are present, the gauge cluster display will show each diagnostic trouble code for 10 seconds and then automatically scroll to the next entry and continue to cycle through the faults. Once all faults have been displayed the number of faults will be displayed again, then the cycle will repeat. To manually cycle through the fault list press and release the cluster display selector button. The following information will be displayed for each fault:

SPN: XXXX FMI: XX
Active
OC: XXX SA: XXX

SPN: XXXX FMI: XX
Previously Active
OC: XXX SA: XXX

NOTE: Turning the key switch off, turning the key switch to the CRANK position, or releasing the park brake will take the gauge cluster out of the diagnostic mode.

1.1.2. Displaying Codes on the VID (if equipped)

The VID can be used to display all diagnostic trouble codes (DTC) on the vehicle. Suspect parameter number (SPN), failure mode indicator (FMI) and occurrence count numbers are listed. Source addresses and DTC descriptions are presented in plain text.

NOTE: The VID will display "Not Available" if a DTC description is not available for a particular fault.

Displaying codes will only be allowed if all of the following conditions are true:

- The key switch is in the IGNITION position.
- AND displaying codes is allowed due to vehicle orderable options
- AND the programmable parameter "**Diagnostics**" is enabled using Diamond Logic® Builder (DLB).
- The vehicle is not moving (the Vehicle Speed is equal to zero).
- The feature is not password protected to prevent unauthorized access. Refer to the Vehicle Information Display Owner's Manual for more information.

Perform the following steps if all of the above conditions are met:

1. Go to the main menu screen

NOTE: The following selections will not be available if the vehicle is not equipped with the option to display codes.

2. Select "DIAGNOSTIC CODES"
3. Select "ACTIVE" or "INACTIVE". The VID may initiate a password prompt if the VID has been password protected. Refer to the Vehicle Information Display Owner's Manual for more information.

The VID will indicate "NO FAULT DETECTED" if faults are not found. Scroll through the list of faults if faults are present.

The following information will be displayed for each fault:

SPN : FMI OC SA DTC Description

2. Clearing Diagnostic Trouble Codes

Previously active diagnostic trouble codes can only be cleared by a service tool, such as Diamond Logic® Builder (DLB). Some previously active codes may not be cleared by this method.

3. Definitions

- "***SPN"*** represents the suspect parameter number. This number identifies the item for which diagnostics are being reported.
- ***"FMI"*** is the failure mode indicator. This number represents the type of failure detected. Refer to Failure Mode Indicators (FMI) for more information.
- ***"Active"*** or ***"Previously Active"*** will be displayed to identify whether a fault is currently active or if the fault was previously active.
- ***"OC"*** is the occurrence count. This number represents the number of times a fault has gone from previously active to active.
- ***"SA"*** is the source address. This number identifies the module reporting the fault. Refer to Source Addresses (SA) for more information.

3.1. Failure Mode Indicators (FMI)

- FMI=0 - Data Valid But Above Normal Operational Range - Most Severe Level
- FMI=1 - Data Valid But Below Normal Operational Range - Most Severe Level
- FMI=2 - Data Erratic, Intermittent Or Incorrect
- FMI=3 - Voltage Above Normal, Or Shorted To High Source
- FMI=4 - Voltage Below Normal, Or Shorted To Low Source
- FMI=5 - Current Below Normal Or Open Circuit
- FMI=6 - Current Above Normal Or Grounded Circuit
- FMI=7 - Mechanical System Not Responding Or Out Of Adjustment
- FMI=8 - Abnormal Frequency Or Pulse Width Or Period
- FMI=9 - Abnormal Update Rate
- FMI=10 - Abnormal Rate Of Change

- FMI=11 - Root Cause Not Known
- FMI=12 - Bad Intelligent Device Or Component
- FMI=13 - Out Of Calibration
- FMI=14 - Special Instructions
- FMI=15 - Data Valid But Above Normal Operating Range - Least Severe Level
- FMI=16 - Data Valid But Above Normal Operating Range - Moderately Severe Level
- FMI=17 - Data Valid But Below Normal Operating Range - Least Severe Level
- FMI=18 - Data Valid But Below Normal Operating Range - Moderately Severe Level
- FMI=19 - Received Network Data In Error
- FMI=20 - Data Drifted High
- FMI=21 - Data Drifted Low
- FMI=31 - Condition Exists

3.2. Source Addresses (*SA)*

In addition to the source address, DLB displays which data link the module's source address is being provided (i.e. drive train SAE J1939 data link).

NOTE: The available source addresses will vary depending on each vehicle configuration.

Module Name	Source Address
Engine Control Module (ECM)	00
Transmission Control Module (TCM)	03
Shift Selector	05
Antilock Brake System (ABS)	11
Electronic Gauge Cluster (EGC)	23
Compass Module	28
Body Controller	33
Vehicle Sensor Module (VSM)	39
Vehicle Information Display (VID)	40
Tire Pressure Monitoring System (TPMS)	51
Rear HVAC	58
Aftertreatment Module	61
Telematics Module	74
Auxiliary Gauge Switch Pack (AGSP) 3	132
Secondary Instrument Cluster (SIC) 1	167
Pyro-ammeter Module (PAM)	232
Hybrid Electric Vehicle (HEV)	239
Power Pack 3	247
Service Tool	249
Global	255

Antilock Brake Systems

This section consists of the following systems:

- Antilock Brake System (ABS)

  This system is designed to optimize slip on all vehicle wheels.

- Automatic Traction Control (ATC)

  This system includes ABS. ATC can improve vehicle traction during acceleration on adverse road conditions.

- Roll Stability Program (RSP)

  This system includes ABS and ATC. The feature adds roll stability, which attempts to prevent the vehicle from rolling over.

- Electronic Stability Program (ESP)

  This system includes ABS, ATC and RSP. The feature adds yaw control, which attempts to prevent the vehicle from spinning out or jackknifing.

1. Bendix® Antilock Brake Systems

The following configurations are available on vehicles equipped with Bendix® Antilock Brake Systems:

Feature Code	Models	Feature Description
04AZA	All	Air ABS
04AZJ	All	Air ABS with Automatic Traction Control
04AZR	ProStar	Roll Stability Program (Includes ABS, ATC)
04AZS	ProStar	Electronic Stability Program (Includes ABS, ATC, RSP)
04AZU	ProStar	6-Channel ABS
04AZV	ProStar	6-Channel ABS with Traction Control

2. Meritor WABCO® Antilock Brake Systems

The following configurations are available on vehicles equipped with Meritor WABCO® Antilock Brake Systems:

Feature Code	Models	Feature Description
04085	3200, 4000, CE Bus	Hydraulic Full Power ABS with Traction Control
04AZE	ProStar, 8600	Air ABS
04AZH	ProStar, 8600	Air ABS with Traction Control
04AZT	ProStar	Roll Stability Program (Includes ABS, ATC)

3. Electrical Components

3.1. Electrical Components

3.1.1. Service Brakes

Vehicles will be equipped with standard service brakes will be equipped with the following electrical components:

- ***Brake fluid warning lamp (04085)*** located in the gauge cluster.
- ***Brake pressure warning lamp (04085)*** located in the gauge cluster.
- ***Hydraulic brake warning lamp (04085) (if equipped)*** located in the lower right portion of the gauge cluster in the warning lamp 4-pack.

- ***Brake Fluid Level Sensor (04085)*** located in the engine compartment on the brake fluid reservoir.
- ***Stop lamp switch (04085)*** located in the engine compartment at the base of the master cylinder.
- ***Stop lamp switch (except 04085)*** includes 2 pressure sensors (primary and secondary) located inside the cab near the air manifold.

3.1.2. ABS

Vehicles equipped with ABS will be equipped with the following electrical components in addition to the components required for Service Brakes:

- ***ABS controller (04085)*** located on the driver side frame rail. Includes hydraulic control unit (HCU).
- ***ABS controller (except 04085)*** located inside the cab in the passenger kick panel.
- **ABS warning lamp** located in the gauge cluster.
- ***4 wheel speed sensors (six sensors with 04AZU and 04AZV)*** one sensor located in each wheel end. The 4-channel system does not include wheel speed sensors on the front rear axle if the vehicle has a tandem rear axle set.
- ***4 ABS modulators (air ABS only) (6 modulators with 04AZU and 04AZV)*** one modulator located near each wheel on the frame rail.
- ***Trailer ABS warning lamp (tractors only)*** located in the gauge cluster.
- ***Trailer ABS ECU relay (tractors only)*** located in the interior PDC
- ***Blink code switch (04AZA) (if equipped)*** located under the instrument panel on the driver side.

3.1.3. ATC

ATC equipped vehicles will be equipped with the following electrical components in addition to the components required for ABS:

- ***ATC warning lamp*** located in the gauge cluster.
- ***Mud snow switch (Wabco®)*** located on the switch pack.
- ***Off-road switch (Bendix®)*** located on the switch pack.
- ***Drive axle traction control valve (except 04085)*** located on a rear frame cross member.
- ***Drive axle traction control valve (04085)*** located in the HCU.

3.1.4. RSP/ESP (Bendix® only)

RSP and ESP equipped vehicles will contain all of the electrical components required for vehicles with ABS and ATC plus the following additional electrical components:

- ***Yaw rate sensor*** located behind the cab on the cross member frame.

- ***Steering angle sensor*** located on the steering column.
- ***Pressure sensor 1 (primary delivery)*** located inside the cab on the foot valve.
- ***Pressure sensor 2 (secondary delivery)*** located inside the cab on the foot valve.
- ***Suspension airbag pressure sensor (Bendix®)*** on the top of the suspension airbag.
- ***Primary traction control valve (rear axle) (Bendix® with RSP or ESP)*** located on a rear frame cross member.
- ***Secondary traction control valve (front axle and trailer)*** on the frame rail near the front of the vehicle.
- ***Trailer modulator (tractors only)*** on the frame rail near the front of the vehicle.

NOTE: These systems utilize the existing ATC warning lamp located in the gauge cluster for stability system faults.

3.1.5. RSC (Wabco® only)

RSC equipped vehicles will contain all of the electrical components required for vehicles with ABS and ATC plus the following additional electrical components:

- ***Lateral accelerometer sensor*** located inside the ECU.
- ***Traction control valve (trailer)*** located on the frame rail near the front of the vehicle.

4. System Description and Operation

The discussion of the various systems in this section is limited to power circuits and data link connectivity. **Refer to the appropriate supplier documentation for detailed information about the operation and troubleshooting for any of the systems described in this section.**

Ignition and battery voltage is supplied to the ABS controller from the interior power distribution center (PDC). The ABS controller receives input from various sensors and communicates on the drive train SAE J1939 data link with other controllers and other systems to perform ABS, ATC, RSP, ESP and warning lamp functions. The ABS controller communicates with the gauge cluster on the SAE J1939 data link to activate the ABS warning Lamp when conditions are appropriate. The ABS controller is also connected to the SAE J1708 data link, which is used primarily for diagnostics and programming.

4.1. Trailer ABS ECU relay (tractors only)

Ignition voltage is provided to the Trailer ABS ECU relay coil while the key switch is in the IGNITION position. Ground is supplied the other side of the relay coil. The switch contacts of the Trailer ABS ECU relay close to provide battery voltage from the interior PDC to the center pin of the trailer socket and to the auxiliary trailer socket (if equipped) when the relay is energized. This provides battery voltage to the trailer ABS module. The Trailer ABS controller (ECU) communicates to the Tractor ABS ECU through the center pin of the trailer socket using power line communication (PLC) while the Trailer ABS ECU relay is energized. The Trailer ABS ECU does this by modulating the voltage above system voltage.

5. Diagnostics

5.1. EZ Tech

The EZ Tech can be used to read and clear diagnostic trouble codes and provide other diagnostic information for the following ABS software types:

- Wabco® Toolbox
- Bendix® Acom

Wabco Toolbox and Bendix Acom diagnostic information is provided by the ABS controller on the SAE J1708 data link. Refer to the appropriate supplier documentation for more information.

5.2. Remote Diagnostic Unit

A portable remote diagnostic unit (RDU) can be used to assist in diagnostic troubleshooting on both Bendix and Wabco systems. This device provides diagnostic information from the SAE J1708 data link, and is available through Bendix. Refer to Bendix for more information. **NOTE: The RDU only provides a general description of faults. Use of Bendix Acom and Wabco Toolbox software will provide more specific diagnostic information.**

If the service tool running the software is not able to communicate with the system's electronic control unit (ECU) there may be a problem with the data link.

Ensure that the SAE J1708 Data Link is not shorted or wired incorrectly. With the key switch turned to the IGNITION position and the ABS controller connector disconnected, voltage from positive data link circuit to ground should be approximately 4 volts. Voltage from negative data link circuit to ground should be approximately 0.5 volts.

5.3. ABS Dash Warning Light

Vehicles equipped with Bendix and Wabco systems must be driven above 4 mph to ensure certain wheel speed related faults are cleared.

5.3.1. Bendix®

The ABS warning lamp will perform a bulb check and then extinguish after a successful self test of the electrical system. If an error is detected at any time, the warning lamp will stay illuminated. **The vehicle must be driven above 4 mph after any faults are cleared to ensure the ABS dash warning light stays off if faults are cleared with a blink code switch.**

5.3.2. Wabco®

The ABS warning lamp will perform a bulb check and then extinguish after a successful self test of the electrical system. When the Wabco controller is initially put into service, or each time the controller is serviced (fault codes cleared), the vehicle must be driven above 4 mph to extinguish the ABS warning lamp.

5.4. Trailer ABS Dash Warning Light (tractors only)

The trailer ABS ECU sends a request to illuminate the trailer ABS warning lamp to the tractor ABS ECU using power line communication (PLC) if a trailer ABS related fault is detected. The tractor ABS ECU sends a message on the SAE J1939 data link to the gauge cluster when it receives the request from the trailer ABS ECU. PLC is discussed in the Trailer ABS ECU relay (tractors only) section.

For vehicle models built in 2007 and beyond, the trailer ABS warning lamp will remain on until either of the following conditions is true:

- The fault is cleared.
- OR, the trailer with the fault is disconnected from the tractor AND the instrument cluster goes 'asleep' **(See Note).**
- OR (for vehicles built after April 2007), the trailer with the fault is disconnected and the ignition key switch is cycled. It will not be necessary for the instrument cluster to go 'asleep'.

NOTE: This occurs at a minimum of 10 seconds after the ignition key switch is OFF AND the driver door is closed.

5.5. Diagnostic Trouble Codes

5.5.1. Displaying Diagnostic Trouble Codes

Diagnostic trouble code (DTC) information can be displayed either on the gauge cluster or vehicle information display (VID) – if equipped. Refer to Displaying Diagnostic Trouble Codes for more information**.** Refer to the appropriate Bendix Service Data Sheet or Wabco Maintenance Manual for list of ABS related diagnostic trouble codes. Ensure that the latest document revision is used. Diamond Logic Builder (DLB) software can also be used to display ABS related fault codes. Some models are equipped with a blink code switch, which can be used to provide blink codes (Bendix Air ABS only). Refer to Bendix for more information.

Aftertreatment

1. Description and Operation

The Aftertreatment System monitors the amount of particulate matter contained in the vehicle's exhaust gas. The Diesel Particulate Filter (DPF) traps this particulate matter. A process called regeneration is used to burn off the particulate matter in the DPF. This is essential to comply with increasing emission regulations.

The engine controls the Aftertreatment System. Therefore, discussion in this section is limited to the body controller's interface to the Aftertreatment System. **Refer to the appropriate engine manual for detailed information on troubleshooting aftertreatment problems related to the engine circuits.** Refer to the Aftertreatment Definitions section for unknown terms.

This feature includes the following vehicle configurations:

Feature Code	Models	Description
0595AZA	3200, 4000 series, 7000 series, 8000 series, CXT, RXT, ProStar	Optional inhibit regeneration switch (three position momentary switch) and switch indicator.
0595AYZ	3200, 4000 series, 7000 series, 8000 series, CXT, RXT, CE Bus	Optional inhibit regeneration switch (two position, latching ON/OFF switch) and switch indicator. **NOTE: This configuration is standard for bus.**
0595AZE	ProStar	High exhaust system temperature (HEST) warning lamp.
0595AYX	3200, 4000 series, 7000 series, 8000 series, CXT, RXT, CE Bus	High exhaust system temperature (HEST) warning lamp.
0595AZG	ProStar	DPF status warning lamp.
0595AYW	3200, 4000 series, 7000 series, 8000 series, CXT, RXT, CE Bus	DPF status warning lamp.
0595AZH	ProStar, 3200, 4000 series, 7000 series, 8000 series, CXT, RXT, CE Bus	Parked regeneration switch and switch indicator.

This feature consists of the following additional electrical components:

- Parked regeneration switch
- Inhibit regeneration switch (if equipped)
- Diesel Particulate Filter (DPF) status warning lamp
- High exhaust system temperature (HEST) warning lamp

NOTE: The feature also utilizes the amber warning lamp (AWL), red stop lamp (RSL), and the gauge cluster for additional operator indications.

The parked regeneration and inhibit regeneration switches may be located either in the lower right portion of the gauge cluster or in a switch pack depending on the vehicle configuration. The HEST and DPF status warning lamps are located in a hardwired warning lamp 4-pack within the gauge cluster.

The parked regeneration switch is used to request regeneration of the DPF. The inhibit regeneration switch is used to prevent DPF regeneration. These switches provide inputs to the body controller.

The body controller sends the appropriate requests to the engine control module (ECM) for parked regeneration or inhibit regeneration. These functions are described in detail in the Feature Functions section.

NOTE: The actual control of the aftertreatment system is performed by the ECM.

The feature provides the operator with an indication of accumulating soot levels described in the Soot Level Accumulation section. The HEST warning lamp operation is described in the Feature Functions section.

2. Aftertreatment Definitions

- ***Parked DPF regeneration –*** Manual request by the operator to regenerate the DPF.
- ***Inhibit DPF regeneration –*** Manual request by the operator to prevent DPF regeneration.
- ***Good Communication –*** Communication is "good" if the body controller is communicating properly with the engine control module (ECM). Diamond Logic Builder (DLB) can be used to monitor the **(Particulate_Trap_Lamp_Command)** signal where a status of (0) indicates that communication is "good".
- ***Lost Communication –*** Communication is "lost" if communication is not "Good Communication".
- ***Parked Regeneration is Allowed –*** The body controller is receiving information from the ECM that the DPF is accumulating soot and regeneration is needed. Refer to **Particulate_Trap_Lamp_Command** in the Signal Definitions section to understand the information which the body controller must receive from the ECM before parked regeneration is allowed.

3. Signal Definitions

This section connects the DLB displayed signal name to the circuit diagram. Refer to the electrical circuit diagram for specific pins. DLB displays the status on certain signals where a value of zero (0) indicates a good status.

- **Parked_Regen_Switch_On** – Data link input from the switch pack to the body controller. DLB displays a value of (1) while the regeneration switch is in the ON position.
- **Parked_Regen_Switch_Cancel** – Data link input from the switch pack to the body controller. DLB displays a value of (1) while the regeneration switch is in the CANCEL position.

- **Regen_Requested** – SAE J1939 output signal from the body controller to the ECM. The body controller uses this signal to request the parked regeneration function. DLB displays a value of (1) while the body controller is requesting the parked regeneration function.

- **Regen_Switch_Ind_Cmd** – Data link output from the body controller to the switch pack.

    - DLB displays a value of (1) while the body controller commands the parked regeneration switch indicator ON.
    - DLB displays a value of (2) while the body controller commands the parked regeneration switch indicator to FLASH.

- **Regen_Inhibit_Switch_On** – Data link input from the switch pack to the body controller. DLB displays a value of (1) while the regeneration inhibit switch is in the ON position.

- **Regen_Inhibit_Switch_Cancel** – Data link input from the switch pack to the body controller. DLB displays a value of (1) while the regeneration switch is in the CANCEL position.

- **Regen_Inhibit_Request** – SAE J1939 output signal from the body controller to the ECM. The body controller uses this signal to request the inhibit regeneration function. DLB displays a value of (1) while the body controller is requesting the inhibit regeneration function.

- **Parked_Regen_State** – Data link output from the body controller to the switch pack.

    - DLB displays a value of (1) while the body controller commands the inhibit regeneration switch indicator ON.
    - DLB displays a value of (2) while the body controller commands the inhibit regeneration switch indicator to FLASH.

- **Particulate_Trap_Lamp_Command** – SAE J1939 input signal from the ECM to the body controller. The body controller uses the information received from the ECM to determine whether parked regeneration is allowed. DLB displays the following values:

    - (0) = Parked regeneration is not allowed (the DPF status lamp is off).
    - (1) or (4) = Parked regeneration is allowed (the DPF status lamp is either on or flashing)

    NOTE: The body controller must receive this signal with a value of (1) or (4) to allow parked regeneration.

- **DPF_Status_Warning_Lamp_Cmd** – Output signal from the body controller to the DPF status warning lamp.

    - **(0595AZG)** – DLB displays ☑ while the body controller provides ground to the DPF status warning lamp.
    - **(0595AYW)** – DLB displays ☑ while the body controller supplies voltage to the DPF status warning lamp.

- **High_Temp_Exhaust_Light** – Output signal from the body controller to the HEST warning lamp.
    - **(0595AZE)** – DLB displays ☑ while the body controller provides ground to the HEST warning lamp.
    - **(0595AYX)** – DLB displays ☑ while the body controller supplies voltage to the HEST warning lamp.

NOTE: There are also programmable parameters within the ECM that affect the parked regeneration and inhibit regeneration functions. **Refer to the appropriate engine manual or documentation for more information.**

4. Body Controller Initialization

The Body Controller will perform a lamp check for the following lamps when the key switch is turned to the IGNITION position:

- DPF Status Warning Lamp
- HEST Warning Lamp

These lamps will turn on for a few seconds and then turn off during the lamp check. The purpose of the lamp check is to confirm that the lamp is in working order.

5. Soot Accumulation Level Indications

This feature will indicate different levels of soot accumulation using a combination of the DPF status warning lamp, amber warning lamp, red stop lamp, and audible alarm.

Refer to Feature Functions for information about how these indications are performed by the feature.

Soot Accumulation	***Operator Indication***
Level 1 (Low)	• DPF Status Warning Lamp illuminates continuously. • **AND** "See Visor for Info" (if equipped) appears in the gauge cluster.

Level 2 (Moderate)	• DPF Status Warning Lamp flashes. • **AND** "See Visor for Info" (if equipped) appears in the gauge cluster.
Level 3 (Full)	• DPF Status Warning Lamp flashes. • **AND** the Amber Warning Lamp illuminates continuously. • **AND** "See Visor for Info" (if equipped) appears in the gauge cluster. • **AND** the Audible Alarm sounds ***five-short-beeps*** every minute.
Level 4 (Over-Full) **(See Note)**	• Red Stop Lamp Illuminates. • **AND** the Audible Alarm sounds ***a repetitive one-short-beep*** while the red stop lamp is illuminated. • **AND** (Caterpillar Engines Only) DPF Status Warning Lamp flashes. • **AND** (Caterpillar Engines Only) the Amber Warning Lamp illuminates continuously. **NOTE: Regeneration cannot be performed at this level. Refer to the appropriate service manual for instructions regarding servicing the DPF.**

Refer to the Vehicle Operator's Manual OR the vehicle visor label for information pertaining to the meaning of the above indications.

6. Feature Functions

6.1. Parked Regeneration

The body controller will request a parked regeneration **(Regen_Requested** =1**)** ***if the following conditions are true:***

- The parked regeneration switch is pressed **(upper position) (Parked_Regen_Switch_On).**
- **AND** the parked regeneration switch has a good status **(Parked_Regen_Switch_On).**
- **AND** the vehicle speed is less than 4 mph **(Vehicle_Speed).**
- **AND** the key switch is in the IGNITION position **(Ignition_Signal_Input).**

- **AND** regeneration is allowed **(Particulate_Trap_Lamp_Command).**
- **AND** SAE J1939 communication is good **(Particulate_Trap_Lamp_Command).**
- **AND [**the inhibit regeneration function is **NOT** being requested **(Regen_Inhibit_Request) OR** the inhibit switch has a bad status **(Regen_Inhibit_Switch_On)**.**]**

The following table is an example of the signal conditions displayed on DLB during parked DPF regeneration. ***For parked regeneration to be requested:***

Table 1 – Parked Regeneration	
Signal	***Condition***
Parked_Regen_Switch_On	(1) = Parked regeneration switch in the ON position
Parked_Regen_Switch_On	Status of (0) indicates a "good status"
Vehicle_Speed	Must be a value of less than (4) mph.
Ignition_Signal_Input	☑ = Ignition signal ON.
Particulate_Trap_Lamp_Command	Must be a value of (1) or (4) to indicate regeneration is allowed
Particulate_Trap_Lamp_Command	Status of (0) indicates a "good communication" status
Regen_Inhibit_Request	(1) = Inhibit regeneration **NOT** being requested.
Regen_Inhibit_Switch_On	Status of (non-zero value) indicates a "bad status"

The body controller sends a request to the ECM when the above conditions are true.

NOTE 1: The ECM decides whether to perform the parked regeneration function once it has received the request from the body controller. **Refer to the appropriate engine manual or documentation for more information.**

NOTE 2: The body controller will not request Parked DPF regeneration if the soot level has reached Level 4. Level 4 indicates that the vehicle requires service. **Refer to the appropriate service manual for instructions regarding servicing the DPF.**

The body controller will request parked regeneration to be cancelled (if previously active) if the key switch is in the IGNITION position* (Ignition_Signal_Input) *and any of the following conditions are true:

- Communication is 'lost'.
- **OR** the parked regeneration switch (**Parked_Regen_Switch_On)** has a bad status
- **OR** the parked regeneration switch (**Parked_Regen_Switch_On)** is pressed in the lower position.
- **OR** ***All of the following conditions are true:***
  [The parked regeneration switch (**Parked_Regen_Switch_On)** has a good

status
AND the parked regeneration switch (**Parked_Regen_Switch_On)** is released (center position)
AND the inhibit switch **(Regen_Inhibit_Switch_On)** has a good status.
AND the inhibit switch **(Regen_Inhibit_Switch_On)** is pressed/placed in the upper position**].**

***The body controller requests parked regeneration to be cancelled by momentarily requesting regeneration to be inhibited* (DLB will indicate Regen_Inhibit_Request** = 1**) for 3 seconds *after* the switch is released.**

NOTE: DLB will indicate (**Regen_Inhibit_Request** = 1) indefinitely if the parked regeneration switch is held in the lower (cancel) position while parked regeneration is in progress.

6.1.1. Switch Test

The following test can be performed using Diamond Logic Builder (DLB) to assist in diagnosing the parked regeneration switch.

- Press and hold the parked regeneration switch in the ON (upper) position. The **Parked_Regen_Switch_On** signal (displayed in DLB) should indicate a value of (1) while the switch is placed in the ON position.

- Press and hold the parked regeneration switch in the CANCEL (lower) position. The **Parked_Regen_Switch_Cancel** signal (displayed in DLB) should indicate a value of (1) while the switch is placed in the CANCEL position.

- Place the parked regeneration switch in the CENTER position. The **Parked_Regen_Switch_On** signal **AND** the **Parked_Regen_Switch_Cancel** signal (displayed in DLB) should indicate a value of (0)**.** This indicates both signals are off.

6.2. Inhibit Regeneration

The body controller will request regeneration to be inhibited
(Regen_Inhibit_Request = 1**) *if the following conditions are true:***

- The key switch is in the IGNITION position **(Ignition_Signal_Input)**.
- **AND** the inhibit regeneration switch is pressed/placed in the upper position **(Regen_Inhibit_Switch_On).**
- **AND** the inhibit regeneration switch has a good status (**Regen_Inhibit_Switch_On)**.
- **AND**

- **[**The parked regeneration switch is **NOT** in the upper position **(Parked_Regen_Switch_On) OR** the parked regeneration switch has a bad status **(Parked_Regen_Switch_On)]**.

The body controller also will request regeneration to be inhibited* (Regen_Inhibit_Request** = 1**)** if parked regeneration is cancelled (See "The body controller will request parked regeneration to be cancelled when…" for more information).***

The following table is an example of the signal conditions displayed on DLB while inhibit regeneration is requested. ***For inhibit regeneration to be requested:***

Table 1 – Inhibit Regeneration	
Signal	***Condition***
Ignition_Signal_Input	☑ = Ignition signal ON.
Regen_Inhibit_Switch_On	(1) = Inhibit regeneration switch in the ON position
Regen_Inhibit_Switch_On	Status of (0) indicates a "good status"
AND either of the following is true:	
Parked_Regen_Switch_On	(1) = Parked regeneration switch not in the upper position
OR	
Parked_Regen_Switch_On	Status of (non-zero value) indicates a "bad status"

The body controller sends a request to the ECM when the above conditions are true.

NOTE 1: The ECM decides whether to perform the inhibit regeneration function once it has received the request from the body controller. **Refer to the appropriate engine manual or documentation for more information.**

The body controller will request the inhibit regeneration to be cancelled if the following conditions are true:

- The key switch is in the OFF position **(Ignition_Signal_Input)**.
- **OR**
- **[**The inhibit regeneration switch is placed in the CANCEL position **(Regen_Inhibit_Switch_Cancel)** AND has a good status **(Regen_Inhibit_Switch_On)]**
- **OR**
- **[**The inhibit regeneration switch is in the CENTER position (see Switch Test)
- AND inhibit regeneration switch has a good status **(Regen_Inhibit_Switch_On)**.
- AND the parked regeneration switch is placed in the ON position **(Parked_Regen_Switch_On)**.
- AND the parked regeneration switch has a good status **(Parked_Regen_Switch_On)].**

6.2.1. Switch Test

The following test can be performed using Diamond Logic Builder (DLB) to assist in diagnosing the inhibit regeneration switch.

- Press and hold the inhibit regeneration switch in the ON (upper) position. The **Regen_Inhibit_Switch_On** signal (displayed in DLB) should indicate a value of (1) while the switch is placed in the ON position.

- Press and hold the inhibit regeneration switch in the CANCEL (lower) position. The **Regen_Inhibit_Switch_Cancel** signal (displayed in DLB) should indicate a value of (1) while the switch is placed in the CANCEL position.

- Place the inhibit regeneration switch **(0595AZA)** in the CENTER position. The **Regen_Inhibit_Switch_On** signal **AND** the **Regen_Inhibit_Switch_Cancel** signal (displayed in DLB) should indicate a value of (0)**.** This indicates both signals are off.

7. Feature Indications

7.1. Parked Regeneration Switch Indicator

The parked regeneration switch indicator has three states: ***Off***, ***On-Solid***, or ***Flashing***. The body controller sends a request to the switch pack on the data link when it determines that conditions are appropriate.

Flashing – This state indicates that the engine or body controller determines that conditions are not appropriate to perform a parked regeneration.

NOTE 1: The body controller momentarily activates the ***flashing*** state before proceeding to the ***on-solid*** state. This is done to allow the body controller to receive confirmation from the engine that the engine is actively regenerating the DPF.

NOTE 2: The indicator also flashes for a few seconds then turns off if the parked regeneration 'cancel' function is used.

NOTE 3: The switch indicator may flash for up to 10 minutes before turning ***on-solid*** while the body controller waits for the engine to acknowledge that the regeneration is active.

NOTE 4: If the engine has not responded that the system is inhibited or in an active regeneration mode within 10 minutes of an operator's request for parked regeneration, the parked regeneration switch indicator will ***flash indefinitely*** until the driver uses the cancel function and restarts the procedure. Insufficient engine coolant temperature, for

example, may require a cancel and restart, depending on the engine manufacturer. Ensure the engine is warm, and all interlocks are met prior to restarting the procedure.

The body controller will command the parked regeneration switch indicator* (Regen_Switch_Ind_Cmd) *to flash for a few seconds after the switch is released (means conditions are not appropriate) if any of the following is true:

- The vehicle speed **(Vehicle_Speed)** is greater than 4 mph.
- **OR** communication is lost **(Particulate_Trap_Lamp_Command)**.
- **OR** regeneration is not allowed **(Particulate_Trap_Lamp_Command)**.
- **OR** the inhibit switch **(Regen_Inhibit_Switch_On)** is pressed/placed the upper position **and** has a good status.
- **OR** an engine interlock is not met.

On-Solid – This state indicates that the engine is actively regenerating the DPF.

The body controller will command the parked regeneration switch indicator* (Regen_Switch_Ind_Cmd) *to illuminate continuously (means regeneration active) if the following conditions are true:

- The key switch is in the IGNITION position.
- **AND** the engine is actively regenerating the DPF.

7.1.1. Switch Indicator Test

The following test can be performed using Diamond Logic Builder (DLB) to assist in diagnosing the parked regeneration switch indicator.

- Command the **Regen_Switch_Ind_Cmd** signal using DLB. The parked regeneration switch indicator should illuminate while this signal is commanded.

7.2. Inhibit Regeneration Switch Indicator

The inhibit regeneration switch indicator has three states: ***Off***, ***On-Solid***, or ***Flashing***. The body controller sends a request to the switch pack on the data link when it determines that conditions are appropriate.

The body controller momentarily activates the ***flashing*** state before proceeding to the ***on-solid*** state. This is done to allow the body controller to receive confirmation from the engine that regeneration is actively inhibited due to the inhibit switch.

Flashing – This state indicates that the body controller has not received confirmation from the engine that regeneration is actively inhibited due to the inhibit switch.

The body controller will command the inhibit regeneration switch indicator* (Parked_Regen_State) *to flash (means not inhibited) if the following conditions are true:

- The key switch is in the IGNITION position.
- **AND** the inhibit function was requested by the inhibit switch. Refer to the Inhibit Regeneration section for more information.
- **AND** the body controller receives information from the engine that regeneration is **NOT** actively inhibited by the inhibit switch.

On-Solid – This state indicates that regeneration of the DPF is actively inhibited.

The body controller will command the inhibit regeneration switch indicator* (Parked_Regen_State) *to illuminate continuously (regeneration inhibited) if the following conditions are true:

- The key switch is in the IGNITION position.
- **AND** the inhibit function was requested by the inhibit switch. Refer to the Inhibit Regeneration section for more information.
- **AND** the body controller receives information from the engine that regeneration is actively inhibited by the inhibit switch.

7.2.1. Switch Indicator Test

The following test can be performed using Diamond Logic Builder (DLB) to assist in diagnosing the inhibit regeneration switch indicator.

- Command the **Parked_Regen_State** signal using DLB. The inhibit regeneration switch indicator should illuminate while this signal is commanded.

7.3. DPF Status Warning Lamp

The DPF status warning lamp is used to indicate the level of soot accumulation in the DPF. This lamp ***illuminates continuously*** up to a ***flashing*** state as the soot level accumulates. This warning lamp is controlled by a message from the ECM.

The body controller controls the DPF Status Warning Lamp output (ON or flashing) depending on the information received from the ECM.

The body controller provides ground **(0595AZG)** or voltage **(0595AYW)** to the DPF status warning lamp while this output is active.

The body controller will control the DPF Status Warning Lamp output OFF if any of the following conditions are true:

- The body controller does **NOT** receive a message from the ECM to illuminate or flash the DPF status warning lamp (**AND** parked regeneration is not currently active).
- **OR** the key switch is placed in the OFF position.
- **OR** parked regeneration is currently active **AND** the body controller receives a message from the ECM that the soot level is **below** level 1.

7.3.1. Warning Lamp Test

The following test can be performed using Diamond Logic Builder (DLB) to assist in diagnosing the DPF status warning lamp.

- Perform the lamp check by cycling the key switch **OR** command the **DPF_Status_Warning_Lamp_Cmd** using DLB. The DPF status warning lamp should illuminate.

7.4. HEST Warning Lamp

The HEST warning lamp provides an indication of high exhaust systems temperatures when the vehicle speed is below 5 mph. This warning lamp is controlled by a message from the ECM.

The body controller will control the HEST warning lamp output* (High_Temp_Exhaust_Light) *to "lamp on" if the following conditions are true:

- The body controller receives information from the ECM to illuminate the HEST warning lamp.
- **AND** the vehicle speed is less than or equal to 5 mph.

The body controller provides ground **(0595AZG)** or voltage **(0595AYW)** to the HEST warning lamp while this output is active.

The body controller will control the HEST warning lamp output to "lamp off" if the following conditions are true:

- The body controller receives information from the ECM to turn off the HEST warning lamp.

7.4.1. Warning Lamp Test

The following test can be performed using Diamond Logic Builder (DLB) to assist in diagnosing the HEST warning lamp.

- Perform the lamp check by cycling the key switch **OR** command the **High_Temp_Exhaust_Light** using DLB. The HEST warning lamp should illuminate.

7.5. Audible Alarm

The gauge cluster provides different audible indications of soot accumulation. The body controller sends a proprietary message to the gauge cluster for these requests.

The body controller will request five-short-beeps every minute if the following conditions are true:

- The body controller receives information from the ECM to flash the DPF status warning lamp.
- **AND** the body controller receives information from the ECM that the soot accumulation is at its highest level.

The gauge cluster will command a continuous repetitive one-short-beep if the following conditions are true:

- The red stop lamp (RSL) is on.

7.6. "See Visor for Info" Text Message (if equipped)

This message, available on vehicles equipped with cluster software version 2.2 and beyond, indicates that DPF regeneration is needed. ***The gauge cluster will display the text message "See Visor for Info" when the following conditions are true:***

- The gauge cluster receives a request from the ECM to activate the DPF status warning lamp.

8. Diagnostics

It is strongly recommended that DLB is used along with this information to enhance diagnostic capabilities. See the diagnostic software manual for details on using the software.

WARNING! Failure to perform Parked Regeneration when exhaust filter Indicator is ON will cause the engine to lose power and eventually shutdown. When performing Parked Regeneration, make certain vehicle is safely off roadway and away from people, or any

flammable materials or structures, as the regeneration process will result in elevated exhaust temperatures. Failure to follow these instructions may result in a loss of engine power, vehicle speed, and may cause an accident or fire resulting in property damage personal injury, or death.

WARNING! If the HEST warning lamp is ON the exhaust system is HOT and regeneration is in progress.

8.1. Diagnostic Trouble Codes

Cross reference the DTC to the applicable section from the DTC table. **Refer to the appropriate engine manual or documentation for diagnostic trouble codes set by the engine control module (ECM).**

8.1.1. Displaying Diagnostic Trouble Codes

Refer to Displaying Diagnostic Trouble Codes.

8.2. Error Operation

If the body controller has “lost communication” with the ECM the following will occur:

- The DPF status warning lamp and the HEST warning lamp will remain in the present state until the data link is repaired or the key switch is turned to the OFF position.
- The body controller will set a fault and will request amber warning lamp (AWL) illumination until the SAE J1939 communication is reestablished.

If the body controller determines that an over current fault is present on the output that controls the DPF status warning lamp or the HEST warning lamp, then the body controller will disable the appropriate output. The fault will be considered active until the condition is removed, or the ignition cycles.

If either of the above described lamps are in the vehicle configuration and becomes inoperative, then the body controller will send a message to request illumination of the AWL, and set a fault.

Aftertreatment

1. Description and Operation

The Aftertreatment System monitors the amount of particulate matter contained in the vehicle's exhaust gas. The Diesel Particulate Filter (DPF) traps this particulate matter. A process called regeneration is used to burn off the particulate matter in the DPF. This is essential to comply with increasing emission regulations.

The engine controls the Aftertreatment System. Therefore, discussion in this section is limited to the body controller's interface to the Aftertreatment System. **Refer to the appropriate engine manual for detailed information on troubleshooting aftertreatment problems related to the engine circuits.** Refer to the Aftertreatment Definitions section for unknown terms.

This feature includes the following vehicle configurations:

Feature Code	Models	Description
0595AZA	3200, 4000 series, 7000 series, 8000 series, CXT, RXT, ProStar	Optional inhibit regeneration switch (three position momentary switch) and switch indicator.
0595AYZ	3200, 4000 series, 7000 series, 8000 series, CXT, RXT, CE Bus	Optional inhibit regeneration switch (two position, latching ON/OFF switch) and switch indicator. **NOTE: This configuration is standard for bus.**
0595AZE	ProStar	High exhaust system temperature (HEST) warning lamp.
0595AYX	3200, 4000 series, 7000 series, 8000 series, CXT, RXT, CE Bus	High exhaust system temperature (HEST) warning lamp.
0595AZG	ProStar	DPF status warning lamp.
0595AYW	3200, 4000 series, 7000 series, 8000 series, CXT, RXT, CE Bus	DPF status warning lamp.
0595AZH	ProStar, 3200, 4000 series, 7000 series, 8000 series, CXT, RXT, CE Bus	Parked regeneration switch and switch indicator.

This feature consists of the following additional electrical components:

- Parked regeneration switch
- Inhibit regeneration switch (if equipped)
- Diesel Particulate Filter (DPF) status warning lamp
- High exhaust system temperature (HEST) warning lamp

NOTE: The feature also utilizes the amber warning lamp (AWL), red stop lamp (RSL), and the gauge cluster for additional operator indications.

The parked regeneration and inhibit regeneration switches may be located either in the lower right portion of the gauge cluster or in a switch pack depending on the vehicle configuration. The HEST and DPF status warning lamps are located in a hardwired warning lamp 4-pack within the gauge cluster.

The parked regeneration switch is used to request regeneration of the DPF. The inhibit regeneration switch is used to prevent DPF regeneration. These switches provide inputs to the body controller.

The body controller sends the appropriate requests to the engine control module (ECM) for parked regeneration or inhibit regeneration. These functions are described in detail in the Feature Functions section.

NOTE: The actual control of the aftertreatment system is performed by the ECM.

The feature provides the operator with an indication of accumulating soot levels described in the Soot Level Accumulation section. The HEST warning lamp operation is described in the Feature Functions section.

2. Aftertreatment Definitions

- ***Parked DPF regeneration –*** Manual request by the operator to regenerate the DPF.
- ***Inhibit DPF regeneration –*** Manual request by the operator to prevent DPF regeneration.
- ***Good Communication –*** Communication is "good" if the body controller is communicating properly with the engine control module (ECM). Diamond Logic Builder (DLB) can be used to monitor the **(Particulate_Trap_Lamp_Command)** signal where a status of (0) indicates that communication is "good".
- ***Lost Communication –*** Communication is "lost" if communication is not "Good Communication".
- ***Parked Regeneration is Allowed –*** The body controller is receiving information from the ECM that the DPF is accumulating soot and regeneration is needed. Refer to **Particulate_Trap_Lamp_Command** in the Signal Definitions section to understand the information which the body controller must receive from the ECM before parked regeneration is allowed.

3. Signal Definitions

This section connects the DLB displayed signal name to the circuit diagram. Refer to the electrical circuit diagram for specific pins. DLB displays the status on certain signals where a value of zero (0) indicates a good status.

- **Parked_Regen_Switch_On** – Data link input from the switch pack to the body controller. DLB displays a value of (1) while the regeneration switch is in the ON position.
- **Parked_Regen_Switch_Cancel** – Data link input from the switch pack to the body controller. DLB displays a value of (1) while the regeneration switch is in the CANCEL position.

- **Particulate_Trap_Regeneration_Force_Switch** – SAE J1939 output signal from the body controller to the ECM. The body controller uses this signal to request the parked regeneration function. DLB displays a value of (1) while the body controller is requesting the parked regeneration function.

- **Parked_Regen_Switch_Ind_Cmd** – Data link output from the body controller to the switch pack.

    - DLB displays a value of (1) while the body controller commands the parked regeneration switch indicator ON.
    - DLB displays a value of (2) while the body controller commands the parked regeneration switch indicator to FLASH.

- **Regen_Inhibit_Switch_On** – Data link input from the switch pack to the body controller. DLB displays a value of (1) while the regeneration inhibit switch is in the ON position.

- **Regen_Inhibit_Switch_Cancel** – Data link input from the switch pack to the body controller. DLB displays a value of (1) while the regeneration switch is in the CANCEL position.

- **Particulate_Trap_Regeneration_Inhibit_Switch** – SAE J1939 output signal from the body controller to the ECM. The body controller uses this signal to request the inhibit regeneration function. DLB displays a value of (1) while the body controller is requesting the inhibit regeneration function.

- **Regen_Inhibit_Switch_Ind_Cmd** – Data link output from the body controller to the switch pack.

    - DLB displays a value of (1) while the body controller commands the inhibit regeneration switch indicator ON.
    - DLB displays a value of (2) while the body controller commands the inhibit regeneration switch indicator to FLASH.

- **Particulate_Trap_Lamp_Command** – SAE J1939 input signal from the ECM to the body controller. The body controller uses the information received from the ECM to determine whether parked regeneration is allowed. DLB displays the following values:

    - (0) = Parked regeneration is not allowed (the DPF status lamp is off).
    - (1) or (4) = Parked regeneration is allowed (the DPF status lamp is either on or flashing)

    NOTE: The body controller must receive this signal with a value of (1) or (4) to allow parked regeneration.

- **DPF_Status_Warning_Lamp_Cmd** – Output signal from the body controller to the DPF status warning lamp.

  - **(0595AZG)** – DLB displays ☑ while the body controller provides ground to the DPF status warning lamp.
  - **(0595AYW)** – DLB displays ☑ while the body controller supplies voltage to the DPF status warning lamp.

- **HEST_Warning_Lamp_Cmd** – Output signal from the body controller to the HEST warning lamp.

  - **(0595AZE)** – DLB displays ☑ while the body controller provides ground to the HEST warning lamp.
  - **(0595AYX)** – DLB displays ☑ while the body controller supplies voltage to the HEST warning lamp.

NOTE: There are also programmable parameters within the ECM that affect the parked regeneration and inhibit regeneration functions. **Refer to the appropriate engine manual or documentation for more information.**

4. Body Controller Initialization

The Body Controller will perform a lamp check for the following lamps when the key switch is turned to the IGNITION position:

- DPF Status Warning Lamp
- HEST Warning Lamp

These lamps will turn on for a few seconds and then turn off during the lamp check. The purpose of the lamp check is to confirm that the lamp is in working order.

5. Soot Accumulation Level Indications

This feature will indicate different levels of soot accumulation using a combination of the DPF status warning lamp, amber warning lamp, red stop lamp, and audible alarm.

Refer to Feature Functions for information about how these indications are performed by the feature.

Soot Accumulation	***Operator Indication***
Level 1 (Low)	• DPF Status Warning Lamp illuminates continuously. • **AND** "See Visor for Info" (if equipped) appears in the gauge cluster.

Level 2 (Moderate)	• DPF Status Warning Lamp flashes. • **AND** "See Visor for Info" (if equipped) appears in the gauge cluster.
Level 3 (Full)	• DPF Status Warning Lamp flashes. • **AND** the Amber Warning Lamp illuminates continuously. • **AND** "See Visor for Info" (if equipped) appears in the gauge cluster. • **AND** the Audible Alarm sounds ***five-short-beeps*** every minute.
Level 4 (Over-Full) **(See Note)**	• Red Stop Lamp Illuminates. • **AND** the Audible Alarm sounds ***a repetitive one-short-beep*** while the red stop lamp is illuminated. • **AND** (Caterpillar Engines Only) DPF Status Warning Lamp flashes. • **AND** (Caterpillar Engines Only) the Amber Warning Lamp illuminates continuously. **NOTE: Regeneration cannot be performed at this level. Refer to the appropriate service manual for instructions regarding servicing the DPF.**

Refer to the Vehicle Operator's Manual OR the vehicle visor label for information pertaining to the meaning of the above indications.

