TRUCK SERVICE MANUAL

ELECTRICAL SYSTEM TROUBLESHOOTING GUIDE — 3200, 4100, 4200, 4300, 4400, 7300, 7400, 7500, 7600, 8500, 8600 Models Built After 05/19/2003

Model: 3200
Start Date: 05/20/2003

Model: 4100
Start Date: 08/01/2005

Model: 4200
Start Date: 05/20/2003

Model: 4300
Start Date: 05/20/2003

Model: 4400
Start Date: 05/20/2003

Model: 7300
Start Date: 05/20/2003

Model: 7400
Start Date: 05/20/2003

Model: 7500
Start Date: 05/20/2003

Model: 7600
Start Date: 05/20/2003

Model: 8500

S082504

Start Date: 05/20/2003

Model: 8600
Start Date: 05/20/2003

S082504

01/04/2008

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SAFETY INFORMATION

IMPORTANT – Read the following before starting the service procedure.

The information contained in this International Service Manual Section was current at the time of printing and is subject to change without notice or liability.

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.

WARNING – A warning indicates procedures that must be followed exactly. Personal injury or possible death can occur if the procedure is not followed.

CAUTION – 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.

This service manual section is intended for use by professional technicians, NOT a "**do-it-yourselfer**." It is written to inform these technicians of conditions that may occur on some vehicles, or to provide information that could assist in the proper service of a vehicle. Properly trained technicians have the equipment, tools, safety instructions, and know-how to do a job properly and safely. If a condition is described, DO NOT assume that the service section applies to your vehicle. See your International Truck Dealer for information on whether this service section applies to your vehicle.

Group Electrical

Table of Contents

1. MANUAL INTRODUCTION

This manual only covers the electrical system of the truck.

Detailed information on engines, transmissions, and antilock brake systems may be found in vendor manuals and other International Truck and Engine Corporation manuals. These systems are addressed in this manual only to cover circuits unique to our trucks, which are not addressed in other manuals.

This manual is intended to be used in conjunction with the electrical circuit diagram book that applies to the specific vehicle requiring repair. There are variations between specific models and periods of manufacture that may only be addressed in the circuit diagram book.

The circuit diagram book has valuable information that can be very helpful to a technician. Beyond circuit diagrams, the book provides information on connector composites and parts, circuit identification and location information, a schematic symbol chart, a relay function and wiring guide, and a lamp bulb chart.

The strategy used in this manual focuses on starting with general information and progressing toward more specific information to guide a technician to the cause of an electrical failure. The manual is grouped into major areas. These major areas are divided into sections covering each feature. Each feature section is further divided into the following areas:

- **Circuit Functions** include a figure representing the major components associated with the feature and a general description of how the feature works.
- **Diagnostics** provides a systematic means of identifying where to start looking for component or circuit failures. Example: Is there a problem with an input circuit to the ESC from a switch or output circuits from the ESC to a load device. Diagnostic trouble code explanations are provided in this area if applicable.
- **Fault Detection Management** provides more detail on circuit operation, a figure identifying typical circuits and connectors (always refer to the circuit diagram book for the latest circuit information) and a chart with the voltages or resistances at key connectors, expected during normal operation. Procedures for checking specific circuits for open or shorted circuits are not provided. It is assumed a technician has received training on circuit fault identification and repair.
- **Extended Description** provides more detail on power and ground circuits for the feature.
- **Component Locations** provides drawings showing locations of important components.
- Other areas such as **Removal**, **Installation** and **Programming** may also be included as required.

Operator observation and warning lights may be used to determine when there is a problem with the vehicle electrical system.

Technicians must still rely on observation of failed components or malfunctioning features. Once the technician has identified a failure he may go to the table of contents and refer to the applicable section for troubleshooting information.

Another way a feature failure may become evident is through the vehicle “on line” diagnostic system of the electrical system controller (ESC).

The check electrical system warning lamp will illuminate when a detectable fault has occurred. The lamp may illuminate either continuously or for 5 seconds depending on the fault. When a fault occurs and the ESC is able to communicate with the electronic gauge cluster (EGC), the lamp will illuminate for 5 seconds. Each time the ignition is cycled and the EGC completes a gauge sweep, the lamp will illuminate for 5 seconds if an active fault is present. If the light remains on consistently, there is a communication problem between the ESC and

EGC. The technician may retrieve diagnostic trouble codes through the EGC odometer display. The technician may then look up the diagnostic trouble codes to locate the applicable troubleshooting information.

ESC diagnostics are not capable of identifying all possible system faults. This is why problem identification through observation is still important.

Diagnostic trouble code retrieval procedures for engines, transmissions, and antilock brake systems vary from the procedure for retrieving diagnostic trouble codes produced by the ESC.

An electronic service tool (EST), such as the EZ-Tech, running the INTUNE software can be used to list vehicle diagnostic trouble codes, monitor inputs to the ESC and exercise outputs from the ESC.

This manual is written to attempt troubleshooting without the service tool, as much as possible. The EZ-Tech, running the appropriate software, can also be used to troubleshoot the engine, transmission and ABS electrical systems.

2. VEHICLE ELECTRICAL SYSTEM OVERVIEW

The electrical system in this vehicle provides a means to distribute electrical power and provides the driver with controls and indications of the vehicle performance. Unlike previous electrical system designs, this approach uses multiplexed wiring technologies for interfacing major functional areas of the vehicle. Furthermore, the system relies on software algorithms to accomplish logic functions instead of implementing similar features using complex wire harness designs with relays and switches.

A natural benefit of this system is increased diagnostic capability in terms on line, off line and off board testing.

On–line diagnostics are performed on the vehicle while it is in operation. If a detectable fault occurs, the check electrical system lamp will illuminate for 5 seconds. If a communication failure between the ESC and EGC occurs, the lamp will stay illuminated until communications are restored.

Off–line diagnostics are enabled when the system is put in diagnostic mode. While the system is in the diagnostic mode, diagnostic trouble codes will be displayed on the odometer.

Off–board diagnostics require the use of an electronic service tool, such as the EZ-Tech, and the INTUNE diagnostic software. The EST is connected to the vehicle diagnostic connector. The INTUNE software will allow the technician to view diagnostic trouble codes, monitor inputs to the ESC and activate outputs from the ESC.

3. ELECTRICAL CIRCUIT DIAGRAM BOOK

Electrical circuit diagram books can be found in Group 08–Electrical in the Master Service Manual.

3.1. CIRCUIT DIAGRAMS

Circuit diagrams provide a schematic picture of how a circuit is powered, what the current path is to circuit components, and how the circuit is grounded.

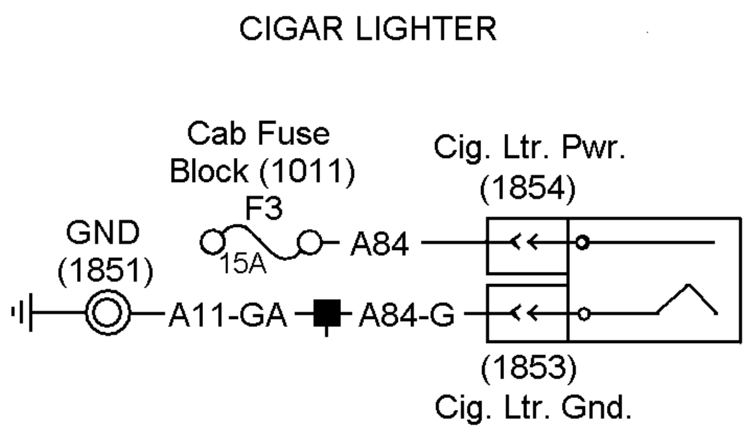


Figure 1 Sample Circuit Diagram

In most cases, the power source will appear at the top of the page, and the ground will be at the bottom of the page (or bottom of circuit). The circuit components are named, using capital letters. Abbreviations may be used (See Sample Circuit Diagram Instructions and Abbreviations).

IMPORTANT – Switch, relay and solenoid positions, as shown on circuit diagrams, indicate NORMAL position with the key switch in the OFF position, unless otherwise noted.

Components which work together are shown together. All electrical components used in any circuit are shown in the circuit diagram. The power source (fuse, circuit breaker, junction point, etc.) is usually shown or indicated at the top of the page. All wires, connectors, and other electrical components are shown in the signal flow to the bottom of the page (or bottom of the circuit).

Circuit Diagram Instructions

Examples of the circuit diagram instructions, abbreviations and symbols are included in Sample Circuit Diagram Instructions, Sample Circuit Diagram Instructions and Abbreviations and Sample Schematic Symbol Chart.

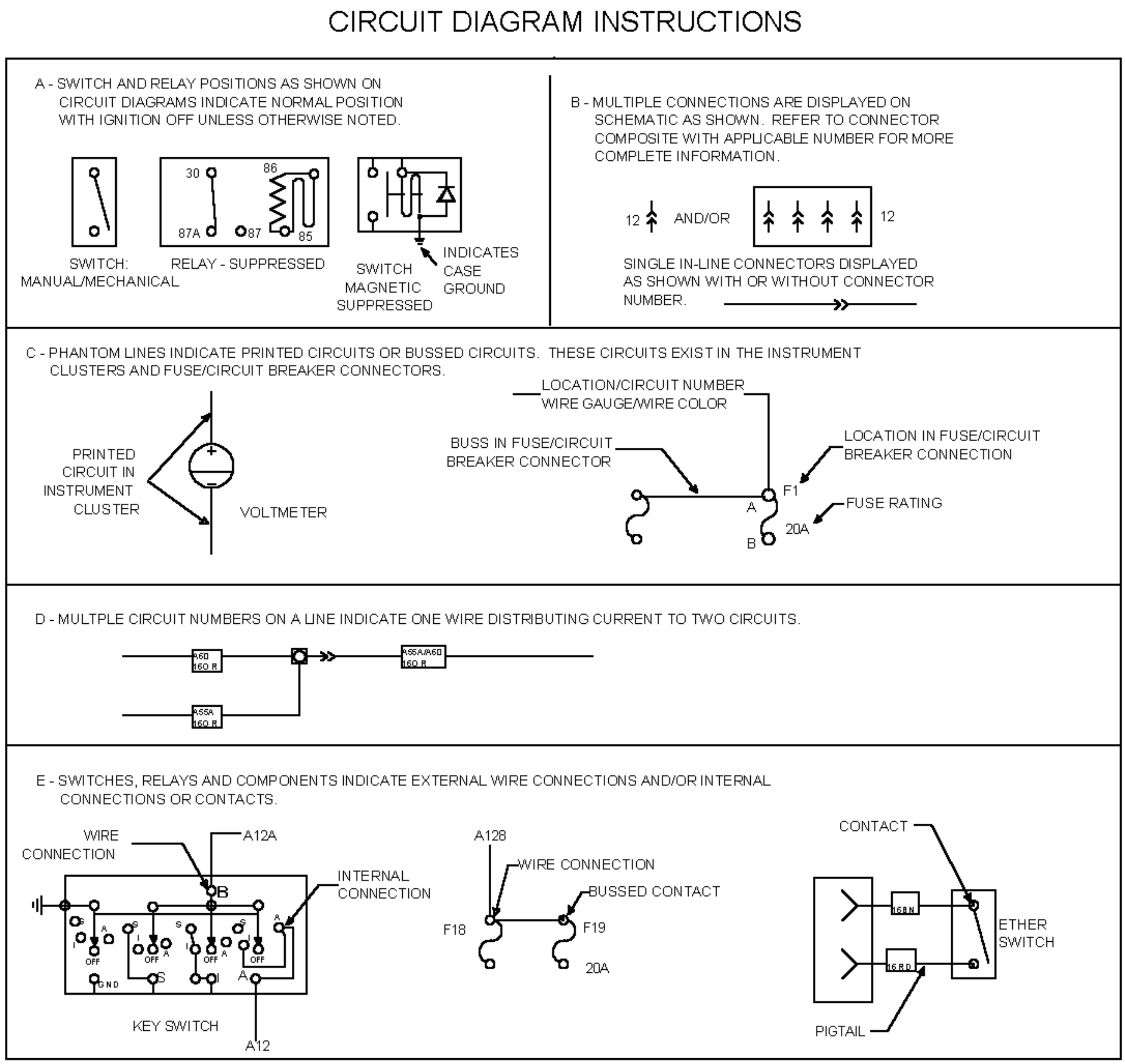


Figure 2 Sample Circuit Diagram Instructions

CIRCUIT DIAGRAM INSTRUCTIONS

F - CIRCUIT "11" DENOTES ANY COMMON GROUND, (MORE THAN ONE CIRCUIT). ANY INDIVIDUAL GROUND CIRCUIT IS IDENTIFIED WITH THAT PARTICULAR CIRCUIT NUMBER. (E.G CIRCUIT 32 AXLE OIL TEMPERATURE, IS IDENTIFIED PER EXAMPLE).

NOTE: FOR CIRCUIT DESCRIPTION OTHER THAN GROUNDS,NEITHER THE LETTER "G" FOR THE COLOR WHITE SHALL BE USED.

GROUND CIRCUITS ARE DESCRIBED THUS:

11-G
11-GA
11-GB

COMMON GROUND CIRCUIT NUMBER

SUFFIX

G IS NOT A SUFFIX BUT INDICATES A GROUND CIRCUIT.

R32-G
R32-GA
R32-GB

LOCATION

INDIVIDUAL GROUND CIRCUIT NUMBER

SUFFIX

G IS NOT A SUFFIX BUT INDICATES A GROUND CIRCUIT.

G - ABBREVIATIONS: COLOR, NOUN AND ENGINE

COLOR ABBREVIATION

AQ - AQUA
BK - BLACK
BL - BLUE
BN - BROWN
DK GN - DARK GREEN
GD - GOLD
GY - GRAY
GN - GREEN
LT BL - LIGHT BLUE
LT GN - LIGHT GREEN
OR - ORANGE
PK - PINK
PL - PURPLE
RD - RED
SIL - SILVER
TN - TAN
VT - VIOLET
WH - WHITE
YL - YELLOW

NOUN ABBREVIATION

A, ACC	ACCESSORY
AC -	AIR CONDITIONER
AUX -	AUXILIARY
AWG -	AMERICAN WIRE GAUGE
B, BAT	BATTERY
CONN-	CONNECTION OR CONNECTOR
DRL -	DAYTIME RUNNING LIGHTS
ENG -	ENGINE
FWD -	FORWARD
GA -	GAUGE
G, GND	GROUND
I, IGN	IGNITION
IND	- INDICATOR
L	- LEFT
LT	- LIGHT
W/O	- WITHOUT
OPT	- OPTIONAL
R	- RIGHT
S	- START OR SENDER
THERMO	- THERMOSTAT
W/	- WITH

ENGINE ABBREVIATION

ISM - MFG (CUMMINS) 10.8 LITER ELECTRONIC ENGINE CONTROL

N14E PLUS - MFG (CUMMINS) 14 LITER ELECTRONIC ENGINE CONTROL

C-10,C-12 - MFG (CATERPILLAR) 10.3 LITER ELECTRONIC ENGINE CONTROL

V8-AVNT - MFG (INTERNATIONAL) V8 6.0 LITER ELECTRONIC ENGINE CONTROL

I6-HEUI - MFG (INTERNATIONAL) NGD I6 DT466 & DT/HT530 ELECTRONIC ENGINE CONTROL

Figure 3 Sample Circuit Diagram Instructions and Abbreviations

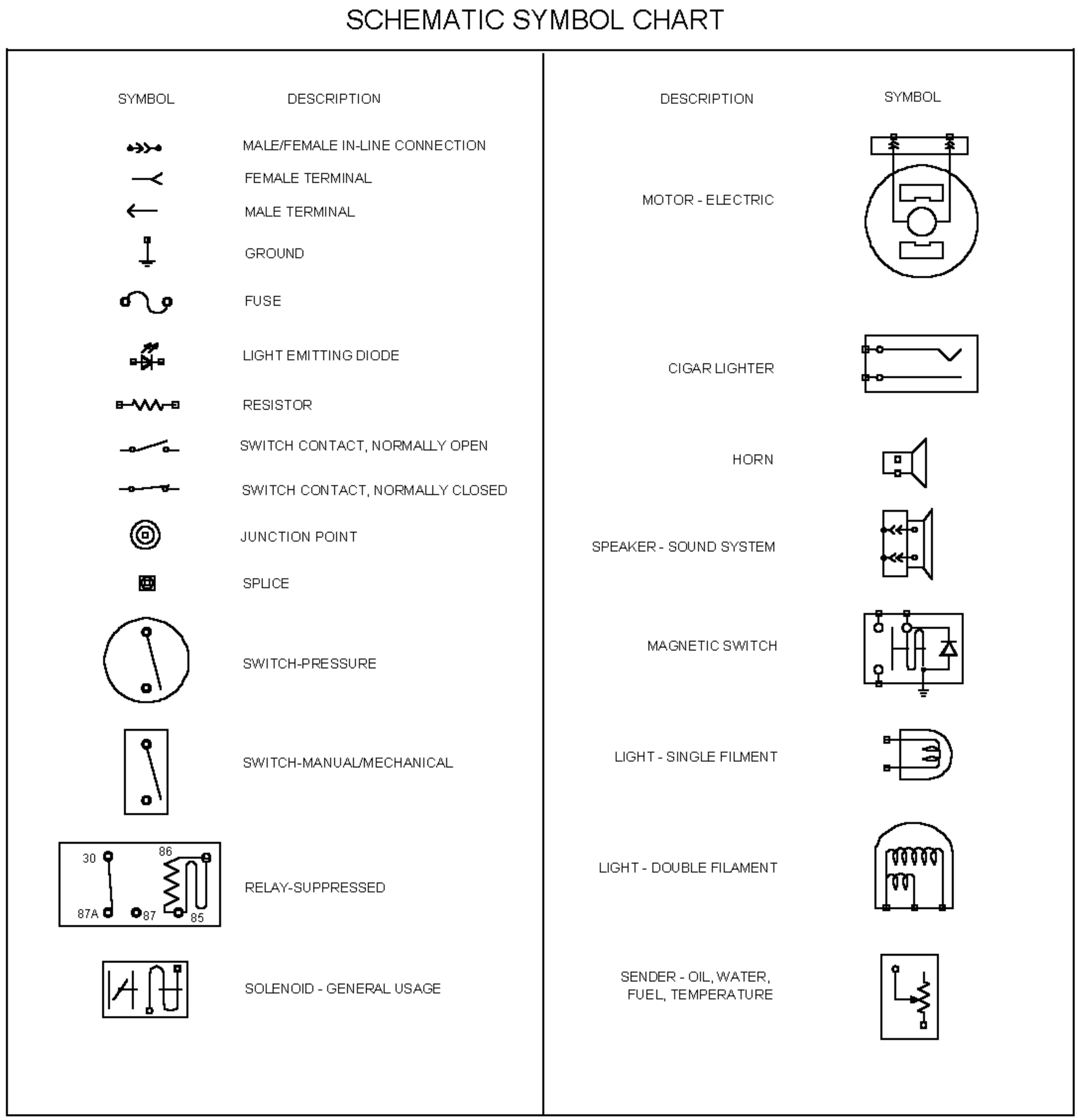


Figure 4 Sample Schematic Symbol Chart

3.2. COMPONENT ILLUSTRATIONS

Each section will provide component location illustrations. The Sample Component Location Illustration shows the location of a circuit component being discussed.

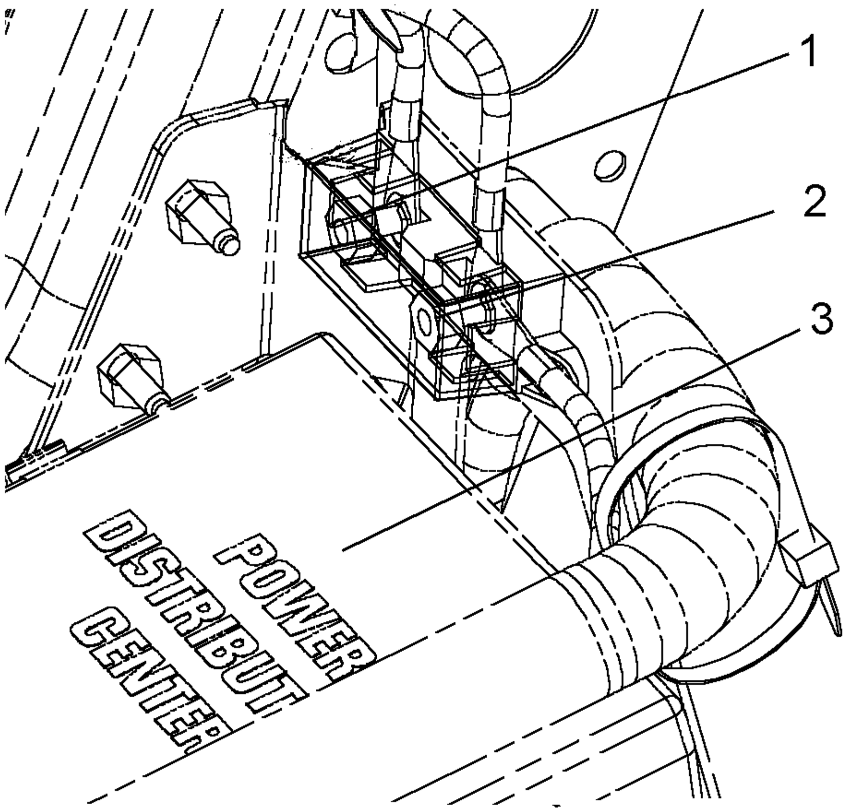


Figure 5 Sample Component Location Illustration

1. FUSED SIDE OF MEGAFUSE
2. UNFUSED SIDE OF MEGAFUSE
3. ENGINE POWER DISTRIBUTION CENTER (PDC)

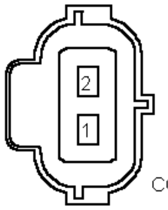
Connector end views found in the Circuit Diagram book provide information on the location of the various connectors.

3.3. CONNECTOR BODY COMPOSITE

Connector Composites are located in the back of the Group 08 - Electrical CIRCUIT DIAGRAMS under Connector Composites. The composites show the pin configuration of the connector and which circuits are attached to the pins as shown in Sample Pin Configuration.

RR AXLE TEMP SENDER (9812)

(LOCATED ON AXLE)

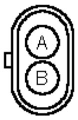


CAV	CIR	GAUGE	COLOR	TERM	SEAL	NOTES
1	R32	18	TN	3536865C1	3536866C1	
2	R9	18	GY	3536865C1	3536866C1	W/TANDEM
2	R9C	18	GY	3536865C1	3536866C1	N/TANDEM

CONNECTOR - 3536864C1

RR AXLE DIFF LOCK WARN LIGHT (9815)

(LOCATED ON AXLE)



CAV	CIR	GAUGE	COLOR	TERM	SEAL
A	R49A	18	GY	0587578C1	1652325C1
B	R49-GA	18	WH	0587578C1	1652325C1

CONNECTOR - 587567C91

Figure 6 Sample Pin Configuration

4. TROUBLESHOOTING

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

4.1. VERIFY THE PROBLEM

Operate the complete system and list all symptoms in order to:

1. Check the accuracy and completeness of the complaint.
2. Learn more that might give a clue to the nature and location of the problem.
3. Analyze what parts of the system are working.

4.2. IMPORTANT STEPS BEFORE TESTING

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.
   a. Do the logged codes correlate to probable causes?
4. Were the codes logged about the same time as the symptoms appeared? Were the codes logged repeatedly?

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

6. **Avoid preconceived ideas!** Eliminate any nonelectrical causes for the problem first (contaminated fuel, clogged air filters, etc.).

7. Perform the following preliminary steps:

   A. Before beginning these test procedures, make sure the vehicle batteries are at 75% state of charge (SOC) or higher. This represents an open circuit voltage (OCV) of 12.4 volts. Batteries with an OCV of 12 volts or less are either completely discharged or have a dead cell.

   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. 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.

4.3. READ "EXTENDED DESCRIPTION"

Read the extended description for the problem circuit (while referring to the circuit diagram). 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.

4.4. 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. Refer to POWER DISTRIBUTION AND GROUNDS in the ELECTRICAL SYSTEM TROUBLESHOOTING GUIDE. 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.

4.5. CHECK FOR CAUSE OF THE PROBLEM

Diagnostic charts are provided 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.

4.6. MAKE THE REPAIR

Repair the problem circuit as directed in the diagnostic charts.

4.7. 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.

5. ELECTRICAL TEST EQUIPMENT

5.1. EZ-TECH® ELECTRONIC SERVICE TOOL (EST)

The EZ-Tech® EST is a ruggedized 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 INTUNE™ software can be used to diagnose the electrical system controller (ESC). See the INTUNE software manual for detailed instructions.

The ICAP software must be used to reprogram or restore programming to the electrical system controller.

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

5.2. ESC BREAKOUT BOX (ZTSE4477)

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

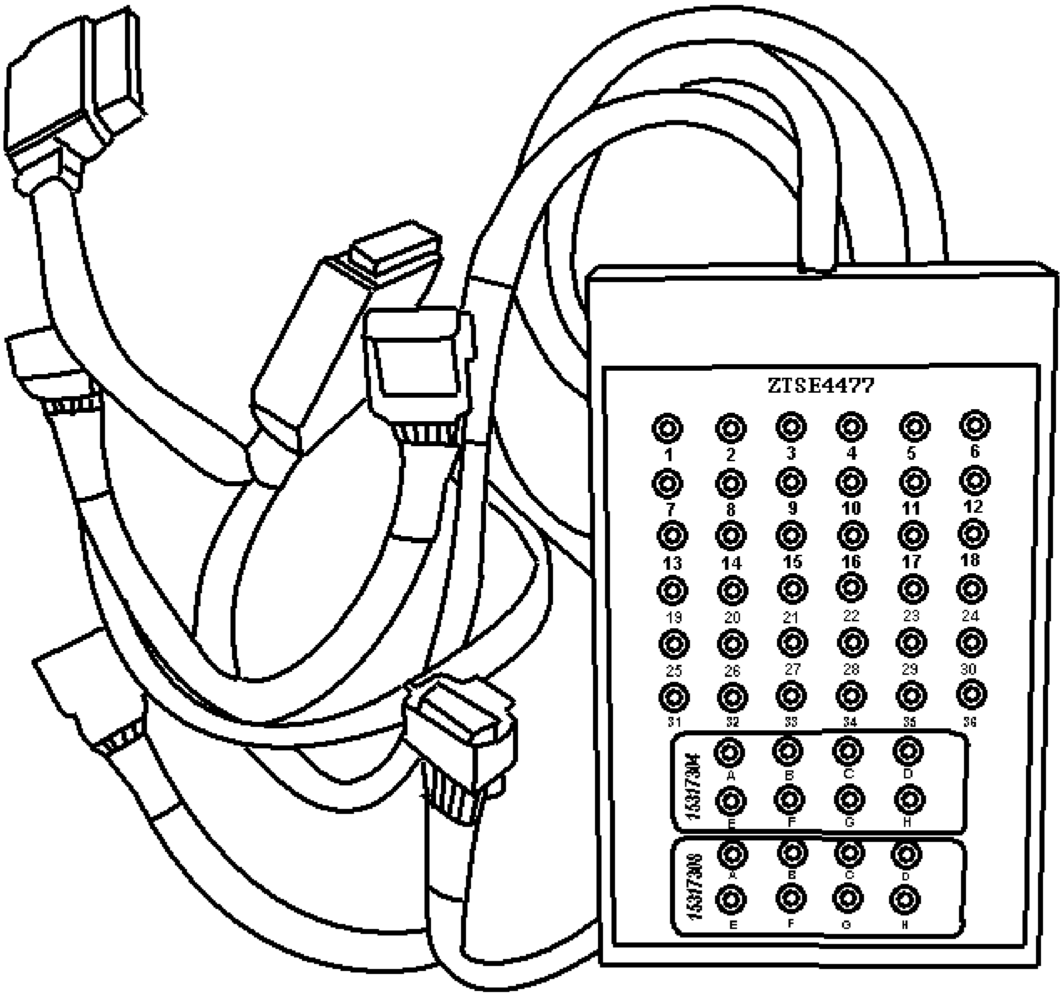


Figure 7 ESC Breakout Box

The breakout box can be connected to the ESC 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 ESC, or to test input circuits to the ESC.

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

5.3. FLUKE 88 DIGITAL MULTIMETER (DMM)

> **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 Multimeter (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 Fluke 88 Multimeter is a digital meter, and is recommended because it uses very little current when performing tests. Digital meters have high impedance (resistance), 10 Mega ohms. Thus they do not damage components or give misleading readings.

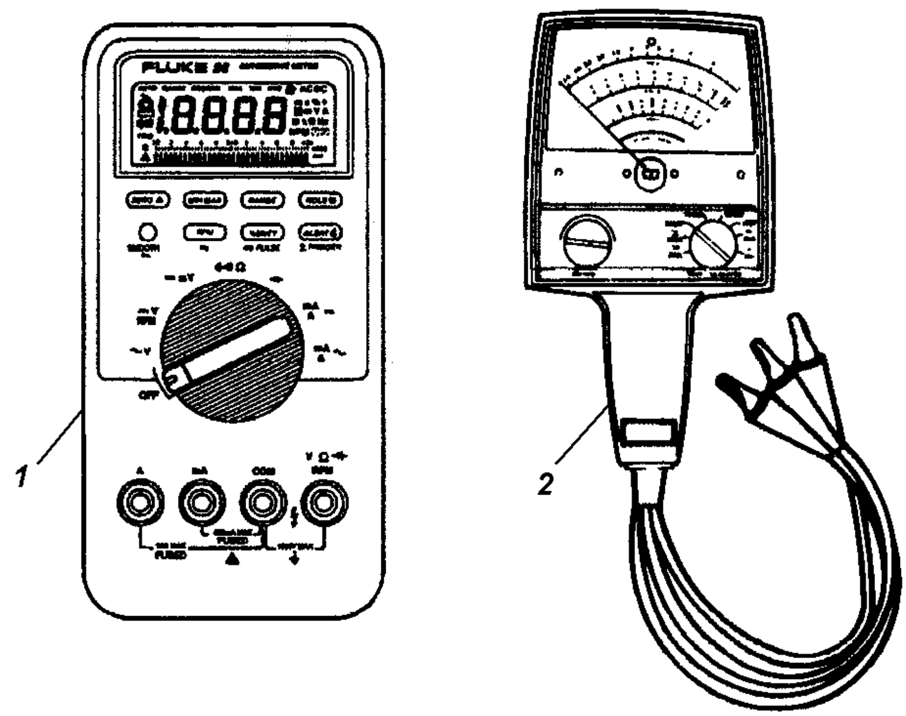


Figure 8 Digital and Analog Meters

1. DIGITAL MULTIMETER
2. ANALOG VOLTMETER

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.

5.4. JUMPER WIRES AND TEST LEADS

Jumper Wires

CAUTION – When using jumpers and test leads, 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.

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

1. If the circuit (Refer toJumpers 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.

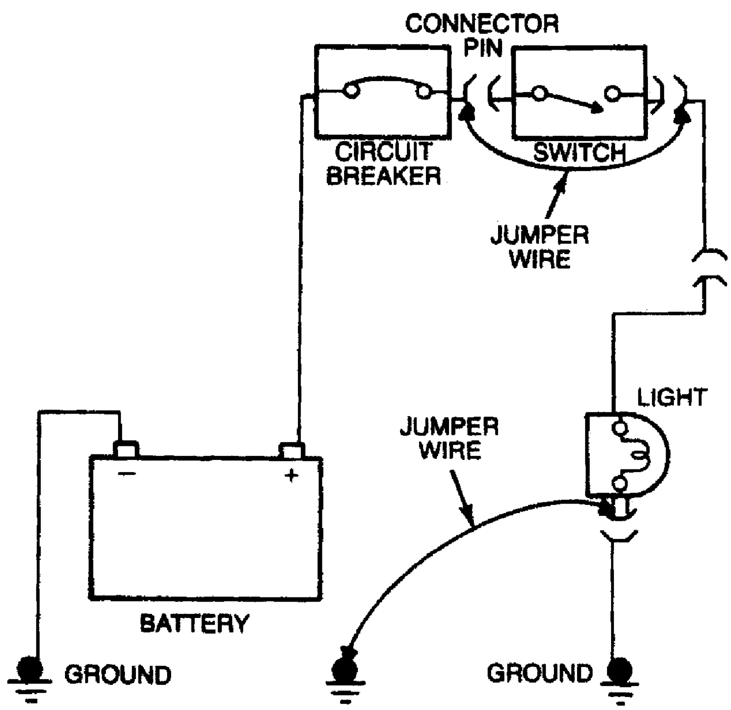


Figure 9 Jumpers in Circuits

2. 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.

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.

5.5. OHMS LAW REVIEW

Ohms Law describes the relationship of voltage, current and resistance, and provides us with a formula to make calculations as is shown in Ohms Law Formula.

Table 1 Ohms Law

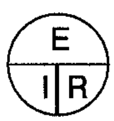
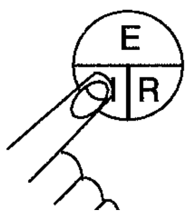
Ohms Law	
	Where: I = Current (Amperes) E = Voltage (Volts) R = Resistance (Ohms)
I = E/R	This formula states that current flow (I) = Voltage (E) applied to a circuit divided by total resistance (R) in the circuit. This shows that an increase in voltage or a decrease in resistance increases current flow.

Table 1 Ohms Law (cont.)

R = E/I	This formula states that resistance (R) = Voltage (E) applied to a circuit divided by current flow (I) in the circuit. This allows us to calculate resistance needed for a specific current flow with a specific voltage applied (like 12V).
E = IR (I multiplied by R)	This formula provides the voltage drop across a particular load device (resistance) that is part of a series of load devices.
	Memorize the formula in the circle. You only have to cover the “letter” that you wish to calculate, with your finger, and you have the formula. For example: If you cover the letter “I”, the formula is I = E/R.

If any two of the values are known for a given circuit, the missing one can be found by substituting the values in amperes, volts, or ohms and solving for the missing value.

In a typical circuit, battery voltage is applied to a bulb through a 10 amp fuse and a switch (Typical Circuit). Closing the switch turns on the bulb.

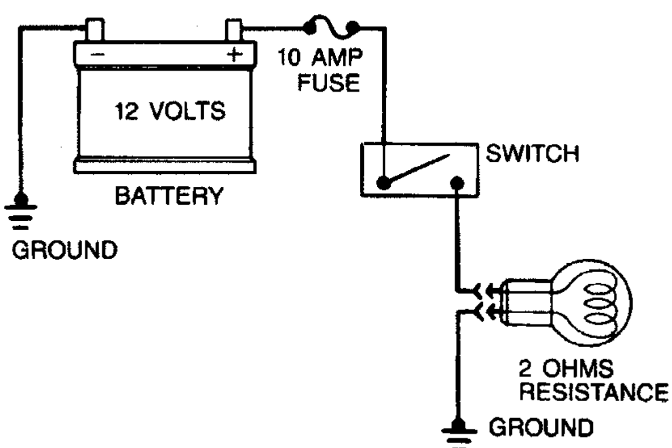


Figure 10 Typical Circuit

To find the current flow use the formula:

I = E / R

Filling in the numbers for the circuit in Figure 11 , we have:

I = 12V/2 ohms or I= 12 divided by 2 = 6 amperes of current flow.

The bulb in this circuit operates at 6 amps and is rated to operate at this level. With 12 volts applied, the bulb will glow at the rated output level (candlepower rating). However:

1. If the voltage applied is low (low battery), then (the value of E is lower) current flow will be less and the bulb will glow less brightly.

2. Or if the connections are loose, or the switch corroded, the circuit resistance will be greater (value of R will be larger) and the current flow will be reduced and the bulb will glow less brightly.

Being able to determine voltage drops is important because it provides the following information:

- Too high a voltage drop indicates excessive resistance. If, for instance, a blower motor runs too slowly or a light glows too dimly, one can be sure that there is excessive resistance in the circuit. By taking voltage drop readings in various parts of the circuit, the problem can be isolated (corroded or loose terminals for example).
- Too low of a voltage drop, likewise, indicates low resistance. If for instance, a blower motor ran too fast, the problem could be isolated to a low resistance in a resistor pack by taking voltage drop readings.
- Maximum allowable voltage drop under load is critical, especially if there is more than one high resistance problem in a circuit. It is important because all voltage drops in a circuit are cumulative. Corroded terminals, loose connections, damaged wires or other similar conditions create undesirable voltage drops that decrease the voltage available across the key circuit components.

Remember our earlier discussion, the increased resistance from the undesirable conditions will also decrease the current flow in the circuit and all the affected components will operate at less than peak efficiency.

A small drop across wires (conductors), connectors, switches, etc. is normal. This is because all conductors have some resistance, but the total should be less than 10 percent of the total voltage drop in the circuit.

5.6. 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, Ohms Law Formula).

Measuring Voltage

In electrical diagnosis, the voltmeter is used to answer:

1. Is voltage present?

2. What is the voltage reading?

3. 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 (Voltmeter Lead Connections Diagram). 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. The Voltmeter Lead Connections Diagram shows how much of the source voltage is available to the device. Note that the meter is connected in parallel to the device.

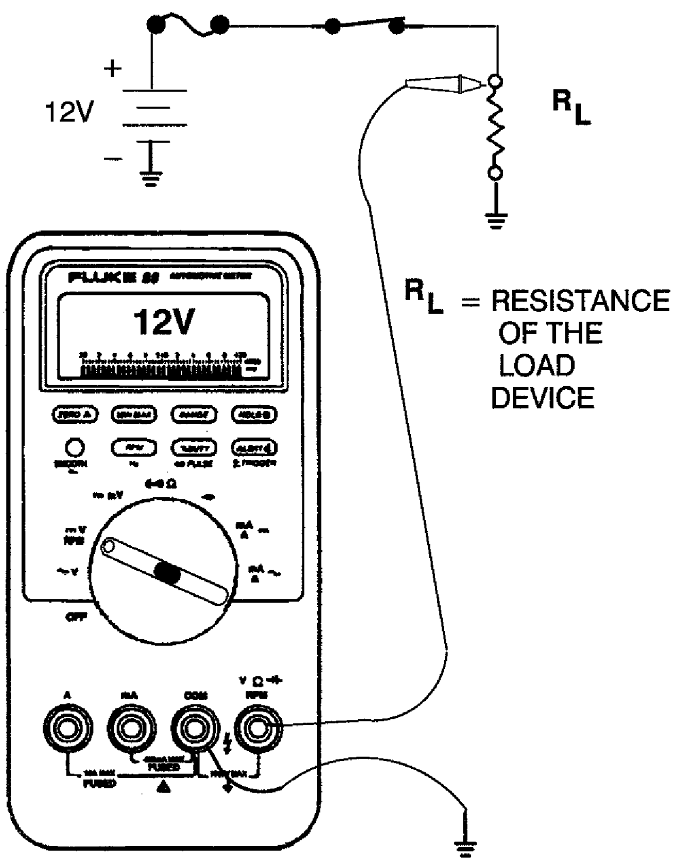


Figure 11 Voltmeter Lead Connections Diagram

Should we need to determine if voltage is available at a connector where we can't readily connect to the device, we can connect the meter in series between ground and the connector (voltage source) as shown in the Connecting the Meter in Series Diagram. The meter's internal resistance is very high so little current will flow in the circuit, and the voltage can be read accurately.

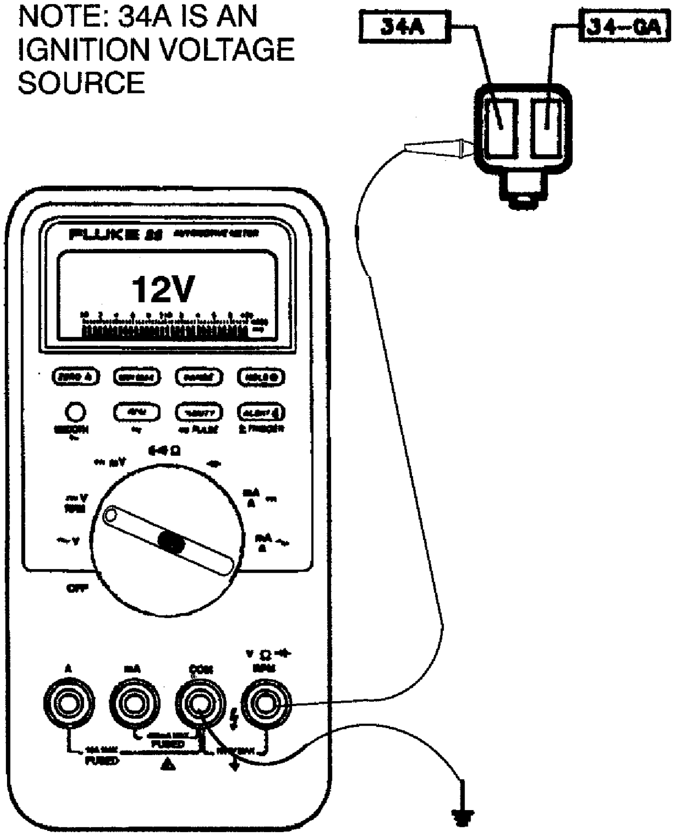


Figure 12 Connecting the Meter in Series Diagram

To check the voltage drop across a load device (Checking Voltage Drop Across a Load Device Diagram), 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. Notice in Checking Voltage Drop Across a Load Device Diagram , since we only have one device, all of the voltage should be dropped at the device. In any circuit, the voltage applied will equal the voltage dropped in the circuit. If in this circuit we only dropped 9V across the load, that would indicate that our wires, connections, etc. were dropping the other 3V, which would indicate excessive circuit resistance.

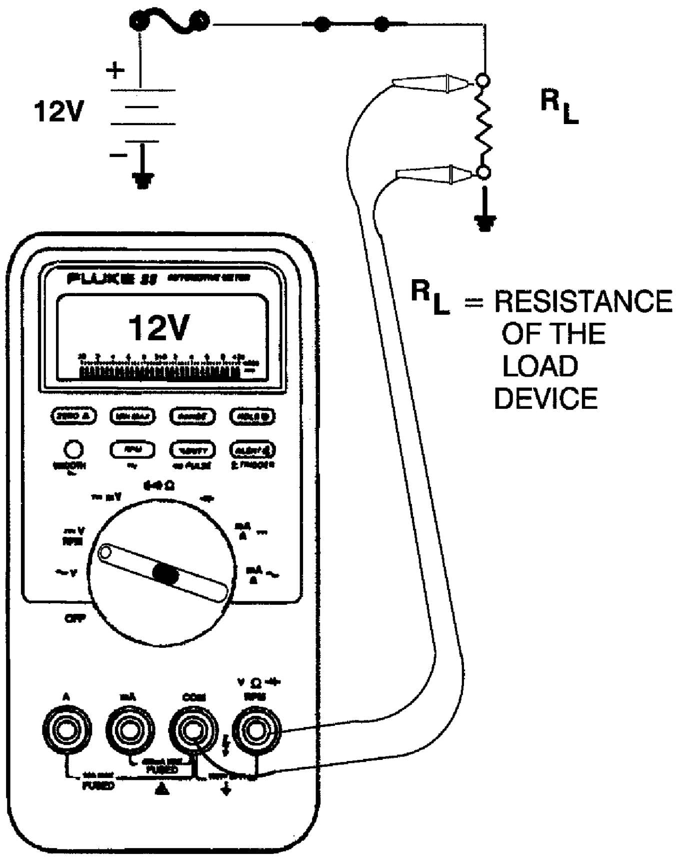


Figure 13 Checking Voltage Drop Across a Load Device Diagram

5.7. 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.

Measuring Amperage

An ammeter is connected in series with the load, switches, resistors, etc. (Measuring Current Flow Diagram). 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.

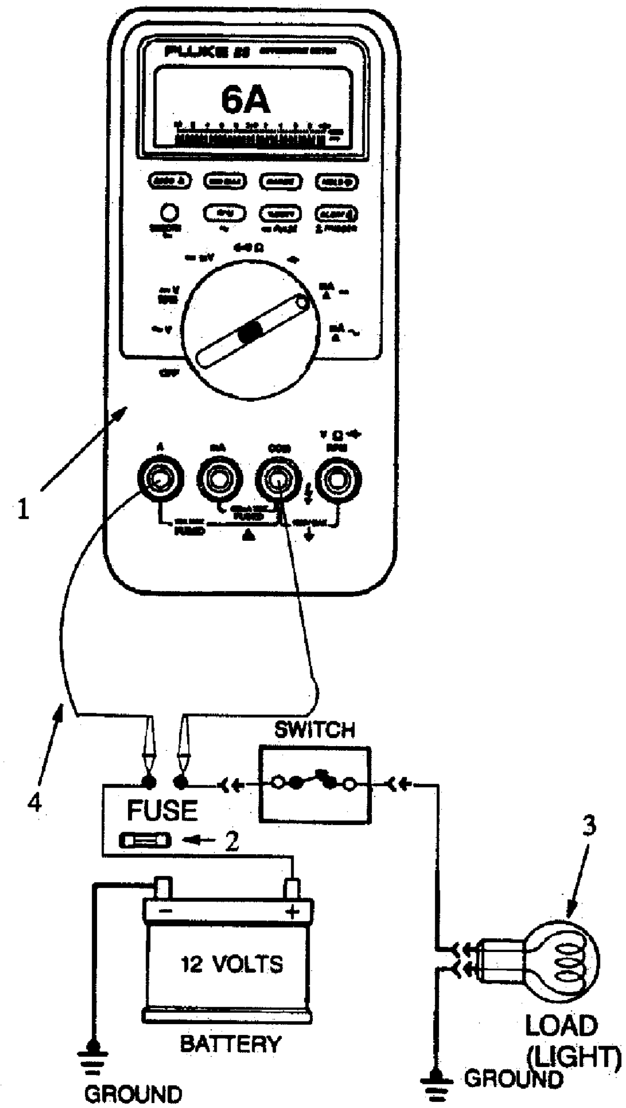


Figure 14 Measuring Current Flow Diagram

1. DMM SET TO MEASURE DC CURRENT
2. FUSE SHOWN REMOVED
3. LIGHT BULB (2 OHMS RESISTANCE)
4. METER LEAD CONNECTED TO 10A METER JACK

The estimate of current flow can easily be calculated. In the Measuring Current Flow Diagram, the resistance of the light bulb is 2 ohms. Applying Ohms Law, we can calculate that current flow will be 6 amps (6A = 12V/2 ohms). If we remove the fuse, and install the ammeter as shown, with the switch closed we will measure 6 amperes of current flowing in the circuit. Notice that the ammeter is installed so that all the current in the circuit flows through it. The ammeter is installed in series.

WARNING – 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.

5.8. 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.

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.

Notice in the Measuring Resistance Diagram that if we wanted to measure the resistance of the load, most of the current flow from the meter would flow through the indicator lamp because it has less resistance. 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.

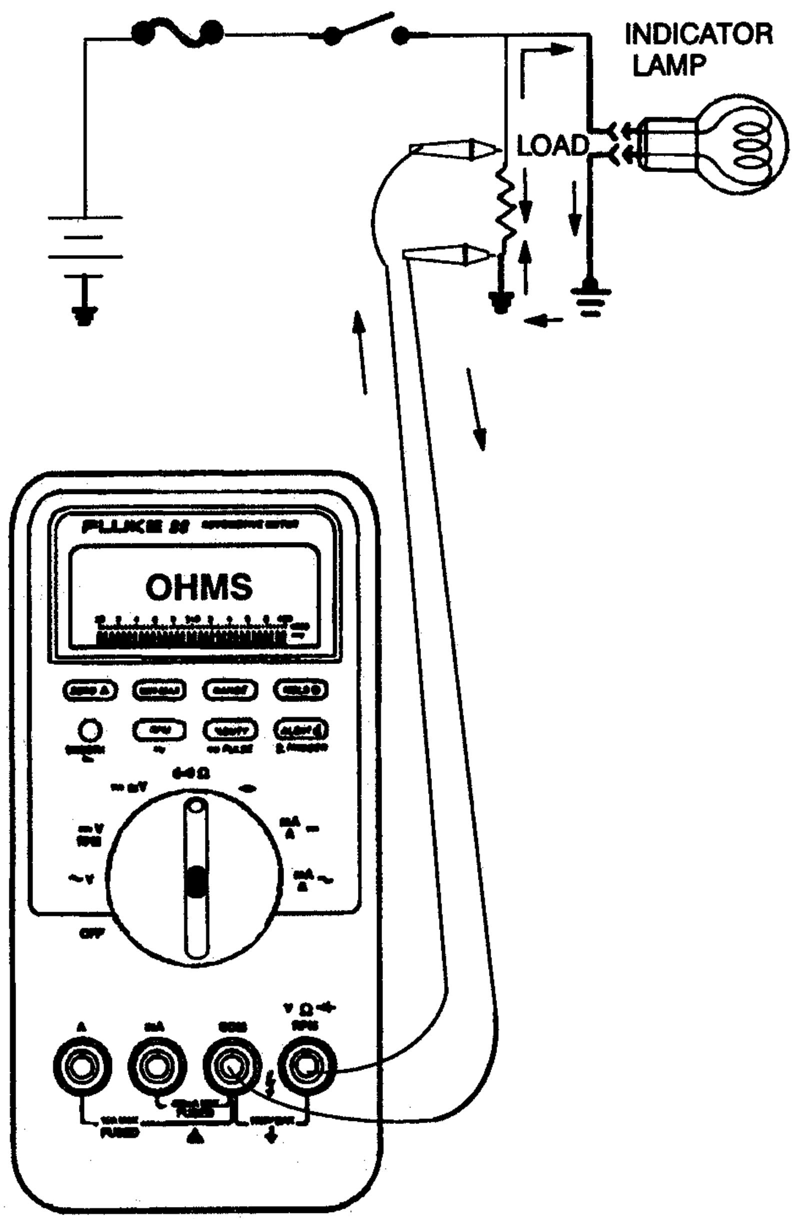


Figure 15 Measuring Resistance Diagram

The ohmmeter leads are then placed across the component or circuit and the resistance will be displayed in ohms (Placing Ohmmeter Leads Across a Component or Circuit Diagram). 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.

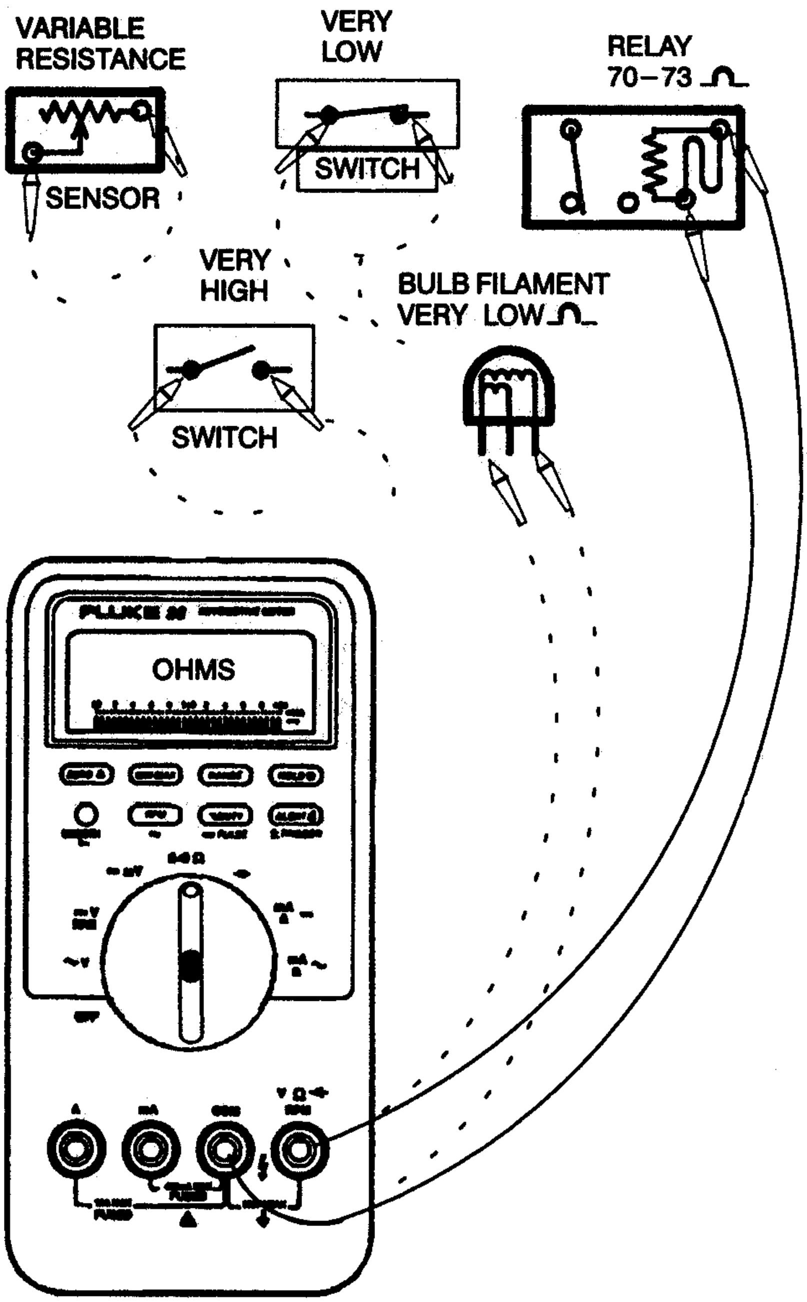


Figure 16 Placing Ohmmeter Leads Across a Component or Circuit Diagram

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 as shown in the Checking For Open Circuits diagram. A high reading (infinity) indicates there is an open in the circuit. A near zero reading is an indication of a continuous circuit. Notice also in the Checking For Open Circuits Diagram that we disconnected the circuit between the light and the ground. This precaution prevents reading a circuit as complete that may be open at the load (light) and shorted to ground ahead of the load device.

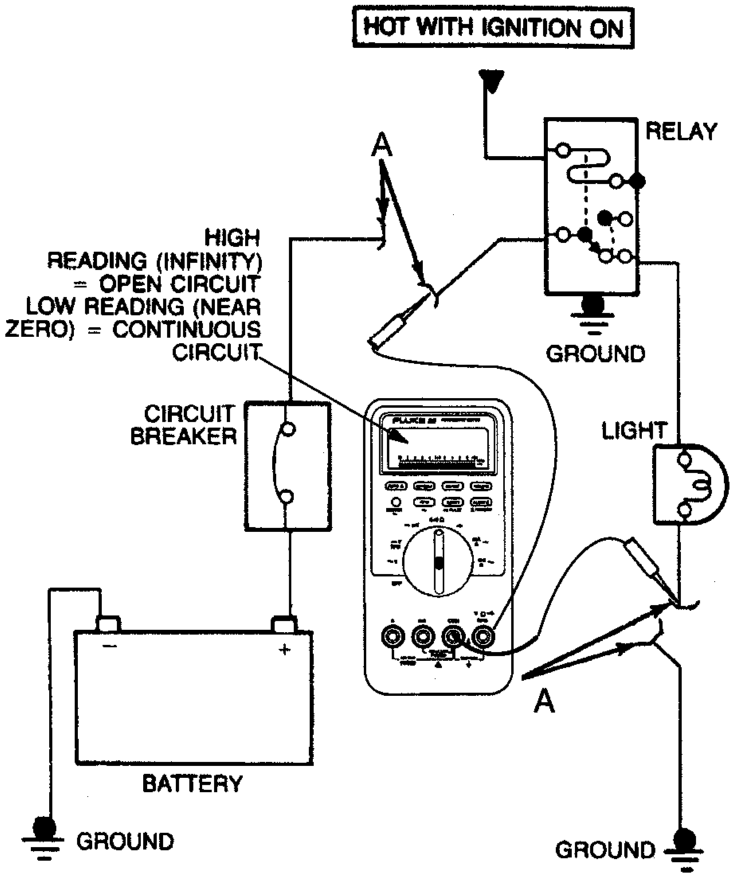


Figure 17 Checking For Open Circuits

A. DISCONNECTED CONNECTOR

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, as shown in the Checking For Short Circuits diagram, 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.

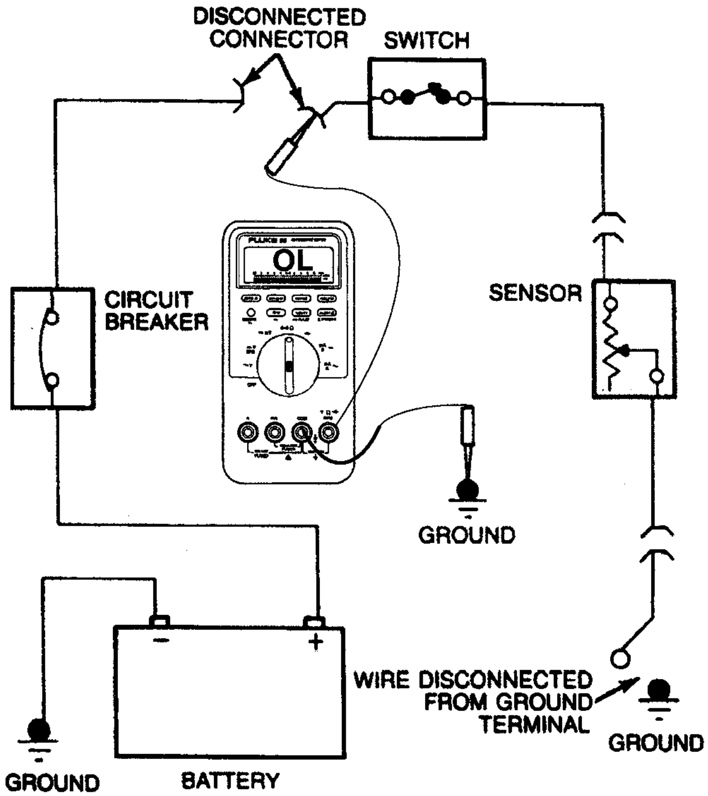


Figure 18 Checking For Short Circuits

6. BENCH TESTING RELAYS

International circuits use suppressed relays for controlling power to load devices. The suppression feature (a resistor circuit parallel to 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.

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.

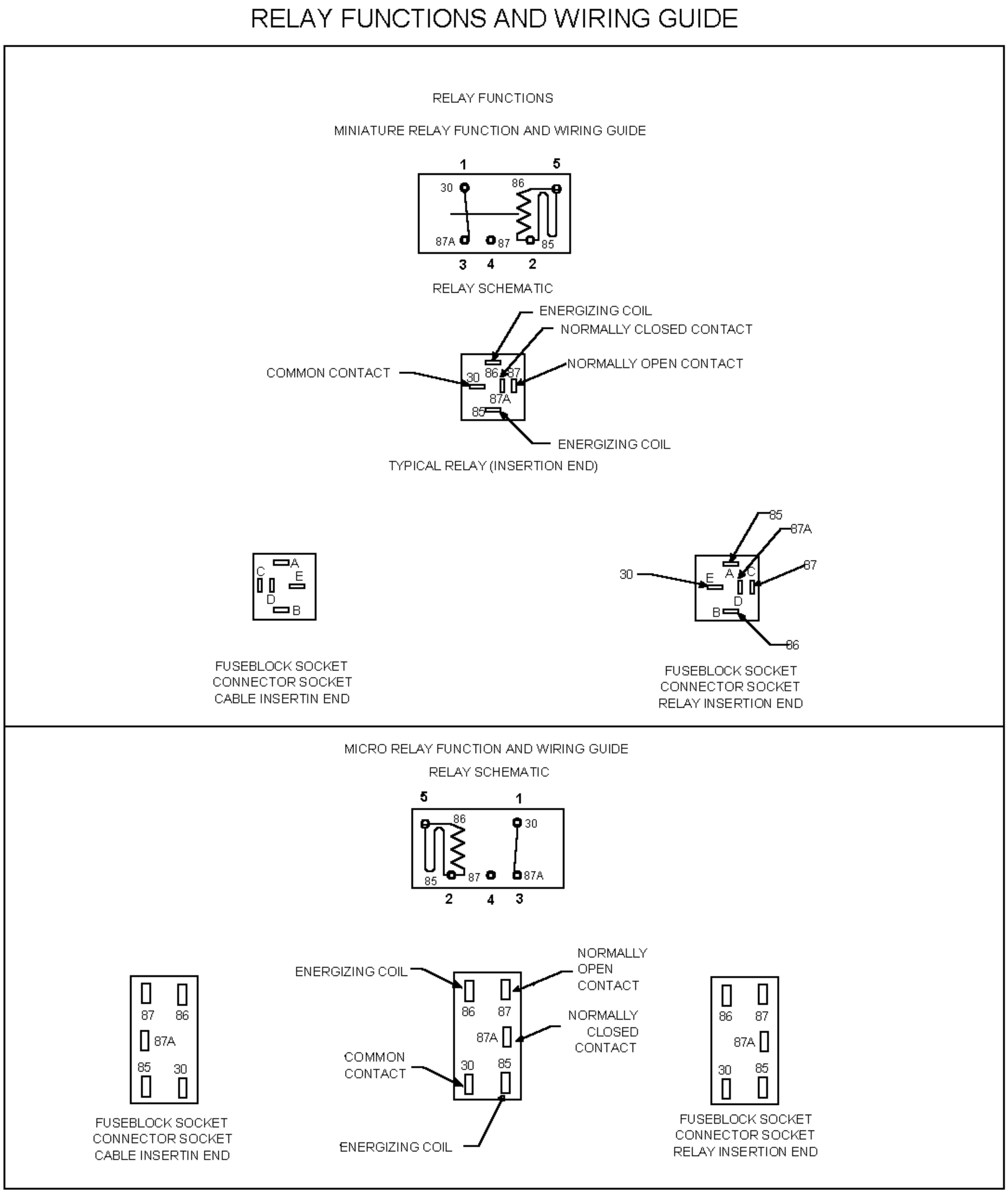


Figure 19 Relay Schematic

Table 2 Bench Check Relay

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	OFF	Bench test relay by measuring resistance from terminal 30 to 87A.	Relay pin 30 to 87A.	<1 ohm.	Go to next step.	Replace relay.
2.	OFF	Bench test relay by applying +12 V to pin 85, ground to pin 86, and measuring resistance from pin 30 to 87.	Energized relay pin 30 to 87.	<1 ohm.	Go to next step.	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 ESC 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 ESC, except the headlight and windshield wiper outputs will act like Type III circuit breakers. The ESC will reset these circuits when the feature is turned off.

8. ABBREVIATIONS

ABS........ Antilock Brake System
AGSP........ Auxiliary Gauge Switch Pack
CEC........ Consolidated Engine Controller
DTC........ Diagnostic Trouble code
ECM........ Electronic Control Module
ECU........ Electronic Control Unit
EGC........ Electronic Gauge Cluster
ESC........ Electrical System Controller
FMI........ Failure Mode Indicator
ISO........ International Standardization Organization
LCD........ Liquid Crystal Display
NSBU........ Neutral Safety and back up Switch (Used on Allison LCT transmission)
PAM........ Pyrometer Ammeter Module
PDC........ Power Distribution Center
RASM........ Remote Air Solenoid Module
RESCM........ Remote Engine Speed Control Module
RPM........ Remote Power Module
SPN........ Suspect Parameter Number
TCM........ Transmission Control Module

Table of Contents

1. CIRCUIT FUNCTIONS

Refer to power distribution function diagram.

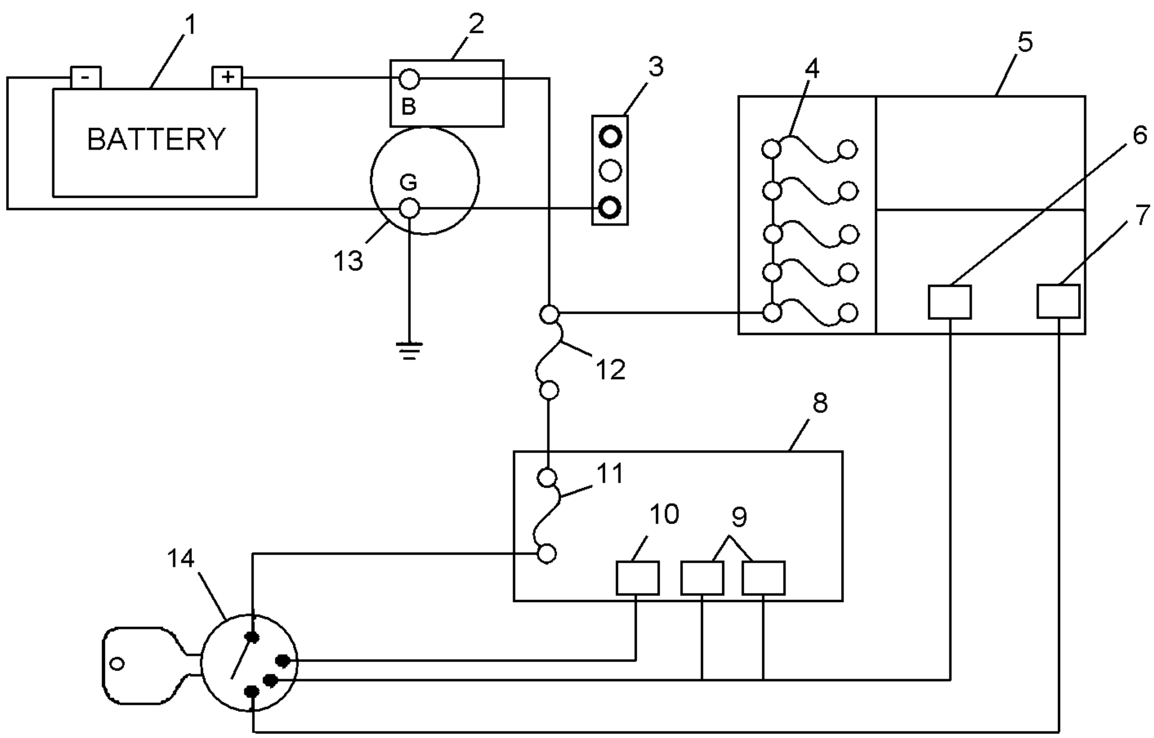


Figure 20 Power Distribution Function Diagram

1. BATTERY
2. CRANK MOTOR SOLENOID
3. GROUND STUD ADAPTER (INSIDE AND OUTSIDE OF CAB)
4. MAXIFUSES IN ENGINE POWER DISTRIBUTION CENTER (4000)
5. ENGINE COMPARTMENT POWER DISTRIBUTION CENTER (4000), (4001), (4002) & (4003)
6. PRIMARY (R9) IGNITION RELAY (4003)
7. STOP LAMPS (R7), STARTER (R12) & CEC (R11) POWER RELAYS (4003)
8. CAB POWER DISTRIBUTION CENTER (1011), (1012), (1013) & (1014)
9. IGNITION RELAYS (IN FUSE BLOCK 2 AND 3) (1012), (1013)
10. ACCESSORY RELAY (IN FUSE BLOCK 2) (1012)
11. 5 AMP KEY SWITCH FUSE F20 (1012)
12. 100 AMP MEGAFUSE
13. CRANKING MOTOR
14. KEY SWITCH

The primary power distribution points in the electrical wiring are the batteries, key switch, megafuse block, engine compartment power distribution center (PDC), cab power distribution center (PDC) and the ground connections. Refer to Power Distribution Function Diagram.

For relay and fuse/circuit breaker locations in the cab PDC, see the product graphics on the back side of the close out panel. For relay and fuse/circuit breaker locations in the engine compartment PDC, see the engine compartment PDC lid.

NOTE – Fuse locations vary from one vehicle to another. Always use the product graphics to identify relay and fuse locations.

A wire connects the negative battery terminal to the frame ground stud. **A wire is also connected between the frame ground stud and the ground connector on the dash panel.** Circuits from the dash panel ground connectors provide ground throughout the vehicle.

Power from the battery is supplied to the “B” terminal of the starter solenoid and from the “B” terminal to the unfused side of the 100 amp megafuse.

Power to the engine PDC is supplied from the unfused side of the megafuse to the maxifuse block.

Power to the cab PDC is supplied from the fused side of the megafuse.

2. BATTERY POWER DISTRIBUTION

2.1. FAULT DETECTION MANAGEMENT

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A malfunction in the battery power distribution circuits will be apparent when battery power is not available in systems that are provided unswitched battery voltage. If a fusible link or megafuse is open, power may be missing from the whole vehicle.

Problems with battery power circuits may be due to loose power connections, loose ground connections, blown fuses, open fusible links or circuits shorted to ground.

Refer to Power Distribution Diagram.

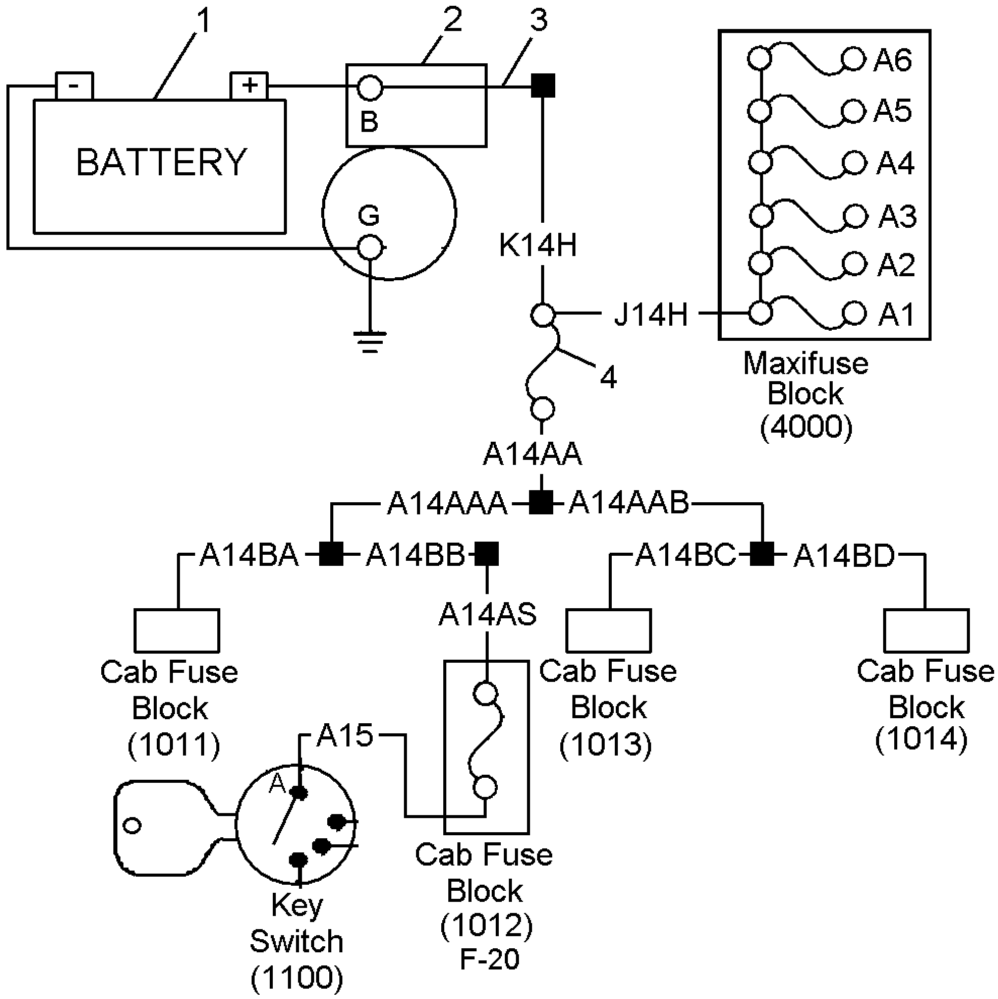


Figure 21 Battery Power Distribution Diagram

1. BATTERY
2. STARTER SOLENOID
   LOCATED ON STARTER
3. FUSIBLE LINK
4. MEGAFUSE

(1011) CAB FUSE BLOCK
LOCATED IN CAB PDC
(1012) CAB FUSE BLOCK
LOCATED IN CAB PDC
(1013) CAB FUSE BLOCK
LOCATED IN CAB PDC
(1014) CAB FUSE BLOCK
LOCATED IN CAB PDC
(1100) KEY SWITCH CONNECTOR
(4000) A1-A6 MAXIFUSES
LOCATED IN ENGINE COMPARTMENT PDC

Table 3 Battery Power Connector Checks

Refer to the Power Distribution Diagram.		
Test Points	Spec.	Comments
Circuit K14H at megafuse to ground.	12 ± 1.5 volts	Power feed to megafuse. If no or low power, check fusible link, cabling and connections from starter solenoid.
Circuit J14H at maxifuse block, in engine PDC, to ground.	12 ± 1.5 volts	Power feed to maxifuses, in engine PDC. If no or low power, check J14H connections to engine PDC and connection to megafuse.
Circuit A14AA at megafuse to ground.	12 ± 1.5 volts	Power after megafuse. If no or low power, check A14AA connections to megafuse. Also check for blown megafuse.
(1012) fuse F-20 terminal F2 to ground	12 ± 1.5 volts	Power input to cab power distribution center, fuse block 2, from megafuse. If voltage is incorrect, check wiring from megafuse to cab power distribution center.
Key switch (1100) terminal A to ground	12 ± 1.5 volts	Fused power feed to key switch. If voltage is incorrect, check fuse F-20 and circuit A15.
There are no diagnostic trouble codes associated with power circuits.		

2.2. EXTENDED DESCRIPTION

Power is supplied from the vehicle batteries to the cranking motor solenoid “B” terminal on a 2/0 or 4/0 red cable. Power from the “B” terminal is supplied through a fusible link and circuit J14H to the 100 amp megafuse. Power from the unfused side of the megafuse connector is fed through circuit J14H to maxifuse block (4000). Power from two 60A fuses in the maxifuse block is fed to the system controller on circuits J14A and J14B. Power from the fused side of the 100A megafuse is supplied on several circuits to power distribution fuse blocks (1011), (1012), (1013) and (1014). Each fuse block provides 12 volts to the fuses connected directly to battery power. This includes circuit A15 to the key switch.

3. ACCESSORY POWER DISTRIBUTION

3.1. FAULT DETECTION MANAGEMENT

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A malfunction in the accessory power circuits will be apparent when accessory power is not available in several systems.

Problems with power circuits may be due to loose power connections, loose ground connections, blown fuses, open fusible links, faulty relays, open circuits or circuits shorted to ground.

Diode assembly 467404C91 insures power to energize the accessory relay during cranking. This prevents diagnostic trouble codes from being logged during engine cranking.

Refer to Accessory Power Distribution Diagram.

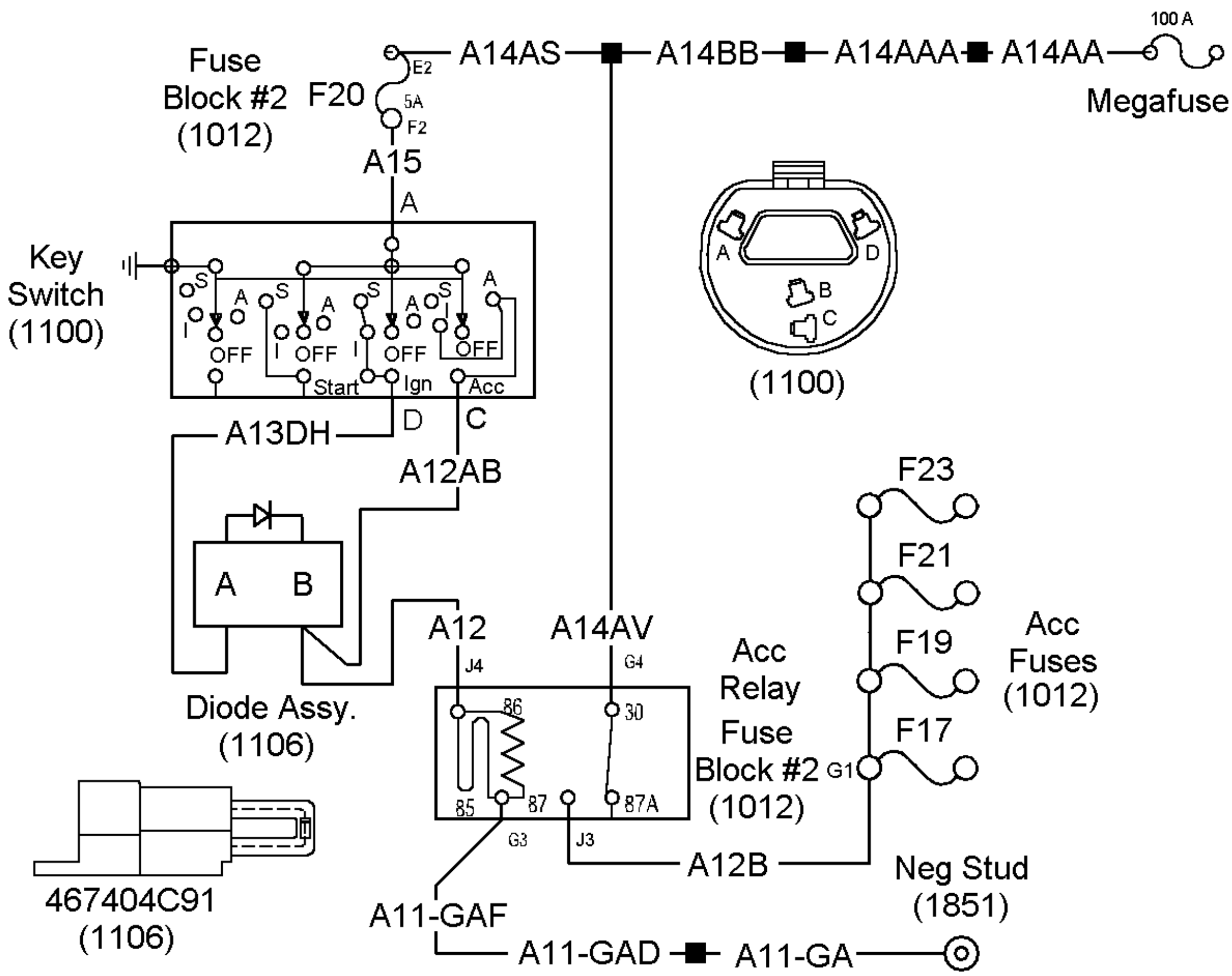


Figure 22 Accessory Power Distribution Diagram—Always Refer to Circuit Diagram Book for Latest Circuit Information

(1100) KEY SWITCH CONNECTOR
LOCATED ON BACK OF KEY SWITCH
(1106) DIODE ASSEMBLY 467404C91
LOCATED BEHIND INSTRUMENT PANEL NEAR KEY SWITCH
(1012) FUSE BLOCK #2
LOCATED IN CAB POWER DISTRIBUTION CENTER
(1851) NEGATIVE STUD
LOCATED ABOVE ELECTRICAL SYSTEM CONTROLLER (ESC) ON DASH PANEL
F17–F23 ACCESSORY FUSES
LOCATED IN CAB POWER DISTRIBUTION CENTER

Table 4 Accessory Power Connector Checks

Megafuse Voltage Check Refer to the Accessory Power Distribution Diagram.		
Test Points	Spec.	Comments

Table 4 Accessory Power Connector Checks (cont.)

Circuit A14AA at MEGAFUSE to ground.	12 ± 1.5 volts	Power feed from megafuse. If no or low power, check for open megafuse, cabling and connections from starter solenoid.
Fuse Block (1012) Voltage Checks (Check With Key In Accessory Position and Accessory Relay Removed.) Refer to the Accessory Power Distribution Diagram.		
(1012) (relay 30) terminal G4 to ground.	12 ± 1.5 volts	Cab power distribution center, accessory relay power, input from megafuse. If voltage is incorrect, check wiring from megafuse to cab power distribution center.
(1012) fuse F20 terminal F2 to ground.	12 ± 1.5 volts	Fused power feed to key switch. If voltage is incorrect, check fuse F-20 and circuit A15.
(1012) (relay 86) terminal J4, accessory relay socket, to ground.	12 ± 1.5 volts	Key voltage to accessory relay. If voltage is incorrect, check for faulty wiring or failed key switch. Perform key switch resistance checks.
(1012) (relay 86) terminal J4, accessory relay socket, to (relay 85) terminal G3.	12 ± 1.5 volts	Ground to accessory relay coil. If voltage is incorrect, check for faulty wiring between G3 and negative stud (1851).
Fuse Block (1012) Voltage Checks (Check With Key In Accessory Position and Accessory Relay Installed.) Refer to the Accessory Power Distribution Diagram.		
Remove fuse F17. Measure voltage between fuse socket G1 to ground.	12 ± 1.5 volts	Voltage from accessory relay to accessory fuses. If voltage is incorrect, check for failed accessory relay or faulty wiring between fuse and relay .
Key Switch Resistance Checks (Check With Key Connector (1100) removed		
With key switch in off position, measure resistance between key switch terminal A to D, B and C.	>100K ohms or O.L.	If resistance is incorrect replace defective switch.
With key switch in start position, measure resistance between key switch terminal A and C.	>100K ohms or O.L.	If resistance is incorrect replace defective switch.
With key switch in accessory position, measure resistance between key switch terminal A and C.	<1 ohm	If resistance is incorrect replace defective switch.
With key switch in ignition position, measure resistance between key switch terminal A and D.	<1 ohm	If resistance is incorrect replace defective switch.
There are no diagnostic trouble codes associated with these circuits.		

3.2. EXTENDED DESCRIPTION

When the key is moved to the ignition or accessory position, power will be supplied on circuit A12AB and A12 to the accessory relay in power distribution fuse block (1012). The accessory relay will energize. Power from circuit A14AV will pass through the accessory relay contacts on circuit A12B, providing 12 volts to the accessory fuses.

4. IGNITION POWER DISTRIBUTION

4.1. CAB IGNITION POWER DISTRIBUTION

Fault Detection Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A malfunction in the cab ignition power circuits will be apparent when ignition power is not available in several cab systems.

Problems with power circuits may be due to loose power connections, loose ground connections, blown fuses, open fusible links, faulty relays, open circuits or circuits shorted to ground.

Refer to Cab Ignition Power Distribution Diagram.