6. Feature Functions

6.1. Parked Regeneration

The body controller will request a parked regeneration **(Particulate_Trap_Regeneration_Force_Switch** = 1**)** ***if the following conditions are true:***

- The parked regeneration switch is pressed **(upper position) (Parked_Regen_Switch_On).**
- **AND** the parked regeneration switch has a good status **(Parked_Regen_Switch_On).**
- **AND** the vehicle speed is less than 4 mph **(Vehicle_Speed).**

- **AND** the key switch is in the IGNITION position **(Ignition_Signal_Input).**
- **AND** regeneration is allowed **(Particulate_Trap_Lamp_Command).**
- **AND** SAE J1939 communication is good **(Particulate_Trap_Lamp_Command).**
- **AND [**the inhibit regeneration function is **NOT** being requested **(Particulate_Trap_Regeneration_Inhibit_Switch) OR** the inhibit switch has a bad status **(Regen_Inhibit_Switch_On)**.**]**

The following table is an example of the signal conditions displayed on DLB during parked DPF regeneration. ***For parked regeneration to be requested:***

Table 1 – Parked Regeneration	
Signal	***Condition***
Parked_Regen_Switch_On	(1) = Parked regeneration switch in the ON position
Parked_Regen_Switch_On	Status of (0) indicates a “good status”
Vehicle_Speed	Must be a value of less than (4) mph.
Ignition_Signal_Input	☑ = Ignition signal ON.
Particulate_Trap_Lamp_Command	Must be a value of (1) or (4) to indicate regeneration is allowed
Particulate_Trap_Lamp_Command	Status of (0) indicates a “good communication” status
Particulate_Trap_Regeneration_Inhibit_Switch	(0) = Inhibit regeneration **NOT** being requested.
Regen_Inhibit_Switch_On	Status of (non-zero value) indicates a “bad status”

The body controller sends a request to the ECM when the above conditions are true.

NOTE 1: The ECM decides whether to perform the parked regeneration function once it has received the request from the body controller. **Refer to the appropriate engine manual or documentation for more information.**

NOTE 2: The body controller will not request Parked DPF regeneration if the soot level has reached Level 4. Level 4 indicates that the vehicle requires service. **Refer to the appropriate service manual for instructions regarding servicing the DPF.**

The body controller will request parked regeneration to be cancelled (if previously active) if the key switch is in the IGNITION position* (Ignition_Signal_Input) *and any of the following conditions are true:

- Communication is ‘lost’.
- **OR** the parked regeneration switch (**Parked_Regen_Switch_On)** has a bad status

- **OR** the parked regeneration switch (**Parked_Regen_Switch_On)** is pressed in the lower position.
- **OR** ***All of the following conditions are true:***
  [The parked regeneration switch (**Parked_Regen_Switch_On)** has a good status
  AND the parked regeneration switch (**Parked_Regen_Switch_On)** is released (center position)
  AND the inhibit switch **(Regen_Inhibit_Switch_On)** has a good status.
  AND the inhibit switch **(Regen_Inhibit_Switch_On)** is pressed/placed in the upper position**].**

***The body controller requests parked regeneration to be cancelled by momentarily requesting regeneration to be inhibited* (DLB will indicate Particulate_Trap_Regeneration_Inhibit_Switch** = 1**) for 3 seconds *after* the switch is released.**

NOTE: DLB will indicate **Particulate_Trap_Regeneration_Inhibit_Switch** = 1 indefinitely if the parked regeneration switch is held in the lower (cancel) position while parked regeneration is in progress.

6.1.1. Switch Test

The following test can be performed using Diamond Logic Builder (DLB) to assist in diagnosing the parked regeneration switch.

- Press and hold the parked regeneration switch in the ON (upper) position. The **Parked_Regen_Switch_On** signal (displayed in DLB) should indicate a value of 1 while the switch is placed in the ON position.

- Press and hold the parked regeneration switch in the CANCEL (lower) position. The **Parked_Regen_Switch_Cancel** signal (displayed in DLB) should indicate a value of 1 while the switch is placed in the CANCEL position.

- Place the parked regeneration switch in the CENTER position. The **Parked_Regen_Switch_On** signal **AND** the **Parked_Regen_Switch_Cancel** signal (displayed in DLB) should indicate a value of 0**.** This indicates both signals are off.

6.2. Inhibit Regeneration

The body controller will request regeneration to be inhibited* (Particulate_Trap_Regeneration_Inhibit_Switch** = 1**) *if the following conditions are true:

- The key switch is in the IGNITION position **(Ignition_Signal_Input)**.

- **AND** the inhibit regeneration switch is pressed/placed in the upper position **(Regen_Inhibit_Switch_On).**
- **AND** the inhibit regeneration switch has a good status (**Regen_Inhibit_Switch_On)**.
- **AND**
- **[**The parked regeneration switch is **NOT** in the upper position **(Parked_Regen_Switch_On) OR** the parked regeneration switch has a bad status **(Parked_Regen_Switch_On)]**.

The body controller also will request regeneration to be inhibited* (Particulate_Trap_Regeneration_Inhibit_Switch** = 1**)** if parked regeneration is cancelled (See "The body controller will request parked regeneration to be cancelled when…" for more information).***

The following table is an example of the signal conditions displayed on DLB while inhibit regeneration is requested. ***For inhibit regeneration to be requested:***

Table 1 – Inhibit Regeneration	
Signal	***Condition***
Ignition_Signal_Input	☑ = Ignition signal ON.
Regen_Inhibit_Switch_On	(1) = Inhibit regeneration switch in the ON position
Regen_Inhibit_Switch_On	Status of (0) indicates a "good status"
AND either of the following is true:	
Parked_Regen_Switch_On	(0) = Parked regeneration switch not in the upper position
OR	
Parked_Regen_Switch_On	Status of (non-zero value) indicates a "bad status"

The body controller sends a request to the ECM when the above conditions are true.

NOTE 1: The ECM decides whether to perform the inhibit regeneration function once it has received the request from the body controller. **Refer to the appropriate engine manual or documentation for more information.**

The body controller will request the inhibit regeneration to be cancelled if the following conditions are true:

- The key switch is in the OFF position **(Ignition_Signal_Input)**.
- **OR**
- **[**The inhibit regeneration switch is placed in the CANCEL position **(Regen_Inhibit_Switch_Cancel)** AND has a good status **(Regen_Inhibit_Switch_On)]**
- **OR**

- **[**The inhibit regeneration switch is in the CENTER position (see Switch Test)
- AND inhibit regeneration switch has a good status **(Regen_Inhibit_Switch_On)**.
- AND the parked regeneration switch is placed in the ON position **(Parked_Regen_Switch_On)**.
- AND the parked regeneration switch has a good status **(Parked_Regen_Switch_On)].**

6.2.1. Switch Test

The following test can be performed using Diamond Logic Builder (DLB) to assist in diagnosing the inhibit regeneration switch.

- Press and hold the inhibit regeneration switch in the ON (upper) position. The **Regen_Inhibit_Switch_On** signal (displayed in DLB) should indicate a value of (1) while the switch is placed in the ON position.

- Press and hold the inhibit regeneration switch in the CANCEL (lower) position. The **Regen_Inhibit_Switch_Cancel** signal (displayed in DLB) should indicate a value of (1) while the switch is placed in the CANCEL position.

- Place the inhibit regeneration switch **(0595AZA)** in the CENTER position. The **Regen_Inhibit_Switch_On** signal **AND** the **Regen_Inhibit_Switch_Cancel** signal (displayed in DLB) should indicate a value of (0)**.** This indicates both signals are off.

7. Feature Indications

7.1. Parked Regeneration Switch Indicator

The parked regeneration switch indicator has three states: ***Off***, ***On-Solid***, or ***Flashing***. The body controller sends a request to the switch pack on the data link when it determines that conditions are appropriate.

Flashing – This state indicates that the engine or body controller determines that conditions are not appropriate to perform a parked regeneration.

NOTE 1: The body controller momentarily activates the ***flashing*** state before proceeding to the ***on-solid*** state. This is done to allow the body controller to receive confirmation from the engine that the engine is actively regenerating the DPF.

NOTE 2: The indicator also flashes for a few seconds then turns off if the parked regeneration 'cancel' function is used.

NOTE 3: The switch indicator may flash for up to 10 minutes before turning ***on-solid*** while the body controller waits for the engine to acknowledge that the regeneration is active.

NOTE 4: If the engine has not responded that the system is inhibited or in an active regeneration mode within 10 minutes of an operator's request for parked regeneration, the parked regeneration switch indicator will ***flash indefinitely*** until the driver uses the cancel function and restarts the procedure. Insufficient engine coolant temperature, for example, may require a cancel and restart, depending on the engine manufacturer. Ensure the engine is warm, and all interlocks are met prior to restarting the procedure.

The body controller will command the parked regeneration switch indicator* (Parked_Regen_Switch_Ind_Cmd) *to flash for a few seconds after the switch is released (means conditions are not appropriate) if any of the following is true:

- The vehicle speed **(Vehicle_Speed)** is greater than 4 mph.
- **OR** communication is lost **(Particulate_Trap_Lamp_Command)**.
- **OR** regeneration is not allowed **(Particulate_Trap_Lamp_Command)**.
- **OR** the inhibit switch **(Regen_Inhibit_Switch_On)** is pressed/placed the upper position **and** has a good status.
- **OR** an engine interlock is not met.

On-Solid – This state indicates that the engine is actively regenerating the DPF.

The body controller will command the parked regeneration switch indicator* (Parked_Regen_Switch_Ind_Cmd) *to illuminate continuously (means regeneration active) if the following conditions are true:

- The key switch is in the IGNITION position.
- **AND** the engine is actively regenerating the DPF.

7.1.1. Switch Indicator Test

The following test can be performed using Diamond Logic Builder (DLB) to assist in diagnosing the parked regeneration switch indicator.

- Command the **Parked_Regen_Switch_Ind_Cmd** signal using DLB. The parked regeneration switch indicator should illuminate while this signal is commanded.

7.2. Inhibit Regeneration Switch Indicator

The inhibit regeneration switch indicator has three states: ***Off***, ***On-Solid***, or ***Flashing***. The body controller sends a request to the switch pack on the data link when it determines that conditions are appropriate.

The body controller momentarily activates the ***flashing*** state before proceeding to the ***on-solid*** state. This is done to allow the body controller to receive confirmation from the engine that regeneration is actively inhibited due to the inhibit switch.

Flashing – This state indicates that the body controller has not received confirmation from the engine that regeneration is actively inhibited due to the inhibit switch.

The body controller will command the inhibit regeneration switch indicator* (Regen_Inhibit_Switch_Ind_Cmd) *to flash (means not inhibited) if the following conditions are true:

- The key switch is in the IGNITION position.
- **AND** the inhibit function was requested by the inhibit switch. Refer to Inhibit Regeneration for more information.
- **AND** the body controller receives information from the engine that regeneration is **NOT** actively inhibited by the inhibit switch.

On-Solid – This state indicates that regeneration of the DPF is actively inhibited.

The body controller will command the inhibit regeneration switch indicator* (Regen_Inhibit_Switch_Ind_Cmd) *to illuminate continuously (regeneration inhibited) if the following conditions are true:

- The key switch is in the IGNITION position.
- **AND** the inhibit function was requested by the inhibit switch. Refer to Inhibit Regeneration for more information.
- **AND** the body controller receives information from the engine that regeneration is actively inhibited by the inhibit switch.

7.2.1. Switch Indicator Test

The following test can be performed using Diamond Logic Builder (DLB) to assist in diagnosing the inhibit regeneration switch indicator.

- Command the **Regen_Inhibit_Switch_Ind_Cmd** signal using DLB. The inhibit regeneration switch indicator should illuminate while this signal is commanded.

7.3. DPF Status Warning Lamp

The DPF status warning lamp is used to indicate the level of soot accumulation in the DPF. This lamp ***illuminates continuously*** up to a ***flashing*** state as the soot level accumulates. This warning lamp is controlled by a message from the ECM.

The body controller controls the DPF Status Warning Lamp output (ON or flashing) depending on the information received from the ECM.

The body controller provides ground **(0595AZG)** or voltage **(0595AYW)** to the DPF status warning lamp while this output is active.

The body controller will control the DPF Status Warning Lamp output OFF if any of the following conditions are true:

- The body controller does **NOT** receive a message from the ECM to illuminate or flash the DPF status warning lamp (**AND** parked regeneration is not currently active).
- **OR** the key switch is placed in the OFF position.
- **OR** parked regeneration is currently active **AND** the body controller receives a message from the ECM that the soot level is **below** level 1.

7.3.1. Warning Lamp Test

The following test can be performed using Diamond Logic Builder (DLB) to assist in diagnosing the DPF status warning lamp.

- Perform the lamp check by cycling the key switch **OR** command the **DPF_Status_Warning_Lamp_Cmd** using DLB. The DPF status warning lamp should illuminate.

7.4. HEST Warning Lamp

The HEST warning lamp provides an indication of high exhaust systems temperatures when the vehicle speed is below 5 mph. This warning lamp is controlled by a message from the ECM.

The body controller will control the HEST warning lamp output* (HEST_Warning_Lamp_Cmd) *to "lamp on" if the following conditions are true:

- The body controller receives information from the ECM to illuminate the HEST warning lamp.
- **AND** the vehicle speed is less than or equal to 5 mph.

The body controller provides ground **(0595AZG)** or voltage **(0595AYW)** to the HEST warning lamp while this output is active.

The body controller will control the HEST warning lamp output to "lamp off" if the following conditions are true:

- The body controller receives information from the ECM to turn off the HEST warning lamp.

7.4.1. Warning Lamp Test

The following test can be performed using Diamond Logic Builder (DLB) to assist in diagnosing the HEST warning lamp.

- Perform the lamp check by cycling the key switch **OR** command the **HEST_Warning_Lamp_Cmd** using DLB. The HEST warning lamp should illuminate.

7.5. Audible Alarm

The gauge cluster provides different audible indications of soot accumulation. The body controller sends a proprietary message to the gauge cluster for these requests.

The body controller will request five-short-beeps every minute if the following conditions are true:

- The body controller receives information from the ECM to flash the DPF status warning lamp.
- **AND** the body controller receives information from the ECM that the soot accumulation is at its highest level.

The gauge cluster will command a continuous repetitive one-short-beep if the following conditions are true:

- The red stop lamp (RSL) is on.

7.6. "See Visor for Info" Text Message (if equipped)

This message, available on vehicles equipped with cluster software version 2.2 and beyond, indicates that DPF regeneration is needed. ***The gauge cluster will display the text message "See Visor for Info" when the following conditions are true:***

- The gauge cluster receives a request from the ECM to activate the DPF status warning lamp.

8. Diagnostics

It is strongly recommended that DLB is used along with this information to enhance diagnostic capabilities. See the diagnostic software manual for details on using the software.

WARNING! Failure to perform Parked Regeneration when exhaust filter Indicator is ON will cause the engine to lose power and eventually shutdown. When performing Parked Regeneration, make certain vehicle is safely off roadway and away from people, or any flammable materials or structures, as the regeneration process will result in elevated exhaust temperatures. Failure to follow these instructions may result in a loss of engine power, vehicle speed, and may cause an accident or fire resulting in property damage personal injury, or death.

WARNING! If the HEST warning lamp is ON the exhaust system is HOT and regeneration is in progress.

8.1. Diagnostic Trouble Codes

Cross reference the DTC to the applicable section from the DTC table. **Refer to the appropriate engine manual or documentation for diagnostic trouble codes set by the engine control module (ECM).**

8.1.1. Displaying Diagnostic Trouble Codes

Refer to Displaying Diagnostic Trouble Codes.

8.2. Error Operation

If the body controller has “lost communication” with the ECM the following will occur:

- The DPF status warning lamp and the HEST warning lamp will remain in the present state until the data link is repaired or the key switch is turned to the OFF position.
- The body controller will set a fault and will request amber warning lamp (AWL) illumination until the SAE J1939 communication is reestablished.

If the body controller determines that an over current fault is present on the output that controls the DPF status warning lamp or the HEST warning lamp, then the body controller will disable the appropriate output. The fault will be considered active until the condition is removed, or the ignition cycles.

If either of the above described lamps are in the vehicle configuration and becomes inoperative, then the body controller will send a message to request illumination of the AWL, and set a fault.

Cruise Control

1. Description and Operation

Cruise control allows an operator to maintain a selected vehicle speed. The feature includes the following vehicle configurations:

Feature Code	Models	Description	Switch Components
0595AYJ	ProStar	Steering Wheel Switches	• CRUISE ON Switch • CRUISE OFF Switch • SET/COAST Switch • RESUME/ACCEL Switch
0595AAP	BE/CE Bus, 3200, CXT, RXT, 4000 series, 7000 series, 8000, series	Steering Wheel Switches	• CRUISE ON/OFF Switch • SET/RESUME Switch
0595AKX	BE/CE Bus	SAE J1708 Switch Pack Switches	• CRUISE ON/OFF Switch • SET/RESUME Switch

Cruise control also consists of the following electrical components in addition to the cruise switches:

- Clutch Switch (if equipped)
- Brake Switch

The brake and clutch switches are located near the top of their respective pedals. The cruise control switches may be located either in the steering wheel or in the SAE J1708 Switch Pack on the wing panel on some busses as noted above.

2. Cruise Control Switches

The only difference to the operation of the cruise control system between vehicles equipped with steering wheel mounted cruise switches and vehicles equipped with switch pack mounted cruise switches is the manner in which the cruise switches are input to the body controller.

2.1. Steering Wheel Mounted Switches

The body controller supplies a zero volt reference (ZVR) though the clock spring to one side of the cruise control switches. The body controller supplies near ignition voltage to the other side of the cruise control switches. Each cruise control switch is connected to a resistor with a different resistance. The switch and resistor are connected in parallel with the other switches and resistors. When a switch is pressed the body controller will sense the voltage drop across the switch and the resistor through an analog input.

2.2. Switch Pack Mounted Switches (Bus)

The switch pack cruise switches provide message inputs to the body controller on the SAE J1708 Switch Data Link.

The body controller sends the appropriate messages on the SAE J1939 data link to the engine control module (ECM) based on the input from the cruise switches. The message sent by the body controller to the ECM will request the appropriate cruise control function depending on which switch (or combination of switches) is pressed. The body controller will also send the enable request to the ECM. The body controller will indicate to the gauge cluster that cruise is enabled via a proprietary J1939 message when it is sending the enable request to the ECM.

The actual control of the cruise control system is performed by the ECM. The ECM sends a message on the SAE J1939 data link indicating what state of cruise control the system is in.

The gauge cluster will indicate to the operator when the cruise control is enabled and active based upon SAE J1939 messages received from the body controller and the ECM.

NOTE: Refer to the Engine Manual (PBB 71000A) (International engines) or the appropriate supplier documentation (non-International engines) for detailed information on troubleshooting cruise control problems not related to the truck circuits.

3. Signal Definitions

This section connects the DLB displayed signal name to the circuit diagram. Refer to the electrical circuit diagram for specific pins. DLB displays the status on certain signals where a value of zero (0) indicates a good status.

- **Cruise_Switch_Signal (0595AYJ, 0595AAP) –** The analog input signal from the steering wheel cruise control switch to the body controller. DLB displays the following values:
    - 5 while no switches are pressed
    - 2 while SET/COAST is pressed
    - 3 while RESUME/ACCEL is pressed
    - 1 while CRUISE ON is pressed
    - 0 while CRUISE OFF is pressed
    - 6 while CRUISE ON AND SET/COAST are pressed
    - 4 while CRUISE ON AND RESUME are pressed

- **BUS_Cruise_Off_Input (0595AKX) –**SAE J1708 switch data link input from the switch pack to the body controller. DLB displays ☑ while CRUISE OFF is pressed.

- **BUS_Cruise_On_Input (0595AKX) –**SAE J1708 switch data link input from the switch pack to the body controller. DLB displays ☑ while CRUISE ON is pressed.

- **BUS_Cruise_Set_Input – (0595AKX) –**SAE J1708 switch data link input from the switch pack to the body controller. DLB displays ☑ while SET is pressed.

- **BUS_Cruise_Resume_Input – (0595AKX) –** SAE J1708 switch data link input from the switch pack to the body controller. DLB displays ☑ while RESUME is pressed.

- **Cruise_Enable_Cmd –** SAE J1939 output signal from the body controller to the ECM. DLB displays a value of (1) when cruise enable is being requested.

- **Cruise_Set_Msg –** SAE J1939 output signal from the body controller to the ECM. DLB displays a value of (1) while SET/COAST is pressed.

- **Cruise_Control_Coast –** SAE J1939 output signal from the body controller to the ECM. DLB displays ☑ while SET/COAST is pressed.

- **Cruise_Resume_Msg –** SAE J1939 output signal from the body controller to the ECM. DLB displays a value of (1) while RESUME/ACCEL is pressed.

- **Cruise_Accel_Msg –** SAE J1939 output signal from the body controller to the ECM. DLB displays a value of (1) while RESUME/ACCEL is pressed.

- **Brake_Switch_Signal –** The input signal from the brake switch. DLB displays ☑ while the brake pedal is pressed.

- **Clutch_Depressed –** The input signal from the clutch switch. DLB displays (0) while the clutch pedal is not pressed and (1) while the clutch pedal is pressed.

- **Clutch_Switch_Signal –** The clutch switch has a good status if this signal status is good.

4. Feature Functions

4.1. Enable Cruise Control

The body controller will request the cruise to be enabled when the following conditions are true:

- The key switch is in the IGNITION position.
- AND CRUISE ON switch is pressed.
- AND the cruise switch has a good status.
- AND the brake switch has a good status.
- AND the clutch switch has a good status.

The following table is an example of the signal conditions displayed on DLB for the enable cruise function. ***To request cruise control to be enabled:***

Signal	Condition
Ignition_Signal	1 = ignition on
Cruise_Switch_Signal (0595AYJ, 0595AAP)	1 while CRUISE ON is pressed
Cruise_Switch_Signal (0595AYJ, 0595AAP)	Status = 0
BUS_Cruise_On_Input (0595AKX)	☑ = CRUISE ON pressed
Brake_Switch_Signal	Status = 0
Clutch_Depressed	Status = 0

The body controller sends a message on the SAE J1939 data link to the ECM for the enable cruise request.

Once enabled, the body controller will continue the enabled request until the conditions for disabling the cruise are true (described under Disable Cruise Control).

NOTE: The ECM decides whether to activate cruise control once it has received the cruise enable request from the body controller. The ECM checks vehicle speed related programmable parameters and other interlocks prior to cruise activation. Refer to the Engine Manual (PBB 71000A) (International engines) or the appropriate supplier documentation (non-International engines) for more information.

4.2. Disable Cruise Control

The body controller will request the cruise to be disabled when the following conditions are true:

- The key switch is not in the IGNITION position
- OR the CRUISE OFF switch is pressed
- OR the cruise switch has a bad status
- OR the brake switch has a bad status
- OR the clutch switch has a bad status
- OR there is a loss of communications with the ABS module

The body controller sends a message on the SAE J1939 data link to the ECM for this request.

NOTE: If the vehicle is equipped with Cummins ICON and the ICON system is active the disable cruise works differently. ***If ICON is active the body controller will request the cruise to be disabled when:***

- The CRUISE OFF switch is pressed
- OR an open circuit is detected in the cruise switch wiring

4.3. Cruise Set

The body controller will request the cruise SET function when:

- The key switch is in the IGNITION position
- AND SET is pressed
- AND the cruise switch has a good status
- AND the brake switch has a good status
- AND the clutch switch has a good status

The body controller sends a message on the SAE J1939 data link to the ECM for this request.

NOTE: If the vehicle is equipped with Cummins ICON and the ICON system is active the cruise set function works differently. **If ICON is active the body controller will request the cruise to be set when SET is pressed, even if the key is turned off.** This is because the accessory signal is forced On when ICON is active.

NOTE: The ECM decides whether to activate cruise control once it has received the request from the body controller.

4.4. Cruise Resume

The body controller will request the cruise RESUME function when:

- The key switch is in the IGNITION position
- AND RESUME is pressed
- AND the cruise switch has a good status
- AND the brake switch has a good status
- AND the clutch switch has a good status

The body controller sends a message on the SAE J1939 data link to the ECM for this request.

NOTE: The ECM decides whether to activate cruise control once it has received the request from the body controller.

4.5. "CRUISE", "CRUISE SET" Messages

4.5.1. "CRUISE"

This message indicates that cruise control is enabled. ***The gauge cluster will display the text message "CRUISE" when the following conditions are true:***

- The gauge cluster is receiving the proprietary cruise enable indication from the body controller.
- AND the gauge cluster is receiving a message from the ECM that cruise control is not active.

4.5.2. "CRUISE SET"

This message indicates that cruise control is active. The gauge cluster will display the text message "CRUISE SET" when:

The gauge cluster is receiving the cruise active indication from the ECM.

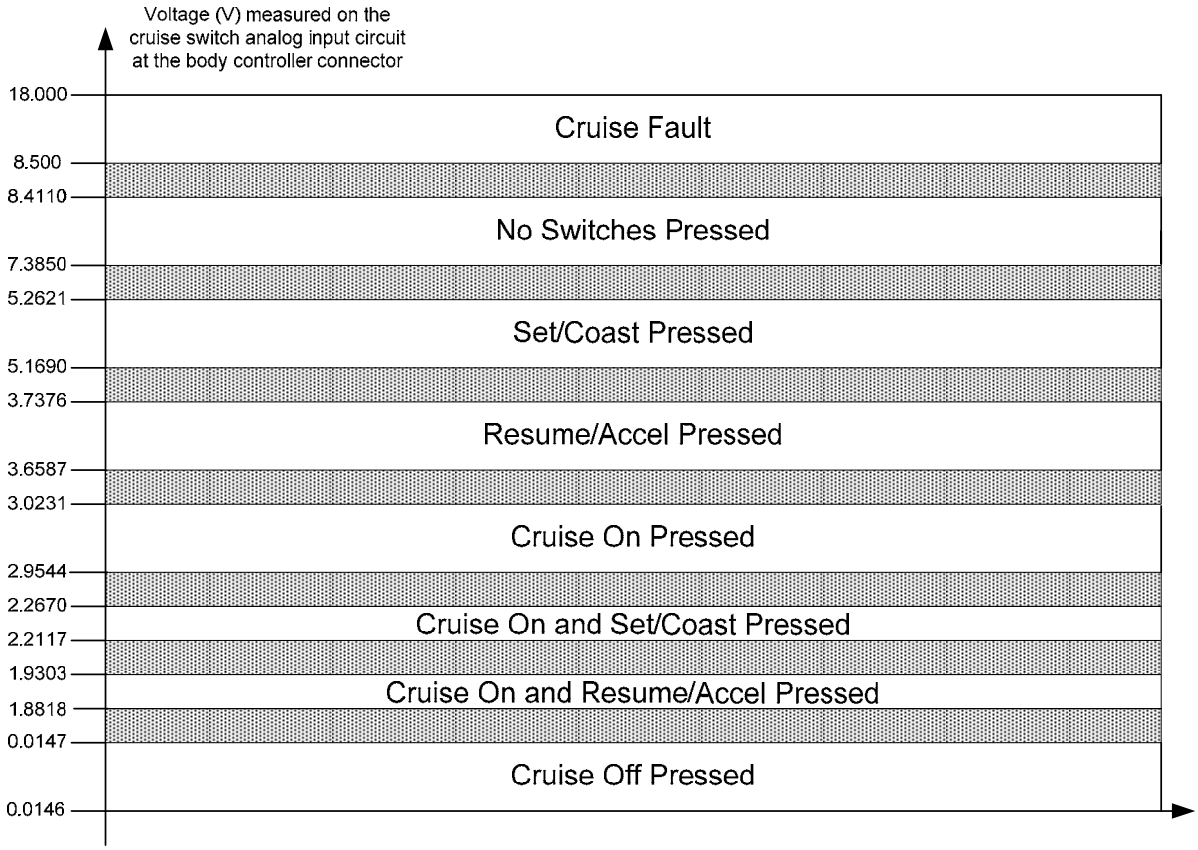
5. Diagnostics

It is strongly recommended that DLB is used along with this information to enhance diagnostic capabilities. See the diagnostic software manual for details on using the software.

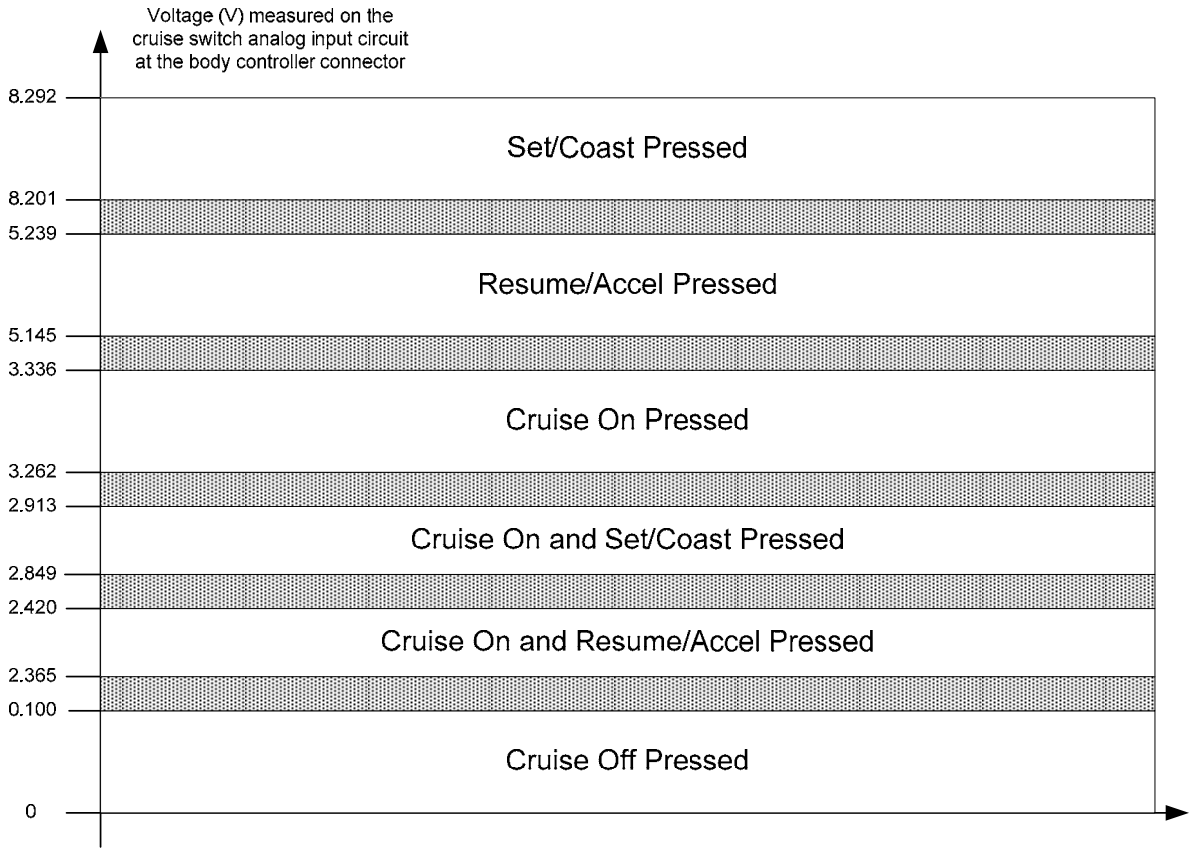
5.1. Switch Reference Voltage Ranges

The following information should only be referenced for vehicles equipped with steering wheel mounted cruise control switches. The information is used to ensure the hardware is providing the appropriate voltages.

5.1.1. Voltage Ranges (0595AYJ)



5.1.2. Voltage Ranges (0595AAP)



5.2. Switch Resistance Checks

The following tests should be performed only on vehicles equipped with steering wheel mounted cruise control switches.

Cruise Control Switch Resistance Checks (0595AYJ) Check with key switch off and clock spring connector removed.		
Test Points	Spec.	Comments
Clock spring connector Between cavity A and D. No switches pushed	• Place multi-meter in diode mode • Connect the positive test lead to cavity A • Connect the negative test lead to cavity B Approximately .8 volts Multi-meter should display an indication of an open circuit if test leads are reversed.	If voltage is incorrect there is a short in one of the switches.
Clock spring connector Between cavity A and D. RESUME/ACCEL switch pushed	1430 ohms ± 14 ohms.	If resistance is incorrect replace the RESUME/ACCEL switch.
Clock spring connector Between cavity A and D. SET/COAST switch pushed	2430 ohms ± 24 ohms	If resistance is incorrect replace the SET/COAST switch.
Clock spring connector Between cavity A and D. CRUISE ON switch pushed	1070 ohms ± 11 ohms.	If resistance is incorrect replace the CRUISE ON switch.
Clock spring connector Between cavity A and D. CRUISE OFF switch pushed	<2 ohms.	If resistance is incorrect replace the CRUISE OFF switch.
If all resistances are within the specified range the switches are functioning properly.		

Cruise Control Switch Resistance Checks (0595AAP) Check with key switch off and clock spring connector removed.		
Test Points	Spec.	Comments
Clock spring connector Between cavity A and D. No switches pushed	>100K ohms.	If resistance is incorrect there is a short in one of the switches.
Clock spring connector Between cavity A and D. RESUME switch pushed	2.4K ± 470 ohms.	If resistance is incorrect replace the SET/RESUME switch.
Clock spring connector Between cavity A and D. SET switch pushed	6.2K ± 1200 ohms.	If resistance is incorrect replace the SET/RESUME switch.
Clock spring connector Between cavity A and D. CRUISE ON switch pushed	1.2K ± 250 ohms.	If resistance is incorrect replace the ON/OFF switch.
Clock spring connector Between cavity A and D. CRUISE OFF switch pushed	<2 ohms.	If resistance is incorrect replace the ON/OFF switch.
If all resistances are within the specified range the switches are functioning properly.		

5.3. Diagnostic Trouble Codes

Refer to the Diagnostic Trouble Code Index (S08327) or the Master Service Manual for a list of Body Controller Diagnostic Trouble Codes.

5.3.1. Displaying Diagnostic Trouble Codes

Refer to Displaying Diagnostic Trouble Codes.

Differential Lock

1. Description and operation

This feature locks the drive axle differential, which transmits power equally to each of the drive wheels on the axle equipped with a differential lock.

This feature includes the following vehicle configurations:

Feature Code	Models	Feature Description
0595ACU	ProStar, RXT, CXT, 3200, 4000 series, 7000 series, 8000 series	This feature offers control of a single rear axle differential, a single rear axle differential of a tandem set, or combined control of both axle differentials of a tandem set.
0595ACT	ProStar, RXT, CXT, 3200, 4000 series, 7000 series, 8000 series	This feature offers independent control of both axles of a tandem axle set.

Vehicles with feature code **0595ACU** will be equipped with the following electrical components:

- One differential lock switch (two position latching switch with indicator)
- One differential lock air solenoid (normally closed)
- One differential locked indicator (incandescent lamp in the gauge cluster)
- One differential locked indicator switch (in the differential) that controls the indicator

Vehicles with feature code **0595ACT** will be equipped with the following electrical components:

- Two differential lock switches (two position latching switch with indicator)
- Two differential lock air solenoids (normally closed)
- Two differential locked indicators (incandescent lamps in the gauge cluster)

- Two differential locked indicator switches (one in each differential) that control the indicators

NOTE: If the vehicle is equipped with feature code **0595ACU** and the vehicle uses single control of both axles of a tandem set, the single air solenoid will be plumbed to both axles.

The operator controlled differential lock switch is located a switch pack. The switch pack location and switch assignment varies depending on the vehicle configuration. The differential lock air solenoids can be located in any air solenoid 4-pack depending on the vehicle configuration. Refer to Diamond Logic® Builder (DLB) for switch pack switch assignment and body controller air solenoid pin assignment for a particular vehicle. The differential locked indicator is located in the gauge cluster.

The switch pack switch sends a request message on the appropriate data link to the body controller to lock or unlock the differential depending on the position of the differential lock switch. The body controller provides near battery voltage to energize the differential lock air solenoid when certain conditions are met. Refer to Feature Functions for conditions. The air solenoids, within the air solenoid 4-pack, share a common ground. The differential lock switch also provides the operator with an indication of the Differential Lock feature's electrical status. Refer to Switch Indicator States for details.

Ignition voltage is supplied to one side of the differential locked indicator. The differential locked indicator switch closes when the differential is locked, which provides ground to the differential locked indicator.

2. Signal Definitions

This section connects the DLB displayed signal name to the circuit diagram. Refer to the electrical circuit diagram for specific pins. DLB displays the status on certain signals where a value of zero (0) indicates a good status.

- **Diff_Lock_Switch (0595ACU)** – Data link input from a switch pack to the body controller. DLB displays ☑ while the differential lock switch is in the upper (locked) position. The differential lock switch has a good status if this signal status is good.

- **Diff_Lock_Solenoid_Cmd (0595ACU)** – The output signal from the body controller to the differential lock air solenoid. DLB displays ☑ while the body controller is supplying voltage to the differential lock air solenoid.

- **Diff_Lock_1_Switch (0595ACT)** – Data link input from a switch pack to the body controller. DLB displays ☑ while the differential lock #1 switch is in the upper (locked) position. The differential lock #1 switch has a good status if this signal status is good.

- **Diff_Lock_2_Switch (0595ACT)** – Data link input from a switch pack to the body controller. DLB displays ☑ while the differential lock #2 switch is in the upper (locked) position. The differential lock #2 switch has a good status if this signal status is good.

- **Diff_Lock_1_Solenoid_Cmd (0595ACT)** – The output signal from the body controller to the differential lock air solenoid #1. DLB displays ☑ while the body controller is supplying voltage to the differential lock air solenoid #1.

- **Differential_Lock_Solenoid_2 (0595ACT)** – The output signal from the body controller to the differential lock air solenoid #2. DLB displays ☑ while the body controller is supplying voltage to the differential lock air solenoid #2.

- **Vehicle_Speed** – The vehicle speed has a good status if this signal status is good.

Solenoid Status: The differential lock air solenoid has a bad status if any of the following conditions are true:

- An over current condition exists on the output of the body controller that controls the air solenoid.
- OR an over current condition was present on the output of the body controller that controls the air solenoid this key cycle.

View the applicable diagnostic trouble code related to the air solenoid output.

3. Programmable Parameters

Name: **Max_Diff_Lock_Speed (ID: 2388)**
Description: The differential will be unlocked automatically when the vehicle speed reaches or exceeds this programmed value.
Access Level: Fleets
Minimum: 3 mph
Maximum: 25 mph
Interval: 1 mph
Default Value: 25 mph

Name: **Diff_Lock_Engmt_Speed (ID: 2386)**
Description: The maximum vehicle speed at which the Differential may be locked.
Access Level: Fleets
Minimum: 3 mph
Maximum: 25 mph
Interval: 1 mph
Default Value: 20 mph

4. Feature Functions

4.1. Differential Control

4.1.1. Lock Differential

The body controller will control the air solenoid to lock the differential when the differential lock switch is moved to the upper (locked) position ***after*** all of the following conditions are true:

- The vehicle speed is less than the programmed **Diff_Lock_Engmt_Speed** value.
- AND the vehicle speed is less than the programmed **Max_Diff_Lock_Speed** value.
- AND the vehicle speed status is good.
- AND the key switch is in the IGNITION position.
- AND the differential lock switch has a good status.
- AND the air solenoid has a good status.

When the body controller commands the Lock Differential operation the air solenoid will be energized. If the solenoid is energized the solenoid is open (supplying air).

4.1.2. Unlock Differential

The body controller will control the air solenoid to unlock the differential when any of the following conditions are true:

- The differential lock switch is in the lower (unlocked) position
- OR the vehicle speed is greater than or equal to the programmed **Max_Diff_Lock_Speed** value.
- OR the vehicle speed has a bad status.
- OR the key switch is not in the IGNITION position.
- OR the differential lock switch has a bad status.
- OR the air solenoid has a bad status.

When the body controller commands the Unlock Differential operation the air solenoid will be de-energized. If the solenoid is de-energized the solenoid is closed (exhausting air), therefore the system is de-pressurized.

5. Switch Indicator States

On-Solid – This state indicates the differential has been locked. The differential lock switch indicator light will ***illuminate continuously*** when:

- The differential lock switch is in the upper (locked) position
- AND the key switch is in the IGNITION position.
- AND the conditions for ***fast flash*** have not been met.
- AND the body controller has controlled the air solenoid to lock the differential (the air solenoid is energized). Refer to Lock Differential for conditions.

Flash Slow – This state indicates the conditions are not appropriate to lock the differential. The differential lock switch indicator light will flash ***1 time per second*** when:

- The differential lock switch is in the upper (locked) position.
- AND the key switch is in the IGNITION position.
- AND the conditions for ***fast flash*** have not been met.
- AND the body controller has controlled the air solenoid to unlock the differential (the air solenoid is de-energized). Refer to Unlock Differential for conditions.

Flash Fast - This state is an indication of an error condition. The differential lock switch indicator light will flash ***2 times per second*** when any of the following conditions are true while the differential lock switch is in the upper (locked) position and the key switch is in the IGNITION position:

- The differential lock switch has a bad status.
- OR the air solenoid has a bad status.
- OR an open circuit condition was present on the output that controls the air solenoid when the differential lock switch was moved to the upper (locked) position. View the applicable diagnostic trouble code related to the air solenoid output
- OR the vehicle speed has a bad status.

6. Audible Alarm

An audible alarm will sound if conditions are not appropriate to lock the differential. The gauge cluster will generate ***5 Short Beeps*** when all of the following conditions are true:

- The differential lock switch is in the upper (Locked) position
- AND the key switch is in the IGNITION position.
- AND the differential is locked
- AND the vehicle speed is greater than or equal to the programmed **Max_Diff_Lock_Speed**

NOTE: This alarm will only sound once per key cycle when all the above conditions are true.

7. Additional Information

Differential Lock will not engage if the differential lock switch is moved to the locked (upper) position and the vehicle speed is greater than or equal to either of the following parameters: **Diff_Lock_Engmt_Speed, Max_Diff_Lock_Speed**. It will disengage automatically when the vehicle speed meets or exceeds the programmed **Max_Diff_Lock_Speed** value.

If the differential is already locked and the vehicle speed accelerates beyond the programmed **Max_Diff_Lock_Speed** the body controller will command the differential to unlock automatically. This will occur even when the switch is in the locked (upper) position; however, the switch indicator will continuously ***flash slow*** until the switch is moved to the unlocked (lower) position to indicate that conditions are not appropriate for the differential to be locked. ***5 short beeps*** will also sound from the gauge cluster as an audible indication.

If the vehicle decelerates to a speed less than or equal to the programmed **Max_Diff_Lock_Speed** the differential will remain unlocked and the indicator will continue to ***flash slow*** until the differential lock switch is turned off and back on again. The differential lock switch indicator will continuously ***flash fast*** if there are any related errors and the ignition power is on.

8. Differential Lock Preliminary Check

NOTE: Ensure there is air pressure to the air solenoid 4-pack, there are no air line restrictions to the air powered feature, and the air powered feature is mechanically sound and adjusted properly before performing diagnostic checks on the electrical system.

9. Diagnostics

It is strongly recommended that DLB is used along with this information to enhance diagnostic capabilities. See the diagnostic software manual for details on using the software.

9.1. Diagnostic Trouble Codes

Refer to the Diagnostic Trouble Code Index (S08327) or the Master Service Manual for a list of Body Controller Diagnostic Trouble Codes.

9.1.1. Displaying Diagnostic Trouble Codes

Refer to the Displaying Diagnostic Trouble Codes.

Fifth Wheel Slide (Feature Code 0595ACY)

1. Description and operation

The 5th Wheel Slide allows the operator to unlock the 5th wheel and adjust its position forward or backward.

This feature consists of the following additional electrical components:

- 5th wheel slide switch (2 position momentary switch with indicator)
- 5th wheel slide air solenoid (normally closed)

The 5th wheel slide switch is located in a switch pack. The switch pack location and switch assignment varies depending on the vehicle configuration. The 5th wheel slide air solenoid can be located in any air solenoid 4-pack depending on the vehicle configuration. Refer to Diamond Logic® Builder (DLB) for switch pack switch assignment and body controller air solenoid pin assignment for a particular vehicle.

The switch pack switch sends a request message on the appropriate data link to the body controller to lock or unlock the 5th wheel slide depending on the position of the switch. The body controller provides near battery voltage to energize the 5th wheel slide air solenoid when certain conditions are met. Refer to Feature Functions for conditions. The air solenoids, within the air solenoid 4-pack, share a common ground. The 5th wheel slide switch also provides the operator with an indication of the 5th wheel slide feature's electrical status. Refer to Switch Indicator States for more information.

2. Signal Definitions

This section connects the DLB displayed signal name to the circuit diagram. Refer to the electrical circuit diagram for specific pins. DLB displays the status on certain signals where a value of zero (0) indicates a good status.

- **Fifth_Wheel_Slide_Switch** – Data link input from a switch pack to the body controller. DLB displays ☑ while the fifth wheel slide switch is in the up (slide) position. The 5th wheel slide switch has a good status if this signal status is good.

- **Fifth_Wheel_Slide_Cmd** – The output signal from the body controller to the 5th wheel slide air solenoid. DLB displays ☑ while the body controller is supplying voltage to the 5th wheel slide air solenoid.

- **Vehicle_Speed** – The vehicle speed has a good status if this signal status is good.

Solenoid Status: The 5th wheel slide air solenoid has a bad status if any of the following conditions are true:

- An over current condition exists on the output of the body controller that controls the air solenoid.
- OR an over current condition was present on the output of the body controller that controls the air solenoid this key cycle.

View the applicable diagnostic trouble code related to the air solenoid output.

3. Programmable Parameters

Name: **Fifth_Wheel_Slide_Max_Speed (ID: 1336)**
Description: This parameter sets the maximum vehicle speed that the 5th wheel slide can be unlocked. The 5th wheel slide will be locked automatically when the vehicle speed exceeds this programmed value.
Access Level: Dealer
Minimum: 0 mph
Maximum: 10 mph
Interval: 1 mph
Default Value: 2 mph.

4. Feature Functions

4.1. 5th Wheel Slide Control

4.1.1. Unlock 5th Wheel Slide

The body controller will control the air solenoid to unlock the 5th wheel slide if the following conditions are true:

- The 5th wheel slide switch is moved to the up (slide) position
- AND the key switch is in the IGNITION position.
- AND the vehicle speed is less than or equal to the programmed **Fifth_Wheel_Slide_Max_Speed**
- AND the vehicle speed has a good status
- AND the 5th wheel slide switch has a good status
- AND the 5th wheel slide air solenoid has a good status

When the body controller commands the Unlock 5th Wheel slide operation the air solenoid will be energized. If the solenoid is energized the solenoid is open (supplying air).

4.1.2. Lock 5th Wheel Slide

The body controller will control the air solenoid to lock the 5th wheel slide if any of the following conditions are true:

- The 5th wheel slide switch is in the down (locked) position
- OR the key switch is in the ACCESSORY position.
- OR the key switch is in the OFF position.
- OR the vehicle speed is greater than the programmed **Fifth_Wheel_Slide_Max_Speed**
- OR the vehicle speed has a bad status
- OR the 5th wheel slide switch has a bad status
- OR the 5th wheel slide air solenoid has a bad status

When the body controller commands the Lock 5th Wheel slide operation the air solenoid will be de-energized. If the solenoid is de-energized the solenoid is closed (exhausting air), therefore the system is de-pressurized.

5. Switch Indicator States

On-Solid – This state indicates the 5th wheel slide has been unlocked. The 5th wheel slide switch indicator light will ***illuminate continuously*** if the body controller has controlled the air solenoid to unlock the 5th wheel slide (the air solenoid is energized). Refer to Unlock 5th Wheel Slide for conditions.

Flash Slow – This state indicates the conditions are not appropriate for the 5th wheel slide to be unlocked. The 5th wheel slide switch indicator light will flash ***1 time per second*** if the following conditions are true:

- The 5th wheel slide switch is in the up (slide) position.
- AND the body controller has controlled the air solenoid to lock the 5th wheel slide (the air solenoid has been de-energized). Refer to Lock 5th Wheel Slide for conditions.
- AND the conditions for ***flash fast*** have not been met.
- AND the key switch is In the IGNITION position.

Flash Fast - This state is an indication of an error condition. The 5th wheel slide switch indicator light will flash ***2 times per second*** when any of the following conditions are true while the 5th wheel slide switch is in the up (slide) position and the key switch is in the IGNITION position:

- The 5th wheel slide switch has a bad status.
- OR the 5th wheel slide air solenoid has a bad status.
- OR an open circuit condition was present on the output of the body controller that controls the 5th wheel slide air solenoid when the 5th wheel slide switch was moved to the up (slide) position. View the applicable diagnostic trouble code related to the air solenoid output.
- OR the vehicle speed status is bad

6. 5th Wheel Slide Preliminary Check

NOTE: Ensure there is air pressure to the air solenoid 4-pack, there are no air line restrictions to the air powered feature, and the air powered feature is mechanically sound and adjusted properly before performing diagnostic checks on the electrical system.

7. Diagnostics

It is strongly recommended that DLB is used along with this information to enhance diagnostic capabilities. See the diagnostic software manual for details on using the software.

7.1. Diagnostic Trouble Codes

Refer to the Diagnostic Trouble Code Index (S08327) or the Master Service Manual for a list of Body Controller Diagnostic Trouble Codes.

7.1.1. Displaying Diagnostic Trouble Codes

Refer to the Displaying Diagnostic Trouble Codes.

Fuel Transfer Pump System

1. Description and operation

Vehicles with two fuel tanks are equipped with an electric fuel transfer pump to balance the fuel between both tanks. The draw tank supplies fuel directly to the engine. This feature automatically transfers fuel from the storage tank to the draw tank to bring the tanks to approximately the same fuel level. However, certain conditions must be met before the transfer of fuel can occur. These conditions are described in the Feature Functions section.

NOTE: The system does not allow fuel to be transferred from the draw tank to the storage tank.

This feature includes the following configurations:

- 0595ABE (Left Draw)
- 0595AXY (Right Draw)

This feature consists of the following additional electrical components:

- 2 Fuel level Sensors (draw tank sensor and storage tank sensor)
- Fuel Transfer Pump Relay
- Fuel Transfer Pump (2-wire)

The fuel level sensors are located on the top of each of the fuel tanks. The draw tank and storage tank can be located on either the right side or the left (driver) side of the vehicle depending on the vehicle configuration. The following table indicates the draw tank and storage tank locations for various truck models.

Models	Draw Tank	Storage Tank	Pump Location
4100	Right Side	Left Side	Right Rail
4200/4300/4400/8500	Right Side	Left Side	Right Rail
7000 series/8600/ProStar	Left Side	Right Side	Transmission Housing

The fuel level sensor signals are monitored by the body controller. Both sensors are connected to zero volt reference (ZVR), which is provided by the body controller.

The body controller provides near battery voltage to energize the fuel transfer pump relay coil when conditions are appropriate to transfer fuel (described below). Battery voltage is then provided through the fuel transfer pump relay switch contacts to the fuel transfer pump.

The **Fuel_Sensor1_Signal** (draw tank fuel level sensor signal) and **Fuel_Sensor2_Signal** (storage tank fuel level sensor signal) are the actual fuel level sensor readings displayed on Diamond Logic® Builder (DLB). These readings will change quickly as fuel is added or removed from the fuel tanks.

The body controller monitors the fuel levels in both tanks and conditions the readings from **Fuel_Sensor1_Signal** and **Fuel_Sensor2_Signal** over time to account for sloshing fuel and to ensure that the draw tank is not overfilled and the supply tank is not emptied. The body controller will not begin to condition these values until the engine is running. The body controller does not activate the transfer pump based on the Fuel Level Sensor signals. The conditioned fuel level sensor signals, **Fuel_Draw_Level** and **Fuel_Storage_Level**, are monitored by the body controller to determine whether or not the fuel transfer pump should be activated. This eliminates the need for the body controller to react to instant changes in the sensor signal values.

2. Feature Functions

2.1. Fuel Transfer Pump On

The body controller will turn on the fuel transfer pump (if pump is off) when all of the conditions below are true.

- The **Fuel_Draw_Level** value – 6% is less than 80% Full
- AND the **Fuel_Storage_Level** value + 6% is greater than 10% Full
- AND the **Fuel_Draw_Level** value + 6% is less than the **Fuel_Storage_Level** value
- AND the engine is running
- AND DLB indicates that the body controller **Engine_State** has a good status.
- AND the body controller is communicating properly with the engine control module
- AND there are no active diagnostic trouble codes on either of the fuel level sensor signal circuits.

Fuel is transferred from the fuel storage tank to the draw tank when the body controller turns on the fuel transfer pump.

2.2. Fuel Transfer Pump Off

The body controller will turn off the fuel transfer pump when any of the conditions below are true.

- The **Fuel_Draw_Level** value – 6% is greater than or equal to the **Fuel_Storage_Level** value
- OR the **Fuel_Draw_Level** value – 6% is greater than or equal to 80% Full
- OR the **Fuel_Storage_Level** value + 6% is less than or equal to 10% Full
- OR the engine is not running
- OR DLB indicates that the body controller **Engine_State** has a bad status.
- OR the body controller is not communicating properly with the engine control module
- OR an active diagnostic trouble code exists on one or more of the fuel level sensor signal circuits

Fuel will no longer be transferred from the fuel storage tank to the draw tank when the body controller turns off the fuel transfer pump.

3. Additional Information

The following table is an example of the signal conditions displayed on DLB during transfer pump operation. ***For pump to turn on:***

Signal	**Condition**
Fuel_Draw_Level	(Fuel_Draw_Level – 6%) < 80%
Fuel_Storage_Level	Fuel_Storage_Level + 6%) > 10%
Fuel_Draw_Level, Fuel_Storage_Level	(Fuel_Draw_Level + 6%) < Fuel_Storage_Level
Fuel_Transfer_Pump_Req	☑ = Turn Pump ON
Engine_Running	☑ = Engine Running

4. Fuel Transfer Pump Replacement

When replacing fuel transfer pump ensure that the new pump is installed with the same orientation as the old pump. It is possible to install the pump backwards.

5. Diagnostics

It is strongly recommended that DLB is used along with this information to enhance diagnostic capabilities. See the diagnostic software manual for details on using the software.

Resistance across each of the fuel level sensors should be 29-37 ohms when tank is full and 234-246 ohms when tank is empty. The fuel sensor signal values, **Fuel_Sensor1_Signal** and **Fuel_Sensor2_Signal**, can be compared to the actual fuel level on each of the fuel tanks using DLB.

WARNING – Do not allow the transfer pump to run if the draw tank has a fuel level above 80%. Failure to heed this warning could result in overfilling the draw tank, spilling fuel, and causing a hazardous waste spill or a fire hazard. WARNING – To avoid property damage, personal injury, or death, park the vehicle on a flat level surface, set the parking brake, and place the vehicle's transmission in neutral prior to beginning diagnostics and/or starting the engine.

CAUTION – Do not allow the transfer pump to run if the storage tank has a fuel level below 10%. Failure to heed this caution could result in running the transfer pump without fuel and causing damage to the pump.

5.1. Diagnostic Trouble Codes

Refer to the Diagnostic Trouble Code Index (S08327) or the Master Service Manual for a list of Body Controller Diagnostic Trouble Codes.

5.1.1. Displaying Diagnostic Trouble Codes

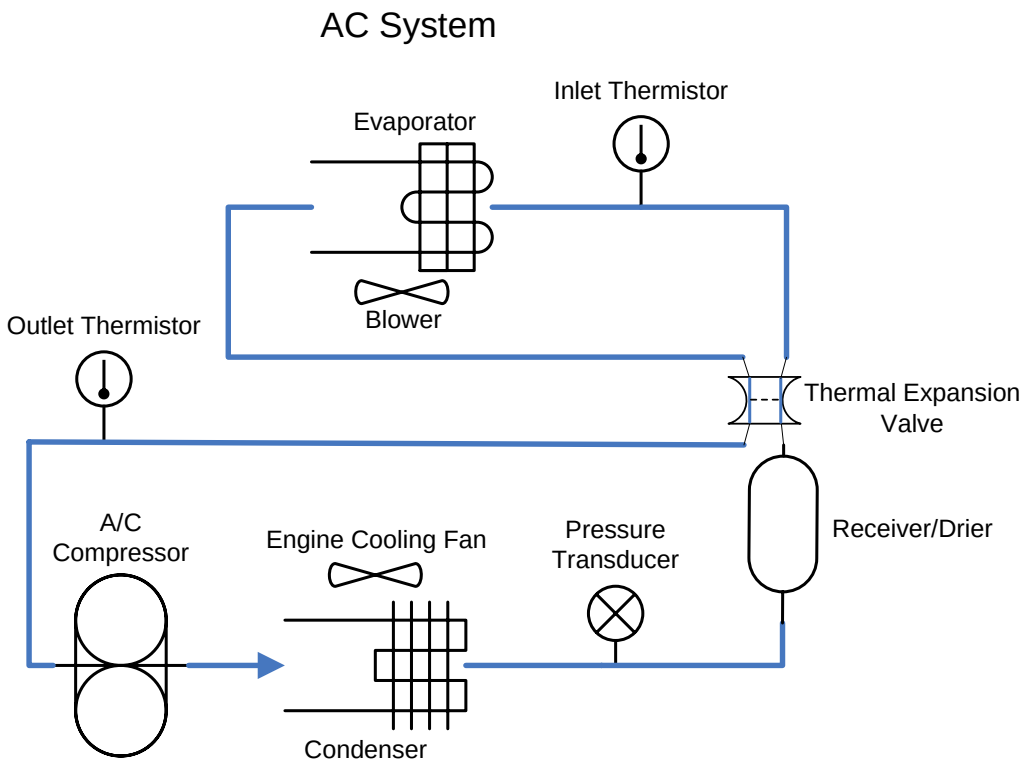
Refer to Displaying Diagnostic Trouble Codes.

HVAC

1. Description and operation

The following information describes the operation of the HVAC electrical system. Refer to the HVAC Manual (S16034) or HVAC Manual (S16039) for a complete description of the HVAC mechanical system.

The following diagram illustrates an overview of the AC system, excluding electronic controls. Please refer to the circuit diagram manual for a complete illustration of the HVAC electrical system.



Be sure to perform the Diagnosis and Troubleshooting Flow Chart in the HVAC Manual (S16034) or HVAC Manual (S16039) (and any referenced procedures) prior to performing tests on the electrical system!

This feature includes the following vehicle configurations:

Feature Code	Models	Feature Description
0595ADL	ProStar, RXT, CXT, 3200, 4000 series, 7000 series, 8000 series	***Front (Cab control) HVAC***.
0595AYH	ProStar, CXT, 4000 series, 7000 series, 8000 series	***Variable Speed Engine Cooling Fan Control***
0595BAB	ProStar	***Variable Speed Engine Cooling Fan Control***

Vehicles with feature code **0595ADL** will be equipped with the following electrical components:

- ***HVAC control head*** located in the center section of the instrument panel.
- ***Linear power module (LPM)*** mounted to the blower scroll housing (part of the heater unit), located in the cab under the right side of the instrument panel.
- ***Mode actuator*** located on heater housing under instrument panel.
- ***Temperature actuator*** located on cab blower housing.
- ***Recirculation actuator located*** on or near the dash mounted evaporator housing on the engine side of the dash panel.
- ***HVAC blower motor*** located in the blower scroll housing (part of the heater unit), mounted in the cab under the right side of the instrument panel.
- ***A/C Pressure transducer*** located on the condenser-to-evaporator refrigerant line.
- ***A/C Clutch*** located on the front of the compressor in the engine compartment.
- ***Evaporator inlet thermistor*** located at the inlet of the evaporator housing on the engine side of the dash panel.
- ***Evaporator outlet thermistor*** located at the outlet of the evaporator housing on the engine side of the dash panel.

1.1. HVAC Electrical System

All major functions of the A/C-heater system are controlled from the HVAC control head. The HVAC control head consists of three knobs connected to potentiometers which electronically control the blower fan speed, the A/C compressor clutch, and the actuators that move the air doors used to control system air distribution and temperature.

The HVAC control head has a direct digital fault communication circuit to the body controller which will tell the body controller to log diagnostic trouble codes for conditions monitored by the control head, such as the operation of the air door actuator motors. The

control head also communicates with the body controller to request compressor turn on (for AC and defrost operation).

The blower speed control has seven detents to provide seven distinct blower speeds. The temperature control has fifteen detents. The mode control is used to select the HVAC operating mode, indicated by the seven mode icons (five mode icons on the 'heat only' system).

NOTE: The following information covers the 'heater/air conditioner' version of the system; the 'heater only' system is nearly identical, except all air conditioning information can be ignored.

The body controller contains the circuitry and the program that controls the cycling of the air conditioner compressor. In general, the body controller monitors the refrigerant sensors (pressure transducer and thermistors) and other system parameters to determine if all parameters are within acceptable limits. If parameters are acceptable, the body controller will turn on the compressor when requested by the control head, and will cycle the compressor to keep the system within acceptable operating parameters.

If the body controller detects readings outside of the acceptable ranges, it will generate and log a diagnostic trouble code. If the body controller determines that continued operation would be destructive, it shuts down the A/C system by preventing the compressor from turning on.

1.2. HVAC Control Head Diagnostics

This section was intended for use with the appropriate circuit diagram manual.

HVAC Control Head Circuit Troubleshooting

Review the General Diagnostic Information section prior to performing the following electrical tests.

Perform the following tests with the harness connector of the HVAC control head disconnected and the key switch in the IGNITION ON position.

Perform tests at the harness connector of the HVAC control head.

Voltage Test

With multi-meter connected between the ignition voltage circuit (A1) of the harness connector and the ground circuit (B6) of the harness connector the meter should read 12 ± 1.5 volts with the key switch in the IGNITION ON position (the engine does not need to be running).

The voltage specified above is provided by the interior power distribution center.

If the specified voltage is not present, correct the condition. ***If the specified voltage is present, proceed***

to the next test.

Voltage Test (Continued)

With multi-meter connected between the battery voltage circuit (A2) of the harness connector and the ground circuit (B6) of the harness connector the meter should read 12 ± 1.5 volts.

The voltage specified above is provided by the interior power distribution center.

If the specified voltage is not present, correct the condition. ***If the specified voltage is present, proceed to the next test.***

Instrument Panel Dimmer Circuit Test

Turn ON the headlamp switch.

With multi-meter connected between the instrument panel dimmer circuit (A12) of the harness connector and the ground circuit (B6) of the harness connector the meter should read between approximately 2 and 12 volts adjustable with the PANEL dimmer control.

The voltage specified above is provided by the gauge cluster.

If the specified voltage is not present, correct the condition. ***If the specified voltage is present, proceed to the next test.***

Diagnostic Circuit Test

Review the **RCD_HVAC_Ctrl_Head_Diag_Signal** description in the Signal Definitions section prior to performing this test.

With multi-meter connected between the diagnostic circuit (A9) of the harness connector and the ground circuit (B6) of the harness connector the meter should read 11 ± 1.5 volts.

The voltage specified above is provided by the body controller.

If the specified voltage is not present, correct the condition. ***If the specified voltage is present, proceed to the next test.***

A/C Request Circuit Test

Review the **A/C_Request** description in the Signal Definitions section prior to performing this test.

With multi-meter connected between the A/C request circuit (A4) of the harness connector and the ground circuit (B6) of the harness connector the meter should read 11 ± 1.5 volts.

The voltage specified above is provided by the body controller.

If the specified voltage is not present, correct the condition. ***If the specified voltage is present, proceed***

to the next test.

HVAC Control Head Circuit Troubleshooting (Continued)

Test with HVAC control head connector reconnected and the engine running at idle.

A/C Request Circuit Test (Continued)

Review the **A/C_Request** description in the Signal Definitions section prior to performing this test.

- Set blower speed to any position other than OFF.
- Set temperature control fully counter-clockwise.
- Monitor the ***AC_Request*** signal using DLB to ensure that the body controller is receiving the signal from the HVAC control head.
- The ***AC_Request*** signal should display ☑ while any AC or defrost mode is selected on the HVAC control head.

With multi-meter connected between the A/C request circuit (A4) of the harness connector and the ground circuit (B6) of the harness connector the meter should read <0.8 volts before the *AC_Request* signal will indicate 'active'.

- Set blower speed to OFF.
- The ***AC_Request*** signal should display ☐ while the A/C is not being requested.

With multi-meter connected between the A/C request circuit (A4) of the harness connector and the ground circuit (B6) of the harness connector the meter should read >4.0 volts before the *AC_Request* signal will indicate 'not active'.

Correct any invalid conditions found during this test.

2. Signal Definitions

This section connects the DLB displayed signal name to the circuit diagram. Refer to the electrical circuit diagram for specific pins. DLB displays the status on certain signals where a value of zero (0) indicates a good status.

NOTE: The body controller conditions certain signals to eliminate sudden changes in the electrical system. The body controller does this by reacting to the conditioned signals instead of

the raw signals. For example, conditioning certain signals prevents the A/C clutch from cycling on and off rapidly.

- ***BC_RCD_Pressure_Signal*** – Analog input signal from the A/C pressure transducer to the body controller. This signal is conditioned from the raw A/C pressure transducer signal and represents the system high side pressure in pounds per square inch. The pressure is measured on the output side of the condenser before the thermal expansion valve.

- ***BC_RCD_Temp_In_Signal –*** Analog input signal from the inlet thermistor to the body controller. This signal is conditioned from the raw inlet thermistor signal and represents the temperature of the refrigerant on the input side of the evaporator in degrees Fahrenheit.

- ***BC_RCD_Temp_Out_Signal –*** Analog Input signal from the outlet thermistor to the body controller. This signal is conditioned from the raw outlet thermistor signal and represents the temperature of the refrigerant on the output side of the evaporator in degrees Fahrenheit.

- ***RCD_HVAC_Ctrl_Head_Diag_Signal –*** Digital diagnostic input signal from the HVAC control head to the body controller. The diagnostic circuit between the HVAC control head and the body controller is pulled up (biased) to near 12V inside the body controller. The HVAC control head pulls this voltage to ground at intervals to communicate diagnostic information to the body controller.

  The symbol ☑ displayed on DLB will blink at different rates depending on the diagnostic status of the HVAC control head.

  Use the HVAC_Diagnostic_Value signal (described below) to understand the diagnostic status of the HVAC control head.

- ***HVAC_Diagnostic_Value*** – Internal signal used by the body controller to indicate various fault conditions. This signal is determined by the frequency of the ***RCD_HVAC_Ctrl_Head_Diag_Signal.*** Some fault conditions cause the body controller to log a fault and disable the A/C system. Lesser faults cause the body controller to log a fault, but allow the A/C system to continue to operate. DLB displays the following values:

  - (0) = No faults.
  - (1) = Air Inlet Fault (Re-circulation Door Fault).
  - (2) = Temp Mix Fault.
  - (3) = Mode Fault.
  - (4) = Multiple Faults (A/C clutch is disabled).
  - (5) = Control Head Fault (A/C clutch is disabled).

- ***AC_Request –*** Digital input signal from the HVAC control head to the body controller. The A/C request circuit between the HVAC control head and the body controller is pulled up (biased) to near 12V inside the body controller. The HVAC control head pulls this voltage to ground when an A/C or defrost mode is selected and the blower speed control is NOT set to OFF.

The A/C request circuit must be <0.8Vdc before this signal will indicate 'active' and >4.0Vdc before the signal will indicate 'not active'. DLB displays ☑ while the air conditioning or the defroster is being requested "on" by the vehicle operator. This normally indicates that an A/C or defrost mode is selected and the blower speed control is set to a position other than OFF.

- ***BC_RCD_AC_Comp_Clutch_Req –*** Internal output signal used by the body controller to engage or disengage AC compressor clutch. The symbol ☑ displayed on DLB indicates the body controller has determined that the AC compressor clutch should be engaged.

- ***AC_Clutch –*** Output signal from the body controller to the A/C clutch. DLB displays ☑ while the body controller supplies voltage to the A/C clutch.

- ***BC_RCD_AC_Comp_Clutch_Current_Signal –*** A/C clutch current in amps. With the engine running and the battery voltage at 13.5 volts, the A/C clutch should pull approximately 4 amps of current.

- ***Fan_Ovrd_Request* (0595ACW) –** Internal output signal from the manual fan override feature to the engine cooling fan request feature. **This signal is controlled by the manual fan override switch (if equipped).** This switch overrides the current requested percent fan speed. DLB displays a value of (1) to indicate that the body controller is requesting the current fan speed request to be overridden. The ***Requested_Percent_Fan_Speed*** will indicate a value of 100% when the value of the ***Fan_Ovrd_Request*** signal is equal to (1), regardless of variable speed fan conditions.

- ***Engine_Fan_Request –*** Advanced ladder logic output signal used to turn on the engine cooling fan at 100% (if configured). DLB displays a value of (1) to indicate that the body controller is requesting the current fan speed request to be overridden. The ***Requested_Percent_Fan_Speed*** will indicate a value of 100% when the value of the ***Engine_Fan_Request*** signal is equal to (1), regardless of variable speed fan conditions.

- ***Requested_Percent_Fan_Speed –*** SAE J1939 output signal from the body controller to the ECM. The body controller sends a request between 0 and 100% to the engine (ECM) depending on system conditions. Refer to Engine Cooling Fan Control for a list of conditions.

- ***Engine_Speed*** – SAE J1939 input signal from the ECM to the body controller. This information is monitored by the body controller to establish one of the conditions required for activation of the A/C compressor clutch.

- ***Vehicle_Speed*** – SAE J1939 input signal from the ECM to the body controller. The body controller uses this information, in conjunction with the high side pressure information, to determine if a fault should be logged for excessive high side pressure. This fault would cause the body controller to disable the A/C compressor clutch, preventing A/C system operation.

- ***Ambient_Air_Temperature*** – SAE J1939 input signal from the gauge cluster to the body controller. This signal represents the outside air temperature that is reported by the gauge cluster. The HVAC system uses this signal to assist in low pressure diagnostics.

3. Programmable Parameters

Name: **BC_RCD_Temp_Out_Compressor_Off (ID: 1942)**
Description: The body controller disengages the AC compressor clutch once the outlet temperature **(BC_RCD_Temp_Out_Signal)** falls below this value AND 7 seconds have elapsed since the compressor was engaged.
Access Level: Fleets
Minimum: 0 F
Maximum: 240 F
Interval: 1 F
Default Value: 24 F

Name: **RCD_AC_Comp_Clutch_Hi_Current (ID: 1893)**
Description: RCD Air Conditioning Compressor Clutch High Current Detection Level (Amps).
Access Level: Fleets
Minimum: 0 A
Maximum: 10 A
Interval: 0.1 A
Default Value: 10 A

Name: **RCD_AC_Comp_Clutch_Lo_Current (ID: 1892)**
Description: RCD Air Conditioning Compressor Clutch Low Current Detection Level (Amps).
Access Level: Fleets
Minimum: 0 A
Maximum: 10 A
Interval: 0.1 A
Default Value: 0.5 A

Name: **RCD_AC_Comp_Clutch_OC_Current (ID: 1894)**
Description: RCD Air Conditioning Compressor Clutch Open Circuit Detection Level (Amps).
Access Level: Fleets
Minimum: 0 A
Maximum: 10 A
Interval: 0.1 A
Default Value: 0.5 A

4. Feature Functions

4.1. HVAC Functions

4.1.1. Refrigerant Control and Diagnostics

The body controller performs the following functions to control the A/C compressor.

- Verifies that safe operating conditions exist before the compressor clutch is energized.
- Keeps the A/C system operating within its optimum range by controlling the cycling of the refrigerant compressor.
- Detects faults or abnormal conditions within the A/C system.

- Protects the A/C compressor by deactivating the compressor when destructive conditions are detected.
- Generates diagnostic trouble codes that may be used to diagnose and isolate problems in the system.

To do this the body controller monitors several input signals from the A/C system and its environment. Refer to the Signal Definitions section for more information.

When certain nondestructive conditions are detected, the body controller will allow the A/C system to continue operating while it generates diagnostic trouble codes. If destructive conditions are detected, in addition to generating diagnostic trouble codes, the body controller will protect the compressor by commanding the compressor off, shutting down the A/C system.

4.1.2. Refrigerant Charge Diagnostics

The body controller protects the A/C system by monitoring the system sensors and indicating when the refrigerant level is low before all cooling ability is lost. The body controller diagnoses refrigerant charge problems, and determines the severity of these problems.

When the A/C compressor is on, the temperature difference between the evaporator inlet refrigerant (inlet thermistor) and the evaporator outlet refrigerant (outlet thermistor) is used to help determine the condition of the system refrigerant charge. In addition to the temperature differential, the body controller considers the heat load and time to calculate the charge level. Refer to Values for Refrigerant Charge Diagnostics for more information.

The following descriptions assume that the compressor is running and the cab temperature has stabilized.

With a fully charged system the temperature difference between the evaporator inlet refrigerant (inlet thermistor) and the evaporator outlet refrigerant (outlet thermistor) is minimal (< 18°F at Extreme operating temperatures). Depending on the heat load, the evaporator inlet refrigerant temperature will be slightly lower or higher than the evaporator outlet refrigerant temperature.

With an A/C system that is less than fully charged, the evaporator inlet refrigerant temperature will be much lower than the evaporator outlet refrigerant temperature. This is because there is an insufficient amount of refrigerant moving through the evaporator to absorb any more heat. The body controller determines the level of system charge by this difference in temperature, also known as temperature differential. The temperature differential increases as the system charge level decreases.

The body controller will de-energize the A/C compressor clutch and set either a 'SERVICE NOW low charge' fault or a 'SERVICE NOW very low charge' fault if it determines that the charge level is too low for safe compressor operation. The

body controller will continue to inhibit A/C compressor operation until the problem is corrected and the fault is cleared.

4.1.3. Values for Refrigerant Charge Diagnostics

Operating Condition	Outlet temperature thermistor signal (BC_RCD_Temp_Out_Signal)	Fault Detection Thresholds (Temperature Differential between Outlet Thermistor and Inlet Thermistor)	
		dT Low Charge (30 minutes)	dT Very Low Charge (15 minutes)
Extreme	>65°F	>35°	>50°
Normal	55° — 65°F	>20°	
Cold	<55°F	>15°	

IMPORTANT–The temperature differences in the table above must be maintained for the specified time periods before a fault code will be set.

Examples:

- Under “Extreme” operating temperatures, a low charge fault will be set if the temperature difference is in the “Low Charge” range **(> 35°F, but < 50°F)** for more than 30 minutes.
- Under “Extreme” operating temperatures, a very low charge fault will be set if the temperature difference is in the “Very Low Charge” range **(> 50°F)** for more than 15 minutes.

4.1.4. System Pressure Diagnostics

The body controller also protects the A/C system from excessive pressure by monitoring the A/C pressure transducer and other operating conditions. Under certain conditions the body controller will cycle the A/C system off without setting a fault. This allows temporary high pressure conditions to occur without disabling the A/C system. When high pressure conditions are determined to be unsafe for A/C compressor operation, the body controller will set an ’excessive pressure’ fault. The body controller will inhibit A/C compressor operation until the problem is fixed and the fault is cleared.

If the A/C pressure transducer **(BC_RCD_Pressure_Signal)** indicates a high side pressure greater than 420 psig, the body controller will de-energize the A/C compressor for at least 8 seconds. If the vehicle speed is less than 20 mph, the body controller will not set a fault. However, the body controller will prevent the

compressor from turning on until the high side pressure drops to less than 250 psig **AND** the compressor has been off for at least 8 seconds.

If this cycle repeats a number of times, the body controller will disable the A/C compressor clutch until:

- 5 minutes have elapsed.
- **OR** the key switch is cycled.
- **OR** the A/C request is cycled.
- **OR** the vehicle speed exceeds 20 mph.

The body controller will re-energize the A/C compressor if any of the conditions above is true. If the vehicle speed remains below 20 mph, the body controller will permit this pattern (including the 5 minute rest periods) to continue without setting a fault. The body controller allows this for PTO applications.

If the vehicle speed is greater than 20 mph and the high side pressure reaches 420 psig during 3 successive clutch ON cycles, the body controller will set a 'SERVICE NOW excessive pressure' fault for a possible fan problem. The body controller will inhibit A/C compressor operation until the problem is fixed and the fault is cleared.

4.1.5. Freeze Protection

The body controller prevents operation of the compressor if too much ice has formed on the evaporator fins. The body controller does this by monitoring the temperature thermistors and the A/C pressure transducer. Ice prevents airflow through the evaporator and does not allow for the heat exchange necessary for air cooling.

4.1.6. A/C Clutch Control

When an air conditioning (or defrost) mode is selected on the HVAC control head, and the blower speed control is NOT set to OFF, the control head will send an AC Request signal **(*AC_Request*)** to the body controller. If the body controller senses that the conditions are within operating limits, it turns on the AC compressor by supplying near accessory voltage to the compressor **(AC_Clutch)**. Conditions are listed in the Engage A/C Clutch section.

The AC compressor is mounted on the engine and is belt-driven through an electromagnetic clutch which acts to engage (turn ON) or disengage (turn OFF) the compressor in response to the air conditioning system controls (HVAC control panel and body controller). When engaged, the clutch armature assembly is magnetically drawn to the pulley assembly on the compressor shaft, thereby engaging the clutch and allowing the drive belt to drive the compressor.

4.1.6.1. Engage A/C Clutch

The A/C system is activated by energizing the A/C compressor clutch. However, safe operating conditions must exist before the compressor clutch is energized.

The body controller will engage the A/C compressor clutch* (AC_Clutch) *when ALL of the following conditions are true:

- The AC request signal **(AC_Request)** is active **(See Note 1).**
- **AND** the inlet thermistor temperature **(BC_RCD_Temp_In_Signal)** is greater than or equal to 43 °F.
- **AND** the compressor has been **OFF** for at least 8 seconds.
- **AND** the A/C pressure transducer **(BC_RCD_Pressure_Signal)** is greater than 40 psig **(See Note 2).**
- **AND** the outlet thermistor temperature **(BC_RCD_Temp_Out_Signal)** is greater than 33 °F **(See Note 2).**
- **AND** the A/C pressure transducer **(BC_RCD_Pressure_Signal)** is less than 250 psig.
- **AND** there are no LOW CHARGE or VERY LOW CHARGE refrigerant faults active.
- **AND [**the HVAC control head DIAGNOSTIC signal **(See Note 3)** must be present at the body controller input, AND it must not indicate "multiple" or "control head" faults**].**
- **AND** the body controller is communicating properly with the engine control module AND the engine is running **(See Note 4).**
- **AND** there must be **NO** active faults detected in the A/C pressure transducer OR temperature thermistor circuits.
- **AND** the A/C compressor clutch virtual fusing circuit in the body controller must not be faulted. The virtual fuse circuit activates when the clutch draws more than 10 Amps (programmable), indicating a fault**.**

The body controller supplies voltage to the A/C clutch when the conditions above are true.

NOTE 1: DLB displays ☑ while the **AC_Request** signal is active. Refer to Signal Definitions for more information.

NOTE 2: The body controller verifies that the pressure is greater than 40 psig **AND** the outlet thermistor temperature is greater than 33°F to verify that the ambient temperature is high enough for safe compressor operation.

NOTE 3: Monitor the **HVAC_Diagnostic_Value** signal using DLB. A value of (4) indicates "multiple" faults are present. A value of (5) indicates a "control head" fault is present, such as a missing diagnostic signal. Refer to Signal Definitions for more information.

NOTE 4: A J1939 engine RPM signal (indicating an engine RPM of at least 300) must have been present at the body controller for at least 8 seconds. Engine RPM signals that are temporarily lost must have been returned for at least 8 seconds.

4.1.6.2. Normal A/C Operation

Once the A/C compressor is turned on and the system is operating normally, the evaporator inlet refrigerant temperature (inlet thermistor) is used to determine when to cycle the compressor off. Too low of an evaporator temperature will cause moisture condensed on the evaporator to turn to ice and block airflow through the evaporator (evaporator freeze-up). When evaporator inlet refrigerant temperature drops to 30°F **AND** the compressor has been on for more than 7 seconds, the A/C compressor clutch is de-energized (cycled off).

After the compressor has been off for at least 8 seconds, the cycle will be repeated when the evaporator inlet refrigerant temperature again reaches 43°F. Both conditions must exist before the compressor can be energized.

Therefore, under light heat load conditions, the fastest cycle rate for the compressor is 15 seconds (8 seconds off and 7 seconds on). Under high heat load conditions, the compressor may remain energized continuously until the engine or the A/C system is shut off. This is because the evaporator inlet refrigerant temperature may not drop below 30°F.

Under some light heat load conditions, the evaporator outlet refrigerant temperature may be several degrees lower than the evaporator inlet refrigerant temperature. If the outlet refrigerant temperature drops below 24°F, **AND** at least 7 seconds have elapsed since the compressor was cycled on, the body controller will de-energize the A/C compressor clutch to help prevent evaporator freeze-up.

4.1.6.3. Disengage A/C Clutch

The body controller will de-energize the A/C compressor clutch* (AC_Clutch) *if any of the following conditions is true:

- The inlet thermistor temperature **(BC_RCD_Temp_In_Signal)** is less than or equal to 30 °F *.
- **OR** the outlet thermistor temperature **(BC_RCD_Temp_Out_Signal)** is less than or equal to 24 °F *.
- **OR** the A/C pressure transducer **(BC_RCD_Pressure_Signal)** is less than 40 psig *.
- **OR** the A/C pressure transducer **(BC_RCD_Pressure_Signal)** is greater than 420 psig.
- **OR** the AC request signal **(AC_Request)** is **NOT** active **(See Note 1)** *.

- **OR**
  [The HVAC control head DIAGNOSTIC signal **(See Note 2)** is indicating "multiple" OR "control head" faults *__]__.__**__
- **OR**
  [The body controller is **NOT** communicating properly with the engine control module **OR** the engine is **NOT** running **(See Note 3)]**.
- **OR** an active fault is detected in the A/C pressure transducer circuits.
- **OR [**an active fault is detected in the temperature thermistor circuits *__]__.__**__
- **OR** the A/C compressor clutch virtual fusing circuit in the body controller has been activated. The virtual fuse circuit activates when the clutch draws more than 10 Amps (programmable), indicating a fault**.**
- **OR** an open circuit is detected on the A/C compressor clutch.
- **OR** the body controller detects a change in the inlet thermistor temperature that is less than or equal to 1F (from the moment the A/C clutch engages to 7 seconds after engagement).
- **OR** a LOW CHARGE or VERY LOW CHARGE refrigerant fault is active.

***Conditions listed with an asterisk * require that the A/C compressor clutch has been energized for at least 7 seconds.**

NOTE 1: DLB displays ☐ while the **AC_Request** signal is **NOT** active. Refer to Signal Definitions for more information.

NOTE 2: Monitor the **HVAC_Diagnostic_Value** signal using DLB. A value of 4 indicates "multiple" faults are present. A value of 5 indicates a "control head" fault is present, such as a missing diagnostic signal. Refer to Signal Definitions for more information.

NOTE 3: A J1939 engine RPM signal (indicating an engine RPM of at least 300) must have been present at the body controller for at least 8 seconds. Engine RPM signals that are temporarily lost must have been returned for at least 8 seconds.

4.1.7. A/C Compressor Diagnostics

This section was intended for use with the appropriate circuit diagram manual.

AC Compressor Power Circuit Troubleshooting

Review the General Diagnostic Information section prior to performing the following electrical tests.

CAUTION – If you attempt to energize the compressor clutch by applying voltage directly to the clutch with jumpers, It is extremely important that the polarity is correct. If a reverse polarity voltage is applied to the clutch, it could destroy a diode used to protect the body controller. This failure may not be evident, but it would

leave the body controller susceptible to damage during compressor cycling.

USE THIS CHART ONLY IF A COMPRESSOR DTC HAS BEEN LOGGED. Refer to COMPRESSOR TROUBLESHOOTING if no DTC's are being logged and the compressor will not operate.

Resolve any DTC's related to the HVAC thermistors, the A/C pressure transducer, or the HVAC control head before performing the following tests.

Test for the following conditions:

- Open or short to ground in the power circuit of the A/C clutch.
- Open or high resistance in the ground circuit of the A/C clutch.
- Faulty A/C clutch **(See Note).**

Note: Measure the resistance of the compressor clutch coil. The resistance should be within the range of 2.2 – 4.5 Ohms.

4.1.8. Engine Cooling Fan Control

The body controller will request the engine cooling fan to assist in cooling the refrigerant in the condenser. The body controller performs this function to lower the pressure in the high side of the AC system. The body controller sends the cooling fan request **(Requested_Percent_Fan_Speed)** the SAE J1939 data link.

NOTE 1: The fan can still be active due to engine needs, even if the body controller is not requesting the fan.

NOTE 2: On some models the cooling fan clutch is operated by compressed air. The air is controlled by a solenoid valve that is normally operated by the engine cooling system; however, when the A/C pressure transducer detects a high discharge pressure, the body controller sends a signal to the engine controller to engage the cooling fan drive.

NOTE 3: Vehicles equipped with viscous-drive fans are not controlled electronically and are therefore not discussed in this document.

The following information describes the operation of both ON/OFF fans and variable speed fans.

4.1.8.1. ON/OFF Fan Control

There are several cases in which the body controller will request the engine cooling fan ON at 100% fan speed **(Requested_Percent_Fan_Speed)** for ON/OFF cooling fans.

(A) The body controller will request 100% fan speed if the following conditions are true:

- **[**The AC request signal **(AC_Request)** is active **(See Note 1).**
- **AND** the A/C pressure transducer **(BC_RCD_Pressure_Signal)** is greater than or equal to 315 psig**].**

(B) Or, the body controller will request 100% fan speed if the following conditions are true:

- **[**The key switch is in the IGNITION ON position.
- **AND** the engine speed is greater than 1200 rpm.
- **AND** the AC request signal **(AC_Request)** is active **(See Note 1).**
- **AND** the above request is **newly** received **(See Note 2)** by the body controller.
- **AND** the vehicle speed is less than 10 mph.
- **AND** the A/C pressure transducer **(BC_RCD_Pressure_Signal)** is greater than 100 psig.
- **AND** the inlet thermistor temperature **(BC_RCD_Temp_In_Signal)** is greater than 85 °F**].**

(C) Or, the body controller will request 100% fan speed if the following conditions are true:

- The vehicle is equipped with a manual fan override switch **(0595ACW).**
- **AND** the manual fan override switch is in the ON position **(*Fan_Ovrd_Request*).**
- **AND** the key switch is in the ON position while the engine is running.

(D) Or, the body controller will request 100% fan speed if: the **Engine_Fan_Request** signal is in the vehicle configuration and the signal is a value of (1).

NOTE 1: DLB displays ☑ while the **AC_Request** signal is active. Refer to Signal Definitions for more information.

NOTE 2: The term “newly” means that the signal changes from “inactive” to “active”.

Once the body controller has requested the fan ON the body controller will continue to request* (*Requested_Percent_Fan_Speed) 100% fan speed until:

- The A/C pressure transducer **(BC_RCD_Pressure_Signal)** is less than or equal to 225 psig.
- **AND** the fan request has been active for at least 30 seconds.

Therefore, once the pressure drops below 225 psig the fan will remain on for 30 seconds after it was last turned on.

If the AC request signal (**AC_Request)** goes inactive while the fan request is active, the body controller will continue to request the fan, while the engine is on, until the pressure drops below 225 psig **AND** 30 seconds have elapsed. If the A/C pressure transducer is faulted **OR** if there is at least one thermistor fault, the fan will be requested off.

4.1.8.2. Variable Speed Fan Control (0595AYH)

Cooling fan requests will be 0%, 100%, or variable between 0 and 100% if feature code **(0595AYH)** is in the vehicle configuration. The body controller will request the appropriate fan mode based on the conditions being monitored.

There are several cases in which the body controller will request the engine cooling fan ON at 100% fan speed **(Requested_Percent_Fan_Speed)** for variable speed cooling fans.

(A) The body controller will request 100% fan speed if the following conditions are true:

- The key switch is in the IGNITION ON position.
- **AND** the vehicle speed is less than 10 mph.
- **AND** the engine speed is greater than 1200 RPM.
- **AND** the A/C pressure transducer **(BC_RCD_Pressure_Signal)** is greater than 100 psig.
- **AND** the inlet thermistor temperature **(BC_RCD_Temp_In_Signal)** is greater than 85 °F**.**
- **AND** the AC request signal **(AC_Request)** is active **(See Note 1).**
- **AND** the above request is **newly** received **(See Note 2)** by the body controller.

NOTE 1: DLB displays ☑ while the **AC_Request** signal is active. Refer to Signal Definitions for more information.

NOTE 2: The term “newly” means that the signal changes from “inactive” to “active”.

If the conditions above are true the fan will stay on at 100% for at least 30 seconds regardless of the pressure indicated by the A/C pressure transducer* (BC_RCD_Pressure_Signal)*.

(B) Or, the body controller will request 100% fan speed if the following conditions are true:

- The key switch is in the IGNITION ON position.
- **AND** the AC request signal **(AC_Request)** is active **(See Note 1).**
- **AND** the A/C pressure transducer **(BC_RCD_Pressure_Signal)** is greater than or equal to 285 psig.

(C) Or, the body controller will request 100% fan speed if the following conditions are true:

- The vehicle is equipped with a manual fan override switch **(0595ACW).**
- **AND** the manual fan override switch is in the ON position **(*Fan_Ovrd_Request*).**
- **AND** the key switch is in the ON position while the engine is running.

(D) Or, the body controller will request 100% fan speed if: the **Engine_Fan_Request** signal is in the vehicle configuration and the signal is a value of (1).

The body controller will NOT request the engine cooling fan (See Note) if the following conditions are true:

- The key switch is in the OFF position.
- **OR** the AC request signal **(AC_Request)** is **NOT** active.
- **OR** the A/C pressure transducer **(BC_RCD_Pressure_Signal)** is less than 250 psig.

NOTE: The **(*Fan_Ovrd_Request*),** controlled by the manual fan override switch must **NOT** be **ON** if **(0595ACW)** is in the vehicle configuration, otherwise the body controller will request 100% cooling fan speed.

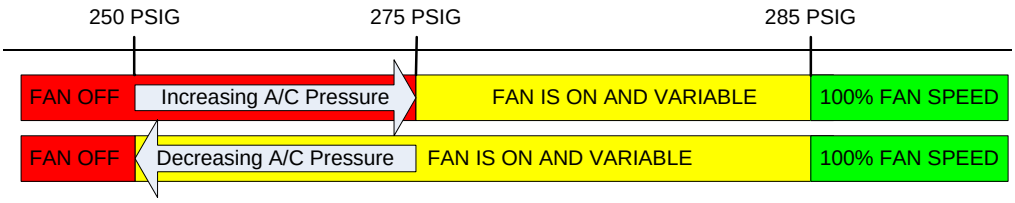
The body controller will request the engine cooling fan ON at a variable speed (Requested_Percent_Fan_Speed) between 0 and 100% if the following conditions are true:

- The key switch is in the IGNITION ON position.
- The AC request signal **(AC_Request)** is active.
- **AND** the A/C pressure transducer **(BC_RCD_Pressure_Signal)** is greater than or equal to 250 psig.
- **AND** the A/C pressure transducer **(BC_RCD_Pressure_Signal)** is less than 285 psig.
- **AND if (0595ACW)** is in the vehicle configuration, the **(*Fan_Ovrd_Request*),** controlled by the manual fan override switch, is **OFF**.
- **AND if** the **Engine_Fan_Request** signal is in the vehicle configuration and the signal is a value of (0).

NOTE: On vehicles equipped with variable speed fans, the body controller will increase its fan speed request **(Requested_Percent_Fan_Speed)** from 0% to 100% as the high side pressure **(BC_RCD_Pressure_Signal)** increases. This variable request only occurs if the body controller determines that the A/C pressure is within acceptable limits for variable speed fan control.

The following diagram illustrates the A/C pressure values at which the fan speed request will be variable.

Variable Speed Fan Range
(0595AYH)



4.1.9. Mode Control

The HVAC system offers the following mode selections.

MAX Air Conditioning Mode. The following will occur if this mode is selected:

- The A/C clutch engages. Refer to A/C Clutch Control for more information.
- The recirculation door closes (if previously open) or remains closed. Refer to Recirculation Actuator (vehicles equipped with A/C) for more information.
- The mode actuator moves the mode doors to the position corresponding with the mode selected. Refer to Mode Actuator for more information.

BI-Level Air Conditioning Mode. The following will occur if this mode is selected:

- The A/C clutch engages. Refer to A/C Clutch Control for more information.
- The recirculation door opens (if previously closed) or remains open. Refer to Recirculation Actuator (vehicles equipped with A/C) for more information.

- The mode actuator moves the mode doors to the position corresponding with the mode selected. Refer to Mode Actuator for more information.

Vent Mode. The following will occur if this mode is selected:

- The recirculation door opens (if previously closed) or remains open. Refer to Recirculation Actuator (vehicles equipped with A/C) for more information.
- The mode actuator moves the mode doors to the position corresponding with the mode selected. Refer to Mode Actuator for more information.

Floor Mode. The following will occur if this mode is selected:

- The recirculation door opens (if previously closed) or remains open. Refer to Recirculation Actuator (vehicles equipped with A/C) for more information.
- The mode actuator moves the mode doors to the position corresponding with the mode selected. Refer to Mode Actuator for more information.

Mix Mode. The following will occur if this mode is selected:

- The recirculation door opens (if previously closed) or remains open. Refer to Recirculation Actuator (vehicles equipped with A/C) for more information.
- The mode actuator moves the mode doors to the position corresponding with the mode selected. Refer to Mode Actuator for more information.

Defrost Mode. The following will occur if this mode is selected:

- The A/C clutch engages. Refer to A/C Clutch Control for more information.
- The recirculation door opens (if previously closed) or remains open. Refer to Recirculation Actuator (vehicles equipped with A/C) for more information.
- The mode actuator moves the mode doors to the position corresponding with the mode selected. Refer to Mode Actuator for more information.

Refer to Air Distribution in the HVAC Manual (S16034) or HVAC Manual (S16039) for a detailed description of the air distribution based on the mode selected.

4.1.10. Blower Control

The HVAC blower motor assembly consists of a permanent magnet motor attached to a balanced 'squirrel-cage' fan unit. The blower speed is controlled by the blower speed control (left knob) on the HVAC control head, located on the instrument panel. The blower speed control is a long life potentiometer with seven distinct blower speeds in addition to OFF.

4.1.10.1. Linear Power Module

When a blower speed is selected, the HVAC control head outputs a voltage (between 0 and 4.75 volts) to the linear power module (LPM). This voltage is variable based on the blower speed control setting.

The LPM responds by acting as a variable resistance between the blower motor and ground. This variable resistance is in the ground circuit of the blower motor. As the blower speed control is turned clockwise, the apparent resistance to ground decreases, the voltage across the blower motor increases, and the speed increases.

4.1.11. Blower Motor Diagnostics

This section was intended for use with the appropriate circuit diagram manual.

No diagnostic trouble codes are associated with the blower circuits.

NOTE: Check for broken fan blades or a wedged fan if no electrical failures are found or if a mechanical problem (such as abnormal noise, etc.) is indicated.

Blower Motor Circuit Troubleshooting (0595ADL)

Review the General Diagnostic Information section prior to performing the following electrical tests.

Perform the following tests with:

- Key switch in the OFF position.
- Linear power module connector connected.
- Blower motor connector connected.

If Blower Motor is Always On

Test for the following conditions if the blower runs constantly:

- A short to ground in the circuit **(See Note)** between the blower motor and the linear power module.

NOTE: The amount of resistance in this "ground circuit" is controlled by the linear power module (described at the beginning of this section). Under normal operating conditions this circuit should appear to be fully grounded when the blower speed control is rotated fully clockwise (maximum blower speed).