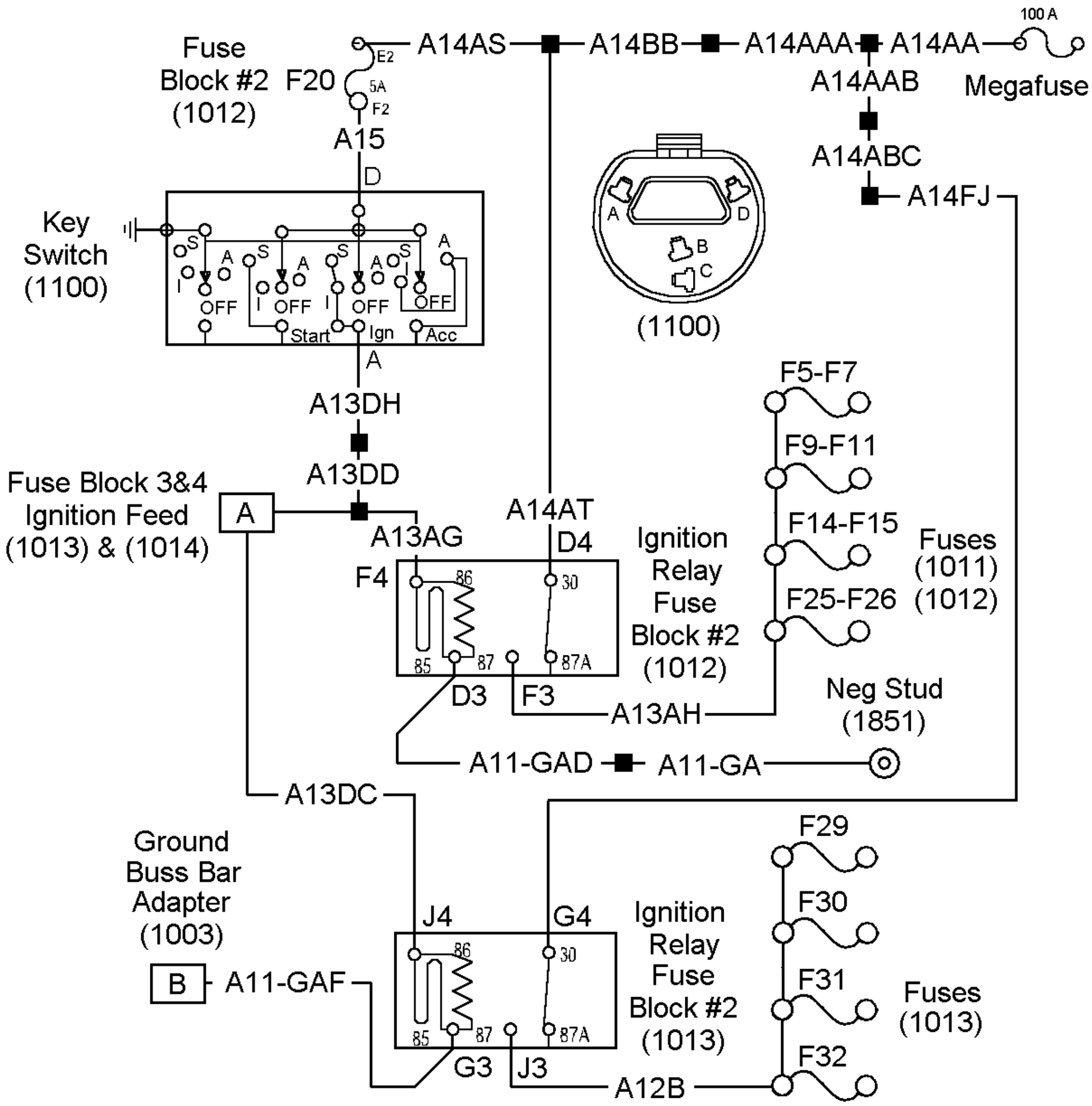


Figure 23 Cab Ignition Power Distribution Diagram—Always Refer to Circuit Diagram Book for Latest Circuit Information

(1003) GROUND ADAPTER
LOCATED IN INSTRUMENT PANEL
(1012) FUSE BLOCK #2,
LOCATED IN CAB POWER DISTRIBUTION CENTER
(1013) FUSE BLOCK #3, CAB POWER DISTRIBUTION CENTER
LOCATED IN CAB POWER DISTRIBUTION CENTER
(1100) KEY SWITCH CONNECTOR
(1013) & (1014) FUSE BLOCK 3&4 IGNITION FEED
LOCATED IN INSTRUMENT PANEL
(1851) NEGATIVE STUD
F5–F32 ACCESSORY FUSES

Table 5 Cab Ignition Power Connector Checks

Megafuse Voltage Check Refer to the Cab Ignition Power Distribution Diagram.		
Test Points	Spec.	Comments
Circuit A14AA at MEGAFUSE to ground.	12 ± 1.5 volts	Power feed from megafuse. If no or low power, check for open megafuse, cabling and connections from starter solenoid.
Fuse Block (1012) Voltage Checks (Check With Key In Ignition Position and Ignition Relay Removed.) Refer to the Cab Ignition Power Distribution Diagram.		
(1012) (relay 30) terminal D4 to ground.	12 ± 1.5 volts	Cab power distribution center, ignition relay power, input from megafuse. If voltage is incorrect, check wiring from megafuse to cab power distribution center.
(1012) fuse F20 terminal F2 to ground.	12 ± 1.5 volts	Fused power feed to key switch. If voltage is incorrect, check fuse F-20 and circuit A15.
(1012) (relay 86) terminal F4, ignition relay socket, to ground.	12 ± 1.5 volts	Key voltage to ignition relay. If voltage is incorrect, check for faulty wiring or failed key switch. Perform key switch resistance checks.
(1012) (relay 86) terminal F4, ignition relay socket, to (relay 85) terminal D3.	12 ± 1.5 volts	Ground to ignition relay coil. If voltage is incorrect, check for faulty wiring between D3 and negative stud (1851).
Fuse Block (1011) Voltage Checks (Check With Key In Ignition Position and Ignition Relay Installed.) Refer to the Cab Ignition Power Distribution Diagram.		
Remove fuse F15. Measure voltage between fuse socket A3 to ground.	12 ± 1.5 volts	Voltage from ignition relay to igniting fuses. If voltage is incorrect, check for failed ignition relay or faulty wiring between fuse and relay .
Fuse Block (1013) Voltage Checks (Check With Key In Ignition Position and Ignition Relay Removed.) Refer to the Cab Ignition Power Distribution Diagram.		
(1013) (relay 30) terminal G4 to ground.	12 ± 1.5 volts	Cab power distribution center, ignition relay power, input from megafuse. If voltage is incorrect, check wiring from megafuse to cab power distribution center.
(1013) (relay 86) terminal J4, ignition relay socket, to ground.	12 ± 1.5 volts	Key voltage to ignition relay. If voltage is incorrect, check for faulty wiring or failed key switch.
(1013) (relay 86) terminal J4, ignition relay socket, to (relay 85) terminal G3.	12 ± 1.5 volts	Ground to ignition relay coil. If voltage is incorrect, check for faulty wiring between G3 and ground adapter (1003).
Fuse Block (1013) Voltage Checks (Check With Key In Ignition Position and Ignition Relay Installed.) Refer to the Cab Ignition Power Distribution Diagram.		
Remove any fuse between F29 and F32. Measure voltage between the right fuse socket cavity to ground.	12 ± 1.5 volts	Voltage from ignition relay to ignition fuses. If voltage is incorrect, check for failed ignition relay or faulty wiring between fuse and relay .
Key Switch Resistance Checks (Check With Key Connector (1100) removed		

Table 5 Cab Ignition Power Connector Checks (cont.)

With key switch in off position, measure resistance between key switch terminal D to A, B and C.	>100K ohms or O.L.	If resistance is incorrect replace defective switch.
With key switch in start position, measure resistance between key switch terminal C and D.	>100K ohms or O.L.	If resistance is incorrect replace defective switch.
With key switch in accessory position, measure resistance between key switch terminal D and C.	<1 ohm	If resistance is incorrect replace defective switch.
With key switch in ignition position, measure resistance between key switch terminal A and D.	<1 ohm	If resistance is incorrect replace defective switch.
There are no diagnostic trouble codes associated with these circuits.		

Extended Description

When the key switch is in the ignition position, power will be supplied to circuit A13DH, A13DD and A13AG to the ignition relay in power distribution fuse block (1012). The ignition relay will energize. Power from circuit A14AT will pass through the accessory relay contacts on circuit A13AH, providing 12 volts to the circuits requiring power when the key switch is in the ignition position.

4.2. CHASSIS IGNITION POWER DISTRIBUTION

Fault Detection Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A malfunction in the chassis ignition power circuits will be apparent when ignition power is not available in several chassis systems.

Problems with power circuits may be due to loose power connections, loose ground connections, blown fuses, open fusible links, faulty relays, open circuits or circuits shorted to ground.

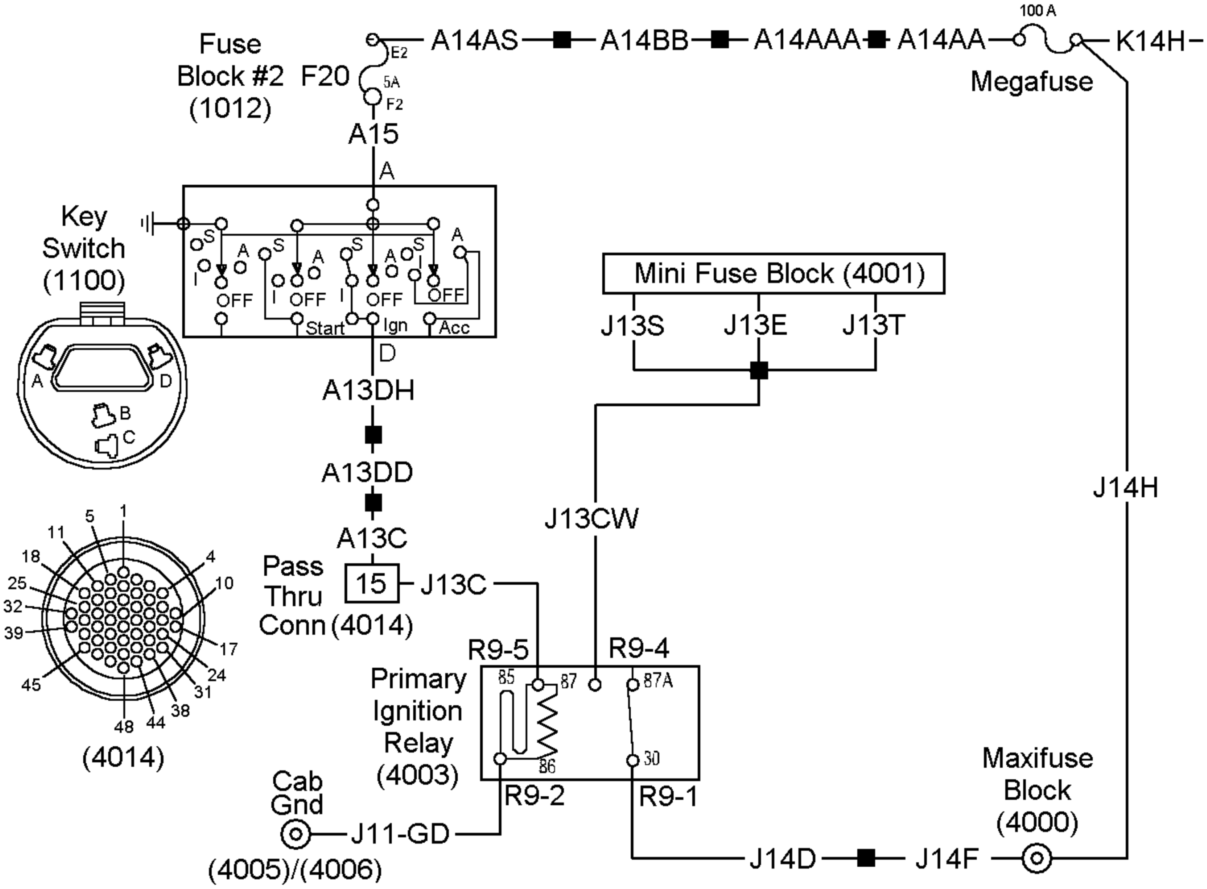


Figure 24 Chassis Ignition Power Distribution Diagram

(1012) FUSE BLOCK #2,
LOCATED IN CAB POWER DISTRIBUTION CENTER
(1100) KEY SWITCH CONNECTOR
LOCATED BEHIND KEY SWITCH
(4000) MAXIFUSE BLOCK STUD
LOCATED ON MAXIFUSE BLOCK IN ENGINE PDC
(4001) MINI FUSE BLOCK
LOCATED IN ENGINE PDC
(4003) R9 PRIMARY IGNITION RELAY
LOCATED IN MINI RELAY BLOCK OF ENGINE PDC
(4005)/4006) CAB GROUND
LOCATED ABOVE ESC ON DASH PANEL
(4014) 48 WAY PASS THRU CONNECTOR
LOCATED ABOVE ESC ON DASH PANEL

Table 6 Chassis Ignition Power System Connector Checks

Megafuse Voltage Check Refer to the Chassis Ignition Power Distribution Diagram.		
Test Points	Spec.	Comments
Circuit A14AA at Megafuse to ground.	12 ± 1.5 volts	Power feed from megafuse. If voltage is incorrect, check for open megafuse, cabling and connections from starter solenoid.
(4003) ISO and Power Relay Block (Primary Ignition Relay) R9 Voltage Checks (Check With Key In Ignition Position and R9 Removed.) Refer to the Chassis Ignition Power Distribution Diagram.		
(4003) Primary ignition relay R9 (relay 85) cavity 5 to ground.	12 ± 1.5 volts	Engine power distribution center ignition voltage from key switch. If voltage is incorrect, check wiring from megafuse, through cab fuse F20 and key switch to engine power distribution center.
(4003) Primary ignition relay R9 (relay 85) cavity 5 to (relay 86) cavity 2.	12 ± 1.5 volts	If voltage is incorrect, check wiring from R9 cavity 2 to cab ground (4005).
(4003) Primary ignition relay R9 (relay 30) cavity 1 to (relay 86) cavity 2.	12 ± 1.5 volts	Battery voltage from maxifuse stud. If voltage is incorrect, check for faulty wiring between unfused side of megafuse to maxifuse stud.
Primary Ignition Relay to Mini Fuse Block (4001) Voltage Checks (Check With Key In Ignition Position and R9 Installed) Refer to the Chassis Ignition Power Distribution Diagram.		
Remove washer pump fuse (5 amp) from mini fuse block. Measure voltage at cavity F1–C2.	12 ± 1.5 volts	Voltage from primary ignition relay. If voltage is incorrect replace primary ignition relay.
There are no diagnostic trouble codes associated with these circuits.		

Extended Description

When the key switch is in the ignition position, power will be supplied to circuit A13DH, A13DD, A13C and pass through connector (4014) to circuit J13C.

This will energize primary ignition relay (R9). Power from circuit J14D will pass through the relay contacts on circuit J13CW, providing battery voltage to several fuses in the engine PDC, which require power when the key switch is in the ignition position.

5. COMPONENT LOCATIONS

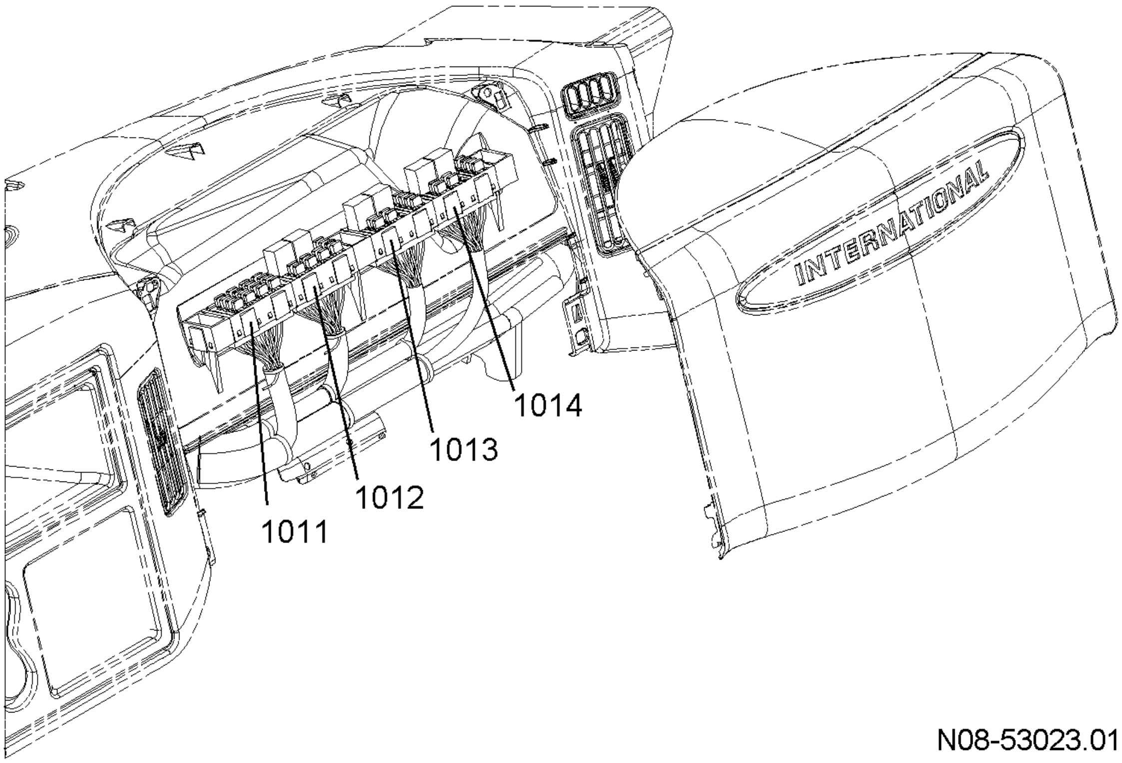


Figure 25 In-Cab Power Distribution Panel (Located on Passenger Side of Instrument Panel Behind Closeout Panel)

(1011) FUSE BLOCK 1
(1012) FUSE BLOCK 2
(1013) FUSE BLOCK 3
(1014) FUSE BLOCK 4

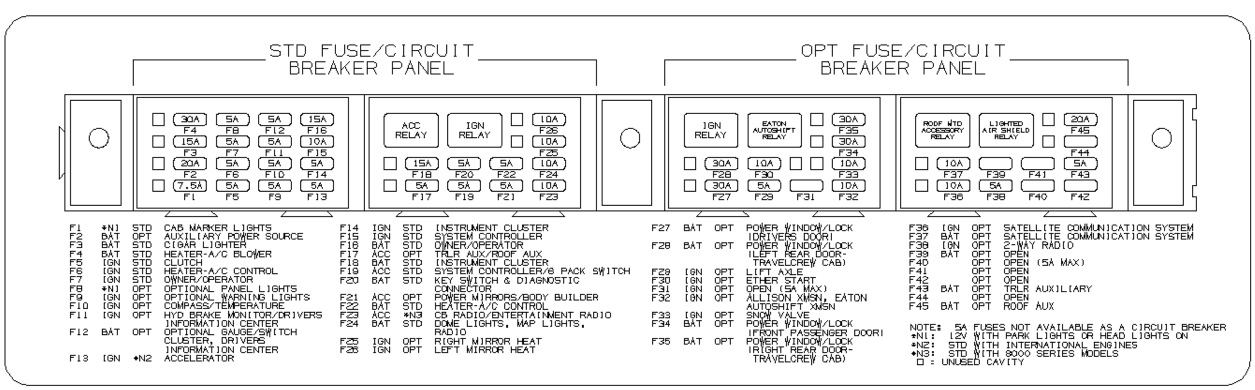


Figure 26 In-Cab Power Distribution Panel Graphic (Located on Back of Passenger Instrument panel Cover

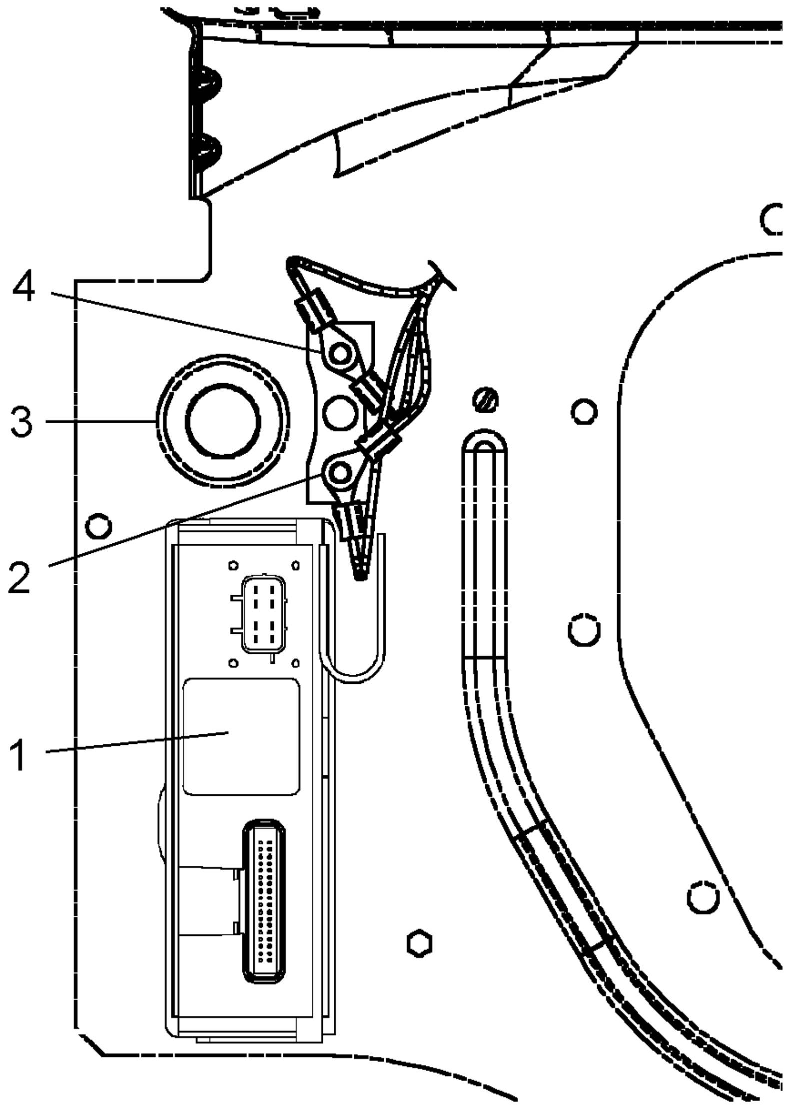


Figure 27 ESC and Ground Stud Location (Viewed From Inside of Cab with Cover Removed)

1. ELECTRICAL SYSTEM CONTROLLER (ESC)
2. GROUND STUD
3. (4014) PASS THROUGH CONNECTOR
4. GROUND STUD

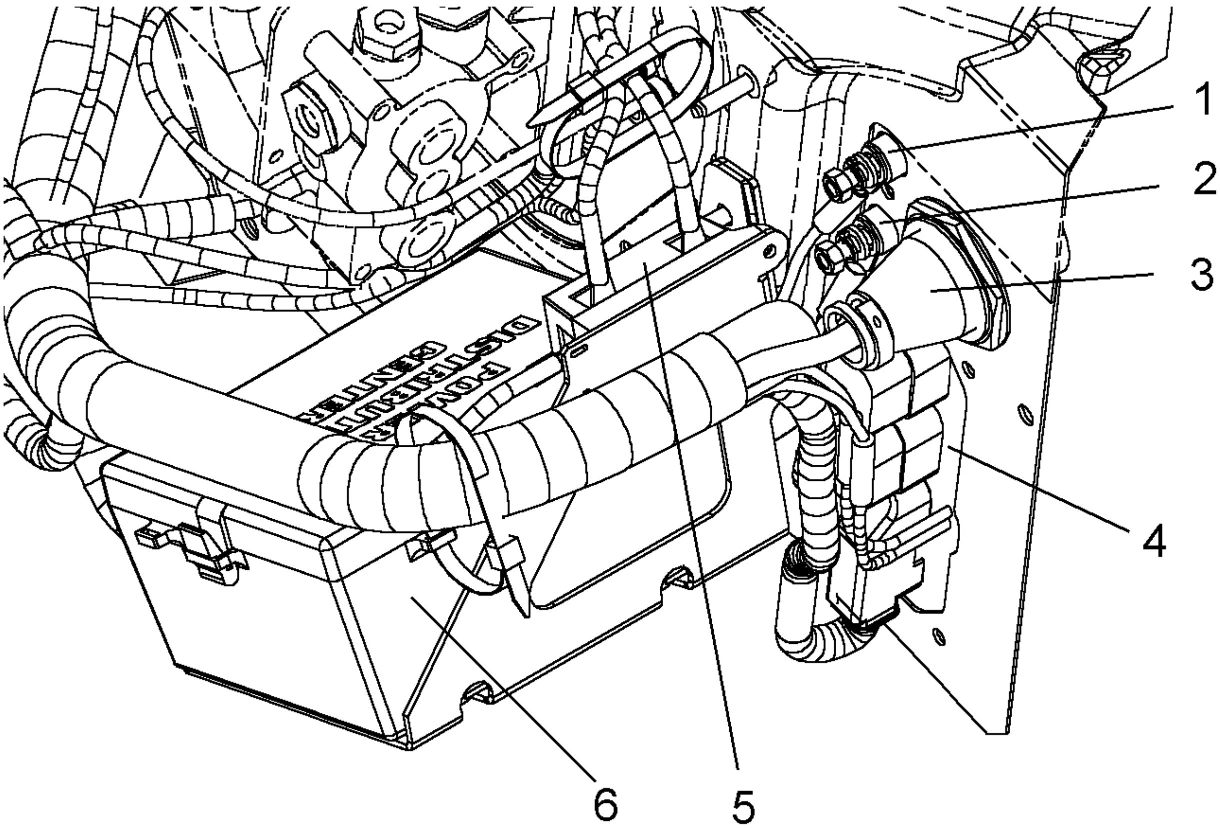


Figure 28 Engine Ground Stud Location (Viewed From Engine Compartment)

1. GROUND STUD
2. GROUND STUD
3. (4014) PASS THROUGH CONNECTOR
4. ELECTRICAL SYSTEM CONTROLLER
5. MEGAFUSE
6. POWER DISTRIBUTION CENTER

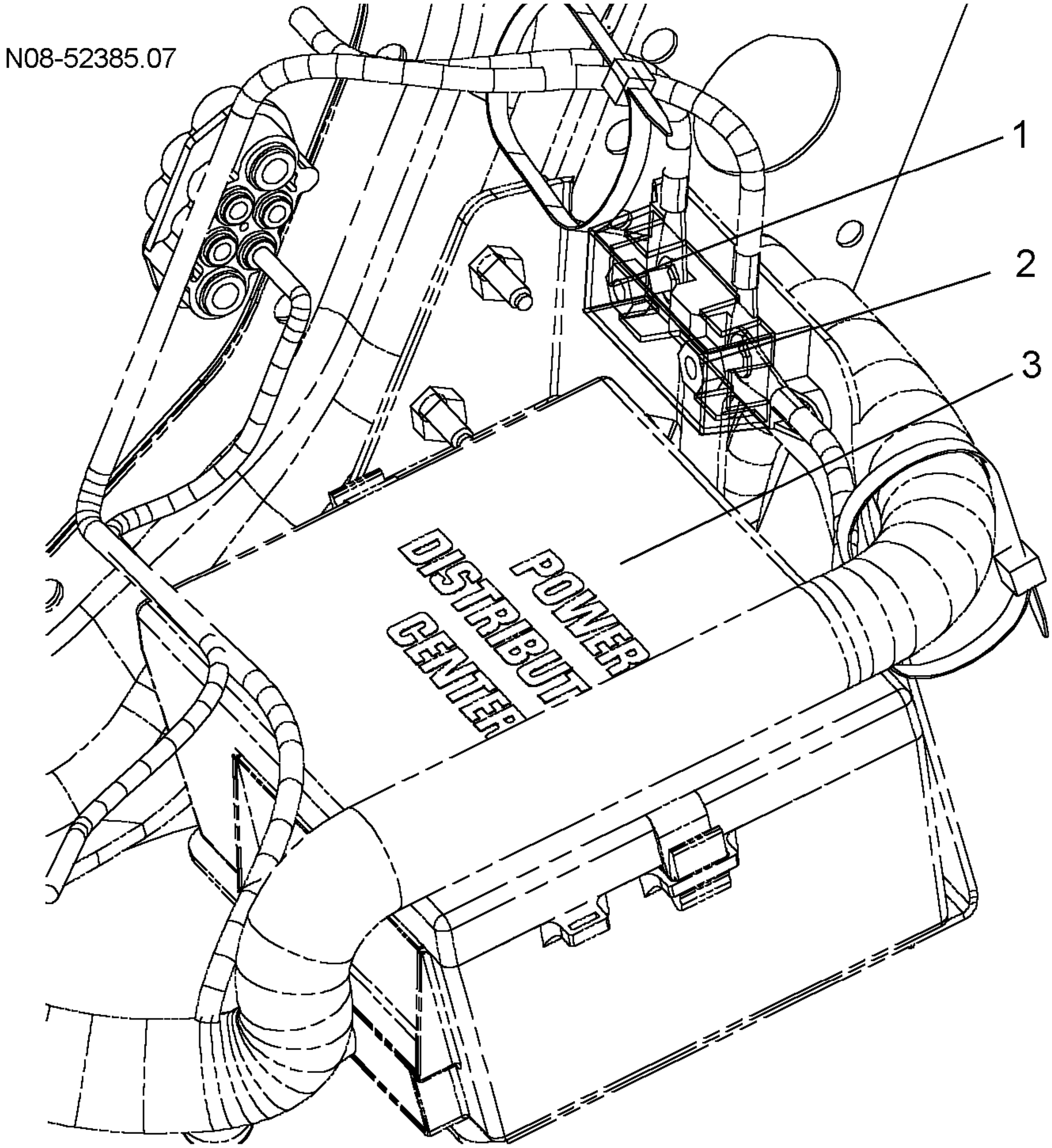


Figure 29 Engine Compartment Wiring

1. FUSED SIDE OF MEGAFUSE
2. UNFUSED SIDE OF MEGAFUSE
3. ENGINE POWER DISTRIBUTION CENTER (PDC)

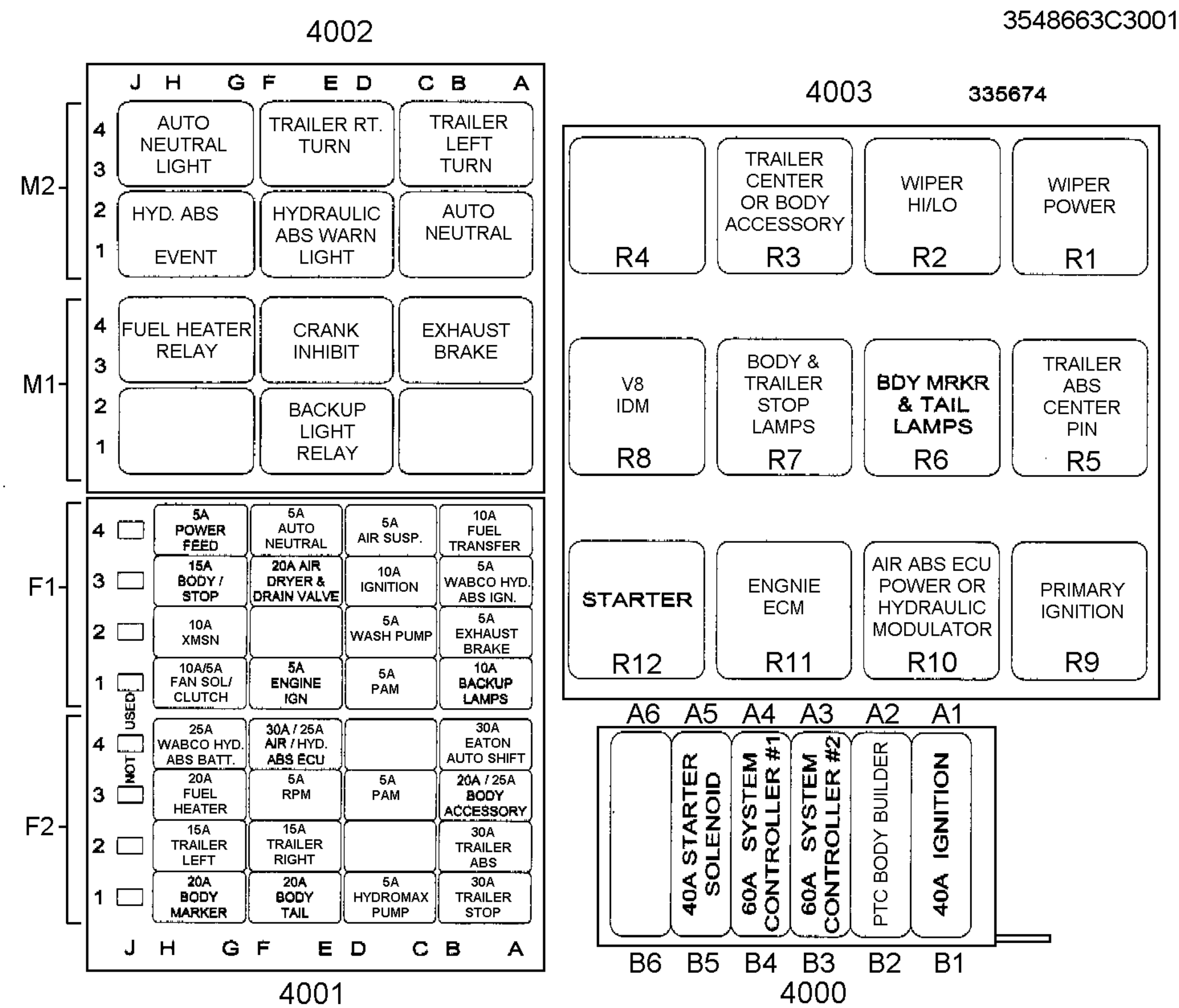


Figure 30 Typical Engine Power Distribution Center – Refer to the Label on the PDC Lid for Specific Configuration

(4000) MAXIFUSE BLOCK
(4001) MINI RELAY BLOCKS
(4002) MICRO RELAY BLOCKS
(4003) STARTER, IGNITION & CEC POWER RELAY BLOCKS

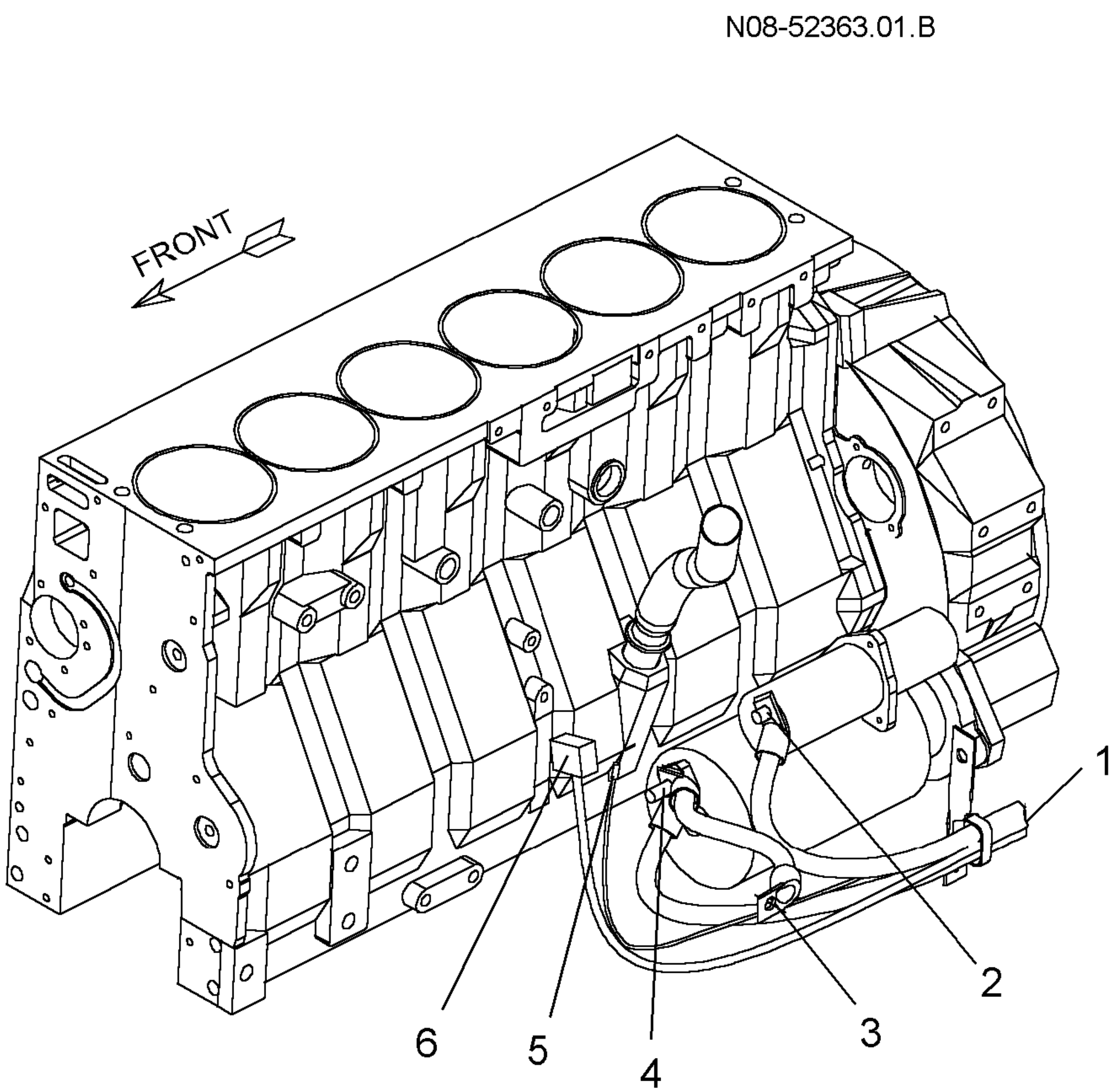


Figure 31 Starter Wiring

1. CABLING TO BATTERY BOX
2. “B” TERMINAL OF STARTER SOLENOID
3. TO FRAME GROUND
4. GROUND TERMINAL ON STARTER MOTOR
5. AMMETER CIRCUIT
6. CLEAN POWER CABLE TO DASH HARNESS FORWARD OF STARTER

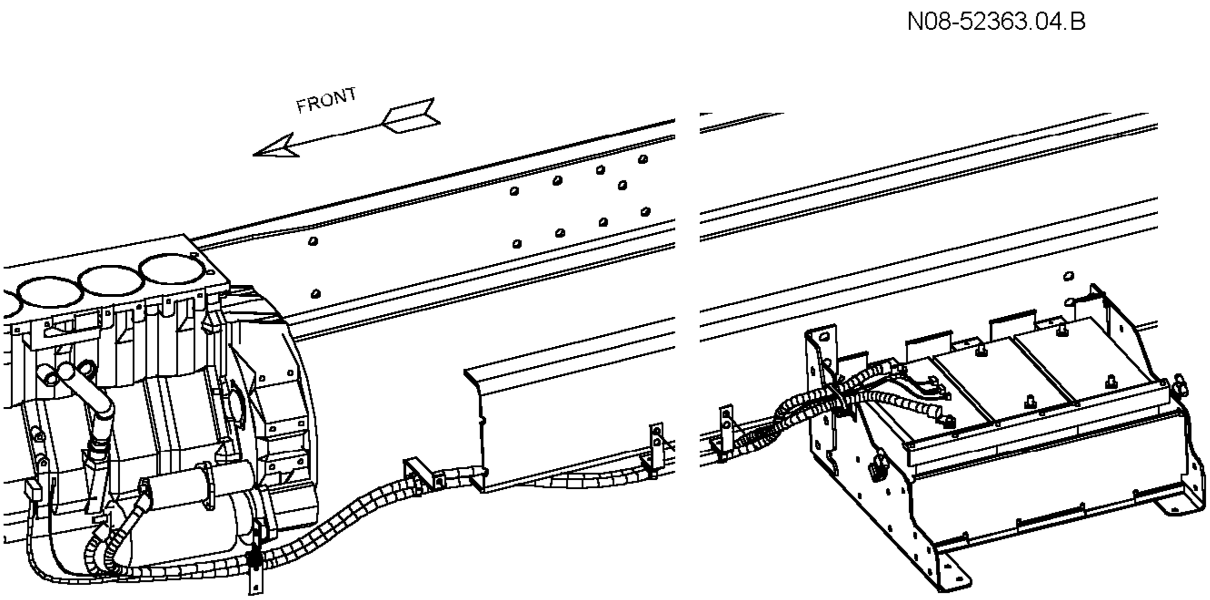
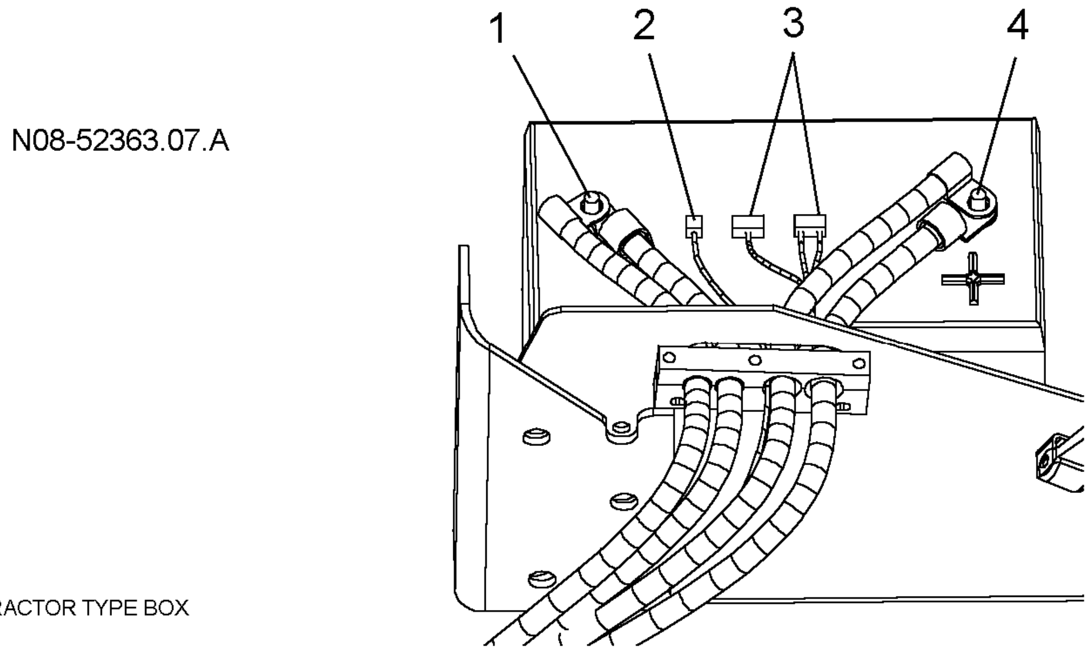
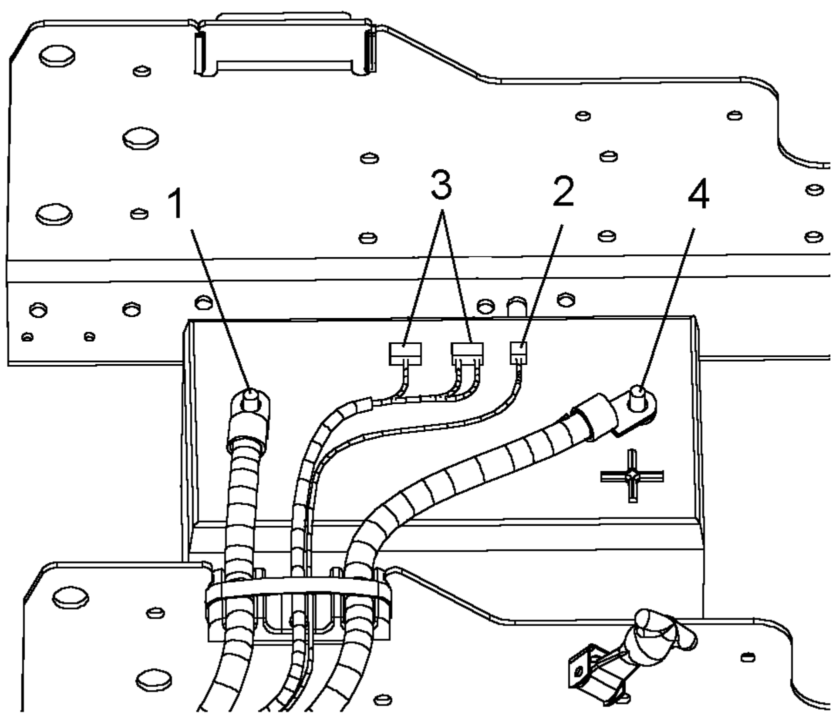


Figure 32 Battery Cable Wiring — Typical, Location And Number Of Batteries May Change Depending On Model And Options



TRACTOR TYPE BOX



TRUCK TYPE BOX

Figure 33 Battery Cable Wiring — Typical (Location And Number Of Batteries May Change Depending On Model And Options)

1. NEGATIVE BATTERY TERMINAL
2. AMMETER SENSE CIRCUIT
3. ECM POWER FEED
4. POSITIVE BATTERY TERMINAL

Table of Contents

1. DESCRIPTION

The electrical system on these vehicles has been significantly redesigned. Unlike the electrical systems on previous models, which utilized point to point wiring for all input signals and output loads, this system uses multiplexed wiring technologies to provide control and communication between major functional areas of the vehicle. Multiplexing simply means, Communicating information through a small number of wires (called a data link) without requiring a wire for each piece of information. This information could be gauge information such as engine oil pressure, or switch information that controls vehicle functions such as headlamps. The electrical system relies on a collection of electronic circuit modules and software to perform vehicle functions instead of implementing similar features using complex wire harness designs with electromechanical relays and switches. These electronic module components are connected together by electronic data links. These data links can be thought of as computer networks that allow the electronic components on the vehicle to communicate with one another.

The concept of multiplexing is not new to International®. Data links for communicating between engine controllers, the instrument cluster and the diagnostic connector have been used for several years.

The goal of multiplexing is to reduce cab harness wiring and to simplify circuits. This is accomplished by using low current data link circuits for communication between cab switches and the electrical system controller and the instrument cluster. Other data links in the vehicle allow other electrical controllers and the instrument cluster to communicate with each other.

International multiplexing uses two types of data links; J1708 and J1939. The J1708 data link is often referred to as ATA and J1939 is often referred to as CAN.

There are four separate data links used on the vehicle.

- Drivetrain 1939 data link - This J1939 data link provides a path for communication between the engine controller, transmission controller, antilock brake system (ABS) controller, pyrometer ammeter module (PAM), electrical system controller (ESC), auxiliary gauge switch pack (AGSP) and the electronic gauge cluster (EGC).
- Body builder data link - This J1939 data link provides a path for communication between the remote power module(s), remote PTO, air solenoid 7 pack(s) and the ESC.
- Switch data link - This J1708 data link provides a path for communication between the center panel switches, door pods and ESC.
- 1708 data link - This is the same J1708 data link (sometimes referred to as ATA) that has been used in the past. This data link will be used almost exclusively for diagnostics and programming of engines and other controllers.

The heart of the multiplexed system is the electrical system controller (ESC). The ESC communicates with the switches on the switch data link, controllers from other features on the drivetrain 1939 data link and remote power modules on the body builder data link. It also receives input from various sensors and hard wire inputs throughout the truck. The ESC converts these inputs into data to be transmitted on the data links. It is also the power source for circuits that feed the components, controlled by the multiplexed switches, inside and outside of the cab.

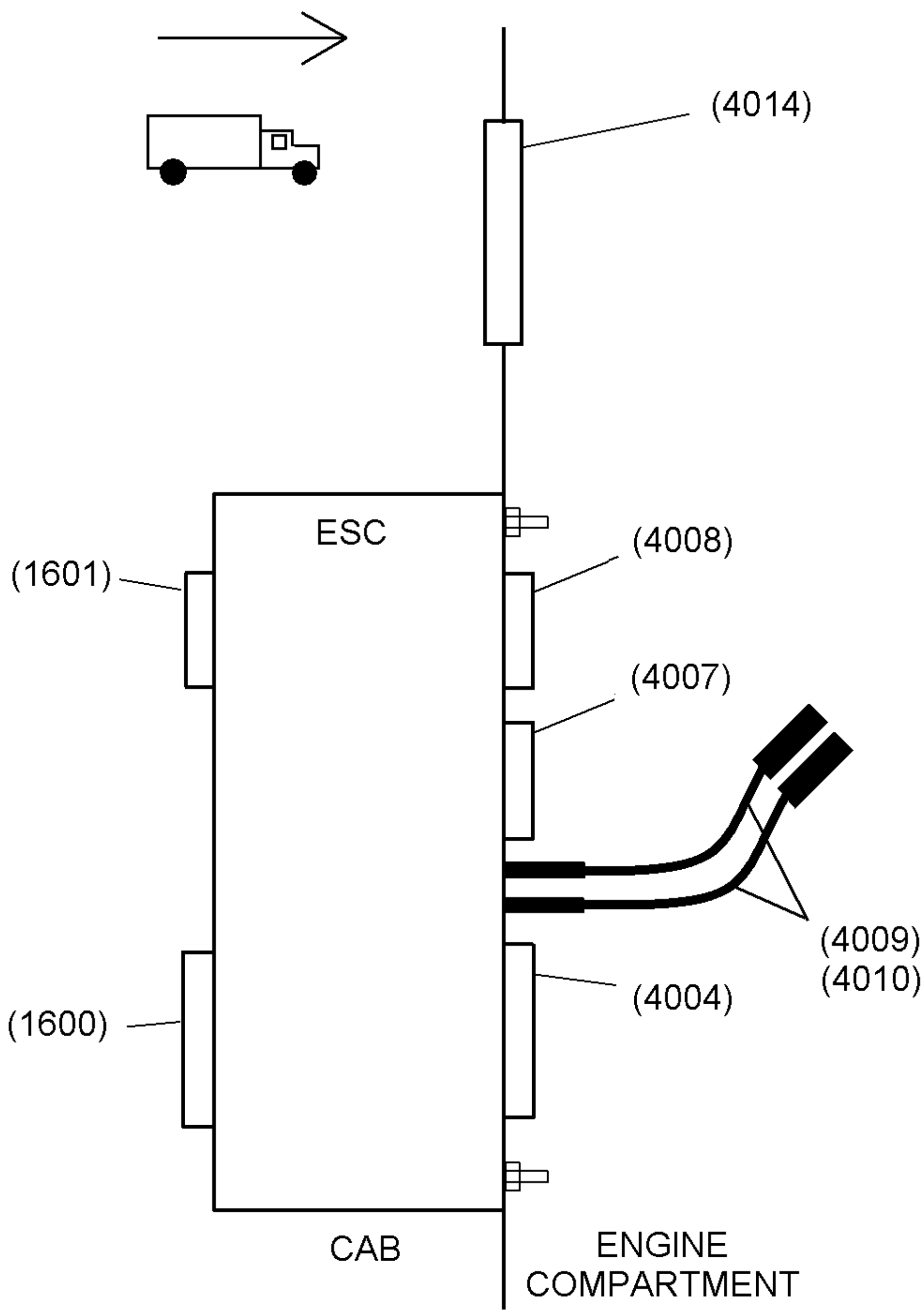


Figure 34 Electrical System Controller (ESC)

(1600) 36 WAY CONNECTOR
(1601) BROWN 8 WAY CONNECTOR
(4014) 48 WAY PASS THROUGH CONNECTOR
(4008) BLUE 8 WAY CONNECTOR
(4007) BROWN 8 WAY CONNECTOR
(4009) & (4010) POWER CONNECTORS
(4004) 36 WAY CONNECTOR

2. DIAGNOSTIC SOFTWARE

On vehicles with International engines, the master diagnostics (MD) software may be used to verify the status of the 1708 data link (diagnostic trouble codes cannot be read from the engine controller if the data link is not available). See the MD software manual for instructions.

The ESC will log a DTC if communication with an electronic device is lost on the drivetrain 1939 data link, body builder data link and switch data link. The DTC’s may be read with the INTUNE diagnostic software. See the INTUNE diagnostic software manual for instructions.

The INTUNE diagnostic software is run on the EZ-Tech (a light version can be run on a personal computer for body builder and fleet customers). An interface cable is required to connect the computer to the diagnostic connector of the truck.

3. DRIVETRAIN 1939 DATA LINK

3.1. CIRCUIT FUNCTION

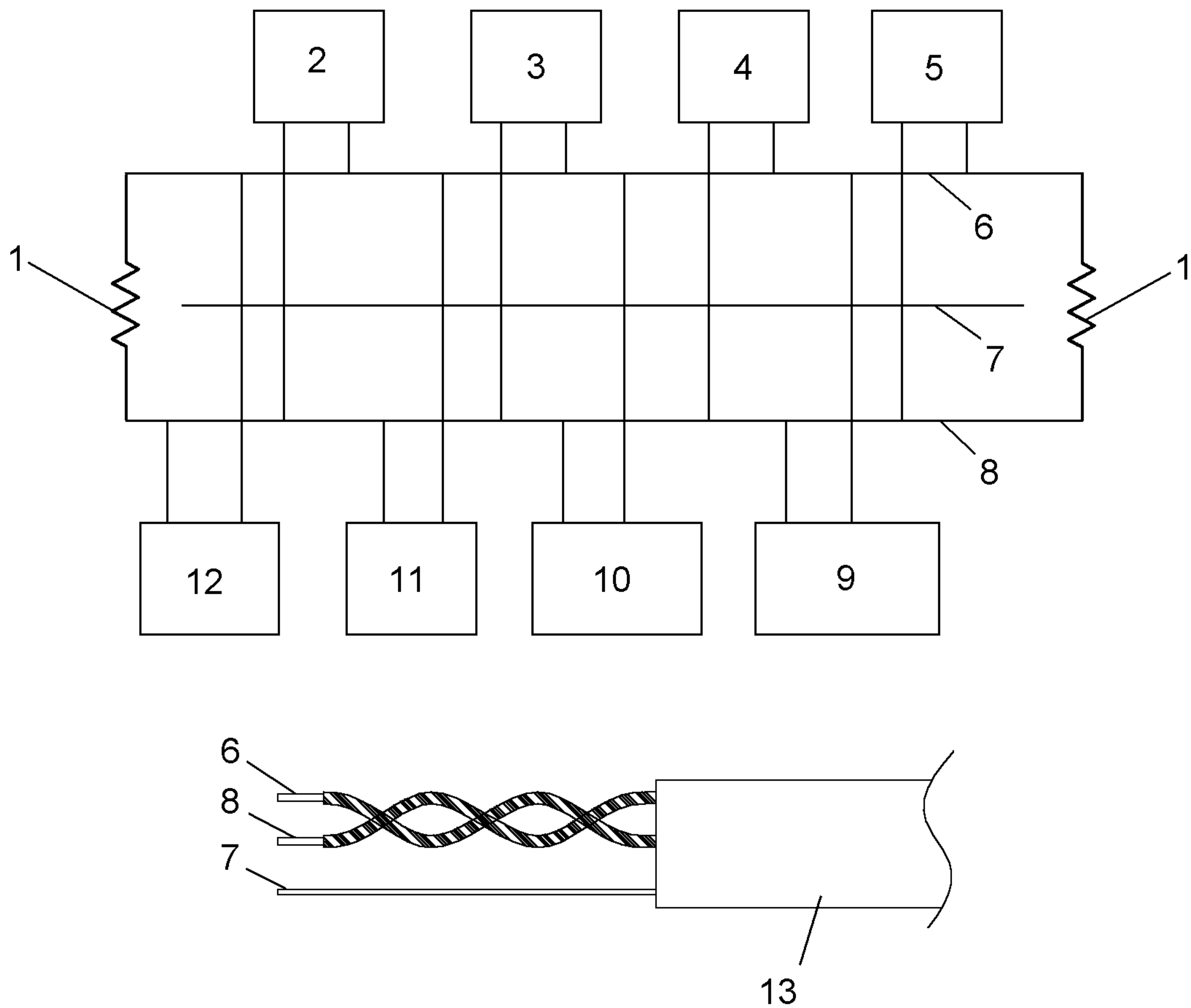


Figure 35 Drivetrain 1939 Data Link Functional Diagram

1. 120 OHM TERMINATING RESISTOR
2. DIAGNOSTIC CONNECTOR (1650)
3. ELECTRONIC GAUGE CLUSTER (1500)
4. AUXILIARY GAUGE AND SWITCH PACK (1510)
5. PYROMETER/AMMETER MODULE (4087)
6. (YELLOW) HIGH SIGNAL WIRE
7. DRAIN WIRE
8. (GREEN) LOW SIGNAL WIRE
9. ELECTRICAL SYSTEM CONTROLLER
10. TRANSMISSION CONTROLLER
11. ABS CONTROLLER
12. ENGINE CONTROLLER
13. BACKBONE CABLE

The drivetrain 1939 data link (a much faster data link than the J1708) provides a path for communication between the ESC, engine controller, transmission controller, ABS controller, auxiliary gauge switch pack (AGSP), electronic gauge cluster (EGC) and any other electronic communication devices as required.

The drivetrain 1939 datelined backbone is composed of three wires. All wires are twisted and circuits in the engine compartment are shielded. The twisted pair of wires are terminated at each end, one outside of the cab and one behind the instrument panel, with a 120 ohm resistor. Devices are connected to the backbone by shorter runs of twisted wire called stubs.

Connections to the backbone in the cab are hard wired. Connections to the backbone outside of the cab are accomplished using “Y” connectors.

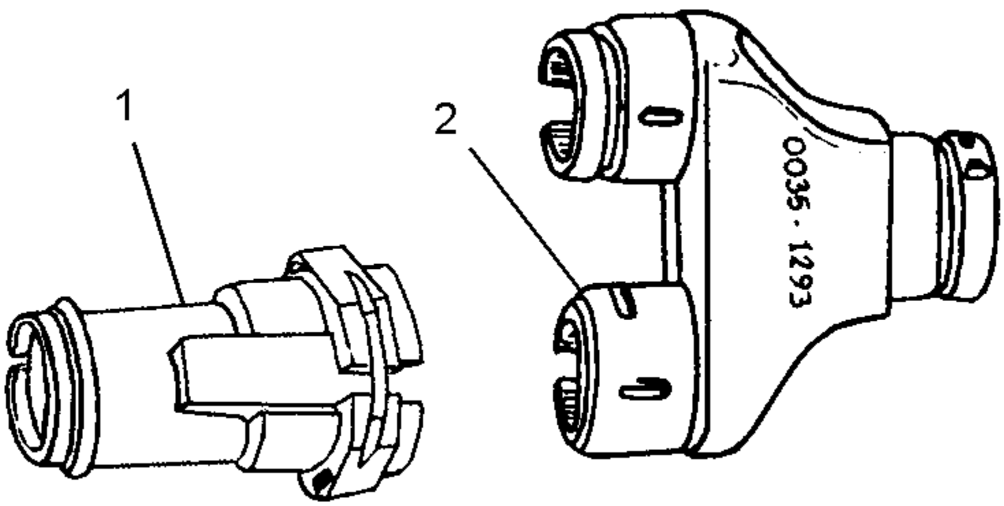


Figure 36 J1939 Termination Resistor and “Y” Connector

1. 120 OHM TERMINATION RESISTOR
2. “Y” CONNECTOR

3.2. FAULT DETECTION MANAGEMENT

If the electronic gauge cluster (EGC) is unable to communicate on the data link, all gauges will sweep to zero and the check electrical system indicator will light.

If communication between the EGC and ESC is lost but the EGC can still communicate with the engine controller, information from the engine controller will continue to be displayed on the EGC until the key is cycled. The check electrical system indicator will still light.

If the engine controller alone is unable to communicate on the data link the gauges in the EGC controlled by the engine controller will sweep to zero.

The “INTUNE” diagnostic software, running on the EZ-Tech (a light version can be run on a personal computer for body builder and fleet customers), may be used to view DTC’s logged for communication problems on the drivetrain 1939 data link. An interface cable is required to connect the computer to the diagnostic connector of the vehicle. See the “INTUNE” diagnostic software manual for instructions.

Refer to Off-Line Diagnostics for DTC retrieval instructions. (See OFF- LINE DIAGNOSTICS, page 1037)

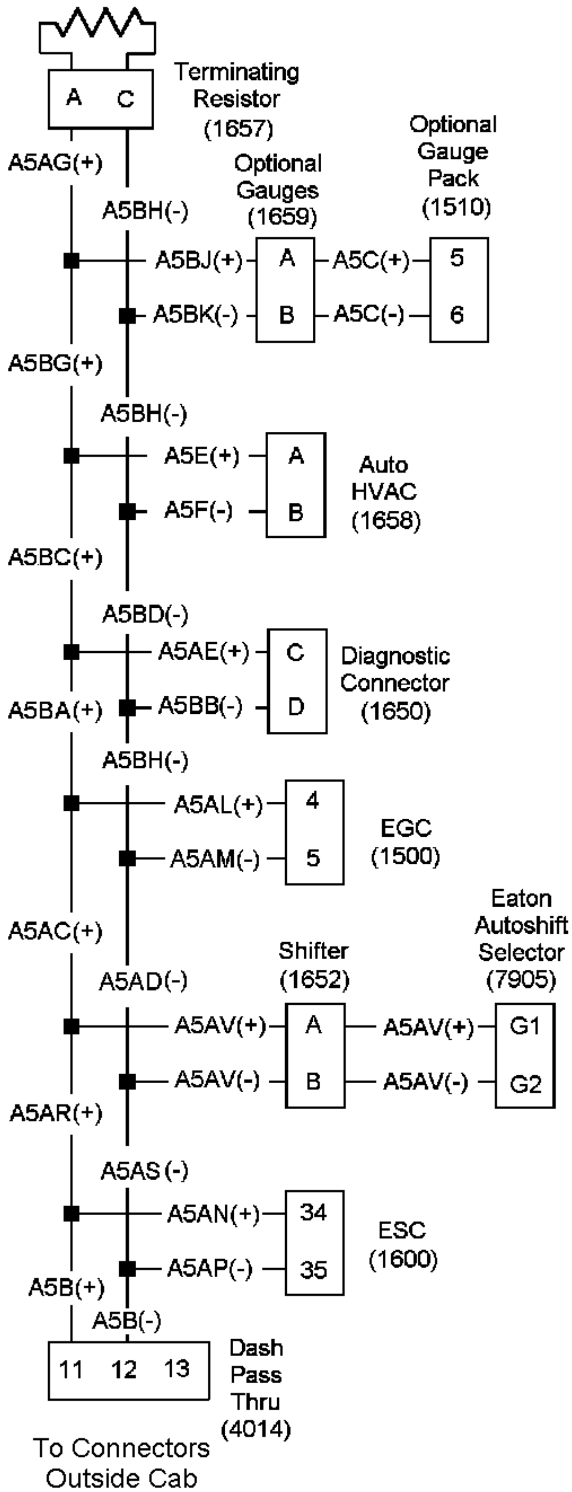


Figure 37 Typical (In Cab) Drivetrain 1939 Data Link connectors Diagram (Connectors Used Will Vary Depending On Features Installed In Vehicle)

(1500) EGC CONNECTOR
LOCATED ON BACK OF ELECTRONIC GAUGE CLUSTER
(1510) AGSP CONNECTOR
LOCATED ON BACK OF AUXILIARY GAUGE SWITCH PACK (OPTIONAL FEATURE)
(1600) 36-WAY CAB ESC CONNECTOR
LOCATED ON CAB SIDE OF ESC
(1650) DIAGNOSTIC CONNECTOR
LOCATED BELOW INSTRUMENT PANEL– LEFT SIDE OF CAB
(1657) DATA LINK TERMINATING RESISTOR
TAPED TO INSTRUMENT PANEL HARNESS BEHIND CIGAR LIGHTER
(1658) AUTO HVAC CONNECTOR
LOCATED BEHIND HVAC CONTROL (OPTIONAL FEATURE)
(4014) PASS THROUGH CONNECTOR
LOCATED IN DASH PANEL ABOVE ESC
(7905) EATON AUTOSHIFT SELECTOR
LOCATED BEHIND EATON AUTOSHIFT SELECTOR (OPTIONAL FEATURE)

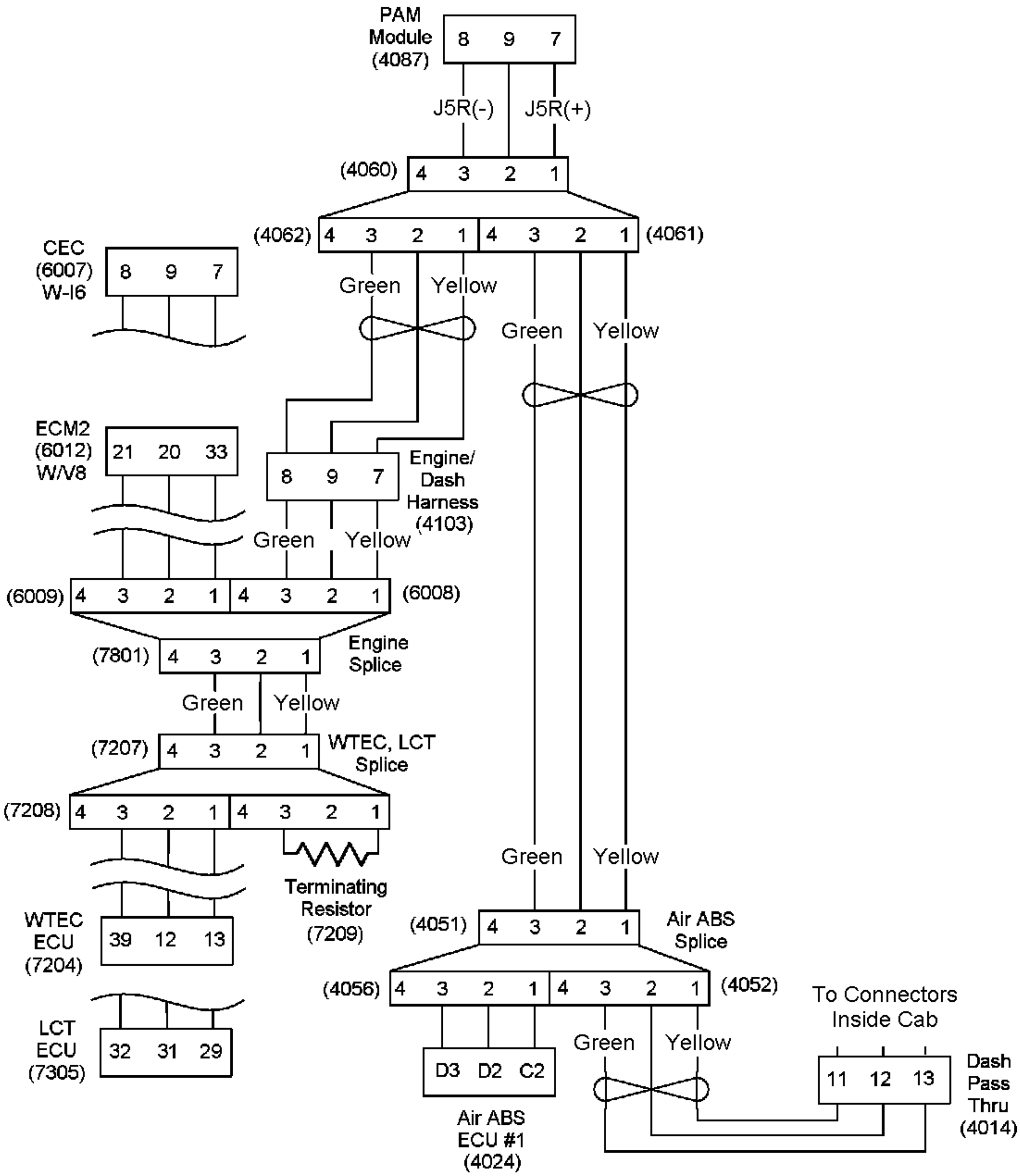


Figure 38 Typical (Outside Of Cab) Drivetrain 1939 Data Link Connectors Diagram (Connectors Used Will Vary Depending On Features Installed On Vehicle)

(4024) AIR ABS CONNECTOR
LOCATED ON AIR ABS ECU (WITH AIR ABS ONLY)
(4051)(4052)(4062) PAM SPLICE CONNECTORS
LOCATED NEAR ENGINE COMPARTMENT POWER DISTRIBUTION CENTER
(4060)(4061)(4056) AIR ABS SPLICE CONNECTORS
LOCATED NEAR ENGINE COMPARTMENT POWER DISTRIBUTION CENTER
(4087) PYROMETER/AMMETER (PAM) MODULE CONNECTOR
LOCATED ON PAM MODULE MOUNTED NEAR AIR FILTER (OPTIONAL FEATURE)
(4103) ENGINE/DASH HARNESS
LOCATED NEAR WIPER MOTOR BRACKET
(6007) ENGINE ECM CONNECTOR
LOCATED ON ENGINE ECM
(6012) ENGINE ECM CONNECTOR
LOCATED ON ENGINE ECM
(6008)(6009)(7801) ENGINE SPLICE CONNECTORS
LOCATED NEAR ENGINE ECM
(7207)(7208) TRANSMISSION SPLICE CONNECTORS
LOCATED ABOVE TRANSMISSION
(7209) TERMINATING RESISTOR
LOCATED ON ENGINE SPLICE CONNECTOR OR TRANSMISSION SPLICE CONNECTOR
(7204) MD (WTEC) ECU CONNECTOR
LOCATED ON TRANSMISSION ECU
(7205) LCT ECU
LOCATED ON LCT TRANSMISSION ECU

Problems with the drivetrain 1939 data link could be the result of crossed or open circuits in the backbone or stubs, shorts to ground in any of the circuits, missing or incorrect terminating resistors, interference on the data link, internal shorts or incorrect output from any electronic device (controller) connected to the data link.

The starting point for isolating drivetrain data link problems is to establish communications between the ESC and EGC. This may require disconnecting other electronic controllers from the data link.

When the diagnostic trouble codes identify only one controller is not communicating with the ESC, check power and data link circuits unique to that device. If there is power to the device, an internal malfunction may be causing the problem.

When the ESC and EGC are communicating but several other controllers are not communicating there is probably an open or crossed circuits in the data link .

It may be necessary to disconnect components from the data link to isolate a device that is causing the problem.

Table 7 Drivetrain 1939 Data Link Circuit Checks

Drivetrain 1939 Circuit Voltage Checks Check with ignition on. **NOTE – Voltages on J1939 data links vary depending on the amount of traffic on the data link.** Presence of voltages will eliminate shorts to ground and may help identify open circuits.		
Test Points	Spec.	Comments

Table 7 Drivetrain 1939 Data Link Circuit Checks (cont.)

(1650) Diagnostic connector pin C, or any other yellow drivetrain 1939 data link circuit, to ground	Approximately 2.5 volts	If voltage is missing, check for open or short to ground in yellow data link circuits.
(1650) Diagnostic connector pin D, or any other green drivetrain 1939 data link circuit, to ground	Approximately 2.5 volts	If voltage is missing, check for open or short to ground in green data link circuits.
Drivetrain 1939 Circuit Resistance Checks Check with battery disconnected. This procedure checks for open circuits or missing terminating resistors in the data link backbone.		
Test Points	Spec.	Comments
(1650) Diagnostic connector Pin C to D	60 ± 10 ohms	If resistance is closer to 120 ohms, check for missing terminating resistor or open circuit. If resistance is higher both terminating resistors may be missing. If resistance is low check for shorts between data link circuits.
(1650) Diagnostic connector Pin C to ground	>100K ohms	If resistance is low check for short to ground in yellow data link circuits
(1650) Diagnostic connector Pin D to ground	>100K ohms	If resistance is low check for short to ground in green data link circuits
If voltages and resistances check good, the data link backbone is good. Check for crossed circuits throughout data link or open circuits between the electronic device and the backbone. If problems persist, something is interfering with data link communication. This could be the result of erratic signals from one of the electronic controllers or some kind of interference.		

3.3. COMPONENT LOCATIONS

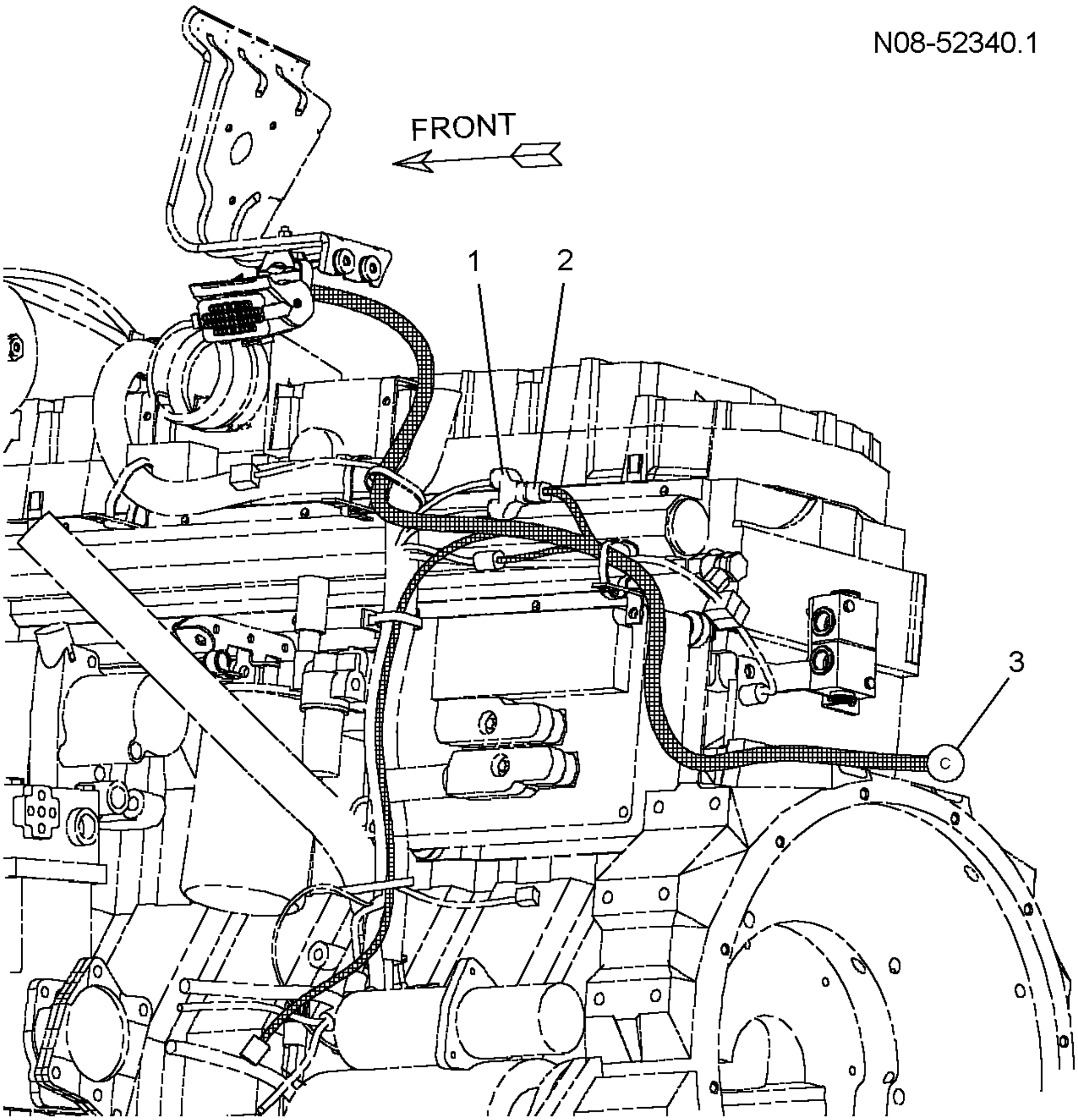


Figure 39 Drivetrain 1939 Data Link Engine Splice (I6 Engine Shown)

1. ENGINE SPLICE (6008) (6009)
2. (7801) WITH ELECTRONIC AUTOMATIC TRANSMISSION -TERMINATING RESISTOR WITH AUTOSHIFT OR MANUAL TRANSMISSION
3. TRANSMISSION HARNESS

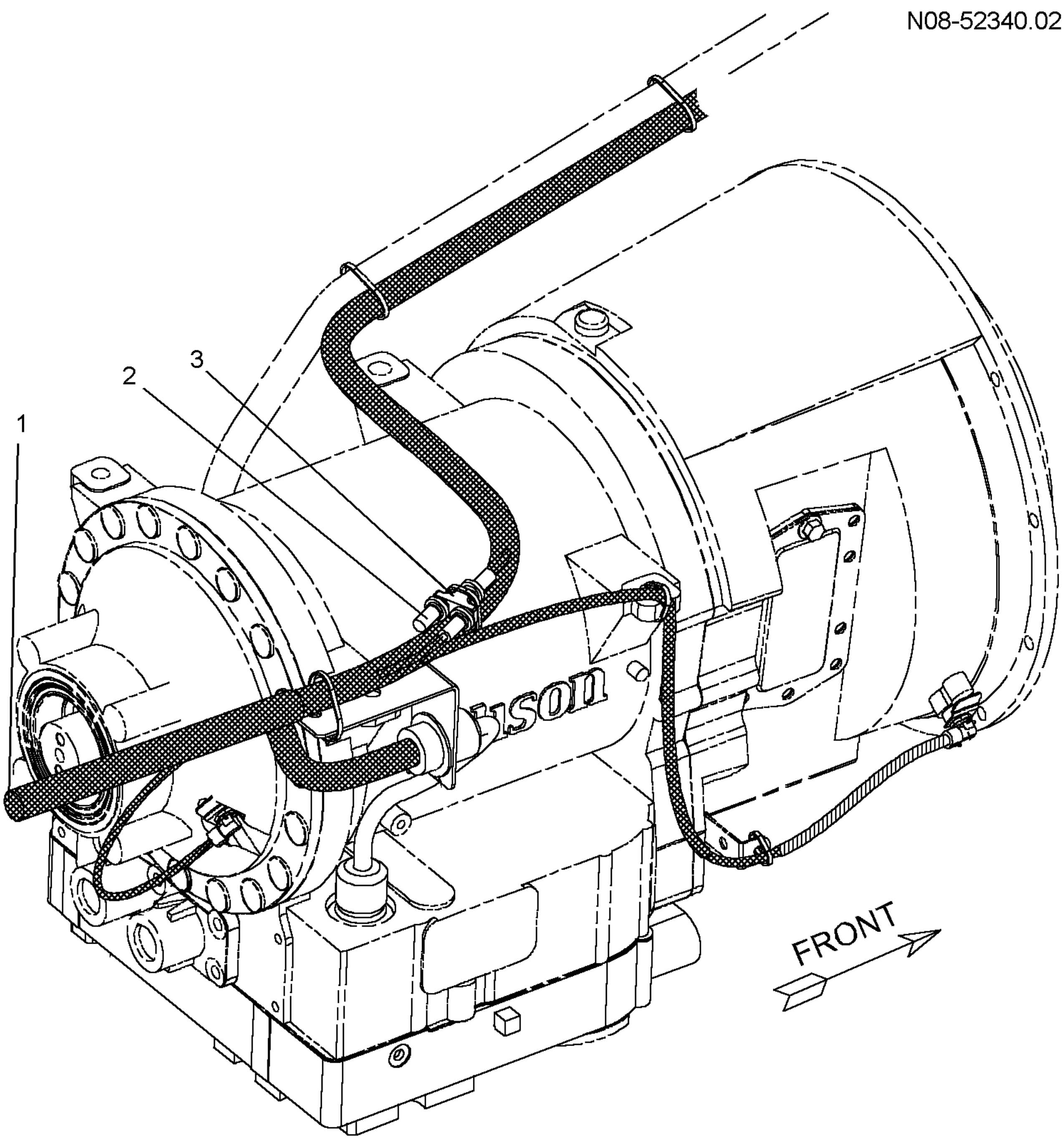


Figure 40 Drivetrain 1939 Data Link Transmission Splice (MD Transmission Shown)

1. TRANSMISSION HARNESS
2. DRIVETRAIN 1939 "Y" CONNECTOR TERMINATOR
3. DRIVETRAIN 1939 "Y" CONNECTOR (7208)

4. BODY BUILDER DATA LINK

4.1. CIRCUIT FUNCTION

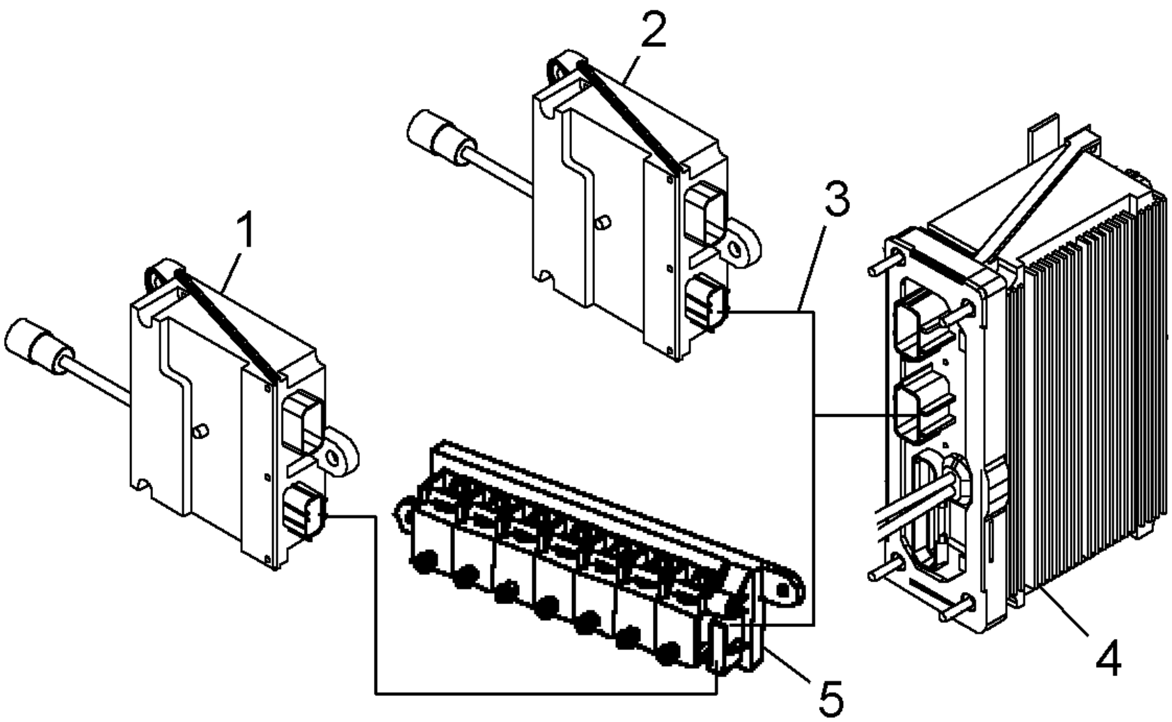


Figure 41 Typical Body Builder Data Link Function Diagram

1. REMOTE POWER MODULE (UNDER CAB, BACK OF CAB OR END OF FRAME)
2. REMOTE POWER MODULE (FORWARD OF CAB)
3. BODY BUILDER DATA LINK
4. ELECTRICAL SYSTEM CONTROLLER
5. AIR SOLENOID (7-PACK)

The body builder data link (a J1939 style data link) provides communication between the ESC and the remote power module(s), 7-pack air solenoid module(s) and remote engine speed control module. The actual wiring associated with this data link will vary depending on the modules installed on the vehicle.