Blower Motor Circuit Troubleshooting (continued)

Perform the following tests with:

- Key switch in the IGNITION ON position.
- Linear power module connector disconnected.
- Blower motor connector disconnected.

Linear Power Module Voltage Test

Perform this test at the harness connector of the linear power module.

With multi-meter connected between the ignition voltage circuit of the harness connector and the ground circuit of the harness connector the meter should read 12 ± 1.5 volts with the key switch in the IGNITION ON position (the engine does not need to be running).

The voltage specified above is provided by the interior power distribution center.

If the specified voltage is not present, correct the condition. ***If the specified voltage is present, proceed to the next test.***

Blower Motor Voltage Test

Perform this test at the harness connector of the blower motor.

With multi-meter connected between the battery voltage circuit of the harness connector and a good ground the meter should read 12 ± 1.5 volts.

The voltage specified above is provided by the interior power distribution center.

If the specified voltage is not present, correct the condition. ***If the specified voltage is present, proceed to the next test.***

Blower Fan Control Circuit Voltage Test

Perform this test at the harness connector of the linear power module.

With multi-meter connected between the blower fan control circuit of the harness connector and the ground circuit of the harness connector the meter should read approximately 0 to 5 volts, depending on the blower speed control setting.

The voltage specified above is provided by the HVAC control head. The control head provides between 0 and 4.75 volts to the linear power module on the blower fan control circuit. The actual voltage range may vary; however, the voltage should be lowest when control is fully counter-clockwise. The voltage should increase as the control is turned clockwise, and should be at its highest value when control is fully clockwise.

If the specified voltage is not present, correct the condition. ***If the specified voltage is present, proceed to the next test.***

Blower Motor Circuit Troubleshooting (continued)

Blower Motor Output/Ground Circuit Test

Perform the following test with:

- Key switch in the OFF position.
- Linear power module connector disconnected.
- Blower motor connector connected.

Momentarily connect a fused jumper from the **"ground"** circuit **(See Note 1)** of the blower motor at the linear power module connector to a good ground.

NOTE 1: The amount of resistance to ground in this "ground circuit" is controlled by the linear power module (described at the beginning of this section). Under normal operating conditions this circuit should appear to be fully grounded when the blower speed control is rotated fully clockwise (maximum blower speed).

Connecting the indicated jumper should energize the blower at maximum speed while the jumper is connected. Once blower operation is checked, REMOVE jumper.

Correct any invalid conditions found from the test results.

4.1.12. Temperature Control

This information is described in the Temperature Actuator section.

4.2. HVAC Sensors

4.2.1. AC Refrigerant Thermistors

The A/C refrigerant thermistors allow the body controller to monitor refrigerant temperatures at the inlet and outlet of the AC evaporator core. This information is used by the body controller to help control the operation of the A/C system, and to help diagnose faults during abnormal system operation.

The body controller provides each sensor with near accessory voltage and a Zero Volt Reference (ZVR). The voltage dropped across each thermistor is monitored by the body controller. These voltages are used by the body controller to control A/C system operation and detect system faults.

These sensors have a negative temperature coefficient, such that the resistance of the sensor decreases as the refrigerant temperature increases. The resistance value of each thermistor is determined by the temperature of the refrigerant at its location. The change in sensor resistance causes a change in the voltage level measured by the body controller at the sensor input. The voltage drop across the thermistor measured at the body controller input increases as the sensor resistance increases. Refer to the Thermistor Cross Reference Table for specific examples.

4.2.1.1. Evaporator Outlet Thermistor

The evaporator outlet thermistor measures the temperature of the refrigerant in the accumulator, located at the evaporator outlet. The outlet thermistor signal representing this temperature, **(*BC_RCD_Temp_Out_Signal*),** is monitored by the body controller.

Under light heat load conditions, this temperature information is used by the body controller to cycle the A/C compressor clutch to prevent evaporator freeze-up. The body controller also uses this temperature information, in conjunction with the high side pressure information, to determine if the ambient temperature is too low for safe compressor operation.

4.2.1.2. Evaporator Inlet Thermistor

The evaporator inlet thermistor measures the temperature of the refrigerant in the evaporator inlet A/C line. The inlet thermistor signal representing this temperature, **(*BC_RCD_Temp_In_Signal*),** is monitored by the body controller.

Under normal operating conditions, this temperature information is used by the body controller to determine when to cycle the A/C compressor clutch.

4.2.2. Thermistor Diagnostics

4.2.2.1. Shorted Thermistor Diagnostics

For diagnostic purposes, the body controller monitors the voltage levels across the inlet thermistor and the outlet thermistor to determine if either thermistor circuit is open or shorted to ground (or zero volt reference).

Because the body controller does not detect the full range of voltage values it cannot directly detect an open or shorted circuit. If the body controller reads a thermistor voltage value at the low end of its range of possible values it assumes that the thermistor circuit is shorted to ground, because this value (which corresponds to 240°F) does not reflect a normal reading.

The body controller will set a fault indicating that the particular thermistor is shorted to ground. In addition, the body controller will inhibit A/C compressor operation until the short is no longer detected, **AND** at least 8 seconds have elapsed since the A/C compressor clutch was de-energized.

4.2.2.2. Open Thermistor Diagnostics

If the body controller reads a thermistor voltage value at the high end of its range of possible values it cannot assume that the thermistor circuit is open because this value (which corresponds to 0°F) can also occur during normal operation. Therefore, the body controller must perform these additional checks to determine if a thermistor circuit is open.

- The thermistor voltage values are checked while the A/C compressor is cycled OFF.
- The A/C pressure transducer value, represented by ***BC_RCD_Pressure_Signal***, is checked to verify that the ambient temperature is not excessively low. Its value must be greater than 20 psig.
- The voltage values of the two thermistors are compared. If one indicates 0°F and the other one indicates more than 30°F, the thermistor circuit indicating 0°F is considered open.

If after making these additional checks the body controller determines that a thermistor circuit is open, the body controller will set a fault indicating that the

particular thermistor circuit is open. In addition, the body controller will inhibit A/C compressor operation until the open is no longer detected, **AND** at least 8 seconds have elapsed since the A/C compressor clutch was de-energized.

The following table was intended for use with the appropriate circuit diagram manual.

Refrigerant Thermistor Circuits Troubleshooting

Review the General Diagnostic Information section prior to performing the following electrical tests.

IMPORTANT: The refrigerant system must be discharged before removing and replacing either thermistor.

IMPORTANT – To perform the following steps, the engine and A/C system must NOT have been run within the last 30 minutes. The temperature of the A/C system MUST BE approximately the same as the ambient temperature.

Thermistor Voltage Test

Test at the harness connector of the appropriate thermistor with the connector disconnected.

With multi-meter connected between the signal circuit of the harness connector and the zero volt reference (ZVR) circuit of the harness connector the meter should read 10 ± 1 volt with the key switch in the ON position (the engine does not need to be running).

The voltage and zero volt reference specified above are provided by the body controller.

If the specified voltage is not present, correct the condition. ***If the specified voltage is present, proceed to the next test.***

Thermistor Resistance Test

Test the appropriate thermistor circuit at the harness connector of the body controller with:

- The thermistor connector reconnected.
- The body controller connector disconnected.
- The key switch in the OFF position.

Measure the approximate temperature of the A/C line near the thermistor (ambient temperature) with a temperature probe, if available.

Look up temperature value in the Thermistor Cross Reference Table, and note the range of equivalent resistance values. Measure the actual resistance of the appropriate thermistor at the harness connector of the body controller. The actual resistance value must fall within the range noted in the table.

If the resistance values are **NOT** within the range, replace the thermistor. If the resistance values are within the range, replace the body controller.

4.2.3. Thermistor Cross Reference Table

Voltage in the table below is as measured at the body controller input. Temperature is as read by a temperature probe.

TEMP (°C)	TEMP (°F)	Minimum Resistance (kOhms)	Nominal Resistance (kOhms)	Maximum Resistance (kOhms)	Voltage at the body controller (See Note)
-15	5	19.531	21.43	22.387	10.07
-10	14	14.948	16.159	16.93	9.90
-5	23	11.56	12.283	12.939	9.78
0	32	9.028	9.407	9.988	9.50
5	41	6.988	7.273	7.646	9.20
10	50	5.456	5.666	5.907	9.03
15	59	4.296	4.447	4.604	8.65
20	68	3.381	3.514	3.618	8.20
25	77	2.725	2.795	2.865	7.85
30	86	2.174	2.237	2.306	7.38
35	95	1.747	1.802	1.868	6.80
40	104	1.413	1.459	1.524	6.18
45	113	1.15	1.188	1.25	5.86
50	122	.942	.973	1.032	5.20
55	131	.773	.803	.853	4.80
60	140	.637	.667	.709	4.20
65	149	.529	.56	.591	3.85
70	158	.443	.469	.495	3.42
75	167	.373	.395	.417	3.14
80	176	.315	.334	.352	2.78
85	185	.267	.283	.299	2.36
90	194	.227	.241	.255	2.10
95	203	.194	.206	.218	1.82
100	212	.166	.177	.187	1.63

Note: Typical thermistor voltages are provided in the table and will vary with the ignition voltage.

4.2.4. AC Pressure Transducer

The A/C pressure transducer signal, represented by **(*BC_RCD_Pressure_Signal*)**, is an analog signal that originates at the pressure transducer in the condenser-to-evaporator A/C refrigerant line. The body

controller provides the transducer with a +5V signal and the Zero Volt Reference (ZVR). The output signal of the transducer reflects the refrigerant pressure level in the high side of the A/C system, and is monitored by the body controller. The voltage from the A/C pressure transducer increases as the pressure level increases. The body controller uses the information from the transducer to control the A/C clutch and the engine cooling fan, and to help diagnose faults during abnormal system operation. The high side pressure input is similar in functionality to a high-pressure cut-off switch, a low-pressure cut-off switch, and a cooling fan switch on a conventional A/C system.

4.2.5. A/C Pressure Transducer Diagnostics

The body controller monitors the voltage value of the A/C pressure transducer to determine if the transducer circuit is operating outside of its normal range. The body controller conditions the raw voltage and reacts to the ***(BC_RCD_Pressure_Signal)***. The body controller will generate diagnostic trouble codes if the voltage readings received from the A/C pressure transducer are either out of range high or out of range low.

If the voltage value approaches 5 Volts (indicating a pressure of >500 psig), the body controller will set a fault indicating that the A/C pressure transducer is operating above the normal range.

The body controller will also set a fault if the transducer voltage value drops to less than 0.42 Volts (indicating a pressure of less than 20 psig or the presence of a vacuum) **AND** the ambient temperature **(Ambient_Air_Temperature)** is less than 40 F. The fault will indicate that the A/C pressure transducer is operating below the normal range.

In addition, the body controller will inhibit A/C compressor operation until the fault is no longer detected, **AND** at least 8 seconds have elapsed since the A/C compressor clutch was de-energized.

The following table was intended for use with the appropriate circuit diagram manual.

A/C Pressure Transducer Circuits Troubleshooting
Review the General Diagnostic Information section prior to performing the following electrical tests. **IMPORTANT: The refrigerant system does not need to be discharged before removing and replacing the A/C pressure transducer.**
A/C Pressure Transducer Voltage Test
Test at the harness connector of the A/C pressure transducer with the connector disconnected.

With multi-meter connected between the 5V reference circuit of the harness connector and the zero volt reference (ZVR) circuit of the harness connector the meter should read 5 ± 0.5 volt with the key switch in the ON position (the engine does not need to be running).

The voltage and zero volt reference specified above are provided by the body controller.

If the specified voltage is not present, correct the condition. ***If the specified voltage is present, proceed to the next test.***

A/C Pressure Transducer Signal Circuit Test

Test for an open or short to ground in the signal circuit of the A/C pressure transducer.

If circuit is open or shorted, correct the condition. ***If no condition is found, proceed to the next test.***

A/C Pressure Transducer Reference Pressure Test

Test with A/C pressure transducer connector reconnected and key switch in the IGNITION ON position (the engine does not need to be running).

Test circuits at the body controller connector.

- Connect the recovery station as specified in the HVAC Manual (S16034) or HVAC Manual (S16039).
- **Measure the output voltage from the A/C pressure transducer with a multi-meter connected between the signal circuit and the zero volt reference (ZVR) circuit of the A/C pressure transducer.**
- Look up the equivalent pressure value in the A/C Pressure Transducer Cross Reference Table and compare to the pressure value indicated on the AC recovery station high side gauge.
- The pressure value indicated by the recovery station and the pressure value from the A/C Pressure Transducer Cross Reference Table should be within 20 psig.

If values disagree, replace the A/C pressure transducer.

If values agree, replace the body controller.

If no electrical faults are found, refer to HIGH HEAD PRESSURE TROUBLESHOOTING in the HVAC Manual (S16034) or HVAC Manual (S16039).

4.2.6. A/C Pressure Transducer Cross Reference Table

Voltage in the table below is as read by a multi-meter.

PRESSURE (PSIG)	Normal Voltage (Volts)
0	<0.25
20	0.42
25	0.48
40	0.62
50	0.71
75	0.92
100	1.15
150	1.59
185	1.90
200	2.03
250	2.48
285	2.80
300	2.92
350	3.38
400	3.81
420	3.99
450	4.26
475	4.48
500	4.71

4.3. HVAC Actuators

4.3.1. Temperature Actuator

The temperature actuator controls a temperature blend air door that regulates the temperature of the air discharged from the vents. The temperature blend door determines what portion of the system input air is deflected through the heater core depending on the setting of the temperature control (center knob) on the HVAC control panel. As the temperature control is rotated clockwise more air is deflected through the heater core, increasing the temperature of the system output air entering the cab. The temperature control has fifteen detents.

When the temperature control setting is changed, the control head will apply a drive voltage to the temperature door actuator motor causing it to turn the temperature blend door to the desired position. Circuitry within the control head senses when the door reaches the correct position, and stops outputting the drive voltage.

Because the actuator motor can be driven in either direction the drive voltage can be of either polarity. In order to position the doors correctly, circuitry within the control head keeps track of the actuator position at all times based on a known

starting position. It can then drive the actuator to any position by applying a drive voltage of the correct polarity, and sensing (counting) the number of actuator motor revolutions through the actuator circuits. To establish a known starting position, the control head runs the actuator and door through a calibration procedure when battery voltage is first applied to the HVAC control head, and then at regular intervals during normal operation.

4.3.2. Mode Actuator

The mode actuator controls the two mode doors located at the top of the heater housing via a kinematics (gear drive) system. The two doors direct air flow to the air outlets (floor ducts, instrument panel vents, and/or defrost vents) based on the mode selected by the operator.

The position of the actuator motor (and mode doors) is controlled by the setting of the mode control (right knob) on the HVAC control head. When a mode is selected that requires a change in position of the mode doors, the control head will apply a drive voltage to the motor causing it to turn the doors to the desired position. Circuitry within the control head senses when the mode doors reach the desired position, and stops outputting the drive voltage.

Because the actuator motor can be driven in either direction the drive voltage can be of either polarity. In order to position the doors correctly, circuitry within the control head keeps track of the actuator position at all times based on a known starting position. It can then drive the actuator to any position by applying a drive voltage of the correct polarity, and sensing (counting) the number of actuator motor revolutions through the actuator circuits. To establish a known starting position, the control head runs the actuator and doors through a calibration procedure when battery voltage is first applied to the HVAC control head, and then at regular intervals during normal operation.

4.3.3. Recirculation Actuator (vehicles equipped with A/C)

The recirculation motor is controlled by the right-hand knob (mode selector) on the HVAC control head. When a mode is selected that requires a change in position of the recirculation door, the control head will apply a drive voltage to the motor causing it to turn the recirculation door to the desired position. Circuitry within the control head senses when the door reaches the correct position, and stops outputting the drive voltage.

Because the actuator motor can be driven in either direction the drive voltage can be of either polarity. In order to position the door correctly, circuitry within the control head keeps track of the actuator position at all times based on a known starting position. It can then drive the actuator to any position by applying a drive voltage of the correct polarity, and sensing (counting) the number of actuator motor revolutions through the actuator circuits. To establish a known starting position, the control head runs the actuator motor and door through a calibration

procedure when battery voltage is first applied to the HVAC control head, and then at regular intervals during normal operation.

4.3.4. HVAC Actuator Electrical Diagnostics

If the actuator motor is provided power but does not move to its selected position, due to an electrical or mechanical problem, the HVAC control head will sense the fault. The control head will communicate this fault condition to the body controller, and the body controller will then set the corresponding diagnostic trouble code.

The following table provides the troubleshooting procedures for isolating the cause of diagnostic trouble codes 3984, 1552, 3981, and 520465 related to the HVAC actuators.

The following table was intended for use with the appropriate circuit diagram manual.

HVAC Actuator Motor Circuit Troubleshooting

Review the General Diagnostic Information section prior to performing the following electrical tests.

Turn OFF the ignition and disconnect connector from the appropriate actuator motor.

IMPORTANT – Whenever the door actuator motor is energized while disconnected (such as during testing), it must be recalibrated after it is reconnected. Refer to HVAC Actuator Calibration for more information.

Action	Spec.	Comments
While observing the drive collar of the actuator motor use a 9 Volt battery and jumpers to apply 9 Volts dc to the terminals of the appropriate actuator motor. After noting the results, swap the jumpers to reverse the polarity of the voltage at the terminals of the actuator motor.	The drive collar of the actuator motor should rotate to one end of its travel when voltage is first applied, and to the opposite end of its travel when the voltage polarity is reversed. **NOTE – If the actuator motor is already at the end of its travel when voltage is first applied, it may be necessary to**	***If motor operates correctly, proceed to the next step.*** If motor does not rotate through its entire range: A. Remove jumpers. B. Remove motor from the appropriate housing. C. Reconnect 9 Volts dc to the motor and verify that the motor drive collar will

	switch polarities twice to see rotation in both directions.	rotate in both directions. • If motor still does not rotate, replace motor. • If motor does rotate, repair mechanical failure or blockage in the appropriate door or housing. Refer to **HVAC Actuator Door Mechanical Troubleshooting** in this section for more information.
Isolate circuits between HVAC control head and the appropriate actuator motor.	Test for open circuits or circuits shorted to ground.	If faulty circuits are found, correct the condition.

4.3.5. HVAC Actuator Mechanical Diagnostics

The following tables provide troubleshooting procedures to isolate the cause of mechanical failures resulting in diagnostic trouble codes.

HVAC Temperature or Recirculation Door Mechanical Troubleshooting

CAUTION – Never force the recirculation air door open. If the door position must be changed, follow the following procedures. Forcing the door will result in a broken door shaft and a costly repair. To open the recirculation air door, turn on key, set mode control to any position except MAX A/C, turn off key.

Possible Causes:
- Jammed/Damaged Door(s)
- Internal Actuator Slippage

Perform the following tests with the ignition key in the OFF position.

Test Points	Spec.	Comments
Remove the appropriate door actuator. Grasp the door shaft and manually move door through its full range of movement.	Door should move freely throughout its range.	***If door operates correctly, proceed to the next step.*** If door does not operate correctly isolate and clear cause of door jam. If door jam cannot be cleared, replace the appropriate door or housing.
Inspect the end of the door	Door shaft should	***If door shaft is not free of excessive wear:***

shaft that is driven by the actuator.	be free of excessive wear.	• Replace recirculation air door (if diagnosing the recirculation door). • Replace blower scroll housing assembly (if diagnosing the temperature door).

HVAC Mode Door Mechanical Troubleshooting **Possible Causes:** • Jammed/Damaged Mode Doors or Gear Train. • Internal Actuator Slippage		
Test Points	Spec.	Comments
With the key switch is the IGNITION ON position, remove actuator from gear train that drives the mode doors. Set blower speed to full clockwise. Grasp the gear train input shaft (normally mates to actuator) and manually rotate the shaft through its full range of movement.	Rotating the gear train input shaft through its full range should move the mode doors to direct the air flow as follows: • Fully counter-clockwise = dash vents • Fully clockwise = defrost vents • Mid position =	***If gear train input shaft operates correctly, proceed to the next step.*** If door does not operate correctly, isolate and clear cause of door jam or kinematics gear train jam. If the jam cannot be cleared, replace heater housing assembly.

	floor ducts	
With the key switch in the OFF position, inspect the gear train and gear train input shaft for wear or damage that may cause slippage.	Gear train and input shaft should be free of excessive wear.	***If door shaft is not free of excessive wear:*** Replace heater housing assembly.

4.3.6. HVAC Actuator Calibration

To establish a known starting position, the HVAC control head runs the actuators and doors through a calibration procedure when battery voltage is first applied to the HVAC control head.

Whenever any door actuator is energized while disconnected (such as during testing), it must be recalibrated after it is reconnected. After reassembling the door and actuator, and reconnecting the actuator electrical connector, disconnect and reconnect the HVAC control head connector (or disconnect the vehicle battery). This will initiate the door position calibration procedure.

5. General Diagnostic Information

Refer to Cautions and Warnings in the HVAC Manual (S16034) or HVAC Manual (S16039) prior to discharging the A/C system.

NOTE: The virtual fuse for the A/C compressor clutch in the body controller will trip during a short. To reset the fuse, the key switch must be cycled.

Be sure to perform the Diagnosis and Troubleshooting Flow Chart (and any referenced procedures) in the HVAC Manual (S16034) or HVAC Manual (S16039) prior to performing tests on the electrical system!

It is strongly recommended that DLB is used along with this information to enhance diagnostic capabilities. See the diagnostic software manual for details on using the software.

5.1. Diagnostic Trouble Codes

The following diagnostic trouble codes are issued by the body controller. The body controller monitors parameters throughout the A/C system and generates diagnostic trouble codes whenever a measured parameter falls outside of its specified range. Also within the HVAC system, the HVAC control head monitors some conditions and notifies the body controller when it detects a fault. The HVAC control head uses the diagnostic circuit to communicate this information. The body controller assigns a diagnostic trouble code to each of these faults. Diagnostic trouble codes are viewed by placing the system into the diagnostic mode. Refer to Refer to Displaying Diagnostic Trouble Codes for more information.

NOTE: Diagnose any "loss of communication" related errors prior to diagnosing codes from the following list. SPN 2000 FMI 9 will be displayed if the body controller has lost communication with the engine.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
1079	5V Sensor Supply	1			5V Sensor Supply Below Normal Range	See below for details.	Switched_5V_Sense_Raw_Signal
This Diagnostic code could be the result of any of the following conditions: • Short to ground or a low resistance on the 5 Volt reference circuit. • Defective body controller. Refer to A/C Pressure Transducer Diagnostics for more information.							
SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
1548	HVAC Duct Temperature	0	1600	B13	HVAC Outlet Temp Sensor reading above normal range	See below for details.	BC_RCD_Temp_Out_Raw_Signal
This Diagnostic code could be the result of any of the following conditions: • Open or high resistance in the outlet thermistor circuit. • Short to voltage in the outlet thermistor circuit. • Defective outlet thermistor. • Defective body controller. Refer to Thermistor Diagnostics for more information.							
SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal

1548	HVAC Duct Temperature	1	1600	B13	HVAC Outlet Temp Sensor reading below normal range	See below for details.	BC_RCD_Temp_Out_Raw_Signal

This Diagnostic code is the result of any of the following:

- Short to ground in the outlet thermistor circuit.
- Defective outlet thermistor.
- Defective body controller.

Refer to Thermistor Diagnostics for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
1547	A/C Evaporator Temperature	0	1600	B5	HVAC Inlet Temp Sensor reading above normal range	See below for details.	BC_RCD_Temp_In_Raw_Signal

This Diagnostic code could be the result of any of the following conditions:

- Open or high resistance in the inlet thermistor circuit.
- Short to voltage in the inlet thermistor circuit.
- Defective inlet thermistor.
- Defective body controller.

Refer to Thermistor Diagnostics for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
1547	A/C Evaporator Temperature	1	1600	B5	HVAC Inlet Temp Sensor reading below normal range	See below for details.	BC_RCD_Temp_In_Raw_Signal

This Diagnostic code is the result of any of the following:

- Short to ground in the inlet thermistor circuit.
- Defective inlet thermistor.
- Defective body controller.

Refer to Thermistor Diagnostics for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal

2609	Cab A/C Refrigerant Compressor Outlet Pressure	0	1600	B12	HVAC Pressure Sensor reading above normal range	See below for details.	BC_RCD_Pressure_ Raw_Signal

This Diagnostic code could be the result of any of the following conditions:

- Open or high resistance in the zero volt reference (ZVR) circuit of the A/C pressure transducer.
- Short circuit between the sensor output and the 5 volt reference circuit of the A/C pressure transducer.
- Defective A/C pressure transducer.
- Defective body controller.

Refer to A/C Pressure Transducer Diagnostics for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
2609	Cab A/C Refrigerant Compressor Outlet Pressure	7	N/A	N/A	AC - Service Now. Fan Problem/ Clogged Pipe	See below for details.	N/A

This Diagnostic code is logged when the body controller senses that the A/C refrigerant system pressure is above acceptable levels. Vehicles with viscous fan will not set this fault unless vehicle speed is greater than 20 mph. The code may be caused by any of the following:

- Defective A/C pressure transducer **(See Note)**
- Blocked condenser.
- Defective fan or fan drive.
- Restriction in high pressure side of system.
- Air/moisture in system.
- Too much oil in refrigerant system.

The body controller prevents A/C compressor operation when this DTC is set.

NOTE: Refer to A/C Pressure Transducer Diagnostics for more information.

If no electrical faults are found, refer to HIGH HEAD PRESSURE TROUBLESHOOTING in the HVAC Manual (S16034) or HVAC Manual (S16039).

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
2609	Cab A/C Refrigerant Compressor Outlet Pressure	1	1600	B12	HVAC Pressure Sensor reading below normal range	See below for details.	BC_RCD_Pressure_ Raw_Signal

This Diagnostic code could be the result of any of the following conditions:

- Open or high resistance in the 5 volt reference circuit.
- Open or short to ground on the signal circuit (output circuit) of the A/C pressure sensor.
- Short circuit between the signal circuit (output circuit) and the 0 volt reference circuit.
- Defective A/C pressure transducer.
- Defective body controller.

Refer to A/C Pressure Transducer Diagnostics for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
3984	Cab HVAC Recirculation Door Control Actuator	2	N/A	N/A	HVAC Control Head Air Inlet DM1	See below for details.	N/A

This Diagnostic code is logged as the result of the recirculation actuator motor being in the wrong position or unresponsive (jammed).

(Detected by HVAC control head.)

This diagnostic code is logged when the recirculation actuator does not respond to voltage from the HVAC control head. The code could be the result of any of the following conditions:

- Short to ground in the circuits between the HVAC control head and the recirculation actuator.
- Open circuit in the circuits between the HVAC control head and the recirculation actuator.
- Defective recirculation actuator.
- Defective HVAC control head.
- Defective body controller.

Refer to HVAC Actuator Electrical Diagnostics for more information.

If no electrical faults are found, this code could be caused by a mechanical problem such as a blocked, binding, or broken recirculation door. Refer to HVAC Actuator Diagnostics mechanical troubleshooting for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
1552	Operator Input device for Cab Climate Control	2	N/A	N/A	HVAC Control Head Temperature Mix DM1	See below for details.	N/A

This Diagnostic code is logged as the result of the temperature actuator motor being in the wrong position or unresponsive (jammed).

(Detected by HVAC control head.)

This diagnostic code is logged when the temperature actuator does not respond to voltage from the HVAC control head. The code could be the result of any of the following conditions:

- Short to ground in the circuits between the HVAC control head and the temperature actuator.
- Open circuit in the circuits between the HVAC control head and the temperature actuator.
- Defective temperature actuator.
- Defective HVAC control head.
- Defective body controller.

Refer to HVAC Actuator Electrical Diagnostics for more information.

If no electrical faults are found, this code could be caused by a mechanical problem such as a blocked, binding, or broken temperature door. Refer to HVAC Actuator Diagnostics mechanical troubleshooting for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
3981	Cab HVAC Mode Control Actuator	2	N/A	N/A	HVAC Control Head Mode Fault DM1	See below for details.	N/A

This Diagnostic code is logged as the result of the mode actuator motor being in the wrong position or unresponsive (jammed).

(Detected by HVAC control head.)

This diagnostic code is logged when the mode actuator does not respond to voltage from the HVAC control head. The code could be the result of any of the following conditions:

- Short to ground in the circuits between the HVAC control head and the mode actuator.
- Open circuit in the circuits between the HVAC control head and the mode actuator.
- Defective mode actuator.
- Defective HVAC control head.
- Defective body controller.

Refer to HVAC Actuator Electrical Diagnostics for more information.

If no electrical faults are found, this code could be caused by a mechanical problem such as a blocked, binding, or broken mode door or gear drive mechanism. Refer to HVAC Actuator Diagnostics mechanical troubleshooting for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
520465	HVAC Control Head Multiple Motor Faults	2	N/A	N/A	HVAC control Head Multiple Motor Faults DM1	See below for details.	N/A

(Detected by HVAC control head)

This Diagnostic code is the result of two or more HVAC actuator related faults being active. The body controller prevents A/C compressor operation when this DTC is set. Refer to HVAC Actuator Diagnostics for more information.

Note: If a problem is found in two or more of the actuator circuits, repair those circuits and clear the diagnostic trouble code.

If a problem is not found in two or more of the above circuits:

- Monitor the control head diagnostic signal using DLB **(*HVAC_Diagnostic_Value*).**
- If the diagnostic signal indicates a value of (4) replace the HVAC control head. (Control head is indicating a multiple fault when none exists.)
- If the diagnostic signal does not indicate a value of (4), replace the body controller.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
3985	Cab HVAC System Controller	9	N/A	N/A	HVAC Control Head Circuit Failed To Communicate With The BC	See below for details.	N/A

This Diagnostic code is the result of an open circuit, short to ground or short to voltage on the digital diagnostic line between the HVAC control head and the body controller.

The body controller prevents A/C compressor operation when this DTC is set.

Refer to HVAC Control Head Diagnostics for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
876	Compressor Clutch Circuit	5	1603	C	HVAC Compressor Clutch Engagement Undercurrent	Open in HVAC AC Compressor Clutch Circuit	BC_RCD_AC_Comp_Clutch_Cmd

This Diagnostic code indicates that the current in the compressor clutch circuit is <0.5A. This condition is the result of an open, or a high resistance, in the compressor clutch circuit. Refer to A/C Compressor Diagnostics for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal

876	Compressor Clutch Circuit	6	1603	C	HVAC Compressor Clutch Engagement Overcurrent	Short to Ground or Overload in HVAC AC Compressor Clutch Circuit	BC_RCD_AC_Comp _Clutch_Cmd

This Diagnostic code is the result of a short to ground in the compressor clutch circuit or a short across the compressor clutch solenoid. Refer to A/C Compressor Diagnostics for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
871	Refrigerant Charge	18	N/A	N/A	AC - Service now low charge	See below for details.	N/A

This Diagnostic code is logged when the body controller senses that the system refrigerant charge is too low to allow safe operation. The code may be caused by any of the following:

- Faulty Thermistor Circuit – Refer to Thermistor Diagnostics for more information.
- Refrigerant Leak **(See Note)**
- Improperly Charged System **(See Note)**

The body controller prevents A/C compressor operation when this DTC is set.

NOTE: Refer to REFRIGERANT CHARGE TROUBLESHOOTING in the HVAC Manual (S16034) or HVAC Manual (S16039) for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
871	Refrigerant Charge	1	N/A	N/A	AC - Service now Very low charge	See below for details.	N/A

This Diagnostic code is logged when the body controller senses that the system refrigerant charge is too low to allow safe operation. The code may be caused by any of the following:

- Faulty Thermistor Circuit – Refer to Thermistor Diagnostics for more information.
- Refrigerant Leak **(See Note)**
- Improperly Charged System **(See Note)**

The body controller prevents A/C compressor operation when this DTC is set.

NOTE: Refer to REFRIGERANT CHARGE TROUBLESHOOTING in the HVAC Manual (S16034) or HVAC Manual (S16039) for more information.

5.2. Displaying Diagnostic Trouble Codes

Refer to Displaying Diagnostic Trouble Codes.

Sleeper Control HVAC (Feature Code 0595ADM)

1. Description and operation

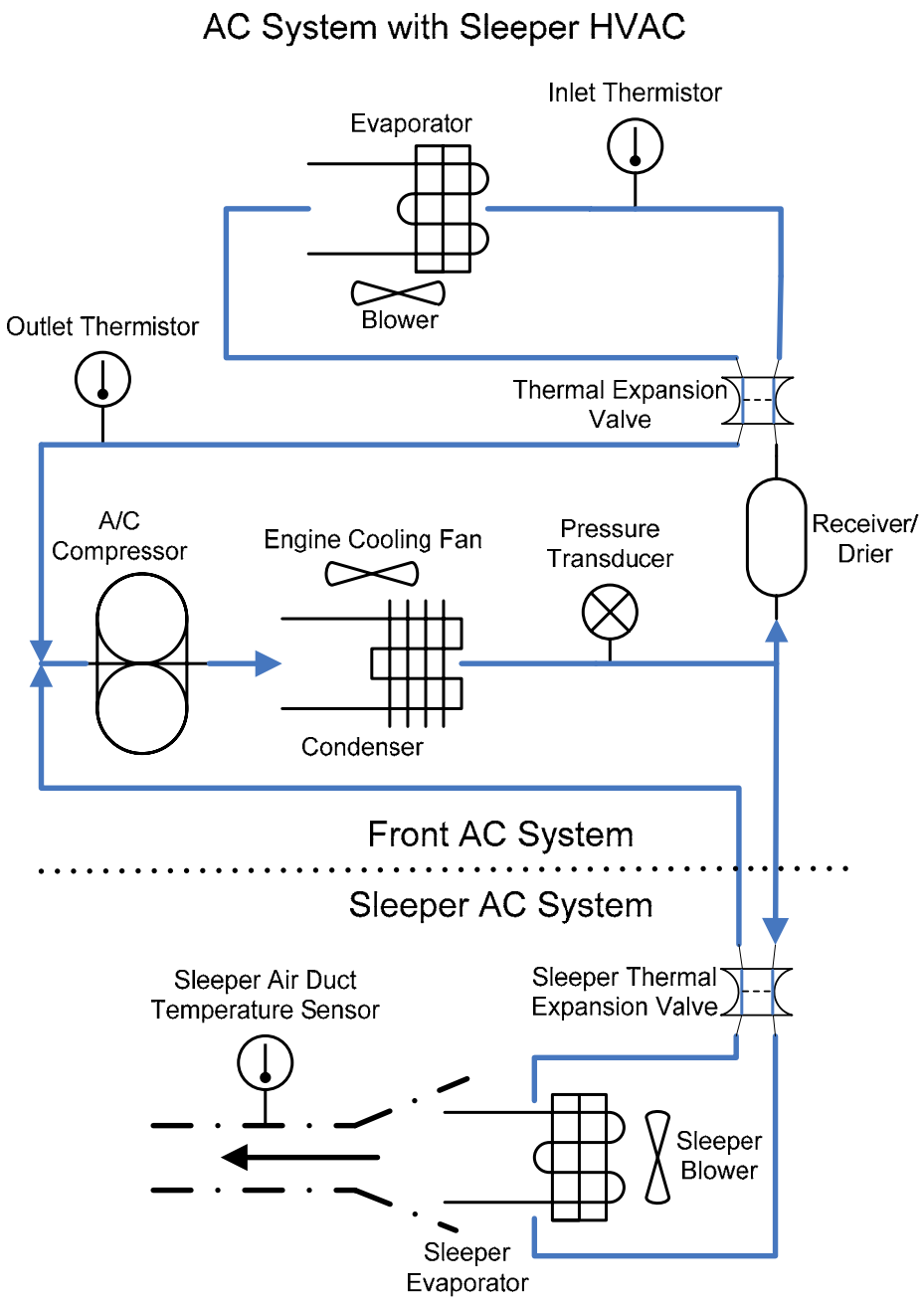
The following information describes the operation of the Sleeper HVAC electrical system on vehicles not equipped with a 'No Idle Heat' system. Refer to the HVAC Manual (S16039) for a complete description of the HVAC mechanical system.

The existing cab control HVAC system provides climate control for the driver environment where the body controller is used to control the engagement of the air conditioning clutch, monitor signals to prevent evaporator freeze-up and protect the A/C compressor. Refer to HVAC in the Electrical Troubleshooting Guide for more information. Sleeper HVAC operates independently from cab control HVAC.

The sleeper HVAC system electronically controls the blower speed and temperature of the air distributed by the sleeper system. This control can be achieved from either the control panel located in the sleeper, or from two switches located on the instrument panel.

The mechanical portion of the sleeper HVAC system includes a rear evaporator and a rear heater core, which are both extensions of the front HVAC system. These are housed in the sleeper HVAC unit along with a blower and blend air door.

The following diagram illustrates an overview of the AC system on vehicles equipped with sleeper HVAC, excluding electronic controls. Please refer to the circuit diagram manual for a complete illustration of the HVAC electrical system.


AC System with Sleeper HVAC
Inlet Thermistor
Evaporator
Blower
Outlet Thermistor
Thermal Expansion Valve
Receiver/ Drier
A/C Compressor
Engine Cooling Fan
Pressure Transducer
Condenser
Front AC System
Sleeper AC System
Sleeper Air Duct Temperature Sensor
Sleeper Thermal Expansion Valve
Sleeper Blower
Sleeper Evaporator

Be sure to perform the Diagnosis and Troubleshooting Flow Chart in the HVAC Manual (S16039) (and any referenced procedures) prior to performing tests on the electrical system!

The sleeper HVAC system may be equipped with rotary or digital sleeper controls depending on vehicle options**.**

Vehicles equipped with sleeper control HVAC will be equipped with the following electrical components in addition to the components required for cab control HVAC:

- ***Sleeper HVAC controls (rotary or digital)*** located in the lower sleeper area.
- ***Sleeper HVAC controller (control module)*** located on the sleeper HVAC module.
- ***Sleeper blower motor*** located on the sleeper HVAC module.
- ***Sleeper accessory relay*** located in the sleeper fuse box.
- ***Sleeper temperature actuator*** located on the sleeper HVAC module.
- ***Sleeper HVAC temperature sensor*** located on the sleeper air duct.
- ***Sleeper HVAC linear power module (LPM)*** located on the sleeper HVAC module.
- ***Sleeper HVAC temperature switch (located on the front instrument panel)***
- ***Sleeper HVAC blower switch (located on the front instrument panel)***

1.1. Sleeper HVAC Electrical System

The following section describes the wiring of the electrical components. Please refer to the circuit diagram manual for a complete illustration of the HVAC electrical system including specific connectors and pins.

All major functions of the sleeper A/C-heater system are initiated by the sleeper HVAC controls, which are electrically connected to the sleeper HVAC controller.

The sleeper accessory relay provides voltage to the sleeper HVAC controller when the key switch is placed in the ACCESSORY or ON position. This 'wakes up' the sleeper HVAC controller. The sleeper HVAC controller is permanently grounded at the ground stud. The sleeper mounted HVAC controls are wired directly to the sleeper HVAC controller. The sleeper HVAC controller provides power and ground to the sleeper control panel mounted sleeper HVAC controls. The sleeper HVAC controller adds panel dimmer illumination functionality if the vehicle is equipped with digital sleeper HVAC controls.

1.1.1. SAE J1939 Communication

There are two data links used for SAE J1939 communication; the bodybuilder data link and the drive train data link.

The sleeper HVAC controller communicates with the body controller by means of the bodybuilder SAE J1939 data link for various functions such as:

- Requesting the A/C compressor
- Receiving the status of the switch pack sleeper HVAC switches

- Receiving the status of the A/C clutch.
- Communicating fault code information to the body controller.

Service tools will not be able to access information from the bodybuilder SAE J1939 data link directly. The body controller interprets and broadcasts the appropriate information on the drive train SAE J1939 data link, which can be viewed using Diamond Logic Builder (DLB).

Communication is considered 'lost' if the body controller has not received a 'heartbeat' from the sleeper HVAC controller for 3 seconds.

The following will occur if communication is lost between the sleeper HVAC controller and the body controller:

- The body controller will set the appropriate "loss of communication" DTC.
- "Reduced power blower mode" will be disabled. Refer to the Reduced Power Blower Mode section for more information.
- The sleeper HVAC controller will not be able to send the A/C request (Rear A/C operation will be inoperative).
- Control of sleeper HVAC will be inoperative from the front switch pack.

1.2. Sleeper HVAC Controller Diagnostics

1.2.1. Sleeper HVAC Controller Power Circuit Diagnostics

The sleeper HVAC controller performs a diagnostic test on the voltage being supplied to the controller via the sleeper accessory relay. The voltage provided on this circuit must be within the range of 9 -16 volts, or the sleeper HVAC controller will detect the fault.

The sleeper HVAC controller will take the following actions if the supply voltage is outside of this range:

- Disables the digital sleeper HVAC controls display (if equipped) by removing the pulse width modulated (PWM) panel dimmer output voltage to the sleeper HVAC controls.
- Stops communication with the body controller.
- Stops sleeper blower function by removing voltage (0 – 5 volts) being provided to the sleeper linear power module (LPM).
- Stops the temperature actuator by controlling the actuator to either fully clockwise or fully counter-clockwise. The position depends on the state of the actuator when the fault is detected.

The controller takes the actions above if the voltage reaches 16.5 volts until it is brought down below 16 volts. The controller also takes the actions above if the voltage reaches 8.5 volts until it is brought up to 9 volts.

The sleeper HVAC controller will transmit an active fault for 10 seconds after the voltage has returned back to 'normal' level. Then the fault will go to history. The body controller does not set a DTC for this condition; however, Diamond Logic Builder (DLB) can be used to monitor the appropriate ***Rear_HVAC_Fault_Occurrence_Count*** signal to determine whether occurrences of this fault **(See Note)** are in the history**.**

Note: Fault 9 is the occurrence count for battery/system voltage. Fault 10 is the occurrence count for battery/system voltage low. These signals are useful in diagnosing an intermittent short on the power circuit to the sleeper HVAC controller. Refer to the Signal Definitions section for more information.

1.2.2. Instrument Panel Dimming Circuit Diagnostics

Instrument panel dimming applies only to vehicles equipped with digital sleeper HVAC controls.

The gauge cluster provides a pulse width modulated voltage (PWM) to the sleeper HVAC controller on the instrument panel dimmer circuit if the key switch is in the ACCESSORY or ON position and the parking lights are on. The voltage on this circuit varies between approximately 2 and 12 volts depending on the position of the instrument panel dimmer switch. The sleeper HVAC controller then reduces this voltage and provides a PWM signal of approximately 0 to 5 volts (depending on the dimmer switch) to illuminate the sleeper HVAC controls.

The gauge cluster monitors the voltage on its instrument panel dimmer output circuit. The output is disabled and a fault is set if a short to ground is detected on this circuit. The output will be disabled until the key switch is cycled. The cluster can't detect a short to battery on this circuit, since this circuit provides battery voltage during the normal "full bright" condition.

The sleeper HVAC controller also monitors the voltage value of its PWM dimmer circuit from the sleeper HVAC controller to the sleeper HVAC controls to determine if the circuit is operating outside of its normal range.

The sleeper HVAC controller will assume the PWM dimmer circuit is shorted to ground if detects that the voltage on the circuit is less than 0.5 volts. On vehicles equipped with a digital display, the sleeper HVAC controls will illuminate its backlighting and bar graph at full brightness if this occurs. The sleeper HVAC controller will assume the PWM dimmer circuit is shorted to battery if detects that the voltage on the circuit is greater than 5 volts.

Fault information will be communicated from the sleeper HVAC controller to the body controller if the voltage readings are either out of range high or out of range low.

Sleeper HVAC Controller Troubleshooting

These tests can be used to resolve problems related to power and ground circuits or the instrument panel dimming input circuit of the sleeper HVAC controller.

Review the General Diagnostic Information section prior to performing the following electrical tests.

Perform the following tests with the key switch in the ACCESSORY or ON position (the engine does not need to be running).

Voltage and Ground Test

Perform this test at the sleeper HVAC controller harness connector with the connector disconnected.

With multi-meter connected between the switched 12V circuit (pin 3) of the harness connector and the ground circuit (pin 4) of the harness connector the meter should read 12 ± 1.5 volts with the key switch in the ACCESSORY position.

The voltage specified above is provided by the sleeper accessory relay.

If the specified voltage is not present, correct the condition. ***If the specified voltage is present, proceed to the next test.***

Instrument Panel Dimmer Input Circuit Test (Digital Sleeper HVAC Controls)

Perform this test at the sleeper HVAC controller harness connector with the connector disconnected.

Turn ON the headlamps or park lamps.

With multi-meter connected between the PWM instrument panel dimmer input circuit (pin 17) of the harness connector and the ground circuit (pin 4) of the harness connector the meter should read between 0 and 12 volts adjustable with the PANEL dimmer control.

Note: This is the dimmer circuit which is output from the gauge cluster and input to the sleeper HVAC controller.

Refer to Digital Controls Troubleshooting for diagnostics related to the PWM dimmer output circuit between the sleeper HVAC controller and the digital sleeper HVAC controls.

If the specified voltage is not present, correct the condition.

1.3. Controlling the System from the Sleeper

The sleeper HVAC controls consist of rotary or digital controls depending on the vehicle options. The main difference in the operation of the two types of controls is the manner in which the circuits are input to the sleeper HVAC controller. The inputs are used by the sleeper HVAC controller to electronically control the sleeper blower fan speed, request the front A/C compressor clutch, and control the actuator that moves the air door used to control sleeper air temperature.

No diagnostic trouble codes are associated with the rear blower or temperature switch control input circuits to the sleeper HVAC controller.

1.3.1. Rotary Sleeper HVAC Controls

The sleeper blower speed control consists of eight (8) distinct blower speeds in addition to the off setting. The sleeper temperature control has twenty one (21) distinct settings.

The rotary sleeper HVAC controls consist of two knobs connected to potentiometers which provide analog inputs to the sleeper HVAC controller. The sleeper HVAC controller provides a zero volt reference (ZVR) and a 5 volt reference signal to both the blower speed control and the temperature control potentiometers. Each potentiometer provides an analog input signal of approximately 0 to 5 volts (depending on the position of the rotary control) to the sleeper HVAC controller. The sleeper HVAC controller uses this information to adjust the blower speed or temperature setting accordingly.

The output side of the sleeper controls is discussed in the Sleeper Blower Control section and the Sleeper Temperature Control section.

1.3.1.1. Rotary Controls Troubleshooting

This section is intended for use with the appropriate circuit diagram manual.

Rotary HVAC Controls Potentiometer Troubleshooting
These tests can be used to resolve problems related to the blower speed control or the temperature control potentiometer circuits. **Review the General Diagnostic Information section and the Rotary Sleeper HVAC Controls section prior to performing the following electrical tests.** **Diagnose and resolve any Diagnostic Trouble Codes prior to performing the following tests.** **Perform the following tests with the key switch in the ACCESSORY or IGNITION position (the engine does not need to be running).**
Potentiometer Signal Output Test
Perform this test at the appropriate control potentiometer connector with all electrical connectors

connected.

With a multi-meter connected between the signal circuit (pin B) of the potentiometer and the zero volt reference (ZVR) circuit (pin C) of the potentiometer the meter should read approximately 0 to 5 volts variable depending on the position of the rotary control.

The voltage specified above is output from the potentiometer.

If the specified voltage is present and a blower control or temperature control problem exists, proceed to the Blower Diagnostics section **OR** the Temperature Actuator Diagnostics section.

If the specified voltage is not present, proceed to the Potentiometer Power and Ground Test.

Potentiometer Power and Ground Test

Perform this test at the appropriate control potentiometer harness connector with the connector disconnected.

With a multi-meter connected between the 5 volt reference circuit (pin A) of the harness connector and the zero volt reference (ZVR) circuit (pin C) of the harness connector the meter should read approximately 5 volts.

The voltage specified above is provided by the sleeper HVAC controller.

If the specified voltage is not present, correct the condition.

If the specified voltage is present, proceed to the Potentiometer Resistance Test.

Potentiometer Resistance Test

Place the key switch in the OFF position.

Perform this test at the appropriate control potentiometer with the harness connector disconnected.

Measure the resistance of the potentiometer with a multi-meter connected between pins B and C of the potentiometer. The resistance should be within the range of approximately 0 – 10K ohms, increasing as the potentiometer is moved from the minimum to the maximum setting (values must fall within the range specified above while the potentiometer is moved).

Measure the resistance of the potentiometer with a multi-meter connected between pins A and B of the potentiometer. The resistance should be within the range of approximately 0 – 10K ohms, decreasing as the potentiometer is moved from the minimum to the maximum setting (values must fall within the range specified above while the potentiometer is moved).

NOTE: Replace the appropriate potentiometer if the resistance does **NOT** fall within the range specified above.

1.3.2. Digital Sleeper HVAC Controls

There are ten (10) distinct blower speeds (in addition to the off setting) and twenty (21) distinct temperature settings on vehicles equipped with digital sleeper HVAC controls.

The digital sleeper HVAC control panel consists of 4 momentary push buttons which provide digital inputs to the sleeper HVAC controller. Two of the buttons are used to adjust the blower speed setting, and the other two buttons are used to adjust the temperature setting. These buttons operate in conjunction with the sleeper HVAC controller to incrementally change the blower speed or temperature setting. A press and release of either switch will change the selected level by one increment. A press and hold of either switch will rapidly change the selected level. A digital display is used to indicate the current temperature and blower setting in the form of a bar graph.

There are 4 circuits associated with the digital blower speed control and temperature controls. These circuits are used to request a change in blower speed or temperature. Each circuit is pulled up (biased) to 5 volts inside the sleeper HVAC controller when the switches are not being pressed. The sleeper HVAC control panel grounds the related circuit when a button is pressed. The sleeper HVAC controller uses this information to adjust the blower speed or temperature setting accordingly.

The output side of the sleeper controls is discussed in the Sleeper Blower Control section and the Sleeper Temperature Control section.

The sleeper HVAC controller uses two additional circuits to communicate the current blower and temperature setting data to the sleeper HVAC controls for the bar graph display. The voltage on these circuits varies anywhere from 0 up to 5 volts depending on the information being sent to the sleeper HVAC control panel. 0 volts should be present on the circuit when there is 'no change' in the setting. **NOTE: Diagnosing these circuits should consist of simple resistance tests only, as the voltages fluctuate rapidly.**

1.3.2.1. Digital Controls Troubleshooting

This section is intended for use with the appropriate circuit diagram manual.

Digital HVAC Controls Troubleshooting

These tests can be used to resolve problems related to circuits on vehicles equipped with a digital sleeper HVAC display.

Review the General Diagnostic Information section and the Digital Sleeper HVAC Controls section prior to performing the following electrical tests.

Perform the following tests with the key switch in the ACCESSORY or ON position (the engine does not need to be running).

Voltage and Ground Test

Perform test at the Digital Sleeper HVAC Controls connector with the connector connected.

With multi-meter connected between the 12V circuit (pin 7) of the digital sleeper HVAC controls and the ground circuit (pin 8) of the digital sleeper HVAC controls the meter should read 12 ± 1.5 volts with the key switch in the ACCESSORY position.

The voltage specified above is provided by the sleeper HVAC controller.

If the specified voltage is not present, correct the condition. ***If the specified voltage is present, proceed to the next test.***

Instrument Panel Dimmer Circuit Test

Perform test at the Digital Sleeper HVAC Control Panel connector with the connector connected.

Review the Instrument Panel Dimming Circuit Diagnostics section prior to performing the following test.

Turn ON the headlamps or park lamps.

With multi-meter connected between the PWM instrument panel dimmer circuit (pin 15) of the digital sleeper HVAC controls and the ground circuit (pin 8) of the digital sleeper HVAC controls the meter should read between 0 and 5 volts adjustable with the PANEL dimmer control.

The voltage specified above is provided by the sleeper HVAC controller.

If the specified voltage is not present, correct the condition. ***If the specified voltage is present, proceed to the next test.***

Push Button Signal Output Test

Perform test at the Digital Sleeper HVAC Controls connector with the connector connected.

Connect a multi-meter between the appropriate circuit (listed below) and the ground circuit (pin 8) of the digital sleeper HVAC controls.

- Temperature Switch “Up” circuit (pin 11)
- Temperature Switch “Down” circuit (pin 12)
- Blower Switch “Up” circuit (pin 13)
- Blower Switch “Down” circuit (pin 14)

Note: Monitor the circuit(s) from the list above that corresponds with the inoperative sleeper HVAC

function.

The meter should read approximately 5 volts when the appropriate switch is not pressed and approximately 0 volts when the switch is pressed.

If the specified voltage is present and a blower control or temperature control problem exists, proceed to the Blower Diagnostics section **OR** the Temperature Actuator Diagnostics section.

If the specified voltage is not present, correct the condition.

1.4. Controlling the System from the Cab

The control of the sleeper HVAC system can also be accomplished from the sleeper HVAC temperature and blower switch pack switches located in the cab on the instrument panel. These switches provide input signals to the body controller on the data link, and are represented by **Rear_HVAC_Blower** and **Rear_HVAC_Temp** in DLB. The body controller sends a request to the sleeper HVAC controller to adjust the temperature or blower speed control setting while the appropriate switch is pressed. These signals are represented by **Blower_Switch_State** and **Temp_Switch_State**.

The sleeper HVAC controller allows the last request (cab or sleeper) to override the last known temperature or blower speed control setting. For example, if the last blower speed was set by the sleeper HVAC controls, and is then adjusted using the cab mounted blower switch; the cab's blower speed request will have priority.

Due to this design, vehicles equipped with rotary sleeper controls may experience the following scenario: Turning the sleeper temperature control clockwise may result in a lower temperature setting than the current sleeper temperature setting if the current setting was last selected by the front (cab mounted) sleeper temperature control. This is a limitation of the design and is considered normal operation. Adjustments from the cab mounted sleeper controls on vehicles equipped with digital sleeper controls, however, will be displayed in the sleeper HVAC controls bar display, and will be synchronized with the sleeper control's settings, such that commands from the sleeper controls will increment up from the last setting adjusted by the front (cab mounted) controls and vice versa.

2. Start-Up Operation (Initialization)

The Sleeper HVAC controller will control the sleeper HVAC system to the setting that existed during the last "key off" when the key is turned to the IGNITION position.

2.1. Sleeper HVAC System Calibration

The following procedure will be performed when supply voltage is first applied to the sleeper HVAC controller. There must not be any active "loss of communication" related diagnostic trouble codes to initiate calibration.

- The sleeper HVAC controller cycles the temperature actuator and air door to establish a known starting position.

Whenever the temperature actuator is energized while disconnected (such as during testing), it must be recalibrated after it is reconnected. After reassembling the door and actuator, and reconnecting the actuator connector, initiate the door position calibration procedure.

There are 2 ways to initiate temperature actuator calibration:

- Press and hold the hot and cold buttons (digital controls only) for approximately 3 seconds.
- **OR** command the **Rear_HVAC_Actuator_Cal_Req** signal using DLB. DLB displays ☑ while calibration is being requested. Check box ☑ for approximately one (1) second to initiate calibration, ***then ensure box is unchecked.***

3. Signal Definitions

This section connects the DLB displayed signal name to the circuit diagram. Refer to the electrical circuit diagram for specific pins. DLB displays the status on certain signals where a value of zero (0) indicates a good status.

3.1. Sleeper HVAC Signals

- ***Rear_HVAC_AC_Req*** – SAE J1939 input signal from the sleeper HVAC controller to the body controller. DLB displays ☑ while the air conditioning is being requested "on" from the sleeper controls. Refer to the Sleeper HVAC A/C Request section for more information.

- ***Rear_HVAC_Actuator_Cal_Req –*** SAE J1939 output signal from the body controller to the sleeper HVAC controller. DLB displays ☑ while the body controller requests the sleeper HVAC controller to calibrate the temperature actuator. Calibration is needed if the temperature actuator is energized while disconnected.

  There are 2 ways to initiate temperature actuator calibration:

  - Press and hold the hot and cold buttons (digital controls only) for approximately 3 seconds.
  - **OR** command the **Rear_HVAC_Actuator_Cal_Req** signal using DLB. DLB displays ☑ while calibration is being requested. Check box ☑ for approximately one (1) second to initiate calibration, ***then ensure box is unchecked.***

- ***Rear_HVAC_Blower_DN –*** Data link input signal from a switch pack to the body controller. DLB displays ☑ while the Sleeper HVAC blower switch (located on the front instrument panel) is pressed (and held) in the LOWER position. The body controller communicates a data link request **(Blower_Switch_State)** to the sleeper HVAC controller while the ***Rear_HVAC_Blower_DN*** signal is active.

- ***Rear_HVAC_Blower_UP –*** Data link input signal from a switch pack to the body controller. DLB displays ☑ while the Sleeper HVAC blower switch (located on the front instrument panel) is pressed (and held) in the UPPER position. The body controller communicates a data link request **(Blower_Switch_State)** to the sleeper HVAC controller while the ***Rear_HVAC_Blower_UP*** signal is active.

- **Blower_Switch_State** – SAE J1939 output signal from the body controller to the Sleeper HVAC Controller. The sleeper HVAC controller uses this information to adjust its blower speed setting accordingly. DLB displays the following:

    - A value of (2) if the blower speed control switch is pressed (and held) in the UPPER position.
    - A value of (1) if the blower speed control switch is pressed (and held) in the LOWER position.
    - A value of (0) if the blower speed control switch is RELEASED.

  NOTE: These values change only if the blower speed control setting is adjusted from the switch pack blower switch located in the cab on the instrument panel.

- ***Rear_HVAC_Temp_DN –*** Data link input signal from a switch pack to the body controller. DLB displays ☑ while the Sleeper HVAC temperature switch (located on the front instrument panel) is pressed (and held) in the LOWER position. The body controller communicates a data link request **(Temp_Switch_State)** to the sleeper HVAC controller while the ***Rear_HVAC_Temp_DN*** signal is active.

- ***Rear_HVAC_Temp_UP –*** Data link input signal from a switch pack to the body controller. DLB displays ☑ while the Sleeper HVAC temperature switch (located on the front instrument panel) is pressed (and held) in the UPPER position. The body controller communicates a data link request **(Temp_Switch_State)** to the sleeper HVAC controller while the ***Rear_HVAC_Temp_UP*** signal is active.

- **Temp_Switch_State** – SAE J1939 output signal from the body controller to the Sleeper HVAC Controller. The sleeper HVAC controller uses this information to adjust its temperature setting accordingly. DLB displays the following:

    - A value of (2) if the temperature control switch is pressed (and held) in the UPPER position.
    - A value of (1) if the temperature control switch is pressed (and held) in the LOWER position.
    - A value of (0) if the temperature control switch is RELEASED.

NOTE: These values change only if the temperature control setting is adjusted from the switch pack blower switch located in the cab on the instrument panel.

- ***Rear_HVAC_Blower_SPD –*** SAE J1939 input signal from the Sleeper HVAC Controller to the body controller. DLB displays the current blower speed in percentage (%). The body controller uses this information to adjust the gauge cluster's display on both rotary and digital controls. The values vary depending on blower setting, engine running state, and whether the vehicle is equipped with rotary or digital sleeper HVAC controls. Refer to the Blower Motor Cross Reference Tables section for more information.

- ***Rear_HVAC_Discharge_Temp_Setting –*** SAE J1939 input signal from the sleeper HVAC controller to the body controller. DLB displays the temperature setting in percentage (%) from 0 to 100% based on the information received from the sleeper HVAC controller (100% corresponds to full hot). The body controller uses this information to adjust the gauge cluster's display on both rotary and digital controls.

  Typical values might be: 0 (coldest), 4.8, 10, 15.2, 20.4, 25.2, 30.4, 35.6, 40.8, 45.6, 50.8, 56, 61.2, 66, 71.2, 76.4, 81.6, 86.4, 91.6, 96.8, and 102 (hottest).

- ***Retrieve_Rear_HVAC_Fault_Occurrence_Count***. – SAE J1939 output signal from the body controller to the sleeper HVAC controller. Enabling this signal ☑ for approximately one (1) second using DLB will request fault occurrences from the sleeper HVAC controller.

- ***Clear_Rear_HVAC_Fault_Occurrence_Count***. – SAE J1939 output signal from the body controller to the sleeper HVAC controller. Enabling this signal ☑ for approximately one (1) second using DLB will request fault occurrences to be cleared from the sleeper HVAC controller.

- ***Rear_HVAC_Fault_(1-16)_Occurrence_Count***. – Occurrence count value for faults 1-16. DLB displays a value of (0) to (255) for each fault. The faults are defined as follows:

Fault #	Definition	Corresponding SPN	FMI
Fault 1	Blower output to LPM over expected voltage.	520210	3
Fault 2	Blower output to LPM under expected voltage.	520210	4
Fault 3	Blower output to LPM short circuited.	520210	6
Fault 4	Temperature door actuator malfunction.	520211	7
Fault 5	Duct temperature sensor voltage high.	1548	3
Fault 6	Duct temperature sensor voltage low.	1548	4
Fault 7	Dimmer output voltage high.	520212	3
Fault 8	Dimmer output voltage low.	520212	4
Fault 9	Battery/System voltage high.	N/A	N/A
Fault 10	Battery/System voltage low.	N/A	N/A

NOTE: Enable the ***Retrieve_Rear_HVAC_Fault_Occurrence_Count*** signal ☑ for approximately one (1) second using DLB to ensure the latest fault information is displayed.

- ***EGC_HVAC_Blower_Speed –*** SAE J1939 output signal from the body controller to the gauge cluster. This is the speed of the blower for display in the gauge cluster. The value of this signal matches the **Rear_HVAC_Blower_SPD** signal value.

- ***EGC_HVAC_Temp_Setting –*** SAE J1939 output signal from the body controller to the gauge cluster. This is the temperature setting of the sleeper HVAC system for display in the gauge cluster. The value of this signal matches the ***Rear_HVAC_Discharge_Temp_Setting*** signal value.

- ***Activate_Front_HVAC_Blower_Message –*** SAE J1939 output signal from the body controller to the gauge cluster. The "Activate HVAC Front Blower" text message is provided by the gauge cluster if the sleeper HVAC controller is requesting engagement of the AC compressor while the front blower control is off. DLB displays ☑ while the body controller sends the request to the gauge cluster for the text message. Refer to the Text Messages section for more information.

- ***Front_AC_Blower_Speed_Raw –*** Analog input from the front HVAC control head to the front linear power module (LPM) monitored by the body controller. The body controller recognizes the state of the front HVAC blower speed setting using the value of this signal. The A/C clutch will not engage unless the front blower speed control is at least in the minimum blower speed setting or greater (not in the off setting). A text message will be displayed in the gauge cluster, represented by the signal (***Activate_Front_HVAC_Blower_Message)*** if the sleeper controls request the A/C ***(Rear_HVAC_AC_Req***) while the front blower speed is set to the off position.

- ***Engine_Speed*** – SAE J1939 input signal from the ECM to the body controller. The body controller passes the information along to the sleeper HVAC controller. This information is monitored by the sleeper HVAC control for reduced power blower mode operation.

- ***Ambient_Air_Temperature*** – SAE J1939 input signal from the gauge cluster to the body controller. The body controller passes the information along to the sleeper HVAC controller. This signal represents the outside air temperature that is reported by the gauge cluster. The sleeper HVAC system uses this information to request A/C in the event of an active sleeper temperature sensor DTC.

3.2. Front HVAC Signals

The following signals (used by the front HVAC) are referenced in this document.

- ***AC_Clutch –*** Output signal from the body controller to the A/C clutch. DLB displays ☑ while the body controller supplies voltage to the A/C clutch.

- ***BC_RCD_Pressure_Signal*** – Analog input signal from the A/C pressure transducer to the body controller. This signal is conditioned from the raw A/C pressure transducer signal and represents the system high side pressure in pounds per square inch. The pressure is measured on the output side of the condenser before the thermal expansion valve.

- ***BC_RCD_Temp_In_Signal –*** Analog input signal from the inlet thermistor to the body controller. This signal is conditioned from the raw inlet thermistor signal and represents the temperature of the refrigerant on the input side of the evaporator in degrees Fahrenheit.

- ***BC_RCD_Temp_Out_Signal –*** Analog Input signal from the outlet thermistor to the body controller. This signal is conditioned from the raw outlet thermistor signal and represents the temperature of the refrigerant on the output side of the evaporator in degrees Fahrenheit.

- ***HVAC_Diagnostic_Value*** – Internal signal used by the body controller to indicate various fault conditions. This signal is determined by the frequency of the ***RCD_HVAC_Ctrl_Head_Diag_Signal.*** Some fault conditions cause the body controller to log a fault and disable the A/C system. Lesser faults cause the body controller to log a fault, but allow the A/C system to continue to operate. DLB displays the following values:

    - (0) = No faults.
    - (1) = Air Inlet Fault (Re-circulation Door Fault).
    - (2) = Temp Mix Fault.
    - (3) = Mode Fault.
    - (4) = Multiple Faults (A/C clutch is disabled).
    - (5) = Control Head Fault (A/C clutch is disabled).

4. Feature Functions

4.1. Sleeper Blower Control

The Sleeper HVAC blower motor assembly consists of a permanent magnet motor attached to a balanced 'squirrel-cage' fan unit. The blower speed is controlled by the blower speed control on the sleeper HVAC controls, located in the sleeper.

Review the section, <u>Controlling the System from the Sleeper</u> for a detailed description and diagnosis of the switch portion of the sleeper blower speed control.

4.1.1. Sleeper Linear Power Module (LPM)

The sleeper linear power module (LPM) receives battery voltage from the interior power distribution center (PDC) located in the cab. The sleeper LPM is permanently grounded at the ground stud. When a blower speed is selected, the sleeper HVAC controller outputs a voltage (between 0 and 4.75 volts) to the linear power module (LPM) on the blower control circuit. This voltage is variable based on the blower speed control setting.

The LPM responds by acting as a variable resistance between the blower motor and ground. This variable resistance is in the ground circuit of the blower motor. As the blower speed control is turned clockwise, the apparent resistance to ground decreases, the voltage across the blower motor increases, and the speed increases. The sleeper LPM provides battery voltage to the sleeper blower motor.

Note 1: When the key switch is turned to the ACCESSORY position, the sleeper blower will slowly ramp up to the current blower speed setting to reduce current draw on the vehicle. The time it takes for this to occur will increase as the set point is increased prior to key cycle. For example, the blower may take several seconds to slowly ramp to the maximum blower speed if the blower speed control switch is set to the highest setting when the key is turned to ACCESSORY.

Note 2: The blower control circuit is pulled up (biased) to near accessory voltage inside the sleeper HVAC linear power module (LPM) if the sleeper HVAC controller electrical connector is disconnected.

4.1.2. Reduced Power Blower Mode

The blower output will be limited to approximately half of the normal maximum speed setting if:

- **[**The engine is **NOT** running **(See Note 1)**.
- **AND** the key switch is in the ACCESSORY position.
- **AND** the sleeper HVAC controller is communicating properly with the body controller **(See Note 2)]**.

OR

- The sleeper HVAC controller does not receive an engine speed message from the body controller.

Reduced power mode will occur if the conditions above are met regardless of the blower speed control setting. For example, the blower speed will be limited to setting # 5 if the engine is off and the vehicle is equipped with digital sleeper HVAC controls. This is true even if the blower speed control is set to the maximum speed. Refer to the Blower Motor Cross Reference Tables for more information.

Note 1: An engine speed message < 100 RPM from the body controller is considered 'engine not running'.

Note 2: The body controller must receive a valid 'heartbeat' message from the sleeper HVAC controller or reduced power blower mode will not be performed. A 'heartbeat' message that is temporarily lost must have been returned for at least 3 seconds.

4.1.3. Blower Diagnostics

4.1.3.1. Blower Control Circuit Diagnostics

The sleeper HVAC controller monitors the voltage value of the blower control circuit from the sleeper HVAC controller to the sleeper HVAC linear power module (LPM) to determine if the circuit is operating outside of its normal range.

The sleeper HVAC controller will assume the blower control circuit is shorted to ground if detects that the voltage on the blower control circuit is 0.35 volts less than the voltage expected by the controller at that blower speed. Similarly, the sleeper HVAC controller will assume the blower control circuit is shorted to battery (or open) if it detects that the voltage on the blower control circuit is 0.35 volts more than the voltage expected by the controller at that blower speed. Refer to the Blower Motor Cross Reference Tables section for expected voltages based on blower speed settings.

Fault information will be communicated from the sleeper HVAC controller to the body controller if the voltage readings are either out of range high or out of range low.

4.1.3.2. Blower Motor Diagnostics

This section was intended for use with the appropriate circuit diagram manual.

NOTE: Check for broken fan blades or a wedged fan if no electrical failures are found or if a mechanical problem (such as abnormal noise, etc.) is indicated.

Sleeper Blower Motor Circuit Troubleshooting

Review the General Diagnostic Information section prior to performing the following electrical tests.

Refer to the Rotary Controls Troubleshooting section or the Digital Controls Troubleshooting section for problems related to the sleeper blower control switch.

If Blower Motor is Always On

Test for the following conditions if the blower runs constantly:

- A short to ground in the circuit **(pin 2)** of the sleeper LPM **(See Note)** between the sleeper blower motor and the sleeper LPM**.**

NOTE: The amount of resistance in the "ground circuit"* (pin 2) *is controlled by the linear power module (described at the beginning of this section). Under normal operating conditions this circuit should appear be fully grounded when the sleeper blower speed control is at the maximum blower speed setting and the engine is running.

Sleeper Blower Motor Circuit Troubleshooting (continued)

Sleeper LPM Voltage and Ground Test

Perform this test at the sleeper LPM connector (5214).

Perform the test with:

- Key switch in the OFF position.
- All electrical connectors connected.

With multi-meter connected between the battery voltage circuit (pin 6) of the LPM and the ground circuit (pin 5) of the LPM the meter should read 12 ± 1.5 volts.

The voltage specified above is provided by the interior power distribution center (PDC).

If the specified voltage is not present, correct the condition. ***If the specified voltage is present, proceed to the next test.***

Sleeper Blower Motor Voltage Test

Perform this test at the sleeper blower motor connector (located on the sleeper LPM).

Perform the test with:

- Key switch in the OFF position.
- All electrical connectors connected.

With multi-meter connected between the battery voltage circuit (pin 1) of the blower motor and a good ground the meter should read 12 ± 1.5 volts.

The voltage specified above is provided by the sleeper linear power module (LPM).

If the specified voltage is not present, correct the condition. ***If the specified voltage is present, proceed to the next test.***

Blower Fan Control Circuit Voltage Test

Review the Blower Control Circuit Diagnostics section prior to performing this test.

Perform this test at the sleeper linear power module (LPM) connector(s).

Perform the test with:

- Key switch in the ACCESSORY or IGNITION position, with the engine OFF.
- All electrical connectors connected.

With multi-meter connected between the blower control circuit (pin 4) of the sleeper LPM and the ground circuit (pin 5) of the sleeper LPM the meter should read within the range of 0 and 2.5 volts (with engine OFF), depending on the blower speed control setting.

NOTE: The voltage must fall within .35 volts of the expected voltage at each blower speed or a DTC is set. This is determined by the sleeper HVAC controller. Refer to Blower Motor Cross Reference Tables for more information.

The voltage specified above is provided by the sleeper HVAC controller. The sleeper HVAC controller provides the voltage to the sleeper LPM on the blower control circuit. The voltage should be lowest when the blower control is at the minimum speed setting. The voltage should increase as blower setting is increased, and should be at its highest value when the blower control is at the maximum speed setting. Refer to the Sleeper Linear Power Module (LPM) section for more information.

If the specified voltage is not present, correct the condition. ***If the specified voltage is present, proceed to the next test.***

Sleeper Blower Motor Circuit Troubleshooting (continued)

Perform the following tests with:

- Key switch in the OFF position.
- All electrical connectors connected.

Sleeper Blower Motor Output/Ground Circuit Test

Momentarily connect a fused jumper from the **"ground"** circuit **(See Note 1)** of the sleeper blower motor at the sleeper LPM connector to a good ground.

NOTE 1: The amount of resistance to ground in this "ground circuit" is controlled by the sleeper LPM (described at the beginning of this section). Under normal operating conditions this circuit should appear be fully grounded when the sleeper blower speed control is at the maximum blower speed setting and the engine is running.

Connecting the indicated jumper should energize the blower at maximum speed while the jumper is connected. Once blower operation is checked, REMOVE jumper.

Correct any invalid conditions found from the test results.

4.1.4. Blower Motor Cross Reference Tables

4.1.4.1. Rotary Sleeper HVAC Controls

Blower Speed Setting	Engine Running (Normal Mode)		Engine OFF, Accessory ON (Reduced Power Mode)	
	Voltage **(See Note 1)**	Blower Speed **(See Note 2)**	Voltage **(See Note 1)**	Blower Speed **(See Note 2)**
0	0	0%	0	0%
1	0.75	15%	0.75	15%
2	1.29	26%	0.99	20%
3	1.82	36%	1.22	24%
4	2.36	47%	1.46	29%
5	2.89	58%	1.69	34%
6	3.43	69%	1.93	39%
7	3.96	79%	2.16	43%
8	4.50	90%	2.40	48%
NOTE: Actual voltage readings and blower speed % may vary. However, voltages must fall within .35 volts of the indicated values, or a DTC will be set.				

Note 1: Voltage in the table is as measured at the blower control circuit (pin 5) of the sleeper HVAC controller.

Note 2: The blower speed percentage **(*Rear_HVAC_Blower_SPD*)** displayed in DLB may vary slightly from the values indicated in this table.

4.1.4.2. Digital Sleeper HVAC Controls

Blower Speed Setting	Engine Running (Normal Mode)			Engine OFF, Accessory ON (Reduced Power Mode)		
	Voltage (See Note 1)	**Blower Speed** (See Note 2)	**Displayed Blower Setting**	**Voltage** (See Note 1)	**Blower Speed** (See Note 2)	**Displayed Blower Setting**
0	0	0%	-	0	0%	-
1	0.75	15%	□	0.75	15%	□
2	1.17	23%	□□	1.17	23%	□□
3	1.58	32%	□□□	1.58	32%	□□□
4	2.00	40%	□□□□	2.00	40%	□□□□
5	2.42	48%	□□□□□	**2.42**	**48%**	□□□□□
6	2.83	57%	□□□□□□	**2.42**	**48%**	□□□□□
7	3.25	65%	□□□□□□□	**2.42**	**48%**	□□□□□
8	3.67	73%	□□□□□□□□	**2.42**	**48%**	□□□□□
9	4.08	82%	□□□□□□□□□	**2.42**	**48%**	□□□□□
10	4.50	90%	□□□□□□□□□□	**2.42**	**48%**	□□□□□
NOTE: Actual voltage readings and blower speed % may vary. However voltages must fall within .35 volts of the indicated values, or a DTC will be set.						

Note 1: Voltage in the table is as measured at the blower control circuit (pin 5) of the sleeper HVAC controller.

Note 2: The blower speed percentage **(*Rear_HVAC_Blower_SPD*)** displayed in DLB may vary slightly from the values indicated in this table.

For example, typical **(*Rear_HVAC_Blower_SPD*)** values for a vehicle equipped with digital sleeper HVAC controls might be 1.6, 15.6, 25.2, 32.4, 42, 50.8, 58, 67.6, 74.8, 83.6, and 93.2 while the engine is running.

4.2. Sleeper Temperature Control

Review the section, Controlling the System from the Sleeper for a detailed description and diagnosis of the switch portion of the sleeper temperature control.

The sleeper temperature control setting **(Rear_HVAC_Discharge_Temp_Setting)** increases between approximately 0 and 100% as the temperature control set point is increased from the minimum to the maximum setting. Refer to Sleeper HVAC Signals for more information about this signal.

4.2.1. Temperature Actuator

The temperature actuator (blend motor) controls a temperature blend air door that regulates the temperature of the air discharged from the vents. The temperature blend door determines what portion of the system input air is deflected through the heater core depending on the setting of the temperature control on the sleeper HVAC controls. As the temperature control setting is increased more air is deflected through the heater core, increasing the temperature of the system output air entering the sleeper.

The sleeper HVAC controller provides accessory voltage and ground to the sleeper HVAC temperature actuator. The sleeper HVAC controller also supplies a constant 5 volt signal on a circuit to the temperature actuator. This voltage is returned back to the sleeper HVAC controller as a variable voltage (0 to 5 volts) on the actuator feedback circuit. The voltage on this feedback circuit varies depending on the position of the temperature actuator. The sleeper HVAC controller uses this information to interpret the position of the actuator based on a known starting position. The sleeper HVAC controller provides different voltages to the temperature actuator via the input control circuit. The temperature actuator's response varies depending on the voltage received.

When the temperature control setting is changed, the sleeper HVAC controller will apply a drive voltage (0 or 5 volts) to the temperature door actuator on the input control circuit. This voltage causes the actuator to turn the temperature blend door to the desired position. The sleeper HVAC controller senses when the door reaches the correct position by monitoring the voltage on the actuator feedback circuit, and then supplies 2.5 volts on the input control circuit to stop the actuator. The following table describes the actuator's response to various voltages received on the input control circuit.

Voltage on the input control circuit	Tolerance (must fall within this range)	Actuator Response
0 volts	–0.4 to 1.0 volts	Rotate actuator counter-clockwise (colder)

2.5 volts	2.0 to 3.0 volts	Stop actuator
5 volts	4.0 to 5.5 volts	Rotate actuator clockwise (warmer)

The sleeper HVAC control will send 0, 2.5, or 5 volts to the temperature actuator for the following reasons:

- The temperature control switch is set to a position which requires the temperature actuator to control the temperature door to that targeted temperature.
- **OR** the sleeper HVAC controller has determined that the temperature from the sleeper air duct (as measured by the temperature sensor) has changed such that the temperature actuator must change its position to maintain the correct sleeper temperature.
- **OR** an actuator calibration is currently being performed.

The sleeper HVAC controller will output the appropriate voltage to the actuator (0 or 5 volts) on the input control circuit as long as it takes to achieve the desired position, and will then output 2.5 volts. The input control circuit should remain at 2.5 volts normally until the actuator receives a command from the sleeper HVAC controller.

The time required for the actuator to rotate from fully counter-clockwise to fully clockwise (or vise versa) is approximately 3-4 seconds. This is done by rotating the temp controls from HOT to COLD.

Note 1: If an actuator calibration is performed, and the controls were set to the middle position, the actuator will rotate clockwise, counterclockwise (to find the end points), then back to the middle position, which could take up to 10 seconds.

Note 2: Maximum COLD corresponds to an actuator rotated fully counter-clockwise. Maximum HOT corresponds to an actuator rotated fully clockwise. This is true while looking down on the actuator from inside the sleeper.

Note 3: Temperature actuator adjustments will be based solely on the position of the temperature control switch if an active DTC exists on the duct temp sensor.

.

To establish a known starting position, the sleeper HVAC controller runs the actuator and door through a calibration procedure when supply voltage is first applied to the sleeper HVAC controller. Refer to the Sleeper HVAC System Calibration section for more information.

4.3. Temperature Actuator Diagnostics

4.3.1. Temperature Actuator Electrical Diagnostics

If the temperature actuator is provided the appropriate voltage on the input control circuit, but does not move to its selected position after 20 seconds, due to an electrical or mechanical problem, the sleeper HVAC controller will sense the fault. The sleeper HVAC controller accomplishes the diagnostic test by comparing the feedback voltage from the actuator with the commanded setting. The sleeper HVAC controller will communicate this fault condition to the body controller, and the body controller will then set the appropriate diagnostic trouble code.

The actuator will attempt to move to the appropriate position once every 30 seconds up to 20 times. After 20 unsuccessful attempts, the sleeper HVAC controller sends the 2.5 volt signal to stop the actuator. This counter will be reset if the key switch is cycled from OFF to ACCESSORY. The occurrence count of the fault condition will be incremented for each unsuccessful attempt of the actuator.

The following table provides the troubleshooting procedures for isolating the cause of diagnostic trouble code 520211 related to the sleeper HVAC temperature actuator.

The following table was intended for use with the appropriate circuit diagram manual.

IMPORTANT: Whenever the temperature actuator is energized while disconnected (such as during testing), it must be recalibrated after it is reconnected. Refer to the Sleeper HVAC System Calibration section for more information.

Temperature Actuator Circuit Troubleshooting
Review the General Diagnostic Information section prior to performing the following electrical tests. ***Perform the following tests at the sleeper temperature actuator connector with:*** • The key switch in the ACCESSORY position. • All electrical connectors connected. **IMPORTANT:** Whenever the temperature actuator is energized while disconnected (such as during testing), it must be recalibrated after it is reconnected. Refer to the Sleeper HVAC System Calibration section for more information. **Refer to the Rotary Controls Troubleshooting section or the Digital Controls Troubleshooting section for problems related to the sleeper temperature control switch.**
Temperature Actuator Preliminary Tests
1. Move the sleeper temperature control switch to the extreme hot, and then to the extreme cold position to

attempt to clear any potential blockage.

2. Perform the actuator calibration procedure **(Rear_HVAC_Actuator_Cal_Req)** using DLB or using the temperature controls (digital controls only). Refer to the Sleeper HVAC System Calibration section for more information.

3. Perform the procedures referenced in the Temperature Actuator Mechanical Diagnostics section.

4. Correct any invalid conditions from the above procedures. ***If no invalid conditions are found, proceed to the next test.***

Temperature Actuator Voltage Tests

Perform the following tests at the sleeper temperature actuator connector with:

- The key switch in the ACCESSORY position (the engine does not need to be running).
- All electrical connectors connected.

IMPORTANT: Whenever the temperature actuator is energized while disconnected (such as during testing), it must be recalibrated after it is reconnected. Refer to the Sleeper HVAC System Calibration section for more information.

1. **With multi-meter connected between the supply voltage circuit (pin 5) of the temperature actuator and the ground circuit (pin 7) of the temperature actuator the meter should read 12 ± 1.5 volts with the key in the ACCESSORY position.**

   The voltage specified above is provided by the sleeper HVAC controller.

2. **With multi-meter connected between the 5 volt reference circuit (pin 10) of the temperature actuator and the ground circuit (pin 7) of the temperature actuator the meter should read approximately 5 volts.**

   The voltage specified above is provided by the sleeper HVAC controller.

3. Perform the actuator calibration procedure **(Rear_HVAC_Actuator_Cal_Req)** using DLB or using the temperature controls (digital controls only). Refer to the Sleeper HVAC System Calibration section for more information. Monitor the voltage on the feedback circuit of the actuator.

   With multi-meter connected between the feedback circuit (pin 9) of the temperature actuator and the ground circuit (pin 7) of the temperature actuator the meter reading should vary (while the actuator is moving) between 0 and 5 volts depending on the actuator's position.

   The voltage specified above is provided by the temperature actuator.

4. **With multi-meter connected between the input control circuit (pin 6) of the temperature actuator and the ground circuit (pin 7) of the temperature actuator the meter reading should read as follows:**

   - Approximately 0 volts when the sleeper temperature controls are moving towards the COLDEST

setting.
- Approximately 5 volts when the sleeper temperature controls are moving towards the WARMEST setting.
- The voltage should return to approximately 2.5 volts after the actuator has reached the correct position for the commanded setting.

Correct any invalid conditions found during the above tests.

NOTE: Replace the temperature actuator If the actuator door moves freely, and all actuator voltages are within the specified ranges,

4.3.2. Temperature Actuator Mechanical Diagnostics

The following tables provide troubleshooting procedures to isolate the cause of mechanical failures resulting in actuator related diagnostic trouble codes.

Sleeper Temperature Door Mechanical Troubleshooting

Possible Causes:
- Jammed/Damaged Door(s)
- Internal Actuator Slippage

Perform the following tests with the ignition key in the OFF position.

Test Points	Spec.	Comments
Remove the temperature door actuator. Grasp the door shaft and manually move door through its full range of movement.	Door should move freely throughout its range.	***If door operates correctly, proceed to the next step.*** If door does not operate correctly isolate and clear cause of door jam. If door jam cannot be cleared, replace the temperature door or housing.
Inspect the end of the door shaft that is driven by the temperature actuator.	Door shaft should be free of excessive wear.	***If door shaft is not free of excessive wear:*** • Replace temperature air door. ***If door shaft is free of excessive wear:*** Return to Temperature Actuator Preliminary Tests

4.4. Sleeper HVAC Sensors

4.4.1. Sleeper HVAC Temperature Sensor

The air duct temperature sensor allows the sleeper HVAC controller to monitor the temperature of the air going into the sleeper. This information is used by the sleeper HVAC controller to help control the temperature of the sleeper, and to help diagnose faults during abnormal system operation.

The sleeper HVAC controller provides the temperature sensor with approximately 5 volts and a Zero Volt Reference (ZVR). The voltage level of the temperature sensor is monitored by the sleeper HVAC controller which is used to control A/C system operation and detect system faults.

The temperature sensor has a negative temperature coefficient, such that the resistance of the sensor decreases as the air duct temperature increases. The resistance value of the temperature sensor is determined by the temperature of the air at its location. The change in sensor resistance causes a change in the voltage level measured by the sleeper HVAC controller at the sensor input. The voltage drop across the temperature sensor measured at the sleeper HVAC controller input increases as the sensor resistance increases.

4.4.2. Temperature Sensor Diagnostics

For diagnostic purposes, the sleeper HVAC controller monitors the voltage levels across the air duct temperature sensor to determine if the temperature sensor circuit is open or shorted to ground (or zero volt reference). The sleeper HVAC controller considers voltage values within 0.05 and 4.8875 volts to be in the normal range.

4.4.2.1. Shorted Temperature Sensor Diagnostics

If the sleeper HVAC controller reads a temperature sensor voltage value at the low end of its range of possible values it assumes that the temperature sensor circuit is shorted to ground, because this value (which corresponds to 340°F) does not reflect a normal reading.

The sleeper HVAC controller will set a fault indicating that the temperature sensor is shorted to ground. This information is communicated to the body controller.

4.4.2.2. Open Temperature Sensor Diagnostics

If the sleeper HVAC controller reads a temperature sensor voltage value at the high end of its range of possible values it assumes that the temperature sensor circuit is open, because this value (which corresponds to -50°F) does not reflect a normal reading.

If the sleeper HVAC controller determines that a temperature sensor circuit is open, it will set a fault accordingly. This information is communicated to the body controller.

Temperature Sensor Circuits Troubleshooting

Review the General Diagnostic Information section prior to performing the following electrical tests.

Temperature Sensor Voltage Test

Test at the harness connector of the temperature sensor with the sensor connector disconnected.

With multi-meter connected between the signal circuit (pin 1) of the harness connector and the zero volt reference (ZVR) circuit (pin 2) of the harness connector the meter should read 5 ± 0.5 volt with the key switch in the ACCESSORY position (the engine does not need to be running).

The voltage and zero volt reference specified above are provided by the sleeper HVAC controller.

If the specified voltage is not present, correct the condition. ***If the specified voltage is present, proceed to the next test.***

Temperature Sensor Resistance Test

Perform test at the temperature sensor with:

- The temperature sensor harness connector disconnected.
- The key switch in the OFF position.

Measure the resistance of the temperature sensor with multi-meter connected between the signal circuit (pin 1) of the temperature sensor and the zero volt reference (ZVR) circuit (pin 2) of the temperature sensor.

The resistance must be within the range of 44 – 271K Ohms.

If the resistance is not within the range specified above, replace the temperature sensor. If the resistance value is within the range, replace the sleeper HVAC controller.

4.5. Text Messages

4.5.1. "Activate HVAC Front Blower"

This text message is provided if the sleeper HVAC controller is requesting engagement of the AC compressor while the front blower control is off.

The body controller will request the "Activate HVAC Front Blower" message when the following conditions are true:

- The sleeper HVAC controller is requesting AC ON **(*Rear_HVAC_AC_Req*)**.
- AND the front blower control is in the OFF position.
- AND the engine is running.
- AND the body controller is receiving the ACCESSORY signal.
- AND there are no active diagnostic trouble codes.

The body controller sends a request to the gauge cluster when the conditions above are true.

4.6. Gauge Cluster Displayed HVAC Settings

Changes in Sleeper HVAC settings will be displayed in the gauge cluster display in the form of a bar display whether the system is adjusted from the front switch pack or from the rear sleeper controls. These settings will be displayed in the gauge cluster for several seconds after the appropriate control switch (blower or temperature) is released. The gauge cluster uses the information received from the body controller to accomplish this. The body controller sends a request to the gauge cluster on the data link to display the blower speed control setting **(*EGC_HVAC_Blower_Speed*)** or the temperature control setting **(EGC_HVAC_Temp_Setting)** as adjustments are made.

4.7. Sleeper A/C Request

Sleeper A/C operation is automatic, as there is no A/C button on the sleeper HVAC controls. The sleeper HVAC controller sends the request to the body controller based on the sleeper temperature control set point, the temperature of the sleeper outlet air duct, and the state of the sleeper blower switch. **The body controller still decides whether to engage the A/C clutch.**

The sleeper HVAC controller will request the A/C (Rear_HVAC_AC_Req) if:

- The sleeper air duct outlet temperature is greater than the sleeper temperature set point **(See Note 1)**.
- **AND** there must be no active temperature sensor **OR** "loss of communication" related diagnostic trouble codes **(See Note 2).**
- **AND** the sleeper blower speed control is **NOT** in the off position.

Note 1: Temperature is determined by the sleeper HVAC controller via the air duct temperature sensor input. The operator selected set point is controlled by either the front switch pack temperature switch or the rear sleeper HVAC controls.

Note 2: The sleeper HVAC controller will request the A/C based on the ambient temperature from the gauge cluster if an active temperature related DTC exists **(Ambient_Air_Temperature > sleeper temperature set point).**

The sleeper HVAC controller sends the A/C request (Rear_HVAC_AC_Req) to the body controller if the conditions above are met.

The A/C request **(Rear_HVAC_AC_Req)** will take longer to occur as the sleeper HVAC temperature set point is increased. The request delay varies between 2 seconds if the temperature control is set to maximum cold up to 64 seconds if the temperature control is set to maximum hot. The conditions for the sleeper A/C request (as described above) must also be met.

If the duct temperature becomes less than the sleeper temperature set point while the A/C request **(Rear_HVAC_AC_Req)** is active, a timer starts before the A/C request turns off. This prevents the A/C compressor from cycling on and off. The time at which the A/C request turns off decreases as the temperature set point increases.

Once the A/C request **(Rear_HVAC_AC_Req)** is received by the body controller, the normal rules for A/C clutch engagement apply.

4.7.1. Sleeper A/C Request Diagnostics

After ensuring there are no “loss of communication” diagnostic trouble codes, control the sleeper temperature set point to maximum cold. The A/C request **(Rear_HVAC_AC_Req)** should come on within approximately 2 seconds if the ambient temperature is greater than 40 degrees F.

4.8. A/C Clutch Control

If the body controller senses that the conditions are within operating limits, it turns on the A/C compressor by providing the compressor **(AC_Clutch)** with near accessory voltage. The complete list of conditions is below.

The body controller will engage the A/C compressor clutch* (AC_Clutch) *when ALL of the following conditions are true:

- The sleeper AC request signal **(Rear_HVAC_AC_Req)** is received from the sleeper HVAC controller with a good status **(See Note 1).**
- The front blower speed control **(Front_AC_Blower_Speed_Raw)** is **NOT** set to OFF **(See Note 2).**
- **AND** the inlet thermistor temperature **(BC_RCD_Temp_In_Signal)** is greater than or equal to 43 °F.
- **AND** the compressor has been **OFF** for at least 8 seconds.
- **AND** the A/C pressure transducer **(BC_RCD_Pressure_Signal)** is greater than 40 psig **(See Note 3).**

- **AND** the outlet thermistor temperature **(BC_RCD_Temp_Out_Signal)** is greater than 33 °F **(See Note 3).**
- **AND** the A/C pressure transducer **(BC_RCD_Pressure_Signal)** is less than 250 psig.
- **AND** there are no LOW CHARGE or VERY LOW CHARGE refrigerant faults active.
- **AND [**the HVAC control head DIAGNOSTIC signal **(See Note 4)** must be present at the body controller input, AND it must not indicate "multiple" or "control head" faults**].**
- **AND** the body controller is communicating properly with the engine control module AND the engine is running **(See Note 5).**
- **AND** there must be **NO** active faults detected in the A/C pressure transducer OR temperature thermistor circuits.
- **AND** the A/C compressor clutch virtual fusing circuit in the body controller must not be faulted. The virtual fuse circuit activates when the clutch draws more than 10 Amps (programmable), indicating a fault**.**

The body controller supplies voltage to the A/C clutch when the conditions above are true.

Note 1: DLB displays ☑ while the **(Rear_HVAC_AC_Req)** signal is active. Refer to the Sleeper HVAC A/C Request section for more information.

Note 2: The body controller contains a circuit which is connected to the blower control circuit where it monitors the front blower speed control set point.

Note 3: The body controller verifies that the pressure is greater than 40 psig **AND** the outlet thermistor temperature is greater than 33°F to verify that the ambient temperature is high enough for safe compressor operation.

Note 4: Monitor the **HVAC_Diagnostic_Value** signal using DLB. A value of (4) indicates "multiple" faults are present. A value of (5) indicates a "control head" fault is present, such as a missing diagnostic signal. Refer to Signal Definitions for more information.

Note 5: A J1939 engine RPM signal (indicating an engine RPM of at least 300) must have been present at the body controller for at least 8 seconds. Engine RPM signals that are temporarily lost must have been returned for at least 8 seconds.
Refer to the A/C clutch section of the HVAC description in the Electrical Troubleshooting Guide for a more information about the A/C clutch and its normal operation.

5. General Diagnostic Information

Refer to Cautions and Warnings in the HVAC Manual (S16039) prior to discharging the A/C system.

Be sure to perform the Diagnosis and Troubleshooting Flow Chart (and any referenced procedures) in the HVAC Manual (S16039) prior to performing tests on the electrical system!

It is strongly recommended that DLB is used along with this information to enhance diagnostic capabilities. See the diagnostic software manual for details on using the software.

5.1. Diagnostic Trouble Codes

The following diagnostic trouble codes are issued by the body controller. These codes are detected by the sleeper HVAC controller. The sleeper HVAC controller communicates DTC information to the body controller on the bodybuilder SAE J1939 data link. The body controller interprets and stores the appropriate DTC information based on the data received from the HVAC control head and transmits this information on the drive train SAE J1939 data link.

NOTE: Diagnose any "loss of communication" related errors prior to diagnosing codes from the following list. SPN 2000 FMI 9 will be displayed if the body controller has lost communication with the engine.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
520210	HVAC Blower Output	3	5210	5	Blower output circuit over voltage	See below for details.	None

This Diagnostic code will be set if the voltage on the blower control circuit is 0.35 volts more than the voltage expected by the sleeper HVAC controller at a specific blower speed.

This Diagnostic code could be the result of any of the following conditions:

- Short to battery on the (sleeper) blower control circuit between the sleeper HVAC controller and the sleeper HVAC LPM.
- Defective sleeper HVAC controller.
- Defective sleeper LPM.

Refer to the Blower Control Circuit Diagnostics section for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
520210	HVAC Blower Output	4	5210	5	Blower output circuit under voltage	See below for details.	None

This Diagnostic code will be set if the voltage on the blower control circuit is 0.35 volts less than the voltage expected by the sleeper HVAC controller at a specific blower speed.