Refer to Body Builder Data Link Diagram.

The vehicle may be equipped with several remote power modules (RPM), up to two 7-pack air solenoid modules (RASM) and/or a remote engine speed control module (RESCM). A “Y” connector splits the data link to components mounted forward of the cab and to components mounted under or behind the cab. If no components are installed on one side of the Y connector, a terminating resistor assembly (3537129C1) must be installed in the open connector. The last component in each chain must have a terminating resistor assembly (3559775C1) on the output connector.

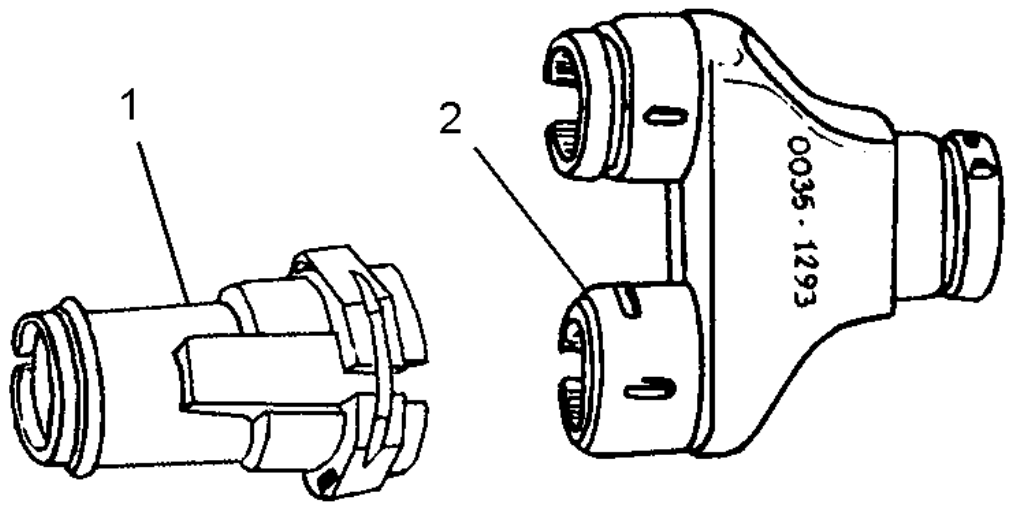


Figure 42 J1939 Termination Resistor and “Y” Connector

1. 120 OHM TERMINATION RESISTOR (3537129C1)
2. “Y” CONNECTOR (3537130C1)

The body builder data link backbone cable consists of three wires. All wires are twisted and shielded. Devices are connected to the data link at the “Y” connector or are daisy chained from one component to the other.

Problems with the body builder data link could be the result of crossed or open circuits in the backbone or stubs, shorts to ground in any of the circuits, missing or incorrect terminating resistors and internal shorts or incorrect output from any electronic device (module) connected to the data link.

4.2. FAULT DETECTION MANAGEMENT

The ESC will log a diagnostic trouble code when messages from installed remote controllers are missing on the body builder data link. Refer to Off-Line Diagnostics for DTC retrieval instructions. (See OFF- LINE DIAGNOSTICS, page 1037)

The “INTUNE” diagnostic software, running on the EZ-Tech (a light version can be run on a personal computer for body builder and fleet customers), may be used to check for diagnostic trouble codes for components communicating to the ESC on the body builder 1939 data link. An interface cable is required to connect the computer to the diagnostic connector of the vehicle. See the “INTUNE” diagnostic software manual for instructions.

Refer to Off-Line Diagnostics for DTC retrieval instructions. (See OFF- LINE DIAGNOSTICS, page 1037)

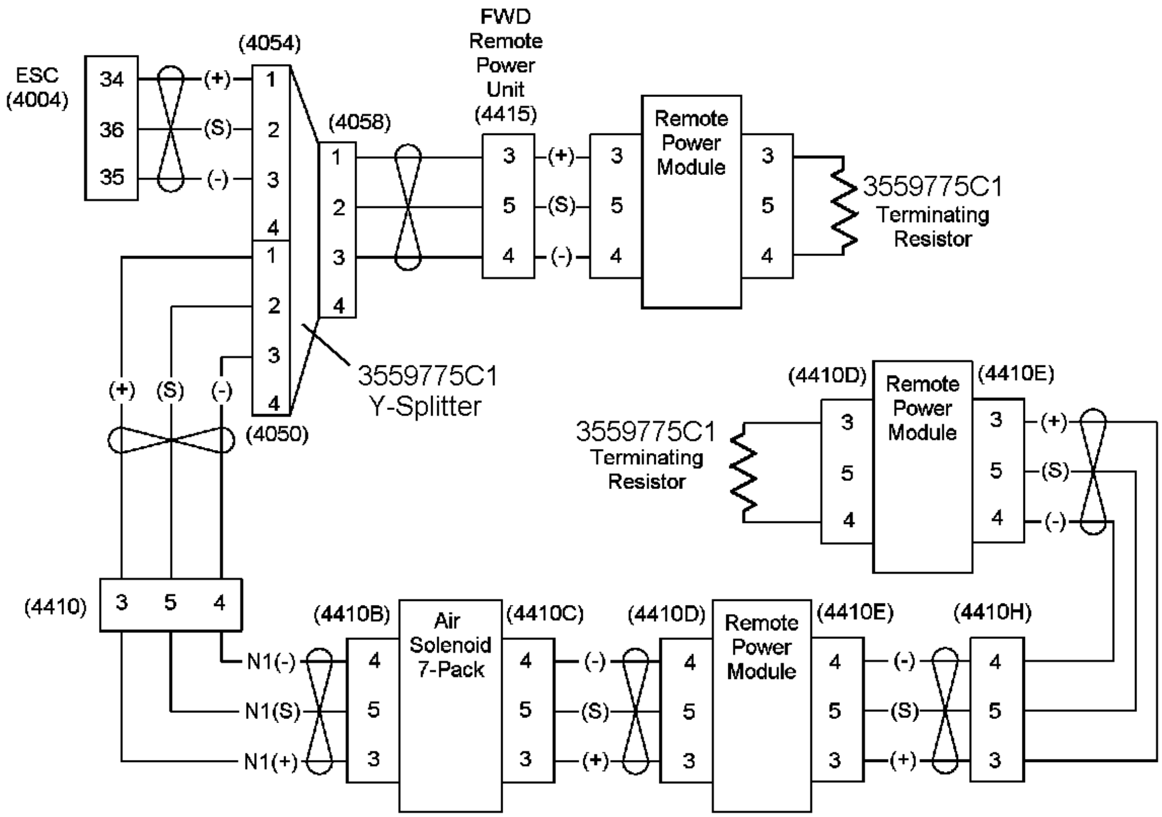


Figure 43 Typical Body Builder Data Link Connector Diagram (Devices Used Determined by Features Installed on Vehicle)

(4004) ELECTRICAL SYSTEM CONTROLLER
(4410) REMOTE SOLENOID POWER MODULE
(4410B & C) SOLENOID MODULE
(4410D & E) REMOTE POWER MODULE
(4410H) REMOTE POWER MODULE CENTER/REAR
(4410M) REMOTE POWER MODULE
(4415) FORWARD REMOTE POWER MODULE UNIT

Problems with the body builder data link could be the result of open circuits in the backbone or stubs, shorts to ground in any of the circuits, missing or incorrect terminating resistors, interference on the data link, internal shorts or incorrect output from any electronic device (module) connected to the data link.

When the diagnostic trouble codes identify only one module is not communicating with the ESC, check power and data link circuits unique to that device. If the device has power it may have an internal failure preventing it from communicating on the data link.

When several devices are not communicating with the ESC there is probably an open in the data link or a crossed circuit.

It may be necessary to disconnect components from the data link to isolate a device that is affecting the data link.

Table 8 Body Builder Data Link Connector Check Chart

Body Builder Data Link Voltage Checks Take measurements by installing breakout box ZTSE4477 between ESC connector (4004) and harness connector (4004). Check with key **on**. Presence of voltages will eliminate shorts to ground and may help identify open circuits.		
Test Points	Spec.	Comments
(4004) Breakout box test point 34 to ground	Approximately 2.5 volts.	If voltage is missing, check for open or short in yellow data link circuits or shorts in components.
(4004) Breakout box test point 35 to ground	Approximately 2.5 volts	If voltage is missing, check for open or short in green data link circuits or shorts in components.
Body Builder 1939 Circuit Resistance Checks Check with battery disconnected. This procedure checks for open circuits or missing terminating resistors in the data link backbone.		
Test Points	Spec.	Comments
(4004) Breakout box test point 34 to 35	60 ± 10 ohms	If resistance is closer to 120 ohms, check for missing terminating resistor or open circuit. If resistance is higher both terminating resistors may be missing. If resistance is low check for shorts between data link circuits.
(4004) Breakout box test point 34 to ground	>100K ohms	If resistance is low check for short to ground in yellow data link circuits
(4004) Breakout box test point 35 to ground	>100K ohms	If resistance is low check for short to ground in green data link circuits
If voltages and resistances check good, the data link backbone is good. Check for crossed circuits throughout data link or open circuits between the electronic device and the backbone. If problems persist, something is interfering with data link communication. This could be the result of erratic signals from one of the electronic controllers or some kind of interference.		

5. SWITCH DATA LINK

5.1. CIRCUIT FUNCTION

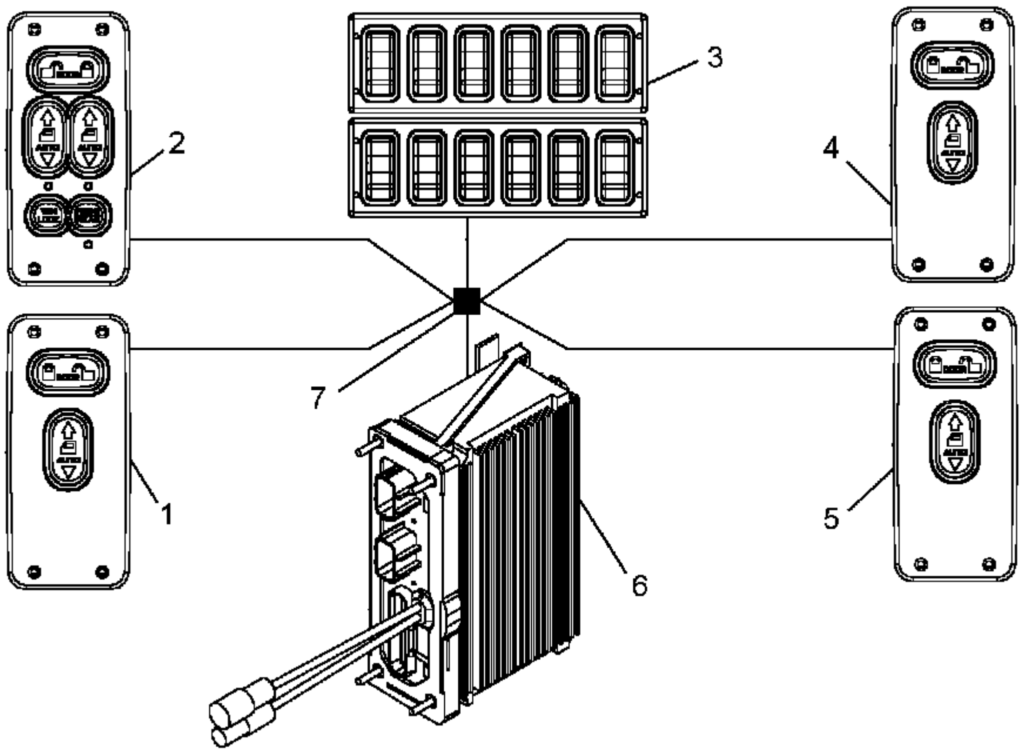


Figure 44 Typical Switch Data Link Function Diagram

1. DRIVER SIDE CREW DOOR POD
2. DRIVER'S DOOR POD
3. SWITCH PACK
4. PASSENGER DOOR POD
5. PASSENGER SIDE CREW DOOR POD
6. ELECTRICAL SYSTEM CONTROLLER
7. SWITCH DATA LINK TWISTED PAIR

The switch data link is a twisted pair of wires. This data link provides a path for communication between the ESC, the instrument panel switches and the door pods. This data link allows the switch packs, door pods and ESC to send messages to each other eliminating the need for individual high current wires between switches and components.

5.2. FAULT DETECTION MANAGEMENT

The ESC will detect an open/short on the data link or an absence of message traffic from other components on the switch data link. A diagnostic trouble code will be logged and the check electrical system indicator will light.

Problems with the switch data link could be the result of open circuits in the data link, shorts to ground in any of the circuits, and internal shorts or incorrect output from any electronic device (module) connected to the data link.

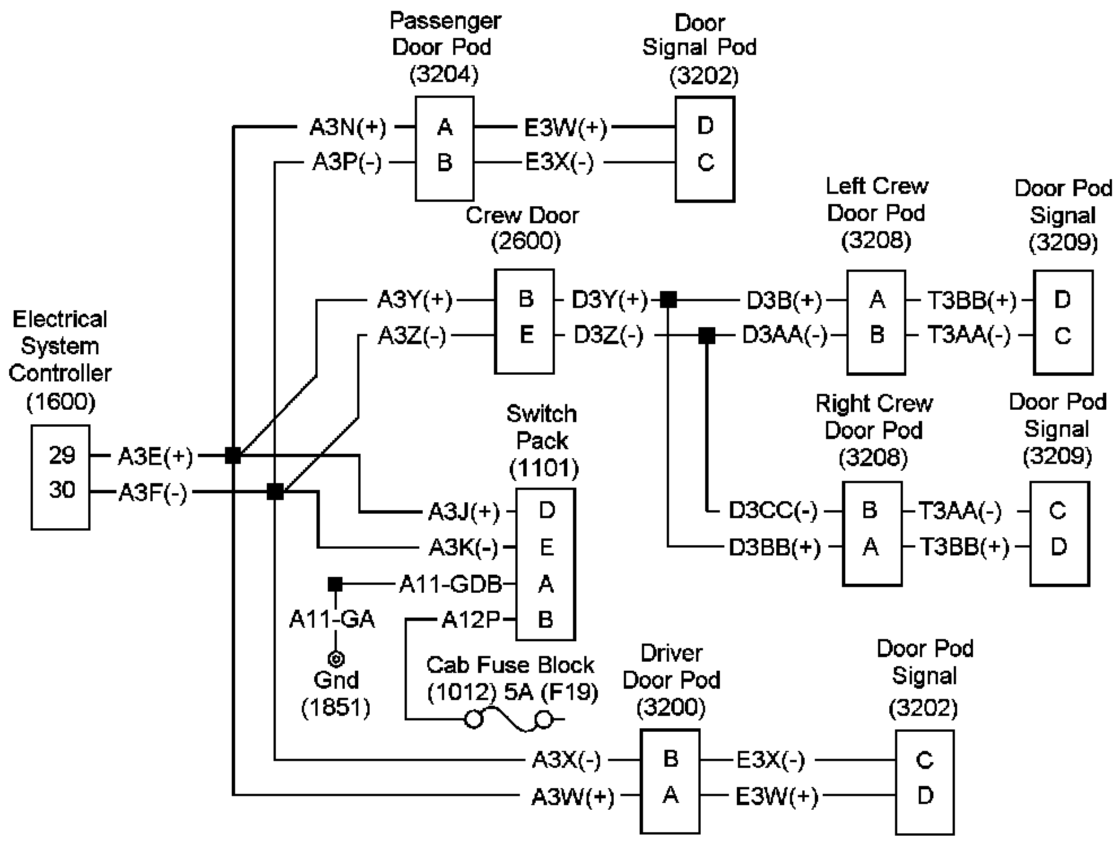


Figure 45 Typical Switch Data Link Function Diagram

Table 9 Switch Data Link Connector Check Chart

Switch Data Link Voltage Checks Take measurements on open connector (1101) behind switch pack(s)		
Test Points	Spec.	Comments
(1101) Pin B to ground	12 ± 1.5 volts	If voltage is missing, check for blown fuse (F19) or open or short in circuits A12P.
(1101) Pin A to ground	0 volts	Ground circuit to pod.
(1101) Pin D to ground	Approximately 3 volts	(+) data link circuit. If voltage is low check for open or short in circuit A3J(+) or shorted components on data link.
(1101) Pin E to ground	Approximately .1 volt	(-) data link circuit. If voltage is low check for open in circuit A3K(-) or shorted components on data link. If voltage is high check for crossed data link wires.

6. 1708 DATA LINK

6.1. CIRCUIT FUNCTION

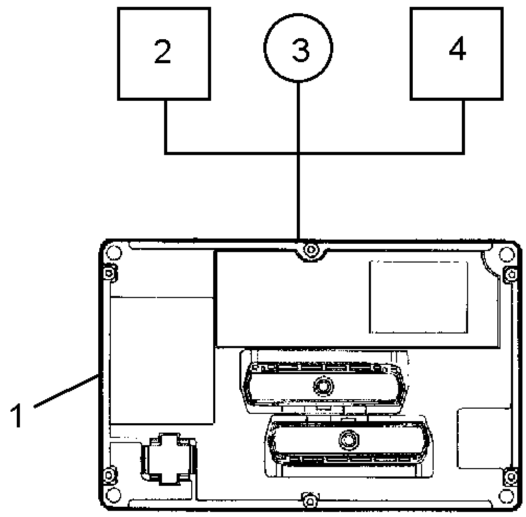


Figure 46 Typical 1708 Data Link Function Diagram

1. ENGINE CONTROLLER
2. TRANSMISSION CONTROLLER
3. DIAGNOSTIC CONNECTOR
4. ABS CONTROLLER

The 1708 data link is a twisted pair of wires. This data link connects the diagnostic connector, engine controller, transmission controller, air or hydraulic ABS controller as required. The primary purpose of this data link is to provide an electronic service tool the capability to program and diagnose the electrical controllers.

6.2. FAULT DETECTION MANAGEMENT

The ESC is not connected to the 1708 data link. If there is an open/short on the 1708 data link the engine controller will log a diagnostic trouble code and the yellow engine warning lamp on the EGC will light.

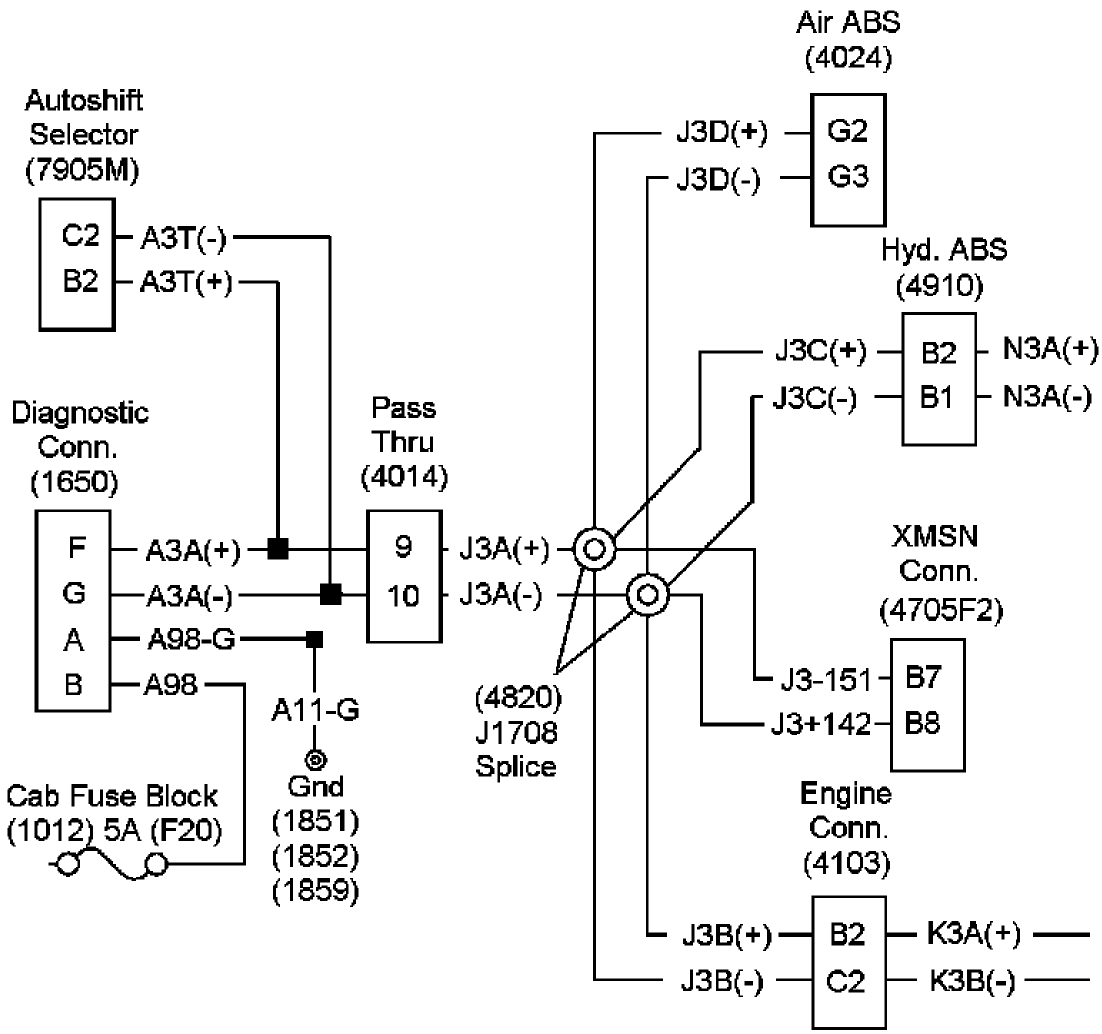


Figure 47 Typical 1708 Data Link Function Diagram

Table 10 1708 Data Link Connector Check Chart

1708 Data Link Voltage Checks at Diagnostic Connector (1650)		
Test Points	Spec.	Comments
(1650) Pin B to ground	12 ± 1.5 volts	If voltage is missing, check for blown fuse (F20) or open or short in circuits A98 to fuse block.
(1650) Pin A to ground	0 volts	Ground circuit.
(1650) Pin F to ground	Approximately 4 volts	(+) data link circuit. If voltage is low check for open in positive data link circuits.
(1650) Pin G to ground	Approximately 1 volt	(-) data link circuit. If voltage is low check for open in negative data link circuits. If voltage is high check for crossed data link circuits.

7. DATA LINK REPAIR

7.1. J1708

Repairs to damaged J1708 circuits should be accomplished using similar types of wiring. Splices should be crimped and soldered. Insure the twist in the wire pair is maintained and individual wires are covered with heat shrink.

7.2. J1939

Repairs to damaged J1939 circuits should be accomplished using similar types of wiring. Splices should be crimped, soldered and covered with heat shrink. Insure the twist in the wire pair is maintained and that any wire bundles in the engine compartment are shielded and covered with heat shrink.

Wire Repair

This instruction addresses termination and splicing of J1939 wire.

WARNING – Always turn off power to any electrical circuit before starting work.

CAUTION – Incorrect Connection or splicing of J1939 wire may result in compromise of function.

Preparation of J1939 wire for connection.

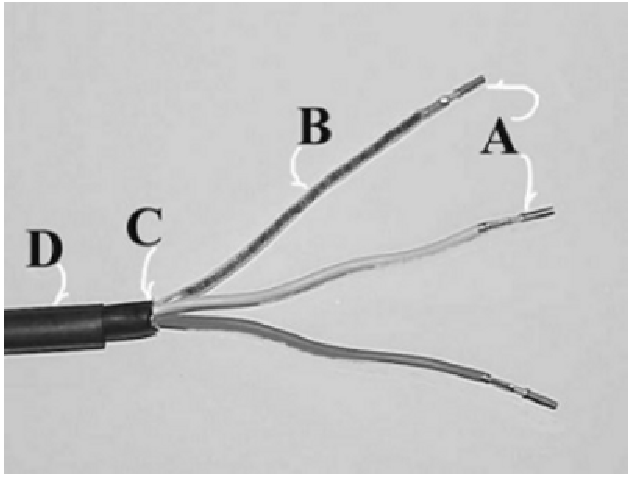


Figure 48

A. Strip back outer shield 3 1/8 in. (76 mm).

B. Strip green wire and yellow wire 1/4 in. (6.35mm) being careful not to cut individual strands. Re-twist the wires if they have separated.

C. Sleeve drain wire. Drain wire may be soldered to aid in sleeving.

D. Install terminals on the wire ends, and crimp.

E. The 1/4” heat shrink tube will be shrunk later after the wires have been inserted into the connector.

Wiring the Connector

CAUTION – The wires must be installed in the correct cavities. Refer to following Figure.

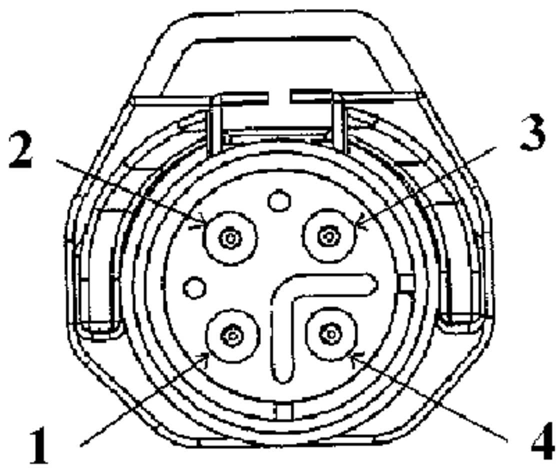


Figure 49 J1939 Connector

A. Yellow wire inserts to position 1.

B. Drain wire inserts to position 2.

C. Green wire inserts to position 3.

D. A plug occupies position 4.

CAUTION – Be sure that the connector pins are fully seated (locked) in the connector. If pins are fully seated, they will not pull back out with moderate pressure.

NOTE – After pins are seated they can only be released by depressing the pin lock (red plastic) at the front side of the connector.

Figure 50

A. PIN LOCK

Wire Splicing

1. Strip wire ends 1/4 inch.

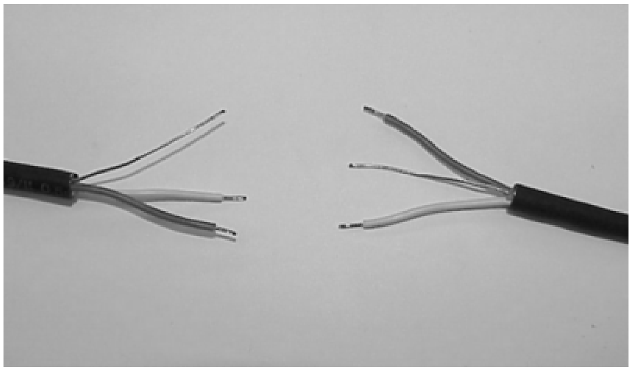


Figure 51

2. Re-twist any loose wire strands

3. Slide 2 inch pieces of heat shrink tube over wire for later use per

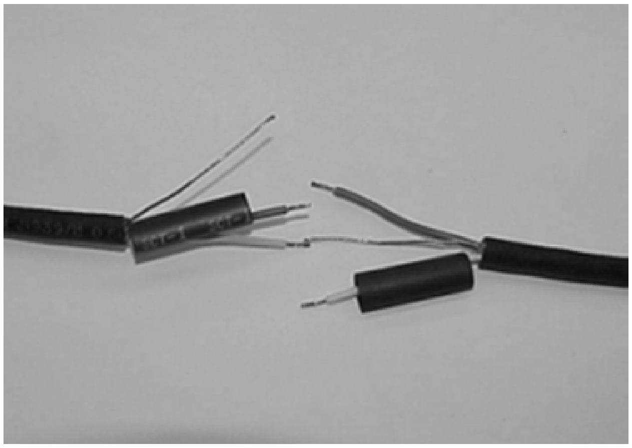


Figure 52

4. Insert ends of wires into splice joint and crimp.

5. Solder the wires and crimp joint together.

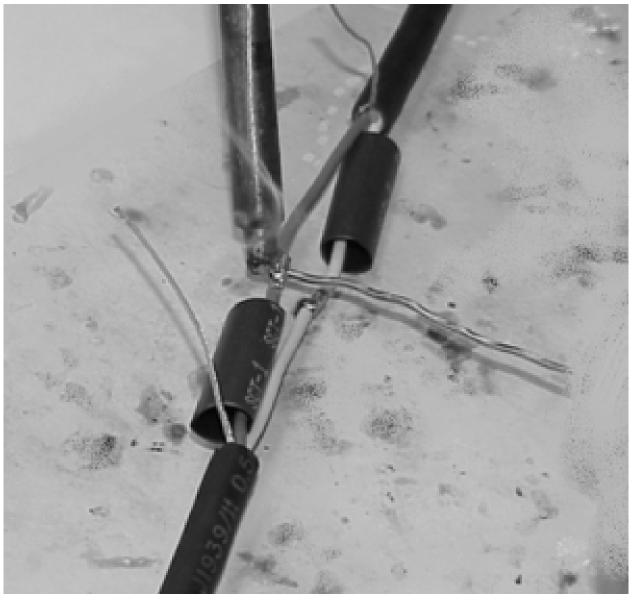


Figure 53

6. Center heat shrink tube over splice and shrink.

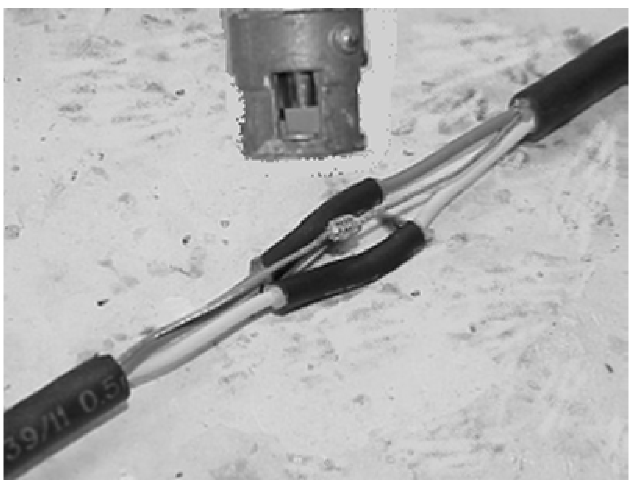


Figure 54

7. Wrap wires and drain with foil tape. Maintain at least 1/2 wrap overlap.

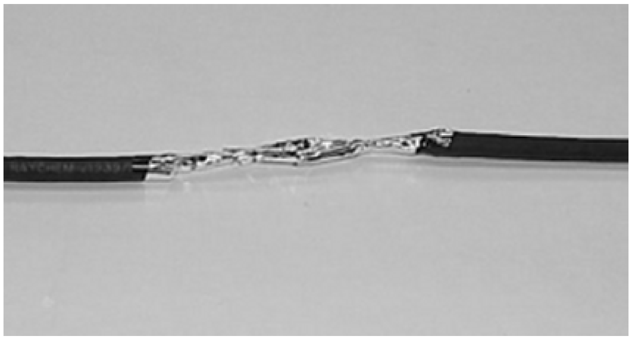


Figure 55

8. Center heat shrink tube over the splice and shrink.

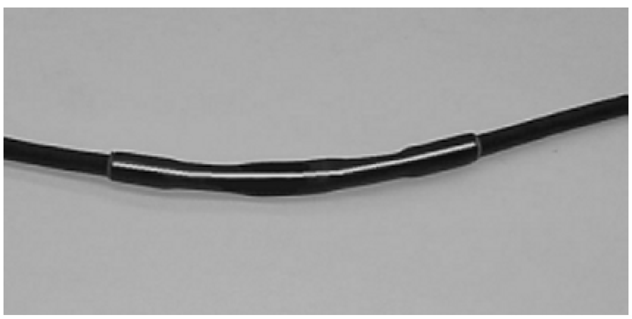


Figure 56

Table of Contents

1. ELECTRICAL SYSTEM CONTROLLER

1.1. DESCRIPTION

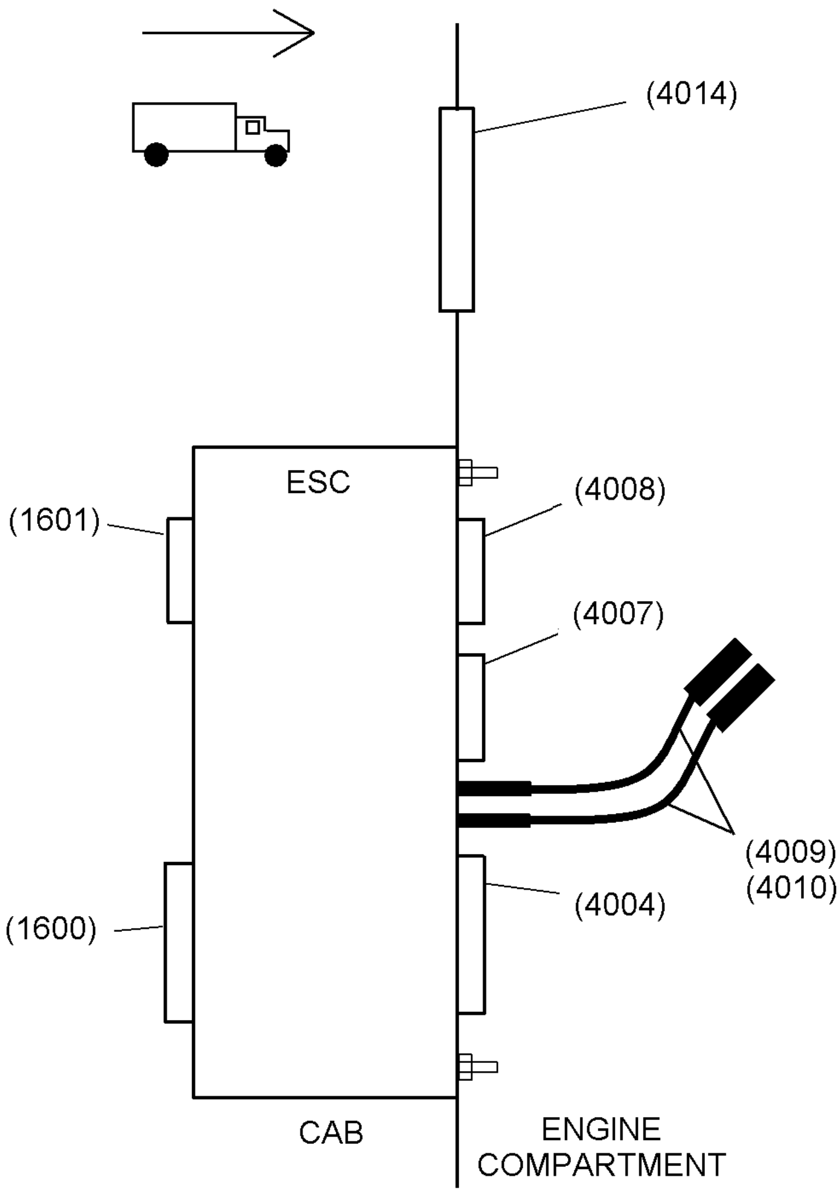


Figure 57

(1600) 36 WAY ESC CONNECTOR (INSIDE CAB)
(1601) BROWN 8 WAY ESC CONNECTOR (INSIDE CAB)
(4004) 36 WAY ESC CONNECTOR (ENGINE COMPARTMENT)
(4007) BROWN 8 WAY ESC CONNECTOR (ENGINE COMPARTMENT)
(4008) BLUE 8 WAY ESC CONNECTOR (ENGINE COMPARTMENT)
(4009) ESC POWER CONNECTOR
(4010) ESC POWER CONNECTOR
(4014) 48 WAY DASH PASS THROUGH CONNECTOR

The Electrical System Controller (ESC) is an electronic assembly providing multiple analog and switched input interfaces to read the status of various user switches and sensors. The ESC System provides a means to distribute electrical power and provide the driver with controls and indications of the vehicle performance. Unlike previous electrical system designs, this approach uses multiplexed wiring technologies for interfacing major functional areas of the vehicle. Furthermore, the system relies on software algorithms to accomplish logic functions instead of implementing similar features using complex wire harness designs with relays and switches. A natural benefit of this system is increased diagnostic capability in terms on line, off line and off board testing.

The Electrical System Controller (ESC) is the heart of the vehicle electrical system. It performs the following functions:

A. Communicates with most of the instrument panel and door switches through a switch (J-1708) data link (multiplex system).

B. Receives input from the HVAC system for HVAC diagnostics and compressor control.

C. Receives inputs from steering column switches to control the horn, turn signal, wash/wipers and cruise control.

D. Receives inputs from the brake switch(es) and clutch switch, while monitoring for open or shorted circuits for each switch.

E. Communicates with the Electronic Gauge Cluster (EGC), on the drivetrain 1939 data link, to display vehicle parameters and system diagnostics.

F. Provides power to several components, inside and outside of the cab, which are controlled by the multiplexed switches or direct inputs.

G. Provides a body builder data link to control remote power modules, remote air solenoids, and remote PTO modules.

H. Communicates with the engine controller, transmission controller and ABS controller on the drivetrain 1939 data link.

The table below contains the list of features controlled by the ESC.

Table 11 Features Controlled by the Multiplex System

Standard Features	Optional Features
Headlights, Park Lights	Air Conditioning Control & Protection
Wiper/Washer System	Mirror Heat
Electric Horn	Work Lights
Turn Signals and Hazard Flashers	Fog Lights
Stop Lights	Powered Park Brake System and Warning Lights
Dome Lights	Drive Line Air Controlled Accessories (Power Divider, Differential. Lock, Suspension. Dump, etc.)
Hydraulic Brake System Monitor and Warning Lights	Warning Lights for Electronic Transmissions
Warning Lights for Anti-Lock Brakes	Engine Brake Systems (Compression Brake, Exhaust Brake, Drive Line Retarder)

Table 11 Features Controlled by the Multiplex System (cont.)

Standard Features	Optional Features
Cruise Control Interface with Engine	Optional Gauges (Transmission Oil Temp, Axle Oil Temp, Ammeter)
Air Pressure Gauge System	Optional Warning Light Systems (Fuel Filter, Change Oil, Water In Fuel, etc.)
Standard Gauge Package (Speedometer, Tach, Volt Meter, Water Temp, Oil Pressure, Fuel Level)	

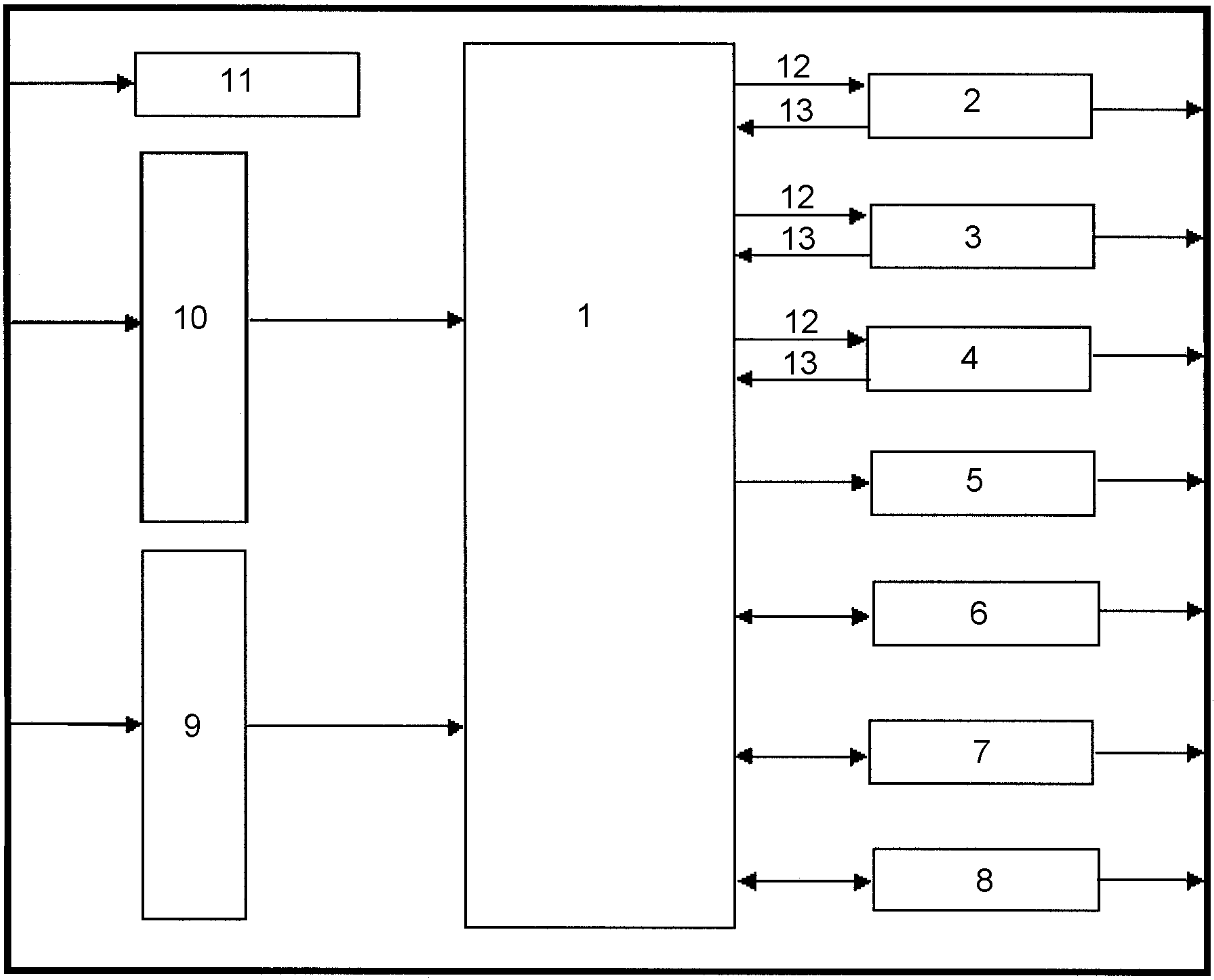


Figure 58 Electrical System Controller Block Diagram

1. MICROPROCESSOR
2. 10 AMP SOLID STATE SWITCHES
3. 20 AMP SOLID STATE SWITCHES
4. 16 CHANNEL RELAY DRIVER
5. SENSOR 5 VOLT SUPPLY OUTPUT
6. SWITCH DATA LINK– J1708 DATA TRANSCEIVER
7. BODY BUILDER DATA LINK J1939 TRANSCEIVER
8. DRIVETRAIN 1939 DATALINK TRANSCEIVER
9. DIGITAL INPUT CONDITIONING CIRCUITS
10. ANALOG INPUT CONDITIONING CIRCUITS
11. ESC MODULE POWER SUPPLY
12. DRIVE SIGNAL
13. STATUS SIGNAL

Since the ESC has electronically programmable inputs and outputs, ESC configuration will vary from vehicle to vehicle.

The ESC is mounted in the dash panel between the cab and the engine compartment. It has a power connector, from switched ignition, inside the cab and a power connector, from the batteries, in the engine compartment.

Power for components controlled by switches and the switch packs is supplied from the ESC.

NOTE – The ESC is not a repairable module. Once it has been determined that the ESC has an internal malfunction, it must be replaced and the replacement must be programmed. There is a chance that reloading the programming might repair some problems.

1.2. DIAGNOSTICS

Should the Electrical System Controller fail to operate, the problem could be attributed to missing power, a problem with a data link, corrupted programming or a failure inside the ESC

Diagnostic trouble codes (DTC's) are generated by the ESC and can be read on the odometer display.

An electronic service tool, running the "INTUNE" diagnostic software, can be used to monitor signals to and from the ESC and will also display DTC's. See the diagnostic software manual for details on using the software.

Electrical System Controller Preliminary Check

Table 12 Electrical System Controller Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Turn key to ignition position. Does "Check Elec System" warning lamp remain illuminated after gauge sweep?	Observe "Check Elec System" warning lamp and gauges on gauge cluster.	Warning lamp remains illuminated and speedometer and Tachometer are working.	Go to next step.	If electrical problems persist refer to the section in this manual for the specific malfunction. A problem with the engine controller may also cause the "Check Elec System" warning lamp to stay on.
2.	On	Check for ESC diagnostic trouble codes (See Diagnostic Trouble Codes , page 90) Are codes 627 14 1 1 or 1542 14 1 1 active?	Read display on odometer.	Codes 627 14 1 1 or 1542 14 1 1 are active.	Go to ESC Power And Ground. (See ESC POWER AND GROUND, page 91)	Go to next step.

Table 12 Electrical System Controller Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
3.	On	Is code 1705 14 150 1 active (EGC Version 8.7), is code 2023 14 150 1 active or is code 2023 14 250 1 active (EGC Version 9.3 and later)?	Read display on odometer.	Code 1705 14 150 1 is active (EGC Version 8.7), is code 2023 14 150 1 active or is code 2023 14 250 1 active (EGC Version 9.3 and later)	Go to ESC Data Links (See ESC DATA LINKS, page 94)	Go to next step.
4.	On	Is code 1557 0 1 1 active?	Read display on odometer.	Code 1557 0 1 1 is active.	Go to ESC REPLACEMENT (See ESC REPLACEMENT, page 123)	

Diagnostic Trouble Codes

To display diagnostic codes, set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch simultaneously for at least 3 seconds. If no faults are present, the cluster odometer will display “NO FAULT”. If faults are present, the gauge cluster display will show each diagnostic trouble code for 5 seconds and then automatically scroll to the next entry and continue to cycle through the faults. To manually cycle through the fault list, press the cluster display selector button. The last character of the diagnostic trouble code will end in “A” for active faults or “P” for previously active faults. Turning the ignition key off will take the ESC and the gauge cluster out of the diagnostic mode.

After all repairs have been made, the diagnostic trouble codes may be cleared by putting the key switch in the accessory position, turning on the left turn signal and pressing the cruise “ON” and “SET” switches simultaneously for 3 seconds.

Table 13 Electrical System Controller Diagnostic Trouble Codes

FAULT CODE	FAULT DESCRIPTION
610 14 1 0	Loss of Ignition feed for 10 seconds while the engine is running
610 14 2 1	Loss of Accessory feed for 10 seconds while the engine is running
612 14 0 1	Ignition out of range low Short to ground or open circuit

Table 13 Electrical System Controller Diagnostic Trouble Codes (cont.)

612 14 0 2	Ignition out of range high Shorted high
627 14 1 1	Open or short in circuit J14A to ESC power supply #1 or maxifuse A4 is blown
1542 14 1 1	Open or short in circuit J14B to ESC power supply #2 or maxifuse A3 is blown
1557 0 1 1	ESC internal fault software main loop time exceeded.
1705 14 150 1	ESC not communicating with the EGC (EGC Version 8.7)
2023 14 150 1	Loss of data link from ESC to primary EGC (150) (EGC Version 9.3 and later)
2023 14 250 1	Loss of data link from ESC to secondary EGC (250) (EGC Version 9.3 and later)

1.3. ESC POWER AND GROUND

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

Battery voltage is supplied to the ESC through two 60A fuses in maxi fuse block (4000) in the engine compartment power distribution center.

NOTE – If one 60 amp maxifuse should happen to blow, the ESC will still be able the operate half of the system outputs. For example: If the maxifuse which feeds the ESC to supply voltage to the low beam headlights blows, the high beam headlights will still operate.

The ESC receives power, with the key switch in the ignition position, from the ignition relay through 10 amp fuse F15.

The ESC receives power on pin 2 of connector (1600), with the key switch in the accessory position, from the accessory relay through 5 amp fuse F19.

The ESC ground is to the negative terminal of the batteries via ground stud (1851).

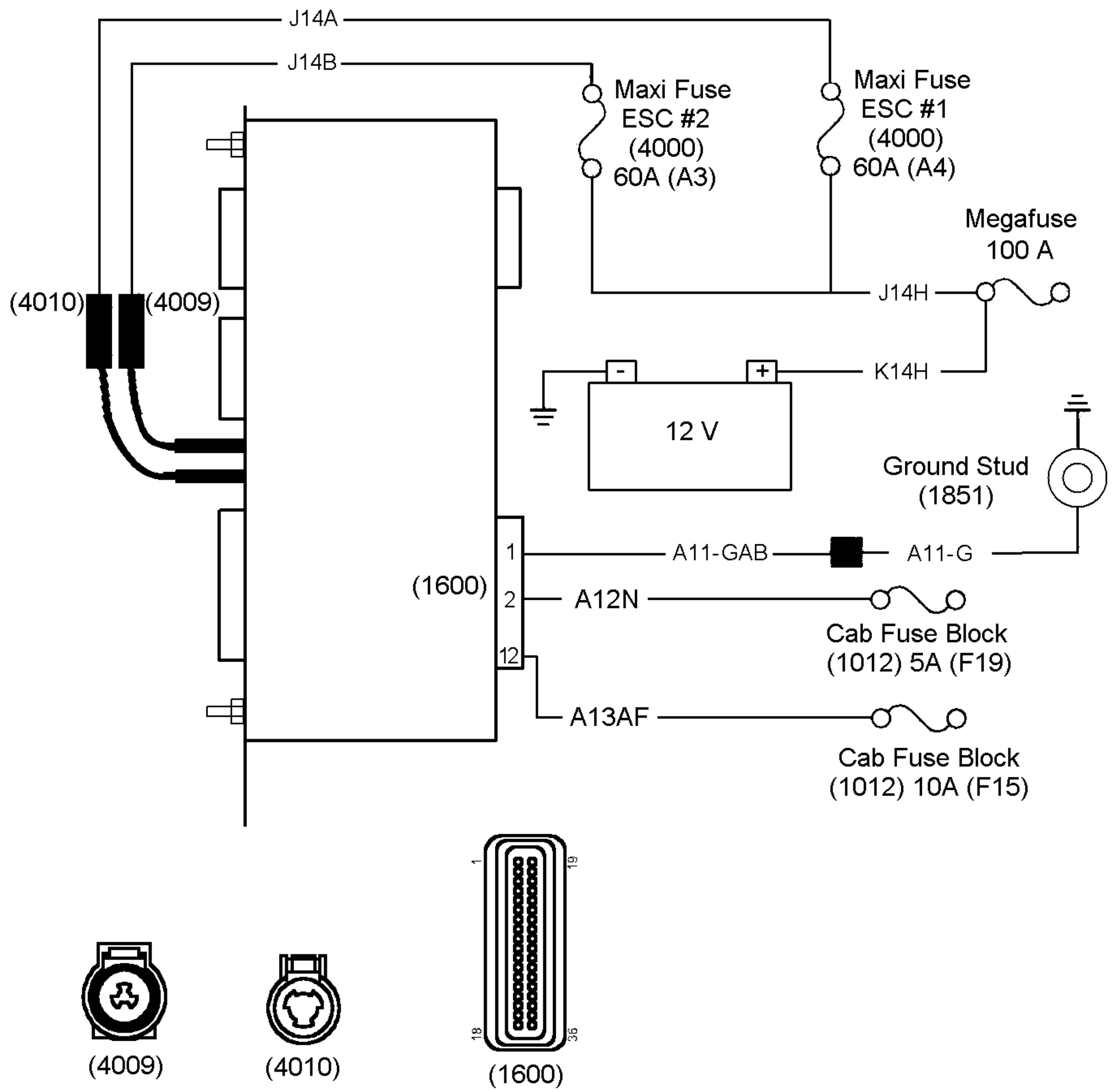


Figure 59 ESC Power and Ground Diagram

(1012) IGNITION RELAY (IN CAB POWER DISTRIBUTION PANEL)
(1100) KEY SWITCH (ON INSTRUMENT PANEL)
(1600) 36 WAY ESC CONNECTOR (INSIDE CAB)
(1851) GROUND STUD (ABOVE ESC)
(4009) ESC POWER FEED #2 CONNECTOR (IN ENGINE COMPARTMENT)
(4010) ESC POWER FEED #1 CONNECTOR (IN ENGINE COMPARTMENT)
A3 60 AMP MAXIFUSE ESC #2 (IN ENGINE COMPARTMENT POWER DISTRIBUTION CENTER)
A4 60 AMP MAXIFUSE ESC #1 (IN ENGINE COMPARTMENT POWER DISTRIBUTION CENTER)
F19 SYSTEM CONTROLLER IGNITION FUSE (IN CAB POWER DISTRIBUTION CENTER)
F20 KEY SWITCH AND DIAGNOSTIC CONNECTOR FUSE (IN CAB POWER DISTRIBUTION CENTER)

Table 14 ESC Power and Ground System Circuitry Voltage Check Chart

ESC connector (4009) – Battery Voltage Check – Check with the Ignition Key “Off” and (4009) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
(4009) harness pin, circuit J14B, to ground.	12 ± 1.5 volts	If voltage is incorrect, check for blown maxifuse A3, blown megafuse or open wiring.
ESC connector (4010) – Battery Voltage Check – Check with the Ignition Key “Off” and (4010) disconnected. **NOTE – Always check connectors for damage or pushed–out terminals.**		
Test Points	Spec.	Comments
(4010) harness cavity, circuit J14A, to ground.	12 ± 1.5 volts	If voltage is incorrect, check for blown maxifuse A4, missing voltage from starter solenoid to megafuse terminal, or open wiring.
ESC Power– Ignition Voltage Check (Check with the Ignition Key “On” and (1600) disconnected) **NOTE – ESC breakout box ZTSE-4477 should be used to make measurements at ESC connectors** **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Harness connector (1600) cavity 12 to ground.	12 ± 1.5 volts	If voltage is incorrect, check for blown fuse F15, missing voltage from ignition relay, missing voltage to relay from key switch or missing voltage from megafuse.
Harness connector (1600) cavity 12 to cavity 1.	12 ± 1.5 volts	If voltage is incorrect, check for open in ground circuit from (1600) to ground stud (1851).
ESC Power–Accessory Voltage Check (Check with the Ignition Key “On” and (1600) disconnected) **NOTE – ESC breakout box ZTSE-4477 should be used to make measurements at ESC connectors** **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Harness connector (1600) cavity 2 to ground.	12 ± 1.5 volts	If voltage is incorrect, check for blown fuse F19, missing voltage from accessory relay, missing voltage to relay from key switch or missing voltage from megafuse.
Harness connector (1600) cavity 2 to cavity 1.	12 ± 1.5 volts	If voltage is incorrect, check for open in ground circuit from (1600) to ground stud (1851).

1.4. ESC SWITCHED 5 VOLT SENSOR SUPPLY

The ESC provides a 5 volt sensor signal for several sensors on the vehicle. A DTC will be logged if the 5 volt signal is shorted to ground. A short in any sensor using the signal or on any circuit carrying the signal will cause all sensors to be inoperative.

1.5. ESC ZERO VOLT REFERENCE LEVEL

The ESC provides a zero volt reference level which is a clean ground for the system. If this signal is missing several features will be inoperative.

1.6. ESC DATA LINKS

The ESC communicates on 3 of the 4 data links on the vehicle. For details on vehicle data links refer to Multiplexing (Data Links).

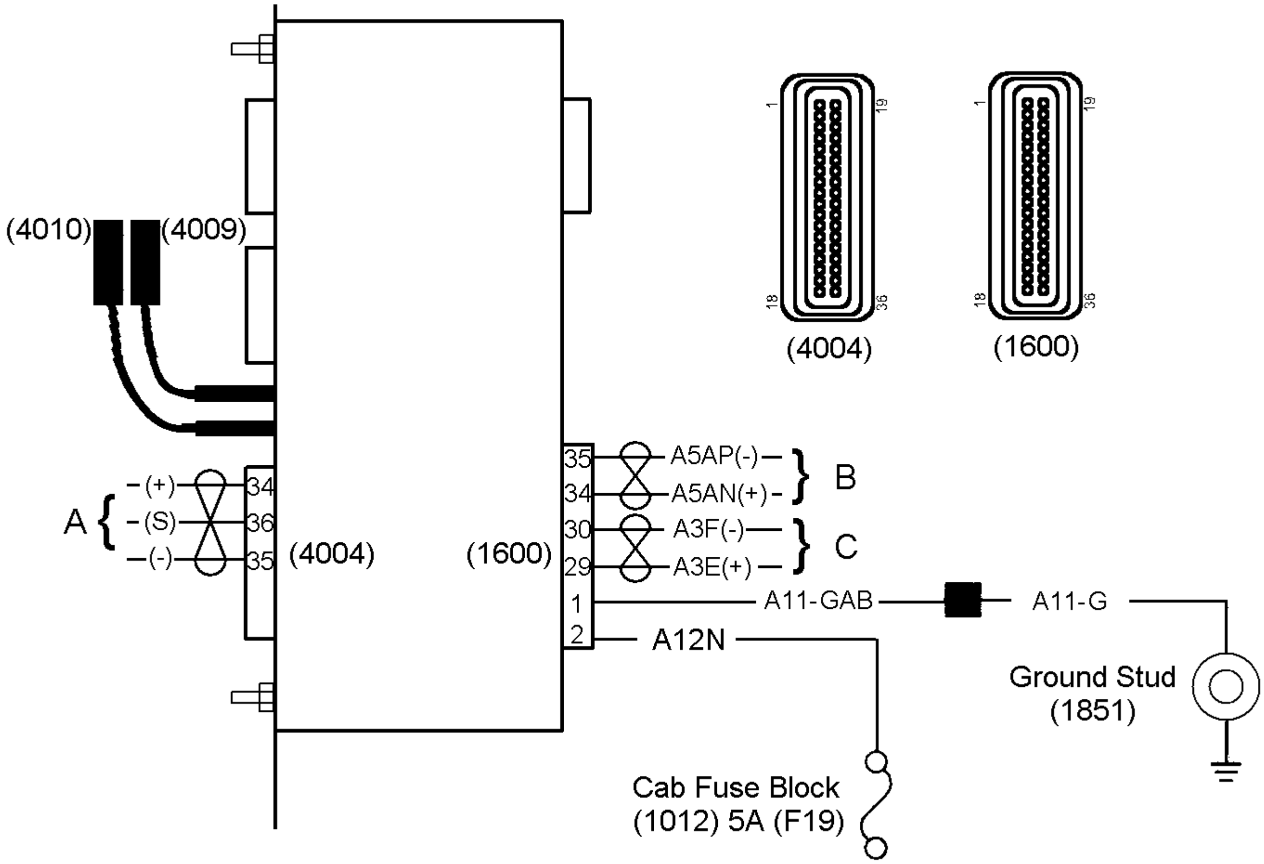


Figure 60 ESC Data Link Diagram

(1600) 36 WAY ESC CONNECTOR (INSIDE CAB)
F19 SYSTEM CONTROLLER IGNITION FUSE (CAB POWER DISTRIBUTION CENTER)
(1851) GROUND STUD (ABOVE ESC)
(4004) 36 WAY ESC CONNECTOR (INSIDE CAB)
A. TO BODY BUILDER 1939 DATA LINK
B. TO DRIVE TRAIN 1939 DATA LINK
C. TO SWITCH DATA LINK

Table 15 ESC Data Link Circuits

ESC Ignition Voltage Check — Check with the Ignition Key "On" and (1600) disconnected **NOTE – ESC breakout box ZTSE-4477 should be used to make measurements at ESC connectors** **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Harness connector (1600) cavity 2 to ground.	12 ± 1.5 volts	If voltage is incorrect, check for blown fuse F19, missing voltage from ignition relay, missing voltage to relay from key switch or missing voltage from megafuse.
Harness connector (1600) cavity 2 to cavity 1.	12 ± 1.5 volts	If voltage is incorrect, check for open in ground circuit from (1600) to ground stud (1851).
ESC Switch Data Link Voltage Check — Check with the Ignition Key "On" and (1600) disconnected **NOTE – ESC breakout box ZTSE-4477 should be used to make measurements at ESC connectors** **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Harness connector (1600) cavity 29 to 1.	Approximately 3 volts	If voltage is incorrect, check for open or short in (+) data link circuits or modules.
Harness connector (1600) cavity 30 to 1.	Approximately .2 volt	If voltage is incorrect, check for open or short in (-) data link circuits or modules.
ESC Drivetrain 1939 Data Link Resistance Check — Check with battery disconnected **NOTE – ESC breakout box ZTSE-4477 should be used to make measurements at ESC connectors** **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Harness connector (1600) cavity 34 to cavity 35.	Approximately 60 ohms	If resistance is incorrect, check for missing or open terminating resistors in data link, open or shorts in data link, and open or shorted modules.

1.7. ESC CONNECTOR PIN-OUTS

NOTE – Pin 3 of the cab 36-way connector and pin 26 of the chassis 36-way connector are 0 volt reference for various sensors on the vehicle and should NEVER have battery voltage applied to them. Doing so will permanently damage the ESC. Do not connect other ground signals to the zero volt reference.

Table 16 Electronic System Controller Module 8–way Connectors

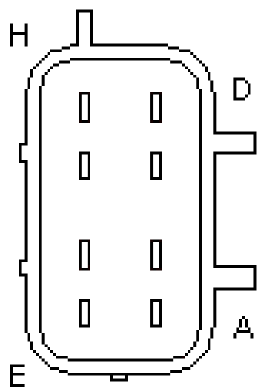
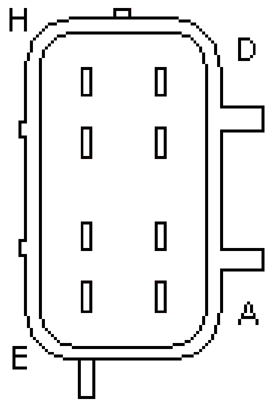
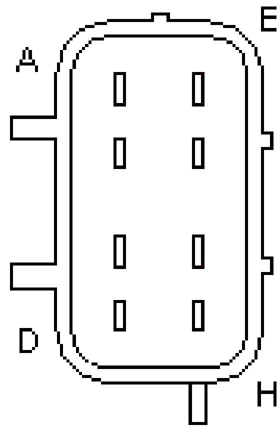
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK (*).								
								
Connector on ESC			Connector on ESC			Connector on ESC		
(4007) Brown Front End Output		Engine Side Bottom 8-way Connector	(4008) Blue Chassis Output		Engine Side Top 8-way Connector	(1601) Brown Inside Cab Output		Inside Cab 8-way Connector
Pin	Source	Description (Circuit)	Pin	Source	Description (Circuit)	Pin	Source	Description (Circuit)
A	20 Amp FET	Fog Lights/ Spare 1 (J64A)	A	10 Amp FET	Solenoid Power (J59E)	A	1 Amp Relay Dr.	Spare
B	10 Amp FET	Right Front Turn Signal (J57AA)	B	10 Amp FET	Right Rear Turn Signal (J57J)	B	Ground	Ground (A11–GAH)
C	10 Amp FET	Left Front Turn Signal (J56AA)	C	10 Amp FET	Left Rear Turn Signal (J56J)	C	10 Amp FET	Dome Lights (A63E)
Dealer	20 Amp FET	Low Beams (J53A)	Dealer	10 Amp FET	Wiper Park Input (J82E)	Dealer	20 Amp FET	Spare
E	10 Amp FET	Horn, Electric (J85AA)	E	10 Amp FET	Spare	E	1 Amp Relay Dr.	Spare

Table 16 Electronic System Controller Module 8–way Connectors (cont.)

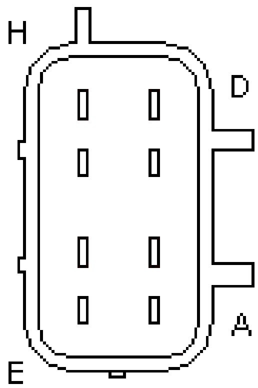
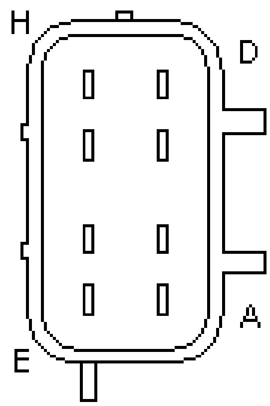
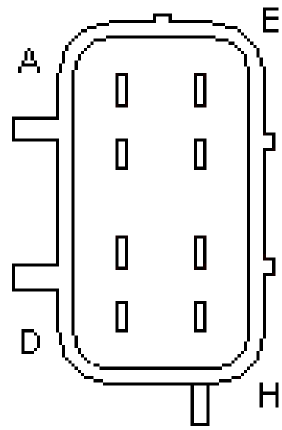
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK (*).								
								
Connector on ESC			Connector on ESC			Connector on ESC		
(4007) Brown Front End Output		Engine Side Bottom 8-way Connector	(4008) Blue Chassis Output		Engine Side Top 8-way Connector	(1601) Brown Inside Cab Output		Inside Cab 8-way Connector
Pin	Source	Description (Circuit)	Pin	Source	Description (Circuit)	Pin	Source	Description (Circuit)
Fleet	10 Amp FET	Work Light (J65)	Fleet	20 Amp FET	Wiper Control (J82F)	Fleet	10 Amp FET	Spare
G	20 Amp FET	High Beams (J52A)	G	10 Amp FET	AC Clutch (J77B)	G	20 Amp FET	Mirror Heat (A78)
H	20 Amp FET	Park Lights (J58A)	H	Ground	Ground Plug	H	20 Amp FET	Park Lights (A58F)

Table 17 **Electronic System Controller Module Power Connectors**

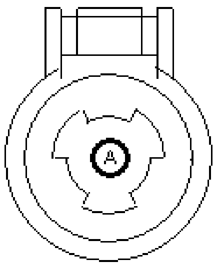
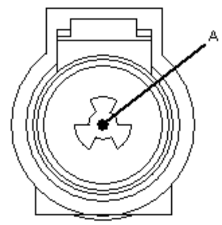
					
View in Direction of ESC			View in Direction of ESC		
#4009 Engine Side Input Power Feed #2 (Circuit J14B)			#4010 Engine Side Input Power Feed #1 (Circuit J14A)		
Pin	Source	Description	Pin	Source	Description
A	Maxi Fuse Block	60 Amp Power Source	A	Maxi Fuse Block	60 Amp Power Source

Table 18 **ESC Module Connector (1600)**

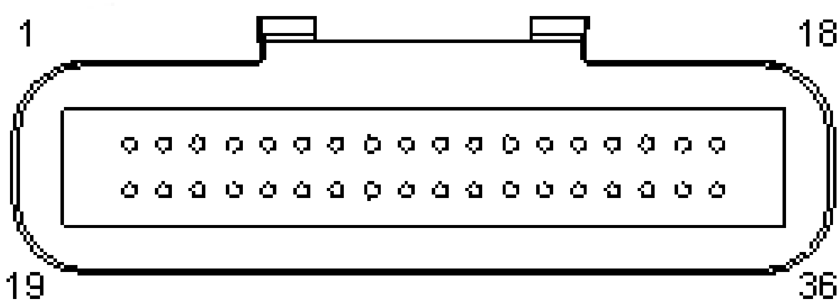
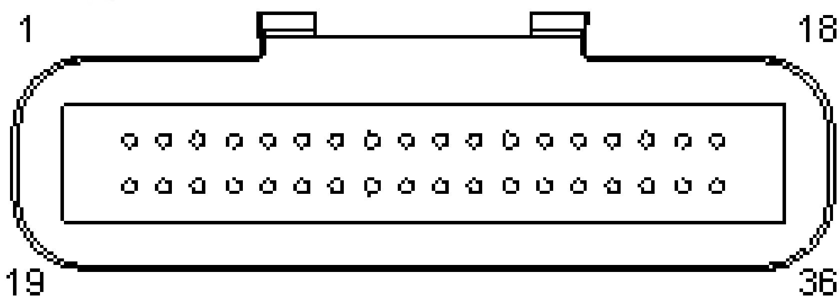
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK (*).					
					
(1600) In Cab 36-way Connector		Air Chassis Pin Description		Hydraulic Chassis Pin Description	
Pin	Type (Circuit)	Automatic Transmission	Manual Transmission	Automatic Transmission	Manual Transmission
1	Chassis Ground (A11–GAB)	Connect to Ground Stud	Connect to Ground Stud	Connect to Ground Stud	Connect to Ground Stud
2*	Input (12V active)* (A12N)	Accessory Input*	Accessory Input*	Accessory Input*	Accessory Input*

Table 18 ESC Module Connector (1600) (cont.)

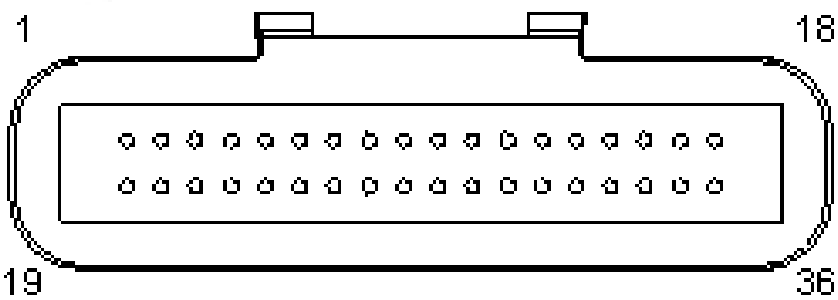
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK (*).



(1600) In Cab 36-way Connector		Air Chassis Pin Description		Hydraulic Chassis Pin Description	
Pin	Type (Circuit)	Automatic Transmission	Manual Transmission	Automatic Transmission	Manual Transmission
3*	Zero Volt Reference* (A9H)	Zero Volt Reference*	Zero Volt Reference*	Zero Volt Reference*	Zero Volt Reference*
4	Output (Ground Active) (128D)	Park Brake On	Park Brake On	Park Brake On	Park Brake On
5	Input (Ground Active) (A85C)	Spare	Spare	Spare	Spare
6	Output (Ground Active)	Spare	Spare	Spare	Spare
7*	Input (Ground Active)* (A77)	A/C Request*	A/C Request*	A/C Request*	A/C Request*
8*	Input (Ground Active)* (A75A)	HVAC Diagnostic 1*	HVAC Diagnostic 1*	HVAC Diagnostic 1*	HVAC Diagnostic 1*
9**	Input (Ground Active) (A90P)	Spare	Spare	Hydraulic Booster Control Monitor	Hydraulic Booster Control Monitor

Table 18 ESC Module Connector (1600) (cont.)

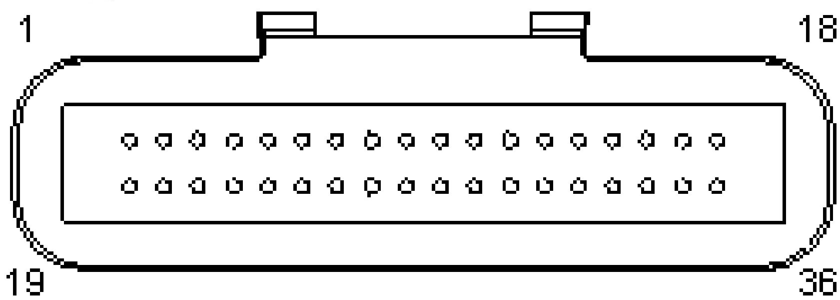
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK (*).



(1600) In Cab 36-way Connector		Air Chassis Pin Description		Hydraulic Chassis Pin Description	
Pin	Type (Circuit)	Automatic Transmission	Manual Transmission	Automatic Transmission	Manual Transmission
10*	Input (Ground Active)* (A96)	Cruise Control Switches*	Cruise Control Switches*	Cruise Control Switches*	Cruise Control Switches*
11	Output (Ground Active)	Spare	Spare	Spare	Spare
12*	Input (12V Active)* (A13AF)	Ignition Input*	Ignition Input*	Ignition Input*	Ignition Input*
13*	Input (12V Active)* (A85B)	Horn Switch*	Horn Switch*	Horn Switch*	Horn Switch*
14*	Input (12V Active)* (A50)	Head Light Enable*	Head Light Enable*	Head Light Enable*	Head Light Enable*
15*	Input* (A40)	Primary Air Sensor*	Primary Air Sensor*	Auxiliary Air Pressure*	Auxiliary Air Pressure*
16#	Input (A40A)	Secondary Air Sensor#	Secondary Air Sensor#	Spare	Spare
17	Input (Ground Active) (A96A)	Spare	Clutch Switch Input	Spare	Clutch Switch Input

Table 18 ESC Module Connector (1600) (cont.)

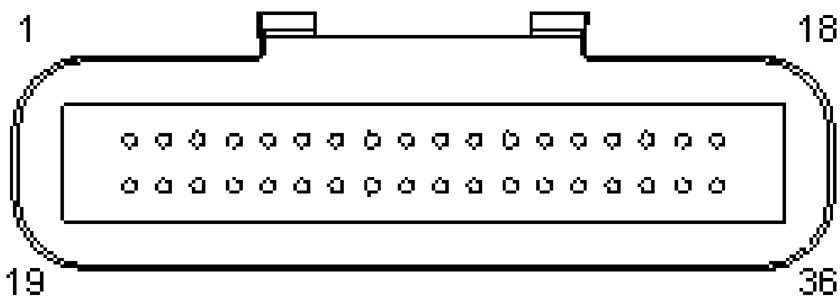
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK (*).



(1600) In Cab 36-way Connector		Air Chassis Pin Description		Hydraulic Chassis Pin Description	
Pin	Type (Circuit)	Automatic Transmission	Manual Transmission	Automatic Transmission	Manual Transmission
18*	Input (Ground Active)* (A57A)	Right Turn*	Right Turn*	Right Turn*	Right Turn*
19*	Input (Ground Active)* (A56A)	Left Turn*	Left Turn*	Left Turn*	Left Turn*
20*	Input (Ground Active)* (A52A)	High Beam Switch Input*	High Beam Switch Input*	High Beam Switch Input*	High Beam Switch Input*
21*	Input (Ground Active)* (A102A)	Flash to Pass*	Flash to Pass*	Flash to Pass*	Flash to Pass*
22*	Input (Ground Active)* (A82)	Wiper_0*	Wiper_0*	Wiper_0*	Wiper_0*
23*	Input (Ground Active)* (A82A)	Wiper_1*	Wiper_1*	Wiper_1*	Wiper_1*
24*	Input (Ground Active)* (A82B)	Wiper_2*	Wiper_2*	Wiper_2*	Wiper_2*

Table 18 ESC Module Connector (1600) (cont.)

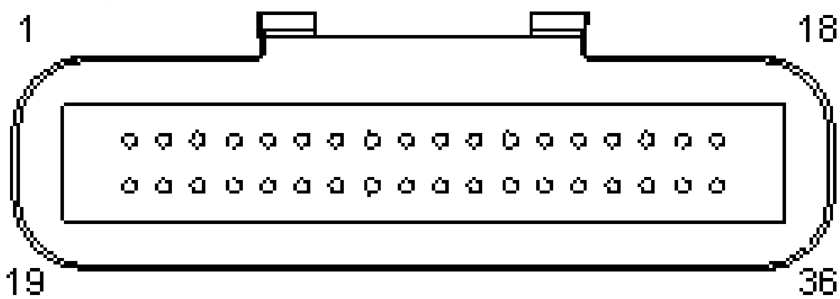
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK (*).



(1600) In Cab 36-way Connector		Air Chassis Pin Description		Hydraulic Chassis Pin Description	
Pin	Type (Circuit)	Automatic Transmission	Manual Transmission	Automatic Transmission	Manual Transmission
25*	Input (Ground Active)* (A63A)	Dome Light Switch Input*	Dome Light Switch Input*	Dome Light Switch Input*	Dome Light Switch Input*
26	Input (Ground Active)	Spare	Spare	Spare	Spare
27*	Output (5 v, 100 milliamp)* (A6H)	Sensor 5 Vdc Out*	Sensor 5 Vdc Out*	Sensor 5 Vdc Out*	Sensor 5 Vdc Out*
28*	Input (Ground Active)* (A87A)	Washer Pump*	Washer Pump*	Washer Pump*	Washer Pump*
29*	Switch Data Link +* (A3E(+))	J1708+ (Switches Only)*	J1708+ (Switches Only)*	J1708+ (Switches Only)*	J1708+ (Switches Only)*
30*	Switch Data Link -* (A3F(-))	J1708- (Switches Only)*	J1708- (Switches Only)*	J1708- (Switches Only)*	J1708- (Switches Only)*
31	Input (Ground Active)	Spare	Spare	Spare	Spare
32*	Input (Ground Active)* (A44BB)	Park Brake Input*	Park Brake Input*	Park Brake Input*	Park Brake Input*

Table 18 ESC Module Connector (1600) (cont.)

NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK (*).



(1600) In Cab 36-way Connector		Air Chassis Pin Description		Hydraulic Chassis Pin Description	
Pin	Type (Circuit)	Automatic Transmission	Manual Transmission	Automatic Transmission	Manual Transmission
33*	Input (Ground Active)* (A70C)	No Connection Allowed*	No Connection Allowed*	Brake Switch Input*	Brake Switch Input*
34	Drive Train J1939+ (A5AN(+))	Power Train J1939+	Power Train J1939+	Power Train J1939+	Power Train J1939+
35	Drive Train J1939- (A5AP(-))	Power Train J1939-	Power Train J1939-	Power Train J1939-	Power Train J1939-
36	Drive Train J1939 Shield	Power Train J1939 Shield	Power Train J1939 Shield	Power Train J1939 Shield	Power Train J1939 Shield

*The circuit attached to this pin should NOT have additional connections or splices added.

** The circuit attached to this pin should NOT have additional connections or splices added on a hydraulic chassis.

#The circuit attached to this pin should NOT have additional connections or splices added on an air chassis.

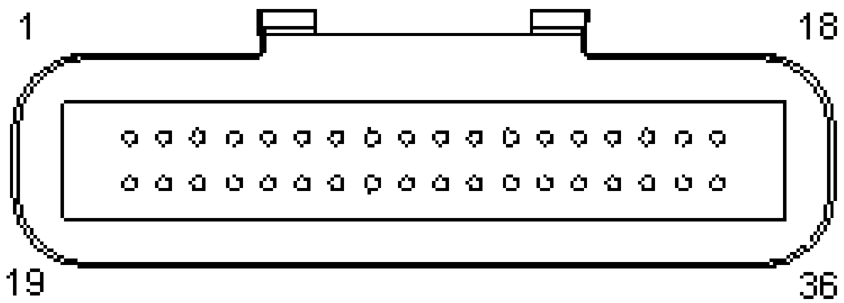
NOTE: All outputs will handle up to a 500 milliamp load unless stated otherwise.

NOTE: Circuits labeled “Ground Active,” “12V Active,” or “5V Active are open circuit until active.

NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS THAT HAVE AN ASTERISK(*).

Table 19 ESC Module Connector #4004

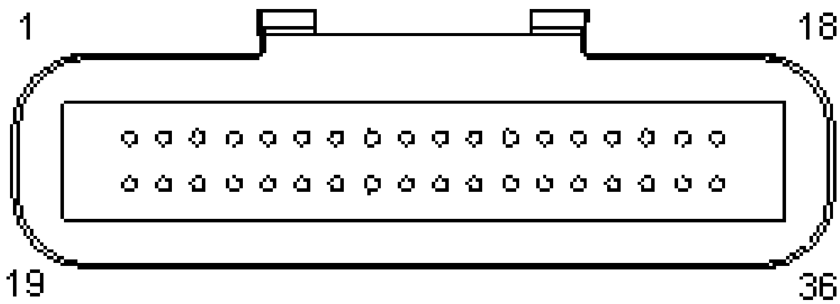
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK(*).



#4004 Chassis Harness Connector		Air Chassis Pin Description		Hydraulic Chassis Pin Description	
Pin	Type (Circuit)	Automatic Transmission	Manual Transmission	Automatic Transmission	Manual Transmission
1*	Input* (J32A)	RR Axle Oil Temperature*	RR Axle Oil Temperature*	RR Axle Oil Temperature*	RR Axle Oil Temperature*
2*	Input* (J32)	FR Axle Oil Temperature*	FR Axle Oil Temperature*	Hyd Brake Pump Monitor*	Hyd Brake Pump Monitor*
3*	Input* (J31)	Spare*	Transmission Oil Temp*	Spare*	Transmission Oil Temp*
4*	Input* (J36B)	Fuel Level Sensor #1*	Fuel Level Sensor #1*	Fuel Level Sensor #1*	Fuel Level Sensor #1*
5*	Input* (J36A)	Fuel Level Sensor #2*	Fuel Level Sensor #2*	Fuel Level Sensor #2*	Fuel Level Sensor #2*
6*	Input* (J77A)	HVAC Sensor 1*	HVAC Sensor 1*	HVAC Sensor 1*	HVAC Sensor 1*
7*	Input* (J77D)	HVAC Sensor 2*	HVAC Sensor 2*	HVAC Sensor 2*	HVAC Sensor 2*
8*	Input* (J77C)	HVAC High Side Xducer*	HVAC High Side Xducer*	HVAC High Side Xducer*	HVAC High Side Xducer*

Table 19 ESC Module Connector #4004 (cont.)

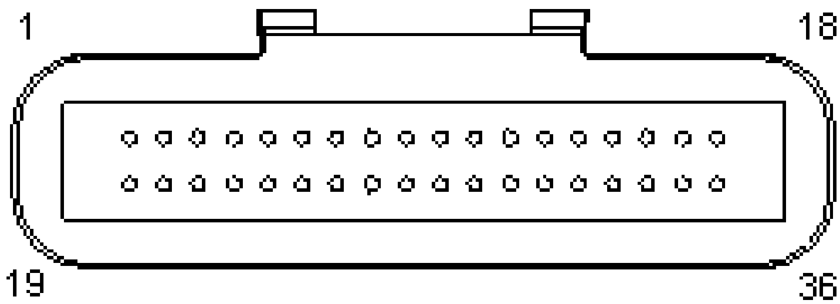
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK(*).



#4004 Chassis Harness Connector		Air Chassis Pin Description		Hydraulic Chassis Pin Description	
Pin	Type (Circuit)	Automatic Transmission	Manual Transmission	Automatic Transmission	Manual Transmission
9	Input (Ground Active) (J44A)	Spare	Spare	Powered Parking Brake Float Switch	Powered Parking Brake Float Switch
10	Input (Ground Active) (J44B)	Spare	Spare	Powered Parking Brake Pump Monitor	Powered Parking Brake Pump Monitor
11*	Input (12V Active)* (J19D)	Water In Fuel Warn Light*	Water In Fuel Warn Light*	Water In Fuel Warn Light*	Water In Fuel Warn Light*
12*	Input (Ground Active)* (J87C)	Low Washer Fluid W/L*	Low Washer Fluid W/L*	Low Washer Fluid W/L*	Low Washer Fluid W/L*
13*	Input (12V Active)* (J94HH)	Brake Application Air*	Brake Application Air*	ABS Drive Axle Event*	ABS Drive Axle Event*
14*	Input (Ground Active)* (J19B)	Fuel Filter Plugged W/L*	Fuel Filter Plugged W/L*	Fuel Filter Plugged W/L*	Fuel Filter Plugged W/L*
15*	Input (12V Active)* (J17B)	Neutral Switch*	Neutral Switch*	Neutral Switch*	Neutral Switch*

Table 19 ESC Module Connector #4004 (cont.)

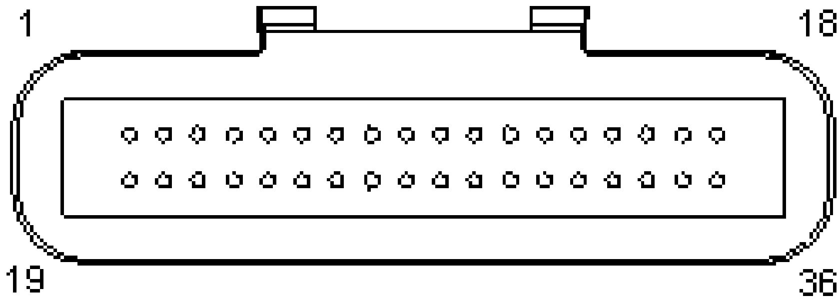
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK(*).



#4004 Chassis Harness Connector		Air Chassis Pin Description		Hydraulic Chassis Pin Description	
Pin	Type (Circuit)	Automatic Transmission	Manual Transmission	Automatic Transmission	Manual Transmission
16*	Input (Ground Active)* (plug)	Check Trans*	Spare*	Check Trans*	Spare*
17	Output (Ground Active) (J58B)	Trailer Marker Relay	Trailer Marker Relay	Trailer Marker Relay	Trailer Marker Relay
18	Input (Ground Active) (J44C)	Spare	2 Spd Axle Switch	Spare	2 Spd Axle Switch
19	Output (Ground Active) (J92DL)	Suspension Inflate Coil	Suspension Inflate Coil	Suspension Inflate Coil	Suspension Inflate Coil
20#	Output (Ground Active) ()	High speed Wiper	High speed Wiper	High speed Wiper	High speed Wiper
21	Output (Ground Active) (J70C)	Separate Stop Relay	Separate Stop Relay	Separate Stop Relay	Separate Stop Relay
22	Output (Ground Active) (J59C)	4 Pack Solenoid Chan 1	4 Pack Solenoid Chan 1	4 Pack Solenoid Chan 1	4 Pack Solenoid Chan 1

Table 19 ESC Module Connector #4004 (cont.)

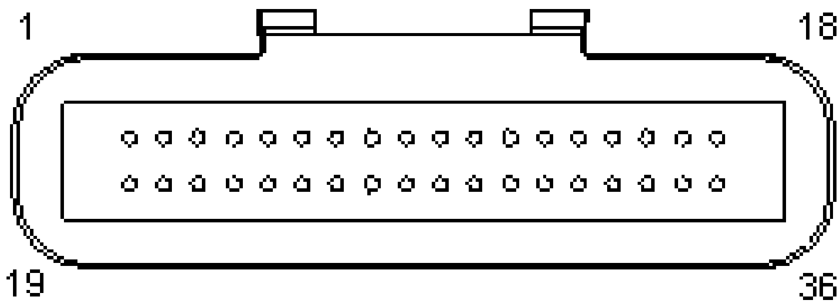
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK(*).



#4004 Chassis Harness Connector		Air Chassis Pin Description		Hydraulic Chassis Pin Description	
Pin	Type (Circuit)	Automatic Transmission	Manual Transmission	Automatic Transmission	Manual Transmission
23	Output (Ground Active) (J94HP)	Spare	Spare	ABS Warning Lamp/ Test*	ABS Warning Lamp/ Test*
24	Output (Ground Active) (J59B)	4 Pack Solenoid Chan 2	4 Pack Solenoid Chan 2	4 Pack Solenoid Chan 2	4 Pack Solenoid Chan 2
25	Output (Ground Active) (J44D)	Spare	Spare	Hyd. Pow Park Brk Monitor	Hyd. Pow Park Brk Monitor
26*	Zero Volt Ref* (J9A)	Zero Volt Reference*	Zero Volt Reference*	Zero Volt Reference*	Zero Volt Reference*
27*	Output (5 volt, 100 milliamp)* (J6A)	Sensor 5 Vdc Out*	Sensor 5 Vdc Out*	Sensor 5 Vdc Out*	Sensor 5 Vdc Out*
28	Output (1 Amp) (12V Active) (J9OJ)	Not Used	Not Used	Not Used	Not Used
29	Output (Ground Active) ()	Low Speed Wiper	Low Speed Wiper	Low Speed Wiper	Low Speed Wiper

Table 19 ESC Module Connector #4004 (cont.)

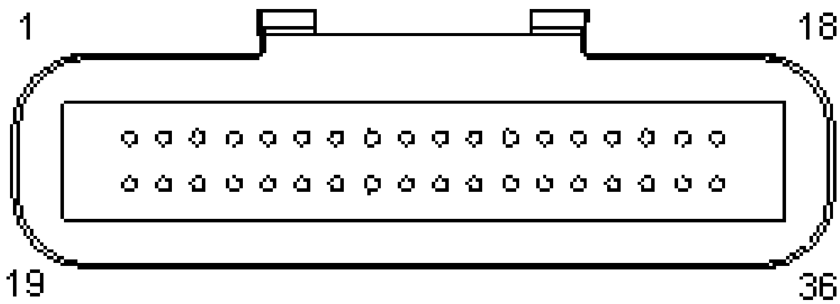
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK(*).



#4004 Chassis Harness Connector		Air Chassis Pin Description		Hydraulic Chassis Pin Description	
Pin	Type (Circuit)	Automatic Transmission	Manual Transmission	Automatic Transmission	Manual Transmission
30	Output (Ground Active) (J59D)	4 Pack Solenoid Chan 3	4 Pack Solenoid Chan 3	4 Pack Solenoid Chan 3	4 Pack Solenoid Chan 3
31	Output (Ground Active) (J59A)	4 Pack Solenoid Chan 4	4 Pack Solenoid Chan 4	4 Pack Solenoid Chan 4	4 Pack Solenoid Chan 4
32	Output (1 Amp) (12V Active) (J44A)	Suspension Dump Coil	Suspension Dump Coil	Suspension Dump Coil	Suspension Dump Coil
33	Input (Ground Active) (plug)	Spare	Spare	Spare	Spare
34	Body Data Link + (J5M(+))	Body Link J1939+	Body Link J1939+	Body Link J1939+	Body Link J1939+
35	Body Data Link - (J5M(-))	Body Link J1939-	Body Link J1939-	Body Link J1939-	Body Link J1939-

Table 19 ESC Module Connector #4004 (cont.)

NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK(*).



#4004 Chassis Harness Connector		Air Chassis Pin Description		Hydraulic Chassis Pin Description	
Pin	Type (Circuit)	Automatic Transmission	Manual Transmission	Automatic Transmission	Manual Transmission
36	Body Data Link Shield (J5M(S))	Body Link J1939 Shield	Body Link J1939 Shield	Bod Link J1939 Shield	Body Link J1939 Shield

*The circuit attached to this pin should NOT have additional connections or splices added.

NOTE: All outputs will handle up to a 500 milliamp load unless stated otherwise.

NOTE: Circuits labeled “Ground Active,” “12V Active,” or “5V Active” are open circuit until active.

1.8. ADDING TERMINALS

8-Way Connectors

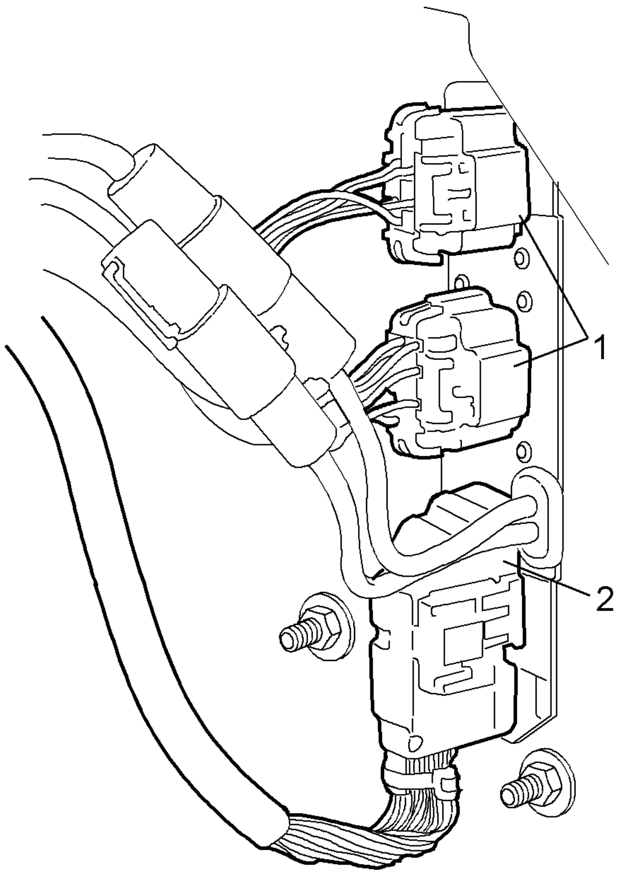


Figure 61 ESC Connectors (Viewed From Engine Compartment)

1. 8–Way Connectors
2. 36–Way Connector

To gain access to the terminals of the 8–way connectors remove the connector from the ESC. Remove the secondary terminal lock from the rear of the connector. Looking into the face of the connector, pry the primary lock away from the terminal being serviced while pulling the wire connected to the terminal out the backside of the connector.

When new terminals are being added the cavity plug must be removed before the new terminal is inserted.

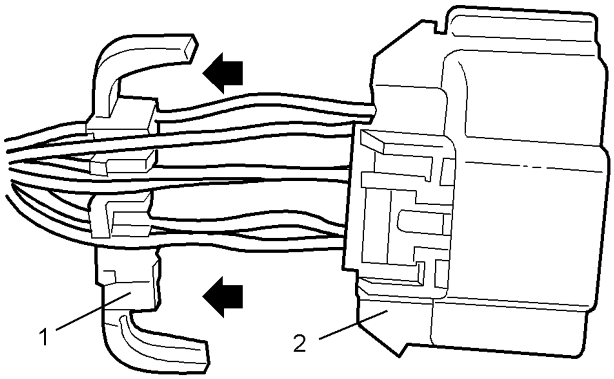


Figure 62 8-Way connector and Secondary Lock

1. SECONDARY LOCK
2. CONNECTOR SHELL

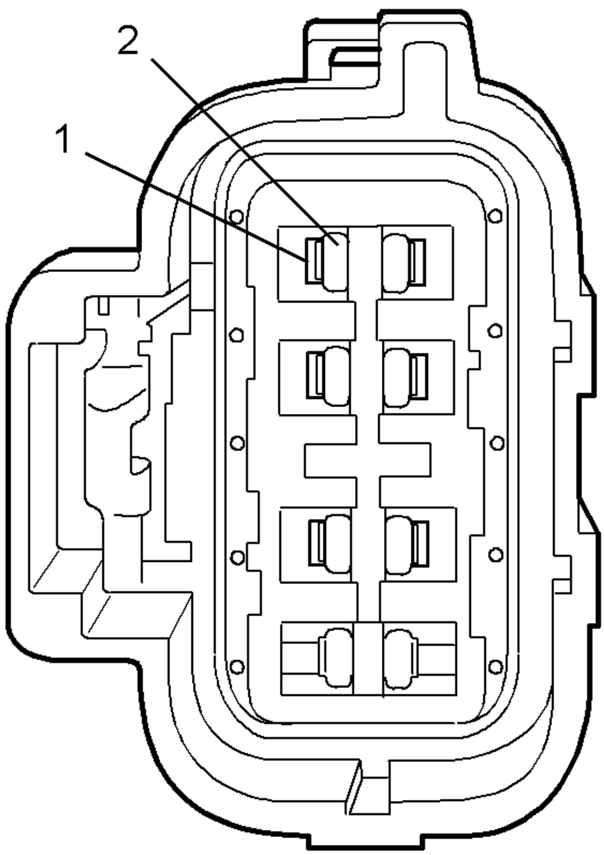


Figure 63 8–Way Connector Face

1. TERMINAL LOCK
2. TERMINAL

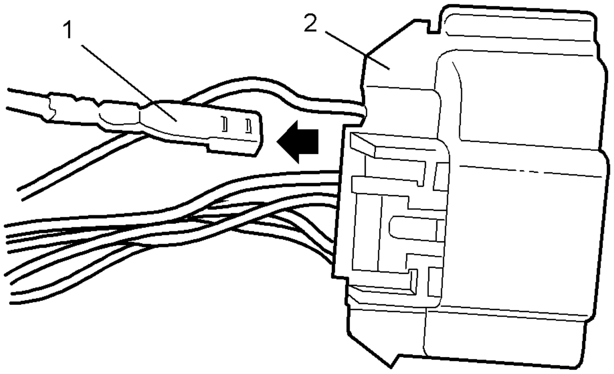


Figure 64 Terminal Removal

1. TERMINAL
2. CONNECTOR SHELL

36–Way Connectors

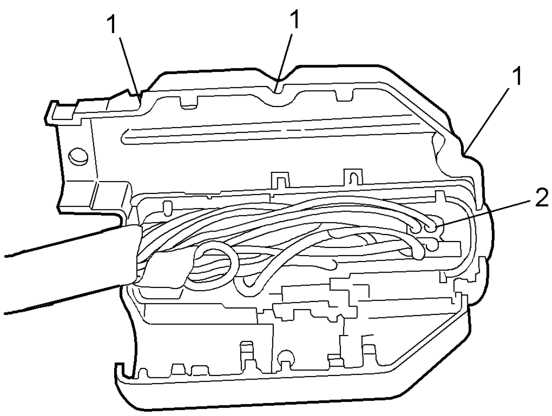


Figure 65 36–Way Connector (Shell Opened)

1. CONNECTOR TABS
2. TERMINAL CAVITY

To gain access to the terminals of the 36–way connectors remove the connector from the ESC. Snap the outer shell of the wiring cover by prying open the three tabs on the back side of the shell. Remove the secondary terminal lock from the front of the connector by pushing in the locking tabs on each end of the lock. Looking into the face of the connector, pry the primary lock away from the terminal being serviced while pulling the wire connected to the terminal out the backside of the connector.

When new terminals are being added the cavity plug must be removed before the new terminal is inserted.

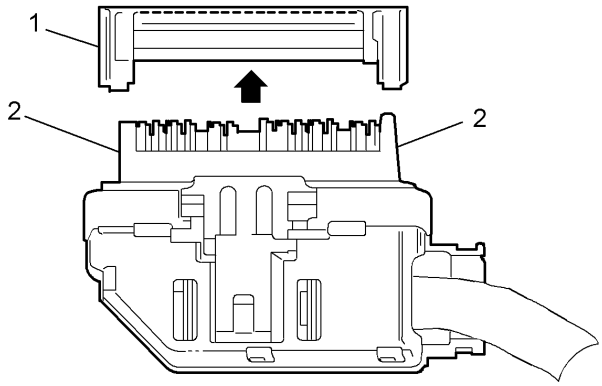


Figure 66 Secondary Lock

1. SECONDARY LOCK
2. LOCKING TABS

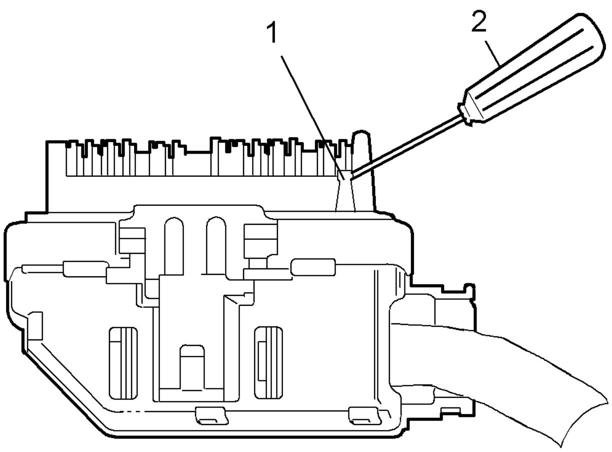


Figure 67 Primary Terminal Lock

1. TERMINAL LOCK
2. THIN TOOL

1.9. PROGRAMMING

When switches or switch packs are added or removed, gauge configurations are changed, features are added, programmable parameters are changed or the ESC is replaced, the ESC must be reprogrammed with an EZ-Tech running the" ICAP" software. The ICAP software can download the current configuration from the truck or from International. When programming changes are completed the software will update the ESC with the new configuration. The new configuration will have to be uploaded to International. This is accomplished by dialing in and uploading the updated programming. A copy of the programming is stored at International and updated each time there is a change. This is required in case there is a need to restore the programming during ESC replacement.

ESC Programmable Features and Parameters

The following parameters may be programmed in the ESC when the applicable feature is enabled. The ICAP software must be used to program the system. Some parameters can only be changed by dealers while others may be changed by body builders (TEMs) or Fleets.

Table 20 ESC Programmable Parameters

Signal Name	Access Rights	Description
Ammeter_Alrm_Ty_Param	Dealer, TEM	Gauge Alarm Type
Ammeter_Filter_Param	Dealer	Gauge update rate
Ammeter_Max_WL_Param	Dealer, TEM	Maximum set point for in-gauge warning light
Ammeter_Min_WL_Param	Dealer, TEM	Minimum set point for in-gauge warning light
AutoLock_Speed	Dealer, TEM, Fleet	The speed at which the vehicle doors will lock automatically (requires power locks)
Battery_Voltage_Alrm_Ty_ Param	Dealer, TEM	Gauge Alarm Type
Battery_Voltage_Filter_Param	Dealer	Gauge update rate
Battery_Voltage_Max_WL_ Param	Dealer, TEM	Maximum set point for in-gauge warning light
Battery_Voltage_Min_WL_ Param	Dealer, TEM	Minimum set point for in-gauge warning light
Brake_App_Alrm_Ty_Param	Dealer, TEM	Gauge Alarm Type
Brake_App_Filter_Param	Dealer	Gauge update rate
Brake_App_Max_WL_Param	Dealer, TEM	Maximum set point for in-gauge warning light
Brake_App_Min_WL_Param	Dealer	Minimum set point for in-gauge warning light
Chirp_Enable	Dealer, TEM	Enables the Chirp when you hit the Keyless Remote Lock
Cruise_Active_Ind_Enabled	Fleet	Deactivate/activate cruise control warning light in the EGC. Cruise control operation not affected by this setting.
Diff_Lock_Engmt_Spd	Dealer, TEM, Fleet	This parameter defines the maximum speed at which a vehicle will allow the Differential Lock to engaged.
Dome_Light_Dim_Enable	Dealer, TEM, Fleet	Theatre dome light disable/enable.
Dome_Light_PWM_Percent_ Level	Dealer, TEM	The level at which the dome light should be set at while it is waiting to dim
Dome_Light_Wait_Time	Dealer, TEM, Fleet	This is the amount of time the dome light should wait before dimming.
DTRL_Enabled	Dealer	Activate/deactivate daytime running lights.
Eng_Oil_Press_Alrm_Ty_Param	Dealer, TEM	Gauge Alarm Type
Eng_Oil_Press_Filter_Param	Dealer	Gauge update rate
Eng_Oil_Press_Max_WL_Param	Dealer, TEM	Maximum set point for in-gauge warning light
Eng_Oil_Press_Min_WL_Param	Dealer, TEM	Minimum set point for in-gauge warning light

Table 20 ESC Programmable Parameters (cont.)

Eng_Oil_Temp_Alrm_Ty_Param	Dealer, TEM	Gauge Alarm Type
Eng_Oil_Temp_Filter_Param	Dealer	Gauge update rate
Eng_Oil_Temp_Max_WL_Param	Dealer, TEM	Maximum set point for in-gauge warning light
Eng_Oil_Temp_Min_WL_Param	Dealer, TEM	Minimum set point for in-gauge warning light
Eng_Speed_Alrm_Ty_Param	Dealer, TEM	Gauge Alarm Type
Eng_Speed_Filter_Param	Dealer	Gauge update rate
Eng_Speed_Max_WL_Param	Dealer, TEM	Maximum set point for in-gauge warning light
Eng_Speed_Min_WL_Param	Dealer, TEM	Minimum set point for in-gauge warning light
Eng_Watr_Temp_Alrm_Ty_ Param	Dealer, TEM	Gauge Alarm Type
Eng_Watr_Temp_Filter_Param	Dealer	Gauge update rate
Eng_Watr_Temp_Max_WL_ Param	Dealer, TEM	Maximum set point for in-gauge warning light
Eng_Watr_Temp_Min_WL_ Param	Dealer, TEM	Minimum set point for in-gauge warning light
Fuel_Level_Alrm_Ty_Param	Dealer, TEM	Gauge Alarm Type
Fuel_Level_Filter_Param	Dealer	Gauge update rate
Fuel_Level_Max_WL_Param	Dealer, TEM	Maximum set point for in-gauge warning light
Fuel_Level_Min_WL_Param	Dealer, TEM	Minimum set point for in-gauge warning light
Fuel_Press_Alrm_Ty_Param	Dealer, TEM	Gauge Alarm Type
Fuel_Press_Filter_Param	Dealer	Gauge update rate
Fuel_Press_Max_WL_Param	Dealer, TEM	Maximum set point for in-gauge warning light
Fuel_Press_Min_WL_Param	Dealer, TEM	Minimum set point for in-gauge warning light
Fwd_RR_Axle_Temp_Alrm_ Ty_Param	Dealer, TEM	Gauge Alarm Type
Fwd_RR_Axle_Temp_ Filter_Param	Dealer	Gauge update rate
Fwd_RR_Axle_Temp_Max_ WL_Param	Dealer, TEM	Maximum set point for in-gauge warning light
Fwd_RR_Axle_Temp_Min_ WL_Param	Dealer, TEM	Minimum set point for in-gauge warning light
LOWW_Enabled	Dealer, TEM, Fleet	Deactivate/activate lights on with wipers
Max_Dump_Spd	Dealer, TEM	This parameter defines the maximum vehicle speed at which a vehicle will allow suspension dump to occur
Max_Low_Range_Spd	Dealer, TEM	This parameter defines the maximum vehicle speed at which a vehicle will allow the rear axle to shift to a lower ratio.
Mirror_Heat_Timeout_Enable	Dealer, TEM, Fleet	Enable Mirror Heat Intervals
Panic_Enable	Dealer, TEM, Fleet	Enables the Panic Mode for the Keyless Remote
PDL_Warning_Spd	Dealer, TEM	Sets the maximum vehicle speed at which the PDL warning light is illuminated.

Table 20 ESC Programmable Parameters (cont.)

PTO_Throttle_Light_Enable	Dealer, TEM	Enable/disable PTO/Throttle Warning Light in the EGC.
PwrMod1_Fuse_Level1_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 1 of RPM1 should be set to when the output is turned on.
PwrMod1_Fuse_Level2_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 2 of RPM1 should be set to when the output is turned on.
PwrMod1_Fuse_Level3_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 3 of RPM1 should be set to when the output is turned on.
PwrMod1_Fuse_Level4_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 4 of RPM1 should be set to when the output is turned on.
PwrMod1_Fuse_Level5_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 5 of RPM1 should be set to when the output is turned on.
PwrMod1_Fuse_Level6_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 6 of RPM1 should be set to when the output is turned on.
PwrMod1_Init_State1_ Param	Dealer, TEM	This parameter indicates if output 1 of RPM1 should be turned on or off initially when the vehicle is turned on.
PwrMod1_Init_State2_ Param	Dealer, TEM	This parameter indicates if output 2 of RPM1 should be turned on or off initially when the vehicle is turned on.
PwrMod1_Init_State3_ Param	Dealer, TEM	This parameter indicates if output 3 of RPM1 should be turned on or off initially when the vehicle is turned on.
PwrMod1_Init_State4_ Param	Dealer, TEM	This parameter indicates if output 4 of RPM1 should be turned on or off initially when the vehicle is turned on.
PwrMod1_Init_State5_ Param	Dealer, TEM	This parameter indicates if output 5 of RPM1 should be turned on or off initially when the vehicle is turned on.
PwrMod1_Init_State6_ Param	Dealer, TEM	This parameter indicates if output 6 of RPM1 should be turned on or off initially when the vehicle is turned on.
PwrMod2_Fuse_Level1_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 1 of RPM2 should be set to when the output is turned on.
PwrMod2_Fuse_Level2_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 2 of RPM2 should be set to when the output is turned on.

Table 20 ESC Programmable Parameters (cont.)

PwrMod2_Fuse_Level3_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 3 of RPM2 should be set to when the output is turned on.
PwrMod2_Fuse_Level4_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 4 of RPM2 should be set to when the output is turned on.
PwrMod2_Fuse_Level5_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 5 of RPM2 should be set to when the output is turned on.
PwrMod2_Fuse_Level6_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 6 of RPM2 should be set to when the output is turned on.
PwrMod2_Init_State1_ Param	Dealer, TEM	This parameter indicates if output 1 of RPM2 should be turned on or off initially when the vehicle is turned on.
PwrMod2_Init_State2_ Param	Dealer, TEM	This parameter indicates if output 2 of RPM2 should be turned on or off initially when the vehicle is turned on.
PwrMod2_Init_State3_ Param	Dealer, TEM	This parameter indicates if output 3 of RPM2 should be turned on or off initially when the vehicle is turned on.
PwrMod2_Init_State4_ Param	Dealer, TEM	This parameter indicates if output 4 of RPM2 should be turned on or off initially when the vehicle is turned on.
PwrMod2_Init_State5_ Param	Dealer, TEM	This parameter indicates if output 5 of RPM2 should be turned on or off initially when the vehicle is turned on.
PwrMod2_Init_State6_ Param	Dealer, TEM	This parameter indicates if output 6 of RPM2 should be turned on or off initially when the vehicle is turned on.
PwrMod4_Fuse_Level1_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 1 of RPM4 should be set to when the output is turned on.
PwrMod4_Fuse_Level2_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 2 of RPM4 should be set to when the output is turned on.
PwrMod4_Fuse_Level3_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 3 of RPM4 should be set to when the output is turned on.
PwrMod4_Fuse_Level4_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 4 of RPM4 should be set to when the output is turned on.
PwrMod4_Fuse_Level5_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 5 of RPM4 should be set to when the output is turned on.

Table 20 ESC Programmable Parameters (cont.)

PwrMod4_Fuse_Level6_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 6 of RPM4 should be set to when the output is turned on.
PwrMod4_Init_State1_ Param	Dealer, TEM	This parameter indicates if output 1 of RPM4 should be turned on or off initially when the vehicle is turned on.
PwrMod4_Init_State2_ Param	Dealer, TEM	This parameter indicates if output 2 of RPM4 should be turned on or off initially when the vehicle is turned on.
PwrMod4_Init_State3_ Param	Dealer, TEM	This parameter indicates if output 3 of RPM4 should be turned on or off initially when the vehicle is turned on.
PwrMod4_Init_State4_ Param	Dealer, TEM	This parameter indicates if output 4 of RPM4 should be turned on or off initially when the vehicle is turned on.
PwrMod4_Init_State5_ Param	Dealer, TEM	This parameter indicates if output 5 of RPM4 should be turned on or off initially when the vehicle is turned on.
PwrMod4_Init_State6_ Param	Dealer, TEM	This parameter indicates if output 6 of RPM4 should be turned on or off initially when the vehicle is turned on.
PwrMod7_Fuse_Level1_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 1 of RPM7 should be set to when the output is turned on.
PwrMod7_Fuse_Level2_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 1 of RPM7 should be set to when the output is turned on.
PwrMod7_Fuse_Level3_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 1 of RPM7 should be set to when the output is turned on.
PwrMod7_Fuse_Level4_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 1 of RPM7 should be set to when the output is turned on.
PwrMod7_Fuse_Level5_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 1 of RPM7 should be set to when the output is turned on.
PwrMod7_Fuse_Level6_ Param	Dealer, TEM	This parameter indicates what the current shut-off threshold of output 1 of RPM7 should be set to when the output is turned on.
PwrMod7_Init_State1_ Param	Dealer, TEM	This parameter indicates if output 1 of RPM7 should be turned on or off initially when the vehicle is turned on.
PwrMod7_Init_State2_ Param	Dealer, TEM	This parameter indicates if output 1 of RPM7 should be turned on or off initially when the vehicle is turned on.

Table 20 ESC Programmable Parameters (cont.)

PwrMod7_Init_State3_ Param	Dealer, TEM	This parameter indicates if output 1 of RPM7 should be turned on or off initially when the vehicle is turned on.
PwrMod7_Init_State4_ Param	Dealer, TEM	This parameter indicates if output 1 of RPM7 should be turned on or off initially when the vehicle is turned on.
PwrMod7_Init_State5_ Param	Dealer, TEM	This parameter indicates if output 1 of RPM7 should be turned on or off initially when the vehicle is turned on.
PwrMod7_Init_State6_ Param	Dealer, TEM	This parameter indicates if output 1 of RPM7 should be turned on or off initially when the vehicle is turned on.
Pyrometer_Alrm_Ty_Param	Dealer, TEM	Gauge Alarm Type
Pyrometer_Filter_Param	Dealer	Gauge update rate
Pyrometer_Max_WL_Param	Dealer, TEM	Maximum set point for in-gauge warning light
Pyrometer_Min_WL_Param	Dealer, TEM	Minimum set point for in-gauge warning light
Rear_RR_Axle_Temp_Alrm_ Ty_Param	Dealer, TEM	Gauge Alarm Type
Rear_RR_Axle_Temp_ Filter_Param	Dealer	Gauge update rate
Rear_RR_Axle_Temp_Max_ WL_Param	Dealer, TEM	Maximum set point for in-gauge warning light
Rear_RR_Axle_Temp_Min_ WL_Param	Dealer, TEM	Minimum set point for in-gauge warning light
Stop_Override_Hazard_ Enabled	Dealer, TEM, Fleet	Enable/disable stoplights override hazard lights.
Susp_Air_Press_Alrm_Ty_ Param	Dealer, TEM	Gauge Alarm Type
Susp_Air_Press_Filter_ Param	Dealer	Gauge update rate
Susp_Air_Press_Min_WL_ Param	Dealer, TEM	Minimum set point for in-gauge warning light
Trans_Oil_Temp_Alrm_Ty_ Param	Dealer, TEM	Gauge Alarm Type
Trans_Oil_Temp_Filter_ Param	Dealer	Gauge update rate
Trans_Oil_Temp_Max_WL_ Param	Dealer	Maximum set point for in-gauge warning light
Turbo_Boost_Press_Alrm_ Ty_ Param	Dealer, TEM	Gauge Alarm Type
Turbo_Boost_Press_Filter_ Param	Dealer	Gauge update rate
Turbo_Boost_Press_Max_ WL_ Param	Dealer, TEM	Maximum set point for in-gauge warning light
Turbo_Boost_Press_Min_ WL_ Param	Dealer, TEM	Minimum set point for in-gauge warning light
Work_Light_Timeout_Enable	Dealer, TEM, Fleet	Enables/disables Work Light timeout

Changing Gauge Configurations

NOTE – Refer to the ICAP software manual for instructions on the use of the programming software.

When a new gauge is added to the current configuration, the EZ-Tech® programming software must be used to determine if there is room to add the desired gauge. Some gauges will only fit in certain locations in the EGC.

If the gauge cannot be located in the EGC, the gauge may be able to fit in the optional auxiliary gauge switch pack (AGSP) module. Adding the AGSP module to the instrument panel can be expensive, especially if only one gauge is being added and the switches in the AGSP are not going to be used. The EZ-Tech programming software must be used to program the ESC and EGC or AGSP to recognize the new gauge.

After the appropriate gauge location has been identified in the EGC or AGSP, the sensor for the gauge and the required wiring must be installed.

The EZ-Tech programming software must be used to determine available circuit locations on the ESC connectors and to program the ESC to recognize the added circuits and sensor.

Installing the new circuits in the ESC connector is accomplished by removing the plug and inserting new connector pins in the appropriate slots of the connector.

Pins with pigtails already connected to them should be available to insert into the connector. The new circuits should be spliced to the pigtail.

NOTE – The 36-way ESC connectors are not very rugged. Take care when disassembling the connector, inserting new pins and reassembling the connector.

Programming Switch Configurations

NOTE – Refer to the EZ-Tech programming software manual for instructions on the use of the programming software.

When a new feature requiring a multiplexed switch is added to the vehicle, the EZ-Tech programming software must be used to determine where the switch should be installed. Hopefully, there will be a vacant position in one of the switch pack modules. If there are no vacant positions, it may be necessary to install an additional switch pack module. The EZ-Tech programming software must be used to program the ESC to recognize the new switch.

After the appropriate switch location has been identified, the wiring and other hardware for the feature must be installed.

The EZ-Tech running the “ICAP” programming software must be used to determine available circuit locations on the ESC connectors and to program the ESC to recognize the added circuits and the feature sensor.

Installing the new circuits in the ESC connector is accomplished by removing the plug from the cavity and inserting new connector pins in the appropriate slots of the connector.

Pins with pigtails already connected to them should be available to insert into the connector. The new circuits should be spliced to the pigtail.

NOTE – The 36-way ESC connectors are not very rugged. Take care when disassembling the connector, inserting new pins and reassembling the connector.

Programming Templates

Mark the following templates to keep track of new switch, gauge or pin requirements assigned by the “ICAP" software.

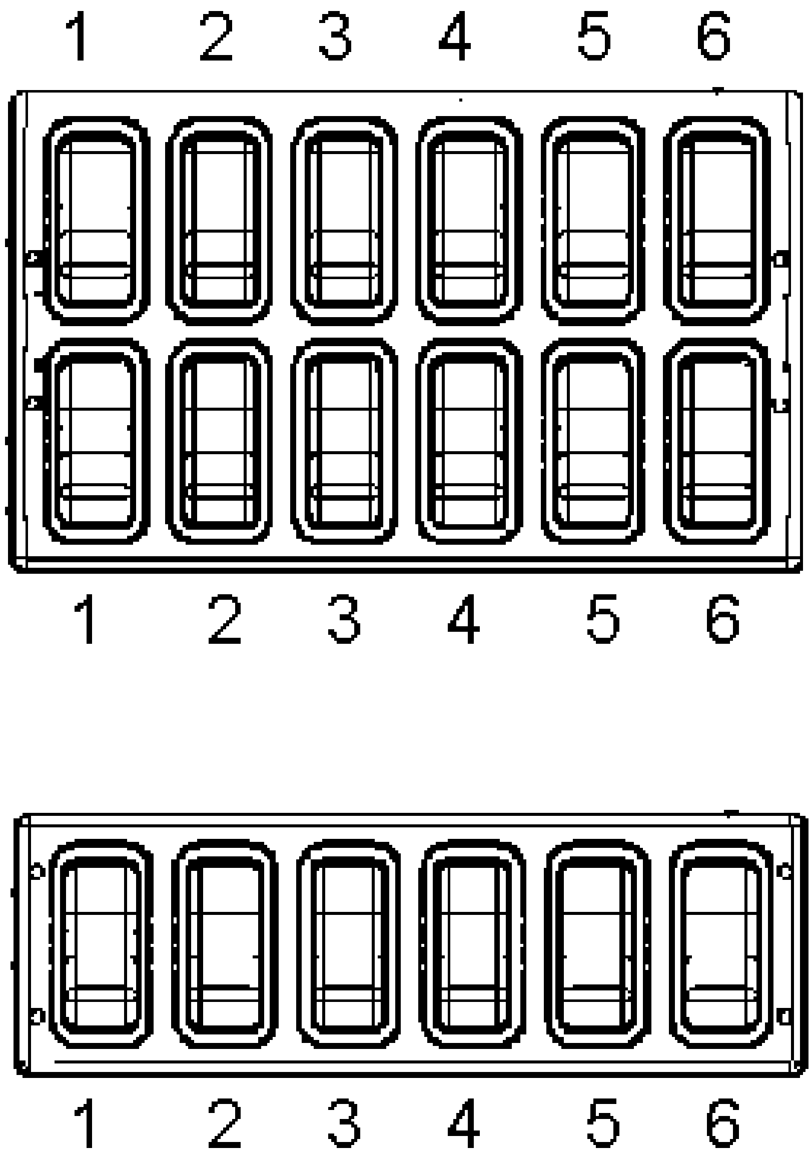


Figure 68 Switch Pack Templates

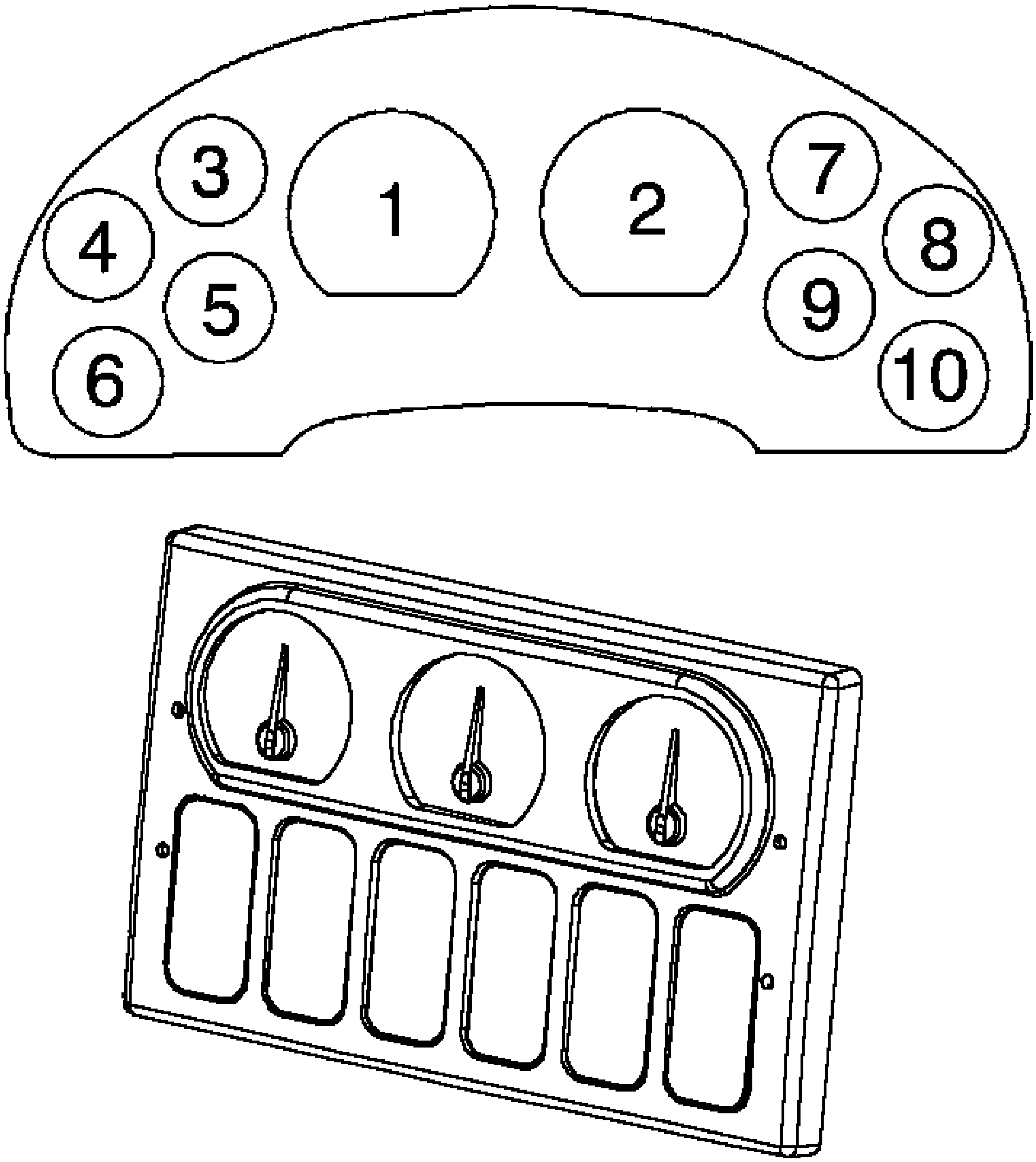


Figure 69 Gauge and AGSP Location Templates

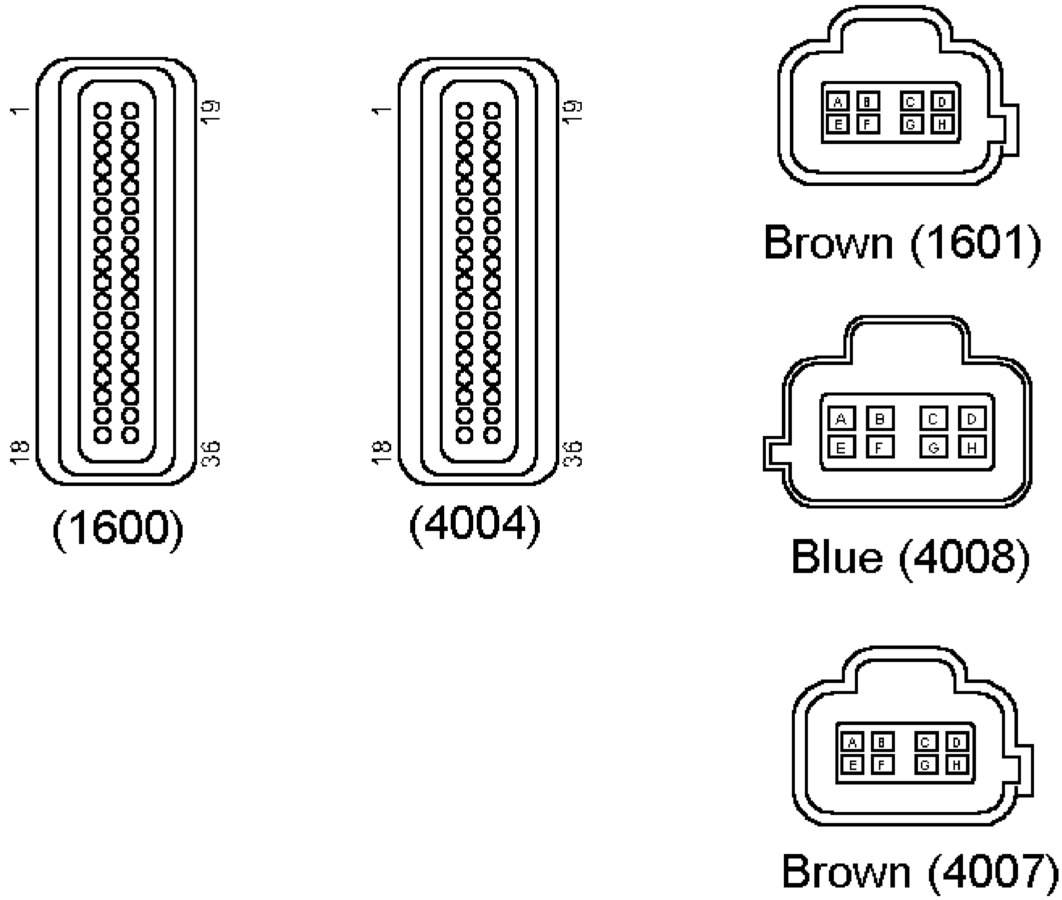


Figure 70 ESC Harness Connector Templates (Mating Views Shown)

(1600) 36–WAY CAB ESC CONNECTOR
(1601) 8–WAY, BROWN, CAB ESC CONNECTOR
(4004) 36–WAY ENGINE ESC CONNECTOR
(4007) 8–WAY, BROWN, ENGINE ESC CONNECTOR
(4008) 8–WAY, BLUE, ENGINE ESC CONNECTOR

1.10. ESC REPLACEMENT

NOTE – When an ESC malfunction is suspected, reloading the ESC programming is recommended prior to replacement. There is a chance the programming may have been corrupted. The "ICAP" software must be used to download the configuration file from International. Refer to the "ICAP" users manual. The "ICAP" software can then be used to reload the configuration file to the ESC. If the malfunction is present after reprogramming, replace the ESC. The "ICAP" software must be used to load the configuration file to the replacement ESC.

To remove the ESC:

1. Remove the kick panel at the side of the drivers left foot which covers the ESC inside the cab.

2. Remove all electrical connections to the ESC, both inside the cab and in the engine compartment.

3. Remove the four nuts in the engine compartment that secure the ESC to the dash panel.

4. Remove the ESC from the inside of the cab.

Install the new ESC by reversing these steps. The new ESC must be loaded with the configuration file from International. Refer to the “ICAP” programming software manual.

2. SWITCH PACK MODULES

2.1. FUNCTION

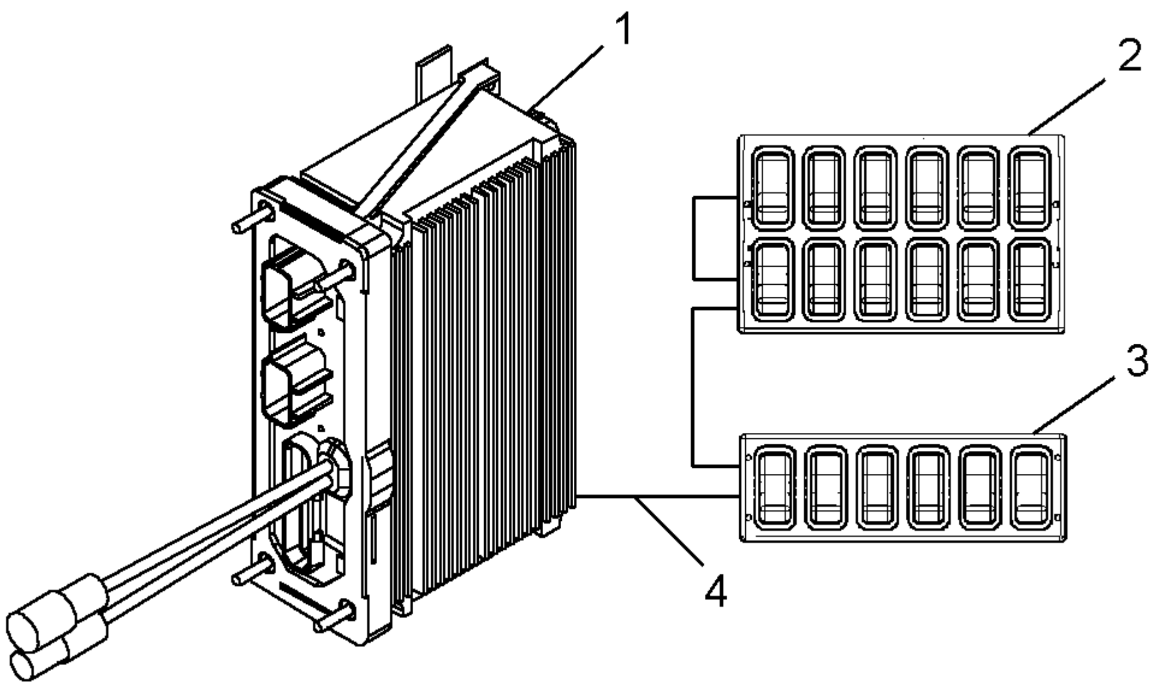


Figure 71 Switch Pack Function Diagram

1. ELECTRICAL SYSTEM CONTROLLER
2. 12 PACK SWITCH MODULE
3. 6 PACK SWITCH MODULE
4. SWITCH DATA LINK

The switch pack modules contain the electronics required to communicate with the ESC, on the switch data link, and the electronics for each switch receptacle.

Switch packs are available in 6 and 12 switch configurations. The 12 pack configuration uses 2 of the 6 pack circuit boards.

The mechanical assembly for each switch snaps into the switch receptacle and can be released from the rear of the switch pack. Different mechanical assemblies determine the actuation of the switch. Blank covers are used when a switch receptacle is not being used.

The function of each switch location is programmed in the ESC as well as the output from the ESC to the appropriate feature controlled by the switch.

The EZ-Tech running the "INTUNE" diagnostic software can be used to identify the programmed function of each switch and to override the switch input to the ESC. See the diagnostic software manual for details on using the software.

Amber LED’s are used for panel lighting of the switches. Green LED’s, as required, are used to indicate that the switch is on. Both types of LED’s are replaceable.

Switch packs are daisy chained together. The first switch pack connected to the instrument panel harness is identified as switch pack #1. The next switch pack (connected to first switch pack) will be identified as switch pack #2. A maximum of four switch packs could be installed on the vehicle.

Switches are identified by number from left to right.

When switches or switch packs are added or relocated, the ESC must be programmed before the changes will work. Refer to Programming Switch Locations. (See Programming Switch Configurations, page 120)

NOTE – If more than one switch pack is being used and the switch pack positions were swapped, the switch functionality may also swap or may not work at all. Be sure not to unintentionally swap positions when working on switches or switch packs.

NOTE – The optional auxiliary gauge and switch pack (AGSP) has three gauges and a row of 6 switches. The AGSP switches do not communicate on the switch data link. The AGSP connects at the end of the switch pack daisy chain for power and dimmer light circuits. The gauges and switches on the AGSP communicate with the ESC on the drivetrain 1939 data link.

2.2. DIAGNOSTICS

Refer to the Diagnostic Trouble Code section (See DIAGNOSTICS, page 1037) of this manual for DTC retrieval procedures and the complete list of diagnostic trouble codes.

The ESC continuously monitors the switch pack communication on the switch data link. If a switch pack fails to communicate with the ESC within the expected period of time, a fault will be logged.

In most cases, the switch pack will also notify the ESC if one of the individual switches has failed. Every switch location contains two microswitches. In addition, as part of normal operation, these two switches will never be closed simultaneously. For all switches, except switches using the center position, these two switches will never be open simultaneously.

Depending on the feature, some switches will flash when a switch is malfunctioning or there is an error associated with the feature controlled by the switch.

There are over 100 DTC’s which apply to possible failures in the switch packs. Refer to the Diagnostic Trouble Code section (See DIAGNOSTICS, page 1037) of this manual for the complete list of diagnostic trouble codes.

Problems with switch packs can be attributed to lack of power, missing ground, a faulty data link, poor connections, or circuit board problems.

Problems with individual switches can be attributed to faulty microswitches, broken mechanical switch assemblies or circuit board failures.

Table 21 Switch Pack(s) Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Are panel lights in switch pack switches operating correctly.	Operate panel lights through entire range.	Panel lights operate correctly	Go to next step.	Refer to Switch Packs. (See SWITCH PACKS, page 127)
2.	On	Verify switch problem. Identify switches that are not functioning correctly.	Attempt to operate all switches and observe reaction of indicator lamps.	Switch(es) are operating correctly.	Problem doesn't exist or is intermittent.	Go to next step.
3.	On	Check for diagnostic trouble codes. Refer to the Diagnostic Trouble Code section (See DIAGNOSTICS, page 1037) of this manual for DTC retrieval procedures and the complete list of diagnostic trouble codes.	Read display on odometer.	Switch pack diagnostic trouble codes are displayed.	Go to next step.	Refer to the section in this manual for the specific feature controlled by the inoperative switch.
4.	On	Are switch packs communicating on the switch data link?	Read display on odometer.	DTC identifies a switch pack is not commun-icating with the ESC.	Refer to Switch Packs.(See SWITCH PACKS, page 127)	Go to next step.
5.	On	Are there faults with individual switches?	Read display on odometer.	DTC identifies an individual switch fault in a switch pack.	Refer to Individual Switches. (See INDIVIDUAL SWITCHES, page 129)	Go to next step.
6.	On	Are any switch indicators flashing?	Look for flashing switch indicators.	**No** Indicator in any switch is flashing.	Go to next step.	Refer to the section in this manual for the specific feature controlled by the flashing switch.

2.3. SWITCH PACKS

Fault Detection Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

Refer to Switch Pack Circuits

The ESC continuously monitors the switch pack communication on the switch data link. If a switch pack fails to communicate with the ESC within the expected period of time, a fault will be logged.

Problems with switch packs can be attributed to lack of power, missing ground, a faulty data link, poor connections, or circuit board problems.

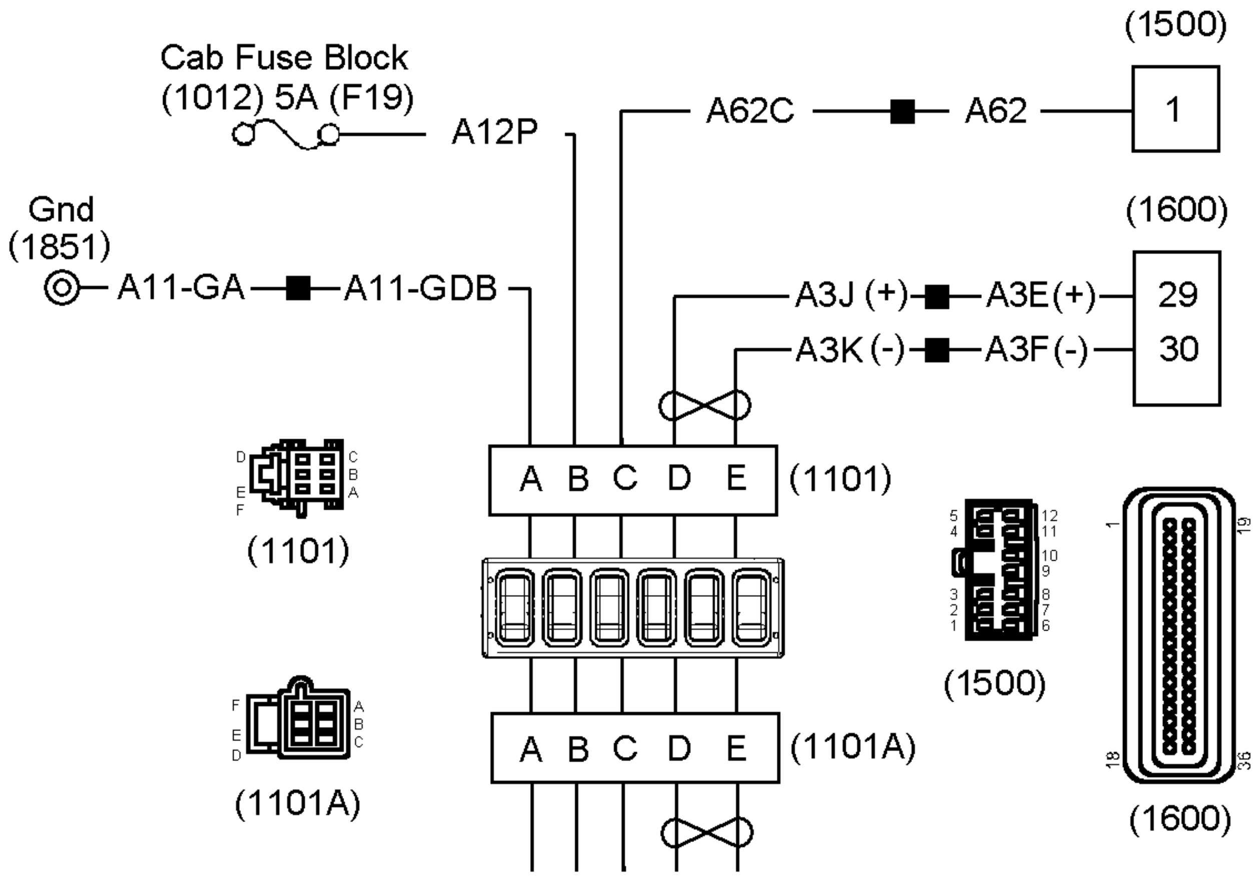


Figure 72 Switch Pack Circuits

(1101) SWITCH PACK CONNECTOR (TO INSTRUMENT PANEL HARNESS OR PREVIOUS SWITCH PACK)
LOCATED BEHIND SWITCH PACK
(1101A) SWITCH PACK CONNECTOR (TO NEXT SWITCH PACK)
LOCATED BEHIND SWITCH PACK
(1500) 12 WAY ELECTRONIC GAUGE CLUSTER CONNECTOR (VOLTAGE FOR PANEL LIGHTS)
LOCATED ON BACK OF ELECTRONIC GAUGE CLUSTER
(1600) 36 WAY ELECTRICAL SYSTEM CONTROLLER CONNECTOR (SWITCH DATA LINK)
LOCATED ON CAB SIDE OF ELECTRICAL SYSTEM CONTROLLER
(1851) GROUND STUD CONNECTOR
F19 SWITCH PACK FUSE (1012)
LOCATED IN CAB POWER DISTRIBUTION CENTER

Table 22 Switch Pack Connector Check Chart

Switch Pack Connector (1101) Voltage Checks This chart assumes there is power to cab fuse block (1012) from the mega fuse.		
Test Points	Spec.	Comments
(1101) Pin B to ground	12 ± 1.5 volts	If voltage is missing, check for blown fuse or open or short in circuits A12P.
(1101) Pin A to ground	0 volts	Ground circuit to pod.
(1101) Pin D to ground	Approximately 4.5 volts	(+) data link circuit. If voltage is low check for open or short in circuit A3J(+) or shorted components on data link.
(1101) Pin E to ground	Approximately .2 volt	(-) data link circuit. If voltage is low check for open in circuit A3K(-) or shorted components on data link. If voltage is high check for crossed data link wires.
If voltage and data link circuits to the pod are good, and a communication fault is still active, the switch pack should be replaced.		
(1101) Pin C to pin A	12 ± 1.5 volts (with park lights on and panel dimmer at maximum).	Panel dimmer voltage from electronic gauge cluster (EGC). If voltage is missing check circuits between switch pack and EGC.
Inoperative panel lights in individual switches should be replaced. If the panel light voltage to the switch pack is correct, but none of the panel lights operate, the switch pack should be replaced.		

Extended Description

Battery voltage to switch pack connector (1101) terminal B is provided from fuse block (1012), fuse F19 on circuit A12P.

System ground to switch pack connector (1101) terminal A is provided from negative stud (1850) on circuit A11–GA and A11–GDB.

The switch data link is connected to switch pack connector (1101) terminal D and E from ESC connector (1600) terminals 29 and 30 on twisted pair A3F(-)/A3E(+), to a splice and on A3K(-)/A3J(+).

Panel light voltage to switch pack connector (1101) terminal C is supplied from EGC connector (1500) on circuits A62 and A62C.

Additional switch packs are connected to the loose connector on the first switch pack.

2.4. INDIVIDUAL SWITCHES

In most cases, the switch pack will notify the ESC if one of the individual switches has failed.

Every switch location contains two microswitches. In addition, as part of normal operation, these two switches will never be closed simultaneously. For all switches, except switches using the center position, these two switches will never be open simultaneously.

Depending on the feature, some switches will flash when a switch is malfunctioning or there is an error associated with the feature controlled by the switch.

Problems with individual switches can be attributed to faulty microswitches, broken mechanical switch actuators or circuit board failures.

If inspection of the switch actuator determines it is broken, replace the switch actuator.

2.5. COMPONENT LOCATIONS

Refer to Typical Switch Pack Locations and Switch Pack Exploded View .

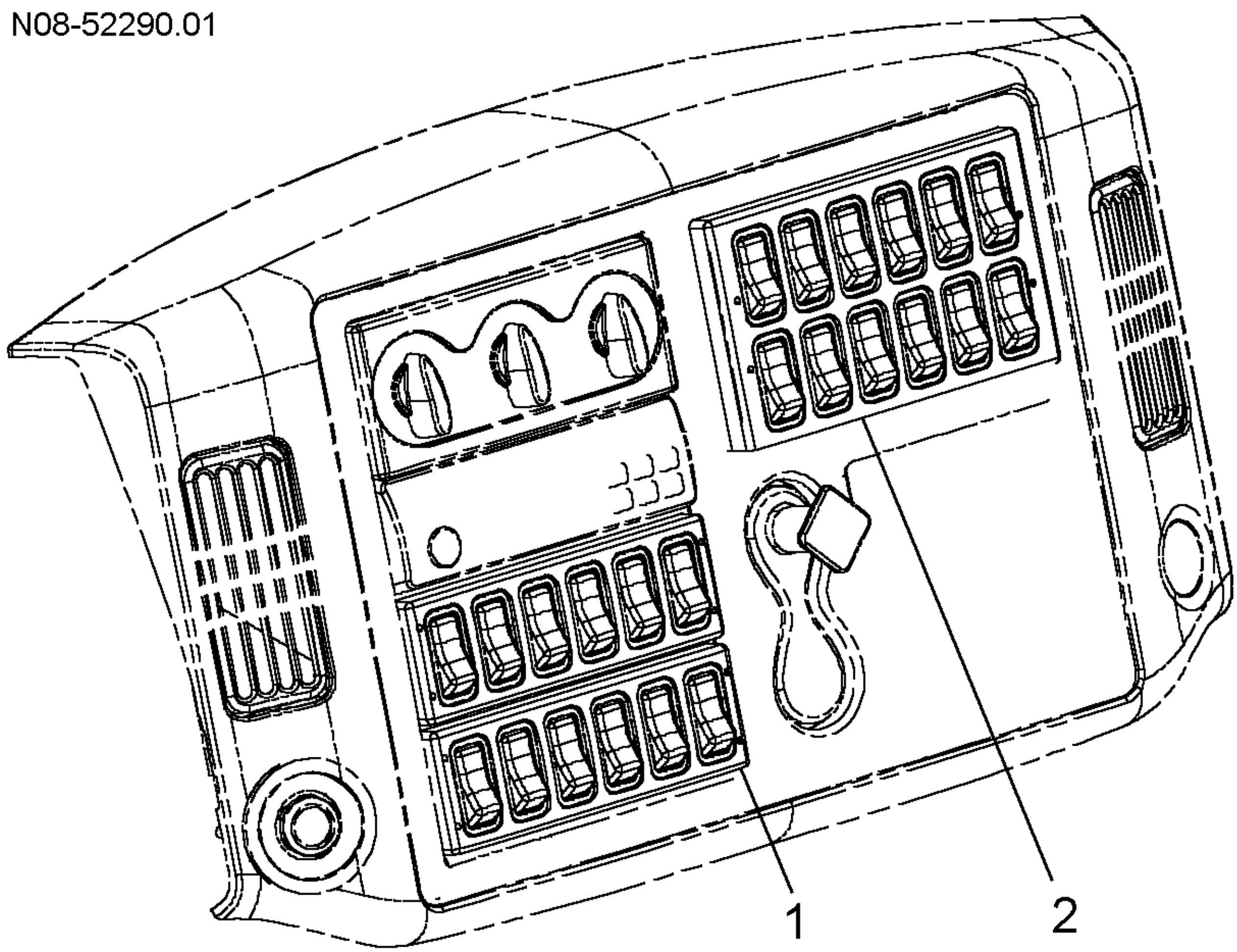


Figure 73 Typical Switch Pack Locations

1. 6 POSITION SWITCH PACK
2. 12 POSITION SWITCH PACK

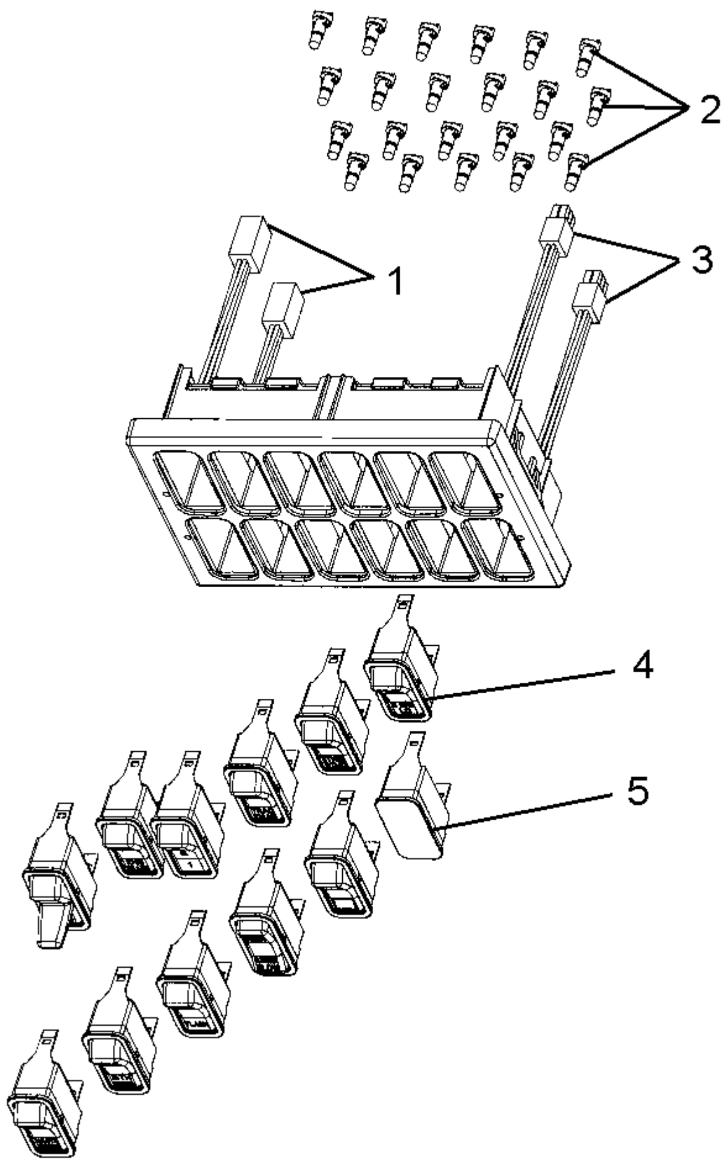


Figure 74 Switch Pack Exploded View (12 Pack Shown)

1. SWITCH PACK CONNECTOR (1101)
2. SWITCH PACK LIGHTS
3. SWITCH PACK CONNECTOR (1101A)
4. TYPICAL SWITCH ACTUATOR
5. UNUSED SWITCH, COVER

2.6. SWITCH AND BULB REPLACEMENT

L.E.D. Bulb Replacement

WARNING – Turn off ignition switch to prevent damage to components or personal injury.

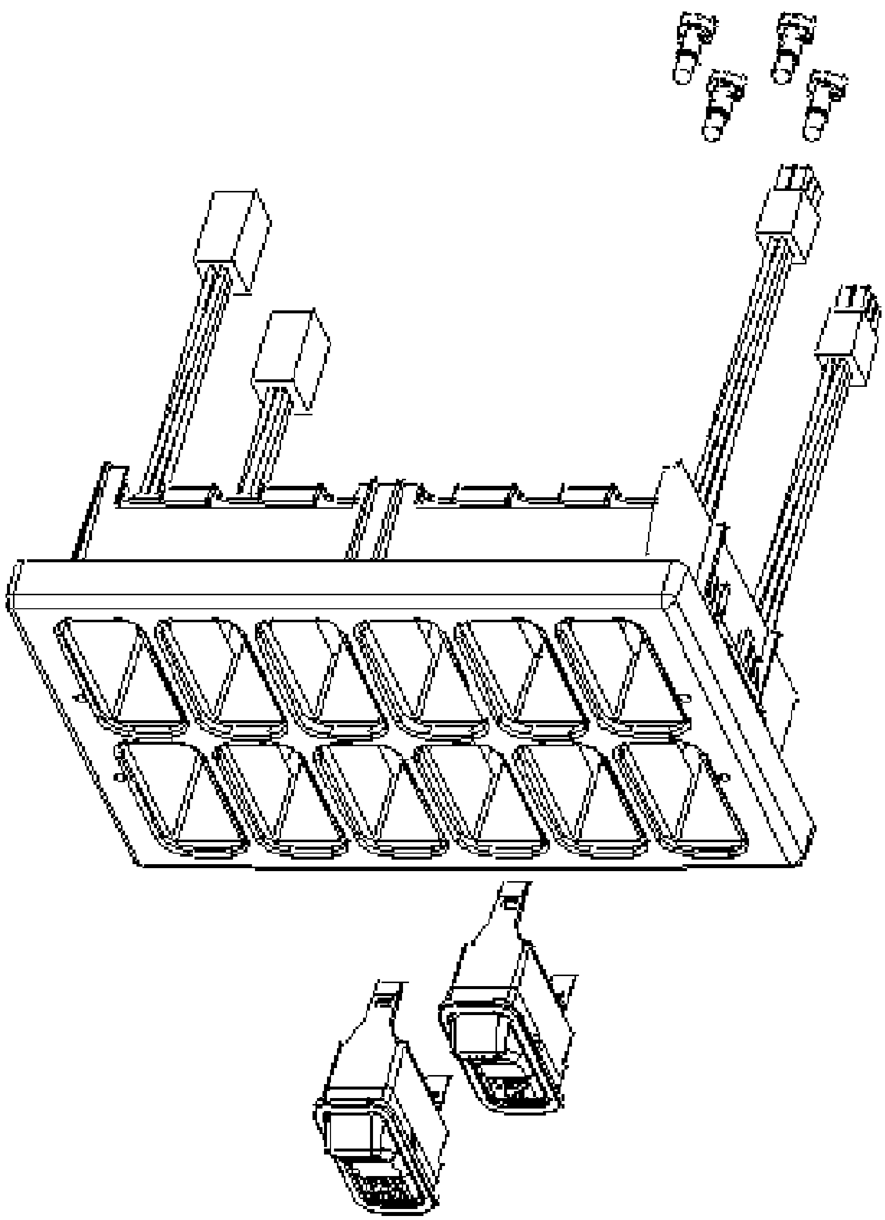


Figure 75 “Twelve Pack” Switch Module with L.E.D. bulbs and Switches

NOTE: The upper bulb socket is a dual-purpose socket. That is, it will accept both backlighting (yellow) bulbs and “ON” indication type (green) bulbs. All upper positions of the switch modules are outfitted this way. There is no specific position that accepts one but not the other. The bottom bulbs are always yellow for backlighting. The bulb apertures are asymmetrical and bulbs are keyed to be inserted into the circuit board in only one orientation.

Refer to Back Side Of Panel. (See Figure 76, page 133)

If the bulb will not insert into the circuit board rotate the bulb one-half turn and try again. Do not force the bulb into the board. Use a wide blade flat screwdriver or a coin to lock the bulb into place with a short clockwise rotation. Do not overtighten the socket. To gain access to the bulbs, carefully remove the snap in the rear corner of the switch assembly.

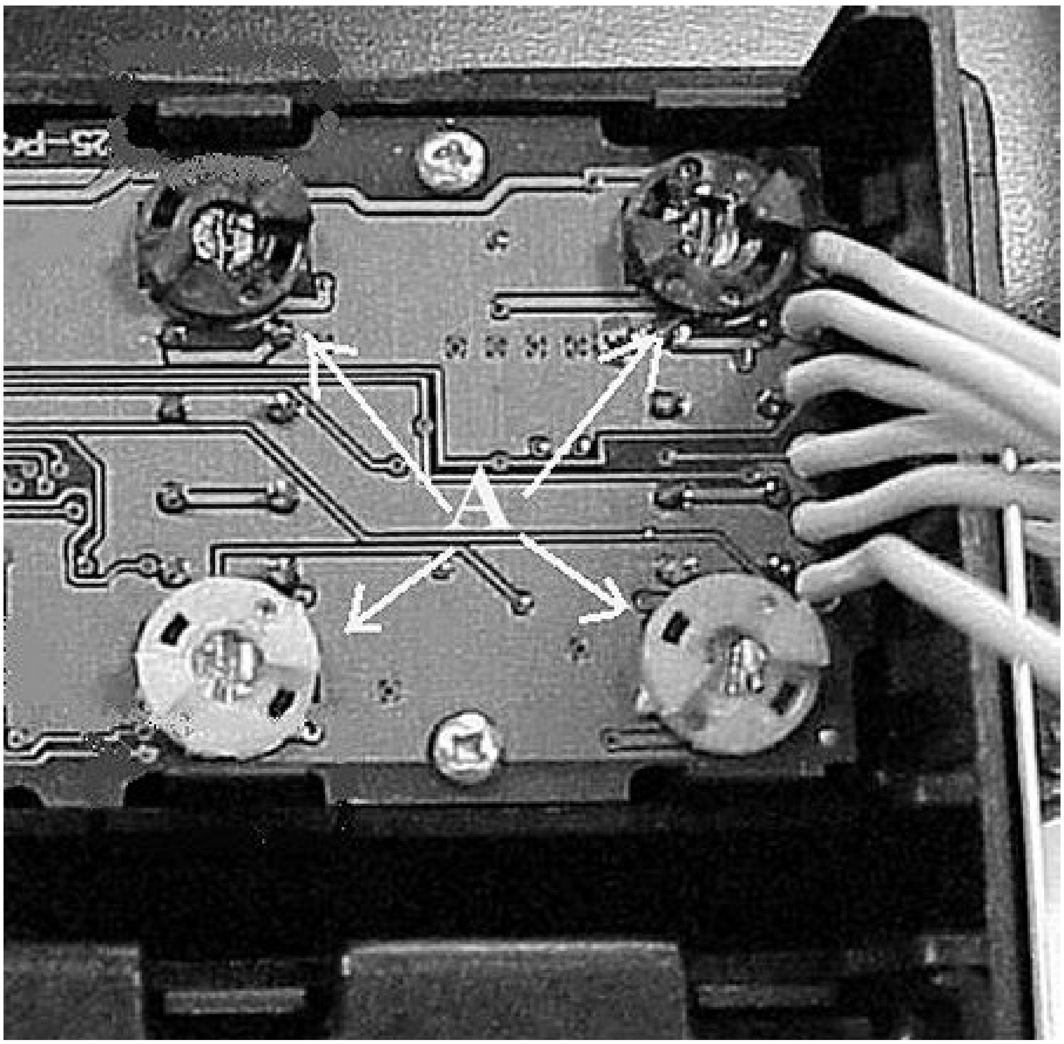


Figure 76 Back Side Of Panel

Instructions For Switches With “ON” Indication

For switches with indication of “ON” the bulbs are colored green and yellow. Install the green bulb in the upper section of the switch on the printed circuit card. Install the yellow bottom section corresponding to the position that this switch is installed.

Instructions For Switches Without “ON” Indication

Install yellow bulbs in both upper and lower sections on the printed circuit board corresponding to the position that this switch is installed.

Switch or Blank Replacement

WARNING – Turn Off the ignition switch to prevent damage to components or personal injury.

CAUTION – There is very little clearance for the switch / blank tabs between the module and the circuit board. Use caution to avoid breaking off the tabs.

To remove switch/blank from Switch Module squeeze the tabs toward each other and push the switch/blank out the front.

Refer to NOTE Tabs. (See Figure 77, page 134)

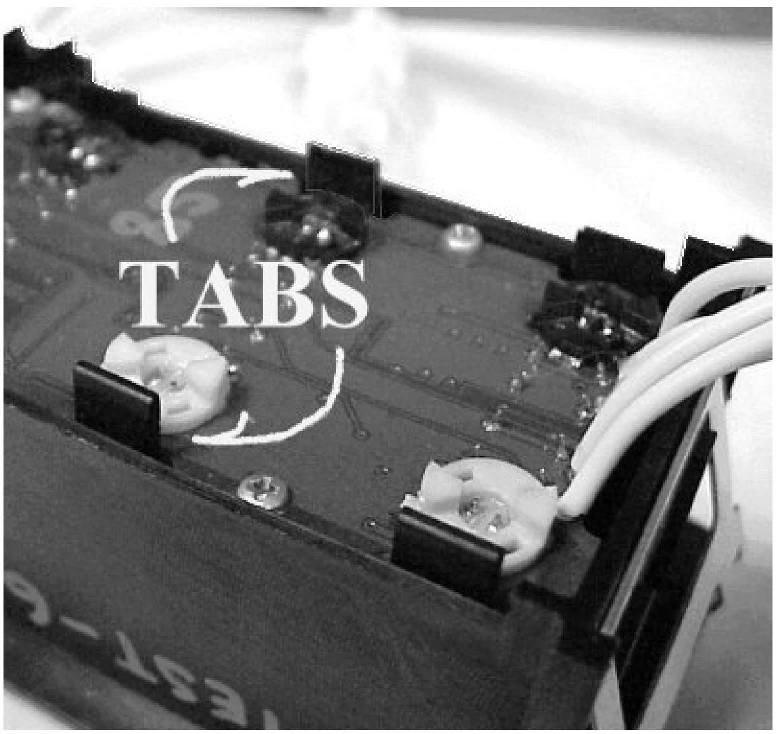


Figure 77 NOTE Tabs

Switch/Blank Installation

All switches/blanks are indexed and can only be installed in one orientation.

Refer to Switch Blank Showing Indexing Key. (See Figure 78, page 135)

Figure 78 Switch Blank Showing Indexing Key

Slide the switch or blank into the module until the tabs lock in place.

Reinstall switch module in Instrument Panel.

Table of Contents

1. DESCRIPTION

The Electronic Gauge Cluster (EGC) components include gauges, warning lamps, an alarm, a digital display, a display set/reset button, and a switch pack containing up to three switches.

The EGC communicates with the electrical system controller (ESC) and other controllers connected to the Drivetrain 1939 data link.

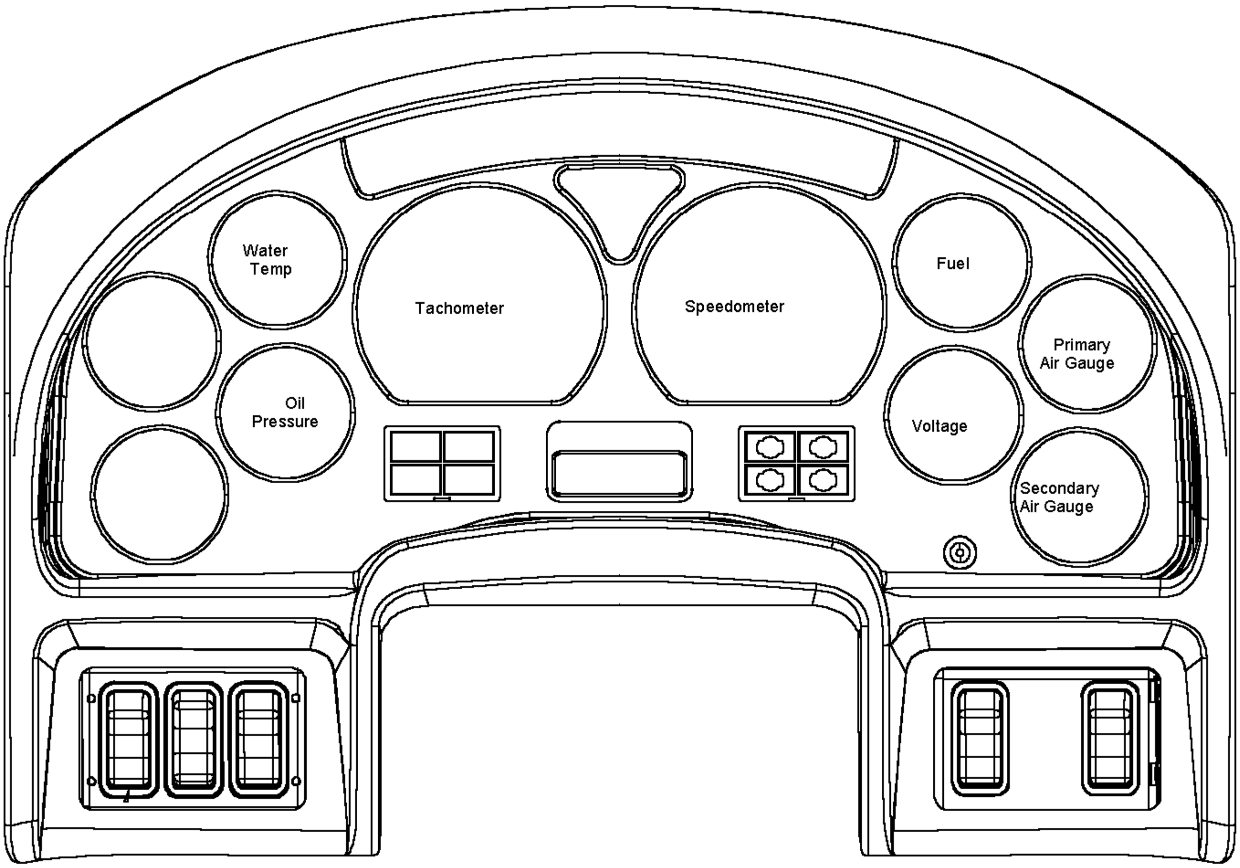


Figure 79 Electronic Gauge Cluster

The AGSP has locations for three gauges and also contains locations for 6 programmable switches.

The AGSP gauges and switches communicate with the electrical system controller (ESC) and other controllers on the Drivetrain 1939 Data Link.