This Diagnostic code could be the result of any of the following conditions:

- Short to ground on the (sleeper) blower control circuit.
- Defective sleeper HVAC controller.
- Defective sleeper LPM

Refer to the Blower Control Circuit Diagnostics section for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
520210	HVAC Blower Output	6	5210	5	Blower output short circuit	See below for details.	None

This Diagnostic code will be set if the voltage on the (sleeper) blower control circuit is greater than 5 volts. This Diagnostic code could be the result of any of the following conditions:

- Short to battery on the (sleeper) blower control circuit between the sleeper HVAC controller and the sleeper HVAC LPM.
- Defective sleeper HVAC controller.
- Defective sleeper LPM.

Refer to the Blower Control Circuit Diagnostics section for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal

520211	HVAC Actuator Position	7	5210	N/A	Actuator position not responding	See below for details.	None

This Diagnostic code could be the result of any of the following conditions:

- Blocked temperature/blend door (the actuator does not reach the position targeted by the sleeper HVAC controller).
- Faulty circuits between the sleeper HVAC controller and the temperature actuator.
- Defective temperature actuator.
- Defective sleeper HVAC controller.

Refer to the Temperature Actuator Diagnostics section for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
1548	Duct Temp Sensor	3	5210	13	Duct temperature sensor voltage high	See below for details.	None

This Diagnostic code could be the result of any of the following conditions:

- Open or short to battery on the signal circuit of the temperature sensor.
- Open or high resistance on the ground circuit of the temperature sensor.
- Defective temperature sensor.
- Defective sleeper HVAC controller.

(0.05 to 4.8875 volts is the acceptable range).

Refer to the Temperature Sensor Diagnostics section for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
1548	Duct Temp Sensor	4	5210	13	Duct temperature sensor voltage low	See below for details.	None

This Diagnostic code could be the result of any of the following conditions:

- Short to ground on the signal circuit of the temperature sensor.
- Defective temperature sensor.
- Defective sleeper HVAC controller.

(0.05 to 4.8875 volts is the acceptable range).

Refer to the Temperature Sensor Diagnostics section for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
520212	HVAC Dimmer Output	3	5210	32	Dimmer output voltage high	See below for details.	None

This Diagnostic code could be the result of any of the following conditions:

- Short to battery on the PWM dimmer circuit between the sleeper HVAC controller and the digital sleeper HVAC controls.
- Defective sleeper HVAC controller.
- Defective digital sleeper control panel.

(0.05 to 4.8875 volts is the acceptable range).

Refer to the Instrument Panel Dimming Circuit Diagnostics section for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
520212	HVAC Dimmer Output	4	5210	32	Dimmer output voltage low	See below for details.	None

This Diagnostic code could be the result of any of the following conditions:

- Short to ground on the PWM dimmer circuit between the sleeper HVAC controller and the digital sleeper HVAC controls.
- Defective sleeper HVAC controller.
- Defective digital sleeper control panel.

(0.05 to 4.8875 volts is the acceptable range).

Refer to the Instrument Panel Dimming Circuit Diagnostics section for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
2058	Module Comm.	9	N/A	N/A	Rear HVAC Data Link Communication Failure	See below for details.	J1939BB_Rcv_61217_058_033_Timer

This Diagnostic code could be the result of any of the following conditions:

- Open or short circuit on the SAE J1939 data link between the sleeper HVAC controller and the body controller.
- Defective sleeper HVAC controller.

The sleeper HVAC controller will disable “reduced power blower mode” when this DTC is set.

Refer to the SAE J1939 Communication section for more information.

SPN	Description	FMI	Conn.	Pin	Message	Probable Cause	Logical Signal
2058	Module Comm.	14	N/A	N/A	Rear HVAC Data Link Communication Failure	See below for details.	J1939BB_Rcv_61217_058_033_Timer

This Diagnostic code is the result of a defective sleeper HVAC controller.

NOTE: Cycle the key switch. If this does not clear the DTC, then replace the sleeper HVAC controller.

Refer to the SAE J1939 Communication section for more information.

5.2. Displaying Diagnostic Trouble Codes

Refer to Displaying Diagnostic Trouble Codes.

Electrical Load Control/Shedding (ELCS) (Feature Code 0595ACL)

1. Description and operation

Electrical Load Control and Shedding (ELCS) is an optional feature (standard w/ sleepers) used to protect the vehicle's batteries from excessive discharge by automatically shutting down electrical loads to conserve battery power.

If the body controller determines the battery voltage is low for a period of time, the feature begins a sequence of events that result in the disabling of certain electrical loads. The feature also provides audible and visual indications to alert the operator that the feature is about to disable loads.

The ELCS feature consists of a latching relay used to disconnect battery voltage from certain electrical loads. The body controller is used to monitor battery voltage, control the latching relay, and turn off certain electrical loads by disabling the appropriate outputs.

The latching relay is located under the engine cover on the module plate. The body controller momentarily supplies near battery voltage to the appropriate input circuit of the latching relay, causing the switch contacts of the relay to open or close. The input circuits of the latching relay normally rest at ground. The latching relay either supplies or removes voltage from certain electrical loads depending on the position of the relay switch. The latching relay switch contacts are closed when ELCS is deactivated.

The body controller communicates via the SAE J1939 data link with the ECM for the engine running state and the gauge cluster for requesting operator alerts.

2. Signal Definitions

This section connects the DLB displayed signal name to the circuit diagram. Refer to the electrical circuit diagram for specific pins. DLB displays the status on certain signals where a value of zero (0) indicates a good status.

- **Load_Shed_Visual_Alarm –** SAE J1939 output signal from the body controller to the gauge cluster. DLB displays a value of (1) while the body controller sends a request to the gauge

cluster to display the “Load Shedding” text message. Refer to the Audible and Visual Alerts section for more information.

- **Load_Shed_Power_Off_RD_Cmd –** Output signal from the body controller to the latching relay **used to activate load shedding**. DLB displays a value of (1) while the body controller supplies near battery voltage (this occurs momentarily) to the ‘LOAD SHEDDING ON’ circuit of the latching relay **(Battery voltage is removed from electrical loads).**

- **Load_Shed_Power_On_RD_Cmd –** Output signal from the body controller to the latching relay **used to de-activate load shedding**. DLB displays a value of (1) while the body controller supplies near battery voltage (this occurs momentarily) to the ‘LOAD SHEDDING OFF’ circuit of the latching relay **(Battery voltage is supplied to electrical loads).**

- **Cummins_ICON_is_Active_Flag (0595ANT, 0595ANZ) –** Internal input signal. The body controller uses this signal to determine if the ICON feature (if equipped) is active. DLB displays ☑ while the ICON feature is Active. The body controller inhibits load shedding while the ICON feature is active.

- **Engine_Running –** SAE J1939 input signal from the ECM to the body controller. The body controller uses this signal to determine if the engine is running. DLB displays ☑ while the engine is running. The body controller inhibits load shedding while the engine is running.

- **Park_Brake –** Input signal from the park brake switch to the body controller. This is used to determine if the park brake is engaged. DLB displays ☑ while the park brake is engaged. The body controller monitors the **Park_Brake** signal status as an interlock for load shedding if the **Engine_Running** signal has a bad status.

- **Accessory_Signal_Input –** Input signal from the vehicle accessory grid to the body controller. DLB displays ☑ while the key switch is placed in the ACCESSORY or IGNITION positions and the body controller is receiving accessory power.

- **Battery_Voltage_Signal –** Input signal that provides the battery voltage to the body controller. The body controller monitors the value of this signal to determine whether to activate the load shedding feature.

3. Feature Functions

The body controller monitors system voltage while the engine is off, regardless of key state. The following will occur if the body controller detects that battery (system) voltage is at or below 12.1 volts for 30 seconds:

1. The operator will receive an audible and visual indication that load shedding is about to disable electrical loads.

2. The appropriate electrical loads will be disabled by the feature.

3.1. Audible and Visual Alerts

The gauge cluster provides audible and visual indications that ELCS will activate soon. The body controller sends a request to the gauge cluster on the SAE J1939 data link for these requests.

The body controller will take the following actions if the battery voltage **(Battery_Voltage_Signal)** is less than 12.1 volts for 30 consecutive seconds:

- Request the gauge cluster to display "Load Shedding" text message in the digital display for 30 seconds **(Load_Shed_Visual_Alarm).**
- **AND** request the gauge cluster to command five-short-beeps for 5 seconds.

The audible and visual alerts are intended to allow the operator time to start the vehicle before loads are disabled by ELCS.

3.2. Electrical Load Control

3.2.1. Disable Loads

The body controller will activate ELCS (disable electrical loads) if the following conditions are true:

- The audible and visual alerts have completed **(See Note 1).**
- **AND** the ICON feature (if equipped) is not active **Cummins_ICON_is_Active_Flag.**
- **AND** the battery voltage signal **Battery_Voltage_Signal** has a good status.
- **AND** ***Either:***
  {The engine is not running **Engine_State** and has a good status.
  OR ***All of the following conditions are true:***
  [The engine state **Engine_State** has a bad status
  AND
  (The parking brake **Park_Brake_Signal** is engaged **OR** the key switch **Key_State** is in the OFF position**)] }.**

The following will occur when the conditions above are met:

- The body controller momentarily supplies near battery voltage to the 'LOAD SHEDDING ON' circuit. This opens the latching relay, removing battery power from the appropriate electrical loads.

- The body controller cancels all active requests **(See Note 2)** and turns off certain electrical loads wired directly to the body controller by disabling the appropriate outputs.

Note 1: The audible and visual indications will take 30 seconds to complete, however, it takes a minimum of 60 seconds from the time at which the voltage drops (and remains) below 12.1 volts to the time at which the loads are actually disabled by ELCS.

If the battery voltage rises above 12.1 volts before the audible and visual alerts have begun, the 30 second timer will be cancelled. The timer will re-start if the voltage drops below 12.1 volts. Once the audible and visual alerts have begun, the feature will shed loads unless the engine is started (the body controller assumes voltage is sufficient while the engine is running).

Note 2: If a particular feature's request is momentary, then the request will be cancelled during ELCS activation and must be requested again by the operator after ELCS has been deactivated.

Refer to the List of Features/Components Disabled by Load Shedding section for a complete list of features/components to be shut down by the load shedding feature.

Once ELCS has disabled the appropriate electrical loads/requests, the loads will remain disabled until the key switch is moved to the ACCESSORY or IGNITION position (or the engine is started). ELCS will then reevaluate the voltage. ELCS will keep the loads disabled if the voltage remains below 12.1 volts. ELCS will enable the loads if the voltage rises above 12.1 volts. Refer to the Enable Loads section for more information.

3.2.2. Body Controller 'Sleep Mode' Operation

3.2.2.1. Vehicles built before August 5, 2007

On vehicles built before August 5, 2007 the body controller won't disable loads connected to the latching relay if the body controller goes into 'sleep mode' while the battery voltage is normal (above 12.1 volts). 'Sleep mode' normally occurs 30 to 60 seconds after the cab doors are closed if no inputs are received. The body controller won't automatically 'wake up' when the battery voltage goes below 12.1 volts (because it cannot monitor voltage while it's 'asleep'), and therefore loads connected to the latching relay will continue to drain the battery.

Loads that are connected to the body controller's outputs directly, however, will keep the body controller awake, enabling the body controller to continue to monitor battery voltage, turn off the appropriate loads as required (including the latching relay), and then enter 'sleep mode'.

NOTE: If the body controller goes into 'sleep mode' following load shedding activation there will be no indication that load shedding is active other than the loads themselves being turned off.

3.2.2.2. Vehicles built on or after August 5, 2007

On vehicles built on or after August 5, 2007 the body controller is forced to remain awake until the battery voltage drops below 12.1 volts. The body controller will then shed what is required and enter 'sleep mode' to conserve as much battery power as possible. If a door is opened, the body controller wakes up and will then reevaluate the voltage as previously described in this document.

3.2.3. Enable Loads

The body controller will deactivate ELCS (enable electrical loads) if any of the following conditions are true:

- **[**The key switch is moved to the ACCESSORY OR IGNITION position **(See Note 1) AND** the battery voltage **(Battery_Voltage_Signal)** is greater than 12.1 volts**].**
- **OR** The engine is running **(Engine_State)** and has a good status.
- **OR** the engine state **(Engine_State)** has a bad status while the key switch is in the IGNITION position.
- **OR** the ICON feature (if equipped) is active **(Cummins_ICON_is_Active_Flag)**.

Note 1: The accessory signal must be on, and must be newly active (key switch was turned to ACCESSORY or IGNITION). Starting the engine will satisfy this condition.

The following will occur when the conditions above are met:

- The body controller momentarily supplies near battery voltage to the 'LOAD SHEDDING OFF' circuit. This closes the latching relay, connecting battery power to the appropriate electrical loads.

NOTE: Certain features may automatically re-activate upon ELCS deactivation. An example might be a switch left on that is mechanically latched.

4. List of Features/Components Disabled by Load Shedding

The following features/components will be disabled when the conditions for ELCS activation are met.

Note: The following is not a comprehensive list of features/components that will be disabled by load shedding and may not include every electronic component on a given vehicle, including any component installed post-original equipment manufacturer (OEM) production assembly plant.

- Fuel Transfer Pump

- Satellite Communication
- Sleeper HVAC LPM
- Sleeper HVAC Controller
- Sleeper Electrical Power Outlets
- Amplifier for Subwoofer
- ICON Crank Relay
- ***All Loads Connected to the Accessory Relay (includes the following):***
    - CB Radio
    - Entertainment Radio
    - Vehicle Sensor Module (VSM)
    - Power mirror
    - Vehicle Information Display (VID)
    - Switch packs
- ***All loads controlled by the Ignition Relay #2 (includes the following):***
    - Front HVAC Control Head (w/ ICON)
    - Vehicle Information Display
    - Eaton Vorad System
    - PTO Relays
    - Satellite Communication
    - Air Dryer and Drain Valve Heating
- ***All Loads Connected to the Ignition Relay #3 (includes the following):***
    - Compass Module
    - Windshield Washer Pump
    - Secondary Instrument Cluster (SIC)
    - Backup Lights
- Skirt Lights
- Vehicle Sensor Module (VSM)
- Trailer Socket Center Pin
- Auxiliary Trailer Relay
- Reading and Wardrobe Lights
- Luggage Compartment Lights
- Refrigerator
- Accent Lights
- Customer Accessory Control (Spare Switch #1)
- Customer Accessory Control (Spare Switch #2)
- Vehicle Information Display (VID)
- Tire Pressure Monitoring (TPM)
- Secondary Instrument Cluster (SIC)
- Cigar Lighting System
- Auxiliary Power Source
- Motorized Mirrors
- Video Entertainment
- Heated Seats
- Fuel Heater (DC version only) **(*)**
- Work Lights **(*)**
- Sleeper Dome Light **(*)**
- Floor Lights **(*)**
- Air Shield Light **(*)**

- Running Lights **(*)**
- Fog Lights **(*)**
- Heated Mirrors **(*)**

Note 1: The asterisk **(*)** indicates features which are controlled directly by the body controller.

Note 2: Certain features are redundantly controlled by ELCS. This means they are disabled by body controller's outputs directly and by the latching relay (controlled by the body controller).

Note 3: The work light and fog light features may still be turned on by the exterior lamp check feature, despite load shedding being active.

5. Diagnostics

It is strongly recommended that DLB is used along with this information to enhance diagnostic capabilities. See the diagnostic software manual for details on using the software.

NOTE: Certain diagnostic trouble codes may result while ELCS is actively disabling electrical loads. This may be caused due to the body controller forcing a particular feature off while electrical controls external to the body controller are attempting to keep the feature on.

5.1. Latching Relay Diagnostics

The body controller monitors the voltage of the 'LOAD SHEDDING' circuits between the body controller and the latching relay. The body controller will set the appropriate diagnostic trouble code if it determines that an open or short to ground is present on either of the circuits.

The following table can be used to assist in diagnosing the latching relay and circuits connected to the latching relay.

Latching Relay Troubleshooting
Review the <u>General Diagnostic Information</u> section prior to performing the following electrical tests.
If a load shedding related DTC is present, test for the following conditions: • Open or shorted input circuits to the latching relay. • Open or high resistance in the ground circuit of the latching relay. ***Replace the latching relay if no faulty circuits are found.***

Power Divider Lock (Feature Code 0595ACZ)

1. Description and operation

Power divider lock (PDL) allows the operator to lock the front axle and the rear axle of a tandem axle set, which transmits power equally to each of the drive axles.

This feature consists of the following additional electrical components:

- PDL switch (2 position latching switch with indicator)
- PDL air solenoid (normally closed)

The PDL switch is located in a switch pack. The switch pack location and switch assignment varies depending on the vehicle configuration. The PDL air solenoid can be located in any air solenoid 4-pack depending on the vehicle configuration. Refer to Diamond Logic® Builder (DLB) for switch pack switch assignment and body controller air solenoid pin assignment for a particular vehicle. The PDL air solenoid supplies pilot air to a larger air solenoid which controls the feature.

The switch pack switch sends a request message on the appropriate data link to the body controller to lock or unlock the PDL depending on the position of the switch. The body controller provides near battery voltage to energize the PDL air solenoid when certain conditions are met. Refer to Feature Functions for conditions. The air solenoids, within the air solenoid 4-pack, share a common ground. The PDL switch also provides the operator with an indication of the PDL feature's electrical status. Refer to Switch Indicator States for more information.

1.1. Options

1.1.1. Audible Alarm – Repetitive Beep

This feature is used to indicate that the power divider is engaged (locked). The body controller sends a request message on the SAE J1939 datalink to the gauge cluster to sound the audible alarm when the following conditions are true:

- The **PDL_Buzzer_Parameter** is enabled. See Programmable Parameters for more information.
- AND the PDL air solenoid is energized

The gauge cluster will sound a ***repetitive beep*** when the conditions above are met.

2. Signal Definitions

This section connects the DLB displayed signal name to the circuit diagram. Refer to the electrical circuit diagram for specific pins. DLB displays the status on certain signals where a value of zero (0) indicates a good status.

- **PDL_Lock_Switch** – Data link input from a switch pack to the body controller. DLB displays ☑ while the fifth wheel slide switch is in the up (slide) position. The PDL switch has a good status if this signal status is good.

- **PDL_Lock_Solenoid_Cmd** – The output signal from the body controller to the PDL air solenoid. DLB displays ☑ while the body controller is supplying voltage to the PDL air solenoid.

- **Vehicle_Speed** – The vehicle speed has a good status if this signal status is good.

- **Solenoid Status:** The PDL air solenoid has a bad status if any of the following conditions are true:
  - An over current condition exists on the output of the body controller that controls the air solenoid.
  - OR an over current condition was present on the output of the body controller that controls the air solenoid this key cycle.

  View the applicable diagnostic trouble code related to the air solenoid output.

3. Programmable Parameters

Name: **PDL_Warning_Speed (ID: 2383)**
Description: The vehicle speed at which the PDL switch indicator will begin to ***flash slow*** while the PDL is locked. The flashing is accompanied by a ***5 short beep*** audible alarm.
Access Level: Fleets
Minimum: 5 mph
Maximum: 100 mph
Interval: 1 mph
Default Value: 100 mph.

Name: **PDL_Buzzer_Parameter (ID: 1938)**
Description: When this parameter is enabled (set to a value of 1) the gauge cluster will sound a continuous beep while the PDL is locked.
Access Level: Dealer
Available values are enabled (1) or disabled (0).

4. Feature Functions

4.1. PDL Control

4.1.1. Lock PDL

The body controller will control the air solenoid to lock the PDL when the following conditions are true:

- The PDL switch is in the upper (locked) position
- AND the key switch is in the IGNITION position.
- AND the PDL switch has a good status
- AND the PDL air solenoid has a good status

When the body controller commands the Lock PDL operation the air solenoid will be energized. If the solenoid is energized the solenoid is open (supplying air).

4.1.2. Unlock PDL

The body controller will control the air solenoid to unlock the PDL when any of the following conditions are true:

- The PDL switch is in the lower (unlocked) position
- OR the PDL switch has a bad status
- OR the key switch is not in the IGNITION position.
- OR the PDL air solenoid has a bad status

When the body controller commands the Unlock PDL operation the air solenoid will be de-energized. If the solenoid is de-energized the solenoid is closed (exhausting air), therefore the system is de-pressurized.

4.2. Switch Indicator States

- ***On-Solid*** – This state indicates the PDL has been locked. The PDL switch indicator light will ***illuminate continuously*** if:
  - The PDL switch is in the upper (locked) position
  - AND the key switch is in the IGNITION position.
  - AND the conditions for ***flash fast*** are not met.
  - AND the conditions for ***flash slow*** are not met.

- ***Flash Slow*** – This state indicates the conditions are not appropriate for the PDL to be locked or remain locked. The PDL switch indicator light will flash ***1 time per second*** when the PDL switch is in the upper (locked) position, the key switch is in the IGNITION position, and any of the following conditions are true:

    - The vehicle speed is greater than the programmed **PDL_Warning_Speed** AND the vehicle speed has a good status.
    - OR the vehicle speed has a bad status

The PDL switch indicator light will continue to ***flash slow*** until any of the following conditions are true:

- The vehicle speed is less than the programmed **PDL_Warning_Speed** value minus 3 mph AND the vehicle speed has a good status. For example: If the **PDL_Warning_Speed** is set to the default (100 mph) the vehicle speed must be less than 97 mph.
- OR the conditions for ***flash fast*** are met.
- OR the PDL switch is in the lower (unlocked) position.
- OR the key switch is not in the IGNITION position

- ***Flash Fast*** - This state is an indication of an error condition. The PDL switch indicator light will flash ***2 times per second*** when any of the following conditions are true while the PDL switch is in the upper (locked) position and the key switch is in the IGNITION position:

    - The PDL switch has a bad status
    - OR the PDL air solenoid has a bad status
    - OR an open circuit condition was present on the output of the body controller that controls the PDL air solenoid when the PDL switch moved to the upper (locked) position. View the applicable diagnostic trouble code related to the air solenoid output.

4.3. Audible Alarm – 5 *short beeps*

This feature is used to alert the operator that conditions are not appropriate for the PDL to be locked or to remain locked. ***The body controller sends a request message on the SAE J1939 datalink to the gauge cluster to sound the audible alarm if the following conditions are true:***

- The **PDL_Buzzer_Parameter** is disabled. See Programmable Parameters for more information.
- AND the PDL switch indicator state changes to ***flash slow***. Refer to Switch Indicator States.

The gauge cluster will sound ***5 short beeps*** if the conditions above are met:

5. Additional Information

If the PDL switch is turned on (switch placed in the upper position), the key switch is on, and there are no related errors, the body controller will command the air solenoid to engage the PDL.

The PDL switch indicator will continuously ***flash slow*** and ***5 short beeps*** will sound from the gauge cluster if the PDL is locked and the vehicle speed accelerates beyond the programmed **PDL_Warning_Speed**. The switch indicator will continue to ***flash slow*** until either the vehcle speed slows below a threshold speed or the switch is moved to the unlocked position.

The PDL switch indicator will continuously ***flash fast*** if there are any related errors while the PDL switch is in the upper position and the ignition power is on.

6. PDL Preliminary Check

NOTE: Ensure there is air pressure to the air solenoid 4-pack, there are no air line restrictions to the air powered feature, and the air powered feature is mechanically sound and adjusted properly before performing diagnostic checks on the electrical system.

7. Diagnostics

It is strongly recommended that DLB is used along with this information to enhance diagnostic capabilities. See the diagnostic software manual for details on using the software.

7.1. Diagnostic Trouble Codes

Refer to the Diagnostic Trouble Code Index (S08327) or the Master Service Manual for a list of Body Controller Diagnostic Trouble Codes.

7.1.1. Displaying Diagnostic Trouble Codes

Refer to Displaying Diagnostic Trouble Codes.

Remote Start Stop

1. Description and operation

This feature is used to start or stop the engine, or to allow the operation of an emergency pump (if equipped) from a remote location outside the vehicle's cab. The bodybuilder provides the remote start/stop switch. Refer to the Body Builder Electrical Guide (S08323) for information related to the switch and to ensure programmable parameters are set correctly.

The following configurations are available on vehicles equipped with Remote Start Stop Systems:

Feature Code	Models	Feature Description
0595AKW	4000 series, 3200, 7000 series, CXT, RXT	Remote Start/Stop
0595AKV	4000 series, 3200, 7000 series, CXT, RXT	Remote Start/Stop with Emergency Pump Motor

This feature consists of the following additional electrical components:

- ***Emergency Pump Solenoid/Motor (0595AKV) (Provided by the Bodybuilder)***
- ***Remote Start/Stop Switch (Provided by the Bodybuilder)***
- ***Hood Switch –*** located under the hood on the splash guard near the driver side headlight.

The following relays, located in the interior power distribution center (PDC), are also used to accommodate this feature:

- ***Remote Switch Relay***
- ***Remote Start Relay***
- ***Remote Stop Relay***
- ***Ignition Relay #1***
- ***Ignition Relay #2***
- ***Ignition Relay #3***
- ***Pump Relay (0595AKV)***
- ***Pump Inhibit Relay (0595AKV)***

The remote start/stop switch, provided by the bodybuilder, has the action of a two position momentary switch. Ground is provided to the body controller input while the switch is pressed.

The body controller uses the input from the remote start/stop switch to perform functions such as starting the engine, stopping the engine, or to operate an emergency pump (if equipped) when the appropriate conditions are met. The function of the switch will be different depending on the state of the vehicle. Refer to Feature Functions for more information.

2. Signal Definitions

This section connects the DLB displayed signal name to the circuit diagram. Refer to the electrical circuit diagram for specific pins. DLB displays the status on certain signals where a value of zero (0) indicates a good status.

- ***TEM_Engine_Crank_Cmd*** – The output signal from the Body Controller to the remote start relay coil. DLB displays ☑ while the body controller is supplying voltage to the remote start relay coil.

- ***TEM_EPump_Inhibit_Relay*** – The output signal from the body controller to the pump inhibit relay coil. DLB displays ☑ while the body controller is supplying ground to the pump inhibit relay coil.

- ***TEM_Engine_Stop_Relay_Cmd*** – The output signal from the body controller to the remote stop relay coil. DLB displays ☑ while the body controller is supplying ground to the remote stop relay coil.

- ***TEM_PTO_Engagement_Switch_On*** – The input from the PTO switch pack switch to the body controller on the switch data link. DLB displays ☑ while the PTO switch is pressed.

- ***TEM_Rem_Start_Stop_Plunger*** – Digital input from the remote start/stop switch to the body controller. DLB displays ☑ while the remote start/stop switch is pressed.

3. Programmable Parameters

Name: **TEM_Rem_Start_Stop_Crank_Delay (ID: 2438)**
Default Value: 0.5 seconds.

Name: **TEM_Rem_Start_Stop_PTO_Ilock (ID: 2192)**
Default Value: Off (0).

Name: **TEM_Remote_Engine_Stop_Time (ID: 2072)**
Default Value: 5 seconds.

Refer to the Body Builder Electrical Guide (S08323) for more information.

4. Feature Functions

4.1. Remote Start Stop (0595AKW)

4.1.1. Cranking the Engine (from remote stopped mode)

The body controller will control the feature to crank the engine if:

- The engine is NOT running.
- **AND** the key is in the IGNITION position (**See Note 2**).
- **AND** the remote start/stop switch is moved to the pressed position (new press).
- **AND** the park brake is set.
- **AND** (if configured) the PTO switch is ON AND has a good status (**See Note 3**).

NOTE 1: The hood must also be closed! The body controller will control the feature to crank the engine if the conditions above are met, but the hardware will not allow the engine to crank until the hood switch is closed. The hood switch operation is described further in this section.

NOTE 2: The key switch must physically be placed in the IGNITION position; however, DLB will display ACCESSORY ON, IGNITON OFF, since the remote stopped mode simulates moving the key switch from the IGNITION position to the ACCESSORY position.

NOTE 3: Refer to the Body Builder Electrical Guide (S08323) to ensure that all remote start/stop related parameters are set appropriately for a specific vehicle application.

When the conditions for cranking the engine (above) are met the following will occur:

- The body controller will de-energize the remote stop relay by removing ground from the remote stop relay coil (de-energized is the normal state of this relay). This applies ignition voltage through the switch contacts of the remote stop relay to the ignition relay #1, ignition relay #2, and ignition relay #3 relay coils. These relays are then energized providing voltage to each ignition grid.

- The body controller will energize the remote start relay by supplying voltage to the remote start relay coil. Ground is provided the other side of the remote start relay coil from the remote start/stop switch while the switch is pressed. The remote start relay will remain energized while the remote start/stop switch is pressed.

- With the remote start relay energized; ignition voltage is supplied through the switch contacts of the remote start relay to the hood switch. With the hood switch closed; ignition voltage continues through the hood switch contacts to the starter relay coil. Depending on the vehicle configuration, either the ECM or the crank inhibit relay provides ground to the other side of the starter relay coil (starts the engine) if the transmission is in the PARK or NEUTRAL position.

NOTE: ***During remote start mode:*** The remote start relay will not energize until the programmed **TEM_Rem_Start_Stop_Crank_Delay** value has elapsed. This keeps the starter from activating before the engine electronics are active. This simulates the key switch being turned to the IGNITION position, delay for the programmed time, then to the crank position.

4.1.2. Stopping the Engine (engine running)

The body controller will control the feature to stop the engine if:

- The engine is running.
- **AND** the key switch is IGNITION position.
- **AND** the remote start/stop switch is moved to the pressed position (new press).
- **AND** the park brake is set.
- **AND** the status of the engine speed message is good.
- **AND** (if configured) the PTO switch is ON AND has a good status (see Note 1).

NOTE: Refer to the Body Builder Electrical Guide (S08323) to ensure that all remote start/stop related parameters are set appropriately for a specific vehicle application.

When the conditions for stopping the engine (above) are met the following will occur:

- The closed remote start/stop switch energizes the remote switch relay by providing ground to the remote switch relay coil. Ignition voltage is supplied through the switch contacts of the remote switch relay to the remote stop relay coil.

- The body controller energizes the remote stop relay by providing ground to the remote stop relay coil.

- Ignition voltage is supplied from the switch contacts of the energized remote stop relay to the remote stop relay coil, latching the remote stop relay switch closed. This removes ignition voltage from the ignition relay #1, ignition relay #2, and ignition relay #3 coils.

NOTE: ***During remote stop mode:*** This mode simulates the key switch being turned from the IGNITION position to the ACCESSORY position.

4.2. Remote Start Stop with Emergency Pump (0595AKV)

4.2.1. Cranking the Engine (from remote stopped mode)

The body controller will control the feature to crank the engine if:

- The engine is NOT running.
- **AND** the key switch is in the IGNITION position (**See Note 2**).
- **AND** the remote start/stop switch is moved to the pressed position (new press).
- **AND** the park brake is set.
- **AND** the last function performed with the engine not running was an emergency pump function OR the last function performed was an engine stop function (using the remote start/stop switch).
- **AND** (if configured) the PTO switch is ON AND has a good status (**See Note 3**).

NOTE 1: The hood must also be closed! The body controller will control the feature to crank the engine if the conditions above are met, but the hardware will not allow the engine to crank until the hood switch is closed. The hood switch operation is described further in this section.

NOTE 2: The key switch must physically be placed in the IGNITION position; however, DLB will display ACCESSORY ON, IGNITON OFF, since the remote stopped mode simulates moving the key switch from the IGNITION position to the ACCESSORY position.

NOTE 3: Refer to the <u>Body Builder Electrical Guide (S08323)</u> to ensure that all remote start/stop related parameters are set appropriately for a specific vehicle application.

When the conditions for cranking the engine (above) are met the following will occur:

- The body controller will de-energize the remote stop relay by removing ground from the remote stop relay coil (de-energized is the normal state of this relay). This applies ignition voltage through the remote stop relay switch contacts to the ignition relay #1, ignition relay #2, and ignition relay #3 coils. These relays are then energized providing voltage to each ignition grid.

- The body controller will energize the remote start relay by supplying voltage to the remote start relay coil. Ground is provided the other side of the remote start relay coil from the remote start/stop switch while the switch is pressed. The remote start relay will remain energized while the remote start/stop switch is pressed. Ignition voltage is removed from the common switch contact of the pump relay AND the pump relay coil while the remote start relay is energized.

- With the remote start relay energized; ignition voltage is supplied through the switch contacts of the remote start relay to the hood switch. With the hood switch closed; ignition voltage continues through the hood switch contacts to the starter relay coil. Depending on the vehicle configuration, either the ECM or the crank inhibit relay provides ground to the other side of the starter relay coil (starts the engine) if the transmission is in the PARK or NEUTRAL position.

NOTE: ***During remote start mode:*** The remote start relay will not energize until the programmed **TEM_Rem_Start_Stop_Crank_Delay** value has elapsed. This keeps the starter from activating before the engine electronics are active. This simulates the key switch being turned to the IGNITION position, delay for the programmed time, then to the crank position.

4.2.2. Stopping the Engine (engine running)

The body controller will control the feature to stop the engine if:

- The engine is running.
- **AND** the key switch is in the IGNITION position.
- **AND** the remote start/stop switch is moved to the pressed position (new press).
- **AND** the park brake is set.
- **AND** the status of the engine speed message is good.
- **AND** (if configured) the PTO switch is ON AND has a good status (**See Note 1**).

NOTE 1: Refer to the <u>Body Builder Electrical Guide (S08323)</u> to ensure that all remote start/stop related parameters are set appropriately for a specific vehicle application.

When the conditions for stopping the engine (above) are met the following will occur:

- The closed remote start/stop switch energizes the remote switch relay by providing ground to the remote switch relay coil. Ignition voltage is supplied through the switch contacts of the remote switch relay to the remote stop relay coil.

- The body controller energizes the remote stop relay by providing ground to the remote stop relay coil.

- Ignition voltage is supplied from the switch contacts of the energized remote stop relay to the remote stop relay coil, latching the remote stop relay switch closed. This removes ignition voltage from the ignition relay #1, ignition relay #2, and ignition relay #3 coils.

NOTE: ***During remote stop mode:*** This mode simulates the key switch being turned from the IGNITION position to the ACCESSORY position.

4.2.3. Running the Emergency Pump

The pump inhibit relay is normally energized while the ignition is on, inhibiting emergency pump operation.

The body controller will control the feature to allow emergency pump operation if:

- The engine is not running.
- **AND** the key switch is in the IGNITION position.
- **AND** the remote start/stop switch is moved to the pressed position (new press).
- **AND** the park brake is set.
- **AND** the last function performed with the engine not running was an engine crank function (not an emergency pump operation function).
- **AND** the remote start/stop switch is pressed and held for at least 5 seconds (programmable). Refer to **TEM_Remote_Engine_Stop_Time** in the Programmable Parameters section for more information.

When the conditions (above) are met the following will occur:

- Ignition voltage is being supplied through the switch contacts of the de-energized remote start relay to the common contact of the pump relay AND the pump relay coil. The remote start/stop switch energizes the pump relay by providing ground to the other side of the pump relay coil. This allows ignition voltage though the switch contacts of the pump relay to the common switch contact of the pump inhibit relay.

- The body controller de-energizes the pump inhibit relay by removing ground from the relay coil. Ignition voltage is supplied through the switch contacts of the de-energized pump inhibit relay to the emergency pump solenoid.

5. Preliminary Check

NOTE: Test all remote start stop related functions to ensure proper operation before performing diagnostic checks on the electrical system. Refer to the Body Builder Electrical Guide (S08323) for more information.

6. Diagnostics

It is strongly recommended that DLB is used along with this information to enhance diagnostic capabilities. See the diagnostic software manual for details on using the software.

6.1. Diagnostic Trouble Codes

Refer to the Diagnostic Trouble Code Index (S08327) or the Master Service Manual for a list of Body Controller Diagnostic Trouble Codes.

6.1.1. Displaying Diagnostic Trouble Codes

Refer to Displaying Diagnostic Trouble Codes.

Remote Start Stop (0595ADJ)

1. Description and operation

This feature is used to start or stop the engine from the bunk/sleeper area, and provides an audible alarm to indicate that the engine is about to start.

This feature consists of the following additional electrical components:

- ***Sleeper Control Enable Switch (2 position latching switch)***
- ***Remote Start/Stop Switch (2 position momentary switch)***
- ***Hood Switch***
- ***Neutral Switch (manual transmissions)***
- ***Engine Start Alarm***

The following relays are also used to accommodate this feature:

- ***Remote Start Relay*** **(ICON/RMT STRT)** located in the sleeper fuse box.
- ***Remote Stop Relay*** located in the sleeper fuse box.
- ***Remote Start/Stop Relay #1*** located in the interior power distribution center (PDC).
- ***Remote Start/Stop Relay #2*** located in the interior PDC.
- ***Ignition Relay #1*** located in the interior PDC.
- ***Ignition Relay #2*** located in the interior PDC.
- ***Ignition Relay #3*** located in the interior PDC.

The sleeper control enable switch is located on the instrument panel. The remote start/stop switch is located in the bunk on the sleeper control panel. The hood switch is located under the hood on the splash guard near the driver side headlight. The neutral switch (if equipped) is located on the transmission. The engine start alarm is located in the (driver side) engine compartment on the air cleaner mounting bracket.

When the sleeper control enable switch is closed:

- The sleeper enable switch provides a zero volt reference (ZVR) to the body controller.
- The body controller supplies voltage through the sleeper control enable switch to the following components ***(if the body controller determines that conditions are appropriate to enable the sleeper controls):***
    - The sleeper control enable switch indicator
    - The remote stop relay coil
    - The remote start/stop switch illumination

NOTE: Refer to Feature Functions for the list of conditions.

When the remote start/stop switch is closed:

- ZVR passes through the remote start/stop switch sending a digital request to the body controller.
- Ground is provided through the remote start/stop switch to the remote start relay coil. ***The remote start relay will not energize until the body controller determines that the conditions are appropriate.***
- Ground is provided to the engine start alarm.

NOTE: The function of the remote start/stop switch will be different depending on the state of the vehicle and various other conditions. Refer to Feature Functions for more information.

When the hood switch AND the neutral switch are closed: ignition voltage is supplied to the coil of the remote start/stop relay #1 and the coil of the remote start/stop relay #2. A permanent ground is provided to the other side of each relay coil***. When remote start/stop relay #1 and remote start/stop relay #2 are energized:***

- ZVR passes through the switch contacts of the remote start/stop relay #1 sending a digital input to the body controller.
- Ignition voltage passes through the switch contacts of the remote start/stop relay #2 to the common switch contact of the remote start relay.

The body controller activates the remote start relay, remote stop relay, and engine start alarm when the appropriate conditions are met (each has unique conditions). These conditions are described in Feature Functions.

2. Signal Definitions

This section connects the DLB displayed signal name to the circuit diagram. Refer to the electrical circuit diagram for specific pins. DLB displays the status on certain signals where a value of zero (0) indicates a good status.

- ***Sleeper_Enable_Request*** – The input signal from the sleeper control enable switch to the body controller. DLB displays ☑ while the sleeper control enable switch is in the enabled position (providing ZVR to the body controller).

- ***Sleeper_Control_Enable_RD*** – The output signal from the body controller. DLB displays ☑ while the body controller supplies voltage to the remote stop relay coil, sleeper control enable switch indicator, and the remote start/stop switch illumination.

- ***Remote_Engine_Start_Stop_Request*** – The input signal from the remote start/stop switch to the body controller. DLB displays ☑ while the remote start/stop switch is pressed (providing ZVR to the body controller).

- ***Remote_Start_RD*** – The output signal from the body controller to the remote start relay coil. DLB displays ☑ while voltage is being supplied to the relay coil.

- ***Remote_Stop_RD*** – The output signal from the body controller to the remote stop relay coil. DLB displays ☑ while ground is being provided to the relay coil.

- ***Remote_Start_Alarm_Buzzer_RD*** – The output signal from the body controller to the engine start alarm. DLB displays ☑ while voltage is being supplied to the engine start alarm.

- ***Remote_Stop_Message_to_Driver*** – SAE J1939 output signal from the body controller to the gauge cluster. The symbol ☑ is displayed in DLB if the feature is in the “Remote Stop” or “Emergency Shutdown” mode. Refer to the Text Messages section for more information.

- ***Engine_Protection_Shutdown*** – SAE J1939 message input signal from the ECM to the body controller. A value of (1) displayed on DLB indicates engine protection is active.

- ***Hood_Closed_and_Neutral_Signal –*** The input signal from the switch contacts of the remote start/stop relay #1 to the body controller. DLB displays ☑ while the hood is closed and a manual transmission (if equipped) is in neutral (ZVR is provided to the body controller).

    - ***NOTE 1:*** This signal only represents the hood being closed if the vehicle is not equipped with a manual transmission.
    - ***NOTE 2:*** Monitor the **Current_Gear** signal to determine if the transmission is in neutral if the vehicle is equipped with an automatic transmission.

3. Start-Up Operation (Initialization)

The body controller will de-activate the remote start relay, remote stop relay, engine start alarm output, and will remove voltage from the sleeper control enable switch when key switch is turned to the IGNITION position (the body controller is powered-up).

4. Feature Functions

4.1. Enable Sleeper Controls

The body controller will control the feature to enable the sleeper controls if:

- The remote start/stop switch is released.
- AND the sleeper control enable switch is in the ENABLED position.
- AND the key switch is in the IGNITION position.
- AND the park brake is set.
- AND the hood is closed **(See Note).**
- AND the transmission is in NEUTRAL OR PARK **(See Note).**
- AND the vehicle speed is equal to zero (0).

NOTE: DLB can be used to monitor the **Hood_Closed_and_Neutral_Signal** signal (manual transmissions) or the **Current_Gear** signal (automatic transmissions). Refer to Signal Definitions for more information.

When the sleeper controls have been enabled (conditions above are met) the feature can be controlled to remotely start or stop the engine. These functions are described below. Refer to Cranking the Engine or Stopping the Engine for more information.

4.2. Disable Sleeper Controls

The body controller will control the feature to disable the sleeper controls if:

- The sleeper control enable switch is NOT in the ENABLED position.
- **OR** the key switch is in the OFF position.
- **OR** the key switch is in the ACCESSORY position (if the feature is not in the remotely stopped mode or the emergency shutdown mode).

4.3. Cranking the Engine

The body controller will control the feature to crank the engine if:

- The remote start/stop switch is pressed for more than 15 seconds and remains pressed **(See Note 1)**.
- **AND** the sleeper control enable switch is in the ENABLED position.
- **AND** the key switch is in the IGNITION position **(See Note 2)**.

- **AND** the park brake is set.
- **AND** the hood is closed **(See Note 3)**.
- **AND** the transmission is in NEUTRAL or PARK **(See Note 3)**.
- **AND** the vehicle speed is equal to zero (0).
- **AND** the engine is NOT running.
- **AND** engine protection is NOT active.
- **AND** the output that controls the engine start alarm has a good status.
- **AND** the output that controls the remote stop relay has a good status.
- **AND** the output that controls the remote start relay has a good status.
- **AND** the current gear signal (automatic transmissions) has a good status.
- **AND** the vehicle speed has a good status.

NOTE 1: An audible engine start alarm will sound during this 15 second delay. Ground is provided to the engine start alarm while the remote start/stop switch is being pressed. The body controller supplies voltage to the engine start alarm.

NOTE 2: The key switch must physically be placed in the IGNITION position; however, DLB will display ACCESSORY ON, IGNITON OFF if the system is in the remote stopped mode. The remote stopped mode simulates moving the key switch from the IGNITION position to the ACCESSORY position.

NOTE 3: DLB can be used to monitor the **Hood_Closed_and_Neutral_Signal** signal (manual transmissions) or the **Current_Gear** signal (automatic transmissions). Refer to Signal Definitions for more information.

When the conditions for cranking the engine (above) are met the following will occur:

- The body controller will de-energize the remote stop relay by removing ground from the remote stop relay coil (de-energized is the normal state of this relay). This applies ignition voltage through the remote stop relay switch contacts to the coils of the ignition relay #1, ignition relay #2, and ignition relay #3. These relays are then energized providing voltage to each ignition grid.

- The body controller will energize the remote start relay by supplying voltage to one side of the remote start relay coil. Ground is provided to the other side of the remote start relay coil from the remote start/stop switch while the switch is pressed. The remote start relay will remain energized while the remote start/stop switch is pressed.

- While the remote start relay is energized; ignition voltage is supplied from the closed switch contacts of the remote start/stop relay #2 through the closed switch contacts of the remote start relay to the starter relay coil. Depending on the vehicle configuration, either the ECM or the crank inhibit relay provides ground to the other side of the starter relay coil (starts the engine) if the transmission is in the PARK or NEUTRAL position.

4.4. Stopping the Engine

The body controller will control the feature to stop the engine if:

- The key switch is in the IGNITION position.
- **AND** the engine is running.
- **AND** the sleeper control enable switch is in the ENABLED position.
- **AND** the output that controls the remote stop relay has a good status.
- **AND** the park brake is set.
- **AND** the hood is closed. **(See Note)**.
- **AND** the remote start/stop switch is moved to the pressed position (new press) and is pressed for more than 0.5 seconds.
- **AND** the transmission is in NEUTRAL or PARK **(See Note)**.
- **AND** the vehicle speed is equal to zero (0).

NOTE: DLB can used to monitor the **Hood_Closed_and_Neutral_Signal** signal (manual transmissions) or the **Current_Gear** signal (automatic transmissions). Refer to Signal Definitions for more information.

When the conditions for stopping the engine (above) are met the following will occur:

The body controller will energize the remote stop relay by providing ground to the remote stop relay coil. This removes ignition voltage from the coils of the ignition relay #1, ignition relay #2, and ignition relay #3. These relays are then de-energized removing voltage from each ignition grid.

NOTE: ***During remote stop mode:*** This mode simulates the key switch being turned from the IGNITION position to the ACCESSORY position.

4.5. Emergency Shutdown

The feature will perform an emergency engine shutdown if:

- (The sleeper control enable switch is in the ENABLED position
- **AND** the remote stop relay has a good status).

AND any one of the following is true:

- The parking brake is NOT set.

- **OR** the transmission is NOT in NEUTRAL or PARK **(See Note)**.
- **OR** the hood is NOT closed **(See Note)**.
- **OR** the vehicle speed greater than zero (0).
- **OR** The body controller has lost SAE J1939 communication with the gauge cluster.
- **OR** the key state has a bad status.
- **OR** The engine state has a bad status.
- **OR** the parking brake has a bad status.
- **OR** the hood neutral has a bad status **(See Note).**
- **OR** the current gear signal (automatic transmissions) has a bad status.
- **OR** the vehicle speed has a bad status.
- **OR** the engine start alarm relay has a bad status.
- **OR** the remote start relay has a bad status.

NOTE: DLB can used to monitor the **Hood_Closed_and_Neutral_Signal** signal (manual transmissions) or the **Current_Gear** signal (automatic transmissions). Refer to Signal Definitions for more information.

When the conditions (above) are met the following will occur:

- The body controller will provide ground to the remote stop relay coil.
- The body controller will send a request **(Remote_Stop_Message_to_Driver)** on the SAE J1939 data link to the gauge cluster to display a text message **(See Note)**.
- The body controller will send a request to the gauge cluster to sound repetitive beeps.

NOTE: Refer to the Text Messages section for more information.

4.6. Remote Stop Failure

This state indicates that the body controller is not able to control the feature to shutdown the engine.

The body controller will send a request* (Remote_Stop_Message_to_Driver) *on the SAE J1939 data link to the gauge cluster to display a text message (See Note) if:

- Sleeper controls are enabled.

AND either of the following is true:

- The remote stop relay has a bad status.

- **OR** the output **(Sleeper_Control_Enable_RD)** that supplies voltage to the following components has a bad status:

    - Remote stop relay coil.
    - Sleeper control enable switch indicator.

- Remote start/stop switch illumination.

NOTE: Refer to the Text Messages section for more information.