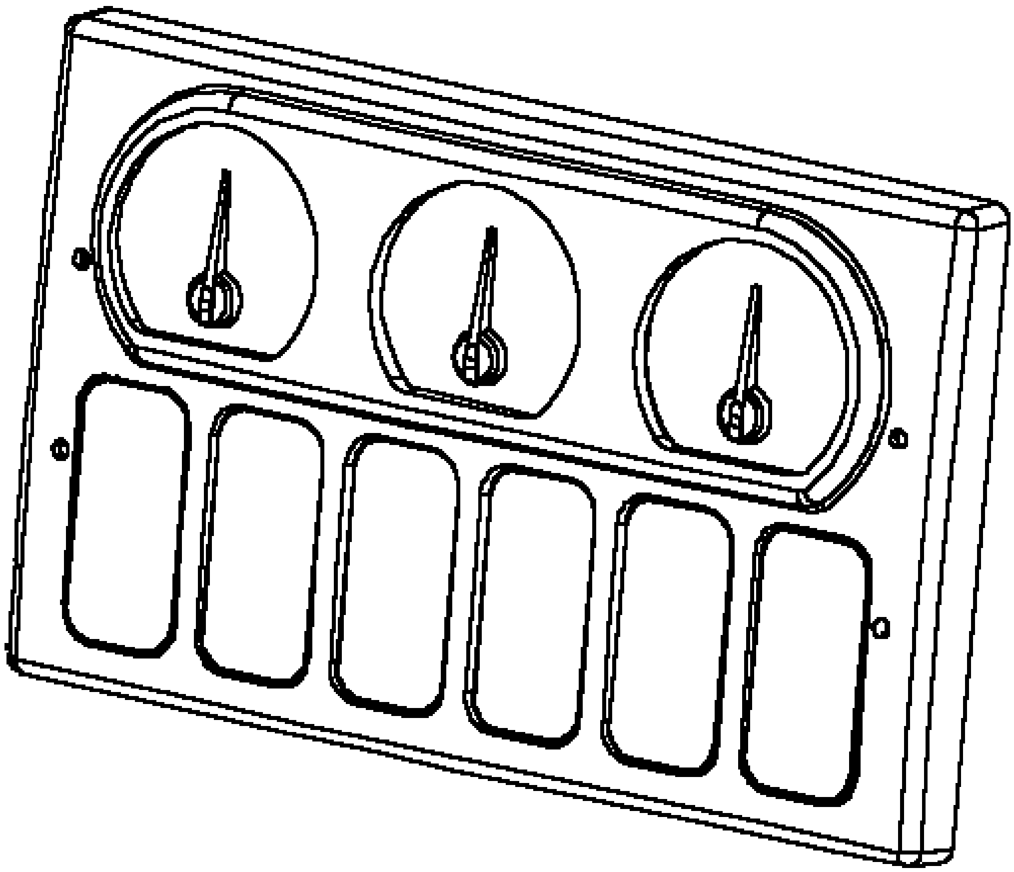


Figure 80 Auxiliary Gauge Switch Pack (AGSP)

1.1. GAUGES

The EGC has locations for 10, stepper motor driven, gauges. Refer to Gauge Locations. The speedometer, tachometer, fuel level gauge, engine oil pressure gauge, engine coolant temperature gauge, and voltmeter gauge are in fixed locations. The other gauges, as required, may be placed in other EGC locations or in an AGSP as programmed in the ESC. Most gauges have their own warning light which signals the operator when a gauge reading is outside of preset limits.

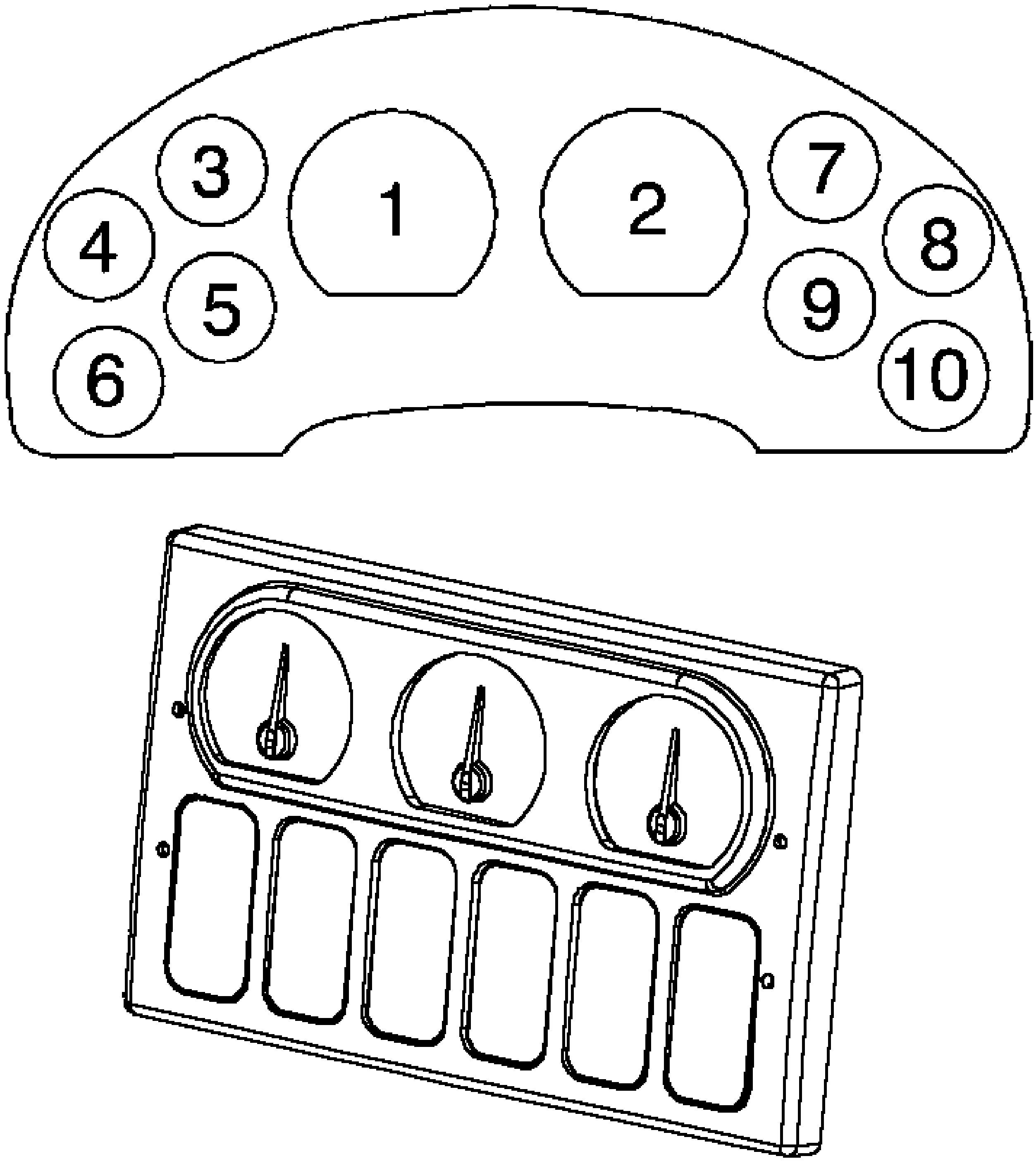


Figure 81 Gauge Locations

Table 23 Gauge Table

Gauge Type	Standard/ Optional	Location	Gauge Min./ Gauge Max.	Warning Light Trip Point	Parameter Group Description	Troubleshooting Cross Reference
Voltmeter Gauge with Integral Warning Light	Standard	9	10/16 Volts	<12 or >15.0 VDC and Engine Speed >325 RPM	Vehicle electric power: Electrical potential (voltage)	Voltmeter (See VOLTMETER, page 238)
Engine Coolant Temperature Gauge with Integral Warning Light	Standard	3	140/260 °F (60/126°C)	>230 °F (>110 °C)	Engine temperature: Engine coolant temperature	Engine Coolant Temperature Gauge (See ENGINE COOLANT TEMPERATURE GAUGE, page 241)
Engine Oil Pressure Gauge with Integral Warning Light	Standard	5	0/100 PSI	<7 PSI and Engine Speed >325 RPM	Engine fluid level/pressure: Engine Oil Pressure	Engine Oil Pressure Gauge (See ENGINE OIL PRESSURE GAUGE, page 244)
Engine Oil Temperature Gauge with Integral Warning Light	Optional	Varies	100/300 °F (38/149 °C)	>230 °F (>110 °C)	Engine temperature: Engine oil temperature	Engine Oil Temperature Gauge (See ENGINE OIL TEMPERATURE GAUGE, page 247)
Pyrometer Gauge					Inlet/exhaust conditions: Exhaust gas temperature	This feature was not available at the time of publication.
Speedometer	Standard	2	0/85 MPH (0/137 KPH)	N/A	Cruise control/vehicle speed: wheelbased vehicle speed.	Speedometer (See SPEEDOMETER, page 250)
Tachometer	Standard	1	0/3000 RPM	N/A	Electronic engine controller #1: Engine speed	Tachometer (See TACHOMETER, page 253)

Table 23 Gauge Table (cont.)

Gauge Type	Standard/ Optional	Location	Gauge Min./ Gauge Max.	Warning Light Trip Point	Parameter Group Description	Troubleshooting Cross Reference
Fuel Level Gauge with Integral Warning Light	Standard	7	Empty/ Full	<12.8%	Dash display: Fuel level	Fuel Level Gauge (See FUEL LEVEL GAUGE, page 256)
Transmission Oil Temperature Gauge with Integral Warning Light	Optional	Varies	100/400 °F (38/204 °C)	>250 °F (121 °C)	Transmission fluids: transmission oil temperature	Transmission Oil Temperature Gauge (See TRANSMISSION OIL TEMPERATURE GAUGE, page 264)
Rear-rear axle oil temperature gauge with Integral Warning Light	Optional	Varies	100/300 °F (38/149°C)	230 °F (110°C)	Rear-rear axle oil temperature gauge	Rear-rear axle oil temperature gauge (See REAR-REAR AXLE OIL TEMPERATURE GAUGE, page 270)
Forward-rear axle oil temperature gauge with Integral Warning Light	Optional	Varies	100/300 °F (38/149°C)	230 °F (110°C)	Forward-rear axle oil temperature gauge	Forward-rear axle oil temperature gauge (See FORWARD-REAR AXLE OIL TEMPERATURE GAUGE, page 275)
Primary Air Pressure Gauge with Integral Warning Light	Optional	8	0/150 PSI (1034 KPa)	<70 PSI (482 KPa)	Brakes: brake primary pressure	Primary Air Pressure Gauge (See PRIMARY AIR PRESSURE GAUGE, page 281)
Secondary Air Pressure Gauge with Integral Warning Light	Optional	10	0/150 PSI (1034 KPa)	<70 PSI (482 KPa)	Brakes: brake secondary pressure	Secondary Air Pressure Gauge (See SECONDARY AIR PRESSURE GAUGE, page 289)

Table 23 Gauge Table (cont.)

Gauge Type	Standard/ Optional	Location	Gauge Min./ Gauge Max.	Warning Light Trip Point	Parameter Group Description	Troubleshooting Cross Reference
Auxiliary Air Pressure Gauge with Integral Warning Light	Optional	Varies	0/150 PSI (1034 KPa)	<70 PSI (482 KPa)	Supply pressure: Auxiliary Equipment supply Pressure	Auxiliary Air Pressure Gauge (See AUXILIARY AIR PRESSURE GAUGE, page 296)
Boost Pressure Gauge with Integral Warning Light	Optional	Varies	0/50 PSI	N/A	Inlet/ exhaust conditions: boost pressure	Boost Pressure Gauge (See BOOST PRESSURE GAUGE, page 303)
Ammeter Gauge with Integral Warning Light	Optional	Varies	-150/+150 Amps	N/A	Vehicle electrical power: Net battery current or Vehicle electrical power: alternator current	Ammeter Gauge (See AMMETER GAUGE, page 305)
Ammeter Gauge (High Resolution) with Integral Warning Light	Optional	Varies	-300/+300 Amps	N/A	Vehicle electrical power: Net battery current or Vehicle electrical power: alternator current	Ammeter Gauge (See AMMETER GAUGE, page 305)
Fuel Pressure Gauge with Integral Warning Light	Optional	Varies	0/150 PSI (1034 KPa)	N/A	Engine fluid level/ pressure: Fuel delivery pressure	Fuel Pressure Gauge (See FUEL PRESSURE GAUGE, page 308)

Table 23 Gauge Table (cont.)

Gauge Type	Standard/ Optional	Location	Gauge Min./ Gauge Max.	Warning Light Trip Point	Parameter Group Description	Troubleshooting Cross Reference
Suspension Air Gauge with Integral Warning Light	Optional	Varies	0/150 PSI (1034 KPa)	N/A	Supply pressure: air suspension supply pressure	Suspension Air Gauge (See SUSPENSION AIR GAUGE, page 310)
Air Application Gauge with Integral Warning Light	Optional	Varies	0/150 PSI (1034 KPa)	N/A	Brakes: Brake application pressure	Air Application Gauge (See AIR APPLICATION GAUGE, page 312)

1.2. WARNING LIGHTS

The EGC also contains warning and indicator lamps to monitor conditions not monitored by the gauges.

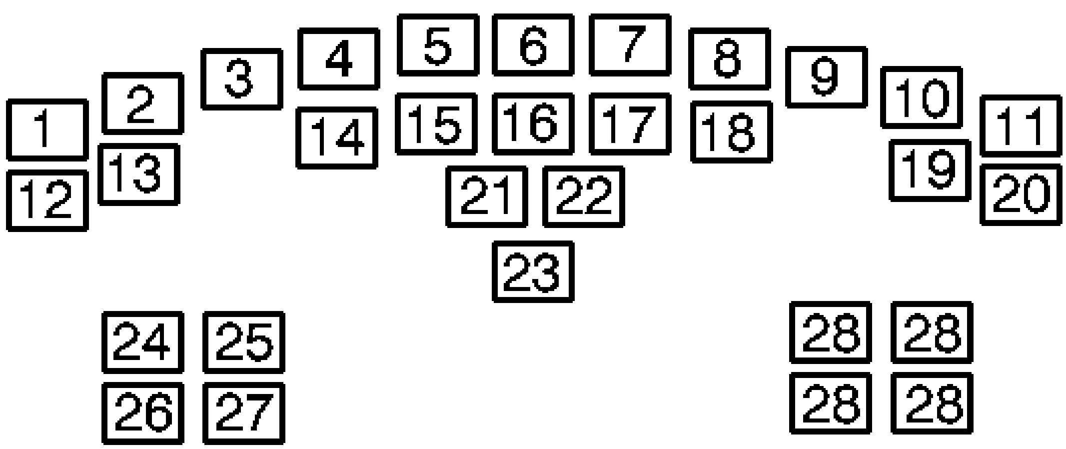


Figure 82 Warning and Indicator Lamps

Table 24 Warning Lamp Table

WARNING LIGHT	REPRESENTATION	COLOR	DRIVEN BY	Loc. Num.	Troubleshooting Cross Reference
Range inhibited	RANGE INHIBITED	Yellow	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from transmission controller.	1	Range inhibited (See RANGE INHIBITED WARNING LAMP, page 179)

Table 24 Warning Lamp Table (cont.)

WARNING LIGHT	REPRESENTATION	COLOR	DRIVEN BY	Loc. Num.	Troubleshooting Cross Reference
Economy Mode	ECONOMY (ECON) [icon]	Yellow	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from transmission controller.	2	Economy Mode(See ECONOMY MODE WARNING LAMP, page 181)
Fuel Filter	FUEL FILTER	Yellow	ON when fuel filter input to ESC from fuel filter.	3	Fuel Filter (See FUEL FILTER WARNING LAMP, page 183)
Warn Engine	ENGINE	Yellow	Status transmitted on Drivetrain 1939 data link from engine controller.	4	Warn Engine (See “YELLOW” ENGINE WARNING LAMP, page 189)
Stop Engine	ENGINE	Red	Status transmitted on Drivetrain 1939 data link from engine controller.	5	Stop Engine (See “RED” ENGINE WARNING LAMP, page 190)
Brake Pressure	BRAKE PRESSURE	Red	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from Hydromax hydraulic brake monitor.	6	Brake Pressure (See BRAKE PRESSURE WARNING LAMP, page 192)
Brake Fluid	Park Icon	Red	This warning lamp is not implemented at this time.	7	
Wait to Start	WAIT TO START	Yellow	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from engine controller.	8	Wait to Start (See WAIT TO START WARNING LAMP, page 226)
Check Transmission	CHECK TRANS	Yellow	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from transmission controller.	9	Check Transmission (See CHECK TRANSMISSION LAMP, page 197)
Trailer ABS	Trailer ABS Icon	Yellow	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from trailer ABS controller.	10	Trailer ABS (See TRAILER ABS LAMP, page 199)
Washer Fluid Low	WASH FLUID LOW	Yellow	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from washer reservoir probe.	11	Washer Fluid Low (See WASHER FLUID LOW WARNING LAMP, page 202)

Table 24 Warning Lamp Table (cont.)

WARNING LIGHT	REPRESENTATION	COLOR	DRIVEN BY	Loc. Num.	Troubleshooting Cross Reference
Left Turn	Left Turn Signal Icon	Green	Status transmitted from ESC on Drivetrain 1939 data link. Input to ESC from turn signal switch.	12	
Traction Control	TRAC CTRL	Green	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from ABS controller.	13	Traction Control (See TRACTION CONTROL LAMP, page 195)
Water in Fuel	WATER IN FUEL	Yellow	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from fuel filter.	14	Water in Fuel (See WATER IN FUEL WARNING LAMP, page 206)
Service Park Brake	SERVICE PARK BRAKE (SERVICE) [icon]	Red	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from SAAR park brake.	15	Service Park Brake (See SERVICE PARK BRAKE WARNING LAMP, page 219)
Check Electrical System	CHECK ELEC SYS	Yellow	On when there is no communication on drivetrain 1939 data link from engine controller or ESC is inactive for more than 10 seconds. Will also come on for one minute when an active fault occurs.	16	Check Electrical System (See CHECK ELECTRICAL SYSTEM WARNING LAMP, page 178)
Park Brake	PARK BRAKE	Red	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from park brake switch.	17	Park Brake (See PARK BRAKE WARNING LAMP, page 212)
Cruise Control Active	CRUISE	Green	Active Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from cruise switch.	18	Cruise Control (See CRUISE CONTROL LAMP, page 222)
Antilock Braking system	ABS Icon	Yellow	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from ABS controller.	19	ABS (See ABS WARNING LAMP, page 224)
Right Turn	Right Turn Signal Icon	Green	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from turn signal switch.	20	

Table 24 Warning Lamp Table (cont.)

WARNING LIGHT	REPRESENTATION	COLOR	DRIVEN BY	Loc. Num.	Troubleshooting Cross Reference
Coolant Level	COOLANT LEVEL	Red	Status transmitted on Drivetrain 1939 data link from ESC. On when Coolant Level < 25%. Input to ESC from surge tank.	21	Coolant Level (See COOLANT LEVEL WARNING LAMP , page 210)
Seat Belt	SEAT BELT	Red	Status transmitted on Drivetrain 1939 data link from ESC.	22	
High Beam	High Beam Icon	Blue	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from high beam switch.	23	
Check Air Conditioner	CHECK A/C	Yellow	Status transmitted on Drivetrain 1939 data link from ESC.	24	Check Air Conditioner (See CHECK A/C WARNING LAMP, page 228)
Retard Over Heat	RETARD OVER HEAT	Red	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from transmission controller.	25	Retard Over Heat (See RETARD OVERHEAT WARNING LAMP, page 230)
PTO/Throttle	PTO/ THROTTLE	Red	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from engine controller.	26	PTO/ Throttle (See PTO/ THROTTLE WARNING LAMP, page 231)
Optional Warning Lamps	Varies	Yellow	These are optional hard wired warning lamps. Example: Alternator Warning, Snow Valve, Optimized Idle or Differential locks.	28	Refer to the applicable section for the feature associated with the warning lamp.

1.3. DIGITAL DISPLAY

The digital display is an LCD located in the bottom-center of the EGC.

The three lines of the digital display provide a transmission shift display, a numeric display, and an alphanumeric line.

The display will dim to match the back lights when the park lights are switched on. The brightness of the display is adjusted with the panel light dimmer switch.

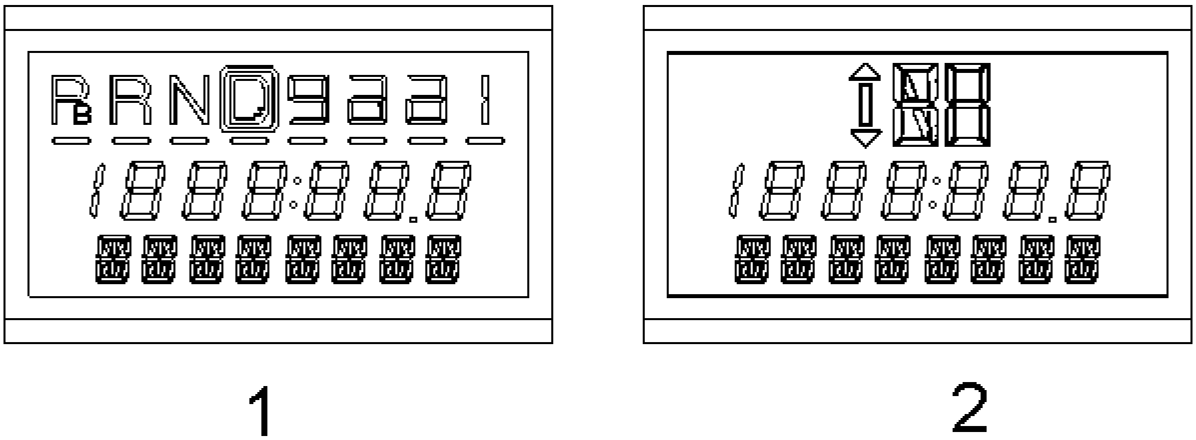


Figure 83 Electronic Gauge Cluster Display

1. EGC DISPLAY WITH ALLISON TRANSMISSIONS
2. EGC DISPLAY WITH EATON AUTOSHIFT TRANSMISSION

Select/Reset Switch

The EGC includes a Select/Reset switch used to control the digital display. The switch interfaces directly with the EGC and is located on the lower right of the EGC lens. The switch allows the user to select modes within each major functional area of the display, as listed below, and perform reset functions. Each time the switch is momentarily depressed it will progress to the next mode. Depressing the switch for period of three seconds, while in the odometer mode, will switch the display between miles and kilometers. Depressing the switch for period of three seconds or more in other modes will clear the display or toggle between options depending upon the current mode. The reset function has no effect if the parameter cannot be reset.

Total Vehicle Distance

The EGC displays the total distance the vehicle has traveled. This value may be toggled between miles and kilometers by depressing the select/reset switch and holding it for 3 seconds while in this mode. The digital display visually indicates whether the current reading is in miles or kilometers. The display indicates the elapsed mileage from 0 to 1,999,999 miles in 1 mile/kilometer increments.

Trip Distance

The display function also includes trip distance. Trip distance is calculated as the total vehicle distance minus total vehicle distance when the trip distance was last cleared. Depressing the select/reset switch for at least three seconds while in this mode will clear the trip distance function and store the total vehicle distance. The digital display visually indicates whether the current reading is trip miles or trip kilometers based upon the current odometer mode. The display indicates the elapsed mileage from 0 to 199,999.9 miles in 0.1 mile/kilometer increments.

Default Odometer Turn On Mode

The display remembers, after the power-on, the last miles or kilometers mode that it was set to before power-off. It will return to this mode upon the next start-up.

Hours Functions

The EGC display provides several engine hours modes.

Total Engine Hours

The hours display is based on engine hours extracted from the engine controller. The digital display visually indicates that the current reading is hours.

Trip Hours

The hours functions also includes trip hours. Trip hours are totaled as accumulated engine hours minus accumulated engine hours when the trip hours function was last cleared. By depressing the select/reset switch for at least three seconds while in this mode, trip hours function will be cleared.

Change Oil

Vehicles with International engines will display a “CHG OIL” message when a programmed engine hours or engine miles interval has been exceeded. Refer to the appropriate engine manual for information on programming the interval and clearing the message.

Diagnostic Message

The LCD is capable of displaying a diagnostic trouble code (DTC) message when requested by the ESC or service tool (EZ-Tech). Refer to On-Line Diagnostics.(See ON-LINE DIAGNOSTICS, page 157)

NOTE – Diagnostic messages from the engine controller, antilock brake system or transmission are not displayed on the electronic gauge cluster (EGC) digital display.

Digital Display Lighting

The display will dim to match the back lights when the park lights are switched on. The brightness of the display is adjusted with the panel light dimmer switch.

1.4. AUDIBLE ALARM

The EGC contains an audible alarm that is capable of producing different beep counts and beep durations. The alarm type for each gauge is determined by the alarm code programmed for that gauge in the ESC.

Pressing and holding the top of the panel dimmer switch and the set/reset switch for 5 seconds shall disable the cluster alarm for all warning conditions until the engine speed reaches 325 RPM or the ignition is cycled.

One-time Five-short-beeps Alarm

An out of range value in any of the following gauges will trigger a one-time, five-short-beep, audible alarm and visual indicator light in the corresponding gauge. The alarm shall sound only once per gauge during each ignition cycle.

- Fuel level
- Voltmeter
- Engine oil pressure
- Engine coolant temperature
- Transmission oil temperature
- Engine oil temperature

- Rear axle temperature
- Front axle temperature
- Boost pressure
- Fuel pressure
- Auxiliary air pressure
- Service Park Brake

Repetitive One-long-beep Alarm

An out of range value in any of the following gauges will trigger a repetitive one-long-beep audible alarm and visual indicator light in the corresponding gauge. The alarm shall stop as soon as normal conditions are reestablished.

- Primary air pressure
- Secondary air pressure

One-time Ten-short-beeps Alarm

The loss of communication to the EGC from the ESC or engine controller, on the Drivetrain 1939 data link, will trigger a one-time, ten-short-beep audible alarm.

One-time Three-long-beeps Alarm

A sensor fault error will result in the small gauge pointer being driven clockwise to the 6 o'clock position and a three long beep audible alarm. The gauge pointers in the speedometer and tachometer will repeat the following three times and then park the pointer at the minimum position until the sensor fault is no longer active.

- Go immediately to the zero position
- Sweep up to a 50% position
- Immediately sweep back to zero
- Pause

Repetitive Short Duration Blips

The turn signal shall be accompanied by a sequence of short blips synchronized with the flashing of the lamps. This audio indicator repeats each time the ESC requests that the EGC turn on the turn signal lights. The audio indicator does not accompany the application of the hazard lights.

1.5. ELECTRONIC GAUGE CLUSTER SWITCHES

The EGC houses up to three user switches. Each switch is interfaced to the gauge cluster microprocessor. The microprocessor transmits the switch status to the ESC on the drivetrain 1939 data link.

Head Lamp/Park Lamp Switch

The EGC directly interfaces with a head lamp switch. The head lamp switch has a latched off position, a latched 'park lamp' position, and a latched 'head lamp' position. The 'head lamp' switch does not have a center off position. Each position of the switch position is back lighted in yellow.

Panel Dimmer

The panel dimmer switch is located in the center position of the left pack of switches. The switch is back lighted in yellow. The panel light dimmer control is a momentary push up/push down, or a press and hold rocker switch. The dimmer retains its brightness level after the key is cycled, but will default to 100% ’on’ after a hard reset.

Work Light Switch

The work light switch is a momentary push up/push down rocker switch. The work light switch is located in the right position of the left bank of cluster switches. The work light switch is back lighted in yellow, the ’on’ position is back lighted in green. Status of the work light switch is communicated to the electrical system controller.

Mode and Select/Reset Switch

The switch allows the user to select modes within each major functional area of the display and perform reset functions. Momentarily depressing the switch will cause the display to scan through the various modes. Depressing the switch for a period of three seconds or more will clear the display or toggle between options depending upon the current mode. The reset function has no effect if the parameter cannot be reset.

1.6. FAIL SAFE STRATEGIES

The EGC provides fail-safe strategies to provide safe vehicle operation during certain malfunctions in the electrical system.

1. If communication between the EGC and electrical system controller is lost for more than five seconds, the EGC will illuminate the CHECK ELEC SYS warning light and maintain the status of all the other warning lights for as long as the ignition key is in the on position and communication is interrupted.

2. If communication from the electrical system controller is lost for more than two seconds, the EGC will enable a single control circuit between the EGC and the ESC. This circuit will enable control of the park and low beam headlights for as long as the ignition key is in the on position and communication between the EGC and ESC is interrupted.

3. If the cluster itself dies, the CHECK ELEC SYS warning lamp will illuminate.

2. PROGRAMMING

When gauge configurations are changed, or the ESC is replaced, the ESC must be programmed with the “ICAP” programming software. The ESC will store the current configuration and update the configuration after changes are made. The new configuration will have to be uploaded to International. This is accomplished by dialing in and uploading the updated programming. A copy of the programming is stored at International and updated each time there is a change. This is required in case there is a need to download the programming for ESC replacement. Refer to Programming in the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)

The EGC faults, with electronic gauge cluster version 8.7, the diagnostic trouble code will display SPN field “1705” and with electronic gauge cluster version 9.3 and later, the diagnostic trouble code will display SPN field “2023”.

3. DIAGNOSTICS

3.1. GAUGE SWEEP

After the ignition is turned on, a gauge sweep of the EGC and AGSP will be performed. Each gauge must sweep from zero to maximum to zero in unison. All of the gauge warning lights will illuminate along with the panel warning lights that are applicable to features installed on the vehicle. The yellow and red “ENGINE” warning lamps should also illuminate (they are turned on by the engine controller not the gauge cluster test). The alarms associated with each gauge warning light do not sound. All of the segments of the EGC LCD should display while the gauges sweep. At the end of the sweep the LCD will turn off all segments for .5 seconds, display the firmware version number, then return to operational mode. The lights controlled by the panel dimmer in the EGC will also come on during the gauge sweep.

A gauge that points between the 9 and 10 o’clock position is most likely connected to the wrong location on the circuit board inside the EGC.

If the instrument cluster or any of the remote modules experience a system fault, they will transmit a fault message to the ESC.

3.2. ON-LINE DIAGNOSTICS

On-line Diagnostics are automatically performed by the ESC while the key is in the accessory or ignition position. Any faults encountered will be entered in the active fault list.

On power up the check electrical system light will turn on then off after the gauge sweep. If there is an active fault the light will stay on for an extra minute. If a fault occurs during operation of the vehicle the light will come on for 1 minute. This will alert the driver that an active fault exists.

If the check electrical system light comes on and stays on after the gauge sweep is completed then the EGC is not communicating with the engine controller and/or the ESC.

If the EGC loses communication with the ESC or engine controller during vehicle operation, the check electrical system light will turn on and stay on. The light will be accompanied by 10 short beeps from the EGC alarm.

Diagnostic trouble codes will be moved to the “previously active” list after the condition creating the fault is repaired.

Placing the EGC in diagnostic mode will allow the EGC to display up to 40 active and previously active diagnostic messages from the ESC.

To engage the diagnostic mode turn the Ignition key “ON” (or in accessory) then press the Cruise “ON” switch and the Cruise “RESUME” switch simultaneously. If no faults are present, the gauge cluster display will read “NO FAULT”. If faults are present, the gauge cluster will display a message with the number of faults followed by the diagnostic codes. Refer to Diagnostic Trouble Code Display. The display will show each DTC for 10 seconds then automatically scroll to the next entry and continue to cycle through the faults. To manually cycle through the fault list, press the cluster display selector button.

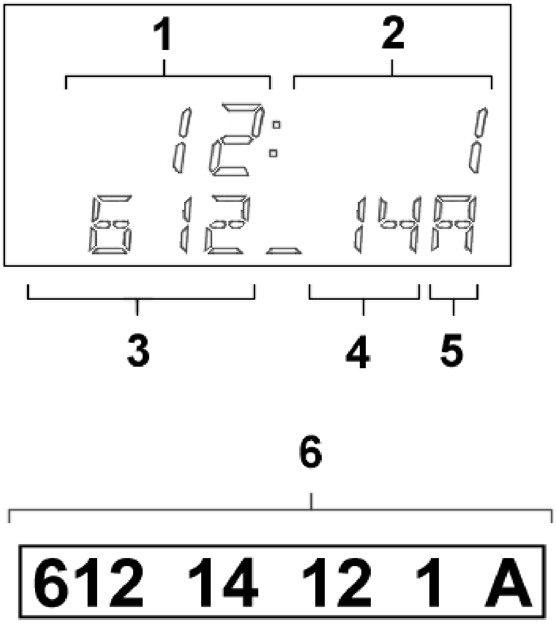


Figure 84 Diagnostic Trouble Code Display

1. BYTE 7 FIELD
2. BYTE 8 FIELD
3. SPN FIELD
4. FMI FIELD
5. ACTIVE/PREVIOUSLY ACTIVE STATUS INDICATOR
6. COMPILED FORMAT OF DIAGNOSTIC TROUBLE CODE

Refer to the Diagnostic Trouble Code List.(See DIAGNOSTIC TROUBLE CODE (DTC) LIST, page 1039)

While in the diagnostic mode, diagnostic trouble codes may be cleared by turning the left turn signal on and pressing the cruise “ON” switch and the cruise “SET” switch simultaneously. All previously active faults will be cleared. Active faults will reappear as the ESC updates faults once a second.

To exit the diagnostic mode, cycle the key switch or release the parking brake.

The diagnostic service tool, running the INTUNE software, can be used to view diagnostic trouble codes and occurrence counts. The tool can also be used to clear previous active ESC diagnostic trouble codes. Other diagnostic software can be used to view and clear engine controller, ABS and transmission diagnostic trouble codes. Refer to the appropriate software manual for details.

3.3. GAUGE DATA

The EGC and AGSP continuously monitor incoming gauge data for out-of-range or data-not-present conditions. If the data is out of range, the Cluster or gauge pack will turn on the LED embedded in the respective gauge.

Missing data to a small gauge in the EGC or AGSP will cause the needle to be driven clockwise to the 6 o’clock position. Missing data to the speedometer or tachometer will cause the gauge to repeat the following three times:

- Go immediately to the zero position
- Sweep up to the 50% position
- Sweep back to zero
- Pause

3.4. LOSS OF DATA LINK

If the EGC or AGSP loses the connection with the data link, all gauges will sweep to zero and the check electrical system indicator will light.

If communication between the ESC or AGSP and EGC is lost but the EGC or AGSP is able to communicate with the engine controller, information from the engine controller will continue to be displayed. The check electrical system indicator will light.

If a communication between the EGC or AGSP and the engine controller is lost but the EGC or AGSP is able to communicate with the ESC, information from the ESC will continue to be displayed. The check electrical system indicator will light.

3.5. THE "INTUNE" DIAGNOSTIC SOFTWARE

The "INTUNE" diagnostic software can be run on the EZ–Tech. An interface cable is required to connect the EZ–Tech to the diagnostic connector of the truck.

The "INTUNE" diagnostic software may be used to exercise individual gauges, and all programmed warning lights to verify their operation. See the "INTUNE" diagnostic software manual for instructions.

The "INTUNE" diagnostic software can also be used to check programmed cluster gauge locations.

4. TROUBLESHOOTING

A. Before beginning these test procedures, make sure the vehicle batteries are at 75% state of charge (SOC) or higher. This represents an open circuit voltage (OCV) of 12.4 volts. Batteries with an OCV of 12 volts or less are either completely discharged or have a dead cell.

B. 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. Inspect all connectors for loose or damaged pins, wires, etc. Refer to TEST EQUIPMENT AND CONNECTOR REPAIR section in GROUP 08 — ELECTRICAL in the Master Service Manual.

D. When the technician 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 technician knows to check for a malfunctioning switch, relay, or solenoid.

4.1. IMPORTANT STEPS BEFORE TESTING

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.
   a. Do the logged codes correlate to probable causes?
4. Were the codes logged about the same time as the symptoms appeared? Were the codes logged repeatedly? (This can only be checked with the EZ-Tech.)
5. Are the logged codes related to other symptoms? Do they have a common cause?
6. **Avoid preconceived ideas!** Eliminate any non-electrical causes for the problem first (contaminated fuel, clogged air filters, etc.).

4.2. INSPECTING ELECTRICAL CONNECTORS

Visual Inspection

The troubleshooting guide requires checking specific connectors. Use the following steps to determine if the connector is causing the problem. If a defective condition is found, make the necessary corrections and continue the process.

1. **Check the connector lock mechanism or retaining screw.** Make sure the connector is capable of properly locking the connector together.
2. **Perform a 10 pound pull-test on each terminal/wire in the connector.** Each terminal/wire assembly should easily withstand 10 pounds of pull and remain in the connector. This test determines (A) if the wire is properly in the terminal and (B) if the terminal is properly inserted into the connector. Correct any defects noted.
3. **Visually inspect wiring.** Inspect for worn or damaged wires. Check for pinched or damaged harness.
4. **Visually inspect connectors.** Verify that pins and sockets are free of corrosion, dirt or any other contaminants, and damage. Verify correct alignment and location of terminals in the connector.
5. **Check individual pins and sockets.** This is especially important with an intermittent symptom. Using a new pin, insert the pin into each socket, one at a time, checking for a good grip on the pin by the socket. Repeat for each pin on the mating side of the connector, using a new female terminal for the test.
6. **Inspect Engine Ground Stud.** Inspect this ground and other related grounds for clean, tight connections that are free of corrosion and/or other defective conditions.

Replacing International Components

When replacing electrical switches, connectors (including pins and sockets), relays or other components, use only approved International replacement parts. Many of the switches have gold or silver plated contacts and some of the connectors have gold plated terminals. By using correct replacement parts, you maintain the design integrity of the system.

4.3. EGC PRELIMINARY SYSTEM CHECK

Problems with EGC operation can be caused by a lack of power, a malfunctioning EGC, a malfunctioning ESC, a malfunctioning data link, incorrect or lost programming in the ESC, problems in the engine controller, problems in the ABS controller, problems in the transmission controller, or problems with wiring or sensors feeding the electronic controllers throughout the system.

EGC Preliminary System Check

The preliminary system check should guide the mechanic to a general area to start troubleshooting.

Table 25 EGC Preliminary System Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/ On	Turn key to ignition position while observing the EGC. Did the EGC have any response to key on?	EGC responds to key on.	Go to next step.	Go to EGC power and ground troubleshooting. (See EGC POWER AND DATA LINK CIRCUITS, page 164)
2.	Off/ On	Turn key to ignition position while observing the EGC. Does the gauge sweep perform without any errors? See gauge sweep (See GAUGE SWEEP, page 157)	EGC gauge sweep performs without any errors.	Go to next step.	Go to troubleshooting malfunctioning EGC (See MALFUNCTIONING EGC , page 166)
3.	On	After the gauge sweep is finished and most warning lamps have gone out, does the check electrical system light illuminate for 1 second or remain illuminated?	Check electrical system light illuminate for 1 second or remain lit.	Go to next step.	Go to troubleshooting for the check electrical system light. (See CHECK ELECTRICAL SYSTEM WARNING LAMP, page 178)
4.	On	After the gauge sweep is finished, do any other warning lights remain illuminated for more than 15 seconds, without turning off?	No warning lamps illuminated.	Go to next step.	Go to troubleshooting for specific warning light. Cross reference from Warning Light Table. (See Table 24, page 149)

Table 25 EGC Preliminary System Check (cont.)

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
5.	On	After the gauge sweep or during vehicle operation, do any gauges point to the 6 o'clock position or provide an incorrect reading?	Gauges operate correctly.	Go to next step.	Go to troubleshooting for specific gauge. Cross reference from Gauge Table. (See Table 23, page 146)
6.	On	Does Select/Reset button function correctly?	Select/ Reset button functions correctly?	Go to next step.	Go to troubleshooting for the Select/Reset switch. (See SELECT/RESET SWITCH, page 319)
7.	On	Do the headlight and dimmer switch work correctly?	Headlight and dimmer switch works correctly?	Go to next step.	Go to troubleshooting for the headlight and dimmer switch (See HEAD LAMP/PARK LAMP SWITCH, page 320)
8.	On	Does the audible alarm sound when a turn signal has been left on after traveling more than one mile?	Alarm sounds when a turn signal has been left on after traveling more than one mile?	EGC alarm is working correctly.	Go to troubleshooting for the alarm. (See AUDIBLE ALARM, page 318)

4.4. AGSP PRELIMINARY SYSTEM CHECK

Problems with AGSP operation can be caused by a lack of power, a malfunctioning AGSP, a malfunctioning ESC, a malfunctioning data link, incorrect or lost programming in the ESC, problems in the engine controller, problems in the ABS controller, problems in the transmission controller, or problems with wiring or sensors feeding the electronic controllers throughout the system.

AGSP Preliminary System Check

The preliminary system check should guide the mechanic to a general area to start troubleshooting.

Table 26 AGSP Preliminary System Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/ On	Turn key to ignition position while observing the AGSP. Did the AGSP have any response to key on?	AGSP responds to key on.	Go to next step.	Go to AGSP power and ground troubleshooting. (See AGSP POWER AND DATA LINK CIRCUITS, page 168)

Table 26 AGSP Preliminary System Check (cont.)

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
2.	Off/ On	Turn key to ignition position while observing the AGSP. Does the gauge sweep perform without any errors? See gauge sweep (See GAUGE SWEEP, page 157)	AGSP gauge sweep performs without any errors.	Go to next step.	Go to troubleshooting malfunctioning AGSP. (See MALFUNCTIONING AGSP, page 170)
3.	On	After the gauge sweep or during vehicle operation, do any gauges point to the 6 o'clock position or provide an incorrect reading?	Gauges operate correctly.	Go to next step.	Go to troubleshooting for specific gauge. Cross reference from Gauge Table. (See Table 23, page 146)
4.	On	Are all of the AGSP switches operating correctly?	AGSP switches operate correctly.	AGSP is operating correctly.	Go to Malfunctioning AGSP switches. (See MALFUNCTIONING AGSP SWITCHES, page 178)

4.5. EGC POWER AND DATA LINK CIRCUITS

Circuit function

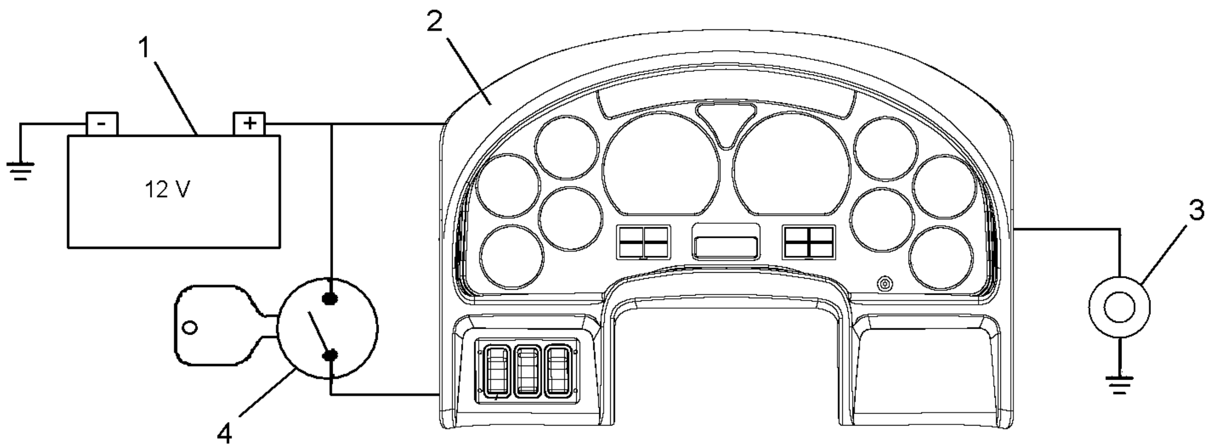


Figure 85 EGC Power And Ground Function Diagram

1. BATTERY
2. ELECTRONIC GAUGE CLUSTER
3. GROUND STUD
4. KEY SWITCH

Refer to EGC Power And Ground Function Diagram.

The EGC receives battery power through fuse block (1012). Switched ignition power is supplied from the ignition relay in fuse block (1012).

The EGC communicates with the ESC and the engine controller on the Drivetrain 1939 Data Link.

Fault Detection/Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

Refer to EGC Power And Ground Simplified Diagram

If the EGC is not receiving ignition power, it will not respond when the key switch is turned on.

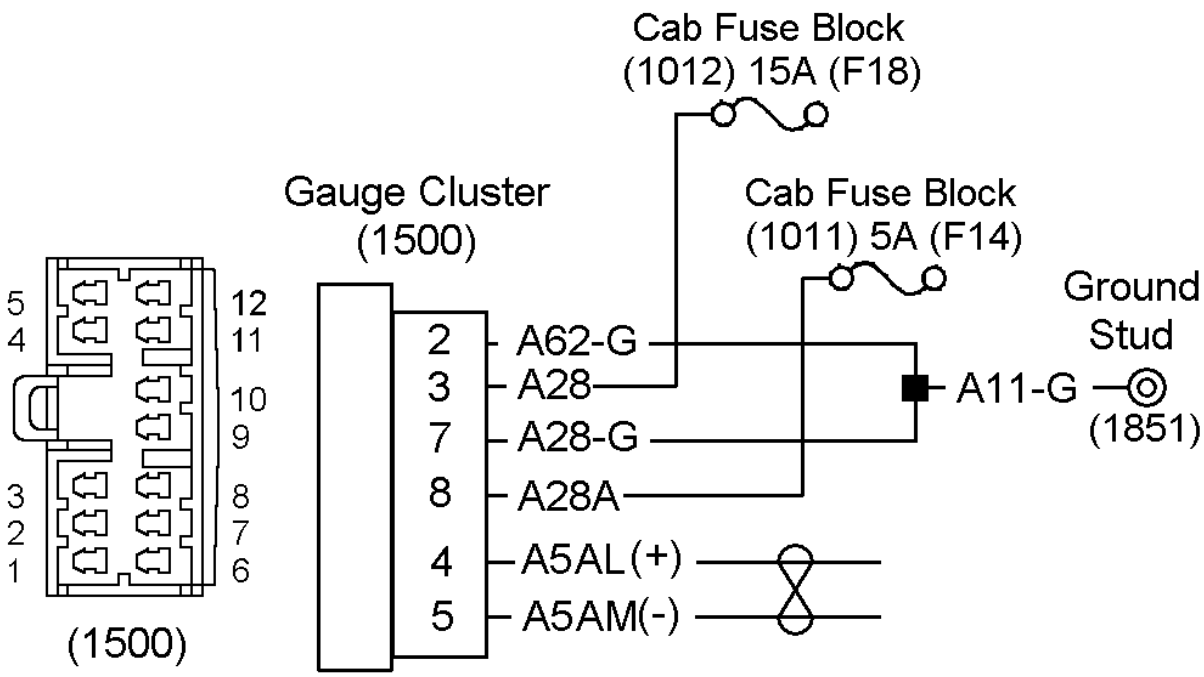


Figure 86 EGC Power And Ground Simplified Diagram–Always Refer To Circuit Diagram Book For Latest Circuit Information

F18 BATTERY FUSE (1012)
F14 IGNITION FUSE (1011)
(1500) ELECTRONIC GAUGE CLUSTER CONNECTOR

Table 27 EGC Power Voltage Check Chart

EGC Connector (1500) Voltage Checks (Check with EGC connector Disconnected and Ignition Key "On") This chart assumes there is power to fuse block (1011) F14 and (1012) F18 from the mega fuse and ignition relay is functioning properly.		
Test Points	Spec.	Comments
(1500) Cavity 3 to ground.	12 ± 1.5 volts	If voltage is incorrect, check for blown fuse (F18) or an open or short in circuit A28.
(1500) Cavity 8 to ground.	12 ± 1.5 volts	If voltage is incorrect, check for blown fuse (F14) or an open or short in circuit A28A.
(1500) Cavity 8 to 7.	12 ± 1.5 volts	If voltage is incorrect, check for an open in circuit A28-G. If all voltages are correct and the EGC does not power up, the EGC should be replaced

Table 27 EGC Power Voltage Check Chart (cont.)

EGC Connector (1500) Voltage Checks (Check with EGC connector Disconnected and Ignition Key "On") This chart assumes there is power to fuse block (1011) F14 and (1012) F18 from the mega fuse and ignition relay is functioning properly.		
Test Points	Spec.	Comments
EGC Connector (1500) Data Link Voltage Checks (Check with EGC connector Disconnected and Ignition Key "On")		
Test Points	Spec.	Comments
(1500) Cavity 4 to ground.	Approximately 2.5 volts.	If voltage is missing check for short to ground or open in circuit A5AL(+) to the cab harness.
(1500) Cavity 5 to ground.	Approximately 2.5 volts.	If voltage is missing check for short to ground or open in circuit A5AM(+) to the cab harness.
If voltages are missing and the circuits are not shorted to ground or open, refer to Drivetrain Data Link Circuits		

Extended Description

Battery voltage to the instrument cluster connector (1500), terminal 3, is provided on circuit A28 from fuse (1012) F18.

Switched ignition voltage to the instrument cluster connector (1500), terminal 8, is provided on circuit A28A from (1011) F14. F4 receives power from the ignition relay.

System ground to EGC connector (1500), terminal 7, is provided on circuit A28–G from DS2 and circuit A11–G to the negative stud (1851).

4.6. MALFUNCTIONING EGC

Fault Detection/Management

Malfunctions in the EGC can be caused by improper programming, an inoperative gauge, an inoperative warning lamp, an inoperative display panel, breaks in the circuit board, or a problem in the microprocessor.

The speedometer, tachometer, microprocessor and circuit board in the EGC are combined in one assembly. When there is a problem in one of these features the whole circuit board assembly must be replaced.

When an EGC is replaced, the current EGC programming will be taught to the new assembly by the ESC. No manual programming should be required.

Table 28 Troubleshooting Malfunctioning EGC

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?	Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See EGC PRELIMINARY SYSTEM CHECK, page 161)
2.	Off	Did all gauges sweep correctly?	All gauges swept correctly.	Go to step 4.	Go to next step.

Table 28 Troubleshooting Malfunctioning EGC (cont.)

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
3.	Off/ On	Swap a working gauge, from the same side of the cluster, with the inoperative gauge. Perform gauge sweep.	The gauge that worked previously still works in the new position.	Replace the defective gauge.	Replace the circuit board assembly.
4.	On	Connect the EZ-Tech and run the cluster the "INTUNE" diagnostic software. Check if the malfunctioning gauge is programmed.	Gauge is programmed.	Go to next step	Insure the gauge is supposed to be installed. Program the gauge with the "ICAP" software. Refer to the ICAP programming software manual for details.
5.	On	Did all warning lamps, for installed features, light during gauge sweep.	Warning lamps on during gauge sweep.	Go to step 7.	Go to next step.
6.	Off	Replace the suspect warning lamp bulb.	Warning lamp works.	Go to next step.	Replace the EGC circuit board assembly.
7.	On	Did the panel lights illuminate while the gauges swept?	Panel lights illuminate during gauge sweep.	Go to step 9.	Go to next step.
8.	On	Replace the suspect panel light bulb.	Panel light works.		Replace the circuit board assembly.
9.	On	Did all LCD segments display while the gauges swept?	All LCD elements displayed during gauge sweep.	EGC is working correctly.	Go to next step.
If the LCD is the only problem, the LCD is probably bad. If other problems occur along with the LCD, the circuit board assembly probably needs to be replaced.					
10.	On	Replace the LCD display. Perform gauge sweep	LCD display works during gauge sweep.	EGC is working correctly.	Replace the circuit board assembly.

4.7. AGSP POWER AND DATA LINK CIRCUITS

Circuit function

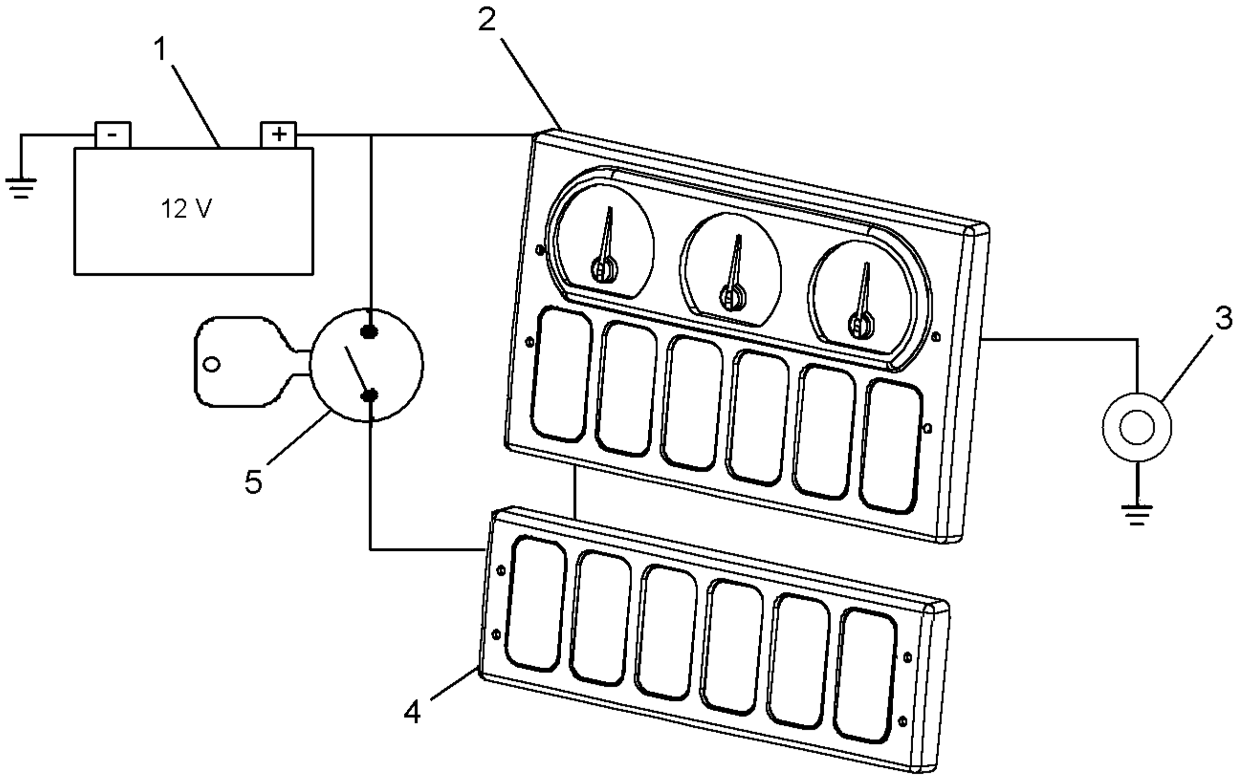


Figure 87 AGSP Power And Ground Function Diagram

1. BATTERY
2. AUXILIARY GAUGE SWITCH PACK (AGSP)
3. GROUND STUD
4. 6 SWITCH PACK
5. KEY SWITCH (ACCESSORY FEED)

Refer to AGSP Power And Ground Function Diagram.

The AGSP receives battery power through fuse block (1011) F12. Switched ignition power is supplied from the ignition relay in fuse block (1012) F19 through the 6 position or 12 position switch pack.

Fault Detection/Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

Refer to AGSP Power And Ground Simplified Diagram

If the AGSP is not receiving ignition power, it will not respond when the key switch is turned on.

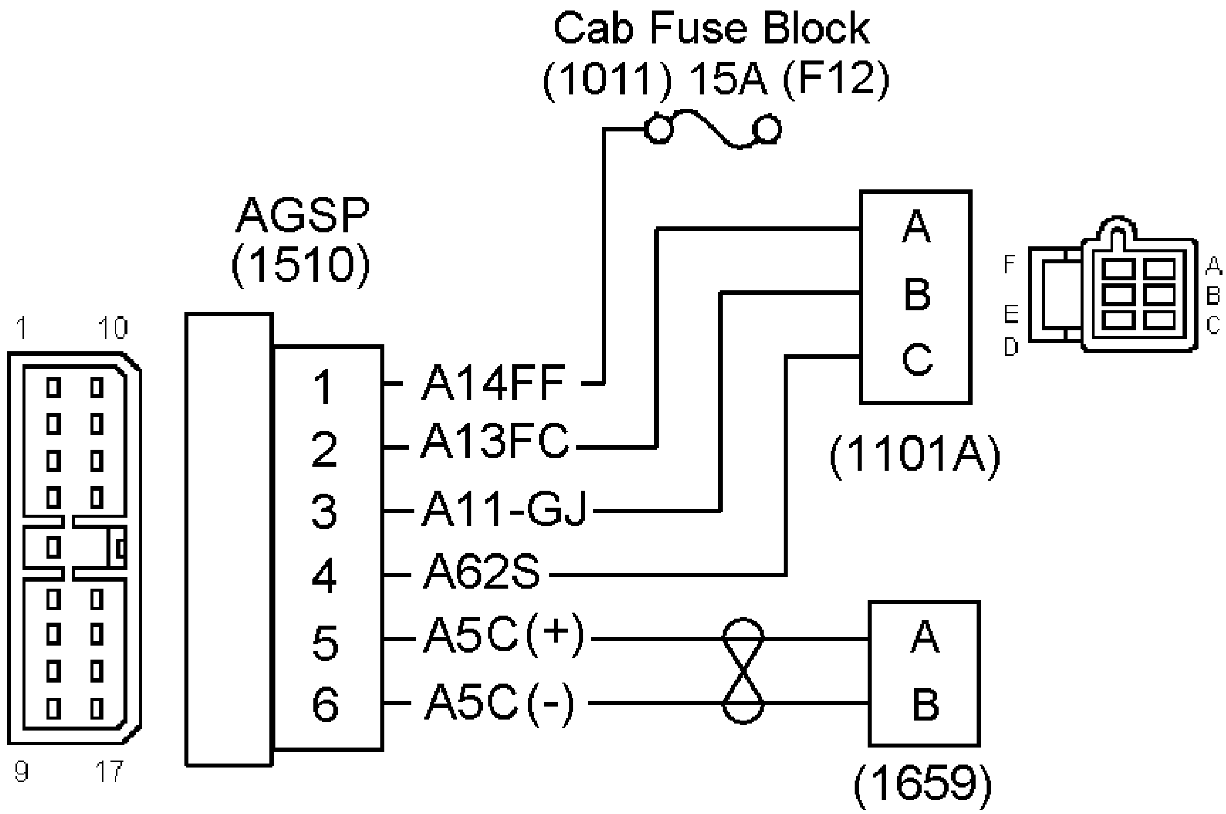


Figure 88 AGSP Power And Ground Simplified Diagram–Always Refer To Circuit Diagram Book For Latest Circuit Information

F12 BATTERY FUSE (1011)
(1510) AGSP CONNECTOR
(1101A) SWITCH PACK CONNECTOR
(1659) DRIVETRAIN 1939 DATA LINK CONNECTOR

Table 29 AGSP Power Voltage Check Chart

AGSP Connector (1510) Voltage Checks (Check with AGSP Connector Disconnected and Ignition Key "On")		
Test Points	Spec.	Comments
(1510) Cavity 1 to ground.	12 ± 1.5 volts	If voltage is incorrect, check for blown fuse (F12) or an open or short in circuit A14FF.

Table 29 AGSP Power Voltage Check Chart (cont.)

AGSP Connector (1510) Voltage Checks (Check with AGSP Connector Disconnected and Ignition Key "On")		
Test Points	Spec.	Comments
(1510) Cavity 2 to ground.	12 ± 1.5 volts	If voltage is incorrect, check for blown fuse (F19) or an open or short in circuit A13FC and circuits through the switch packs. Refer to the Switch Pack Module section of this manual. (See SWITCH PACK MODULES, page 124)
(1510) Cavity 1 to 3.	12 ± 1.5 volts	If voltage is incorrect, check for an open in circuit A11-GJ and circuits through the switch packs. Refer to the Switch Pack Module section of this manual. (See SWITCH PACK MODULES, page 124)
If all voltages are correct and the AGSP does not function, the AGSP should be replaced.		

Extended Description

Battery voltage to the AGSP connector (1510), terminal 3, is provided on circuit A14FF from fuse (1011) F12.

Switched accessory voltage to the AGSP connector (1510), terminal 2, is provided on circuit A13FC from switch pack connector (1101A).

System ground to AGSP connector (1510), terminal 3, is provided on circuit A11–GJ from switch pack connector (1101A).

4.8. MALFUNCTIONING AGSP

Fault Detection/Management

Malfunctions in the AGSP can be caused by improper programming, an inoperative gauge, an inoperative warning lamp, an inoperative display panel, breaks in the circuit board, or a problem in the microprocessor.

When an AGSP is replaced, the current AGSP programming will be taught to the new assembly by the ESC. No manual programming should be required.

Table 30 Troubleshooting Malfunctioning AGSP

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?	Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See AGSP PRELIMINARY SYSTEM CHECK, page 162)
2.	On	Did any gauges sweep correctly?	Some gauges swept correctly.	Go to next step.	Replace AGSP circuit board.
3.	On	Did all gauges sweep correctly?	All gauges swept correctly.	Go to next step 5.	Go to next step.

Table 30 Troubleshooting Malfunctioning AGSP (cont.)

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
4.	Off/ On	Swap a working gauge with the inoperative gauge. Perform gauge sweep.	The gauge that worked previously still works in the new position.	Replace the defective gauge.	Replace the circuit board assembly.
5.	On	Check for AGSP diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 171) Read display on odometer.	AGSP diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 178)	Go to next step
6.	On	Connect the EZ-Tech and run the cluster the "INTUNE" diagnostic software. Check if the malfunctioning gauge is programmed.	Gauge is programmed.	Go to next step	Insure the gauge is supposed to be installed. Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
7.	On	Did the panel lights illuminate while the gauges swept?	Panel lights illuminate during gauge sweep.	AGSP is working correctly.	Go to next step.
8.	On	Replace the suspect panel light bulb.	Panel light works.	AGSP is working correctly.	Replace the circuit board assembly.

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 31 AGSP Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
614 14 40 1	Auxiliary Gauge Switchpack #1 checksum error fixed by reteach. The configuration checksum in the AGSP did not match the teach/reteach checksum in the ESC. This situation was corrected by the teach/reteach operation.

Table 31 AGSP Diagnostic Trouble Codes (cont.)

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
614 14 40 2	Auxiliary Gauge Switchpack #1 checksum error could not be fixed. The configuration checksum in the AGSP did not match the teach/reteach checksum in the ESC. This situation could not be corrected by the teach/reteach operation.
2023 14 50 1, 2023 14 20 1, 2023 14 30 1 or 2023 14 40 1	ESC not communicating with AGSP 1 (50), AGSP 2 (20), AGSP 3 (30), AGSP 4 (40). Loss of communication in excess of 10 seconds. Drivetrain J1939 data link.
2023 14 50 10, 2023 14 20 10, 2023 14 30 10 or 2023 14 40 10	Ignition signal from datalink from ESC does not match hardwired ignition signal on AGSP 1 (50), AGSP 2 (20), AGSP 3 (30), AGSP 4 (40). Ignition Circuit to ESC/AGSP.
2023 14 1 5, 2023 14 11 5, 2023 14 21 5 or 2023 14 31 5	Gauge location 1 sensor fault on AGSP 1 (1), AGSP 2 (11), AGSP 3 (21), AGSP 4 (31). There is a problem with the sensor that provides the data for this gauge.
2023 14 1 6, 2023 14 11 6, 2023 14 21 6 or 2023 14 31 6	Gauge location 1 data unavailable on AGSP 1 (1), AGSP 2 (11), AGSP 3 (21), AGSP 4 (31). The data that this gauge displays should be, but is not available at this time.
2023 14 1 7, 2023 14 11 7, 2023 14 21 7 or 2023 14 31 7	Gauge location 1 data missing on AGSP 1 (1), AGSP 2 (11), AGSP 3 (21), AGSP 4 (31). The data for this gauge is not being transmitted on the datalink.
2023 14 2 5, 2023 14 12 5, 2023 14 22 5 or 2023 14 32 5	Gauge location 2 sensor fault on AGSP 1 (2), AGSP 2 (12), AGSP 3 (22), AGSP 4 (32). There is a problem with the sensor that provides the data for this gauge.

Table 31 AGSP Diagnostic Trouble Codes (cont.)

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
2023 14 2 6, 2023 14 12 6, 2023 14 22 6 or 2023 14 32 6	Gauge location 2 data unavailable on AGSP 1 (2), AGSP 2 (12), AGSP 3 (22), AGSP 4 (32). The data that this gauge displays should be, but is not available at this time.
2023 14 2 7, 2023 14 12 7, 2023 14 22 7 or 2023 14 32 7	Gauge location 2 data missing on AGSP 1 (2), AGSP 2 (12), AGSP 3 (22), AGSP 4 (32). The data for this gauge is not being transmitted on the datalink.
2023 14 3 5, 2023 14 13 5, 2023 14 23 5 or 2023 14 33 5	Gauge location 3 sensor fault on AGSP 1 (3), AGSP 2 (13), AGSP 3 (23), AGSP 4 (33). There is a problem with the sensor that provides the data for this gauge.
2023 14 3 6, 2023 14 13 6, 2023 14 23 6 or 2023 14 33 6	Gauge location 3 data unavailable on AGSP 1 (3), AGSP 2 (13), AGSP 3 (23), AGSP 4 (33). The data that this gauge displays should be, but is not available at this time.
2023 14 3 7, 2023 14 13 7, 2023 14 23 7 or 2023 14 33 7	Gauge location 3 data missing on AGSP 1 (3), AGSP 2 (13), AGSP 3 (23), AGSP 4 (33). The data for this gauge is not being transmitted on the datalink.
2040 14 1 1	AGSP #1 Switch #1, microswitch inputs are in an invalid state. Both microswitches are not depressed. The ESC sets the status of AGSP #1 Switch #1 to the default value. Replace switch acturator
2040 14 1 2	AGSP #1 Switch #1, microswitch inputs are in an invalid state. Both microswitches are depressed. The ESC sets the status of AGSP #1 Switch #1 to the default value. Replace faulty microswitch

Table 31 AGSP Diagnostic Trouble Codes (cont.)

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
2040 14 1 3	AGSP #1 Switch #1, microswitch inputs are in an invalid state. Top microswitch depressed, bottom microswitch not depressed. The ESC sets the status of AGSP #1 Switch #1 to the default value. Replace switch acturator
2040 14 1 4	AGSP #1 Switch #1, microswitch inputs are in an invalid state. Top microswitch not depressed, bottom microswitch depressed. The ESC sets the status of AGSP #1 Switch #1 to the default value. Replace switch acturator
2040 14 1 5	AGSP #1 Switch #1, This switch should be empty but one or both of the microswitches is pressed. The ESC sets the status of AGSP #1 Switch #1 to the default value. Replace switch acturator or faulty microswitch
2040 14 2 1	AGSP #1 Switch #2, microswitch inputs are in an invalid state. Both microswitches are not depressed. The ESC sets the status of AGSP #1 Switch #2 to the default value. Replace switch acturator
2040 14 2 2	AGSP #1 Switch #2, microswitch inputs are in an invalid state. Both microswitches are depressed. The ESC sets the status of AGSP #1 Switch #2 to the default value. Replace faulty microswitch
2040 14 2 3	AGSP #1 Switch #2, microswitch inputs are in an invalid state. Top microswitch depressed, bottom microswitch not depressed. The ESC sets the status of AGSP #1 Switch #2 to the default value. Replace switch acturator
2040 14 2 4	AGSP #1 Switch #2, microswitch inputs are in an invalid state. Top microswitch not depressed, bottom microswitch depressed. The ESC sets the status of AGSP #1 Switch #2 to the default value. Replace switch acturator

Table 31 AGSP Diagnostic Trouble Codes (cont.)

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
2040 14 2 5	AGSP #1 Switch #2, This switch should be empty but one or both of the microswitches is pressed. The ESC sets the status of AGSP #1 Switch #2 to the default value. Replace switch acturator or faulty microswitch
2040 14 3 1	AGSP #1 Switch #3, microswitch inputs are in an invalid state. Both microswitches are not depressed. The ESC sets the status of AGSP #1 Switch #3 to the default value. Replace switch acturator
2040 14 3 2	AGSP #1 Switch #3, microswitch inputs are in an invalid state. Both microswitches are depressed. The ESC sets the status of AGSP #1 Switch #3 to the default value. Replace faulty microswitch
2040 14 3 3	AGSP #1 Switch #3, microswitch inputs are in an invalid state. Top microswitch depressed, bottom microswitch not depressed. The ESC sets the status of AGSP #1 Switch #3 to the default value. Replace switch acturator
2040 14 3 4	AGSP #1 Switch #3, microswitch inputs are in an invalid state. Top microswitch not depressed, bottom microswitch depressed. The ESC sets the status of AGSP #1 Switch #3 to the default value. Replace switch acturator
2040 14 3 5	AGSP #1 Switch #3, This switch should be empty but one or both of the microswitches is pressed. The ESC sets the status of AGSP #1 Switch #3 to the default value. Replace switch acturator or faulty microswitch
2040 14 4 1	AGSP #1 Switch #4, microswitch inputs are in an invalid state. Both microswitches are not depressed. The ESC sets the status of AGSP #1 Switch #4 to the default value. Replace switch acturator

Table 31 AGSP Diagnostic Trouble Codes (cont.)

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
2040 14 4 2	AGSP #1 Switch #4, microswitch inputs are in an invalid state. Both microswitches are depressed. The ESC sets the status of AGSP #1 Switch #4 to the default value. Replace faulty microswitch
2040 14 4 3	AGSP #1 Switch #4, microswitch inputs are in an invalid state. Top microswitch depressed, bottom microswitch not depressed. The ESC sets the status of AGSP #1 Switch #4 to the default value. Replace switch acturator
2040 14 4 4	AGSP #1 Switch #4, microswitch inputs are in an invalid state. Top microswitch not depressed, bottom microswitch depressed. The ESC sets the status of AGSP #1 Switch #4 to the default value. Replace switch acturator
2040 14 4 5	AGSP #1 Switch #4, This switch should be empty but one or both of the microswitches is pressed. The ESC sets the status of AGSP #1 Switch #4 to the default value. Replace switch acturator or faulty microswitch
2040 14 5 1	AGSP #1 Switch #5, microswitch inputs are in an invalid state. Both microswitches are not depressed. The ESC sets the status of AGSP #1 Switch #5 to the default value. Replace switch acturator
2040 14 5 2	AGSP #1 Switch #5, microswitch inputs are in an invalid state. Both microswitches are depressed. The ESC sets the status of AGSP #1 Switch #5 to the default value. Replace faulty microswitch
2040 14 5 3	AGSP #1 Switch #5, microswitch inputs are in an invalid state. Top microswitch depressed, bottom microswitch not depressed. The ESC sets the status of AGSP #1 Switch #5 to the default value. Replace switch acturator

Table 31 AGSP Diagnostic Trouble Codes (cont.)

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
2040 14 5 4	AGSP #1 Switch #5, microswitch inputs are in an invalid state. Top microswitch not depressed, bottom microswitch depressed. The ESC sets the status of AGSP #1 Switch #5 to the default value. Replace switch acturator
2040 14 5 5	AGSP #1 Switch #5, This switch should be empty but one or both of the microswitches is pressed. The ESC sets the status of AGSP #1 Switch #5 to the default value. Replace switch acturator or faulty microswitch
2040 14 6 1	AGSP #1 Switch #6, microswitch inputs are in an invalid state. Both microswitches are not depressed. The ESC sets the status of AGSP #1 Switch #6 to the default value. Replace switch acturator
2040 14 6 2	AGSP #1 Switch #6, microswitch inputs are in an invalid state. Both microswitches are depressed. The ESC sets the status of AGSP #1 Switch #6 to the default value. Replace faulty microswitch
2040 14 6 3	AGSP #1 Switch #6, microswitch inputs are in an invalid state. Top microswitch depressed, bottom microswitch not depressed. The ESC sets the status of AGSP #1 Switch #6 to the default value. Replace switch acturator
2040 14 6 4	AGSP #1 Switch #6, microswitch inputs are in an invalid state. Top microswitch not depressed, bottom microswitch depressed. The ESC sets the status of AGSP #1 Switch #6 to the default value. Replace switch acturator
2040 14 6 5	AGSP #1 Switch #6, This switch should be empty but one or both of the microswitches is pressed. The ESC sets the status of AGSP #1 Switch #6 to the default value. Replace switch acturator or faulty microswitch

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the gauge.

Refer to Air Application Gauge Transducer Circuits.

4.9. MALFUNCTIONING AGSP SWITCHES

Fault Detection/Management

Malfunctions in the AGSP switches can be caused by improper programming, a broken switch actuator, breaks in the circuit board, or a problem in the microprocessor.

When an AGSP is replaced, the current AGSP programming will be taught to the new assembly by the ESC. No manual programming should be required.

4.10. CHECK ELECTRICAL SYSTEM WARNING LAMP

Circuit Function

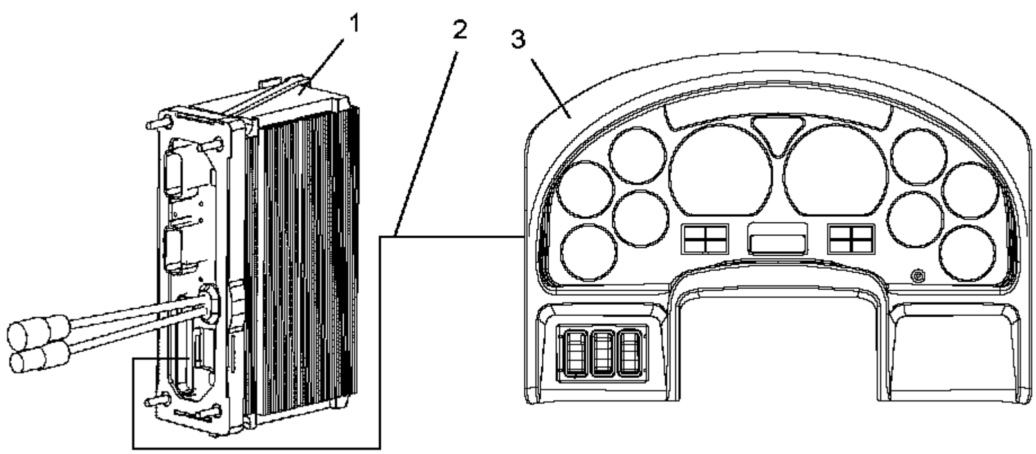


Figure 89 Check Electrical System Warning Lamp Function Diagram

1. ELECTRICAL SYSTEM CONTROLLER (ESC)
2. DRIVE TRAIN 1939 DATA LINK
3. ELECTRONIC GAUGE CLUSTER (EGC)

The check electrical system warning lamp will light and stay on any time the EGC loses communication with the ESC or power to ESC connector (4009) or (4010). The lamp will also light if communication from the engine controller is lost. The gauges controlled by the ESC will go to zero if communication between the EGC and ESC is lost. The gauges controlled by the engine controller will go to zero if communication between the EGC and engine controller is lost.

The check electrical system warning lamp should light during the EGC gauge sweep, after the key is turned to the ignition position. If the lamp doesn't light during the gauge sweep the lamp could be burned out or there may be a problem in the EGC.

The check electrical system warning lamp should come on for 1 minute when a fault is detected by the ESC.

Fault Detection/Management

If the stays on continuously and none of the gauges are working correctly after the gauge sweep, the EGC is not communicating on the Drivetrain 1939 Data Link or there is a problem with the data link. Refer to Drivetrain 1939 Data Link. (See DRIVETRAIN 1939 DATA LINK, page 60)

If the lamp stays on continuously when no active faults are present or doesn't come on when active faults are present, the problem may be in ESC/EGC programming or ESC/EGC hardware.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to turn all warning lamps on and off. The service tool can also be used to verify if the problem is limited to the ESC, EGC or the data link.

4.11. RANGE INHIBITED WARNING LAMP

System Function

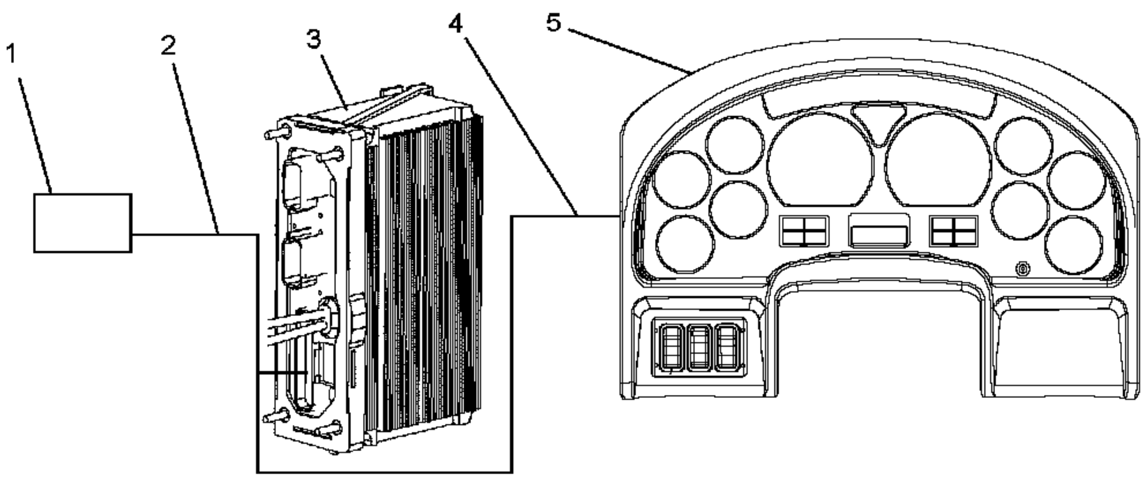


Figure 90 Range Inhibited Warning Lamp Function Diagram

1. TRANSMISSION CONTROL MODULE (TCM)
2. DRIVE TRAIN 1939 DATA LINK
3. ELECTRICAL SYSTEM CONTROLLER (ESC)
4. DRIVE TRAIN 1939 DATA LINK
5. ELECTRONIC GAUGE CLUSTER (EGC)

If an Allison automatic transmission is installed on the vehicle, the range inhibited warning lamp should light during the EGC gauge sweep after the key is turned to the ignition position. If the lamp doesn't light during the gauge sweep the lamp could be burned out or there may be a problem in the EGC.

The range inhibited warning lamp lights when the transmission controller (only used with electronic transmissions) has restricted shifting.

This may be due to a problem in the transmission or use of a P.T.O.

See the manual for the specific transmission installed in the vehicle if a problem is suspected.

Diagnostics

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the warning lamp.

The service tool (EZ-Tech) running transmission diagnostic software can also be used to verify correct operation of the range inhibited warning lamp and check for faults logged in the transmission control module. See the appropriate transmission service manual for information on using the diagnostic software.

If the lamp stays on continuously or doesn't come on when commanded by the transmission controller, the problem may be in ESC/EGC programming or ESC/EGC hardware.

Table 32 Range Inhibited Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	On	Verify range inhibited warning lamp is malfunctioning.	Range inhibited warning lamp is on only when transmission range is inhibited.	Problem doesn't exist or is intermittent.	Go to next step.
2.	Off/ On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programing in the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)
3.	On	Attempt to exercise the range inhibited warning lamp with the "INTUNE" diagnostic software.	Range inhibited warning lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
4.	On	Use "INTUNE" diagnostic software to verify range inhibited commands from the transmission controller are being generated and match transmission status.	Commands from the transmission controller are being generated and match transmission status.	Go to next step.	Message from transmission controller is not being transmitted. Refer to the troubleshooting manual for the transmission installed in the vehicle.
5.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC

Table 32 Range Inhibited Warning Lamp Preliminary Check (cont.)

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
				Replace circuit board on original EGC.	REPLACEMENT, page 123)

4.12. ECONOMY MODE WARNING LAMP

System Function

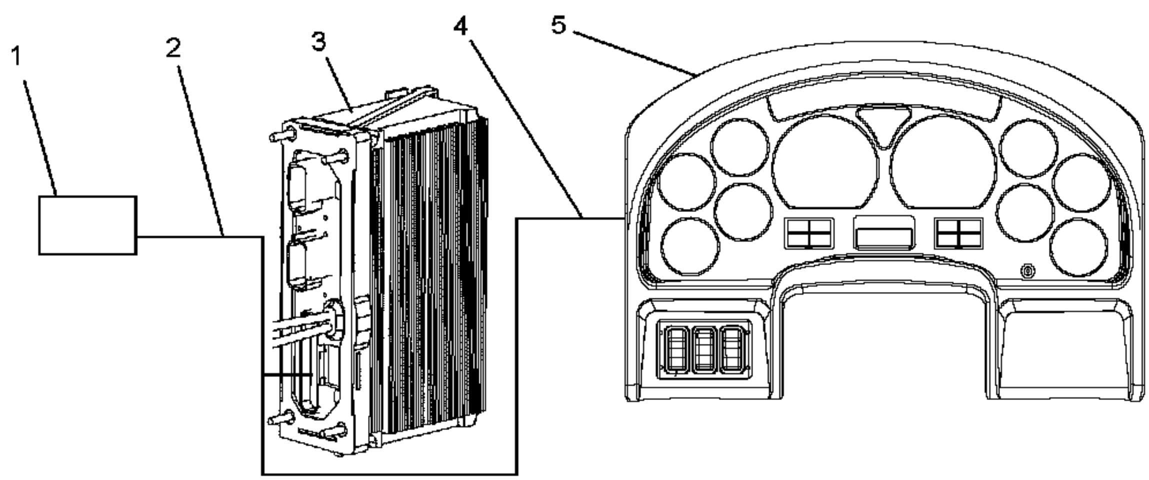


Figure 91 Economy Mode Function Diagram

1. TRANSMISSION CONTROL MODULE (TCM) FROM THE SHIFTER MODE BUTTON
2. DRIVE TRAIN 1939 DATA LINK
3. ELECTRICAL SYSTEM CONTROLLER (ESC)
4. DRIVE TRAIN 1939 DATA LINK
5. ELECTRONIC GAUGE CLUSTER (EGC)

The "ECON" lamp indicates the transmission is using it's secondary shift schedule. The operator selects this shift schedule using a button on the shifter. Normal function, you press the MODE button once, the ECON lamp turns on, you press the button again, the ECON lamp turns off.

If an Allison automatic transmission is installed on the vehicle, the economy mode warning lamp should light during the EGC gauge sweep after the key is turned to the ignition position. If the lamp doesn't light during the gauge sweep the lamp could be burned out or there may be a problem in the EGC.

The economy mode warning lamp lights when the transmission is using it's secondary shift schedule.

See the manual for the specific transmission installed in the vehicle if a problem is suspected.

Fault Detection/Management

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the warning lamp.

For the WT's: The MODE button is used. The activation of the button is communicated over existing shifter wiring. If the lamp doesn't turn on when requested, make sure the shifter is communicating with the TCM (will the truck go into gear?), make sure the TCM is communicating to the ESC (fault code for missing trans message?), make sure the ESC is communicating to the cluster (fault code for missing cluster or ESC message?), and make sure the lamp in the cluster works (bulb check at gauge sweep or use diagnostic tool).

For the LCT's: The button on the shift lever is used. The contacts on this button connect to two pins on the transmission controller. If the lamp doesn't turn on when requested, make sure the shifter is communicating with the TCM (do the wires at the TCM short and open with the switch is cycled?), make sure the TCM is communicating to the ESC (fault code for missing trans message?), make sure the ESC is communicating to the cluster (fault code for missing cluster or ESC message?), and make sure the lamp in the cluster works (bulb check at gauge sweep or use diagnostic tool).

The service tool (EZ-Tech) running transmission diagnostic software can also be used to verify correct operation of the economy mode warning lamp and check for faults logged in the transmission control module. See the appropriate transmission service manual for information on using the diagnostic software.

If the lamp stays on continuously or doesn't come on when commanded by the transmission controller, the problem may be in ESC/EGC programming or ESC/EGC hardware.

Table 33 Economy Mode Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	On	Verify Economy Mode lamp is malfunctioning.	Economy Mode lamp is on when running engine is cold.	Go to next step.	Problem doesn't exist or is intermittent.
2.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)
3.	On	Attempt to exercise the warning lamp with the "INTUNE" diagnostic software.	Warning lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.

Table 33 Economy Mode Lamp Preliminary Check (cont.)

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
4.	On	Use "INTUNE" diagnostic software to verify Economy Mode commands from the transmission controller are being generated and match transmission status.	Commands from the transmission controller are being generated and match transmission status.	Go to next step.	Message from transmission controller is not being transmitted. Refer to the troubleshooting manual for the transmission installed in the vehicle.
5.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 123)

4.13. FUEL FILTER WARNING LAMP

Circuit Functions

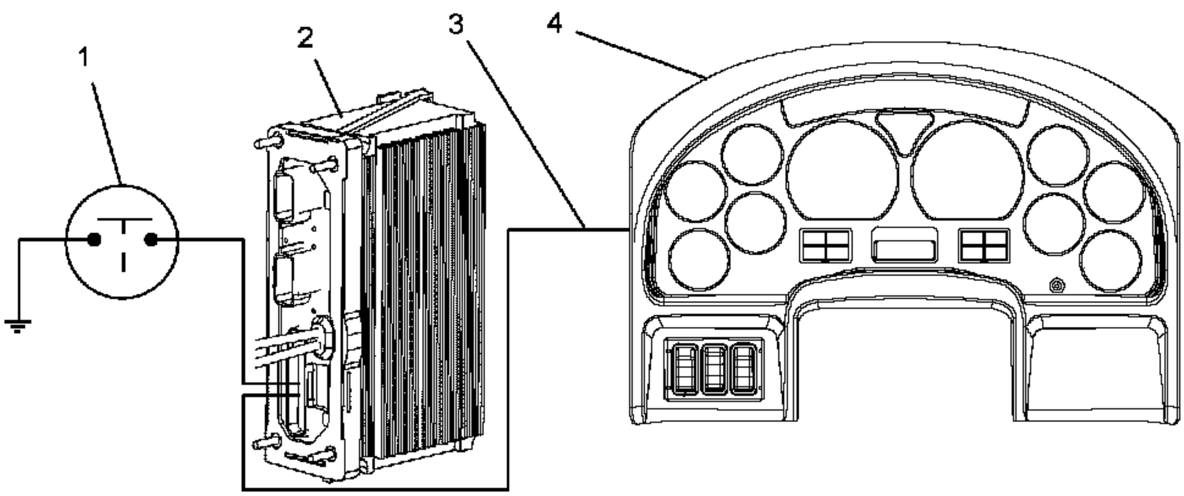


Figure 92 Fuel Filter Warning Lamp Function Diagram

1. VACUUM SWITCH
2. ELECTRICAL SYSTEM CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

The fuel filter warning lamp should light during the EGC gauge sweep, after the key is turned to the ignition position. If the lamp doesn’t light during the gauge sweep the lamp could be burned out or there may be a problem in the EGC.

The fuel filter warning lamp lights when there is a restriction in the fuel filter system. A vacuum switch in the fuel filter provides a ground to the ESC which will generate the signal to activate the lamp. The light should go out when the fuel restriction is removed.

The most probable cause of a warning lamp malfunction, other than a burned out lamp, is a problem with the vacuum sensor.

Diagnostics

The electronic service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the light and monitor activation of the fuel filter vacuum switch.

Table 34 Fuel Filter Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	On	Fuel filter warning lamp is malfunctioning.	Fuel filter warning lamp is only on when fuel is restricted.	Problem doesn't exist or is intermittent.	Go to next step.
2.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)
3.	On	Attempt to exercise the warning lamp with the "INTUNE" diagnostic software.	Warning lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
4.	On	Use "INTUNE" diagnostic software to monitor vacuum switch circuit inputs to the ESC.	Vacuum switch circuit inputs to the ESC match fuel restriction.	Go to next step.	Go to Fault Detection Management. (See Fault Detection Management, page 184)
5.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 123)

Fault Detection Management

The electronic service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the light and monitor activation of the fuel filter vacuum switch.

If the lamp stays on when there is no restriction or doesn't come on when there is a fuel restriction, the problem may be in ESC/EGC programming, ESC/EGC hardware or problems with the vacuum switch or wiring.

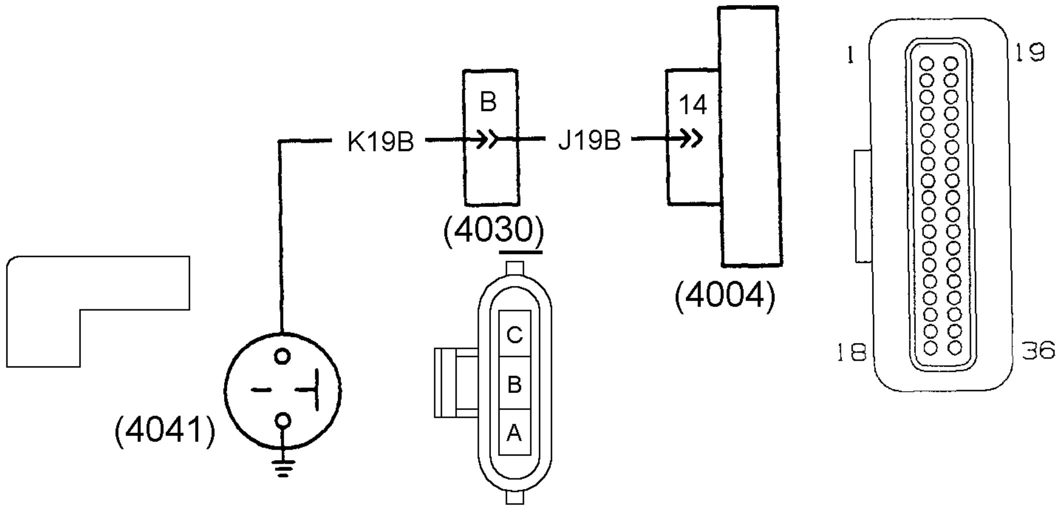


Figure 93 Fuel Filter Sensor Wiring to ESC

1. FUEL FILTER VACUUM SWITCH (4041)
   LOCATED ON FUEL FILTER
2. FUEL FILTER WARNING LIGHT CONNECTOR (4030)
   LOCATED AT FUEL FILTER
3. ELECTRICAL SYSTEM CONTROLLER CONNECTOR (4004)
   LOCATED ON ENGINE SIDE OF ESC

Table 35 Fuel Filter Warning Lamp Voltage Check Chart

Fuel Filter Warning Lamp Connector (4041) Voltage Checks (Check with Vacuum Switch Pigtail Disconnected and the Ignition Key “On”) **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**		
Test Points	Spec.	Comments
(4041) harness connector, cavity B to ground.	12 ± 1.5 volts	If voltage is correct the sensor is defective. If voltage is incorrect, check circuit J19B and K19B for an open or short. If no shorts or opens exist and voltage is not being supplied by ESC. Consider replacing ESC. Refer to ESC Replacement in this manual. (See ESC REPLACEMENT, page 123)
Fuel Filter Warning Light Connector (4041) Resistance Checks (Check with Vacuum Switch Pigtail Disconnected and the Ignition Key “Off”)		
Test Points	Spec.	Comments
(4041) connector on fuel filter, terminal A on vacuum switch to ground.	> 100K ohms.	If resistance is incorrect, the vacuum switch is stuck closed or there is a restriction in the fuel line.
There are no diagnostic trouble codes associated with this feature.		

Extended Description

When there is a restriction in the fuel line, the fuel filter vacuum switch will close supplying ground through the switch, fuel warning light connector (4030) terminal B, and circuit J19B to system controller connector (4004) terminal 14.

The light will go out when the fuel filter has been replaced or the fuel restriction is removed.

The EGC activates the fuel filter indicator when it receives a message on the drivetrain 1939 data link from the ESC.

Component Locations

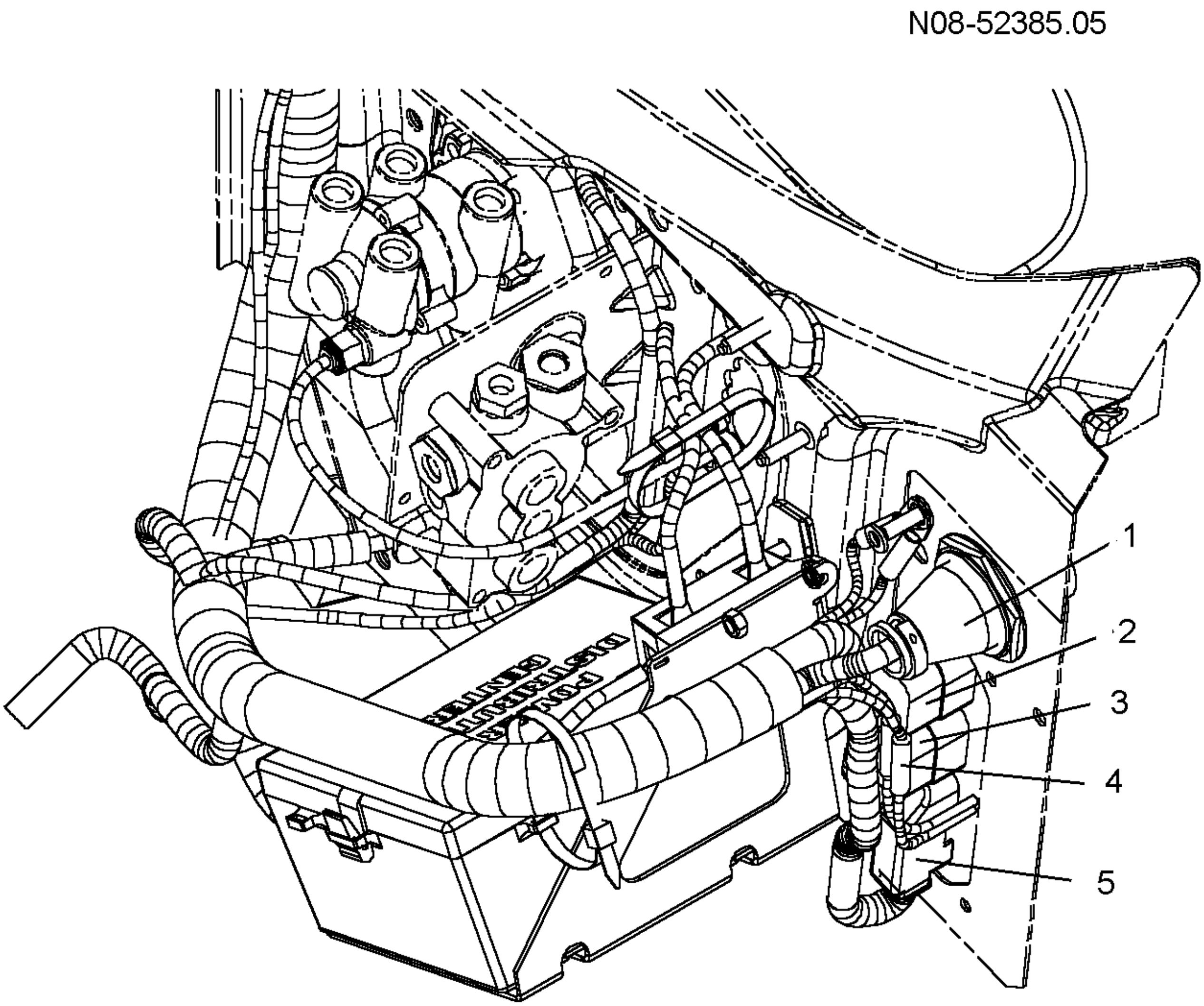


Figure 94 Engine ESC Connector Location

1. 48 WAY DASH CONNECTOR (4014)
2. 8 WAY (4008)
3. 8 WAY (4007)
4. POWER CONNECTORS (4009) & (4010)
5. 36 WAY CONNECTOR (4004)

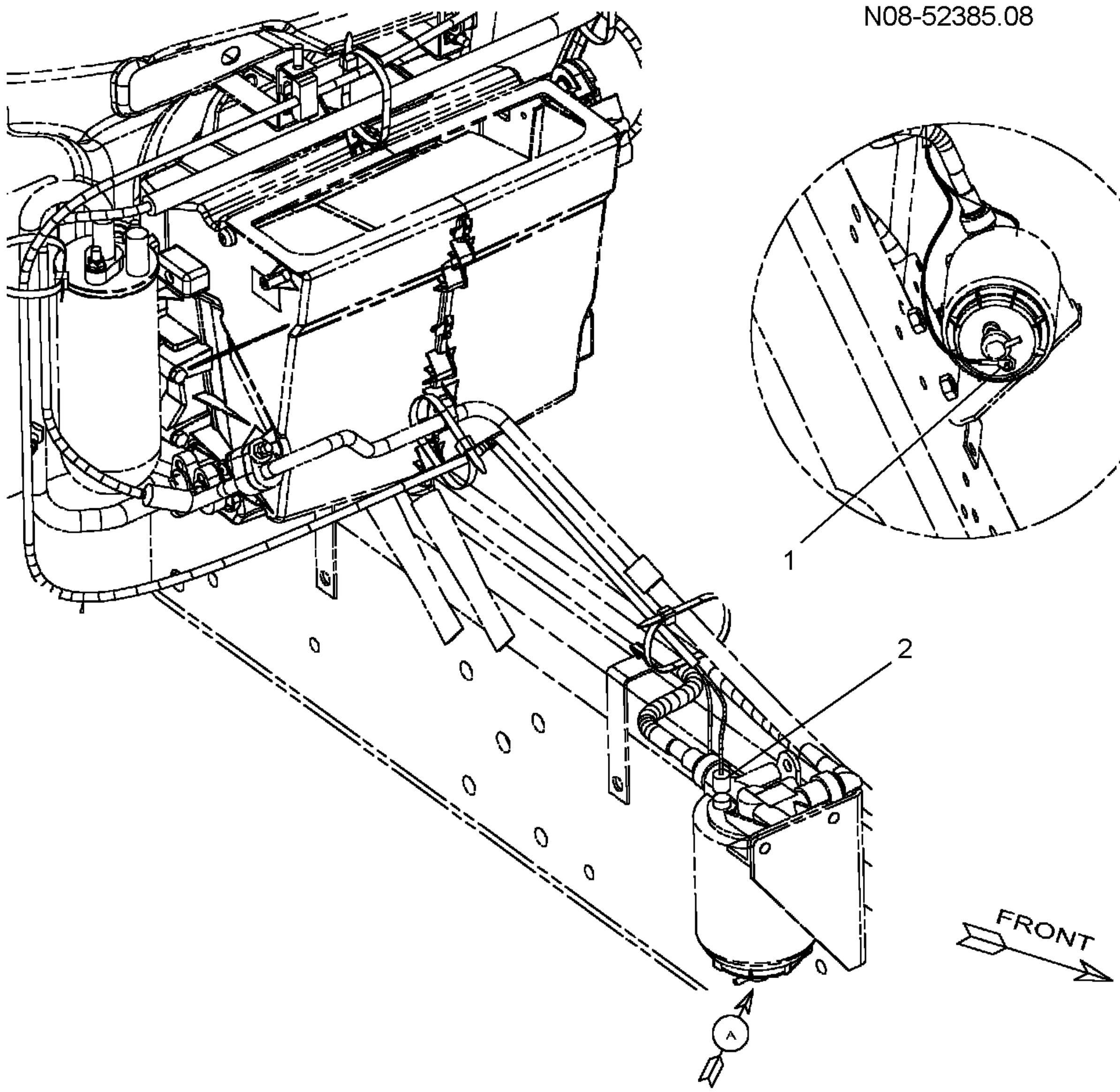


Figure 95 Fuel Filter Sensor Location

1. WIF LIGHT FUEL FILTER VACUUM SWITCH (4041)
2. FUEL HEATER CONNECTOR

4.14. “YELLOW” ENGINE WARNING LAMP

Circuit Function

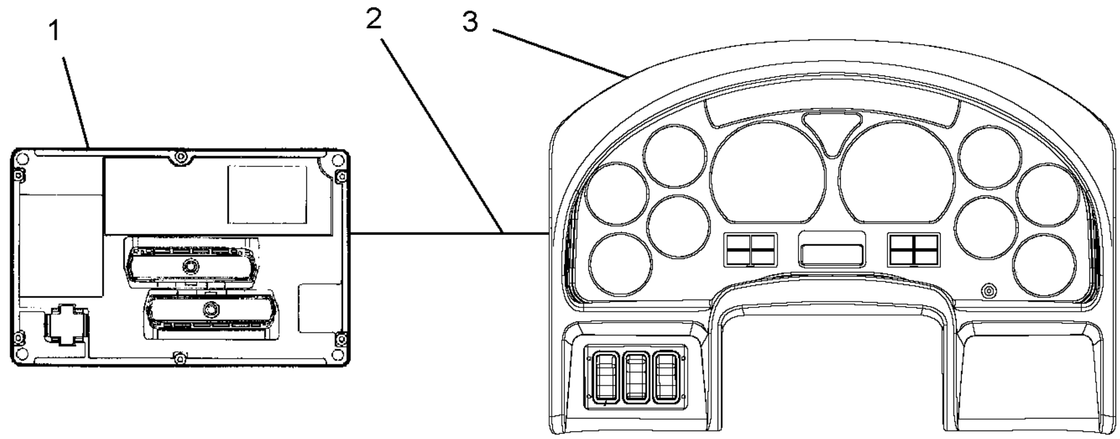


Figure 96 Yellow Engine Lamp Function Diagram

1. ELECTRONIC ENGINE CONTROLLER
2. DRIVE TRAIN 1939 DATA LINK
3. ELECTRONIC GAUGE CLUSTER (EGC)

The "yellow" engine lamp should light should be commanded on by engine controller, during the EGC gauge sweep, after the key is turned to the ignition position.

The "yellow" engine lamp should light when the engine controller detects certain faults. The light will be accompanied with a message on the odometer display.

The light will go out when the fault is cleared from the engine controller.

If the lamp stays on continuously when not commanded by the engine controller or doesn’t come on when commanded by the engine controller, the problem may be in ESC/EGC programming or ESC/EGC hardware.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software will **not** check operation of the light.

The service tool (EZ-Tech) running the Master Diagnostics software will list diagnostic trouble codes in the engine controller.

See the engine diagnostic manual on the engine installed in the truck for details.

Diagnostics

Table 36 Yellow Engine Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	On	Put the vehicle in diagnostic mode and check for activation of the warning lamp.	Warning lamp responds to EGC diagnostic mode.	Warning lamp is operating.	Go to next step.
2.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	If LED in warning lamp is good, replace circuit board on original EGC.	There is a problem in the engine controller. Refer to the troubleshooting manual for the engine controller installed on the truck.

4.15. “RED” ENGINE WARNING LAMP

Circuit Function

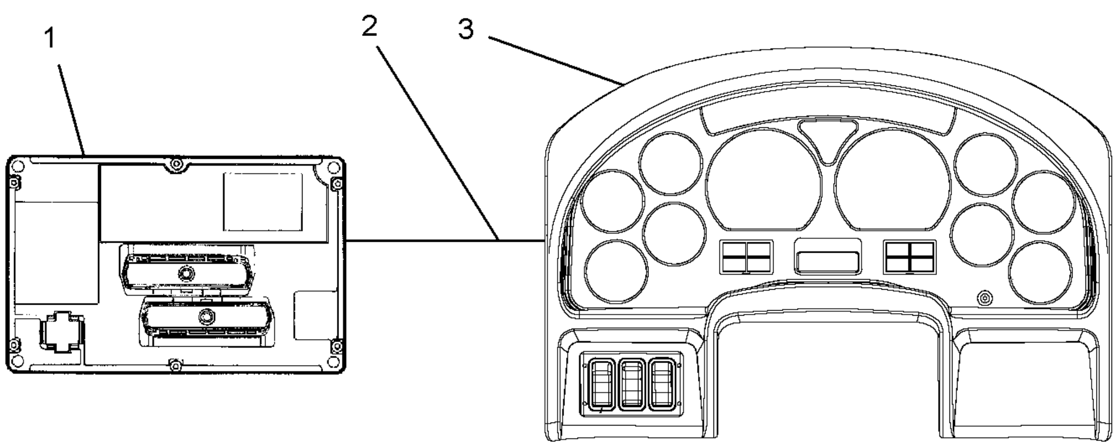


Figure 97 “Red” Engine Warning Lamp Function Diagram

1. ELECTRONIC ENGINE CONTROLLER
2. DRIVE TRAIN 1939 DATA LINK
3. ELECTRONIC GAUGE CLUSTER (EGC)

The "red" engine warning lamp should light while the key is turned to the ignition position and the engine is not running.

If the lamp stays on continuously when not commanded by the engine controller or doesn’t come on when commanded by the engine controller, the problem may be in ESC/EGC programming or ESC/EGC hardware.

The EGC activates the "red" engine warning indicator when it receives a message on the Drivetrain 1939 data link from the engine controller. The engine controller will send this message when warning thresholds for coolant temperature, coolant level and/or low engine oil pressure have been exceeded. The indicator lamp will be accompanied by a message on the odometer display and the EGC alarm will sound.

The light will go out when the condition is resolved and the fault is cleared from the engine controller.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to turn on all of the warning lamps

See the engine diagnostic manual, EGES 215, for detailed information on operation of this warning lamp.

Diagnostics

Table 37 “Red” Engine Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	On	Put the vehicle in diagnostic mode and check for activation of the warning lamp.	Warning lamp responds to EGC diagnostic mode.	Warning lamp is operating.	Go to next step.
2.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	If LED in warning lamp is good, replace circuit board on original EGC.	There is a problem in the engine controller. Refer to the troubleshooting manual for the engine controller installed on the truck.

4.16. BRAKE PRESSURE WARNING LAMP

Circuit Function

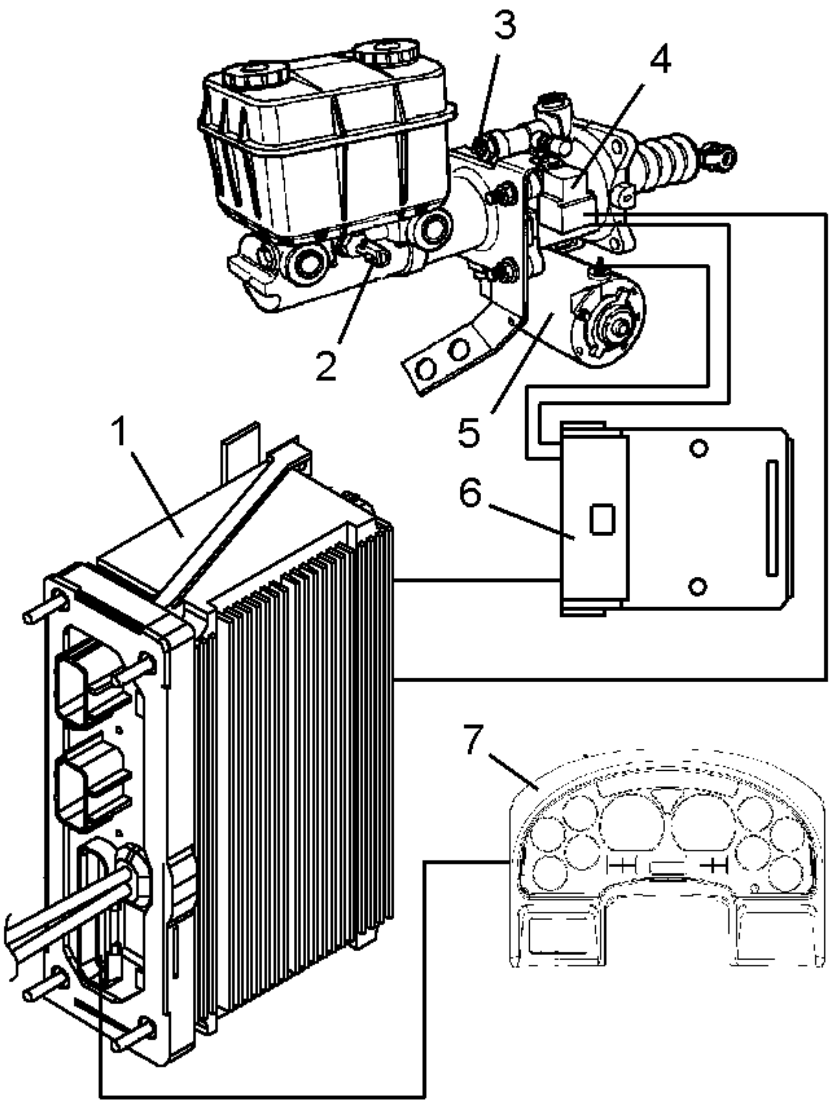


Figure 98 Brake Pressure Warning Lamp Function Diagram

1. ELECTRICAL SYSTEM CONTROLLER
2. DIFFERENTIAL PRESSURE SWITCH
3. FLOW SWITCH
4. HYDROMAX PUMP RELAY
5. HYDROMAX PUMP
6. HYDROMAX BRAKE MODULE
   LOCATED BEHIND INSTRUMENT PANEL
7. ELECTRONIC GAUGE CLUSTER

The brake pressure warning lamp is only used with the hydraulic brake system. The EGC activates the brake pressure warning lamp when it receives a message on the Drivetrain 1939 data link from the ESC. An alarm should sound while the lamp is illuminated. The ESC generates this information based on input from the Hydromax brake monitor module. The brake module monitors a circuit from the differential pressure switch and the power steering pump flow switch as well as a circuit from the pump motor.

The light will go out when the condition is resolved.

The brake pressure warning lamp should light during the EGC gauge sweep, after the key is turned to the ignition position. If the lamp doesn't light during the gauge sweep the lamp could be burned out or there may be a problem in the EGC.

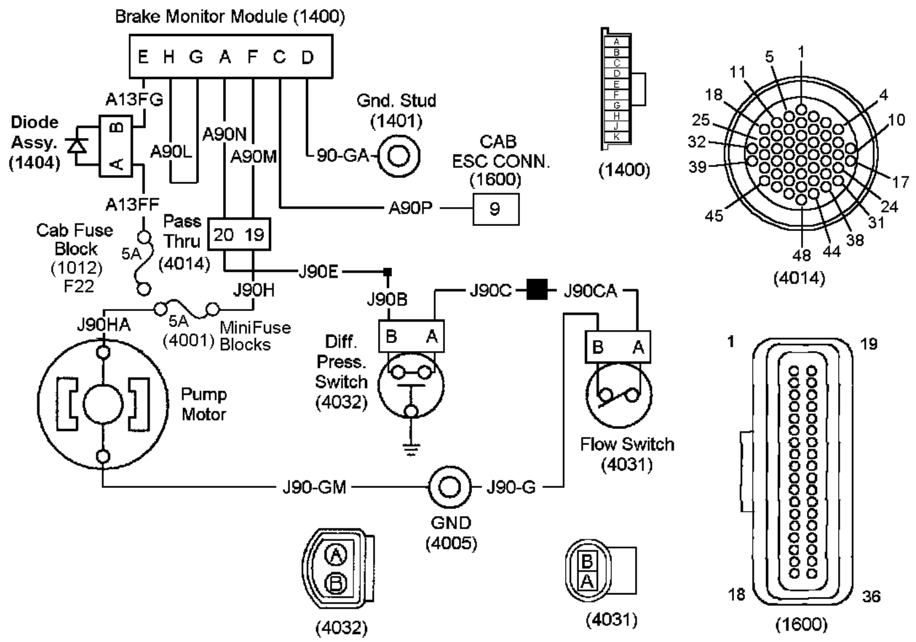


Figure 99 Hydromax Monitor Module And Warning Circuits—Always Refer To Circuit Diagram Book For Latest Circuit Information

(1400) HYDROMAX MONITOR MODULE
LOCATED IN INSTRUMENT PANEL
(1600) 36–WAY ELECTRICAL SYSTEM CONTROLLER CONNECTOR
LOCATED ON CAB SIDE OF ESC
(4005) GROUND STUD
(4014) PASS THROUGH CONNECTOR
LOCATED ON DASH PANEL ABOVE ESC
(4031) FLOW SWITCH CONNECTOR
LOCATED ON HYDROMAX BOOSTER ASSEMBLY
(4032) DIFFERENTIAL PRESSURE SWITCH CONNECTOR
LOCATED BELOW BRAKE FLUID RESERVOIR ASSEMBLY

Diagnostics

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can command the ESC to turn on all of the warning lamps. This will verify that the EGC is working and communicating on the data link.

If the lamp illuminates when there are no problems in the brake system or doesn't illuminate when conditions exist that should turn it on, the problem may be in ESC/EGC programming, ESC/EGC hardware or problems with the sensors or sensor wiring to the ESC.

Table 38 Brake Pressure Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/ On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)
2.	On	Attempt to exercise the warning lamp with the "INTUNE" diagnostic software.	Warning lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
3.	On	Monitor the inputs to the ESC for the warning lamp with the "INTUNE" diagnostic software.	Inputs are correct.	Go to next step.	Refer to Monitor Module and Warning Circuit Inputs To ESC.
4.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 123)

4.17. TRACTION CONTROL LAMP

Circuit Function

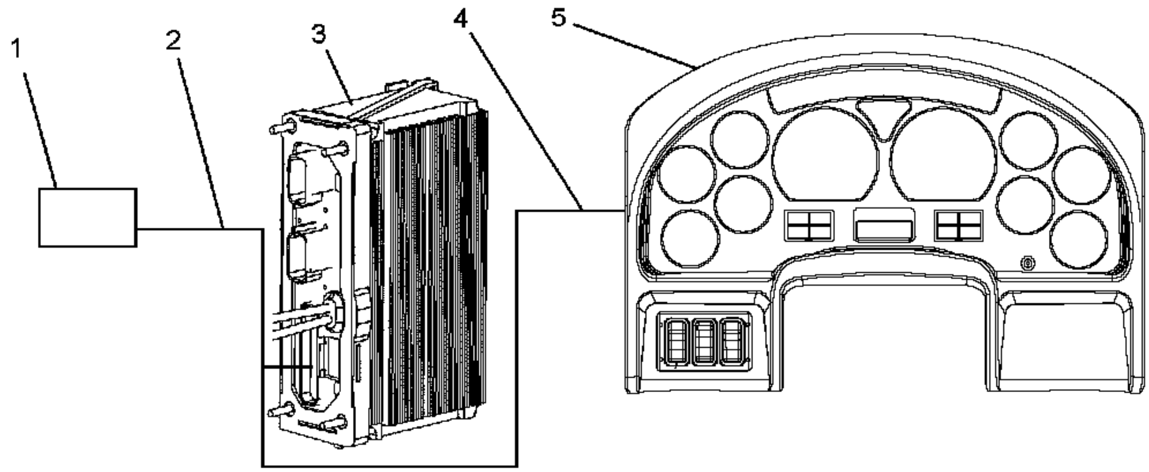


Figure 100 Traction Control Lamp Function Diagram

1. AIR ABS ELECTRONIC CONTROL MODULE
2. DRIVE TRAIN 1939 DATA LINK
3. ELECTRICAL SYSTEM CONTROLLER
4. DRIVE TRAIN 1939 DATA LINK
5. ELECTRONIC GAUGE CLUSTER (EGC)

The EGC activates the traction control indicator when it receives a message on the Drivetrain 1939 data link from the ESC. The ESC generates the command when it receives a command from the ABS controller. The ABS controller generates this information when traction control is activated.

Diagnostics

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can command the ESC to turn on all of the warning lamps. This will verify that the EGC is working and communicating on the data link.

If the lamp stays on continuously or doesn't come on when commanded by the ABS controller, the problem may be in ESC/EGC programming, ABS Controller/EGC hardware or problems with the sensors or sensor wiring to the ABS Controller.

Table 39 Traction Control Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/ On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)
2.	On	Attempt to exercise the warning lamp with the "INTUNE" diagnostic software.	Warning lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
3.	On	Monitor the commands to the ESC from the ABS controller with the "INTUNE" diagnostic software.	Commands are correct.	Go to next step.	Refer to the troubleshooting manual for the specific ABS controller.
4.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 123)

4.18. CHECK TRANSMISSION LAMP

Circuit Function

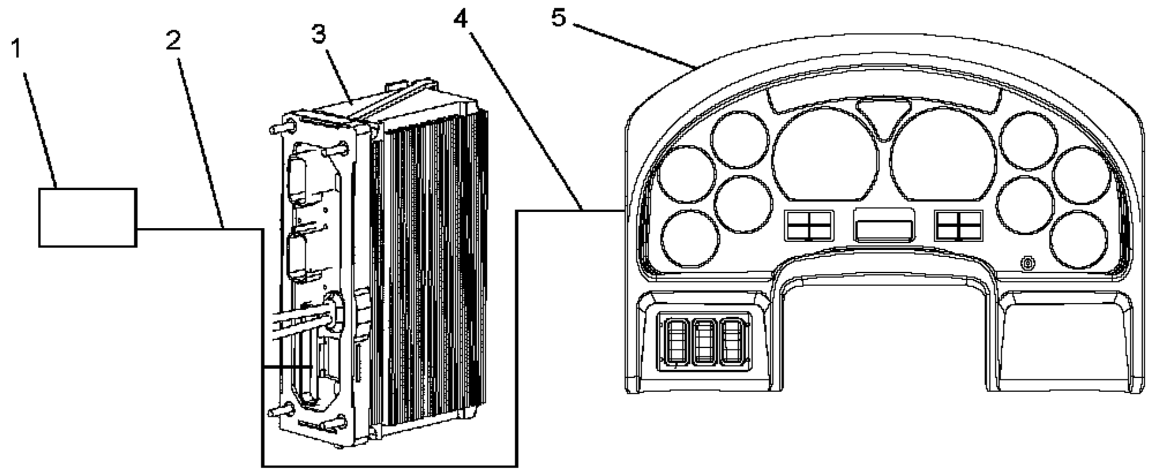


Figure 101 Check Transmission Lamp Function Diagram

1. TRANSMISSION CONTROL MODULE
2. DRIVE TRAIN 1939 DATA LINK
3. ELECTRICAL SYSTEM CONTROLLER
4. DRIVE TRAIN 1939 DATA LINK
5. ELECTRONIC GAUGE CLUSTER (EGC)

The EGC activates the check transmission lamp when it receives a message on the Drivetrain 1939 data link from the ESC. The ESC generates this message when the transmission controller notifies it that a fault has been detected.

The lamp should go out after the fault is corrected and cleared.

If the lamp stays on continuously or doesn't come on when commanded by the ESC, the problem may be in ESC/EGC programming, ESC/EGC hardware or problems with the sensors or sensor wiring to the transmission controller.

See the appropriate troubleshooting manual for the particular transmission installed in the truck for details.

Diagnostics

The service tool (EZ-Tech) running the “INTUNE” diagnostic software can command the ESC to turn on all of the warning lamps. This will verify that the EGC is working and communicating on the data link.

Table 40 Check Transmission Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	On	Check for transmission diagnostic codes. Refer to On-Line Diagnostics.(See ON-LINE DIAGNOSTICS, page 157)	**No** transmission diagnostic codes are present.	Go to next step.	Refer to the Transmission section of this manual.
2.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)
3.	On	Attempt to exercise the warning lamp with the "INTUNE" diagnostic software.	Warning Lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
4.	On	Monitor command from transmission controller to ESC with the "INTUNE" diagnostic software.	Commands are correct.	Go to next step.	Refer to the troubleshooting manual for the specific transmission installed on the truck.
5.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 123)

4.19. TRAILER ABS LAMP

Circuit Function

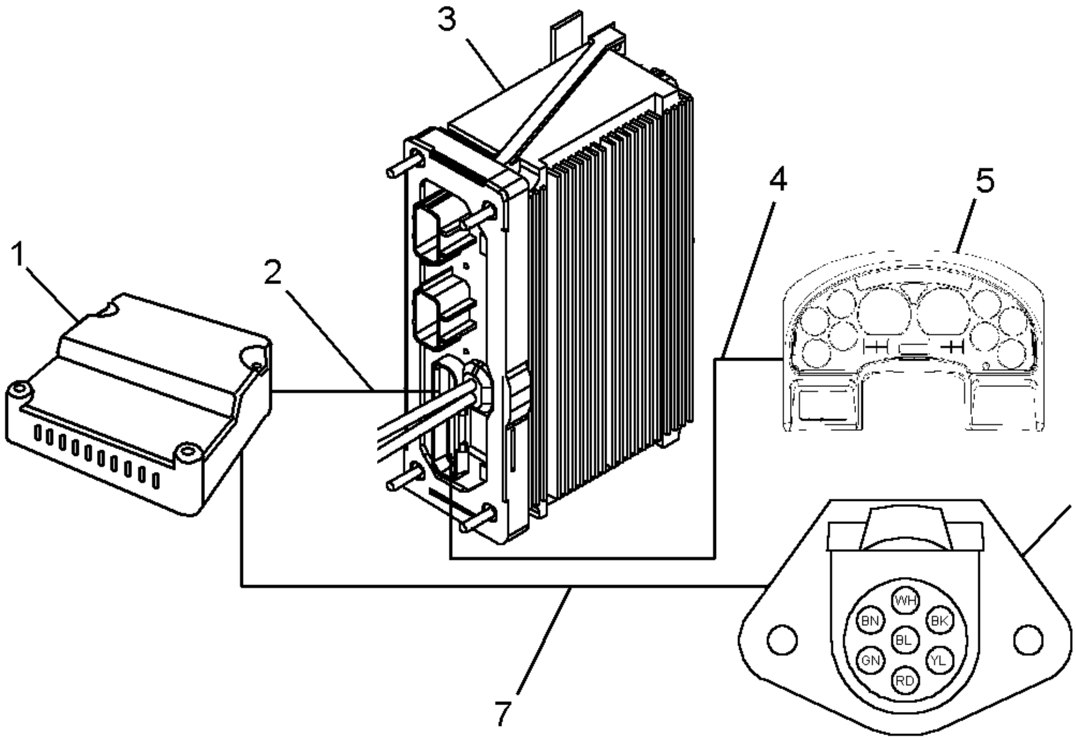


Figure 102 Trailer ABS Function Diagram

1. BENDIX EC-30 AIR ABS ELECTRONIC CONTROL UNIT
2. DRIVETRAIN 1939 DATA LINK
3. ELECTRICAL SYSTEM CONTROLLER
4. DRIVETRAIN 1939 DATA LINK
5. ELECTRONIC GAUGE CLUSTER
6. TRAILER SOCKET
7. POWER CIRCUITS TO AIR ABS CONTROLLER AND TRAILER SOCKET

Beginning March 1, 2001, all tractors used to tow trailers must have an in–cab trailer ABS warning lamp.

The request to illuminate this warning lamp originates from the air ABS controller and is communicated on the drive train 1939 data link. The air ABS controller also communicates with the trailer ABS controller over a power line carrier (PLC) on the blue wire of the trailer electrical socket.

The EGC activates the ABS warning lamp when it receives a message on the Drivetrain 1939 data link from the ESC. The ESC commands the EGC when it receives a message from the air ABS controller. The air ABS controller generates this information when it detects a fault from the trailer ABS controller or when trailer ABS is active.

The lamp should go out after the trailer ABS event is over, the fault is corrected and cleared or the trailer is disconnected.

See the appropriate air ABS and trailer ABS troubleshooting manuals for details.

Diagnostics

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can command the ESC to turn on all of the warning lamps. This will verify that the EGC is working and communicating on the data link.

If the lamp stays on continuously or doesn't come on when commanded by the trailer ABS controller, the problem may be in ESC/EGC programming, air ABS controller problems, EGC hardware or problems with the trailer ABS controller.

See the appropriate air ABS and trailer ABS troubleshooting manuals for details.

Table 41 Trailer ABS Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)
2.	On	Attempt to exercise the warning lamp with the "INTUNE" diagnostic software.	Warning Lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
3.	On	Monitor commands from the ABS controller to the ESC with the "INTUNE" diagnostic software.	Commands from ABS controller are correct.	Go to next step.	Refer to the troubleshooting manual for the air ABS installed on the truck.
4.	On	Check for Trailer ABS Lamp diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 201) Read display on odometer.	Trailer ABS Lamp diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 201)	Go to next step
5.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 123)

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 42 Trailer ABS Lamp Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
2023 14 150 9 or 2023 14 250 9	Trailer ABS warning light malfunction on primary EGC (150) or secondary EGC (250)

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

Extended Description

When the ignition is on the trailer ABS center pin relay will energize providing battery voltage to the blue connector of the trailer socket and the trailer ABS controller, when an ABS equipped trailer is connected.

The trailer ABS controller will transmit information to the air ABS controller over the battery power circuits.

When the air ABS controller receives a command from the trailer ABS controller the air ABS controller will transmit a message to the ESC to command the trailer ABS warning lamp on.

4.20. WASHER FLUID LOW WARNING LAMP

Circuit Function

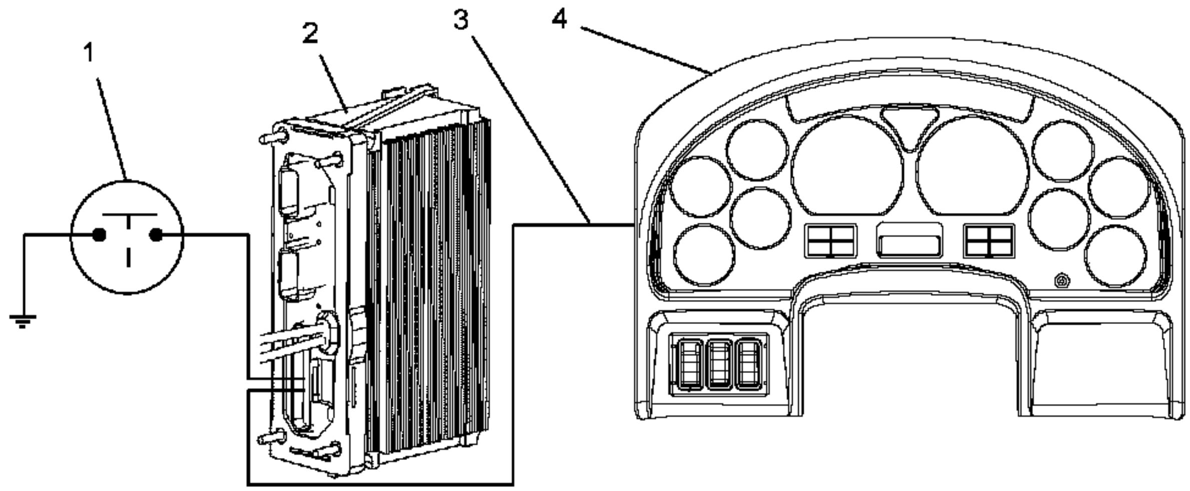


Figure 103 Washer Fluid Low Warning Lamp

1. WASHER FLUID LEVEL SENSOR
2. ELECTRICAL SYSTEM CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

The washer fluid low warning lamp lights when the washer fluid level is low.

The light will go out when the condition is resolved and the fault is cleared from the system controller.

Diagnostics

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can command the ESC to turn on all of the warning lamps. This will verify that the EGC is working and communicating on the data link.

If the lamp stays on continuously or doesn't come on when commanded by the ESC, the problem may be in ESC/EGC programming, EGC hardware or problems with the input circuits to the ESC from washer fluid sensor.

Table 43 Washer Fluid Low Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)

Table 43 Washer Fluid Low Warning Lamp Preliminary Check (cont.)

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
2.	On	Attempt to exercise the warning lamp with the "INTUNE" diagnostic software.	Warning Lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
3.	On	Monitor inputs from the washer fluid sensor with the "INTUNE" diagnostic software.	Inputs are correct.	Go to next step.	Go to Fault Detection Management. (See Fault Detection Management, page 203)
4.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 123)

Fault Detection Management

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can command the ESC to turn on all of the warning lamps. This will verify that the EGC is working and communicating on the data link.

If the lamp stays on continuously or doesn’t come on when the washer fluid level is low, the problem may be in ESC/EGC programming, ESC/EGC hardware or problems with the sensors or sensor wiring to the ESC.

Refer to Washer Fluid Level Sensor Circuits.

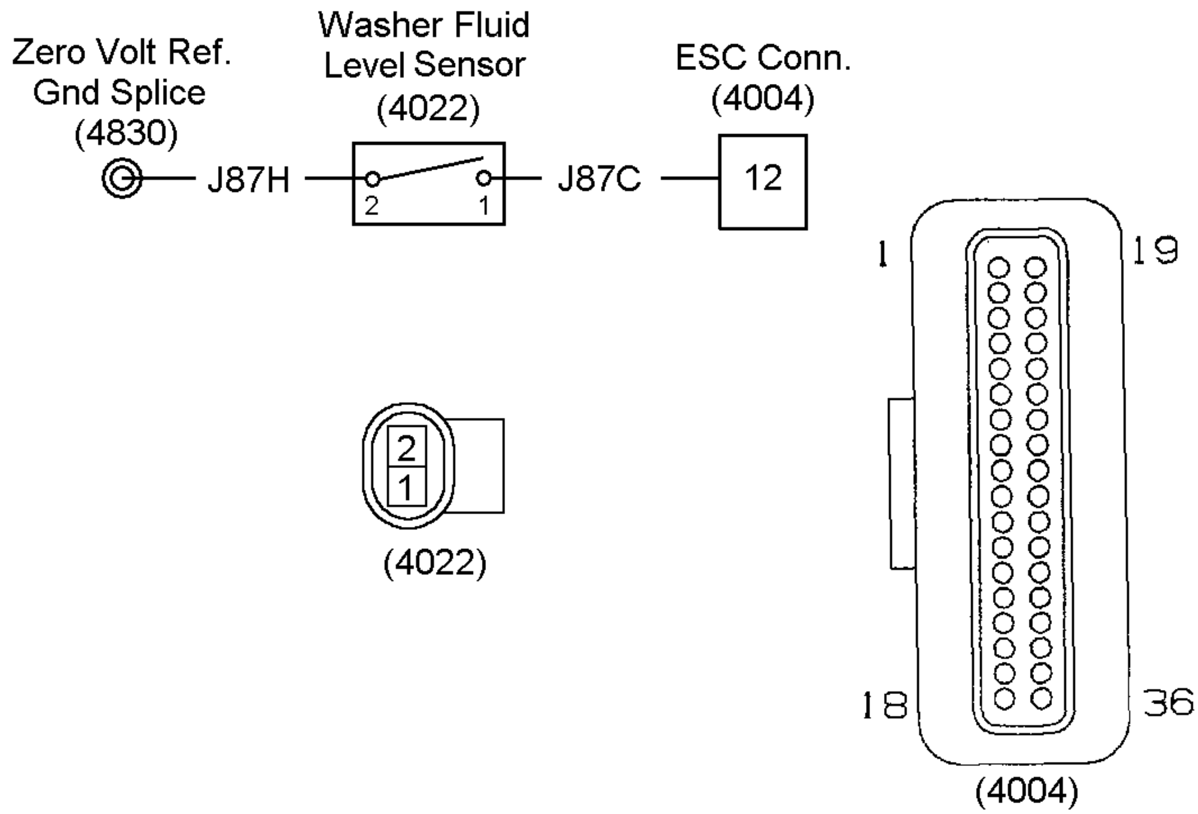


Figure 104 Washer Fluid Level Sensor Circuits

(4004) 36–WAY SYSTEM CONTROLLER CONNECTOR
ON ENGINE COMPARTMENT SIDE OF ESC
(4022) WASHER FLUID LEVEL SENSOR CONNECTOR
ON WASHER BOTTLE
(4830) ZERO VOLT REFERENCE GROUND SPLICE
LOCATED NEAR POWER DISTRIBUTION CENTER

Table 44 Washer Fluid Level Sensor Connector Chart

Diagnostic Trouble Codes		
There are no diagnostic trouble codes associated with the washer fluid level sensor circuits.		
Washer Fluid Level Sensor Harness Connector (4022) Voltage Checks Check with ignition on and (4022) disconnected.		
Test Points	Spec.	Comments
(4022) Harness connector, cavity 1 to ground	11 ± 1.5 volts	If voltage is missing, check for open or short in circuit J87C. If circuits check good and fault is still present, verify voltage out of ESC. **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**
Washer Fluid Level Sensor Harness Connector (4022) Resistance Checks Check with (4022) disconnected.		
Test Points	Spec.	Comments
(4022) Harness connector, cavity 2 to ground	<1 ohm	If resistance is incorrect, check for open in circuit J87H. Also insure proper signal at (4830) from ESC. **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**
Washer Fluid Level Sensor Resistance Checks Check at sensor with (4022) disconnected.		
Test Points	Spec.	Comments
Across washer fluid sensor terminals	Washer bottle empty; >50K ohms Washer bottle full; <1 ohm	If resistance is incorrect, replace failed sensor.

Extended Description

The ESC supplies 11 volts from system controller connector (4004) terminal 12 to washer fluid level sensor connector (4022) terminal 1.

Ground for the washer fluid level sensor is supplied from zero volt reference ground splice (4830) to washer fluid level sensor connector (4022) terminal 2.

When the washer fluid level drops below the switch, the switch will open removing the ground to the ESC. The ESC will send a message to the electronic gauge cluster commanding the washer fluid level warning light on.

4.21. WATER IN FUEL WARNING LAMP

Circuit Function

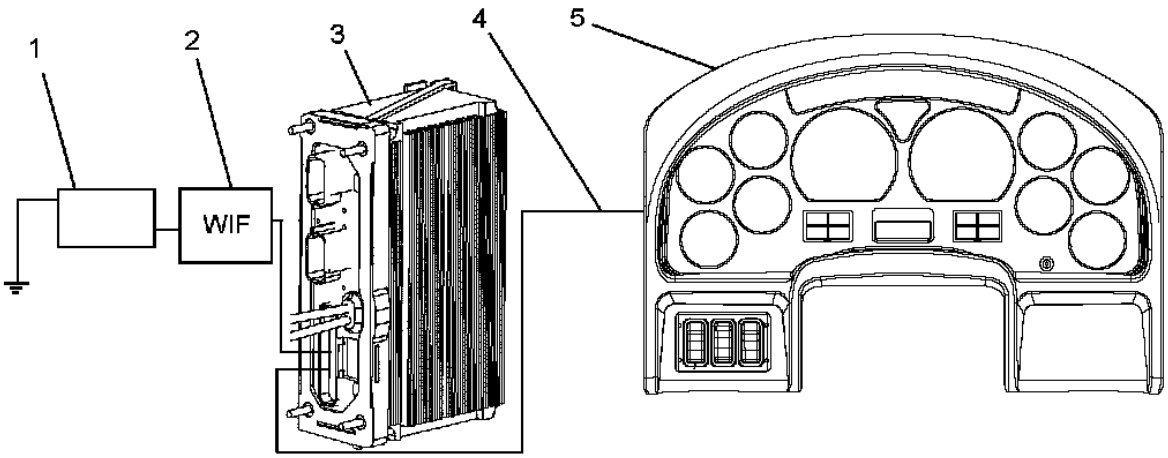


Figure 105 Water In Fuel Warning Lamp Function Diagram

1. WATER PROBE
2. WATER IN FUEL MODULE
3. ELECTRICAL SYSTEM CONTROLLER (ESC)
4. DRIVE TRAIN 1939 DATA LINK
5. ELECTRONIC GAUGE CLUSTER (EGC)

The EGC activates the water in fuel indicator when it receives a message on the Drivetrain 1939 data link from the ESC. The ESC will send this information based on input from the water in fuel (WIF) module.

A short in the water in fuel probe, water in fuel (WIF) module or wiring to the ESC can also cause the lamp to light.

Diagnostics

There are no diagnostic trouble codes associated with this feature.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can command the ESC to turn on all of the warning lamps. This will verify that the EGC is working and communicating on the data link.

If the lamp stays on continuously or doesn't come on when commanded by the ESC, the problem may be in ESC/EGC programming, EGC hardware or problems with the input circuits to the ESC from water in fuel module.

Table 45 Water in Fuel Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)
2.	On	Attempt to exercise the warning lamp with the "INTUNE" diagnostic software.	Warning Lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
3.	On	Monitor inputs from the water in fuel module with the "INTUNE" diagnostic software.	Inputs are correct.	Go to next step.	Go to Fault Detection Management. (See Fault Detection/Management, page 208)
4.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 123)

Fault Detection/Management

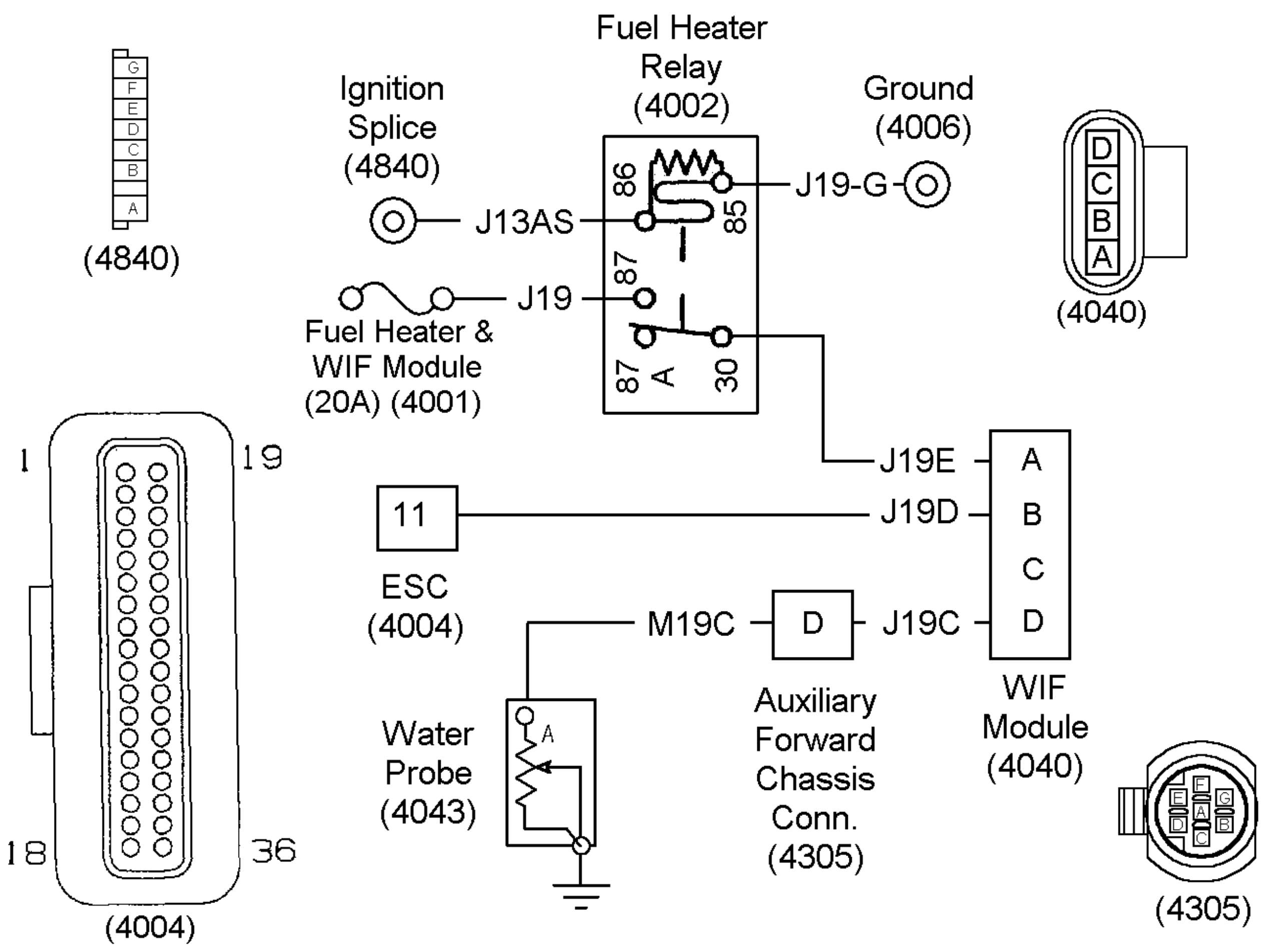


Figure 106 Water in Fuel Circuits (Frame Mounted Fuel Filter)—Always Refer to Circuit Diagram Book for Latest Circuit Information

(4001) MINI FUSE BLOCK
LOCATED IN ENGINE POWER DISTRIBUTION CENTER
(4002) FUEL HEATER RELAY
LOCATED IN ENGINE POWER DISTRIBUTION CENTER
(4004) ELECTRICAL SYSTEM CONTROLLER (ESC) CONNECTOR
LOCATED ON ENGINE SIDE OF ESC
(4006) GROUND
(4040) WATER IN FUEL MODULE
LOCATED NEAR EXTERIOR DASH PANEL, LEFT SIDE
(4043) WATER PROBE
LOCATED AT FUEL FILTER
(4305) AUXILIARY FORWARD CHASSIS CONNECTOR
LOCATED IN ENGINE COMPARTMENT NEAR LEFT FRAME RAIL
(4840) IGNITION SPLICE
LOCATED INSIDE POWER DISTRIBUTION CENTER

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the light.

To quickly verify operation of the water in fuel circuits, remove the connector from the water in fuel sensor. When the key is on the WIF warning lamp should not be illuminated. Connect a jumper from the sensor harness connector to ground. When the key is on the WIF lamp should illuminate. If both of these checks work, the problem is in the sensor.

If the lamp stays on continuously or doesn’t come on when there is water in the fuel, the problem may be in ESC/EGC programming, ESC/EGC hardware, water in fuel probe, water in fuel (WIF) module or wiring to the ESC.

Table 46 Water in Fuel Warning Lamp Circuits Voltage Check Chart

Water in Fuel Module Connector (4040) Voltage Checks (Check with Water in Fuel Module Disconnected and the Ignition Key “On”) **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**		
Test Points	Spec.	Comments
(4040) harness connector, cavity A to ground.	12 ± 1.5 volts	If voltage is incorrect, check for voltage from fuel heater relay. Also check circuit J19E for an open or short circuit.
(4040) harness connector, cavity A to cavity B.	12 ± 1.5 volts	If voltage is incorrect, check circuit J19D for an open circuit. If no opens exist, there is a problem with the ESC.
Water Probe Connector (4043) voltage Checks (Check with WATER in Fuel Module Connected, Water Probe Connector Disconnected and the Ignition Key “On”)		
Test Points	Spec.	Comments
(4043) harness connector, terminal A to ground.	12 ± 1.5 volts	If voltage is incorrect, check for opens or shorts in circuits K19C or J19C. If no circuits are open or shorted, replace the WIF module. If voltage is correct and the feature is not operating correctly, replace the sensor.
There are no diagnostic trouble codes associated with this feature.		

Extended Description

With the key on, 12 volts from mini fuse block (4001) is supplied on circuit J19E to WIF module connector (4040) terminal A.

The ground path for the water-in-fuel module (432) is not a dedicated circuit. The fuel filter housing is grounded through its mounting bracket and whenever water builds up to an unacceptable level in the filter, the water completes the circuit between the probe contacts and the housing. This energizes the water-in-fuel module.

When the water-in-fuel module becomes energized, power is supplied on circuit J19D to ESC connector (4004) terminal 11. This will cause the ESC to send a message to the EGC to illuminate the warning lamp.

4.22. COOLANT LEVEL WARNING LAMP

Circuit Function

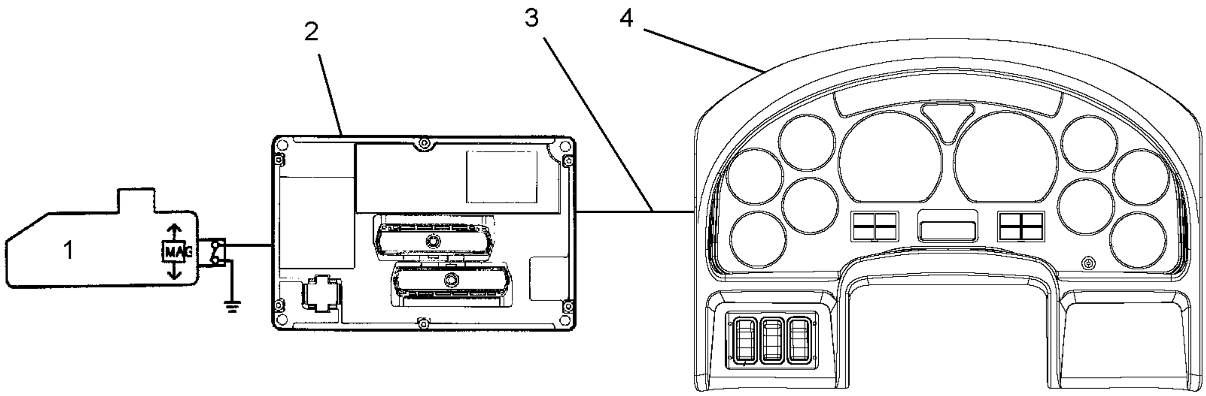


Figure 107 Coolant Level Warning Lamp Diagram

1. COOLANT SURGE TANK
2. ELECTRONIC ENGINE CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

The EGC activates the coolant level indicator when it receives a message on the Drivetrain 1939 data link from the engine controller. The engine controller will generate this message based on input from the sensor in the coolant surge tank.

The lamp should go out when the coolant level is restored.

Diagnostics

The INTUNE diagnostic software can be used to command all of the warning lamps on and monitor the coolant level command from the engine controller.

The most probable cause of malfunctions with the warning lamps, besides burnt out lamps, is input circuits from sensors to the ESC or engine controller. Although unlikely, it is possible for the malfunction to be in the ESC or EGC.

Refer to the engine manual on the specific engine installed in the vehicle for (sensor to engine controller) troubleshooting procedures.

Table 47 Coolant Level Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	On	Verify coolant warning lamp is malfunctioning. Check level in coolant tank.	Coolant warning lamp is on when coolant level is not low or lamp is off when coolant is low.	Go to next step.	Problem doesn't exist or is intermittent.
2.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)
3.	On	Attempt to exercise the coolant warning lamp with the "INTUNE" diagnostic software.	Coolant warning lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
4.	On	Use "INTUNE" diagnostic software to verify coolant level commands from the engine controller are being generated and match coolant level.	Commands from the engine controller are being generated and match coolant level.	Go to next step.	Message from engine controller is not being transmitted. Refer to the engine troubleshooting manual for the engine installed in the vehicle.
5.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 123)

4.23. PARK BRAKE WARNING LAMP

Circuit Function

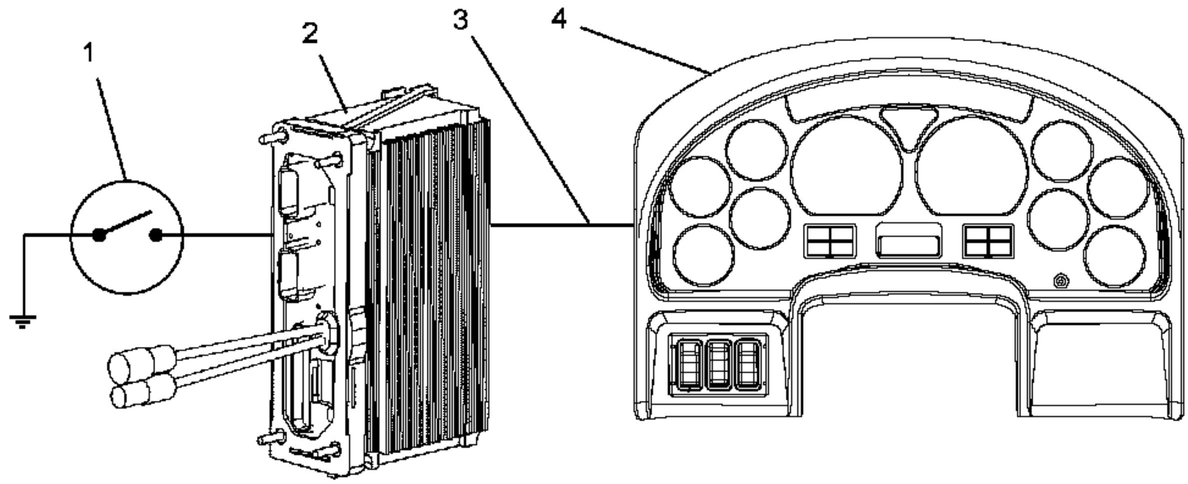


Figure 108 Park Brake Warning Lamp Function Diagram

1. PARK BRAKE SWITCH
2. ELECTRICAL SYSTEM CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

The EGC activates the park brake indicator when it receives a message on the Drivetrain 1939 data link from the ESC. The ESC generates this message based on input from the park brake switch.

The light should go out when the park brake is released.

The park brake input to the ESC is also used in the diagnostic trouble code retrieval procedure and to turn off the daytime running lights when the headlights are off, the engine is not running and the key is in the ignition position.

Diagnostics

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can command the ESC to turn on all of the warning lamps. This will verify that the EGC is working and communicating on the data link.

If the lamp stays on continuously or doesn’t come on when commanded by the ESC, the problem may be in ESC/EGC programming, EGC hardware or problems with the input circuits to the ESC from the park brake switch.

Table 48 Park Brake Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)
2.	On	Attempt to exercise the warning lamp with the "INTUNE" diagnostic software.	Warning Lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
3.	On	Check for Park Brake Warning Lamp diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 213) Read display on odometer.	Park Brake Warning Lamp diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 214)	Go to next step
4.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 123)

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 49 Park Brake Warning Lamp Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
70 14 1 0	Air Powered Park Brake is stuck. Occurs when the park brake switch does not match the spring apply air release (SAAR) chamber travel sensor. This indicates the park brake cannot be applied or cannot be released.
70 14 1 1	The auto apply portion with the Air Powered Park Brake is not operating. Occurs when the park brake switch is not set within 5 seconds of the receipt of the Park as the requested gear. This failure would indicate a failure in the auto apply or in the air lines between the auto apply relay and the Park Brake switch.

Fault Detection/ Management

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can command the ESC to turn on all of the warning lamps. This will verify that the EGC is working and communicating on the data link. See the diagnostic software manual for details on using the software.

If the lamp stays on continuously or doesn’t come on when the park brake is on, the problem may be in ESC/EGC programming, ESC/EGC hardware, the park brake switch or the park brake switch wiring to the ESC.

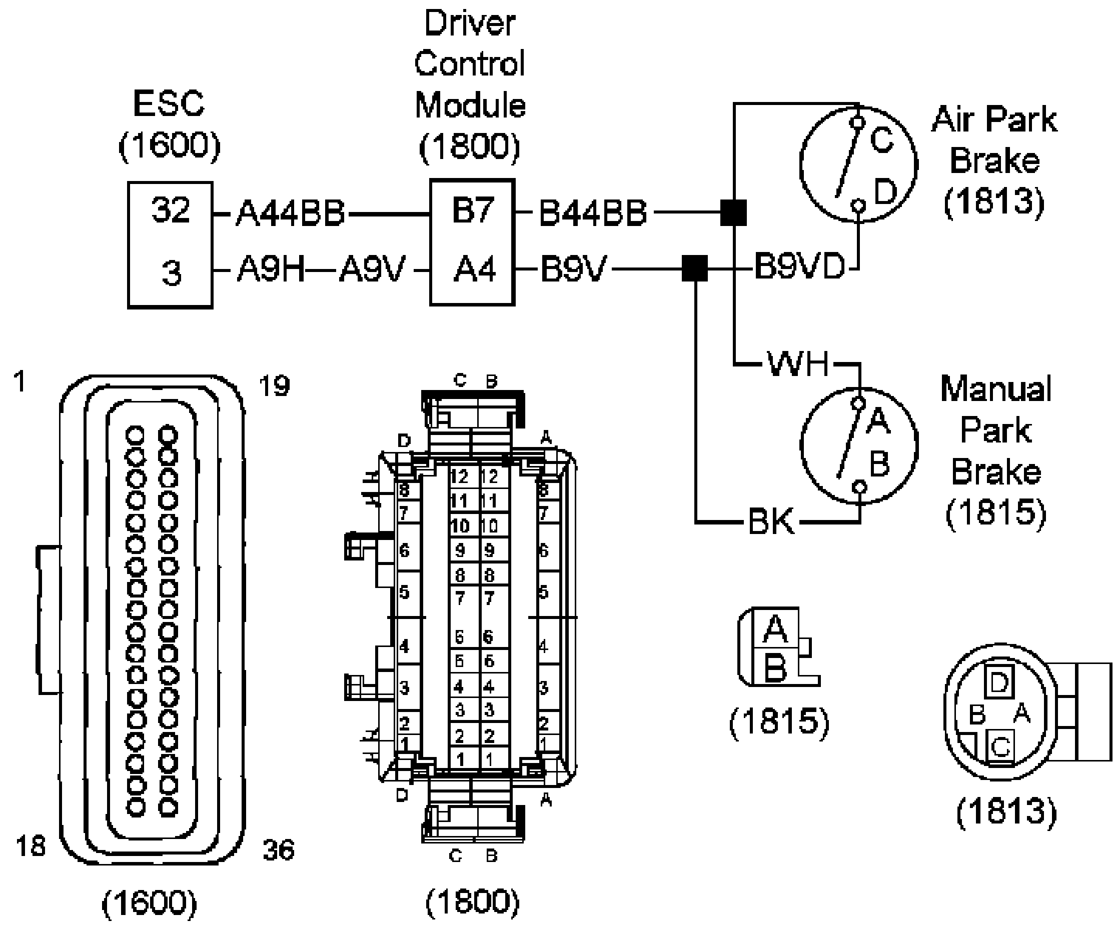


Figure 109 Park Brake Circuits—Always Refer to Circuit Diagram Book for Latest Circuit Information

(1600) ESC CONNECTOR
LOCATED ON CAB SIDE OF ESC
(1800) DRIVER CONTROL MODULE CONNECTOR
LOCATED TO THE RIGHT OF STEERING COLUMN
(1813) PARK BRAKE SWITCH (WITH AIR BRAKES)
LOCATED NEAR ENGINE CONTROLLER
(1815) PARK BRAKE SWITCH (WITH HYDRAULIC BRAKES)
LOCATED NEAR ENGINE CONTROLLER

Table 50 Park Brake Lamp Circuits Voltage Check Chart

Park Brake Switch Connector (1813) or (1815) Voltage Checks (Check with Brake Switch Disconnected and the Ignition Key "On")		
Test Points	Spec.	Comments
(1813) harness connector, cavity C or (1815) cavity A to ground.	12 ± 1.5 volts	If voltage is incorrect, check circuit B44BB or A44BB for open or short circuits. If circuits check good voltage is missing from ESC connector (1600) pin 32.
(1813) harness connector, cavity C or (1815) cavity A to (1813) cavity D or (1815) cavity B.	12 ± 1.5 volts	If voltage is correct and condition still exists, the brake switch has failed. Replace brake switch. If voltage is incorrect, check circuit B9V, A9V or A9H for an open circuit or good connection to ground.
There are no diagnostic trouble codes associated with this feature.		

Extended Description

On vehicles with hydraulic brakes, the zero volt reference level is supplied from ESC connector (1600) terminal 3 to park brake switch connector (1815) terminal B.

On vehicles with air brakes, the zero volt reference level is supplied from ESC connector (1600) terminal 3 to park brake switch connector (1813) terminal C.

When the park brake is engaged the switch is closed and the zero volt reference level is supplied to ESC connector (1600) terminal 32 signaling the ESC that the park brake has been applied.

Component Locations

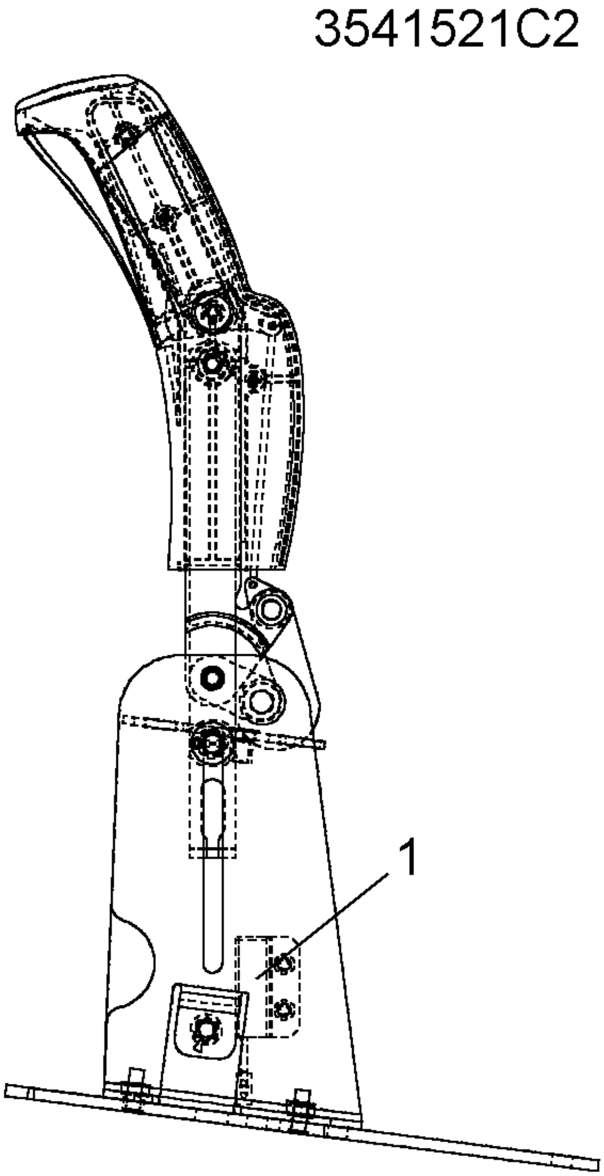


Figure 110 Park Brake Switch Location (With Hydraulic Brakes)

1. PARK BRAKE SWITCH

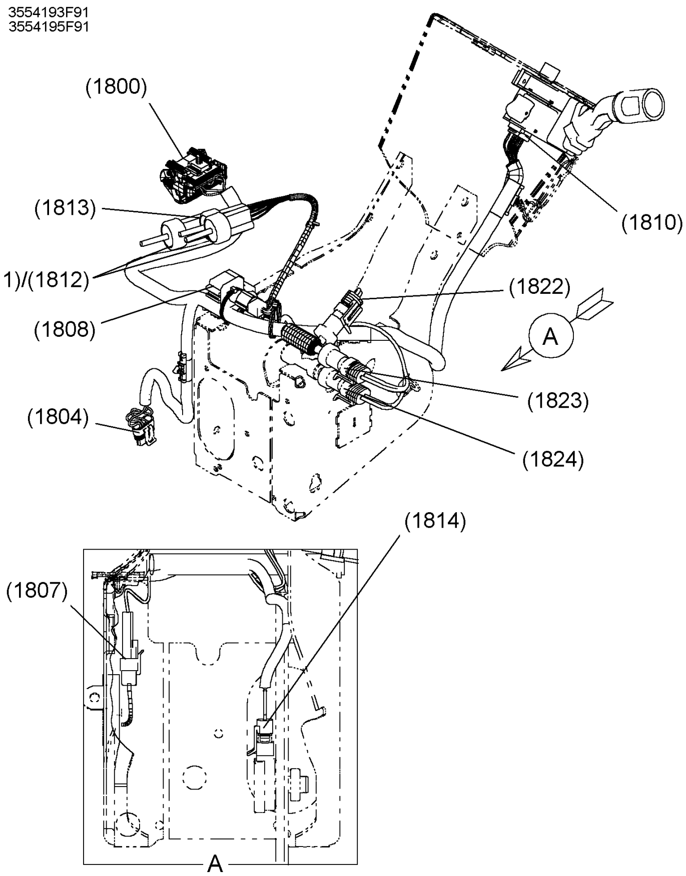


Figure 111 Air Park Brake Switch Location (Steering Column Support View)

(1813) PARK INDICATION PRESSURE SWITCH
(1800) DCM CONNECTOR

4.24. SERVICE PARK BRAKE WARNING LAMP

Circuit Function

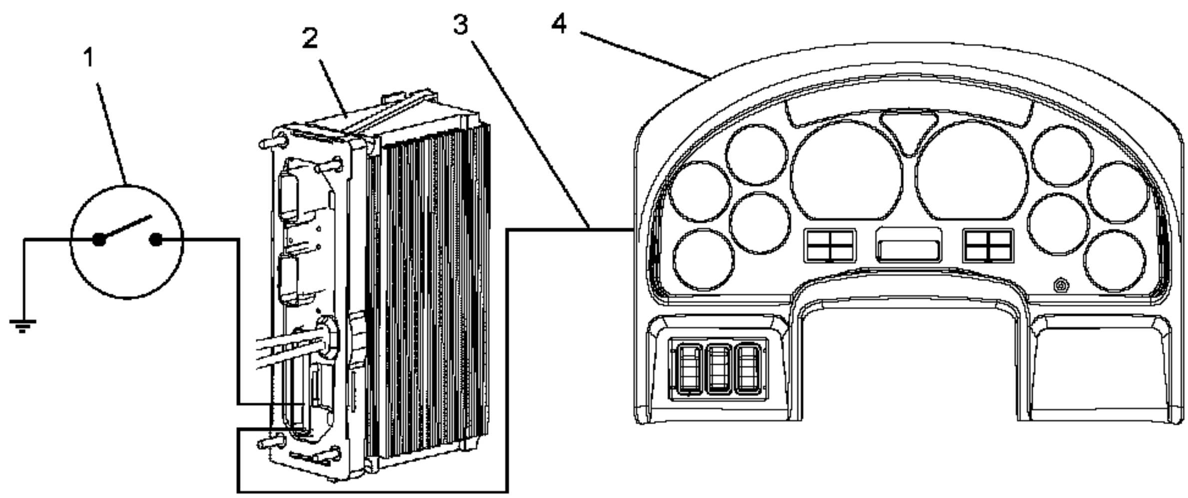


Figure 112 Service Park Brake Warning Lamp Function Diagram

1. AIR ACTUATED PARK BRAKE SAAR TRAVEL SENSOR
2. ELECTRICAL SYSTEM CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

The electrical circuits for the Travel Sensor integrated within the Spring Apply / Air Release (SAAR) Chamber used on the powered park brake system. The powered park brake system is an option for vehicles equipped with a hydraulic park brake system.

The electrical output is provided to indicate the SAAR piston has moved when air pressure is released from the chamber. A failure of the piston to move may indicate a park brake malfunction or maladjustment. The sensor output will interface with a digital input on the ESC.

SAAR – Spring Apply / Air Release: A component that actuates the park brake via a cable attached to a piston. Then air is applied to the chamber at a great enough pressure to compress the spring, the park brake is released. When air is evacuated from the chamber, the spring pushes back on the piston, which in turn pulls the cable, which then actuates the piston.

Inputs to the device shall consist of a nominal voltage of 14 VDC, and a ground connection.

Outputs:

Apply condition. The device shall deliver a HI signal when SAAR stroke is less than 19.05 +/- 3.175 mm (.75 +/- .125 inches) and when the SAAR stroke exceeds 64.8 +/- 3.175 mm (2.55 +/- .125 inches) in the apply condition. At all other times the device shall deliver a low signal.

Release condition. The device shall deliver a HI signal when the SAAR stroke is less than 17.78 +/- 3.175 mm (.70 +/- .125 inches) and when the SAAR stroke exceeds 63.50 +/- 3.175 mm (2.50 +/- .125 inches) in the release condition. At all other times the device shall deliver a low signal.

The device is meant to drive a low-current, digital input.

The EGC activates the Service Park Brake warning lamp when it receives a message on the Drivetrain 1939 data link from the ESC.

Diagnostics

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can command the ESC to turn on all of the warning lamps. This will verify that the EGC is working and communicating on the data link.

The Service Park Brake Warning lamp is on when the Air Powered Park Brake is stuck. This occurs when the park brake switch does not match the spring apply air release (SAAR) chamber travel sensor. This indicates the park brake cannot be applied or cannot be released.

The Service Park Brake Warning lamp is on when the auto apply portion with the Air Powered Park Brake is not operating. This occurs when the park brake switch is not set within 5 seconds of the receipt of the Park as the requested gear. This failure would indicate a failure in the auto apply or in the air lines between the auto apply relay and the Park Brake switch.

If the lamp stays on continuously or doesn't come on when commanded by the ESC, the problem may be in ESC/EGC programming, EGC hardware or problems with the input circuits to the ESC from the park brake switch.

Table 51 Service Park Brake Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programmingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)
2.	On	Attempt to exercise the warning lamp with the "INTUNE" diagnostic software.	Warning Lamp responds to EGC diagnostic input.	Lamp circuits from data link to EGC are working correctly.	Insure bulb is not burned out. Replace EGC circuit board.

Table 51 Service Park Brake Warning Lamp Preliminary Check (cont.)

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
3.	On	Check for Service Park Brake Warning Lamp diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 221) Read display on odometer.	Service Park Brake Warning Lamp diagnostic trouble codes are active.	Go to the Air Actuated Park Brake in the Chassis Features section of the manual.(See AIR Actuated Park Brake, page 809)	Go to next step
4.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 123)

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 52 Service Park Brake Warning Lamp Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
70 14 1 0	Air Powered Park Brake is stuck. Occurs when the park brake switch does not match the spring apply air release (SAAR) chamber travel sensor. This indicates the park brake cannot be applied or cannot be released.
70 14 1 1	The auto apply portion with the Air Powered Park Brake is not operating. Occurs when the park brake switch is not set within 5 seconds of the receipt of the Park as the requested gear. This failure would indicate a failure in the auto apply or in the air lines between the auto apply relay and the Park Brake switch.