5. Text Messages

5.1. "ENG CNTL SHUTDOWN" Text Message

The gauge cluster will display a text message: **"ENG CNTL SHUTDOWN"** when the feature enters the Remote Stop Failure **OR** the Emergency Shutdown Mode. The gauge cluster must receive the **(Remote_Stop_Message_to_Driver)** signal from the body controller to perform this function.

6. Preliminary Check

NOTE: Test all remote start stop related functions to ensure proper operation before performing diagnostic checks on the electrical system. Refer to the Operator's Manual for more information.

7. Diagnostics

It is strongly recommended that DLB is used along with this information to enhance diagnostic capabilities. See the diagnostic software manual for details on using the software.

7.1. Diagnostic Trouble Codes

Cross reference the DTC to the applicable section from the DTC table.

7.1.1. Displaying Diagnostic Trouble Codes

Refer to Displaying Diagnostic Trouble Codes.

8. Additional Information

The body controller will not be able to determine if the operator is cranking the engine with the push button start option. If a push button start is included with the vehicle, the operator will need

to transition the key switch to the OFF position before cranking. Otherwise the body controller will not de-energize the Remote Stop relay, thus removing ignition power from the vehicle.

Suspension Dump (Feature Code 0595ACA)

1. Description and operation

This feature allows the operator to lower the rear of the vehicle by dumping the air from the suspension bags, or raise the rear of the vehicle to the set point controlled by the suspension height control valve.

This feature consists of the following components:

- Suspension dump switch (2 position latching)
- Suspension dump switch indicator light
- 2 (normally open) air solenoids
- Shuttle valve (2 position latching)

The suspension dump switch is located in a switch pack. The switch pack location and switch assignment varies depending on the vehicle configuration. The suspension dump air solenoids can be located in any air solenoid 4-pack depending on the vehicle configuration. However, both solenoids will reside in the same 4-pack. Refer to Diamond Logic® Builder (DLB) for switch pack switch assignment and body controller air solenoid pin assignment for a particular vehicle.

The switch pack sends a request message on the appropriate data link to the body controller to dump or raise the suspension depending on the switch position. The body controller provides near battery voltage to energize the appropriate air solenoid. The air solenoids, within the air solenoid 4-pack, share a common ground.

The shuttle valve installs directly into the two adjacent air solenoids. The shuttle valve traps air pressure in the air line to the suspension height control valve to keep the suspension dumped, or blocks air pressure in the air line to the suspension height control valve to keep the suspension inflated.

2. Signal Definitions

This section connects the DLB displayed signal name to the circuit diagram. Refer to the electrical circuit diagram for specific pins. DLB displays the status on certain signals where a value of zero (0) indicates a good status.

- **Suspension_State** – Indicates the last known state of the suspension. DLB displays the following information:
    - A value of (0) indicates that the last known suspension state was unknown.
    - A value of (1) indicates that the last known suspension state was raised.
    - A value of (2) indicates that the last known suspension state was dumped.

- **Susp_Dump_Dump_Switch** – Data link input from a switch pack to the body controller. DLB displays ☑ while the suspension dump switch is in the DUMP position.

- **Susp_Dump_Susp_Switch** – Data link input from a switch pack to the body controller. DLB displays ☑ while the suspension dump switch is in the SUSP position.

NOTE: The suspension dump switch has a good status if the **Susp_Dump_Dump_Switch** AND the **Susp_Dump_Susp_Switch** have a good status.

- **Susp_Dump_Solenoid_A_Cmd** – The output signal from the body controller to the suspension dump air solenoid A. DLB displays ☑ while the body controller is supplying voltage to the suspension dump air solenoid A.

- **Susp_Dump_Solenoid_B_Cmd** – The output signal from the body controller to the suspension dump air solenoid B. DLB displays ☑ while the body controller is supplying voltage to the suspension dump air solenoid B.

NOTE: The suspension dump air solenoid has a bad status if any of the following conditions are true:

- An over current condition exists on the output of the body controller that controls the air solenoid.
- OR an over current condition was present on the output of the body controller that controls the air solenoid this key cycle.

View the applicable diagnostic trouble code related to the air solenoid output.

3. Start-Up Operation (Initialization)

The body controller will compare the last known state of the suspension (raised or dumped) with the suspension dump switch position when the key switch is turned to the IGNITION position. The body controller will control the solenoids to the last known state if the last known state of the suspension and the position of the switch are the same. If they are not the same or the last known state of the suspension is not known the body controller will leave both solenoids de-energized and the switch indicator will ***flash slow*** until the switch is moved. Refer to Switch Indicator States for more information.

4. Feature Functions

4.1. Dump Suspension

When requesting suspension DUMP the operator is requesting the body controller to release air from the air suspension. The system applies air pressure to the dump control line port of the suspension height control valve mounted above the rear axle. ***The body controller will control the air solenoids to dump the suspension when:***

- The key switch is in the IGNITION position.
- **AND** the suspension dump switch is moved to the DUMP position.
- **AND** the suspension dump switch has a good status.
- **AND** the vehicle speed is less than or equal to 5 MPH.
- **AND** the vehicle speed has a good status.
- **AND** both solenoid A and B have a good status.
- **AND** an open circuit condition was not present for solenoid A this key cycle.

When the body controller commands the Dump Suspension operation:

- Solenoid A will be de-energized (open).
- **AND** solenoid B will be energized (closed).

Air pressure is then passed from solenoid A through the delivery port of the latching valve to the suspension height control valve dump port, which keeps the suspension deflated.

4.2. Raise Suspension

When requesting suspension SUSP the operator is requesting the air suspension to be supplied with air pressure (or remain supplied). ***The body controller will control the air solenoids to raise the suspension when the suspension dump solenoid A has a good status AND:***

- **[**The vehicle speed is greater than 5 MPH AND the vehicle speed has a good status**]**
- **OR**
  [the key switch is in the IGNITION position AND the suspension dump switch is moved to the SUSP position AND the suspension dump switch has a good status**]**

When the Body Controller commands the Raise Suspension operation:

- Solenoid A will be energized (closed)
- **AND** solenoid B will be de-energized (open)

Then shuttle valve then moves to block the air supply from going to the suspension height control valve dump port and the air will flow out around the exhaust shield of the latching shuttle valve, which allows the suspension to rise.

5. Switch Indicator States

On-Solid – This state indicates the suspension has been lowered. ***The suspension dump switch indicator light will illuminate continuously when:***

- All of the conditions to dump the suspension are met
- **AND** an open circuit condition was **not** present for solenoid B this ignition cycle.

Flash Slow – This state indicates the conditions are not appropriate to dump the suspension. ***The suspension dump switch indicator light will flash 1 time per second when:***

- The key switch is in the IGNITION position ***OR*** the vehicle speed is greater than 5 MPH
- **AND** the suspension dump switch has a good status
- **AND** both air solenoids have a good status
- **AND** an open circuit condition was **not** present on either suspension dump solenoid this ignition cycle.
- **AND [**both suspension dump solenoids are de-energized ***OR*** **(**the vehicle speed has a good status AND the suspension dump switch is in the DUMP position AND the body controller has controlled the solenoids to raise the suspension. Refer to Raise Suspension for conditions.**)]**

Flash Fast -This state is an indication of an error condition. ***The suspension dump switch indicator light will flash 2 times per second when the key switch is in the IGNITION position AND any of the following conditions are true:***

- **[**The suspension dump switch has a bad status
- **OR** the suspension dump solenoid A has a bad status
- **OR** the suspension dump solenoid B has a bad status
- **OR** an open circuit condition was present for solenoid (A or B) this ignition cycle.
- **OR**
  (the suspension dump switch is in the DUMP position AND the vehicle speed has a bad status**)]**

6. Additional Information

If the suspension is dumped and the vehicle speed accelerates beyond 5 MPH the suspension will re-inflate automatically. The automatic re-inflation due to vehicle speed will occur even if the switch is in the DUMP position; however, the suspension dump switch indicator will continuously ***flash slow*** to indicate that conditions are not appropriate to dump the suspension. If the vehicle then slows to less than or equal to 5 MPH the suspension will remain inflated and the indicator will continue to ***flash slow*** until the dump switch is turned off and back on again. The suspension dump indicator will continuously ***flash fast*** if there are any related errors and ignition power is on.

The two normally open (when no power is applied) air solenoids will be set to opposite states under normal operation with the key switch in the IGNITION position. The suspension system will only change state (raise or lower suspension) when the key switch is in the IGNITION position due to the design of the latching shuttle valve. The Dump Suspension function will continue to release air from the air suspension once activated even if the key switch is turned to the OFF position. The Raise Suspension function will operate in a similar manner if the key switch is turned off following activation, but will instead continue to raise the suspension.

The body controller will de-energize both solenoids when:

- The key switch is not in the IGNITION position
- **AND**
  [the vehicle speed has a bad status **OR (**the vehicle speed has a good status AND the vehicle speed is less than or equal to 5 MPH**)]**

7. Suspension Dump Preliminary Check

NOTE: Ensure there is air pressure to the air solenoid 4-pack, there are no air line restrictions to the air powered feature, and the air powered feature is mechanically sound and adjusted properly before performing diagnostic checks on the electrical system.

8. Diagnostics

It is strongly recommended that DLB is used along with this information to enhance diagnostic capabilities. See the diagnostic software manual for details on using the software.

8.1. Diagnostic Trouble Codes

Refer to the Diagnostic Trouble Code Index (S08327) or the Master Service Manual for a list of Body Controller Diagnostic Trouble Codes.

8.1.1. Displaying Diagnostic Trouble Codes

Refer to Displaying Diagnostic Trouble Codes.

8.2. Error Operation

If either suspension dump solenoid A or suspension dump solenoid B has a bad status, the body controller will de-energize the solenoid that has a bad status.

Tire Pressure Monitoring (Feature Code 16VCM)

1. Description and operation

The tire pressure monitoring system (TPMS) is an optional feature used to monitor and display tire pressure. The vehicle information display (VID), standard on vehicles equipped with TPMS, is used to display and program TPMS related information. Refer to the Vehicle Information Display Operator's Manual for more information.

Vehicles equipped with TPMS will be equipped with the following additional electrical components:

- ***TPMS controller*** located under the engine cover on the module plate next to the ICON module.
- ***Up to 3 tire pressure antennas***
  - ***Front tire pressure antenna*** located below the cab and behind the front axle, near the horn.
  - ***Left rear tire pressure antenna*** located on the outer portion of the left rear frame rail.
  - ***Right rear tire pressure antenna*** located on the outer portion of the right rear frame rail.

- ***10 tire pressure sensors*** (1 sensor mounted in each wheel)
    - If equipped with super single wheels – located 180 degrees from the valve stem hole.
    - If equipped with dual wheels – located on the back of the valve stem.

1.1. Tire Pressure Monitoring Electrical System

The following section describes the wiring of the electrical components. Please refer to the circuit diagram manual for a complete illustration of the electrical system including specific connectors and pins.

The TPMS controller receives battery voltage from the interior power distribution center (PDC). The accessory relay provides voltage to the TPMS controller when the key switch is placed in the ACCESSORY or ON position. This 'wakes up' the TPMS controller. The TPMS controller is permanently grounded at the ground stud.

Each tire is monitored by a tire pressure sensor. These sensors are not hardwired. Instead, the tire pressure sensor transmits a radio frequency (RF) signal which is received by the tire pressure antenna. The tire pressure antennas have been located to optimize system performance. Reception of the front wheels is performed primarily by the front tire pressure antenna. Reception of the rear wheels is performed primarily by the left rear and right rear tire pressure antennas.

The antenna units are connected to the TPMS controller by LIN bus, which consists of three circuits per antenna. The TPMS controller provides a zero volt reference (ZVR) and 12V signal to each antenna. The antenna communicates information to the TPMS controller on the signal circuit. The TPMS controller processes the data received from the antennas and sends the information to the vehicle information display (VID) via the SAE J1939 data link.

1.1.1. SAE J1939 Communication

The tire pressure monitoring controller communicates with the vehicle information display (VID) by means of the SAE J1939 data link for various functions such as:

- TPMS related programming via the VID.
- TPMS related data for display on the VID.
- Communicating TPMS related DTC information.

1.1.1.1. 'Lost' SAE J1939 Communication

Communication is considered 'lost' if the VID has not received a 'heartbeat' from the TPMS controller for 30 seconds.

The following will occur if communication is lost between the TPMS controller and the VID:

- The VID will display all tires in RED on the TPMS screen **AND** an N/A next to each tire (rather than temp/pressure).

The actions above will occur until the communication has been restored. This normally takes approximately 30 seconds.

1.1.2. LIN Bus Communication

The TPMS controller communicates with the 3 tire pressure antennas via LIN bus communication for various functions such as:

- Receiving tire pressure/temperature information from the tire pressure sensors.
- Receiving tire transmitter ID information from the tire pressure sensors.
- Receiving fault code information from the tire pressure sensors.

1.1.2.1. 'Lost' LIN Bus Communication

Each tire pressure antenna communicates with the TPMS controller via the LIN bus. If the TPMS controller does not receive a transmission from the antenna upon initial key cycle or during normal operation the TPMS controller will attempt to communicate by transmitting to the antenna every 30 seconds on the LIN bus.

The following will occur if the TPMS controller is unable to communicate with the antenna (LIN bus communication is 'lost') for 2.5 minutes:

- **"TPMS Antenna Lost Communication"** popup message will be displayed in the VID.
- **AND** the VID will display all tires in BLACK on the TPMS screen **AND** an N/A next to each tire (rather than a temp/pressure value).
- **AND** the TPMS controller will set a 'defective antenna' DTC for the appropriate antenna.
- **AND** the TPMS controller will set a 'LIN bus communication' DTC for the appropriate antenna.

The actions above will occur until the communication has been restored. This normally takes 2.5 minutes.

1.2. Tire Pressure Monitoring Controller Diagnostics

1.2.1. Battery Voltage Circuit Diagnostics

The TPMS controller performs a diagnostic test on the battery voltage circuit at the TPMS controller connector. The voltage provided on this circuit must be within the range of 9.5 -17.0 volts, or the TPMS controller will detect the fault.

The following will occur if the battery voltage is below 9.5 volts:

- The TPMS controller will set a "below normal level" voltage DTC.
- **AND** the VID will not receive data from the TPMS controller on the SAE J1939 data link.
- **AND** the TPMS screen in the VID will display all tires in RED.
- **AND** all TPMS related functions are inoperative.

NOTE: The TPMS controller will shut down if the voltage is below 6.5 volts.

The TPMS controller takes the actions above until it is brought up above 11.8 volts.

The following will occur if the battery voltage is above 17 volts:

- The TPMS controller will set an "above normal level" voltage DTC.

NOTE: The TPMS controller will shut down if the voltage is greater than 18.0 volts.

The controller takes the action above until it is brought down below 15.0 volts.

1.3. Tire Pressure Sensors

Tire pressure and temperature are measured periodically by an intelligent tire pressure sensor located inside each wheel. The sensor uses sensitive silicon microelectronics to detect changes in tire pressure (similar to a diaphragm being pushed). Each sensor is powered by a lithium battery and contains a radio frequency (RF) transmitter.

The tire pressure sensor sends tire pressure/temperature information along with the unique identification number (ID) of the current tire via 433 MHz RF signal to the tire pressure antenna. The tire pressure antenna processes the RF signals received from the tire pressure sensors and transfers the data via TPMS LIN-bus to the TPMS controller. The tire transmitter ID allows the TPMS controller to determine the wheel location.

The tire pressure sensor also provides status information such as remaining life of sensor battery, sensor battery under voltage, fast pressure loss, and over temperature information. Sensor battery life is typically 5 years, however, life will be reduced under critical system conditions in which fast data transmission is required.

Under normal operating conditions, the tire pressure sensors transmit data to the tire pressure monitoring controller once every minute.

1.3.1. Sensor Diagnostics

If any tire sensor is moved out of the range of the antenna, fails to transmit, has a low sensor battery, or is unable to measure tire information correctly, the TPMS controller will detect the condition and set a corresponding DTC. Refer to the Diagnostic Trouble Codes section for more information about the DTC associated with the tire pressure sensor.

1.3.2. Fast Transmit Mode

The sensor will be placed in 'fast transmit mode' (transmits data once every second) if:

- The sensor is replaced **AND** the tire has been newly pressurized **(See Note 1)**.
- **OR** if a 'fast leak' condition occurs **(See Note 1)**.

Note 1: 2 - 3 PSI air pressure must be added or removed from the tire within 1 second for 'fast transmit' mode to occur. The sensor will remain in fast transmit mode for approximately 3 minutes after the above conditions are true.

Note 2: Placing the tire sensor in 'fast transmit' mode by releasing air from the appropriate tire can be useful in locating tires on the VID screen.

The following will occur if the sensor is placed into 'fast transmit mode':

- The VID will display **"WARNING: Fast Tire Pressure Loss"** as a popup message **(See Note 3)** if air has been removed.
- **AND** a corresponding 'fast leak' DTC will be set by the TPMS controller **(See Note 3)** if air has been removed.
- **AND** any sensor in 'fast transmit' mode will appear first in the list of detected sensors on the vehicle information display (VID).
- **AND** any sensor in 'fast transmit' mode will have an asterisk next to that tire transmitter ID on the VID.
- **AND** sensor battery life will be reduced while in 'fast transmit' mode.

Note 3: Warnings and diagnostic trouble codes will only be generated for sensors that have been programmed into the system. Sensors can be programmed only after they have been initialized. Refer to the Sensor Initialization section for more information.

1.3.3. Sensor Initialization

To preserve sensor battery life, tire sensors are in 'sleep mode' while in storage and will not transmit data. When a tire sensor is installed (must be pressurized) for the first time, the sensor will be placed into 'fast transmit mode' for 3 minutes, but no warnings will be generated by the TPMS controller.

During this first pressurization, if the pressure is reduced to less than 22 PSI within 3 minutes, the tire sensor goes back into 'sleep mode'. After the first pressurization, 'sleep mode' is no longer available. After the tire sensor has been programmed into the system, YELLOW or RED tire pressure warnings may be displayed in the VID depending on the programmed value in the VID "Pressure Setup" screen.

1.4. Tire Pressure Antennas

The tire pressure antenna processes the RF signals received from the tire pressure sensors into digital information. An antenna unit is equipped with a RF receiver and a microcontroller which performs the following:

- Decodes the received RF signals.
- Converts the RF signals into serial data.
- Transfers the data via LIN bus to the TPMS controller.

1.4.1. Antenna Diagnostics

The TPMS controller monitors the voltage on each of the tire pressure antenna 12V circuits. If any of the 3 antenna 12V circuits is outside the range of 6.5 to 17.0 volts then the TPMS controller will immediately shut down the power supply to the respective antenna.

1.4.1.1. Short Circuit Diagnostics

If either of the LIN bus data circuits is shorted to ground then TPMS controller will detect the condition and set a corresponding "grounded circuit on LIN bus" DTC. In addition, the antenna will no longer communicate with the TPMS controller on the LIN bus. Refer to the 'Lost' LIN Bus Communication section for more information.

1.4.1.2. Open Circuit Diagnostics

If any of the antenna circuits (12V, ZVR, or signal) are open, the TPMS controller will detect the condition, and the antenna will no longer communicate with the TPMS controller on the LIN bus. Refer to the 'Lost' LIN Bus Communication section for more information.

2. Programmable Parameters

The following parameter is programmable only using the vehicle information display (VID). Go to "TPMS Setup", "Pressure Setup" for access.

Name: **Pressure Setup**
Description: This parameter sets the target tire pressure. The 'low' and 'extremely low' tire pressure warnings in the VID are activated based on a threshold below this target value. Refer to the Monitoring Tire Pressure and Tire Temperature section for more information.

IMPORTANT! The value programmed into the 'pressure setup' should be set to the recommended cold inflation pressure specified in the Operator's Manual.

Access Level: Dealer
Minimum: 88 PSI
Maximum: 121 PSI
Interval: 1 PSI
Default Value: 102 PSI

3. Feature Functions

The following functions are performed by the system.

3.1. Monitoring Tire Pressure and Tire Temperature

The TPMS controller monitors pressure in conjunction with temperature to detect system faults. For example, if a low tire pressure condition exists while the temperature is increased it is likely that the condition is due to low tire pressure, since low tire pressure causes excess friction/heat. Likewise, if a temperature related condition exists in the absence of a low pressure condition it is likely that the condition is due to friction from a faulty wheel bearing or dragging brake. The tire pressure displayed in the VID, however, reflects the actual tire pressure gauge reading and is not temperature compensated.

The TPMS system knows what the corresponding pressure should be at any given temperature, and therefore will not set erroneous faults based on normal pressure changes in proportion to temperature. The system generates warnings based on the difference between the target tire pressure, programmed into the VID "Pressure Setup" parameter, and the expected pressure for a particular tire temperature.

Refer to the Tire Pressure Diagnostics section to understand the thresholds at which tire pressure diagnostics are performed and warnings are displayed.

The feature will monitor tire information if all of the following conditions are true:

- The key switch is placed in the ACCESSORY position **(See Note 1)**.
- No active 'loss of communication' errors are present.
- No active TPMS antenna related diagnostic trouble codes are present.

Note 1: The voltage received by the TPMS controller via the ACCESSORY relay must be greater than 3.5 volts for the controller to 'wake up'. Otherwise, the controller will remain 'asleep' in which the following conditions will be true:

- All TPMS related functions are inoperative.
- **AND** the VID cannot receive data from the TPMS controller on the SAE J1939 data link.
- **AND** the TPMS screens will be accessible, but the VID will display all tires in RED.

Because the tire sensors normally transmit data only once every minute, it may be necessary to wait up to 2 minutes for the feature to receive data from all of the sensors. The wheel may appear BLACK on the VID TPMS screen before the data is received from the tire sensor.

3.2. Tire Pressure Warnings

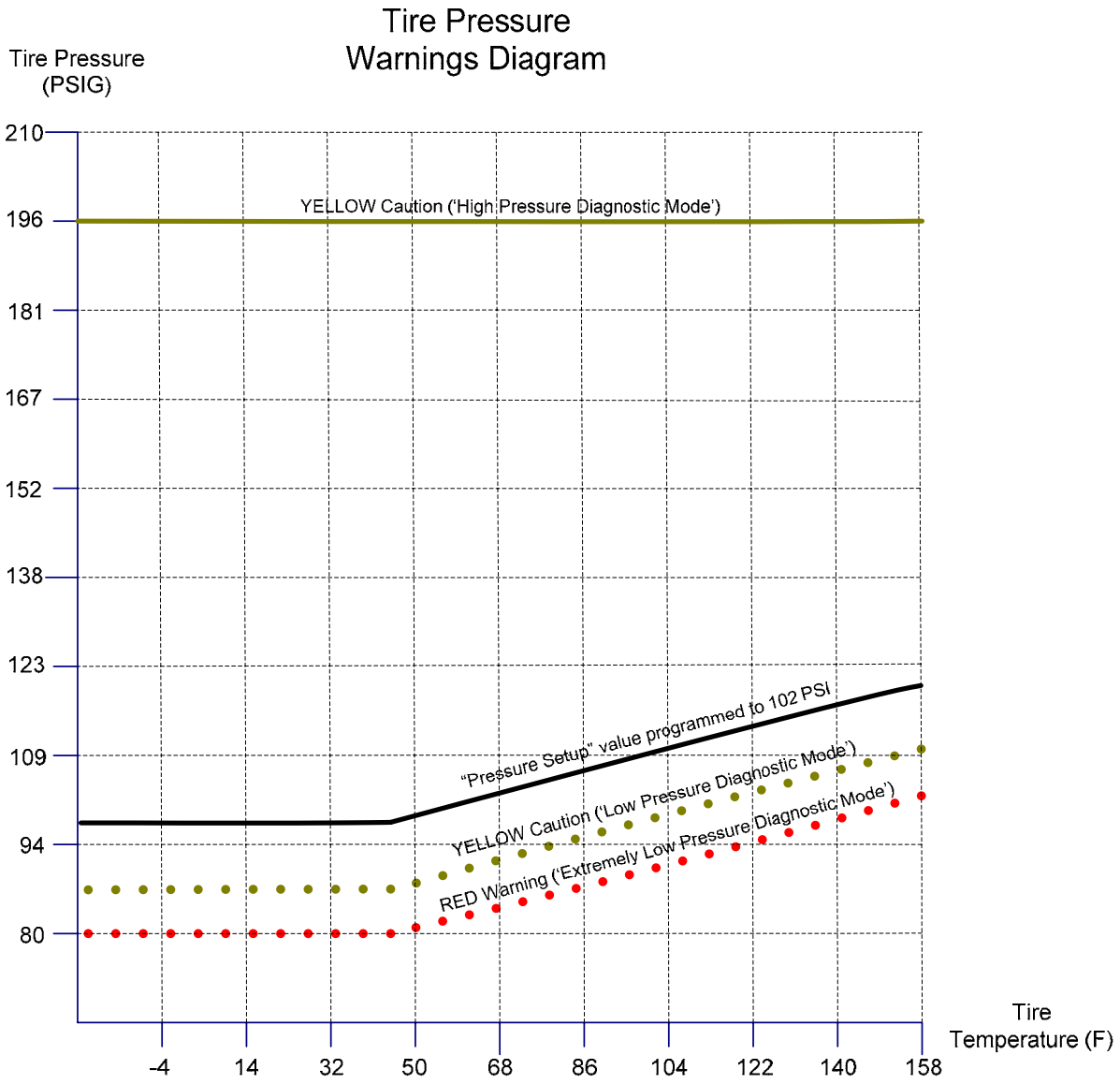
Tire pressure warnings will be displayed in the VID if:

- The tire pressure reaches a predetermined threshold preset by the vehicle manufacturer **(See Note 1).**
- The respective tire sensor has been programmed into the system **(See Note 2).**
- The "WE sensor" error is **not** present for the wheel location in which the tire warnings are desired.

Note 1: Refer to the "Tire Pressure Warnings" diagram in this section to understand the point at which the warnings will be displayed based on the programmed "Pressure Setup" value and the expected tire pressure for a particular tire temperature.

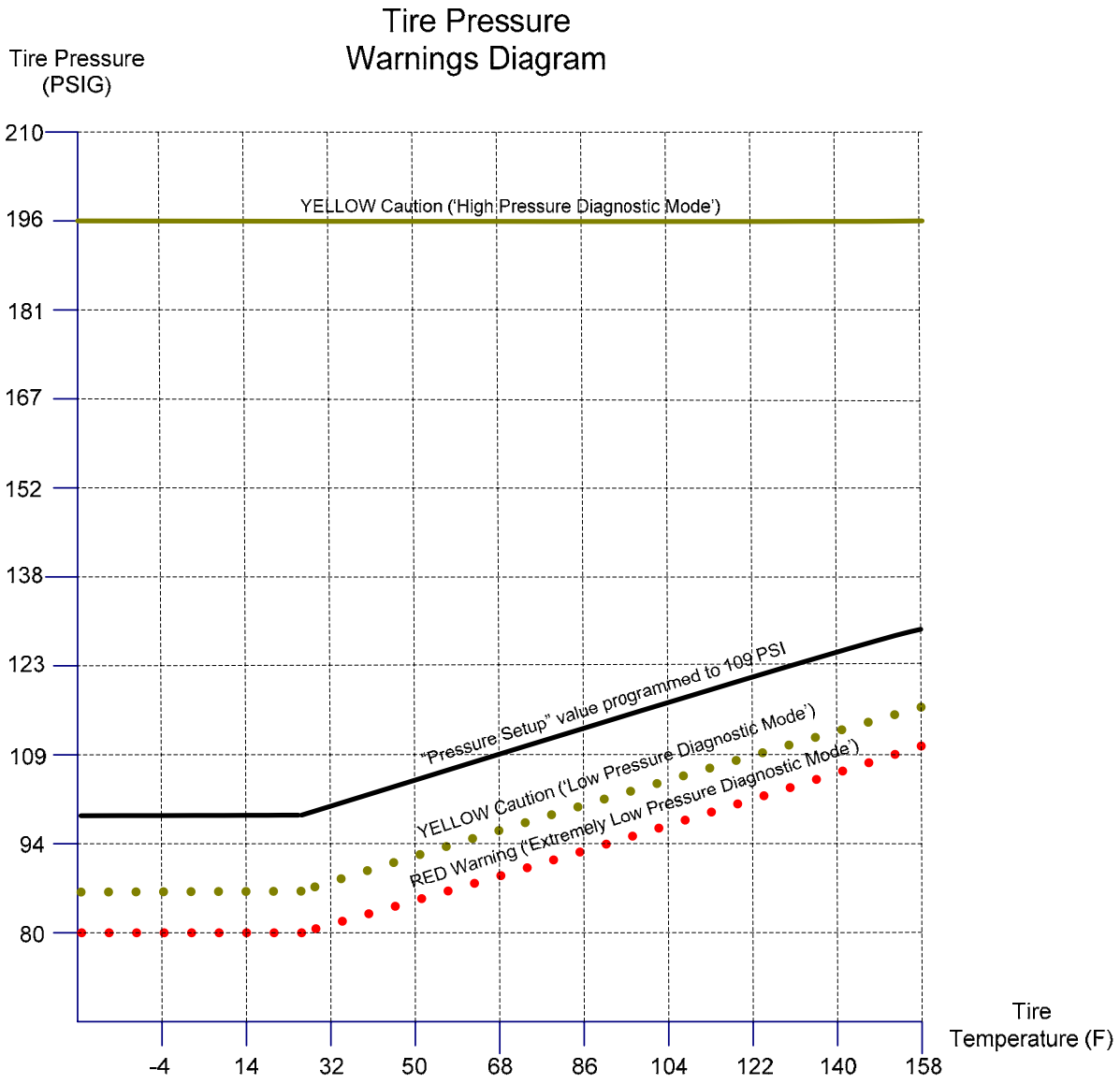
Note 2: The VID can be used to program tire sensors that have not been associated to a particular wheel location. Refer to Tire Transmitter ID Programming for more information.

The following graph illustrates the point at which the YELLOW and the RED warnings appear in the VID based on a programmed “Pressure Setup” value of 102 PSI.



NOTE: The horizontal portion of the diagonal line represents the minimum pressure recommended by the tire manufacturer for any temperature or load condition.

The next graph is based on a programmed “Pressure Setup” value of 109 PSI. Notice how the pressure at which the YELLOW and RED warnings appear is increased.



NOTE: The horizontal portion of the diagonal line represents the minimum pressure recommended by the tire manufacturer for any temperature or load condition.

3.3. Tire Pressure Diagnostics

The system alerts the operator on the VID and sets a corresponding DTC if a fast leak, low pressure, extremely low pressure, or excess pressure condition exists.

Refer to "TPMS Setup", "Pressure Setup" in the VID to verify the current programmed pressure value.

If the tire pressure becomes less than the pressure expected at that particular temperature, the TPMS controller will set a DTC and the VID will display a YELLOW or RED warning depending on the pressure value below the pressure needed for that particular temperature.

3.3.1. Low Pressure Diagnostic Mode

The tire sensor goes into 'low pressure diagnostic mode' if the difference between the programmed "Pressure Setup" parameter, and the expected pressure for a particular tire temperature reaches a predetermined threshold.

For example, if the tire temperature is at approximately 70F (20C), a YELLOW caution appears if the tire pressure falls more than approximately 10 PSI below the programmed "Pressure Setup" value in the VID. This means the tire pressure must drop to 91 PSI for 'low pressure diagnostic mode' to occur if the programmed value is set to the default value of 102 PSI.

The following will occur while the tire sensor is in the 'low pressure diagnostic mode'.

- **"CAUTION Low Tire Pressure Detected"** popup message is displayed in the VID.
- **AND** the corresponding tire will be displayed in YELLOW on the VID.
- **AND** the tire pressure monitoring controller will set a DTC.

The low pressure DTC will remain active and the VID will display the appropriate tire in YELLOW until adequate pressure has been restored to the tire.

IMPORTANT! As tire temperatures increase, the expected tire pressure also increases. Both the tire temperature and the programmed "Pressure Setup" value change the point at which the warnings will be displayed. The Tire Pressure Warnings diagram illustrates this concept. Refer to the Tire Pressure Warnings section for more information.

3.3.2. Extremely Low Pressure Diagnostic Mode

The tire sensor goes into 'extremely low pressure diagnostic mode' if the difference between the programmed "Pressure Setup" parameter, and the

expected pressure for a particular tire temperature reaches a predetermined threshold.

For example, if the tire temperature is at approximately 70F (20C), a RED warning appears if the tire pressure falls more than approximately 17 PSI below the programmed “Pressure Setup” value in the VID. This means the tire pressure must drop to 84 PSI for ‘extremely low pressure diagnostic mode’ to occur if the programmed value is set to the default value of 102 PSI.

The following will occur while the tire sensor is in the ‘extremely low pressure’ diagnostic mode:

- **"Warning Extremely Low Tire Pressure Detected"** popup message is displayed in the VID.
- **AND** the corresponding tire will be displayed in RED on the VID.
- **AND** the tire pressure monitoring controller will set a DTC.

The extremely low pressure DTC will remain active and the VID will display the appropriate tire in RED until adequate pressure has been restored to the tire.

IMPORTANT! As tire temperatures increase, the expected tire pressure also increases. Both the tire temperature and the programmed “Pressure Setup” value change the point at which the warnings will be displayed. The Tire Pressure Warnings diagram illustrates this concept. Refer to the Tire Pressure Warnings section for more information.

3.3.3. High Pressure Diagnostic Mode

The tire sensor goes into ‘high pressure diagnostic mode’ if the tire pressure reaches 196 PSI or higher.

The following will occur while the tire sensor is in the ‘high pressure diagnostic mode’:

- **"Caution High Tire Pressure Detected"** popup message is displayed in the VID.
- **AND** the corresponding tire will be displayed in YELLOW on the VID.
- **AND** the tire pressure monitoring controller will set a DTC.

The high pressure DTC will remain active and the VID will display the appropriate tire in RED until the proper pressure (default = 102 PSI) has been restored to the tire.

3.4. Tire Temperature Diagnostics

The system also alerts the operator on the VID and sets a corresponding DTC if an over temperature condition exists, as described below.

3.4.1. High Temperature Diagnostic Mode

The tire sensor goes into 'over temperature mode' if the following conditions are true:

- The temperature measured by the tire sensor is greater than 248F (120C).

The following will occur while the tire sensor is in the 'over temperature mode':

- The tire sensor will stop transmitting data.
- **AND** the corresponding tire will be displayed in RED on the VID.
- **AND** the tire pressure monitoring controller will set a 'Temperature cut-out' DTC.

The tire sensor goes back to "normal mode" (transmitting data once every minute) after the temperature becomes less than or equal to 212F (100C).

4. Caution When Performing TPMS Service

CAUTION: Extreme care must be taken when servicing TPMS equipped wheels, tires and tire sensors. Refer to TSI–07–17–01 prior to servicing any of these components.

5. General Diagnostic Information

It is strongly recommended that DLB is used along with this information to enhance diagnostic capabilities. See the diagnostic software manual for details on using the software.

5.1. Diagnostic Trouble Codes

The following diagnostic trouble codes are issued by the TPMS controller (Source Address = 51). The TPMS controller communicates DTC information to the vehicle information display (VID) on the SAE J1939 data link.

Definitions: Certain DTC are wheel specific. The information contained within the message displayed in the VID, for example, will specify a particular wheel location according to the SPN.

In the DTC List below, A1 = the front axle, A2 = the front rear axle, A3 = Axle 3 = the rear rear axle, LI = the left inner wheel, LO = the left outer wheel, RI = the right inner wheel, and RO = the right outer wheel.

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
521000	Operating voltage Analog Digital (AD) converter defective	4	N/A	N/A	ECU power supply Operating voltage AD converter defective	N/A	See Note 1 below for details.
521001	Memory check EEPROM category A	31	N/A	N/A	Memory EEPROM category A ECU Category A memory check error	N/A	See Note 1 below for details.
521002	Memory check EEPROM category B	31	N/A	N/A	Memory EEPROM category B ECU Category B memory check error	N/A	See Note 1 below for details.
521003	Memory check EEPROM category C	31	N/A	N/A	Memory EEPROM category C ECU Category C memory check error	N/A	See Note 1 below for details.
521004	Memory check EEPROM category E	31	N/A	N/A	Memory EEPROM category D ECU Category D memory check error	N/A	See Note 1 below for details.
521005	RAM error	31	N/A	N/A	ECU RAM RAM error	N/A	See Note 1 below for details.

521006	EEPROM checksum	31	N/A	N/A	ECU EEPROM EEPROM checksum write error	N/A	See Note 1 below for details.
521007	ROM error	31	N/A	N/A	ECU ROM ROM error	N/A	See Note 1 below for details.
521009	TSS defective	31	N/A	N/A	ECU Health ECU defective	N/A	See Note 1 below for details.

Note 1: All of the above listed diagnostic codes (521000, 521001, 521002, 521003, 521004, 521005, 521006, 521007, and 521009) are the result of a defective TPMS controller.

Cycle the key switch. If this does not clear the DTC, then replace the TPMS controller.

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
521012	Implausible parameterization	11	N/A	N/A	ECU Parameter error Parameter out of range	N/A	See below for details

This Diagnostic code could be the result of any of the following conditions:

- 1 or more tire sensors have not been programmed into the system.
- **OR** the same tire sensor is programmed onto 2 different wheel locations.

If this diagnostic code is present, ensure that all of the tire pressure sensors are programmed properly into the system. Refer to Tire Transmitter ID Programming for more information.

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
521021	Interruption of power supply	31	8952	3	Vehicle power supply interruption Interruption of power supply (terminal 30)	N/A	See below for details

Conditions for Setting the DTC: This Diagnostic code is set when there is an interruption of power on the battery voltage circuit of the TPMS controller while the engine is running.

Conditions for Clearing the DTC: The active Diagnostic code is cleared if the ignition key is cycled from OFF to ON, but the DTC will remain in the history.

This Diagnostic code could be the result of any of the following conditions:

- There is an intermittent or poor connection on the battery voltage circuit of the TPMS controller.
- **OR** the TPMS controller is defective.

NOTE: Cycle the key switch after the repair is completed.

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
521032, 521038, 521044, 521050, 521056, 521062, 521068, 521074, 521080, 521086, NOTE: Includes SPN 1697 (FMI=12)	WE sensor error	31	N/A	N/A	Axle “X” Wheel “XX” sensor health 521032 (A1 LI), 521038 (A1 RI), 521044 (A2 LO), 521050 (A2 LI), 521056 (A2 RI), 521062 (A2 RO), 521068 (A3 LO), 521074 (A3 LI), 521080 (A3 RI), 521086 (A3 RO) Refer to the beginning of the Diagnostic Trouble Codes section for definitions.	Appropriate wheel is BLACK.	See below for details.

Conditions for Setting the DTC: This Diagnostic code will be set if the tire sensor is not able to measure the tire pressure information properly. The TPMS controller sets the DTC after receiving 3 successive “error” messages from the tire sensor.

Conditions for Clearing the DTC: This Diagnostic code is cleared if the “error” message is no longer being received from the tire sensor.

This Diagnostic code could be the result of any of the following conditions:

- Defective tire pressure sensor.

Perform the following steps if this diagnostic code is present:

- Replace the appropriate tire pressure sensor.
- Perform the Tire Transmitter ID Programming procedure after the sensor is replaced.

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
521033, 521039, 521045, 521051, 521057, 521063, 521069, 521075, 521081, 521087, NOTE: Includes SPN 1697	WE no reception	11	N/A	N/A	Axle “X” Wheel “XX” sensor transmission 521033 (A1 LI), 521039 (A1 RI), 521045 (A2 LO), 521051 (A2 LI), 521057 (A2 RI), 521063 (A2 RO), 521069 (A3 LO), 521075 (A3 LI), 521081 (A3 RI), 521087 (A3 RO) Refer to the beginning of the Diagnostic Trouble Codes section for definitions.	Appropriate wheel is BLACK.	See below for details.

Conditions for Setting the DTC: This DTC is set when a particular tire sensor's information is missed 10 times consecutively while the vehicle is moving (speed greater than 4.3 mph).

Conditions for Clearing the DTC: This Diagnostic code is cleared when the TPMS controller receives information again from the tire sensor for at least 1 occurrence (normally takes 1 minute).

This Diagnostic code could be the result of any of the following conditions:

- Defective tire pressure sensor (sensor not transmitting).
- **OR** the wheel/sensor was replaced, but the sensor was not programmed into the system using the VID.
- **OR** the wheel/sensor is out of the range of the system.
- **OR** the system is not receiving information from the tire sensor due to RF interference.

Perform the following steps if this diagnostic code is present:

1. Ensure that all TPMS equipped wheels are installed on the vehicle.
2. Pull the vehicle away from the garage (100 ft or more from other TPMS equipped vehicles).
3. Ensure that the key switch is placed in the IGNITION ON position.
4. Wait at least 2 minutes. This allows time for the wheel sensor’s information to be received by the TPMS controller.
5. Ensure that the wheel sensor is programmed into the system using the VID (the appropriate wheel should be GREEN on the VID).
6. If the wheel is BLACK on the VID, program the tire sensor into the system using the VID. Refer to Tire Transmitter ID Programming for more information. The wheel should change from BLACK to GREEN on the VID TPMS screen after programming is complete.
7. Wait at least 2 minutes.

(Continued below)

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
521033, 521039, 521045, 521051, 521057, 521063, 521069, 521075, 521081, 521087, NOTE: Includes SPN 1697	WE no reception **(Continued)**	11	N/A	N/A	Axle “X” Wheel “XX” sensor transmission 521033 (A1 LI), 521039 (A1 RI), 521045 (A2 LO), 521051 (A2 LI), 521057 (A2 RI), 521063 (A2 RO), 521069 (A3 LO), 521075 (A3 LI), 521081 (A3 RI), 521087 (A3 RO) Refer to the beginning of the Diagnostic Trouble Codes section for definitions.	Appropriate wheel is BLACK.	See below for details.

Perform the following steps (continued from above):

8. If the wheel changes to GREEN after programming, then the system is OK. (GREEN indicates that the tire information is being received correctly).
9. If the wheel is still BLACK on the VID, drive the vehicle (at least 4.3 mph) for at least 10 minutes (DTC should go away). This eliminates the chance of RF interference being the cause. Two (2) or more sensors not being received (BLACK on the VID) indicates a stronger likelihood that RF interference is present.
10. If the wheel is still BLACK on the VID, replace the appropriate tire sensor.
11. Perform the Tire Transmitter ID Programming procedure after the sensor is replaced. The wheel should change from BLACK to GREEN on the VID TPMS screen after programming is complete.

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
521029, 521035 521041, 521047 521053, 521059 521065, 521071 521077, 521083, NOTE: Includes SPN 241 (FMI=0)	Excess pressure	16	N/A	N/A	Axle “X” Wheel “XX” over pressure Excess pressure 521029 (A1 LI), 521035 (A1 RI), 521041 (A2 LO), 521047 (A2 LI), 521053 (A2 RI), 521059 (A2 RO), 521065 (A3 LO), 521071 (A3 LI), 521077 (A3 RI), 521083 (A3 RO) Refer to the beginning of the Diagnostic Trouble Codes section for definitions.	• "Caution High Tire Pressure Detected" popup displayed. • Wheel is YELLOW on the TPMS screen.	See below for details

Conditions for Setting the DTC: This Diagnostic code is set when the TPMS controller has received 60 successive ‘excessive pressure’ readings from the tire sensor (normally takes about an hour). The tire pressure is considered ‘excessive’ if the pressure reaches 196 PSI or higher. Refer to the High Pressure Diagnostic Mode section for more information.

Conditions for Clearing the DTC: This Diagnostic code is cleared when the TPMS controller has received a pressure reading of 152 PSI or less from the tire sensor for 2 consecutive occurrences (normally takes about 2 minutes).

This Diagnostic code could be the result of any of the following conditions:

- The tire is over inflated.
- **OR** the tire sensor is defective (the tire sensor is not reporting pressure correctly).
- **OR** the TPMS controller is defective.

Perform the following steps if this diagnostic code is present:

- Cycle the ignition key.
- Diagnose any “WE Sensor Error” (if present) DTC prior to performing the remaining steps.
- Check the tire for proper pressure. Refer to the Operator’s Manual for the recommended cold inflation pressure.

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
521030, 521036, 521042, 521048, 521054, 521060, 521066, 521072, 521078, 521084, NOTE: Includes SPN 242 (FMI=0)	Temperature cut-out	31	N/A	N/A	Axle “X” Wheel “XX” temperature Temperature cut-out 521030 (A1 LI), 521036 (A1 RI), 521042 (A2 LO), 521048 (A2 LI), 521054 (A2 RI), 521060 (A2 RO), 521066 (A3 LO), 521072 (A3 LI), 521078 (A3 RI), 521084 (A3 RO) Refer to the beginning of the Diagnostic Trouble Codes section for definitions.	• Wheel is RED on the TPMS screen.	See below for details

Conditions for Setting the DTC: This Diagnostic code is set when the TPMS controller receives a temperature value greater than 248F (120C) from the tire sensor.

Conditions for Clearing the DTC: This Diagnostic code is cleared when the TPMS controller receives a temperature value less than or equal to 212F (100C) from the tire sensor.

This Diagnostic code could be the result of any of the following conditions:

- Faulty wheel bearing causing excess friction/heat in the wheel.
- **OR** a brake issue (hanging/dragging/misuse) causing excess friction/heat in the wheel.

Perform the following steps if this diagnostic code is present:

- Inspect the wheels/brakes, etc. for malfunctions.

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
521031, 521037, 521043, 521049, 521055, 521061, 521067, 521073, 521079, 521085, NOTE: Includes SPN 1697 (FMI=17)	WE low battery	31	N/A	N/A	Axle “X” Wheel “XX” sensor battery Sensor low battery 521031 (A1 LI), 521037 (A1 RI), 521043 (A2 LO), 521049 (A2 LI), 521055 (A2 RI), 521061 (A2 RO), 521067 (A3 LO), 521073 (A3 LI), 521079 (A3 RI), 521085 (A3 RO) Refer to the beginning of the Diagnostic Trouble Codes section for definitions.	N/A	See below for details

Conditions for Setting the DTC: This Diagnostic code is set when the TPMS controller receives information from the tire sensor that the sensor battery is low.

Conditions for Clearing the DTC: A new tire pressure sensor must be installed **(battery cannot be replaced separately).**

Perform the following steps if this diagnostic code is present:

- Replace the tire pressure sensor at the next tire service **(battery cannot be replaced separately).**
- Program the tire pressure sensor into the system using the VID. Refer to Tire Transmitter ID Programming for more information. The wheel should change from BLACK to GREEN on the VID TPMS screen after programming is complete.

Additional Information: The sensor battery may have up to 6 months left when the ‘low battery’ DTC is first set. The wheel will turn BLACK on the TPMS screen when the sensor battery goes completely dead, therefore, it may be helpful to keep track of the Tire Transmitter ID corresponding to the weak tire sensor when the DTC is first set.

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
521029, 521035 521041, 521047 521053, 521059 521065, 521071 521077, 521083, NOTE: Includes SPN 2586	Fast pressure loss	0	N/A	N/A	Axle “X”, Wheel “XX”, leakage Fast pressure loss 521029 (A1 LI), 521035 (A1 RI), 521041 (A2 LO), 521047 (A2 LI), 521053 (A2 RI), 521059 (A2 RO), 521065 (A3 LO), 521071 (A3 LI), 521077 (A3 RI), 521083 (A3 RO) Refer to the beginning of the Diagnostic Trouble Codes section for definitions.	"WARNING Fast Tire Pressure Loss" popup displayed.	See below for details

Conditions for Setting the DTC: This Diagnostic code is set when 2 - 3 PSI air pressure is removed from the tire within 1 second.

Conditions for Clearing the DTC: This Diagnostic code is cleared upon the next ignition cycle (if the condition is no longer present).