4.25. CRUISE CONTROL LAMP

Circuit Function

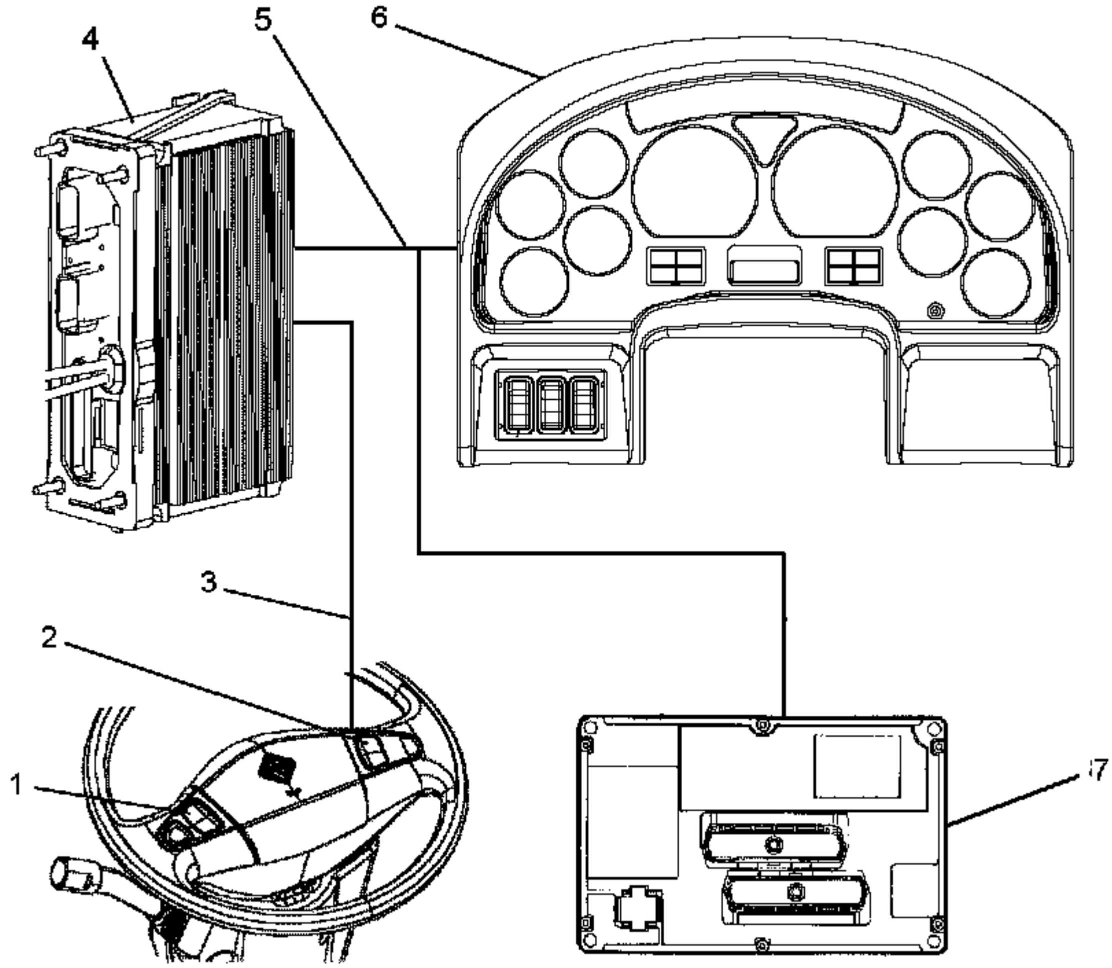


Figure 113 Cruise Control Lamp Function Diagram

1. CRUISE ON/OFF SWITCH
2. CRUISE SET/RESUME SWITCH
3. DIRECT CIRCUITS TO ESC
4. ESC
5. DRIVETRAIN 1939 DATA LINK
6. ELECTRONIC GAUGE CLUSTER (EGC)
7. ENGINE CONTROLLER
8. BRAKE AND CLUTCH SWITCH CIRCUITS (NOT SHOWN)

The EGC activates the cruise control indicator when it receives a message on the Drivetrain 1939 data link from the ESC. The ESC generates this message when it receives a cruise on message from the engine controller.

The light should go out when the cruise control is deactivated.

Diagnostics

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to illuminate all of the warning lamps and monitor inputs to the ESC from the cruise control switches on the steering wheel.

A problem with the cruise lamp will be apparent when the cruise control is activated and the lamp doesn't illuminate or the lamp stays on when the cruise is deactivated.

For problems with the cruise control activating refer to Cruise Control.

There are no diagnostic trouble codes for cruise control circuits

If the lamp stays on continuously or doesn't come on when the cruise control is engaged, the problem may be in ESC/EGC programming, ESC/EGC hardware, engine controller.

Table 53 Cruise Control Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	On	Verify cruise control is functioning. Insure the brake and clutch are released, there are no active brake or clutch DTC's and no ABS/ATC events.	Cruise control is functioning.	Go to next step.	Go to Cruise Control.
2.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)
3.	On	Attempt to exercise the cruise lamp with the "INTUNE" diagnostic software.	Cruise lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.

Table 53 Cruise Control Lamp Preliminary Check (cont.)

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
4.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp. Activate cruise control and verify lamp operation.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Go to next step.
5.	On	Use "INTUNE" diagnostic software to verify cruise commands from the engine controller are being generated.		Message from ESC is not being transmitted. Consider replacing ESC . (See ESC REPLACEMENT, page 123)	Message from engine controller is not being transmitted. Refer to the engine troubleshooting manual for the engine installed in the vehicle.

4.26. ABS WARNING LAMP

Circuit Function

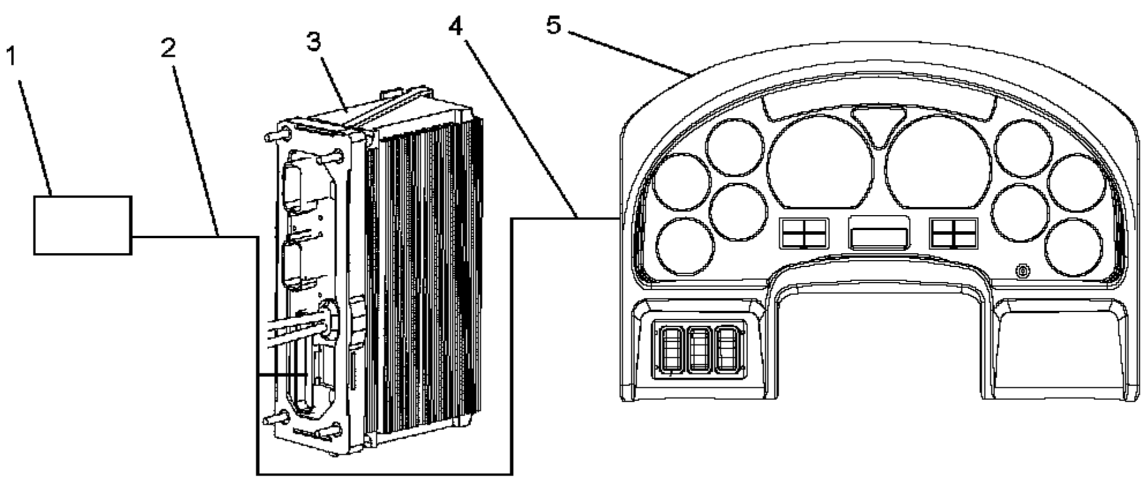


Figure 114 ABS Warning Lamp Function Diagram

1. ABS ELECTRONIC CONTROL MODULE
2. DRIVE TRAIN 1939 DATA LINK
3. ELECTRICAL SYSTEM CONTROLLER
4. DRIVE TRAIN 1939 DATA LINK
5. ELECTRONIC GAUGE CLUSTER (EGC)

The EGC activates the ABS indicator when it receives a message on the Drivetrain 1939 data link from the electrical system controller (ESC). The ABS controller sends a message to the ESC requesting the lamp be turned on when ABS is activate or there is a failure in the ABS system.

The lamp should go out after the ABS event is over or the failure is repaired and the fault is cleared.

See the appropriate ABS manual for details.

Diagnostics

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can command the ESC to turn on all of the warning lamps. This will verify that the EGC is working and communicating on the data link.

The EZ-Tech can also run ABS diagnostic software to validate operation of the warning lamp. Refer to the applicable ABS manual for the vehicle.

If the lamp stays on continuously or doesn't come on when commanded by the ABS controller, the problem may be in ESC/EGC programming, ESC/EGC hardware or problems with the ABS controller.

Table 54 ABS Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)
2.	On	Attempt to exercise the warning lamp with the "INTUNE" diagnostic software.	Warning lamp responds to EGC diagnostic input.	Lamp circuits from data link to EGC are working correctly. Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
3.	On	Check for ABS Warning Lamp diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 225) Read display on odometer.	ABS Warning Lamp diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 226)	Go to next step
4.	On	Monitor the inputs for the warning lamp with the "INTUNE" diagnostic software.	Inputs are correct.	Go to next step.	Refer to the troubleshooting manual for the specific ABS installed on the truck.

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 55 ABS Warning Lamp Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
2023 14 150 8 or 2023 14 250 8	ABS warning light malfunction on primary EGC (150) or secondary EGC (250)

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

4.27. WAIT TO START WARNING LAMP

Circuit Function

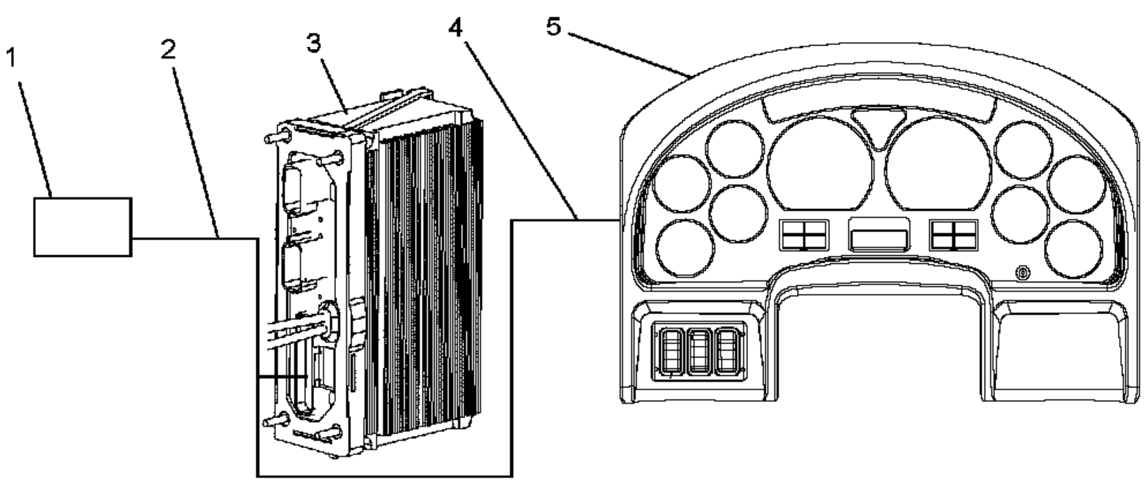


Figure 115 “Wait To Start” Warning Lamp Function Diagram

1. ELECTRONIC ENGINE CONTROLLER
2. DRIVE TRAIN 1939 DATA LINK
3. ELECTRICAL SYSTEM CONTROLLER
4. DRIVE TRAIN 1939 DATA LINK
5. ELECTRONIC GAUGE CLUSTER (EGC)

The EGC activates the “wait to start” indicator when it receives a message on the drivetrain 1939 data link from the electrical system controller (ESC). The ESC will generate this message when it receives a message from any engine controller that requires a “wait to start” function.

The light should go out when the glow plugs have reached a sufficient temperature to start the engine.

Fault Detection/Management

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can command the ESC to turn on all of the warning lamps. This will verify that the EGC is working and communicating on the data link.

If the lamp stays on continuously or doesn’t come on when the engine is cold, the problem may be in ESC/EGC programming, ESC/EGC hardware or problems with the engine controller or wiring to the engine controller.

See the engine diagnostic manual for detailed information on troubleshooting problems with the “wait to start” warning lamp inputs.

Diagnostics

Table 56 Wait To Start Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programmingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)
2.	On	Attempt to exercise the warning lamp with the "INTUNE" diagnostic software.	Warning Lamp responds to diagnostic input.	Lamp circuits from data link to EGC are working correctly.	Insure bulb is not burned out. Replace EGC circuit board.

4.28. CHECK A/C WARNING LAMP

Circuit Function

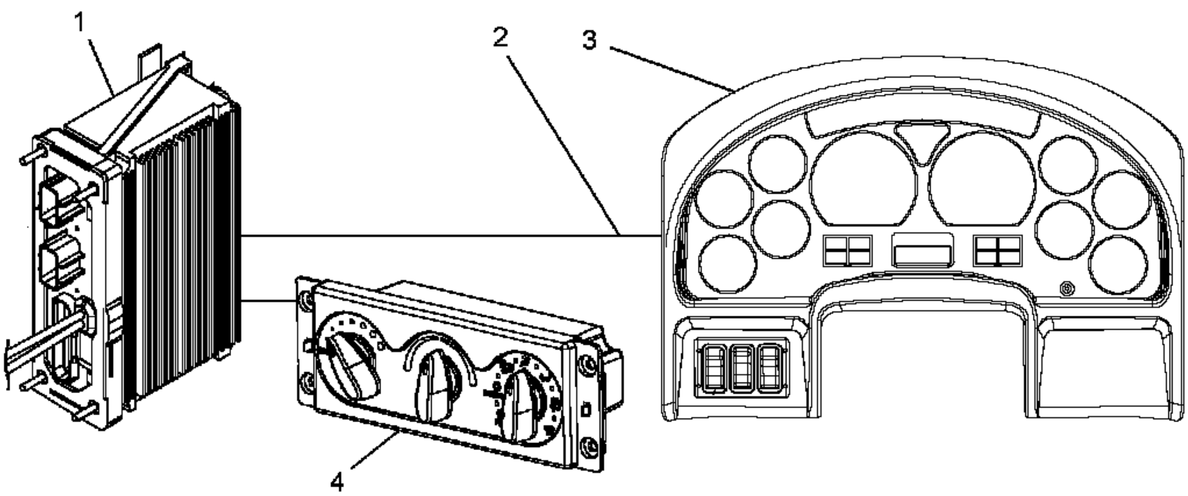


Figure 116 Check A/C Warning Lamp Function Diagram

1. ELECTRICAL SYSTEM CONTROLLER
2. DRIVE TRAIN 1939 DATA LINK
3. ELECTRONIC GAUGE CLUSTER (EGC)
4. HVAC CONTROL HEAD

The EGC activates the check A/C warning lamp when it receives a message on the drivetrain 1939 data link from the electrical system controller (ESC). The ESC will generate this message when it determines there is a failure in the air conditioning system or the HVAC control head notifies it of an HVAC failure.

Diagnostics

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can command the ESC to turn on all of the warning lamps. This will verify that the EGC is working and communicating on the data link.

If the lamp stays on continuously when there is not an HVAC system failure or doesn’t come on when there is an HVAC system failure, the problem may be in ESC/EGC programming, ESC/EGC hardware, or problems with the HVAC control head or control head circuits.

Refer to the Heater and Air Conditioner (HVAC) section of this manual.

Table 57 Check A/C Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/ On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)
2.	On	Attempt to exercise the warning lamps with the "INTUNE" diagnostic software.	Warning lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
3.	On	Monitor the inputs to the ESC for the warning lamp with the "INTUNE" diagnostic software.	Inputs are correct.	Go to next step.	Refer to AC Compressor Circuits in the HVAC service manual section S16025.
4.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 123)

4.29. RETARD OVERHEAT WARNING LAMP

Circuit Function

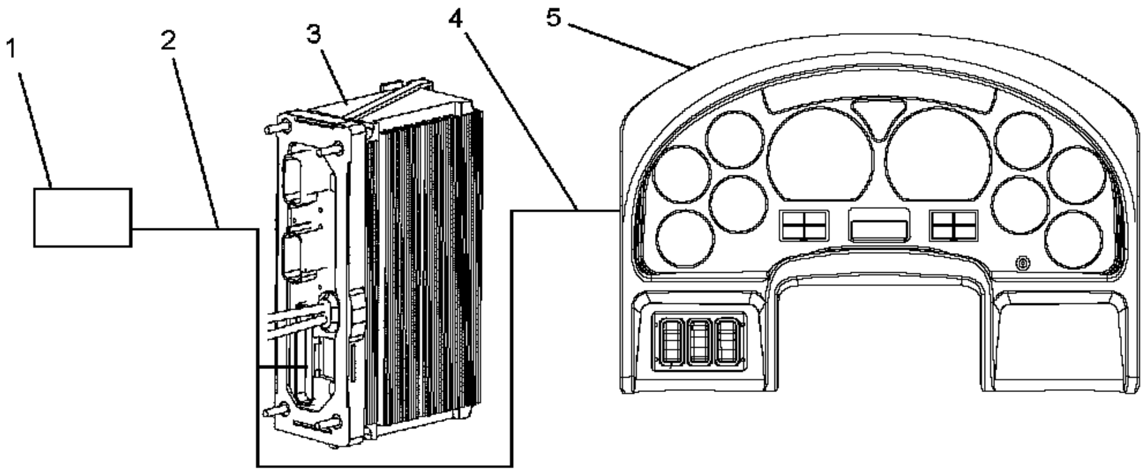


Figure 117 Retard Overheat Warning Lamp Function Diagram

1. TRANSMISSION ELECTRONIC CONTROL MODULE
2. DRIVE TRAIN 1939 DATA LINK
3. ELECTRICAL SYSTEM CONTROLLER
4. DRIVE TRAIN 1939 DATA LINK
5. ELECTRONIC GAUGE CLUSTER (EGC)

The EGC activates the retard overheat warning lamp when it receives a message on the drivetrain 1939 data link from the electrical system controller (ESC). The ESC will generate this message when it receives a message from the transmission controller informing it that the retarder is overheating.

The lamp should go out after the retarder has cooled off.

Diagnostics

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can command the ESC to turn on all of the warning lamps. This will verify that the EGC is working and communicating on the data link.

If the lamp stays on continuously or doesn’t come on when the transmission retarder is overheating, the problem may be in ESC/EGC programming, ESC/EGC hardware or problems with engine controller circuits or the engine controller.

See the appropriate transmission manual for details.

Table 58 Retard Overheat Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)
2.	On	Attempt to exercise the warning lamp with the "INTUNE" diagnostic software.	Warning lamp responds to EGC diagnostic input.	Lamp circuits from data link to EGC are working correctly.	Insure bulb is not burned out. Replace EGC circuit board.

4.30. PTO/ THROTTLE WARNING LAMP

Circuit Function

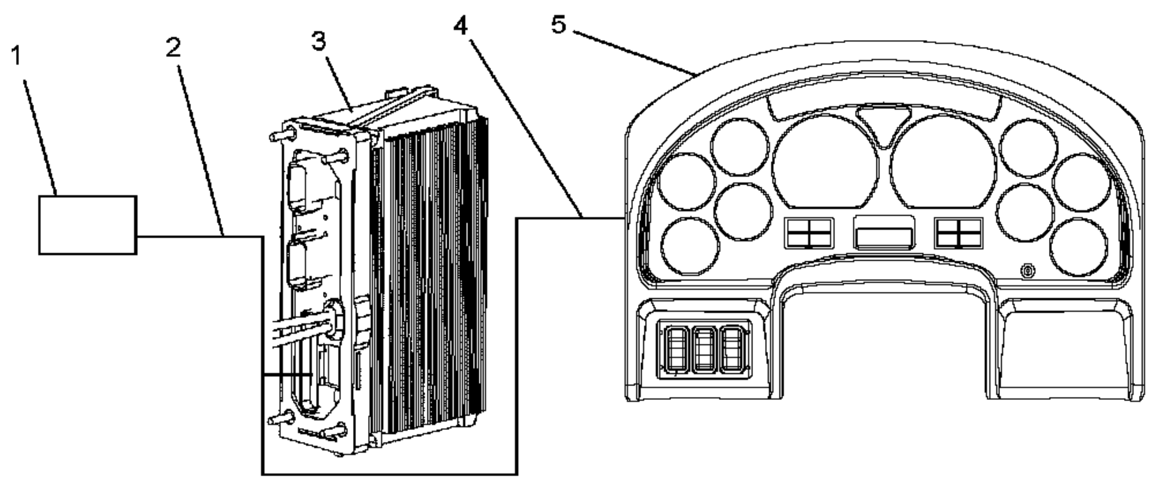


Figure 118 PTO/Throttle Warning Lamp Function Diagram

1. ELECTRONIC ENGINE CONTROLLER
2. DRIVE TRAIN 1939 DATA LINK
3. ELECTRICAL SYSTEM CONTROLLER
4. DRIVE TRAIN 1939 DATA LINK
5. ELECTRONIC GAUGE CLUSTER (EGC)

The EGC activates the PTO/throttle warning lamp when it receives a message on the drivetrain 1939 data link from the ESC. The ESC will generate this message when it receives a message from the engine controller that the PTO is engaged.

The lamp should go out when PTO is disengaged.

Diagnostics

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can command the ESC to turn on all of the warning lamps. This will verify that the EGC is working and communicating on the data link.

If the lamp stays on continuously or doesn't come on when commanded by the ESC, the problem may be in ESC/EGC programming, ESC/EGC hardware or problems with the sensors or sensor wiring to the transmission controller.

See the appropriate engine manual for details on PTO operation.

Table 59 PTO/throttle Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 113)
2.	On	Attempt to exercise the warning lamp with the "INTUNE" diagnostic software.	Warning lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
3.	On	Attempt to exercise the warning lamp with the "INTUNE" diagnostic software.	Warning lamp responds to EGC diagnostic input.	Lamp circuits from data link to EGC are working correctly.	Insure bulb is not burned out. Replace EGC circuit board.

4.31. ALTERNATOR WARNING LAMP

Circuit Function

Refer to Alternator Warning Lamp Function Diagram.

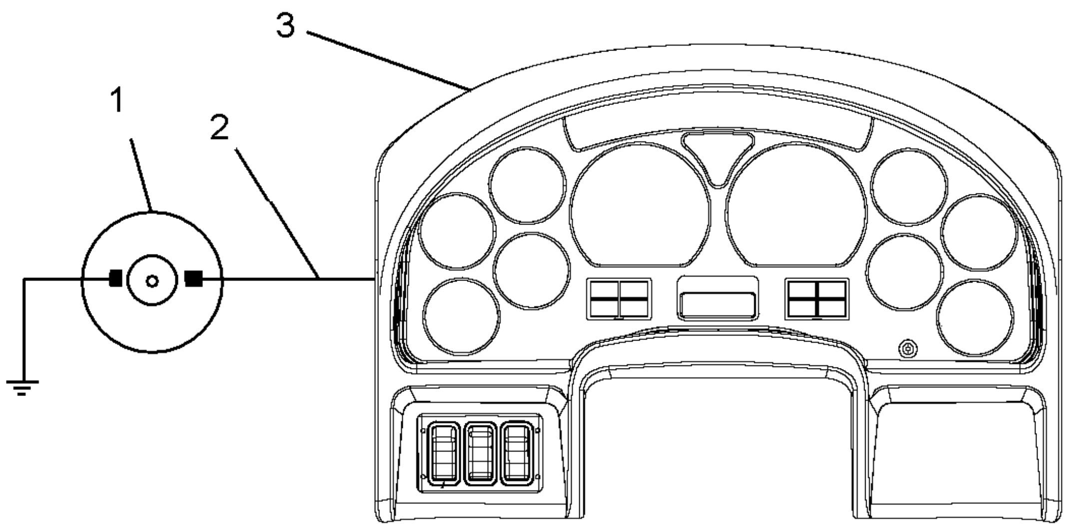


Figure 119 Alternator Warning Lamp Function Diagram

1. ALTERNATOR
2. DIRECT CIRCUIT FROM ALTERNATOR TO WARNING LAMP
3. ELECTRONIC GAUGE CLUSTER (EGC)

The optional alternator warning lamp is directly controlled by the alternator.

The light will illuminate when the output from the alternator is incorrect.

The light will go out when the output from the alternator is corrected.

4.32. DIFFERENTIAL LOCK WARNING LAMP

Circuit Function

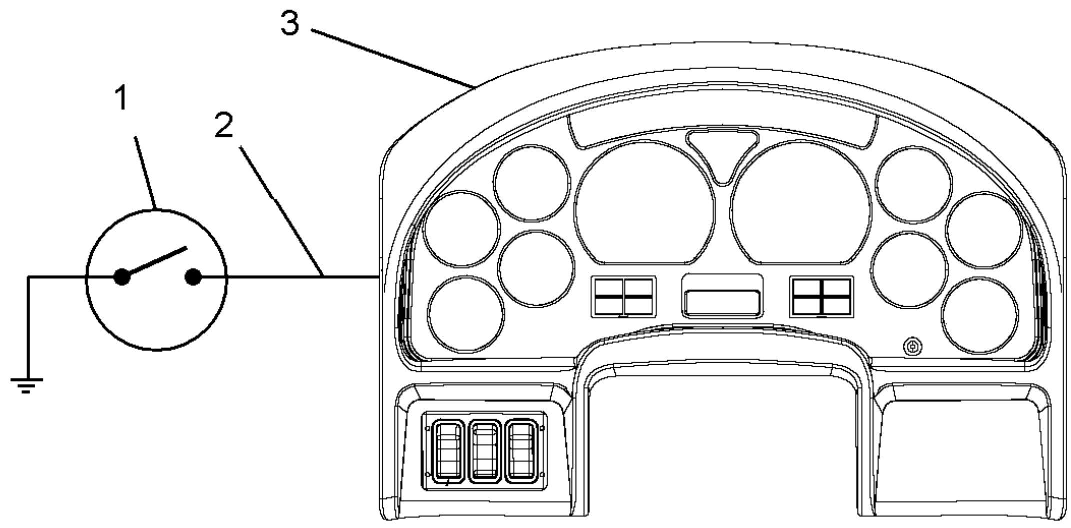


Figure 120 Differential Lock Warning Lamp Function Diagram

1. DIFFERENTIAL LOCK SWITCH (ON DIFFERENTIAL)
2. DIRECT CIRCUIT FROM DIFFERENTIAL TO WARNING LAMP
3. ELECTRONIC GAUGE CLUSTER (EGC)

The optional differential lock warning lamp is directly controlled by the switch on the axle differential. There is no interaction with the ESC.

On vehicles with dual rear axles, a separate warning lamp is provided for each axle.

Diagnostics

When the key is in ignition position, the light will illuminate when the differential is locked. The light will go out when the differential lock is released.

Table 60 Differential Lock Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	On	Turn on differential lock switch.	Warning Lamp should come on.	Go to next step.	Insure bulb is not burned out. Check for open circuits between lamp and axle switch.
2.	On	Warning lamp should go out.	Warning lamp turns off.	Warning lamp is operating correctly.	Check for short to ground in circuits between lamp and axle switch. Also check for failed axle switch.

Fault Detection/Management

A fault in the differential lock warning lamps will be evident when the lamps fail to illuminate.

When the key is in ignition position, the light will illuminate when the differential is locked. The light will go out when the differential lock is released.

If the lamp fails to illuminate the bulb could be burned out or there could be a an open or shorted circuit between the axle switch and the lamp.

Refer to Differential Lock Warning Lights Circuit.

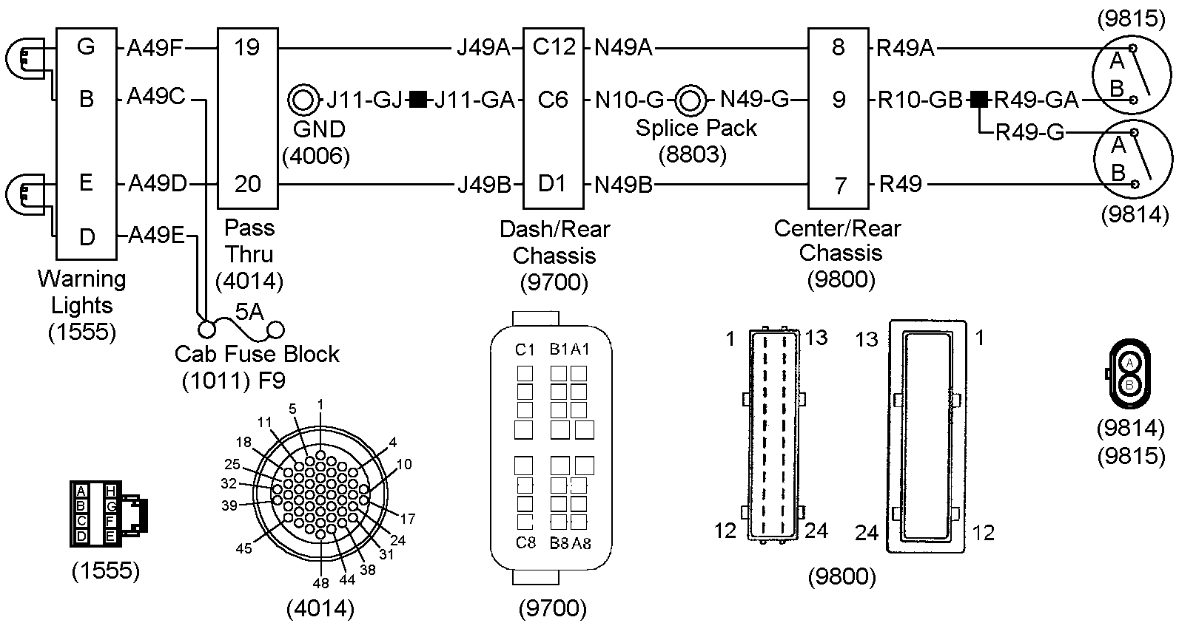


Figure 121 Differential Lock Warning Lights Circuit (Connectors Viewed From Mating End) — Always Refer to Circuit Diagram Book for Latest Circuit Information

(1555) OPTIONAL WARNING LIGHT CONNECTOR
LOCATED ON EGC
(4006) GROUND STUD
LOCATED ON DASH PANEL ABOVE ESC
(4014) PASS THROUGH CONNECTOR
LOCATED ON DASH PANEL ABOVE ESC
(8803) CHASSIS GROUND SPLICE PACK
LOCATED NEAR LEFT FRAME RAIL
(9700) DASH/CENTER CHASSIS CONNECTOR
LOCATED IN ENGINE COMPARTMENT NEAR LEFT FRAME
(9800) CENTER/REAR CHASSIS CONNECTOR
LOCATED BY LEFT FRAME RAIL NEAR REAR AXLES
(9814) FRONT REAR AXLE DIFFERENTIAL LOCK SWITCH CONNECTOR
LOCATED ON AXLE
(9815) REAR-REAR AXLE DIFFERENTIAL LOCK SWITCH CONNECTOR
LOCATED ON AXLE
F9 OPTIONAL WARNING LIGHT FUSE
LOCATED ON FUSE BLOCK 1 OF CAB POWER DISTRIBUTION PANEL

Table 61 Rear-Rear Differential Lock Warning Light Voltage Check

Rear-Rear Warning Light Switch Connector (9815) Voltage Checks (Check with switch disconnected and the ignition key "On")		
Test Points	Spec.	Comments
(9815) harness connector, cavity A to ground.	12 ± 1.5 volts	Insure fuse and lamp are not open. If voltage is incorrect, check for open or short in circuits R49A, N49A, J49A or A49F.
(9815) harness connector, cavity A to B.	12 ± 1.5 volts	If voltage is incorrect, check for an open in circuits R49-GA, R10-GB, N49-G, N10-G, J11–GA or J11–GJ to ground. If voltage is correct and lamps do not light when the differential is locked, the axle switch has failed or is not actuating. Replace axle switch if it is faulty.

Table 62 Front Rear Differential Lock Warning Light Voltage Check

Front Rear Warning Light Switch Connector (9814) Voltage Checks (Check with switch disconnected and the ignition key "On")		
Test Points	Spec.	Comments
(9814) harness connector, cavity A to ground.	12 ± 1.5 volts	Insure fuse and lamp are not open. If voltage is incorrect, check for open or short in circuits R49, N49B, J49B or A49D.
(9814) harness connector, cavity A to B.	12 ± 1.5 volts	If voltage is incorrect, check for an open in circuits R49-G, R10-GB, N49-G, N10-G, J11–GA or J11–GJ to ground. If voltage is correct and condition still exists, the axle switch has failed or is not actuating. Replace axle switch.

Extended Description

Battery voltage is applied to the warning light lamps from fuse F9 when the key is in the ignition position.

When the rear axle(s) are locked the axle switch(es) will close supplying a ground to the lamp(s) causing them to illuminate.

Snow Valve Warning Lamp

Refer to Snow Valve (Engine Intake). (See SNOW VALVE (ENGINE INTAKE), page 346)

Optimized Idle

This feature is not implemented.

4.33. VOLTMETER

Circuit Function

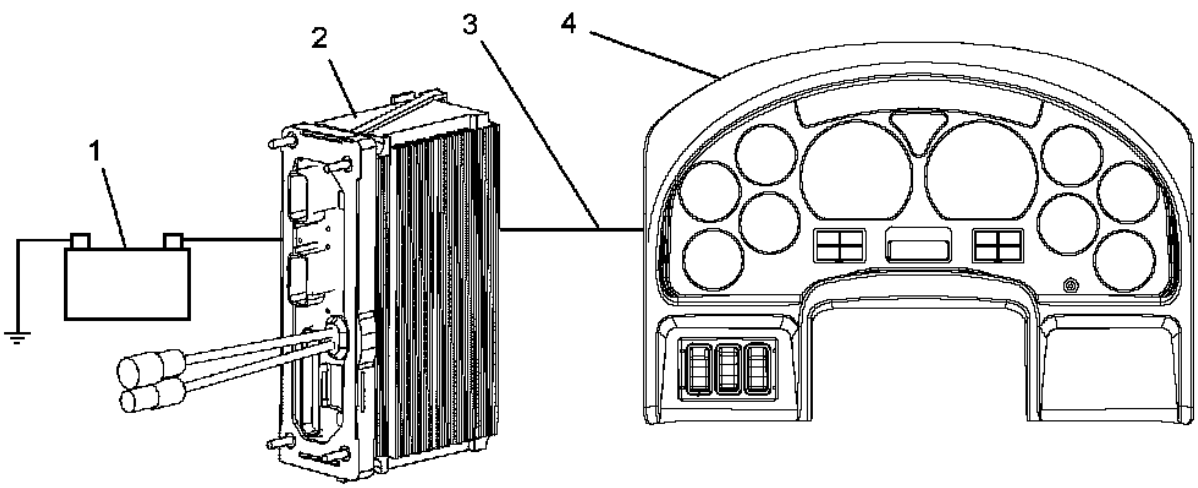


Figure 122 Voltmeter Function Diagram

1. BATTERY
2. ELECTRICAL SYSTEM CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information for the voltmeter is provided on the Drivetrain 1939 data link from the ESC. The ESC generates this information based on the system voltage.

Assuming the gauge swept at gauge sweep. Check gauge with service tool (EZ-Tech). If gauge responds to service tool (EZ-Tech), data is not being transmitted from the ESC.

Diagnostics

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the gauge.

The pointer in a small gauge, pointing to the six o'clock position, indicates that there is a sensor error for that gauge. A gauge pointing to 10 o'clock is connected to an unprogrammed connector on the EGC circuit board.

A problem with the data link will demonstrate several problems on the EGC, as well as a diagnostic trouble code. If other gauges are not operating correctly, the problem is not isolated to the voltmeter inputs.

A gauge with an incorrect reading may be the result of incorrect programming, an incorrect jumper connection between the EGC circuit board and the gauge or a problem in the sensor circuitry for that gauge. The following procedures will provide guidance for determining why the gauge is malfunctioning.

Table 63 Voltmeter Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the gauge operate correctly during gauge sweep?	Gauge sweeps from minimum to maximum and back.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install.
2.	On	Check for Voltmeter gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 239) Read display on odometer.	Voltmeter gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 240)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.	Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
4.	On	Attempt to exercise the gauge with the "INTUNE" diagnostic software.	Gauge responds to "INTUNE" diagnostic input.	If gauge responds to diagnostic tool, but doesn’t work during normal operations, replace the ESC.	Verify jumper harness between gauge and circuit board is in correct locations. If jumper locations are correct, replace EGC circuit board.
5.	Consider replacing ESC. (See ESC REPLACEMENT, page 123)				

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 64 Voltmeter Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
1705 14 109 3 (EGC Version 8.7)	EGC gauge location 9 (Voltmeter) out of range high Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 109 4 (EGC Version 8.7)	EGC gauge location 9 (Voltmeter) out of range low Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 109 5 (EGC Version 8.7)	EGC gauge location 9 (Voltmeter) sensor fault There is a problem with the sensor that provides the data for this gauge.
1705 14 109 6 (EGC Version 8.7)	EGC gauge location 9 (Voltmeter) data unavailable The data that this gauge displays should be, but is not available at this time.
2023 14 109 5 or 2023 14 209 5 (EGC Version 9.3 and later)	Voltmeter sensor fault to primary EGC (109) or secondary EGC (209) There is a problem with the sensor that provides the data for this gauge.
2023 14 109 6 or 2023 14 209 6 (EGC Version 9.3 and later)	Voltmeter gauge data unavailable to primary EGC (109) or secondary EGC (209) The data that this gauge displays should be, but is not available at this time.
2023 14 109 7 or 2023 14 209 7 (EGC Version 9.3 and later)	Voltmeter gauge data missing to primary EGC (109) or secondary EGC (209) The data for this gauge is not being transmitted on the datalink.

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

4.34. ENGINE COOLANT TEMPERATURE GAUGE

Circuit Function

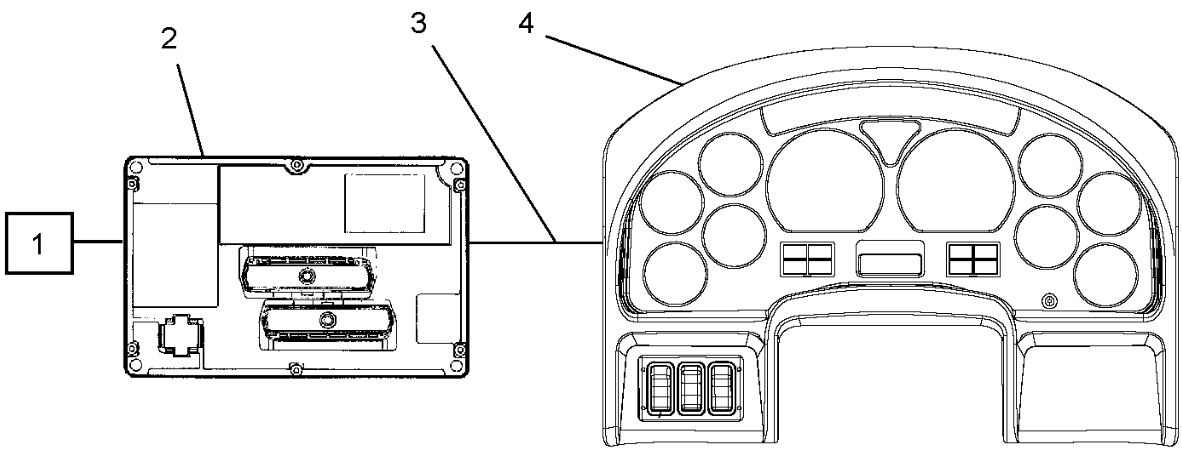


Figure 123 Engine Coolant Temperature Gauge Function Diagram

1. ENGINE COOLANT TEMPERATURE SENSOR
2. ELECTRONIC ENGINE CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information for the engine coolant temperature gauge is provided on the drivetrain 1939 data link from the engine controller. The engine controller generates this information based on input from a sensor on the engine.

Diagnostics

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the gauge.

The pointer in a small gauge, pointing to the six o'clock position, indicates that there is a sensor error for that gauge. A gauge pointing to 10 o'clock is connected to an unprogrammed connector on the EGC circuit board.

A problem with the data link will demonstrate several problems on the EGC, as well as a diagnostic trouble code. If other gauges are not operating correctly, the problem is not isolated to the engine coolant temperature gauge inputs.

See the engine diagnostic manual for detailed information on troubleshooting problems with the engine coolant temperature sensor circuits.

Problems with the engine coolant temperature gauge can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, an incorrect connection inside the EGC, a loss of programming, a problem in the engine controller, a problem with the engine coolant temperature sensor or a problem with wiring to the sensor.

The following procedures will provide guidance for determining why the gauge is malfunctioning.

Table 65 Engine Coolant Temperature Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the gauge operate correctly during gauge sweep?	Gauge sweeps from minimum to maximum and back.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install.
2.	On	Check for Engine Coolant Temperature gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 242) Read display on odometer.	Engine Coolant Temperature gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 243)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.	Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
4.	On	Attempt to exercise the gauge with the "INTUNE" diagnostic software.	Gauge responds to "INTUNE" diagnostic input.	If gauge responds to diagnostic tool, but doesn’t work during normal operations, replace the ESC.	Verify jumper harness between gauge and circuit board is in correct locations. If jumper locations are correct, replace EGC circuit board.
5.	Engine coolant temperature message is not being generated by the engine controller. Refer to the applicable engine troubleshooting manual for this vehicle.				
6.	Consider replacing ESC. (See ESC REPLACEMENT, page 123)				

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 66 Engine Coolant Temperature Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
1705 14 103 3 (EGC Version 8.7)	EGC gauge location 3 (Engine Coolant Temperature) out of range high Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 103 4 (EGC Version 8.7)	EGC gauge location 3 (Engine Coolant Temperature) out of range low Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 103 5 (EGC Version 8.7)	EGC gauge location 3 (Engine Coolant Temperature) sensor fault There is a problem with the sensor that provides the data for this gauge.
1705 14 103 6 (EGC Version 8.7)	EGC gauge location 3 (Engine Coolant Temperature) data unavailable The data that this gauge displays should be, but is not available at this time.
2023 14 103 5 or 2023 14 203 5 (EGC Version 9.3 and later)	Engine Coolant Temperature sensor fault to primary EGC (103) or secondary EGC (203) There is a problem with the sensor that provides the data for this gauge.
2023 14 103 6 or 2023 14 203 6 (EGC Version 9.3 and later)	Engine Coolant Temperature gauge data unavailable to primary EGC (103) or secondary EGC (203) The data that this gauge displays should be, but is not available at this time.
2023 14 103 7 or 2023 14 203 7 (EGC Version 9.3 and later)	Engine Coolant Temperature gauge data missing to primary EGC (103) or secondary EGC (203) The data for this gauge is not being transmitted on the datalink.

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

4.35. ENGINE OIL PRESSURE GAUGE

Circuit Function

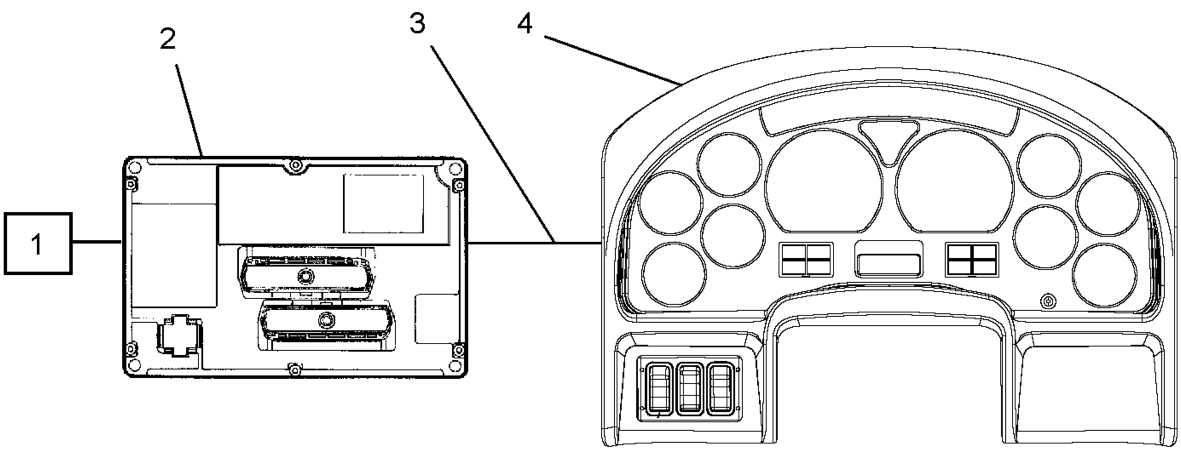


Figure 124 Engine Oil Pressure Gauge Function Diagram

1. ENGINE OIL PRESSURE SENSOR
2. ELECTRONIC ENGINE CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving the engine oil pressure gauge is provided on the Drivetrain 1939 data link from the engine controller. The engine controller generates this information based on signals from sensors on the engine.

Diagnostics

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the gauge.

The pointer in a small gauge, pointing to the six o’clock position, indicates that there is a sensor error for that gauge. A gauge pointing to 10 o’clock is connected to an unprogrammed connector on the EGC circuit board.

A problem with the data link will demonstrate several problems on the EGC, as well as a diagnostic trouble code. If other gauges are not operating correctly, the problem is not isolated to the engine oil pressure gauge inputs.

See the engine diagnostic manual for detailed information on troubleshooting problems with the engine coolant temperature inputs.

Problems with the engine oil pressure gauge can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, an incorrect connection inside the EGC, a loss of programming, a problem in the engine controller, a problem with the engine oil pressure sensor or a problem with wiring to the sensor.

The following procedures will provide guidance for determining why the gauge is malfunctioning.

Table 67 Engine Oil Pressure Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the gauge operate correctly during gauge sweep?	Gauge sweeps from minimum to maximum and back.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install.
2.	On	Check for Engine Oil Pressure gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 245) Read display on odometer.	Engine Oil Pressure gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 246)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.	Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
4.	On	Attempt to exercise the gauge with the "INTUNE" diagnostic software.	Gauge responds to "INTUNE" diagnostic input.	If gauge responds to diagnostic tool, but doesn’t work during normal operations, replace the ESC.	Verify jumper harness between gauge and circuit board is in correct locations. If jumper locations are correct, replace EGC circuit board.
5.	Engine oil pressure message is not being generated by the engine controller. Refer to the applicable engine troubleshooting manual for this vehicle.				
6.	Consider replacing ESC. (See ESC REPLACEMENT, page 123)				

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 68 Engine Oil Pressure Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
1705 14 105 3 (EGC Version 8.7)	EGC gauge location 5 (Engine Oil Pressure) out of range high Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 105 4 (EGC Version 8.7)	EGC gauge location 5 (Engine Oil Pressure)) out of range low Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 105 5 (EGC Version 8.7)	EGC gauge location 5 (Engine Oil Pressure) sensor fault There is a problem with the sensor that provides the data for this gauge.
1705 14 105 6 (EGC Version 8.7)	EGC gauge location 5 (Engine Oil Pressure) data unavailable The data that this gauge displays should be, but is not available at this time.
2023 14 105 5 or 2023 14 205 5 (EGC Version 9.3 and later)	Engine Oil Pressure sensor fault to primary EGC (105) or secondary EGC (205) There is a problem with the sensor that provides the data for this gauge.
2023 14 105 6 or 2023 14 205 6 (EGC Version 9.3 and later)	Engine Oil Pressure gauge data unavailable to primary EGC (105) or secondary EGC (205) The data that this gauge displays should be, but is not available at this time.
2023 14 105 7 or 2023 14 205 7 (EGC Version 9.3 and later)	Engine Oil Pressure gauge data missing to primary EGC (105) or secondary EGC (205) The data for this gauge is not being transmitted on the datalink.

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

4.36. ENGINE OIL TEMPERATURE GAUGE

Circuit Function

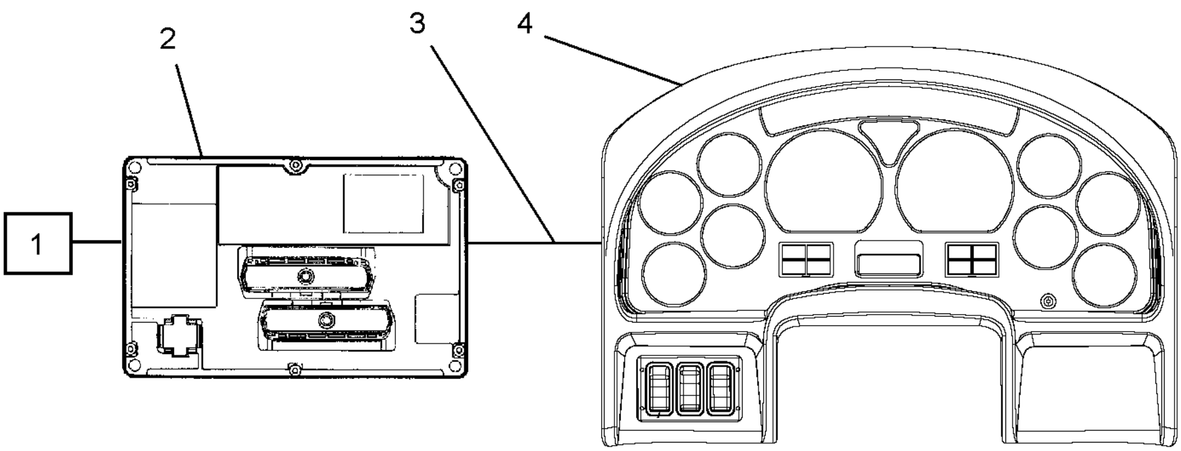


Figure 125 Engine Oil Temperature Gauge Function Diagram

1. ENGINE OIL TEMPERATURE SENSOR
2. ENGINE CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving the engine oil temperature gauge is provided on the Drivetrain 1939 data link from the engine controller. The engine controller generates this information based on signals from sensors on the engine.

Diagnostics

The pointer in a small gauge, pointing to the six o'clock position, indicates that there is a sensor error for that gauge. A gauge pointing to 10 o'clock is connected to an unprogrammed connector on the EGC circuit board.

A gauge with an incorrect reading may be due to incorrect programming, an incorrect jumper connection between the EGC circuit board and the gauge or a problem in the sensor circuitry for that gauge. The following procedures will provide guidance for determining why the gauge is malfunctioning.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the gauge.

See the engine diagnostic manual for detailed information on troubleshooting problems with the engine oil temperature sensor inputs.

Problems with the engine oil temperature gauge can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, an incorrect connection inside the EGC, a loss of programming, a problem in the engine controller, a problem with the engine oil temperature sensor or a problem with wiring to the sensor.

Table 69 Engine Oil Temperature Gauge Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the gauge operate correctly during gauge sweep?	Gauge sweeps from minimum to maximum and back.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer toRemove and Install.
2.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.	Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the "ICAP" software. Refer to the ICAP programming software manual for details.
3.	On	Check for Engine Oil Temperature Gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 248) Read display on odometer.	Engine Oil Temperature Gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 249)	Go to next step
4.	On	Attempt to exercise the gauge with the "INTUNE" diagnostic software.	Gauge responds to "INTUNE" diagnostic input.	Go to next step.	Verify jumper harness between gauge and circuit board is in correct locations. If jumper locations are correct, replace EGC circuit board.
5.	On	Engine oil temperature message is not being generated by the engine controller. Refer to the applicable engine troubleshooting manual for this vehicle.			

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key "ON". Then press the Cruise "ON" switch and the Cruise "Resume" switch. If no diagnostic trouble codes are present, the cluster odometer will display "NO FAULT". If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in "A" for active diagnostic trouble codes or "P" for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 70 Engine Oil Temperature Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
612 14 33 1	Engine Oil Temperature/Power Park Brake out of range low Short to ground or open circuit
612 14 33 2	Engine Oil Temperature/Power Park Brake out of range high Shorted high

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

4.37. PYROMETER GAUGE – (THIS FEATURE IS NOT CURRENTLY AVAILABLE)

This figure is no longer used and was intentionally left blank.

Figure 126 Unused Figure

Table 71 Unused Table

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
This table is no longer used and was intentionally left blank.						

4.38. SPEEDOMETER

Circuit Function

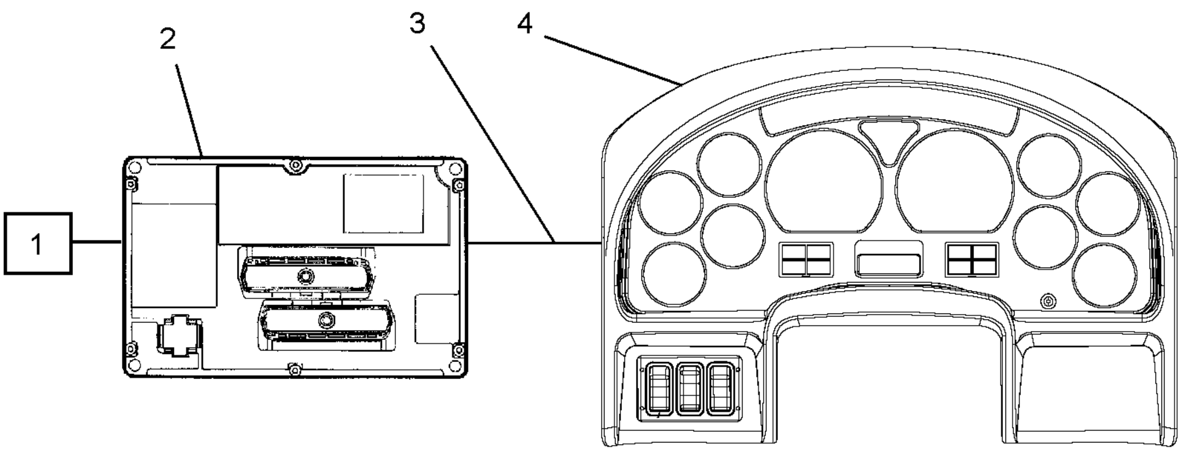


Figure 127 Speedometer Function Diagram

1. VEHICLE SPEED SIGNAL (VSS)
2. ELECTRONIC ENGINE CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving the speedometer is provided on the Drivetrain 1939 data link from the engine controller. The engine controller generates this information based on the vehicle speed signal from a sensor on the transmission or from the transmission control module.

Diagnostics

If the speedometer go to zero, sweep up to 50% and return to zero three times, there is a sensor error.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the gauge.

A problem with the data link will demonstrate several problems on the EGC, as well as a diagnostic trouble code. If other gauges are not operating correctly, the problem is not isolated to the speedometer inputs.

Problems with the speedometer can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, a loss of programming, a problem in the engine controller or missing signal from the vehicle speed sensor (VSS) or transmission controller.

The following procedures will provide guidance for determining why the gauge is malfunctioning.

Table 72 Speedometer Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the gauge operate correctly during gauge sweep?	Gauge sweeps from minimum to maximum and back.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install.
2.	On	Check for Speedometer gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 251) Read display on odometer.	Speedometer gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 252)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.	Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
4.	On	Attempt to exercise the gauge with the "INTUNE" diagnostic software.	Gauge responds to "INTUNE" diagnostic input.	If gauge responds to diagnostic tool, but doesn’t work during normal operations, replace the ESC.	Verify jumper harness between gauge and circuit board is in correct locations. If jumper locations are correct, replace EGC circuit board.
5.	Speedometer signal is not being transmitted from the engine controller. Refer to the applicable engine troubleshooting manual for this vehicle. Also refer to the appropriate transmission troubleshooting manual. Manual transmissions use the traditional vehicle speed sensor (VSS). Automatic transmissions transmit the signal from the transmission ECU.				
6.	Consider replacing ESC. (See ESC REPLACEMENT, page 123)				

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 73 Speedometer Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
1705 14 102 3 (EGC Version 8.7)	EGC gauge location 2 (Speedometer) out of range high Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 102 4 (EGC Version 8.7)	EGC gauge location 2 (Speedometer) out of range low Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 102 5 (EGC Version 8.7)	EGC gauge location 2 (Speedometer) sensor fault There is a problem with the sensor that provides the data for this gauge.
1705 14 102 6 (EGC Version 8.7)	EGC gauge location 2 (Speedometer) data unavailable The data that this gauge displays should be, but is not available at this time.
2023 14 102 5 or 2023 14 202 5 (EGC Version 9.3 and later)	Speedometer sensor fault to primary EGC (102) or secondary EGC (202) There is a problem with the sensor that provides the data for this gauge.
2023 14 102 6 or 2023 14 202 6 (EGC Version 9.3 and later)	Speedometer gauge data unavailable to primary EGC (102) or secondary EGC (202) The data that this gauge displays should be, but is not available at this time.
2023 14 102 7 or 2023 14 202 7 (EGC Version 9.3 and later)	Speedometer gauge data missing to primary EGC (102) or secondary EGC (202) The data for this gauge is not being transmitted on the datalink.

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

4.39. TACHOMETER

Circuit Function

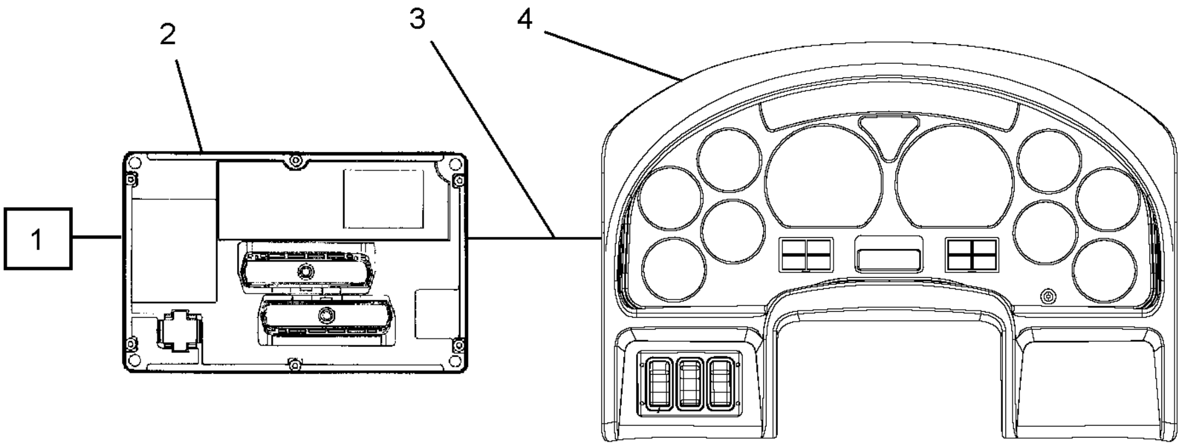


Figure 128 Tachometer Function Diagram

1. TACHOMETER SENSOR
2. ELECTRONIC ENGINE CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving the tachometer is provided on the Drivetrain 1939 data link from the engine controller.

Diagnostics

If the tachometer go to zero, sweep up to 50% and return to zero three times, there is a sensor error.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the gauge.

A problem with the data link will demonstrate several problems on the EGC, as well as a diagnostic trouble code. If other gauges are not operating correctly, the problem is not isolated to the tachometer inputs.

Problems with the tachometer can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, a loss of programming, a problem in the engine controller, a problem with the engine tachometer sensor or a problem with wiring to the sensor.

The following procedures will provide guidance for determining why the gauge is malfunctioning.

Table 74 Tachometer Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the gauge operate correctly during gauge sweep?	Gauge sweeps from minimum to maximum and back.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install.
2.	On	Check for Tachometer gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 254) Read display on odometer.	Tachometer gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 255)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.	Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
4.	On	Attempt to exercise the gauge with the "INTUNE" diagnostic software.	Gauge responds to "INTUNE" diagnostic input.	If gauge responds to diagnostic tool, but doesn’t work during normal operations, replace the ESC.	Verify jumper harness between gauge and circuit board is in correct locations. If jumper locations are correct, replace EGC circuit board.
5.	Tachometer signal is not being transmitted from the engine controller. Refer to the applicable engine troubleshooting manual for this vehicle.				
6.	Consider replacing ESC. (See ESC REPLACEMENT, page 123)				

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 75 Tachometer Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
1705 14 101 3 (EGC Version 8.7)	EGC gauge location 1 (Tachometer) out of range high Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 101 4 (EGC Version 8.7)	EGC gauge location 1 (Tachometer) out of range low Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 101 5 (EGC Version 8.7)	EGC gauge location 1 (Tachometer) sensor fault There is a problem with the sensor that provides the data for this gauge.
1705 14 101 6 (EGC Version 8.7)	EGC gauge location 1 (Tachometer) data unavailable The data that this gauge displays should be, but is not available at this time.
2023 14 101 5 or 2023 14 201 5 (EGC Version 9.3 and later)	Tachometer sensor fault to primary EGC (101) or secondary EGC (201) There is a problem with the sensor that provides the data for this gauge.
2023 14 101 6 or 2023 14 201 6 (EGC Version 9.3 and later)	Tachometer gauge data unavailable to primary EGC (101) or secondary EGC (201) The data that this gauge displays should be, but is not available at this time.
2023 14 101 7 or 2023 14 201 7 (EGC Version 9.3 and later)	Tachometer gauge data missing to primary EGC (101) or secondary EGC (201) The data for this gauge is not being transmitted on the datalink.

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

4.40. FUEL LEVEL GAUGE

Circuit Function

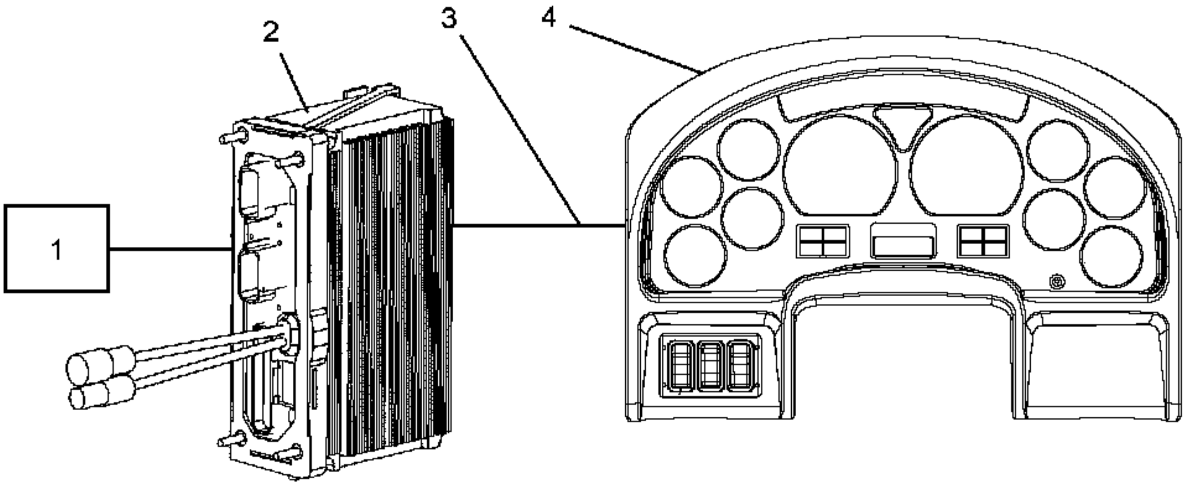


Figure 129 Fuel Level Gauge Function Diagram

1. FUEL LEVEL SENSOR
2. ELECTRICAL SYSTEM CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving the fuel level gauge is provided on the Drivetrain 1939 data link from the ESC. The ESC generates this information based on input from the fuel level sensor.

Diagnostics

The pointer in a small gauge, pointing to the six o'clock position, indicates that there is a sensor error for that gauge. A gauge pointing to 10 o'clock is connected to an unprogrammed connector on the EGC circuit board.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the gauge.

Problems with the fuel level gauge can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, an incorrect connection inside the EGC, a loss of programming, a problem in the ESC, a problem with the fuel level sensor or a problem with wiring to the sensor. The following procedures will provide guidance for determining why the gauge is malfunctioning.

Table 76 Fuel Level Gauge Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the fuel level gauge operate during the gauge sweep?		Gauge performs during gauge sweep.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install.

Table 76 Fuel Level Gauge Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
2.	On	Check for fuel level gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 257)	Read display on odometer.	Fuel level gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 259)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.		Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
4.	On	Attempt to exercise the gauge with the "INTUNE" diagnostic software.		Gauge responds to "INTUNE" diagnostic input.	Go to next step.	Insure gauge operates during gauge sweep. Insure jumper harness between gauge and circuit board is in correct location. If jumper is correct, replace EGC circuit board.
5.	Consider replacing ESC. (See ESC REPLACEMENT, page 123)					

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 77 Fuel Level Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
612 14 25 1	Draw tank, fuel level sensor out of range low. This code is associated with a short to ground on the fuel level sensor on the draw tank for both single tank and dual tank vehicles. Short to ground.
612 14 25 2	Draw tank, fuel sensor out of range high. This code is associated with a short to accessory or open circuit on the fuel level sensor on the draw tank for both single tank and dual tank vehicles. Shorted high or open circuit.
612 14 23 1	Storage tank, fuel level sensor out of range low. This code is associated with a short to ground on the fuel level sensor on the storage tank for dual tank vehicles. Short to ground.
612 14 23 2	Storage tank, fuel level sensor out of range high. This code is associated with a short to accessory or open circuit on the fuel level sensor on the storage tank for dual tank vehicles. Shorted high or open circuit.
1705 14 107 3 (EGC Version 8.7)	EGC gauge location 7 (fuel level) out of range high Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 107 4 (EGC Version 8.7)	EGC gauge location 7 (fuel level) out of range low Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 107 5 (EGC Version 8.7)	EGC gauge location 7 (fuel level) sensor fault There is a problem with the sensor that provides the data for this gauge.
1705 14 107 6 (EGC Version 8.7)	EGC gauge location 7 (fuel level) data unavailable The data that this gauge displays should be, but is not available at this time.

Table 77 Fuel Level Gauge Diagnostic Trouble Codes (cont.)

2023 14 107 5 or 2023 14 207 5 (EGC Version 9.3 and later)	Fuel gauge sensor fault to primary EGC (107) or secondary EGC (207) There is a problem with the sensor that provides the data for this gauge.
2023 14 107 6 or 2023 14 207 6 (EGC Version 9.3 and later)	Fuel gauge data unavailable to primary EGC (107) or secondary EGC (207) The data that this gauge displays should be, but is not available at this time.
2023 14 107 7 or 2023 14 207 7 (EGC Version 9.3 and later)	Fuel gauge data missing to primary EGC (107) or secondary EGC (207) The data for this gauge is not being transmitted on the datalink.

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

NOTE – For vehicles with dual fuel tanks refer to the Fuel Transfer section of this manual. (See FUEL TRANSFER PUMP SYSTEM, page 681) The transfer pump circuits can affect fuel gauge operation.

A fault in the fuel sensor circuits will be apparent when the fuel gauge points straight down. Fuel sensor diagnostic trouble codes will also be present.

Problems in sensor circuits could be the result of open or shorted sensors, open circuits, shorted circuits, or a failure in the ESC.

Refer to Fuel Sensor Circuits.

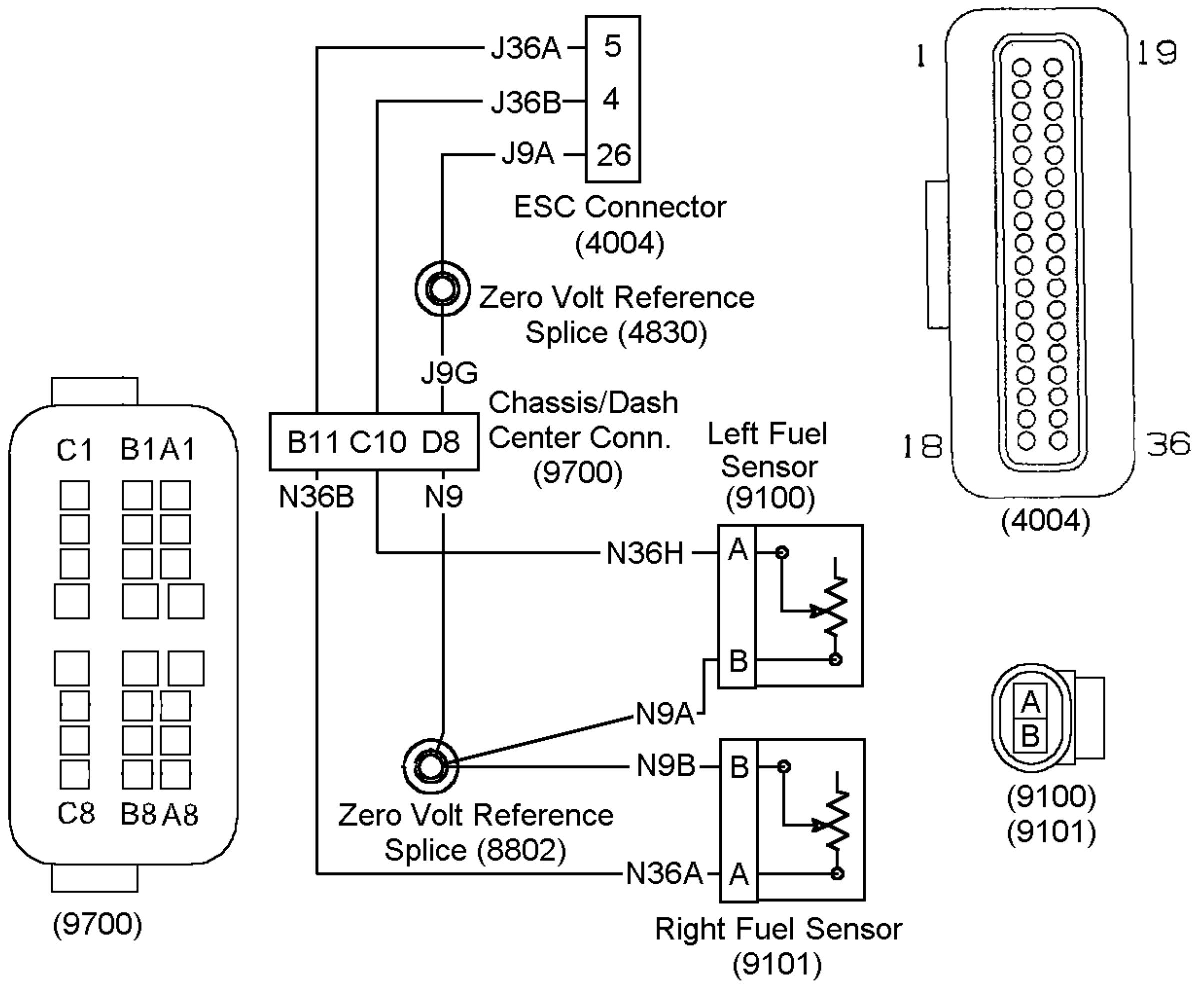


Figure 130 Fuel Sensor Circuits—Always Refer to Circuit Diagram Book for Latest Circuit Information

(4004) ELECTRICAL SYSTEM CONTROLLER (ESC) CONNECTOR
LOCATED ON ENGINE SIDE OF ESC
(4830) ELECTRONIC REF GROUND SPLICE
LOCATED NEAR POWER DISTRIBUTION CENTER
(8802) ISOLATED GROUND SPLICE PACK
LOCATED CHASSIS
(9100) LEFT FUEL SENSOR CONNECTOR
LOCATED IN LEFT DUAL FUEL TANKS
(9101) RIGHT FUEL SENSOR CONNECTOR
LOCATED IN RIGHT DUAL FUEL TANKS
(9700) CHASSIS/DASH INTERCONNECT
LOCATED IN REAR CHASSIS

Table 78 Fuel Level Gauge Diagnostic Trouble Codes

612 14 25 1	Draw tank, fuel level sensor out of range low. This code is associated with a short to ground on the fuel level sensor on the draw tank for both single tank and dual tank vehicles. Short to ground.
612 14 25 2	Draw tank, fuel sensor out of range high. This code is associated with a short to accessory or open circuit on the fuel level sensor on the draw tank for both single tank and dual tank vehicles. Shorted high or open circuit.
612 14 23 1	Storage tank, fuel level sensor out of range low. This code is associated with a short to ground on the fuel level sensor on the storage tank for dual tank vehicles. Short to ground.
612 14 23 2	Storage tank, fuel level sensor out of range high. This code is associated with a short to accessory or open circuit on the fuel level sensor on the storage tank for dual tank vehicles. Shorted high or open circuit.
1705 14 107 3 (EGC Version 8.7)	EGC gauge location 7 (fuel level) out of range high Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 107 4 (EGC Version 8.7)	EGC gauge location 7 (fuel level) out of range low Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 107 5 (EGC Version 8.7)	EGC gauge location 7 (fuel level) sensor fault There is a problem with the sensor that provides the data for this gauge.
1705 14 107 6 (EGC Version 8.7)	EGC gauge location 7 (fuel level) data unavailable The data that this gauge displays should be, but is not available at this time.
2023 14 107 5 or 2023 14 207 5 (EGC Version 9.3 and later)	Fuel gauge sensor fault to primary EGC (107) or secondary EGC (207) There is a problem with the sensor that provides the data for this gauge.

Table 78 Fuel Level Gauge Diagnostic Trouble Codes (cont.)

2023 14 107 6 or 2023 14 207 6 (EGC Version 9.3 and later)	Fuel gauge data unavailable to primary EGC (107) or secondary EGC (207) The data that this gauge displays should be, but is not available at this time.
2023 14 107 7 or 2023 14 207 7 (EGC Version 9.3 and later)	Fuel gauge data missing to primary EGC (107) or secondary EGC (207) The data for this gauge is not being transmitted on the datalink.

Table 79 Fuel Level Gauge Tests

Left Fuel Level Gauge Voltage Checks

Check with ignition on and fuel level sensor disconnected.

NOTE – Always check connectors for damage and pushed–out terminals.

Always use breakout box ZTSE 4477 to take measurements on ESC connectors.

Test Points	Spec.	Comments
(9100) cavity A to ground.	10 ± 1 volts	If voltage is missing, check for open or shorts in circuit N36E, N36H or J36B to ESC connector (4004) cavity 4. If circuits check good, check for missing 10 volt signal from ESC.
(9100) cavity A to B.	10 ± 1 volts	If voltage is present replace or repair fuel sensor If voltage is missing, check for open in circuits N9A, N9, J9G or J9A to ESC connector (4004) cavity 26. If circuits check good, check for missing zero volt reference from ESC.

Extended Description

A zero volt reference signal from ESC connector (4004) terminal 26 is supplied to fuel sensor connector (9100) terminal B through circuits J9A, J9G, Dash/Chassis connector (9700) terminal D8, circuit N9 and N9A.

The signal from the fuel sensor is supplied from fuel sensor connector (9100) terminal A to ESC connector (4004) terminal 4 through circuit N36E, Dash/Chassis connector (9700) terminal C10, and circuit J36B.

Component Locations

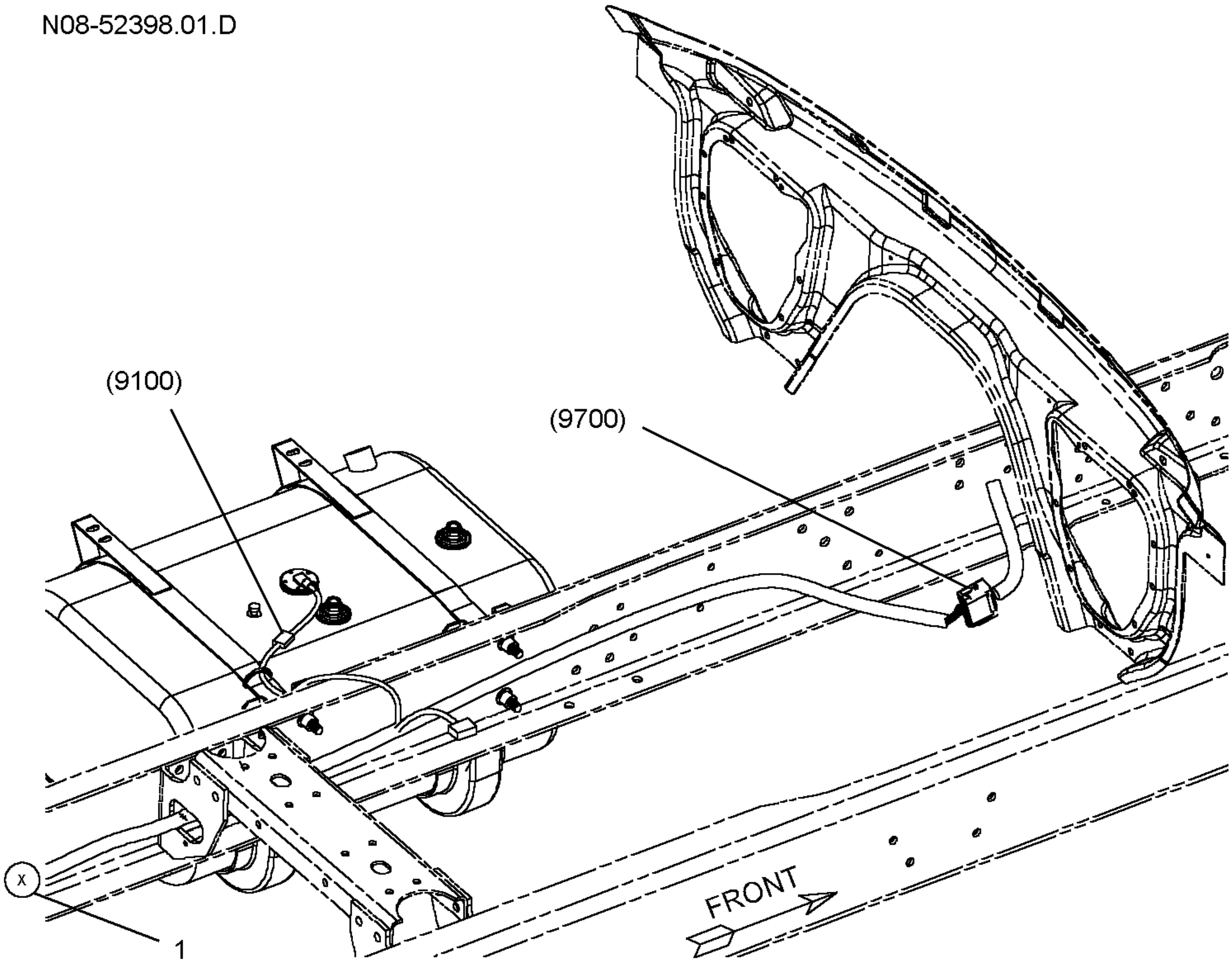


Figure 131 Fuel Sensor Connector Locations

(9100) FUEL LEVEL SENSOR CONNECTOR
(9700) REAR CHASSIS CONNECTOR

4.41. TRANSMISSION OIL TEMPERATURE GAUGE

Circuit Function

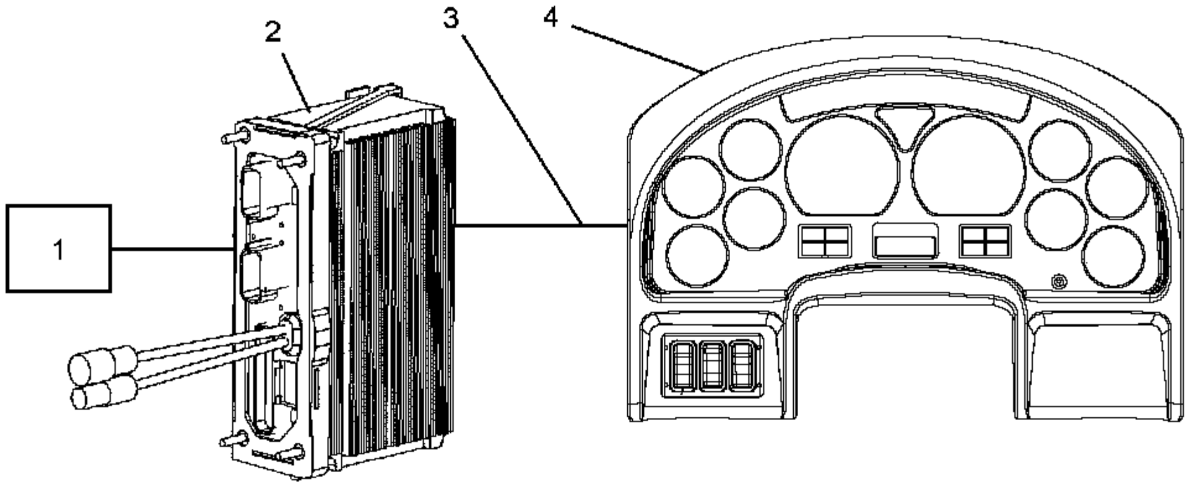


Figure 132 Transmission Oil Temperature Gauge Function Diagram

1. TRANSMISSION OIL TEMPERATURE SENSOR
2. ELECTRICAL SYSTEM CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

On a vehicle with a manual transmission, information driving the transmission oil temperature gauge is provided on the Drivetrain 1939 data link from the ESC. The ESC generates this information based on input from a sensor on the transmission.

On a vehicle with an automatic transmission manual transmission, information driving the transmission oil temperature gauge is provided on the Drivetrain 1939 data link from transmission electronic control Unit (ECU)

Diagnostics

The pointer in a small gauge, pointing to the six o'clock position, indicates that there is a sensor error for that gauge. A gauge pointing to 10 o'clock is connected to an unprogrammed connector on the EGC circuit board.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the gauge.

Problems with the transmission oil temperature gauge can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, an incorrect connection inside the EGC, a loss of programming, a problem in the ESC, a problem with the transmission oil temperature sensor or a problem with wiring to the sensor.

Table 80 Transmission Oil Temperature Gauge Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the transmission temperature gauge operate during the gauge sweep?		Gauge performs during gauge sweep.	Go to next step.	Replace gauge and check jumper harness . If problem persists, replace EGC circuit board. Refer to Remove and Install.
2.	On	Check for transmission temperature gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 266)	Read display on odometer.	Transmission temperature gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 266)	Go to next step.
3.	On	There are no DTC's for an open in sensor circuits. Does gauge read minimum when it should obviously be reading a higher temperature.	Observe gauge temperature reading when transmission is hot.	Transmission temperature gauge reads minimum when transmission is hot.	Go to fault detection management. (See Fault Detection/ Management, page 266)	Go to next step.
4.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.		Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the "ICAP" software. Refer to the ICAP programming software manual for details.

Table 80 Transmission Oil Temperature Gauge Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
5.	On	Attempt to exercise the gauge with the "INTUNE" diagnostic software.		Gauge responds to "INTUNE" diagnostic input.	Go to next step.	Insure gauge operates during gauge sweep. Insure jumper harness between gauge and circuit board is in correct location. If jumper is correct, replace EGC circuit board.
6.	On a vehicle with a manual transmission, Consider replacing ESC. (See ESC REPLACEMENT, page 123) On a vehicle with automatic transmission, refer to the applicable transmission manual.					