This Diagnostic code could be the result of any of the following conditions:

- The tire has a leak due to foreign object, faulty valve, etc.

Perform the following steps if this diagnostic code is present:

- Inspect the tire for leaks, and perform any necessary repairs.
- Check the tire for proper pressure. Refer to the Operator’s Manual for the recommended cold inflation pressure.
- Cycle the ignition key.

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
521029, 521035 521041, 521047 521053, 521059 521065, 521071 521077, 521083, NOTE: Includes SPN 241	Dropped below warning limit	18	N/A	N/A	Axle “X” Wheel “XX” second pressure level Dropped below warning limit 521029 (A1 LI), 521035 (A1 RI), 521041 (A2 LO), 521047 (A2 LI), 521053 (A2 RI), 521059 (A2 RO), 521065 (A3 LO), 521071 (A3 LI), 521077 (A3 RI), 521083 (A3 RO) Refer to the beginning of the Diagnostic Trouble Codes section for definitions.	• "Caution Low Tire Pressure Detected" popup displayed. • Wheel is YELLOW on the TPMS screen.	See below for details

Conditions for Setting the DTC: This Diagnostic code is set when the TPMS controller has received 10 successive ‘low pressure’ readings from the tire sensor (normally takes about 10 minutes). Refer to the Low Pressure Diagnostics section for more information.

Conditions for Clearing the DTC: This Diagnostic code is cleared when the TPMS controller receives information from the tire sensor that ‘low pressure’ condition is no longer present for 1 occurrence (takes about one minute).

This Diagnostic code could be the result of any of the following conditions:

- The tire has a leak due to foreign object, faulty valve, etc.
- **OR** the tire sensor is defective (the tire sensor is not reporting pressure correctly).
- **OR** the TPMS controller is defective.

Perform the following steps if this diagnostic code is present:

- Inspect the tire for leaks, and perform any necessary repairs.
- Check the tire for proper pressure. Refer to the Operator’s Manual for the recommended cold inflation pressure.

NOTE: Ensure that the pressure value in the “Pressure Setup” screen on the VID is set to the proper pressure based on the current vehicle load.

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
521029, 521035 521041, 521047 521053, 521059 521065, 521071 521077, 521083, NOTE: Includes SPN 241	Dropped below minimum pressure	1	N/A	N/A	Axle “X” Wheel “XX” first pressure level Dropped below minimum pressure 521029 (A1 LI), 521035 (A1 RI), 521041 (A2 LO), 521047 (A2 LI), 521053 (A2 RI), 521059 (A2 RO), 521065 (A3 LO), 521071 (A3 LI), 521077 (A3 RI), 521083 (A3 RO) Refer to the beginning of the Diagnostic Trouble Codes section for definitions.	• "Warning Extremely Low Tire Pressure Detected" popup displayed. • Wheel is RED on the TPMS screen.	See below for details

Conditions for Setting the DTC: This Diagnostic code is set when the TPMS controller has received 2 successive ‘extremely low pressure’ readings from the tire sensor (normally takes about 2 minutes). Refer to the Extremely Low Pressure Diagnostics section for more information.

Conditions for Clearing the DTC: This Diagnostic code is cleared when the TPMS controller receives information from the tire sensor that ‘extremely low pressure’ condition is no longer present for 1 occurrence (takes about one minute).

This Diagnostic code could be the result of any of the following conditions:

- The tire has a leak due to foreign object, faulty valve, etc.
- **OR** the tire sensor is defective (the tire sensor is not reporting pressure correctly).
- **OR** the TPMS controller is defective.

Perform the following steps if this diagnostic code is present:

- Inspect the tire for leaks, and perform any necessary repairs.
- Check the tire for proper pressure. Refer to the Operator’s Manual for the recommended cold inflation pressure.

NOTE: Ensure that the pressure value in the “Pressure Setup” screen on the VID is set to the proper pressure based on the current vehicle load.

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
521168, 521178, 521188	Grounded circuit on LIN bus	31	N/A	4, 5, 6	Antenna “X” LIN bus short circuit Grounded circuit on LIN bus 521168 (Antenna1), 521178 (Antenna2), 521188 (Antenna3).	• "TPMS Antenna Lost Communication" popup displayed. • All wheels RED on the TPMS screen.	See below for details

Conditions for Setting the DTC: This Diagnostic code is set when any of the antenna signal circuits is shorted to ground for 2.5 minutes. Refer to the Short Circuit Diagnostics section for more information.

Conditions for Clearing the DTC: Cycle the ignition key. If the communication is reestablished, then the DTC will be cleared.

This Diagnostic code could be the result of any of the following conditions:

- Short to ground on any of the antenna signal circuits.
- **OR** a defective tire pressure antenna.
- **OR** a defective TPMS controller.

Perform the following steps if this diagnostic code is present:

- Repair any faulty circuits, replace any faulty components.
- Cycle the key switch.

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
521167, 521177, 521187	Open circuit on LIN bus	31	N/A	4, 5, 6	Antenna “X” LIN bus open circuit Open circuit on LIN bus 521167 (Antenna1), 521177 (Antenna2), 521187 (Antenna3).	• "TPMS Antenna Lost Communication" popup displayed. • All wheels RED on the TPMS screen.	See below for details

Conditions for Setting the DTC: This Diagnostic code is set when any of the antenna signal circuits are open.

Conditions for Clearing the DTC: Cycle the ignition key if the active DTC does not clear automatically following the repair.

This Diagnostic code could be the result of any of the following conditions:

- Open or high resistance in any of the antenna signal circuits.
- **OR** a defective tire pressure antenna.
- **OR** a defective TPMS controller.

Perform the following steps if this diagnostic code is present:

- Repair any circuits, and then cycle the key switch.

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
521169, 521179, 521189	No communication on LIN bus	31	N/A	N/A	Antenna “X” LIN communication No communication on LIN bus 521169 (Antenna1), 521179 (Antenna2), 521189 (Antenna3).	• "TPMS Antenna Lost Communication" popup displayed. • All wheels RED on the TPMS screen.	See below for details

Conditions for Setting the DTC: The TPMS controller has not been able to communicate with one or more of the antennas for 2.5 minutes.

Conditions for Clearing the DTC: Cycle the ignition key, if the communication is reestablished, then the DTC will be cleared.

This Diagnostic code could be the result of any of the following conditions:

- Open, high resistance, short to ground, or short to battery on any of the antenna signal circuits.
- **OR** an open or high resistance on any of the antenna ZVR circuits.
- **OR** an open, high resistance or short to ground on any of the antenna 12V circuits.
- **OR** a defective antenna.
- **OR** a defective TPMS controller.

Perform the following steps if this diagnostic code is present:

- Repair any faulty circuits, and then cycle the key switch.

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
521172, 521182, 521192	Antenna power supply is below normal level	31	N/A	7, 8, 9	Antenna “X” power supply Antenna power supply is below normal level 521172 (Antenna1), 521182 (Antenna2), 521192 (Antenna3).	• "TPMS Antenna Lost Communication" popup displayed. • All wheels BLACK on the TPMS screen.	See below for details

Conditions for Setting the DTC: The TPMS controller receives information from the antenna that the voltage being received at the antenna power supply is below normal.

Conditions for Clearing the DTC: The condition for setting the DTC is no longer present, and the key switch is cycled.

This Diagnostic code could be the result of any of the following conditions:

- Open, high resistance, or short to ground on any of the antenna 12V circuits.
- **OR** a defective tire pressure antenna.
- **OR** a defective TPMS controller.

Perform the following steps if this diagnostic code is present:

- Repair any faulty circuits, and then cycle the key switch.

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
521175, 521185, 521195, NOTE: Includes SPN 1699	Antenna defective	11	N/A	N/A	Antenna “X” power supply Antenna power supply is below normal level 521175 (Antenna1), 521185 (Antenna2), 521195 (Antenna3).	• "TPMS Antenna Lost Communication" popup displayed. • All wheels RED on the TPMS screen.	See below for details

Conditions for Setting the DTC: The TPMS controller sets this DTC (additionally) if any of the following DTC is present:

- ‘No communication on LIN bus’ (521169, 521179, 521189)
- ‘Grounded circuit on LIN bus’ (521168, 521178, 521188)
- ‘Antenna power supply is below normal level’ (521172, 521182, 521192)
- ‘RAM fault in antenna’ (521170, 521180, 521190)
- ‘ROM fault in antenna’ (521171, 521181, 521191)
- ‘Wrong frequency of antenna’ (521174, 521184, 521194)
- ‘Antenna receiver offset too low’ (521173, 521183, 521193)

Conditions for Clearing the DTC: The conditions for setting the DTC are no longer present.

Perform the following steps if this diagnostic code is present:

- Resolve any of the above DTC conditions, and this DTC will be automatically cleared.

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
521170, 521180, 521190	RAM fault in Antenna	31	N/A	N/A	Antenna “X” RAM RAM fault in Antenna 521170 (Antenna1), 521180 (Antenna2), 521190 (Antenna3).	N/A	See Note 1 below for details.
521171, 521181, 521191	ROM fault in Antenna	31	N/A	N/A	Antenna “X” ROM ROM fault in Antenna 521171 (Antenna1), 521181 (Antenna2), 521191 (Antenna3).	N/A	See Note 1 below for details.
521173, 521183, 521193	Antenna receiver offset too low	31	N/A	N/A	Antenna “X” receiver offset Antenna receiver offset too low 521173 (Antenna1), 521183 (Antenna2), 521193 (Antenna3).	N/A	See Note 1 below for details.
521174, 521184, 521194	Wrong frequency of antenna	31	N/A	N/A	Antenna “X” frequency Wrong frequency of Antenna 521174 (Antenna1), 521184 (Antenna2), 521194 (Antenna3).	N/A	See Note 1 below for details.

Note 1: All of the above listed diagnostic codes (521170, 521180, 521190, 521171, 521181, 521191, 521173, 521183, 521193, 521174, 521184, and 521194) are the result of a defective tire pressure antenna.

Cycle the key switch. If this does not clear the DTC, then replace the appropriate tire pressure antenna.

SPN	Description	FMI	Conn.	Pin	VID Message Displayed	VID symptom	Probable Cause
2051	TSS defective	11	N/A	N/A	Tire Pressure Monitor Controller is defective	N/A	See below for details

Conditions for Setting the DTC: This DTC will be displayed (additionally) if any of the following DTC is present: 521001, 521002, 521003, 521004, 521005, 521006, 521007, or 521009.

Conditions for Clearing the DTC: None of the DTC listed above are present.

This Diagnostic code could be the result of a defective TPMS controller.

Perform the following steps if this diagnostic code is present:

- Cycle the key switch. If this does not clear the DTC, then replace the TPMS controller.

5.2. Displaying Diagnostic Trouble Codes

Refer to Displaying Diagnostic Trouble Codes.

6. Frequently Asked Questions:

1. **Question:** “Why do I keep getting low tire pressure warnings displayed on the VID?”

   Answer: This is part of the normal operation of the system as described in the Tire Pressure Diagnostics section of this document.

   NOTE: The threshold at which certain tire pressure warnings appear is adjustable on the VID **“Pressure Setup”** screen. However, the default value is preset by the vehicle manufacturer.

   To ensure tire pressure warnings are displayed properly on the VID, set the current pressure value in the “Pressure Setup” screen to the recommended cold inflation pressure as specified in your Operator’s Manual. This should include adjustments based on vehicle loading.

2. **Question:** "Why are the low tire pressure warnings being displayed in the VID when the tire pressure is at or above the recommended inflation?"

   Answer: By the laws of physics, pressure increases with increasing temperature. Tire temperature is increased as a result of friction from normal driving and braking. Therefore, although the tire pressure displayed in the VID may be close to the recommended cold inflated tire pressure; due to increased tire temperature while driving, tire pressure should have also increased.

   If the system detects that the tire pressure has not increased with the rise in temperature, it assumes that the air volume has changed (air has leaked from the tire); hence the YELLOW (or RED) warning appears in the VID. This loss of air needs to be replaced until the YELLOW (or RED) warning in the VID goes out (the wheel turns GREEN on the VID TPMS screen).

   As a standard practice, tire inflation should be done only when tires are cold, or incorrect air pressures will result.

3. **Question:** "Why is the tire information not being displayed on the VID when I turn the key switch to the IGNITION ON position **OR** when I start the vehicle? Several wheels are BLACK (empty) on the TPMS screen for almost a full minute.”

   Answer: It may take up to 2 minutes before the TPMS controller receives all of the sensor’s information, due to the rate at which they transmit (once per minute). Therefore, the sensor’s information may not be received by the TPMS controller immediately following an ignition key cycle.

4. **Question:** "Why are the low tire pressure warnings being displayed in the VID? Although the VID indicates that the air pressure for the tire is low on the TPMS screen, the tire pressure gauge reading indicates that the tire pressure is sufficient when I checked it."

   Answer: Ensure all of the Tire Transmitter IDs have been programmed to the correct wheel location. The VID does not actually know the location of the tire sensors. Each tire sensor has been programmed to a wheel location, and these locations can be changed manually using the VID.

   If a Tire Transmitter has been programmed into the wrong wheel location, the wheel location corresponding to the YELLOW or RED wheel on the TPMS screen will be incorrect. The fact that one of the wheels has lost air will be true, however.

Tire Transmitter ID Programming

This document provides vehicle information display (VID) related programming information supplemental to the tire pressure monitoring system (TPMS).

1. Replacing a Wheel/Rim

Initial tire transmitter ID programming is necessary under any of the following conditions:

- The "Tire Type" is changed on the VID "TPMS Setup" screen, such as from dual wheels to super single wheels or vice versa **(See Note 1).**
- **OR** the TPMS controller has been replaced **(See Note 1).**
- **OR** [either the wheel **OR** tire sensor has been replaced].

Note 1: All wheel associations will be cleared on the VID if the "Tire Type" is changed or the TPMS controller is replaced.

Note 2: It is recommended that the vehicle being serviced is moved more than 100 feet from other TPMS equipped vehicles and/or wheels. If it is not feasible to move the vehicle away from other TPMS equipped vehicles and/or wheels, remove 2-3 PSI air pressure from the tire within one second. This will place the tire sensor in fast transmit mode for approximately 2 minutes. That sensor will then appear 1st in the list of detected sensors on the Tire Transmitter ID screen (and with an asterisk), which helps to identify the particular wheel.

1.1. *Procedure*

1. From the Main Menu, choose "Setup".

2. From the Setup Menu, choose “TPMS Setup”. **Note:** This screen will be grayed out if the vehicle is not stationary.

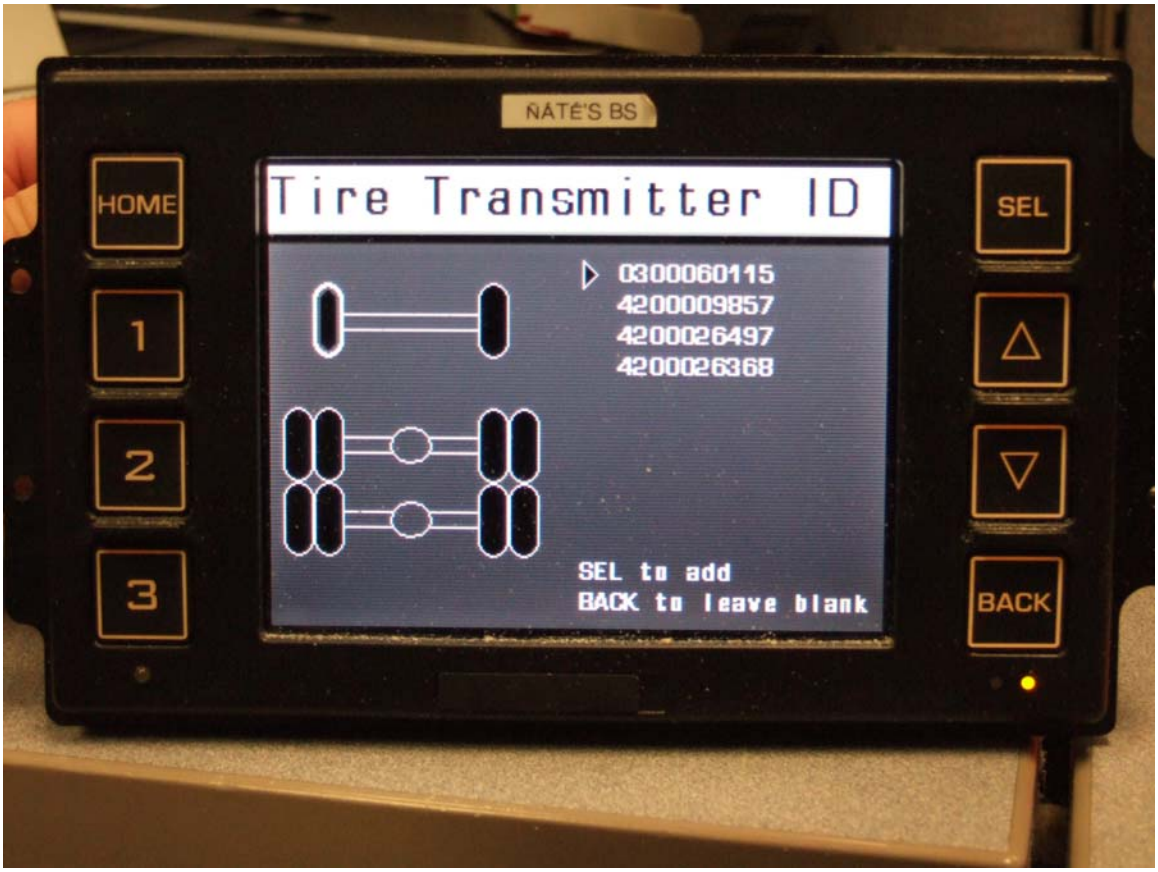
3. From the TPMS Setup screen, choose “Tire Sensors”.

The arrow keys can be used to highlight the appropriate wheel. We’ll assume that the technician would like to replace the left front wheel (highlighted below) in this example.

The 0300060115 indicates the Tire Transmitter ID currently programmed into that wheel location (LF). Different IDs will be displayed for different wheel selections using the arrow keys, if desired.

4. Press SEL while LF wheel is highlighted. The VID should prompt the question: “Remove this sensor from the system?”

5. Press SEL again while LF wheel is highlighted.



The VID will display all detected sensors. In the example above, there are 4 Tire Transmitter IDs detected. The first ID in the list (0300060115) is the sensor which was removed. This allows the user a chance to add the sensor back if it was mistakenly removed (this is also useful when rotating wheels, since the other wheel will be displayed 1st). The other 3 IDs are sensors which the TPMS antenna detects, but are not associated with that particular wheel location.

6. Select the appropriate Tire Transmitter ID from the list by pressing SEL. In this example, we will select the second Tire Transmitter ID (4200009857) from the list.

7. Press SEL again while the arrow is next to Tire Transmitter ID (4200009857). That sensor is now programmed into the LF wheel location, and the ID appears while the LF wheel is highlighted.

8. Refill any deflated tires to the recommended cold inflation pressure. Refer to the Operator's Manual for more information.

9. Wait at least 2 minutes for the TPMS system to update its tire pressure data.

10. Ensure that the tire pressure measured by the tire pressure gauge matches the tire pressure displayed on the TPMS screen in the VID for the newly associated wheel.

2. Rotating the Wheels

If rotating tires (such as LF with RF), Tire Transmitters must be disassociated with both wheels and then both Transmitter IDs must be reprogrammed to their new wheel locations. Actual tires may be rotated before or after programming.

2.1. *Keeping Track of Wheel Locations*

It's important to ensure that tire sensors are not being reprogrammed back into the same location.

IMPORTANT! Prior to servicing a particular TPMS equipped wheel, keep track of its location with respect to the vehicle. Each wheel indicates the respective Tire Transmitter ID on a sticker in case wheels are moved from their original orientation.

If the TPMS sensor ID sticker on the wheel has been removed:

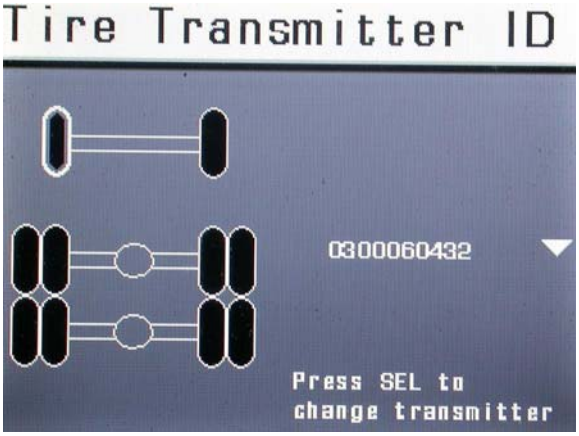
- **Either**, write the Tire Transmitter ID being received for that wheel location (displayed on the VID) by placing a sticker with that ID on the appropriate wheel *before* removing the wheel from the vehicle.
- **Or,** write the wheel's location (left front, for example) using a sticker on the wheel being serviced *before* removing the wheel from the vehicle.

If the Tire Transmitter ID is unknown AND the wheel was moved from its original orientation:

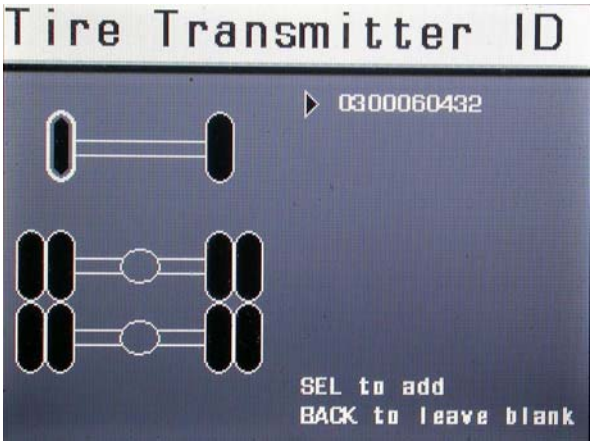
- **Either**, remove 2-3 PSI air pressure from the tire with the unknown Tire Transmitter ID within one second. This will place the tire sensor in fast transmit mode for approximately 2 minutes. That Tire Transmitter ID will then appear 1st in the list of detected sensors on the Tire Transmitter ID screen (and with an asterisk).
- **Or**, retrieve the Tire Transmitter ID (sensor serial #) from the tire sensor by removing the tire.

2.2. *Procedure*

1. With the starting wheel highlighted as shown (LF in this case), press SEL 2 times.



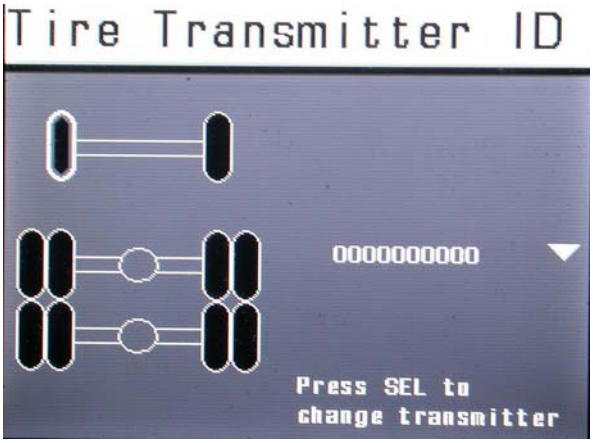
2. The screen below will then be displayed on the VID.



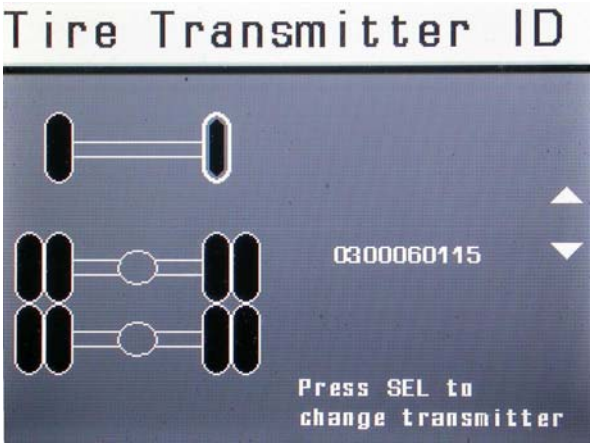
At this point (screen above) the tire sensor (0300060432) has been disassociated from the LF location and either a Tire Transmitter ID must now be added or the tire location must be "blanked" (no IDs will be associated with the location). Since we don't want to reprogram the LF tire back to that location, we'll leave it blank as instructed in the next step.

Note: In this case, the sensor removed is the only one in the list. In a shop environment, however, other IDs may be present due to the system receiving other TPMS equipped vehicles/wheels. If other sensors are detected, the first Transmitter ID in the list will be the one which was removed (LF).

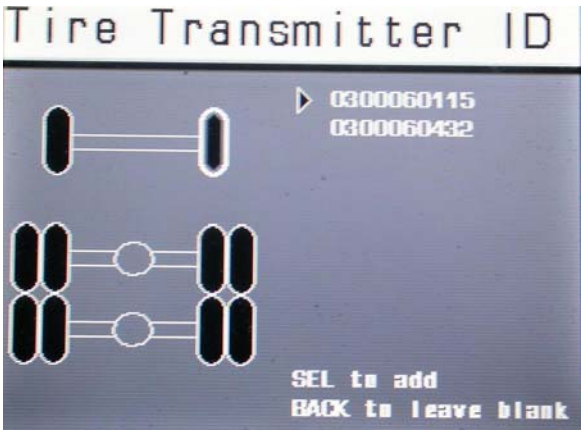
3. Press BACK to leave the current wheel location blank. All sensors will remain disassociated with this location and 0000000000 will be displayed (as shown below) for this location when the wheel is selected.



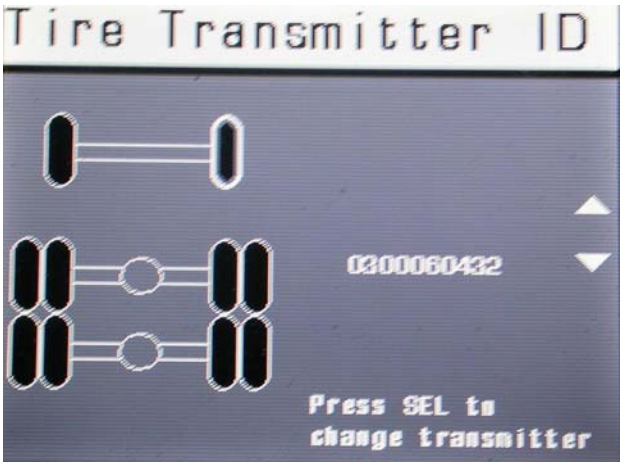
4. Press the down arrow until the RF wheel location is highlighted (as shown below).



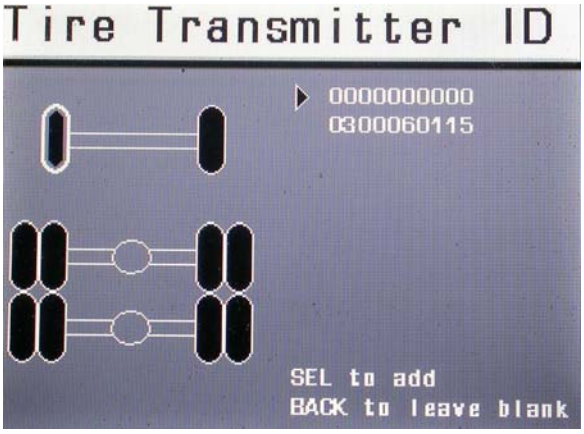
5. Press SEL 2 times while the RF wheel location is highlighted.



6. At this point (screen above) the previously programmed RF sensor (0300060115) has been disassociated from the RF location (shown first in the list). The only other sensor in the vicinity is the LF wheel (0300060432). That is the wheel which needs to be programmed into the RF location, so we'll select and add that wheel to the RF location by using the down arrow followed by pressing SEL. The screen below illustrates the results of the newly programmed RF sensor.

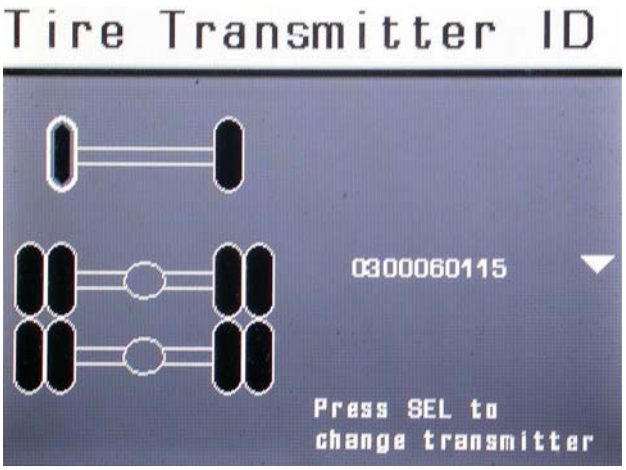


7. Press the up arrow to go back to the LF wheel location, then press SEL 2 times.



0000000000 will be the first Transmitter ID in the list (shown above). The second Transmitter ID (0300060115) is the one that was previously associated with RF location.

8. Press down to select the sensor that was previously associated with the RF location (0300060115) and press SEL to associate that sensor with the LF location. The association is shown is the example below.



9. Procedure completed.

Vehicle Information Display (Feature Code 016HKG)

1. Description and Operation

The vehicle information display (VID) provides detailed vehicle and diagnostic information. It is also a required feature for certain prognostic packages (if equipped). Three external video inputs are provided for optional camera inputs. Refer to Feature Functions for more information.

This feature consists of the following component(s):

- Vehicle Information Display

The VID is located in the wing panel. The VID is connected to the public (powertrain) SAE J1939 data link. Data is received through this link and displayed on the VID. The VID is connected to battery and accessory voltage. **The VID must receive both battery and accessory voltage inputs to operate properly.**

2. Feature Functions

2.1. Tripometer, Fuel Economy, Usage

These functions are described in the Vehicle Information Display Operator's Manual.

2.2. Diagnostic Codes

Refer to Displaying Diagnostic Trouble Codes.

2.3. Prognostics

Tire pressure monitoring, brake stroke, and brake lining information are presented to the operator in graphical form. Refer to the Vehicle Information Display Operator's Manual for more information.

2.4. Video

Three separate video inputs (1-3) are provided for aftermarket cameras or other video sources to be displayed on the VID. NTSC RCA style connectors are provided on the rear of the unit for connecting composite video sources.

NOTE: Input #4 is not used.

3. Setup

Several setup screens are provided to adjust the display, language, units, date and time, password and access levels.

4. Adjustable Parameters

4.1. VID Adjustable Parameters

The following parameters are adjustable only through the VID.

Name (Screen Revision 2.0 or after): **"Diagnostic Level"**
Name (Screen Revision 1.9 or before): **"Message List"**
Description: This parameter selects which, if any, diagnostic codes and information will be displayed on the VID. Refer to the Vehicle Information Display Operator's Manual for more information.

4.2. VID/DLB Adjustable Parameters

The following parameters are adjustable through the VID OR using Diamond Logic® Builder (DLB) software.

"Screen Timeout" and **"Backlight Timer"** serve the same function. These parameters set the maximum time in which the backlighting remains active without VID key press activity in order to extend bulb life. The manner in which each of these parameters is adjusted differs between VID and DLB; however.

Name: **Screen Timeout**
Programmable parameter in the VID.
Minimum: 10 minutes
Maximum: 120 minutes
Interval: 10 minutes
Default Value: 20 minutes

Name: **Backlight tmr (ID: 32768)**
Programmable parameter in DLB.
DLB Access Level: Dealer

Minimum: 60 seconds
Maximum: 32767 seconds
Interval: 1 second
Default Value: 1200 seconds

VID Name: **Brightness**
DLB displayed name: **User Brightness (ID: 32769)**
Description: This parameter adjusts the level of brightness on the VID display
DLB Access Level: Dealer
Minimum: 0 percent
Maximum: 100 percent
Interval (if adjusted on the VID): 5 percent
Interval (if programmed using DLB):1 percent
Default Value: 50 percent
NOTE: Actual changes in brightness will only occur if the "Auto Dim" is "Off".

Name: **Auto Dimming (ID: 32770)**
Description: This parameter enables or disables control of backlighting by the photo sensor.
DLB Access Level: Dealer
Allowed Values: Off (0), On (1)
Default Value: Off (0)

Name: **Language (ID: 32771)**
Description: This parameter sets the language displayed on the VID.
DLB Access Level: Dealer
Allowed Values: English (0), French (1), Spanish (2)
Default Value: English

Name: **Units (ID: 32772)**
Description: This parameter sets the units of measure displayed on the VID.
DLB Access Level: Dealer
Allowed Values: Metric (1), US Customary (0)
Default Value: US Customary (0)

Name: **Password Length (ID: 32773) – See Note 1 and 2 for VID programming**
Description: This parameter sets the number of allowed characters in the password. If the **Password String** is set to 12313221 and the length is set to 5, then the password is actually 12313.
DLB Access Level: Dealer
Allowed Values:

- 0 (Password Disabled)
- 1 byte password
- 2 byte password

- 3 byte password
- 4 byte password
- 5 byte password
- 6 byte password
- 7 byte password
- 8 byte password

Default Value: 0 (Password Disabled)

NOTE 1: Setting this parameter to “Disabled” (0) in DLB or selecting a blank password (zero characters) using the VID will erase the current password.

NOTE 2: The number of characters entered into the current password will determine the password length if adjusting the password length using the VID.

Name: **Popup Warnings (ID: 32793)**
Description: This parameter selects whether pop-up diagnostic warnings will be displayed on the VID and to what level these warnings will be displayed.
DLB Access Level: Dealer
Allowed Values: None (0) = no warnings will be displayed, Partial (1) = only severe warnings will be displayed, Full (2) = all warnings will be displayed.
Default Value: None (0)

NOTE: User must enter the current password (if password protection is enabled) to access this parameter on the VID display.

4.3. DLB Programmable VID Related Parameters

The following parameters are only adjustable using Diamond Logic® Builder (DLB) software:

Name: **Diagnostics (ID: 32800)**
Description: This parameter enables or disables diagnostic code information from being displayed on the VID.
DLB Access Level: Dealer
Allowed Values: Off (0), On (1)
Default Value: On (1)

NOTE: Other parameters may be available on DLB pertaining to the VID in addition to the parameters listed above.

5. Frequently Asked Questions:

1. **Question:** How do I completely disable codes from being displayed on the VID?

Answer: Disable the programmable parameter, “Diagnostics”, using Diamond Logic® Builder (DLB) Software.

2. **Question:** How do I prevent codes from being displayed on the VID unless a valid password is entered?

   Answer: Set up password protection using the VID by performing the following steps:

   a. Select “Setup”, then “Password”, and input a new password.
   b. Select “Diag Code Setup”, then “Diagnostic Level” **(See Note)**. Change to “None”.
   c. Cycle the key switch.

   NOTE: “Diagnostic Level” is referred to as “Message List” if the vehicle is equipped with VID screen revision 1.9 or before.

3. **Question:** How do I disable password protection?

   Answer: The user must know the current password. Select “Password”. Enter the current password. When prompted with “Enter New” and “Confirm New” press the “Select” button two times. This will disable password protection until a new password is entered.

4. **Question:** How do I recover a lost password?

   Answer: Go to the “Features” tab using DLB. Select “Password Length”, and then choose “Password Disable” from the dropdown menu selection. This erases the current password. At this point a new password may be entered to enable password protection.

5. **Question:** How do I change the language if a foreign language is currently displayed on the VID?

   a. **Answer using the VID:** Main Menu, “Setup”, “Display”, “Language”, then select the appropriate language.

      i. If changed to French: Main Menu (“Menu Principal”), “Configuration”, “Vidéo”, “Langue”, Select “Anglais” (for English).

      ii. If changed to Spanish: “Menu Principal”, “Configuración”, “Video”, “Lengua”, “Inglés” (for English).

   b. **Answer using DLB:** Go to the programmable parameter, “Language”, and select the appropriate language.

6. **Question:** Why hasn’t the VID display adjusted its brightness according to the changes I recently made?

Answer: Ensure that “Auto Dim” is “Off”. This selection is located on the same screen as the “Brightness” selection. The actual display brightness will change as the “Brightness” is adjusted when “Auto Dim” is “Off”.

7. **Question:** Why is the “Average” Fuel Economy not displayed?

   Answer: Because the VID is not currently in an active trip. Select “Trip Meter”, then “Start New Trip” to start an active trip.

Windshield Wiper and Washer Pump

1. Description and operation

This feature includes the following configurations:

Feature Code	Models	Feature Description
0595AYC	RXT, CXT, CE Bus, 3000 series, 4000 series, 7000 series, 8000 series	This feature includes low speed wipers, high speed wipers, intermittent wipers, wiper park, and windshield washer. Refer to Feature Functions for more information.
0595AAE	ProStar	This feature includes all of the base functions of **0595AYC** plus an additional ***washer fluid low indication (0595AYD)***.
0595AYD	3200, RXT, CXT, 4000 series, 7000 series, 8000 series	***Washer Fluid Low Indication***. Refer to Orderable Options for more information.
0595AJD	3200, RXT, CXT, 4000 series, 7000 series, 8000 series	***Wiper Speed Override***. Refer to Orderable Options for more information. Vehicle must be equipped with ***0595AYC***.

The windshield wiper and washer pump feature consists of the following additional electrical components:

- Wiper/Washer switch
- Wiper Power Relay
- Wiper High/Low Relay
- Wiper Motor
- Washer Pump

The wiper motor is located on the cowl at the rear of the engine compartment. The wiper switches and the washer switch are located inside the turn signal switch assembly. The washer pump is located inside the washer bottle.

The following chart indicates various washer bottle/pump locations:

Model	Bottle/Pump Location
ProStar	Engine compartment on the passenger side frame rail towards the front axle.
4000 Series	Driver side frame rail
7000 Series, 8500	Under the cab on the driver side
8600	Under the cab on the passenger side
CE Bus	Passenger side frame rail (front near radiator)

Both wiper relays are located in the interior power distribution center (PDC). The three wiper switches in the turn signal assembly are hardwired directly to the body controller. A zero volt reference (ZVR) signal will pass through the appropriate wiper switch to the body controller when any of these switches is closed.

The windshield wipers have eight speeds: off, high, low, and five different intermittent speeds. These speeds are determined by the condition of the three wiper switches. Each of the eight possible wiper switch settings causes a different combination of open and closed switches. The combination of open or closed switches is used by the body controller to determine which switch position the operator has selected.

The state of the three wiper switch signals **Wiper_0_Signal**, **Wiper_1_Signal**, and **Wiper_2_Signal** change as the wiper switch is placed in each of the switch positions. This is indicated in the example shown in Table 1. Diamond Logic® Builder (DLB) displays the symbol ☑ for Switch Open and ☐ for Switch Closed on each of the wiper switch signals.

The body controller interprets the wiper switch states to provide the appropriate wiper function. The key switch is assumed to be in the IGNITION position for all states shown in Table 1. Refer to signal definitions to understand the relationship between the signal names and the wiring.

Inputs				Outputs			
Wiper Switch State	**Wiper_2_Signal**	**Wiper_1_Signal**	**Wiper_0_Signal**	Wiper delay (Between Wipes)	**Wipers_Req**	**Wiper_Low_Speed**	**Wiper_High_Speed**
Off	☐	☐	☐	0	☑		
Intermittent	☐	☐	☑	13.5 Sec	☑	**See Note**	
Intermittent	☐	☑	☐	9.5 Sec	☑	**See Note**	
Intermittent	☐	☑	☑	6.5 Sec	☑	**See Note**	
Intermittent	☑	☐	☐	3.5 Sec	☑	**See Note**	
Intermittent	☑	☐	☑	1.5 Sec	☑	**See Note**	
Low	☑	☑	☐	0	☑	☑	
High	☑	☑	☑	0	☑	☑	☑

Table 1

Note: The body controller enables the **Wiper_Low_Speed** output for the duration of one wipe periodically (period of time depends on the intermittent mode requested).

1.1. Orderable Options

1.1.1. Wiper Speed Override (Feature Code 0595AJD)

This feature is used to prevent unnecessary dry wipe damage to the windshield and wiper blades by overriding the active wiper speed when the parking brake is set and the truck is stationary for a length of time. ***The windshield wipers will automatically go to the lowest intermittent wiper speed if:***

- The **Wipers_To_Low_Int_Enable** parameter is enabled
- AND the windshield wipers are on
- AND the park brake is set
- AND the vehicle is stationary longer than the programmed **Wipers_To_Low_Int_Timeout** value (see programmable parameters for more information).
- AND the vehicle speed has a good status. The **Vehicle_Speed** signal status can be viewed using DLB where a value of (0) indicates a good status
- AND the key switch is in the IGNITION position.

NOTE: Operator manipulation of the wiper switch will override this feature until the programmed **Wipers_To_Low_Int_Timeout** time has expired again.

1.1.2. Washer Fluid Low Indicator (Feature Code 0595AYD)

This feature is used to provide an indication that the windshield washer fluid is low. The feature consists of the following components:

- Washer Fluid Level Sensor
- Low Washer Fluid Indicator

ZVR is provided to the body controller through the switch contacts of the washer fluid level sensor when the switch closes. The body controller then sends a message on the SAE J1939 serial data link to the instrument cluster that the washer fluid level is low.

The text message "LOW WASHER FLUID" will be displayed in the instrument cluster if:

- The key switch is in the IGNITION position
- AND the instrument cluster receives the message from the body controller that the washer fluid is low.

2. Signal Definitions

This section connects the DLB displayed signal name to the circuit diagram. Refer to the electrical circuit diagram for specific pins. DLB displays the status on certain signals where a value of zero (0) indicates a good status.

Wiper_0_Signal: The input signal from the wiper 0 switch in the turn signal switch assembly to the body controller. DLB displays ☐ while wiper switch 0 is closed (ZVR is being provided to the body controller).

Wiper_1_Signal: The input signal from the wiper 1 switch in the turn signal switch assembly to the body controller. DLB displays ☐ while wiper switch 1 is closed (ZVR is being provided to the body controller).

Wiper_2_Signal: The input signal from the wiper 2 switch in the turn signal switch assembly to the body controller. DLB displays ☐ while wiper switch 2 is closed (ZVR is being provided to the body controller).

Wipers_Req: The windshield wiper power output signal. DLB displays ☑ while the body controller provides voltage to the wiper power relay coil and the wiper high/low relay coil.

Wiper_Low_Speed: The output signal from the body controller to the wiper power relay coil. DLB displays ☑ while the body controller provides ground to the wiper power relay coil.

Wiper_High_Speed: The output signal from the body controller to the wiper high/low relay coil. DLB displays ☑ while the body controller provides ground to the wiper power relay coil.

Washer_Pump_Signal: The input signal from the washer switch to the body controller. DLB displays ☑ while the washer switch is closed (Ground is being provided to the body controller).

Low_Washer_Fluid_WL_Signal (0595AYD): The input signal from the washer fluid level sensor. DLB displays ☑ while the switch contacts of the washer fluid level sensor are closed (ZVR is being provided to the body controller).

3. Programmable Parameters

Name: **Wipers_To_Low_Int_Enable (ID: 2171)**
Description: Enables or disables the wipers to low intermittent feature
Access Level: Fleets
Default Value: 1 (On) when 0595AJD is ordered

Name: **Wipers_To_Low_Int_Timeout (ID: 2228)**
Description: This parameter sets the amount of time the park brake must be set before the wipers are forced to their lowest intermittent speed.
Access Level: Fleets
Minimum: 10 seconds
Maximum: 300 seconds
Interval: 10 seconds
Default Value: 60 seconds when 0595AJD is ordered.

NOTE: Changing these parameters will not result in actual feature or function changes, unless 0595AJD is ordered

4. Start-Up Operation (Initialization)

The three windshield wiper switch inputs and the washer pump switch input will be ignored by the body controller for 0.5 seconds before being monitored by the body controller when the key is turned to the IGNITION position.

5. Feature Functions

5.1. Low and High Speed Windshield Wipers

The body controller supplies battery voltage to the wiper motor, the wiper power relay, and the wiper high/low relay when the key switch is in the IGNITION position. ***The body controller supplies ground to the wiper power relay coil if:***

- The high speed or the low speed wipers are selected
- AND the key switch is in the IGNITION position

This will energize the wiper power relay and apply battery voltage to the common contact of the wiper high/low relay switch.

5.1.1. Low Speed Windshield Wipers

The body controller will control the windshield wipers to Low Speed if:

- The key switch is in the IGNITION position
- AND the low speed wipers are selected

The wiper high/low relay will remain de-energized and the voltage at the common contact of the wiper high/low relay switch will pass through the normally closed contact to the low speed wiper motor windings. Ground for the wiper motor is supplied from the ground stud.

5.1.2. High Speed Windshield Wipers

The body controller will control the windshield wipers to High Speed if:

- The key switch is in the IGNITION position
- AND the high speed wipers are selected

The wiper high/low relay will energize and the voltage at the common contact will pass through the normally open contact to the high speed wiper motor windings. Ground for the wiper motor is supplied from the ground stud.

5.1.3. Intermittent Windshield Wipers

The body controller supplies ground for less than one second intermittently to the wiper power relay coil if:

- The key switch is in the IGNITION position
- AND the requested wiper mode is one of the five intermittent modes

NOTE: The amount of time between wipes depends on which of the intermittent modes is requested (refer to table 1 for more information).

5.2. Windshield Washer

The washer pump is wired directly to the washer switch in the turn signal switch assembly. Ignition voltage is also provided to the washer pump. Ground is supplied to the washer pump when the washer switch closes causing the washer pump to activate.

The ground from the washer switch is also applied to the body controller, which signals the body controller that the washer has been activated. The body controller activates the low speed wipers for three wiper cycles when it receives this signal. This occurs only if the wipers are not currently in the high speed wiper mode.

The washer mode will stop if the requested wiper mode changes during these three wiper cycles, and the new requested mode will begin immediately. That is unless the mode change is from one intermittent state to another intermittent state.

The windshield washer will have priority if the operator selects both windshield wipers and windshield washer.

5.3. Wiper Park

This function is used to return the wiper to its home position automatically when the multifunction switch is placed in the off position.

The body controller de-energizes both wiper relays when the wipers are switched to off while the key switch is in the IGNITION position. The body controller provides battery voltage to the wiper park switch (internal to wiper motor) while the wipers are not parked and the key switch is in the IGNITION position. Battery voltage is therefore provided through the park switch to the normally closed contact of the wiper power relay. Current flows through the normally closed contact of the wiper power relay and through the normally closed contact of the high/low relay to the low speed terminal of the wiper motor. This causes the wiper motor to operate at low speed, until the wipers are parked. The voltage being supplied to the wiper motor will be replaced by a ground when the wipers reach the park position causing the wiper motor to stop in the parked position.

6. Diagnostics

NOTE: The virtual fuse for the windshield wiper power output signal in the body controller will trip during a short. To reset the fuse, the key switch must be cycled.

Test for continuity in the wiper speed control switch (wiper switch 0, 1, and 2) at the turn signal switch assembly connector if DLB is not available to monitor signals during wiper functions. Perform test with the key switch in the OFF position and the turn signal switch connector disconnected. Check for continuity between the zero volt reference (ZVR) terminal and each of the three wiper switch terminals with the wiper speed control placed in the OFF position. Replace the turn signal switch assembly if there is no continuity. Operate wiper speed control to the HI position and check for continuity. Replace the turn signal switch assembly if there is continuity.

It is strongly recommended that DLB is used along with this information to enhance diagnostic capabilities. See the diagnostic software manual for details on using the software.

6.1. Diagnostic Trouble Codes

Refer to the Diagnostic Trouble Code Index (S08327) or the Master Service Manual for a list of Body Controller Diagnostic Trouble Codes.

6.1.1. Displaying Diagnostic Trouble Codes

Refer to Displaying Diagnostic Trouble Codes.