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key "ON". Then press the Cruise "ON" switch and the Cruise "Resume" switch. If no diagnostic trouble codes are present, the cluster odometer will display "NO FAULT". If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in "A" for active diagnostic trouble codes or "P" for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 81 Transmission Temperature Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
612 14 36 1	Transmission temperature sensor shorted to ground

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A short in the transmission temperature sensor circuits will be apparent when the temperature gauge points straight down. Transmission temperature sensor diagnostic trouble codes will also be present.

The ESC and EGC are not able to recognize an open circuit to the temperature sensor or an open sensor. There is no DTC for this condition.

Problems in sensor circuits could be the result of open or shorted sensor, open circuits, shorted circuits, a failure in the ESC or a transmission ECU problem.

Refer to Manual Transmission Temperature Sensor Circuits.

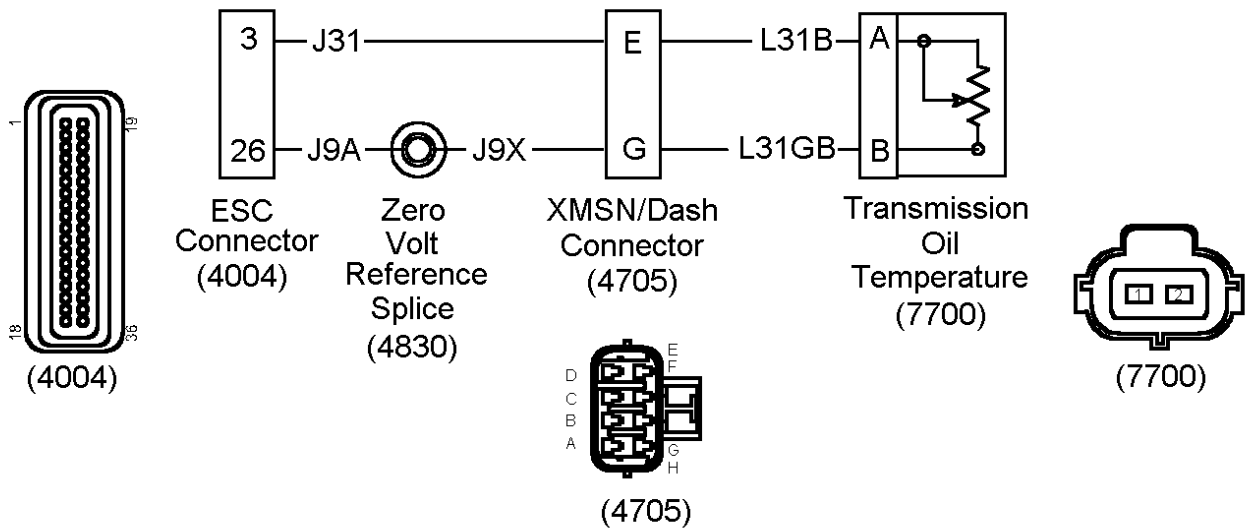


Figure 133 Manual Transmission Temperature Sensor Circuits—Always Refer to Circuit Diagram Book for Latest Circuit Information

(4004) ESC CONNECTOR
LOCATED ON ENGINE SIDE OF ESC
(4705) TRANSMISSION/DASH CONNECTOR
(4830) ZERO VOLT REFERENCE SPLICE
LOCATED ON CAB SIDE OF ESC
(7700) TRANSMISSION OIL TEMPERATURE
LOCATED ON MANUAL TRANSMISSION

Table 82 Transmission Oil Temperature Gauge Diagnostic Trouble Codes

612 14 36 1	Transmission temperature sensor shorted to ground

Table 83 Transmission Oil Temperature Gauge Tests

Transmission Oil Temperature Gauge Voltage Checks Check with ignition on and transmission oil temperature sensor (7700) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.** **Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**		
Test Points	Spec.	Comments
(7700) cavity A to ground.	10 ± 1 volts	If voltage is missing, check for open or shorts in circuit L31B or J31 to ESC connector (4004) cavity 3. If circuits check good, check for missing 10 volt signal from ESC.
(7700) cavity A to cavity B.	10 ± 1 volts	If voltage is missing, check for open in circuits L31GB, J9X or J9A to ESC connector (4004) cavity 26. If circuits check good, check for missing zero volt reference from ESC. If voltage is present, circuits to temperature sensor are good. Replace sensor.

Extended Description

A zero volt reference signal is supplied from ESC connector (4004) terminal 26 to transmission oil temperature sensor connector (7700) terminal B through circuit J9A, J9X and L31–GB.

10 volts from ESC connector (4004) terminal 3 is supplied to the transmission oil temperature sensor connector (7700) terminal through circuit J31 and L31B. This voltage will drop across the sensor providing the ESC with temperature information.

Component Locations

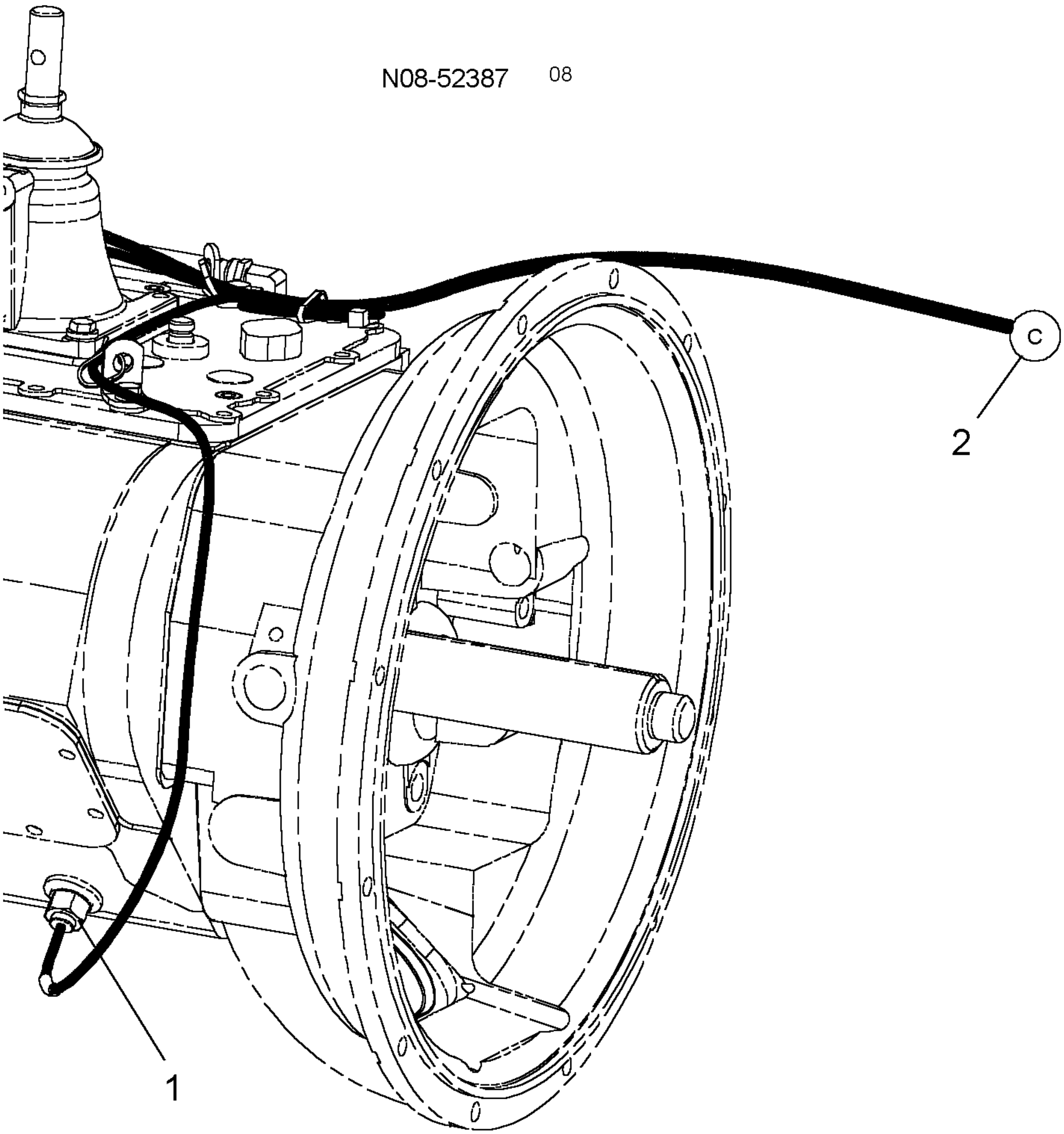


Figure 134 Typical Manual Transmission Oil Temperature Sensor Location

1. MANUAL TRANSMISSION OIL TEMPERATURE SENSOR
2. TRANSMISSION HARNESS

4.42. REAR-REAR AXLE OIL TEMPERATURE GAUGE

Circuit Function

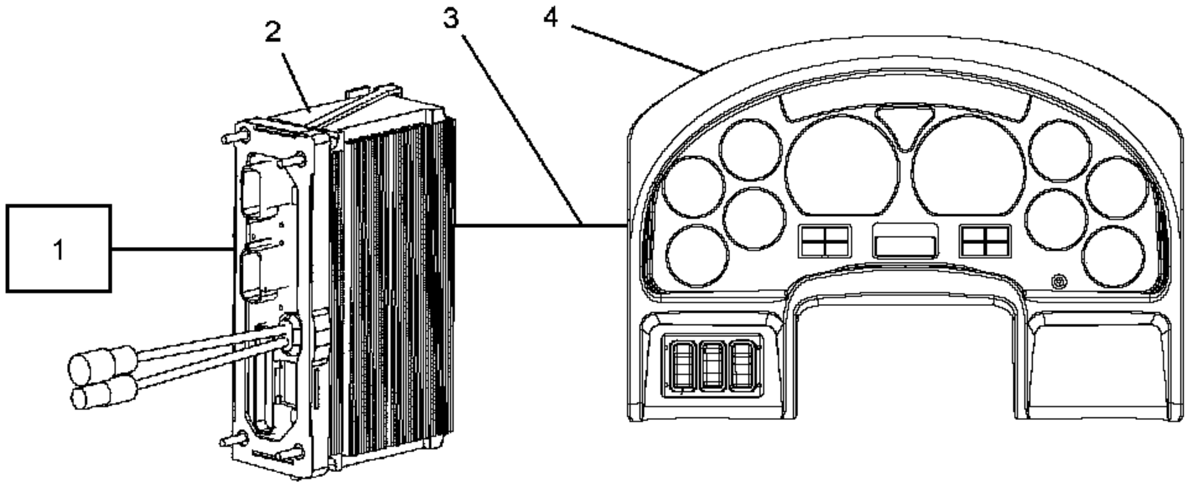


Figure 135 Rear-Rear Axle Oil Temperature Gauge Function Diagram

1. REAR-REAR AXLE OIL TEMPERATURE SENSOR
2. ELECTRICAL SYSTEM CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving the rear-rear axle oil temperature gauge is provided on the Drivetrain 1939 data link from the ESC. The ESC generates this information based on input from a sensor on the rear-rear axle.

Diagnostics

The pointer in a small gauge, pointing to the six o'clock position, indicates that there is a sensor error for that gauge. A gauge pointing to 10 o'clock is connected to an unprogrammed connector on the EGC circuit board.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the gauge.

Problems with the rear-rear axle temperature gauge can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, an incorrect connection inside the EGC, a loss of programming, a problem in the ESC, a problem with the rear-rear axle temperature sensor or a problem with wiring to the sensor.

Table 84 Rear-Rear Axle Oil Temperature Gauge Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the rear-rear axle oil temperature gauge operate during the gauge sweep?		Gauge performs during gauge sweep.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install.

Table 84 Rear-Rear Axle Oil Temperature Gauge Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
2.	On	Check for rear-rear axle oil temperature gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 271)	Read display on odometer.	Rear-rear axle oil temperature gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 272)	Go to next step.
3.	On	There are no DTC's for an open in sensor circuits. Does gauge read minimum when it should obviously be reading a higher temperature.	Observe gauge temperature reading when axle is hot.	Rear-rear axle temperature gauge reads minimum when axle is hot.	Go to fault detection management. (See Fault Detection/ Management, page 272)	Go to next step.
4.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.		Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the "ICAP" software. Refer to the ICAP programming software manual for details.
5.	On	Attempt to exercise the gauge with the "INTUNE" diagnostic software.		Gauge responds to "INTUNE" diagnostic input.	Go to next step.	Insure gauge operates during gauge sweep. Insure jumper harness between gauge and circuit board is in correct location. If jumper is correct, replace EGC circuit board.
6.	Consider replacing ESC. (See ESC REPLACEMENT, page 123)					

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key "ON". Then press the Cruise "ON" switch and the Cruise "Resume" switch. If no diagnostic trouble codes are present, the cluster odometer will display "NO FAULT". If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 85 Rear–Rear Axle Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
612 14 32 1	Rear Axle Oil Temperature out of range low Shorted to ground or open circuit.
612 14 32 2	Rear Axle Oil Temperature out of range high Shorted high.

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A short in the Rear—rear axle oil temperature sensor circuits will be apparent when the temperature gauge points straight down. Transmission temperature sensor diagnostic trouble codes will also be present.

The ESC and EGC are not able to recognize an open circuit to the temperature sensor or an open sensor. There is no DTC for this condition. A gauge with an open sensor circuit will always read minimum.

Problems in sensor circuits could be the result of open or shorted sensor, open circuits, shorted circuits or a failure in the ESC.

Refer to Rear–Rear Axle Temperature Sensor Circuits.

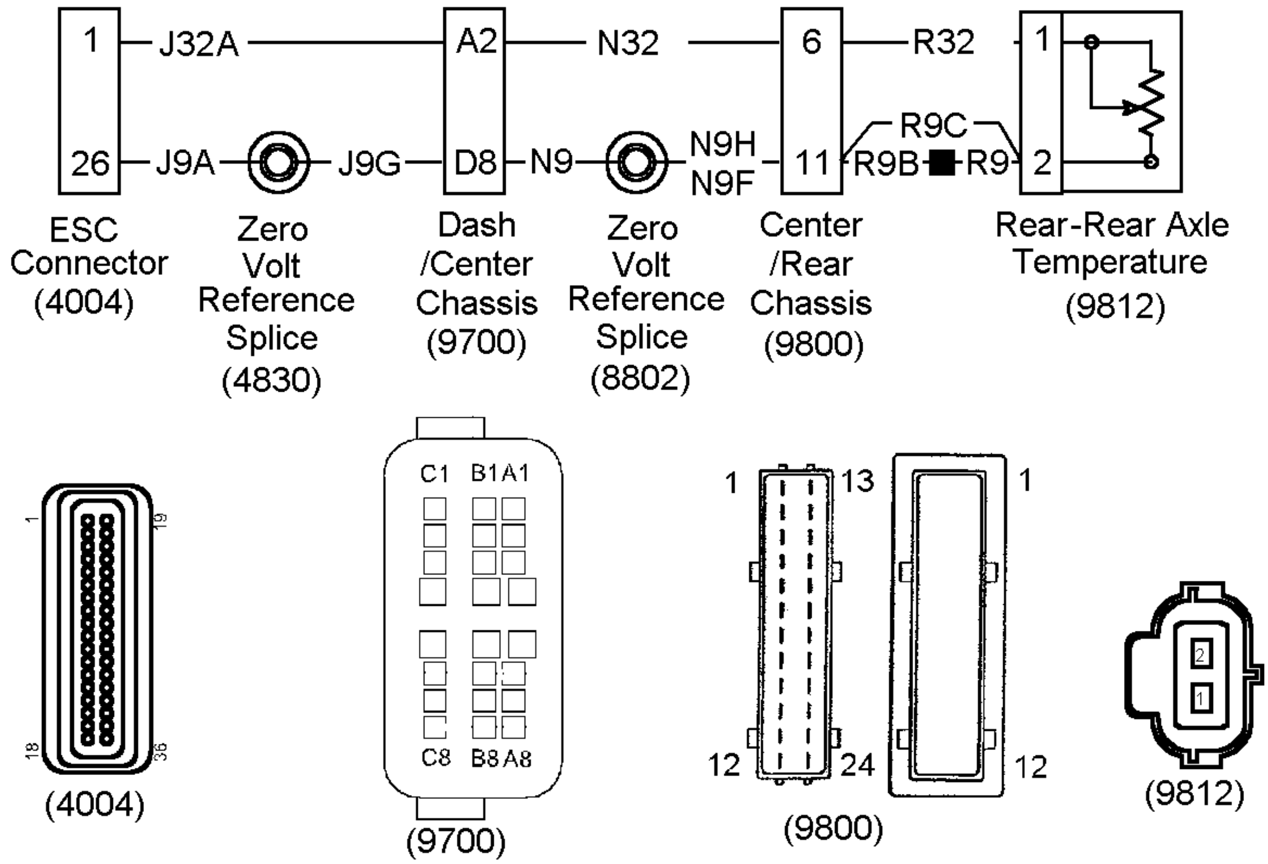


Figure 136 Rear–Rear Axle Oil Temperature Sensor Circuits—Always Refer to Circuit Diagram Book for Latest Circuit Information

(4004) ELECTRICAL SYSTEM CONTROLLER (ESC) CONNECTOR
LOCATED ON ENGINE SIDE OF ESC
(4830) ELECTRONIC REF GROUND SPLICE
LOCATED NEAR POWER DISTRIBUTION CENTER
(8802) ISOLATED GROUND SPLICE PACK
LOCATED CHASSIS
(9100) LEFT FUEL SENSOR CONNECTOR
LOCATED IN LEFT DUAL FUEL TANKS
(9101) RIGHT FUEL SENSOR CONNECTOR
LOCATED IN RIGHT DUAL FUEL TANKS
(9700) CHASSIS/DASH INTERCONNECT
LOCATED IN REAR CHASSIS
(9800) CENTER/REAR CHASSIS CONNECTOR
LOCATED BY LEFT FRAME RAIL NEAR REAR AXLES
(9812) REAR–REAR AXLE OIL TEMPERATURE
LOCATED ON REAR–REAR AXLE DIFFERENTIAL

Table 86 Rear–Rear Axle Oil Temperature Gauge Diagnostic Trouble Codes

612 14 32 1	Rear Axle Oil Temperature out of range low Shorted to ground or open circuit.
612 14 32 2	Rear Axle Oil Temperature out of range high Shorted high.

Table 87 Rear–Rear Axle Oil Temperature Gauge Tests

Rear–Rear Axle Oil Temperature Gauge Voltage Checks

Check with ignition on and rear–rear axle oil temperature sensor (9812) disconnected.

NOTE – Always check connectors for damage and pushed–out terminals.

Always use breakout box ZTSE 4477 to take measurements on ESC connectors.

Test Points	Spec.	Comments
(9812) cavity 1 to ground.	10 ± 1 volts	If voltage is missing, check for open or shorts in circuit R32, N32 or J32A to ESC connector (4004) cavity 1. If circuits check good, check for missing 10 volt signal from ESC.
(9812) cavity 1 to 2.	10 ± 1 volts	If voltage is missing, check for open in circuits R9X, N9X, J9G or J9A to ESC connector (4004) cavity 26. If circuits check good, check for missing zero volt reference from ESC. If voltage is present, circuits to temperature sensor are good. Replace sensor.

Extended Description

The zero volt reference signal from the ESC is supplied from ESC connector (4004) terminal 26 to rear-rear axle temperature sensor connector (9812) terminal 2.

10 volts from ESC connector (4004) terminal 1 is supplied to rear-rear axle temperature sensor connector (9812) terminal 1. This voltage will drop across the sensor providing the ESC with temperature information.

Component Locations

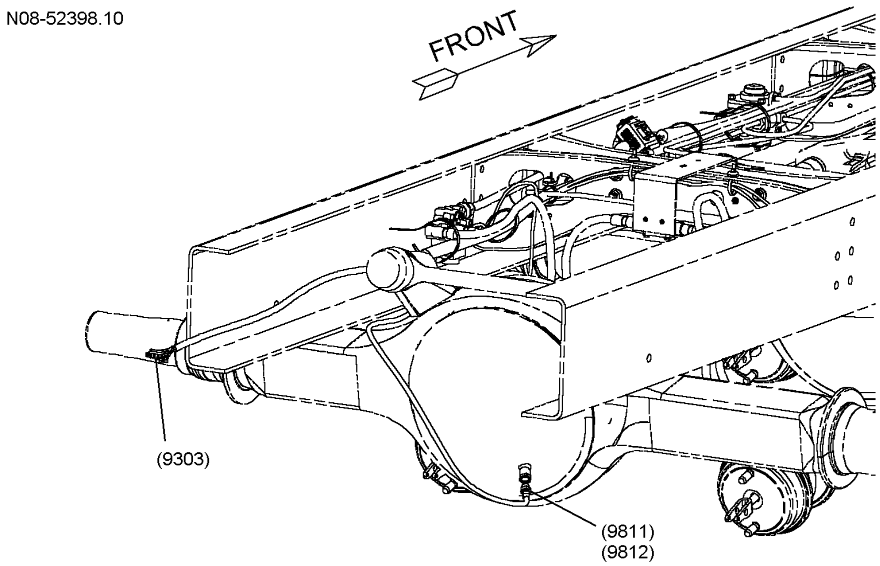


Figure 137 Axle Oil Temperature Sensor Location

(9812) REAR–REAR AXLE OIL TEMPERATURE SENSOR

4.43. FORWARD-REAR AXLE OIL TEMPERATURE GAUGE

Forward-Rear Axle Oil Temperature Gauge

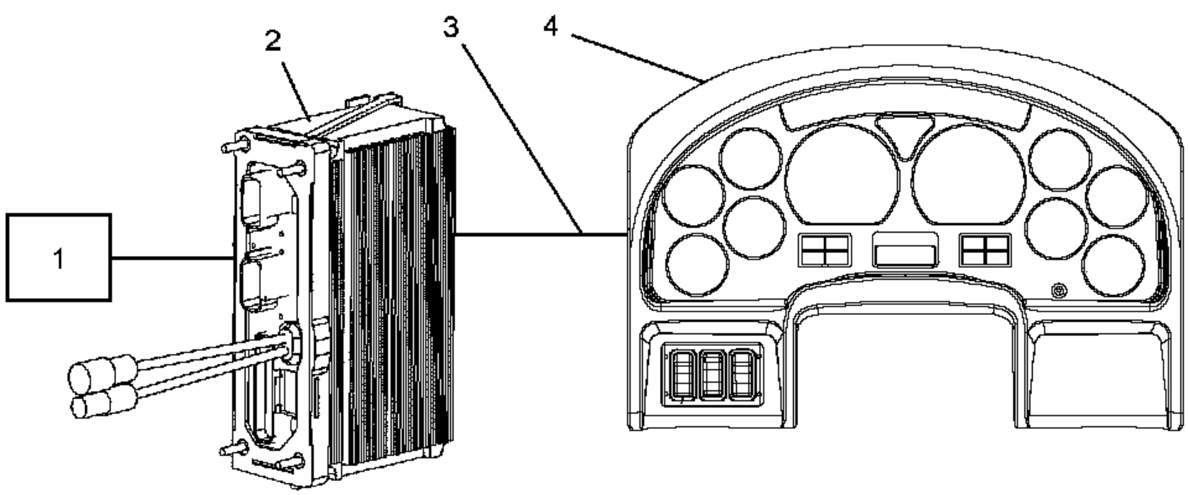


Figure 138 Forward-Rear Axle Oil Temperature Gauge Function Diagram

1. FORWARD-REAR AXLE OIL TEMPERATURE SENSOR
2. ELECTRICAL SYSTEM CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving the forward-rear axle oil temperature gauge is provided on the Drivetrain 1939 data link from the ESC. The ESC generates this information based on input from a sensor on the forward-rear axle.

Diagnostics

The pointer in a small gauge, pointing to the six o'clock position, indicates that there is a sensor error for that gauge. A gauge pointing to 10 o'clock is connected to an unprogrammed connector on the EGC circuit board.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the gauge.

Problems with the forward-rear axle oil temperature gauge can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, an incorrect connection inside the EGC, a loss of programming, a problem in the ESC, a problem with the forward-rear axle oil temperature sensor or a problem with wiring to the sensor.

Table 88 Forward-Rear Axle Oil Temperature Gauge Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the forward-rear axle oil temperature gauge operate during the gauge sweep?		Gauge performs during gauge sweep.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install.
2.	On	Check for forward-rear axle oil temperature gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 277)	Read display on odometer.	Forward—rear axle oil temperature gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 278)	Go to next step.
3.	On	There are no DTC's for an open in sensor circuits. Does gauge read minimum when it should obviously be reading a higher temperature.	Observe gauge temperature reading when axle is hot.	Forward-rear axle oil temperature gauge reads minimum when axle is hot.	Go to fault detection management. (See Fault Detection/ Management, page 278)	Go to next step.

Table 88 Forward-Rear Axle Oil Temperature Gauge Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
4.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.		Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
5.	On	Attempt to exercise the gauge with the "INTUNE" diagnostic software.		Gauge responds to "INTUNE" diagnostic input.	Go to next step.	Insure gauge operates during gauge sweep. Insure jumper harness between gauge and circuit board is in correct location. If jumper is correct, replace EGC circuit board.
6.	Consider replacing ESC. (See ESC REPLACEMENT, page 123)					

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 89 Forward-Rear Axle Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
612 14 34 1	Forward-Rear Axle Oil Temperature out of range low Shorted to ground or open circuit.
612 14 34 2	Forward-Rear Axle Oil Temperature out of range high Shorted high.

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A short in the forward–rear oil temperature sensor circuits will be apparent when the temperature gauge points straight down. Transmission temperature sensor diagnostic trouble codes will also be present.

The ESC and EGC are not able to recognize an open circuit to the temperature sensor or an open sensor. There is no DTC for this condition. A gauge with an open sensor circuit will always read minimum.

Problems in sensor circuits could be the result of open or shorted sensor, open circuits, shorted circuits or a failure in the ESC.

Refer to Forward–Rear Axle Oil Temperature Sensor Circuits.

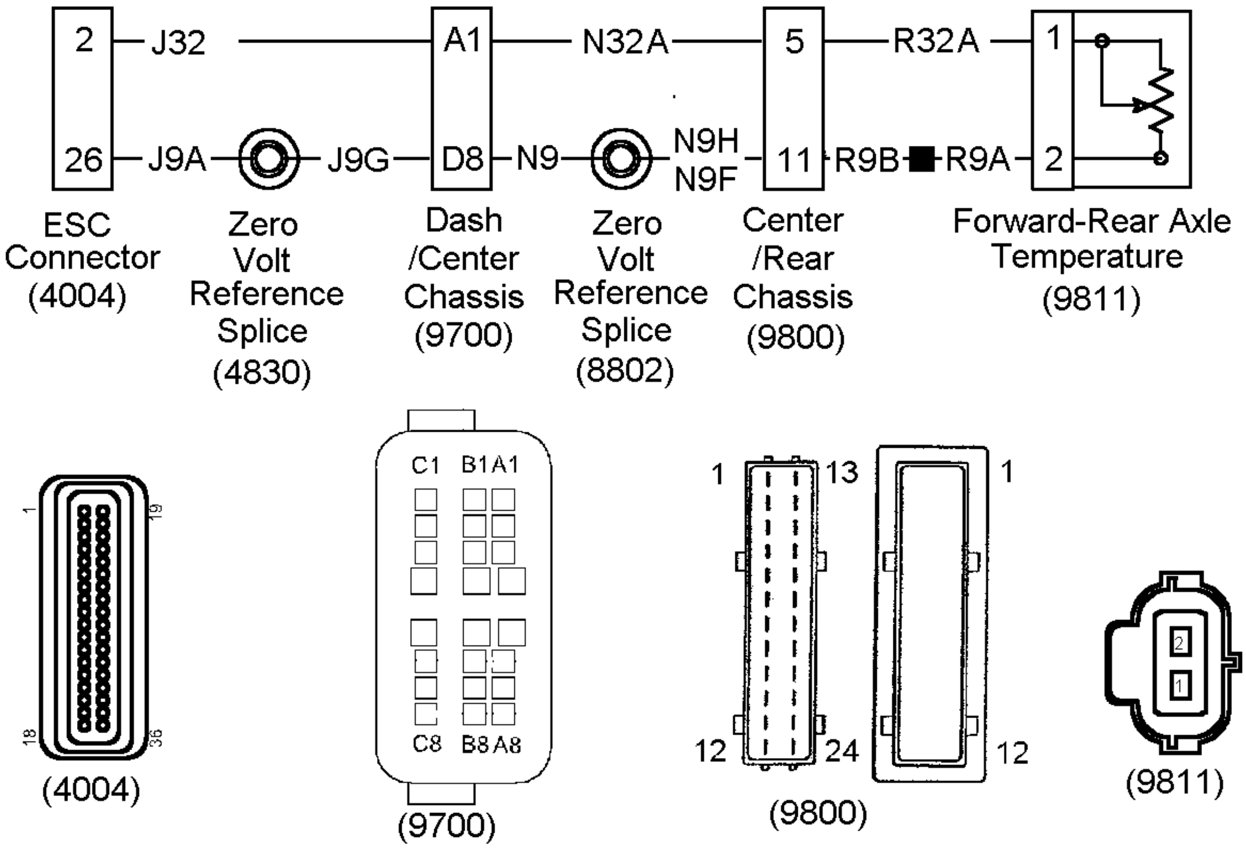


Figure 139 Forward–Rear Axle Oil Temperature Sensor Circuits—Always Refer to Circuit Diagram Book for Latest Circuit Information

(4004) ELECTRICAL SYSTEM CONTROLLER (ESC) CONNECTOR
LOCATED ON ENGINE SIDE OF ESC
(4830) ELECTRONIC REF GROUND SPLICE
LOCATED NEAR POWER DISTRIBUTION CENTER
(8802) ISOLATED GROUND SPLICE PACK
LOCATED CHASSIS
(9100) LEFT FUEL SENSOR CONNECTOR
LOCATED IN LEFT DUAL FUEL TANKS
(9101) RIGHT FUEL SENSOR CONNECTOR
LOCATED IN RIGHT DUAL FUEL TANKS
(9700) CHASSIS/DASH INTERCONNECT
LOCATED IN REAR CHASSIS
(9800) CENTER/REAR CHASSIS CONNECTOR
LOCATED BY LEFT FRAME RAIL NEAR REAR AXLES
(9811) FORWARD–REAR AXLE OIL TEMPERATURE
LOCATED ON FORWARD–REAR AXLE DIFFERENTIAL

Table 90 Forward–Rear Axle Oil Temperature Gauge Diagnostic Trouble Codes

612 14 34 1	Forward–rear axle oil temperature sensor shorted to ground
612 14 34 2	Forward-Rear Axle Oil Temperature out of range high. Shorted high.

Table 91 Forward–Rear Axle Oil Temperature Gauge Tests

Forward–Rear Axle Oil Temperature Gauge Voltage Checks		
Check with ignition on and forward–rear axle oil temperature sensor (9811) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.** **Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**		
Test Points	Spec.	Comments
(9811) cavity 1 to ground.	10 ± 1 volts	If voltage is missing, check for open or shorts in circuit R32A, N32A or J32 to ESC connector (4004) cavity 2. If circuits check good, check for missing 10 volt signal from ESC.
(9811) cavity 1 to 2.	10 ± 1 volts	If voltage is missing, check for open in circuits R9A, R9B, J9G, N9H, N9. J9G or J9A to ESC connector (4004) cavity 26. If circuits check good, check for missing zero volt reference from ESC. If voltage is present, circuits to temperature sensor are good. Replace sensor.

Extended Description

The zero volt reference signal from the ESC is supplied from ESC connector (4004) terminal 26 to forward-rear axle oil temperature sensor connector (9811) terminal 2.

10 volts from ESC connector (4004) terminal 2 is supplied to forward-rear axle temperature sensor connector (9811) terminal 1. This voltage will drop across the sensor providing the ESC with temperature information.

Component Locations

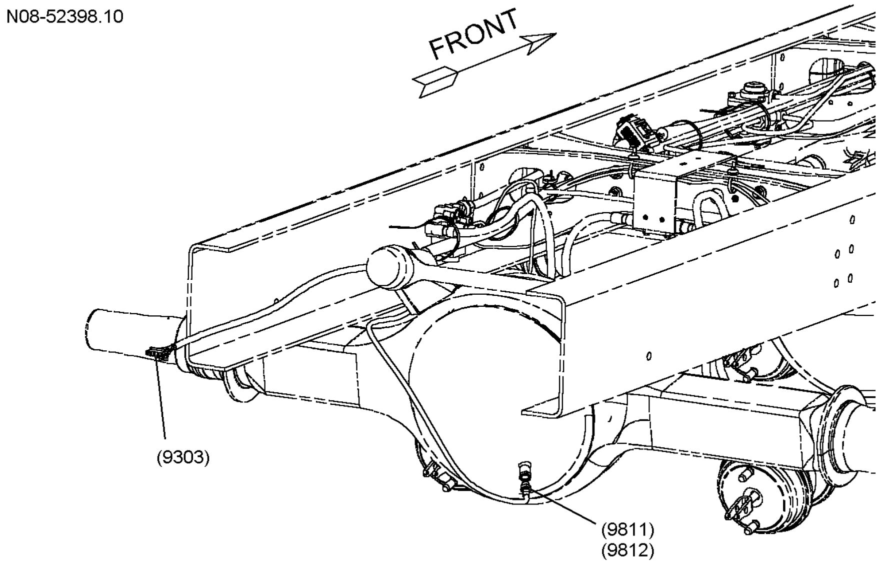


Figure 140 Axle Oil Temperature Sensor Location

(9811) FORWARD-REAR AXLE OIL TEMPERATURE SENSOR

4.44. PRIMARY AIR PRESSURE GAUGE

Circuit Functions

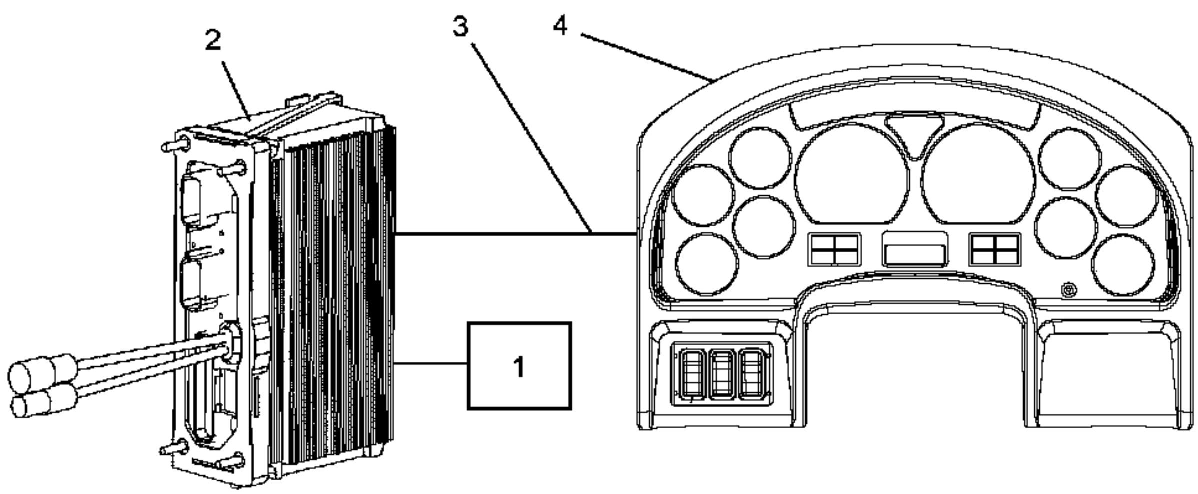


Figure 141 Primary Air Pressure Gauge Function Diagram

1. PRIMARY AIR PRESSURE SENSOR
2. ELECTRICAL SYSTEM CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving the primary air pressure gauge is provided on the Drivetrain 1939 data link from the ESC. The ESC generates this information based on input from a transducer connected to the air line.

The pointer in a small gauge, pointing to the six o’clock position, indicates that there is a sensor error for that gauge. A gauge pointing to 10 o’clock is connected to an unprogrammed connector on the EGC circuit board.

Diagnostics

Problems with the primary air pressure gauge can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, an incorrect connection inside the EGC, a loss of programming, a problem in the ESC, a problem with the air brake application transducer or a problem with wiring to the sensor.

Table 92 Primary Air Pressure Gauge Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the primary air pressure gauge perform during the gauge sweep?		Gauge performs during gauge sweep.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install.
2.	On	Check for primary air pressure gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 283)	Read display on odometer.	Primary air pressure gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 284)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.		Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.

Table 92 Primary Air Pressure Gauge Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
4.	On	Attempt to exercise the gauge with the "INTUNE" diagnostic software.		Gauge responds to "INTUNE" diagnostic input.	Go to next step.	Insure gauge operates during gauge sweep. Insure jumper harness between gauge and circuit board is in correct location. If jumper is correct, replace EGC circuit board.
5.	Consider replacing ESC. (See ESC REPLACEMENT, page 123)					

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 93 Primary Air Pressure Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
612 14 4 1	Primary air pressure out of range low Short to ground, open circuit or missing 5 volts from ESC
612 14 4 2	Primary air pressure out of range high Shorted high
1705 14 108 3 (EGC Version 8.7)	EGC gauge location 8 (primary air pressure) out of range high Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 108 4 (EGC Version 8.7)	EGC gauge location 8 (primary air pressure) out of range low Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.

Table 93 Primary Air Pressure Gauge Diagnostic Trouble Codes (cont.)

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
1705 14 108 5 (EGC Version 8.7)	EGC gauge location 8 (primary air pressure) sensor fault There is a problem with the sensor that provides the data for this gauge.
1705 14 108 6 (EGC Version 8.7)	EGC gauge location 8 (primary air pressure) data unavailable The data that this gauge displays should be, but is not available at this time.
2023 14 108 5 or 2023 14 208 5 (EGC Version 9.3 and later)	Primary air pressure gauge sensor fault to primary EGC (108) or secondary EGC (208) There is a problem with the sensor that provides the data for this gauge.
2023 14 108 6 or 2023 14 208 6 (EGC Version 9.3 and later)	Primary air pressure gauge data unavailable to primary EGC (108) or secondary EGC (208) The data that this gauge displays should be, but is not available at this time.
2023 14 108 7 or 2023 14 208 7 (EGC Version 9.3 and later)	Primary air pressure gauge data missing to primary EGC (108) or secondary EGC (208) The data for this gauge is not being transmitted on the datalink.

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the gauge.

Refer to Primary Air Pressure Transducer Circuits.

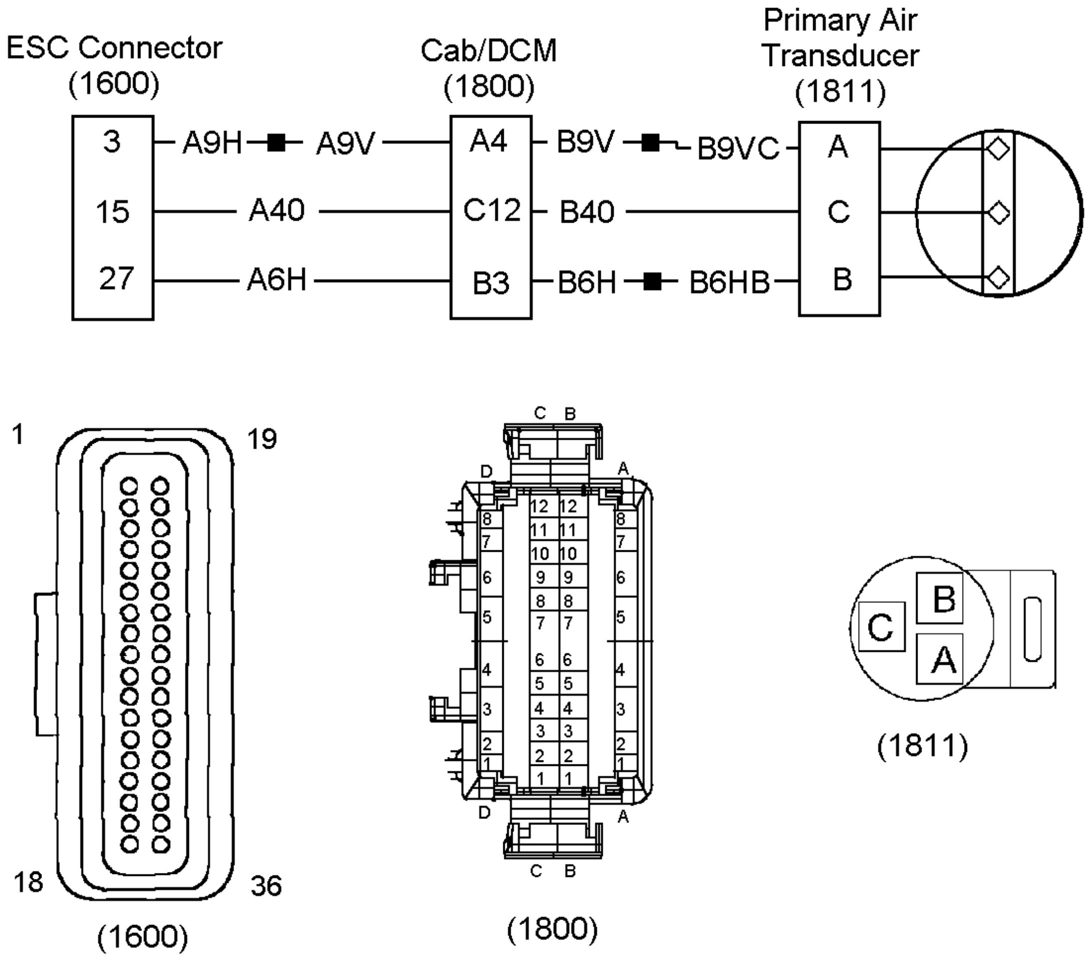


Figure 142 Primary Air Pressure Transducer Circuits—Always Refer To Circuit Diagram Book For Latest Circuit Information

(1600) ELECTRICAL SYSTEM CONTROLLER CONNECTOR
LOCATED IN DASH COMPARTMENT SIDE OF ESC
(1800) CAB/DCM CONNECTOR
LOCATED BEHIND CLUSTER
(1811) PRIMARY AIR PRESSURE TRANSDUCER CONNECTOR
LOCATED TO LEFT OF LOWER STEERING COLUMN

Table 94 Primary Air Pressure Gauge Tests

Diagnostic Trouble Codes	
612 14 4 1	Primary Air Pressure out of range low Short to ground, open circuit or missing 5 volts from ESC
612 14 4 2	Primary Air Pressure out of range high Shorted to high.
1705 14 108 3 (EGC Version 8.7)	EGC gauge location 8 (primary air pressure) out of range high Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 108 4 (EGC Version 8.7)	EGC gauge location 8 (primary air pressure) out of range low Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 108 5 (EGC Version 8.7)	EGC gauge location 8 (primary air pressure) sensor fault There is a problem with the sensor that provides the data for this gauge.
1705 14 108 6 (EGC Version 8.7)	EGC gauge location 8 (primary air pressure) data unavailable The data that this gauge displays should be, but is not available at this time.
2023 14 108 5 or 2023 14 208 5 (EGC Version 9.3 and later)	Primary air pressure gauge sensor fault to primary EGC (108) or secondary EGC (208) There is a problem with the sensor that provides the data for this gauge.
2023 14 108 6 or 2023 14 208 6 (EGC Version 9.3 and later)	Primary air pressure gauge data unavailable to primary EGC (108) or secondary EGC (208) The data that this gauge displays should be, but is not available at this time.

Table 94 Primary Air Pressure Gauge Tests (cont.)

Diagnostic Trouble Codes	
2023 14 108 7 or 2023 14 208 7 (EGC Version 9.3 and later)	Primary air pressure gauge data missing to primary EGC (108) or secondary EGC (208) The data for this gauge is not being transmitted on the datalink.

Primary Air Pressure Gauge Voltage Checks

Check with ignition on and (1811) disconnected.

NOTE – Always check connectors for damage and pushed–out terminals.

Always use breakout box ZTSE 4477 to take measurements on ESC connectors.

Test Points	Spec.	Comments
(1811) cavity B to ground.	5 ± .5 volts	If voltage is missing, check for open or shorts in circuit B6HB, B6H or A6H to ESC connector (1600) cavity 27. If circuits check good, check for missing 5 volt signal from ESC.
(1811) cavity B to cavity A.	5 ± .5 volts	If voltage is missing, check for open in circuits B9VC, B9V, A9V or A9H to ESC connector (1600) cavity 3. If circuits check good, check for missing zero volt reference from ESC.
(1811) cavity B to cavity C.	5 ± .5 volts	If voltage is incorrect, check for open or short to voltage in circuits B40, or A40 to ESC connector (1600) cavity 15. If voltage is present, circuits to transducer are good. Replace transducer

Extended Description

The 5 volt sensor supply signal is supplied to primary air pressure transducer connector (1811) pin B from ESC connector (1600) pin 27.

The zero volt reference signal is supplied to air brake application transducer connector (1811) pin A from ESC connector (1600) pin 3.

The pressure transducer acts like a potentiometer. The transducer will provide a voltage to ESC connector (1600) pin 15, which will vary with changes in applied pressure.

Component Locations

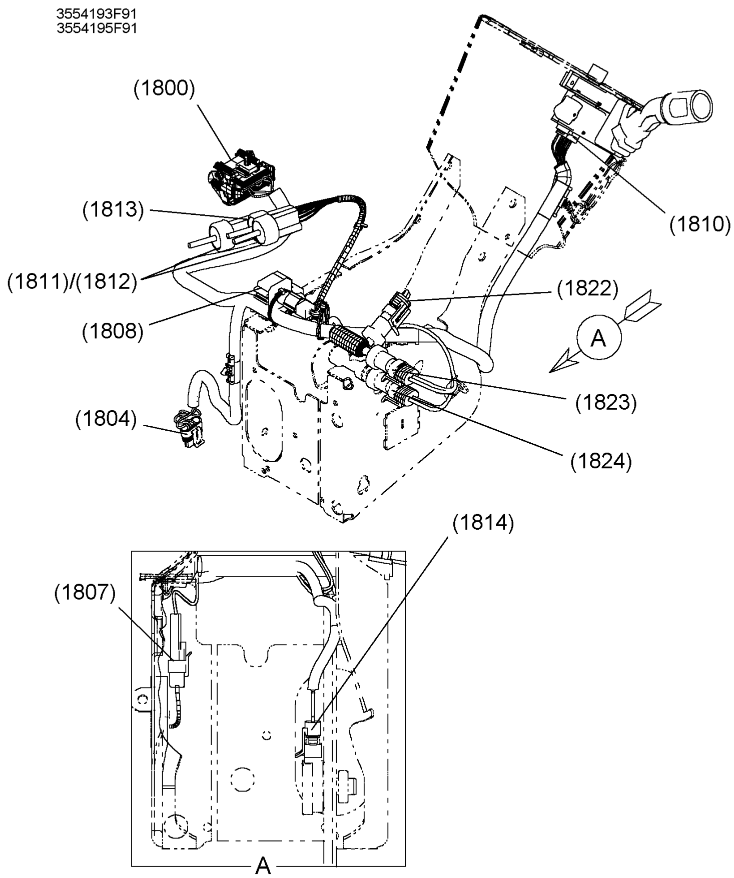


Figure 143 Primary Air Gauge Transducer Location (Steering Column Support View)

(1800) DRIVER CONTROL MODULE (DCM) CONNECTOR
(1811) PRIMARY AIR TRANSDUCER
(1812) SECONDARY AIR TRANSDUCER
(1822) AIR APPLICATION TRANSDUCER

4.45. SECONDARY AIR PRESSURE GAUGE

Circuit Function

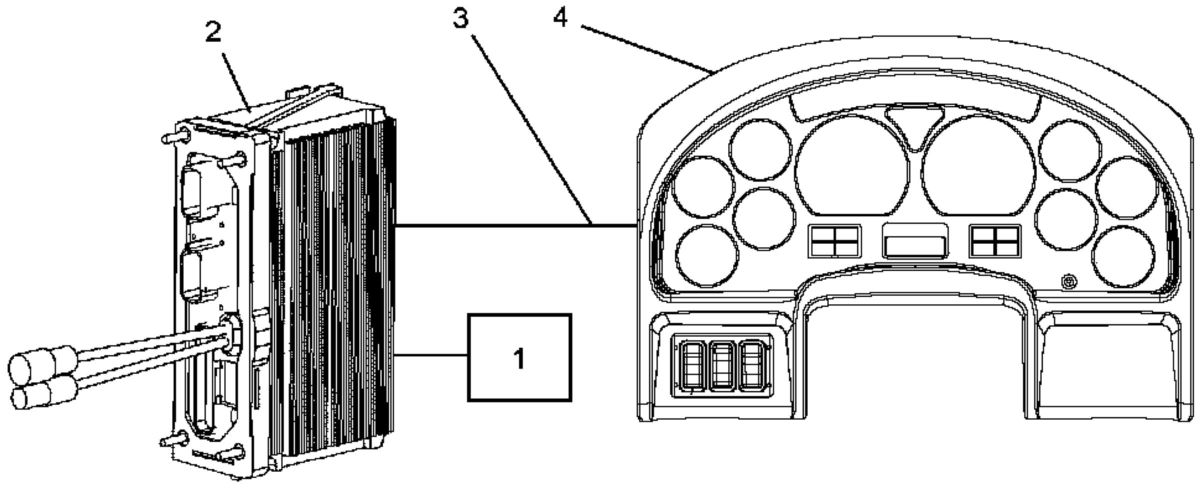


Figure 144 Secondary Air Pressure Gauge Function Diagram

1. SECONDARY AIR PRESSURE SENSOR
2. ELECTRICAL SYSTEM CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving the secondary air pressure gauge is provided on the drivetrain 1939 data link from the ESC. The ESC generates this information based on input from a transducer connected to the air line.

The pointer in a small gauge, pointing to the six o'clock position, indicates that there is a sensor error for that gauge. A gauge pointing to 10 o'clock is connected to an unprogrammed connector on the EGC circuit board.

Diagnostics

Problems with the secondary air pressure gauge can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, an incorrect connection inside the EGC, a loss of programming, a problem in the ESC, a problem with the air brake application transducer or a problem with wiring to the sensor.

Table 95 Secondary Air Pressure Gauge Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the secondary air pressure gauge perform during the gauge sweep?		Gauge performs during gauge sweep.	Go to next step.	Replace gauge and check jumper harness . If problem persists, replace EGC circuit board. Refer to Remove and Install.

Table 95 Secondary Air Pressure Gauge Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
2.	On	Check for secondary air pressure gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 290)	Read display on odometer.	Secondary air pressure gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 291)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.		Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
4.	On	Attempt to exercise the gauge with the "INTUNE" diagnostic software.		Gauge responds to "INTUNE" diagnostic input.	Go to next step.	Insure gauge operates during gauge sweep. Insure jumper harness between gauge and circuit board is in correct location. If jumper is correct, replace EGC circuit board.
5.	Consider replacing ESC . (See ESC REPLACEMENT, page 123)					

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 96 Secondary Air Pressure Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
612 14 3 1	Secondary Air Pressure out of range low Short to ground, open circuit or missing 5 volts from ESC
612 14 3 2	Secondary Air Pressure out of range high Shorted high
1705 14 110 3 (EGC Version 8.7)	EGC gauge location 10 (secondary air pressure) out of range high Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 110 4 (EGC Version 8.7)	EGC gauge location 10 (secondary air pressure) out of range low Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 110 5 (EGC Version 8.7)	EGC gauge location 10 (secondary air pressure) sensor fault There is a problem with the sensor that provides the data for this gauge.
1705 14 110 6 (EGC Version 8.7)	EGC gauge location 10 (secondary air pressure) data unavailable The data that this gauge displays should be, but is not available at this time.
2023 14 110 5 or 2023 14 210 5 (EGC Version 9.3 and later)	Secondary air pressure gauge sensor fault to primary EGC (110) or secondary EGC (210) There is a problem with the sensor that provides the data for this gauge.
2023 14 110 6 or 2023 14 210 6 (EGC Version 9.3 and later)	Secondary air pressure gauge data unavailable to primary EGC (110) or secondary EGC (210) The data that this gauge displays should be, but is not available at this time.
2023 14 110 7 or 2023 14 210 7 (EGC Version 9.3 and later)	Secondary air pressure gauge data missing to primary EGC (110) or secondary EGC (210) The data for this gauge is not being transmitted on the datalink.

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

The pointer in a small gauge, pointing to the six o’clock position, indicates that there is a sensor error for that gauge. A gauge pointing to 10 o’clock is connected to an unprogrammed connector on the EGC circuit board.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the gauge.

Refer to Secondary Air Pressure Transducer Circuits.

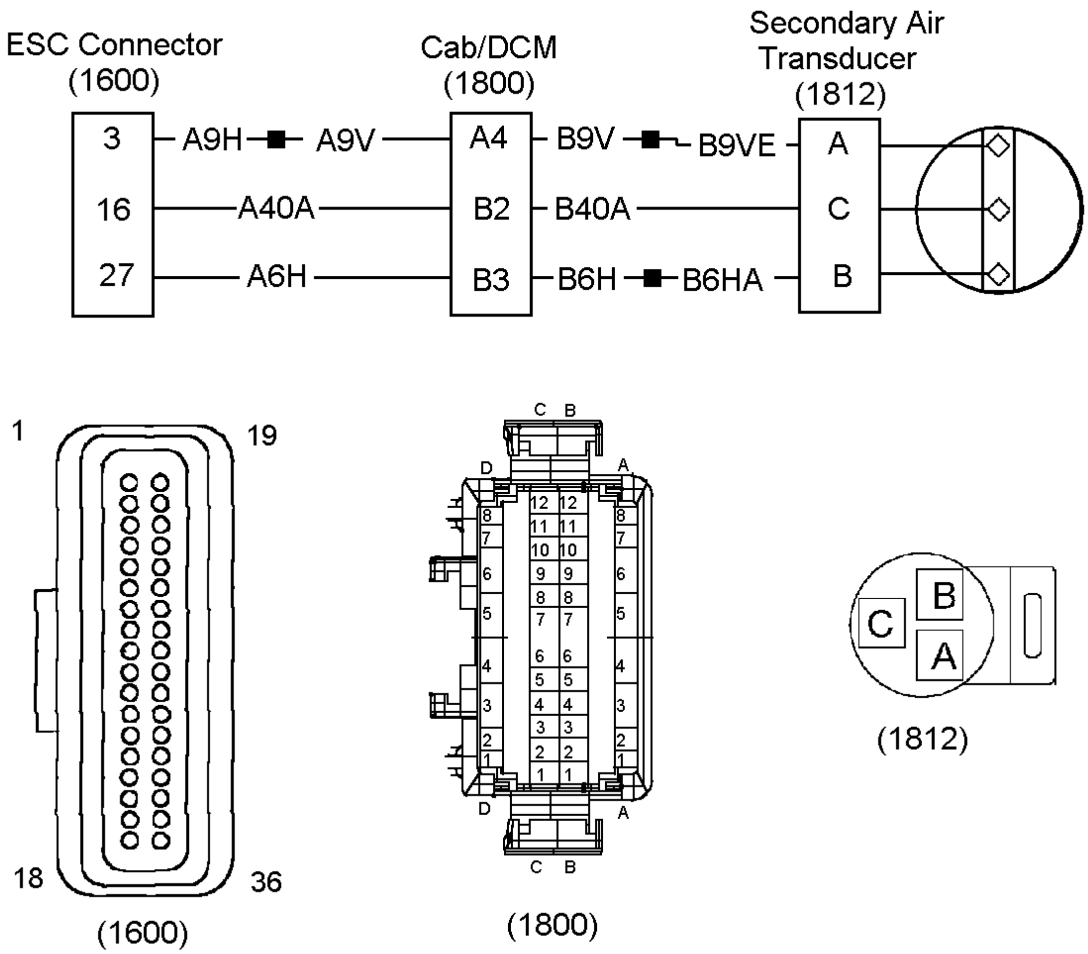


Figure 145 Secondary Air Pressure Transducer Circuits—Always Refer To Circuit Diagram Book For Latest Circuit Information

(1600) ELECTRICAL SYSTEM CONTROLLER CONNECTOR
LOCATED IN DASH COMPARTMENT SIDE OF ESC
(1800) CAB/DCM CONNECTOR
LOCATED BEHIND CLUSTER
(1812) SECONDARY AIR PRESSURE TRANSDUCER CONNECTOR
LOCATED TO LEFT OF LOWER STEERING COLUMN

Table 97 **Secondary Air Pressure Gauge Tests**

Diagnostic Trouble Codes	
612 14 3 1	Secondary Air Pressure out of range low Short to ground, open circuit or missing 5 volts from ESC
612 14 3 2	Secondary Air Pressure out of range high Shorted to high
1705 14 110 3 (EGC Version 8.7)	EGC gauge location 10 (secondary air pressure) out of range high Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 110 4 (EGC Version 8.7)	EGC gauge location 10 (secondary air pressure) out of range low Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 110 5 (EGC Version 8.7)	EGC gauge location 10 (secondary air pressure) sensor fault There is a problem with the sensor that provides the data for this gauge.
1705 14 110 6 (EGC Version 8.7)	EGC gauge location 10 (secondary air pressure) data unavailable The data that this gauge displays should be, but is not available at this time.
2023 14 110 5 or 2023 14 210 5 (EGC Version 9.3 and later)	Secondary air pressure gauge sensor fault to primary EGC (110) or secondary EGC (210) There is a problem with the sensor that provides the data for this gauge.
2023 14 110 6 or 2023 14 210 6 (EGC Version 9.3 and later)	Secondary air pressure gauge data unavailable to primary EGC (110) or secondary EGC (210) The data that this gauge displays should be, but is not available at this time.

Table 97 Secondary Air Pressure Gauge Tests (cont.)

Diagnostic Trouble Codes	
2023 14 110 7 or 2023 14 210 7 (EGC Version 9.3 and later)	Secondary air pressure gauge data missing to primary EGC (110) or secondary EGC (210) The data for this gauge is not being transmitted on the datalink.

Secondary Air Pressure Gauge Voltage Checks

Check with ignition on and (1812) disconnected.

NOTE – Always check connectors for damage and pushed–out terminals.

Always use breakout box ZTSE 4477 to take measurements on ESC connectors.

Test Points	Spec.	Comments
(1812) cavity B to ground.	5 ± .5 volts	If voltage is missing, check for open or shorts in circuit B6HA, B6H or A6H to ESC connector (1600) cavity 27. If circuits check good, check for missing 5 volt signal from ESC.
(1812) cavity B to cavity A.	5 ± .5 volts	If voltage is missing, check for open in circuits B9VE, B9V, A9V or A9H to ESC connector (1600) cavity 3. If circuits check good, check for missing zero volt reference from ESC.
(1812) cavity B to cavity C.	5 ± .5 volts	If voltage is incorrect, check for open or short to voltage in circuits B40A or A40A to ESC connector (1600) cavity 16. If voltage is present, circuits to transducer are good. Replace transducer

Extended Description

The 5 volt sensor supply signal is supplied to secondary air pressure transducer connector (1812) pin B from ESC connector (1600) pin 27.

The zero volt reference signal is supplied to air brake application transducer connector (1812) pin A from ESC connector (1600) pin 3.

The pressure transducer acts like a potentiometer. The transducer will provide a volage to ESC connector (1600) pin 16, which will vary with changes in applied pressure.

Component Locations

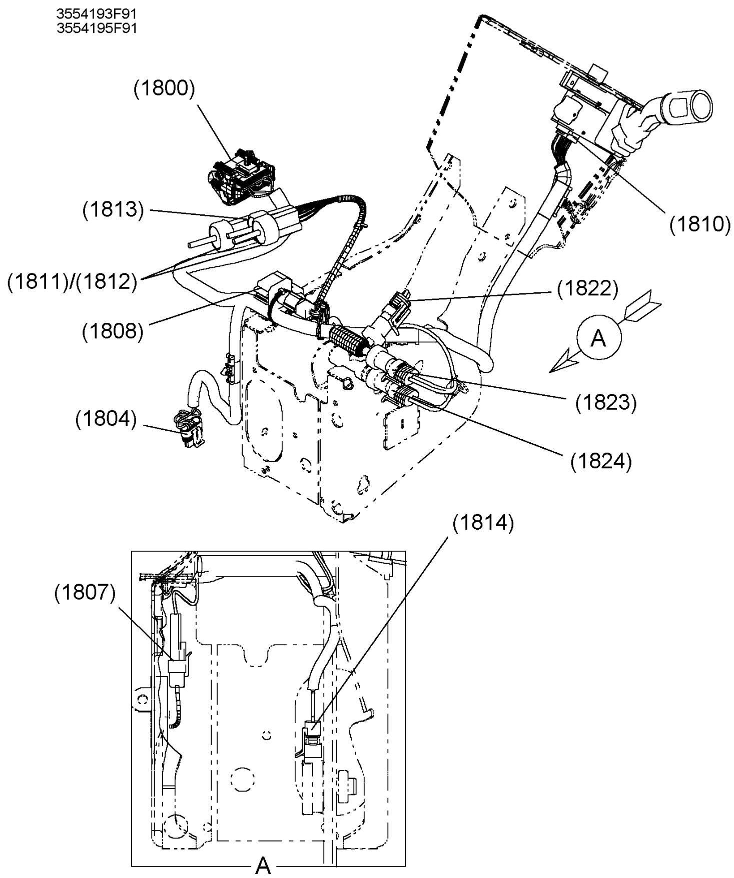


Figure 146 Secondary Air Pressure Gauge Transducer Location (Steering Column Support View)

(1800) DRIVER CONTROL MODULE (DCM) CONNECTOR
(1811) SECONDARY AIR PRESSURE TRANSDUCER
(1812) SECONDARY AIR TRANSDUCER
(1822) AIR APPLICATION TRANSDUCER

4.46. AUXILIARY AIR PRESSURE GAUGE

Auxiliary Air Pressure Gauge

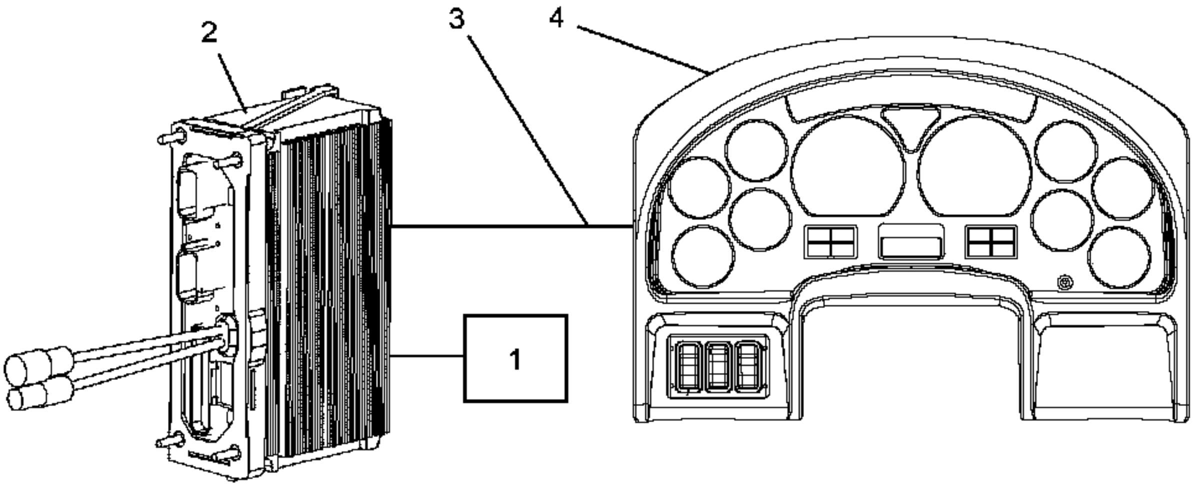


Figure 147 Auxiliary Air Pressure Gauge Function Diagram

1. AUXILIARY AIR PRESSURE SENSOR
2. ELECTRICAL SYSTEM CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving the auxiliary air pressure gauge is provided on the Drivetrain 1939 data link from the ESC. The ESC generates this information based on input from a transducer connected to the air line.

The pointer in a small gauge, pointing to the six o'clock position, indicates that there is a sensor error for that gauge. A gauge pointing to 10 o'clock is connected to an unprogrammed connector on the EGC circuit board.

Diagnostics

Problems with the auxiliary air pressure gauge can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, an incorrect connection inside the EGC, a loss of programming, a problem in the ESC, a problem with the auxiliary air pressure transducer or a problem with wiring to the sensor.

Table 98 Auxiliary Air Pressure Gauge Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the auxiliary air pressure gauge perform during the gauge sweep?		Gauge performs during gauge sweep.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install.

Table 98 Auxiliary Air Pressure Gauge Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
2.	On	Check for auxiliary air pressure gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 297)	Read display on odometer.	Auxiliary air pressure gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 298)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.		Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
4.	On	Attempt to exercise the gauge with the "INTUNE" diagnostic software.		Gauge responds to "INTUNE" diagnostic input.	Go to next step.	Insure gauge operates during gauge sweep. Insure jumper harness between gauge and circuit board is in correct location. If jumper is correct, replace EGC circuit board.
5.	Consider replacing ESC . (See ESC REPLACEMENT, page 123)					

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 99 Auxiliary Air Pressure Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
612 14 4 1	Auxiliary Air Pressure out of range low Short to ground, open circuit or missing 5 volts from ESC
612 14 4 2	Auxiliary Air Pressure out of range high Shorted high
1705 14 108 3 (EGC Version 8.7)	EGC gauge location 8 (auxiliary air pressure) out of range high Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 108 4 (EGC Version 8.7)	EGC gauge location 8 (auxiliary air pressure) out of range low Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 108 5 (EGC Version 8.7)	EGC gauge location 8 (auxiliary air pressure) sensor fault There is a problem with the sensor that provides the data for this gauge.
1705 14 108 6 (EGC Version 8.7)	EGC gauge location 8 (auxiliary air pressure) data unavailable The data that this gauge displays should be, but is not available at this time.
2023 14 108 5 or 2023 14 208 5 (EGC Version 9.3 and later)	Auxiliary air pressure gauge sensor fault to primary EGC (108) or secondary EGC (208) There is a problem with the sensor that provides the data for this gauge.
2023 14 108 6 or 2023 14 208 6 (EGC Version 9.3 and later)	Auxiliary air pressure gauge data unavailable to primary EGC (108) or secondary EGC (208) The data that this gauge displays should be, but is not available at this time.
2023 14 108 7 or 2023 14 208 7 (EGC Version 9.3 and later)	Auxiliary air pressure gauge data missing to primary EGC (108) or secondary EGC (208) The data for this gauge is not being transmitted on the datalink.

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the gauge.

Refer to Auxiliary Air Pressure Gauge Transducer Circuits.

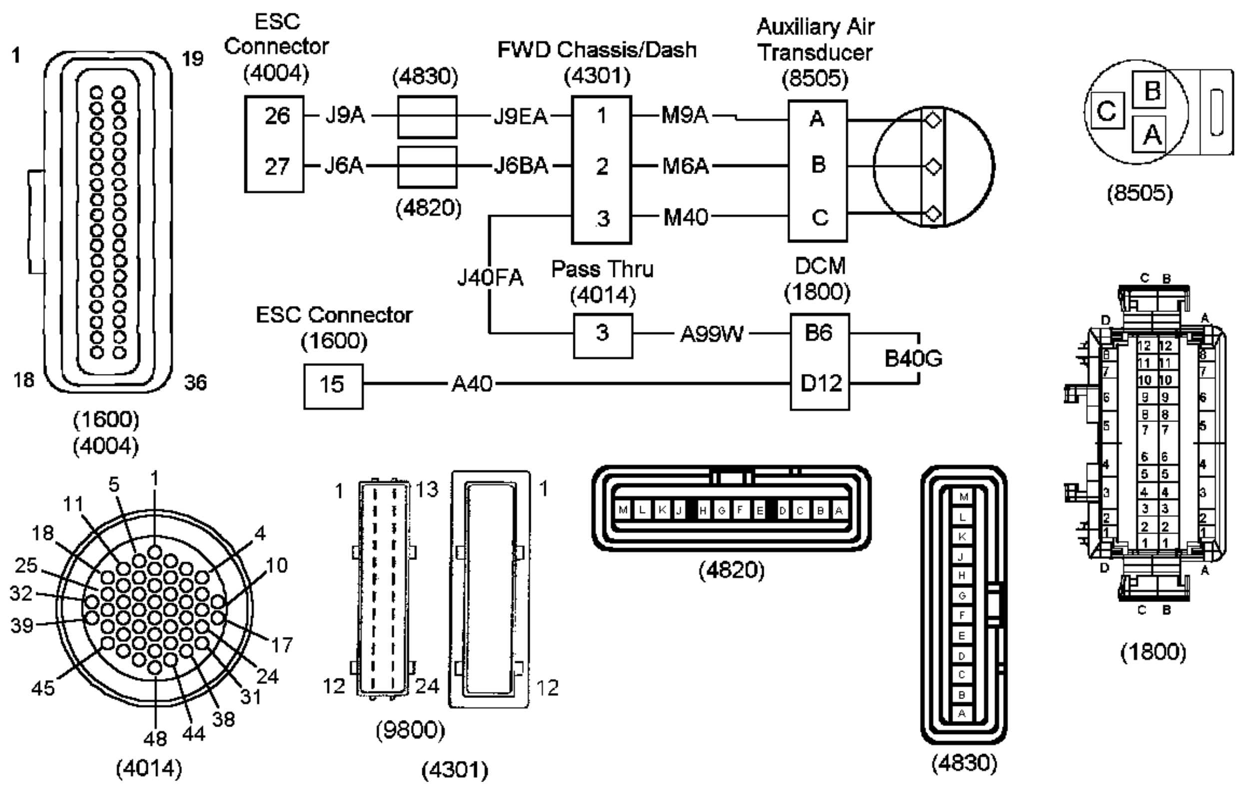


Figure 148 Auxiliary Air Pressure Gauge Transducer Circuits—Always Refer To Circuit Diagram Book For Latest Circuit Information

(1600) ELECTRICAL SYSTEM CONTROLLER CONNECTOR
LOCATED IN DASH COMPARTMENT SIDE OF ESC
(1800) CAB/DCM CONNECTOR
LOCATED BEHIND CLUSTER
(4004) ELECTRICAL SYSTEM CONTROLLER (ESC) CONNECTOR
LOCATED ON ENGINE SIDE OF ESC
(4014) DASH PASS THRU CONNECTOR
LOCATED ABOVE ESC
(4301) FORWARD CHASSIS/DASH PASS CONNECTOR
LOCATED IN ENGINE COMPARTMENT NEAR LEFT FRAME RAIL
(4820) J1708 & 5 VOLT REF SPLICE
LOCATED NEAR WIPER MOTOR BRACKET
(4830) ELECTRONIC REF GROUND SPLICE
LOCATED NEAR POWER DISTRIBUTION CENTER
(8505) AUXILIARY AIR TRANSDUCER CONNECTOR
LOCATED IN ENGINE COMPARTMENT NEAR LEFT FRAME RAIL

Table 100 Auxiliary Air Pressure Gauge Tests

Diagnostic Trouble Codes	
612 14 4 1	Auxiliary Air Pressure out of range low Short to ground, open circuit or missing 5 volts from ESC
612 14 4 2	Auxiliary Air Pressure out of range high Shorted to 12 volts.
1705 14 108 3 (EGC Version 8.7)	EGC gauge location 8 (auxiliary air pressure) out of range high Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 108 4 (EGC Version 8.7)	EGC gauge location 8 (auxiliary air pressure) out of range low Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 108 5 (EGC Version 8.7)	EGC gauge location 8 (auxiliary air pressure) sensor fault There is a problem with the sensor that provides the data for this gauge.
1705 14 108 6 (EGC Version 8.7)	EGC gauge location 8 (auxiliary air pressure) data unavailable The data that this gauge displays should be, but is not available at this time.
2023 14 108 5 or 2023 14 208 5 (EGC Version 9.3 and later)	Auxiliary air pressure gauge sensor fault to primary EGC (108) or secondary EGC (208) There is a problem with the sensor that provides the data for this gauge.
2023 14 108 6 or 2023 14 208 6 (EGC Version 9.3 and later)	Auxiliary air pressure gauge data unavailable to primary EGC (108) or secondary EGC (208) The data that this gauge displays should be, but is not available at this time.

Table 100 Auxiliary Air Pressure Gauge Tests (cont.)

Diagnostic Trouble Codes		
2023 14 108 7 or 2023 14 208 7 (EGC Version 9.3 and later)		Auxiliary air pressure gauge data missing to primary EGC (108) or secondary EGC (208) The data for this gauge is not being transmitted on the datalink.
Auxiliary Air Pressure Gauge Voltage Checks Check with ignition on and (8505) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.** **Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**		
Test Points	Spec.	Comments
(8505) cavity B to ground.	5 ± .5 volts	If voltage is missing, check for open or shorts in circuit M6A, J6BA or J6A to ESC connector (4004) cavity 27. If circuits check good, check for missing 5 volt signal from ESC.
(8505) cavity B to cavity A.	5 ± .5 volts	If voltage is missing, check for open in circuits M9A, J9EA or J9A to ESC connector (4004) cavity 26. If circuits check good, check for missing zero volt reference from ESC.
(8505) cavity B to cavity C.	5 ± .5 volts	If voltage is incorrect, check for open or short to voltage in circuits B40F, A40F or J40F to ESC connector (1600) cavity 15. If voltage is present, circuits to transducer are good. Replace transducer

Extended Description

The 5 volt sensor supply signal is supplied to auxiliary air pressure transducer connector (8505) pin B from ESC connector (4004) pin 27.

The zero volt reference signal is supplied to auxiliary air pressure transducer connector (8505) pin A from ESC connector (4004) pin 26.

The pressure transducer acts like a potentiometer. The transducer will provide a volage to ESC connector (1600) pin 15, which will vary with changes in applied pressure.

Component Locations

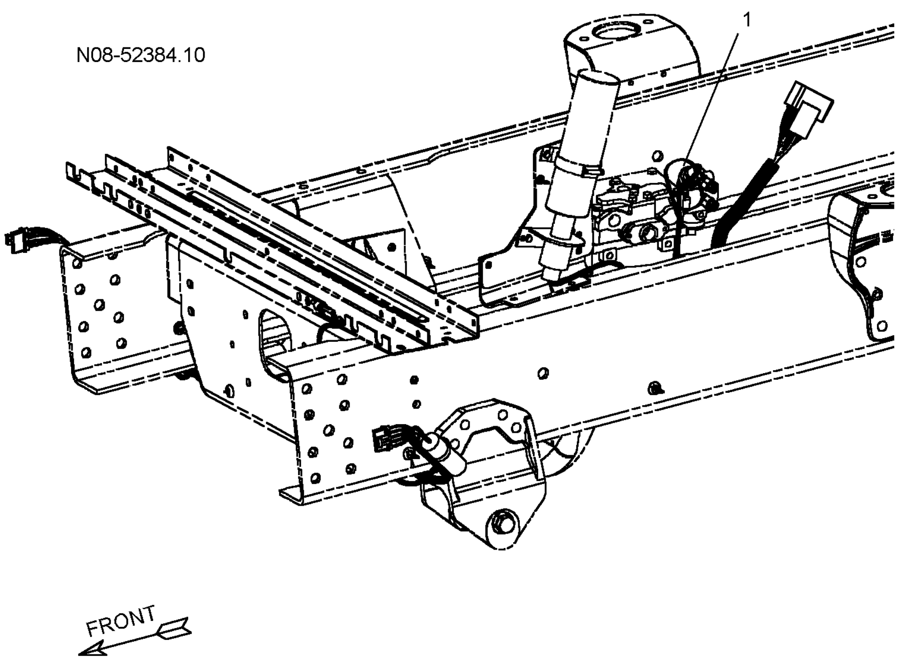


Figure 149 Auxiliary Air Pressure Gauge Transducer Location

1. AIR PRESSURE TRANSDUCER

4.47. BOOST PRESSURE GAUGE

Circuit Function

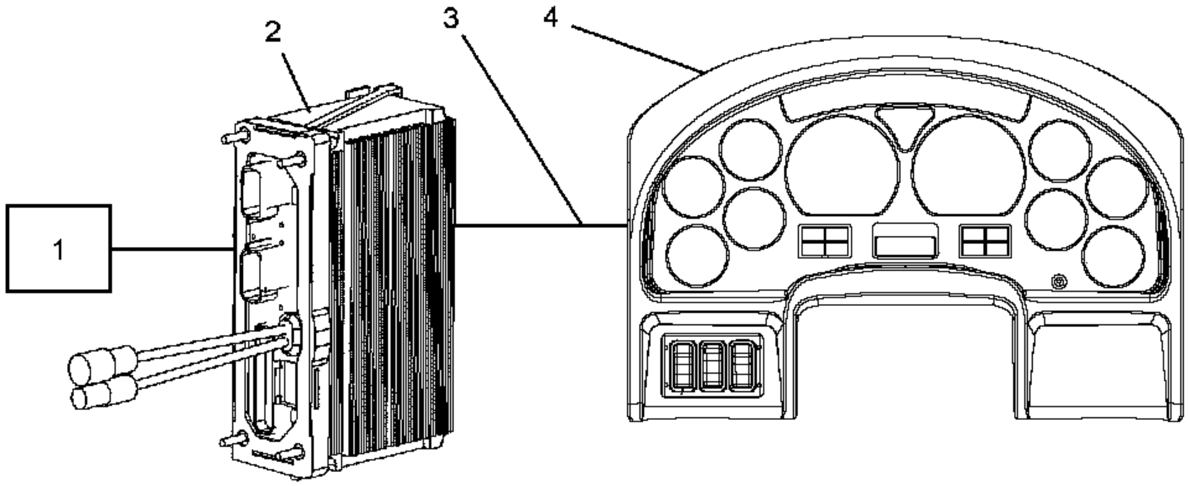


Figure 150 Boost Pressure Gauge Function Diagram

1. BOOST PRESSURE SENSOR
2. ELECTRICAL SYSTEM CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving the boost pressure gauge is provided on the Drivetrain 1939 data link from the ESC. The ESC generates this information based on input from a sensor connected to the turbo charger.

Diagnostics

The pointer in a small gauge, pointing to the six o'clock position, indicates that there is a sensor error for that gauge. A gauge pointing to 10 o'clock is connected to an unprogrammed connector on the EGC circuit board.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the gauge.

Problems with the turbo boost pressure gauge can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, an incorrect connection inside the EGC, a loss of programming, a problem in the ESC, a problem with the boost sensor or a problem with wiring to the sensor.

Table 101 Boost Pressure Gauge Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the turbo boost gauge operate during the gauge sweep?		Gauge performs during gauge sweep.	Go to next step.	Replace gauge and check jumper harness . If problem persists, replace EGC circuit board. Refer toRemove and Install.
2.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.		Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
3.	On	Attempt to exercise the gauge with the "INTUNE" diagnostic software.		Gauge responds to "INTUNE" diagnostic input.	Go to next step.	Insure gauge operates during gauge sweep. Insure jumper harness between gauge and circuit board is in correct location. If jumper is correct, replace EGC circuit board.
4.	Consider replacing ESC. (See ESC REPLACEMENT, page 123)					

4.48. AMMETER GAUGE

Circuit Function

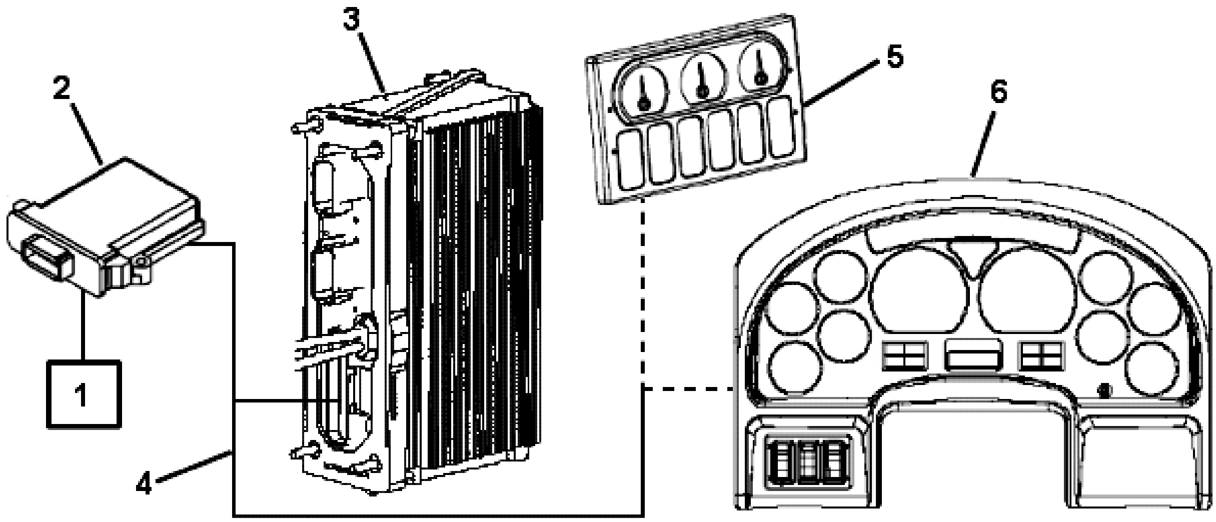


Figure 151 Ammeter Gauge Diagram

1. AMMETER SENSE CIRCUITS
2. PYROMETER/AMMETER MODULE (PAM)
3. ELECTRICAL SYSTEM CONTROLLER (ESC)
4. DRIVE TRAIN 1939 DATA LINK
5. AUXILIARY GAUGE SWITCH PACK (AGSP)
6. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving the ammeter gauge is provided on the Drivetrain 1939 data link from the pyrometer/ammeter module (PAM). The PAM determines the net battery current flow by measuring the differential voltage between the starter ground stud and the negative battery stud.

Either of two ammeter gauges are available. The ranges are, -150/+150 amps and -300/+300 amps (high resolution).

Diagnostics

The pointer in a small gauge, pointing to the six o'clock position, indicates that there is a sensor error for that gauge. A gauge pointing to 10 o'clock is connected to an unprogrammed connector on the Electronic Gauge Cluster (EGC) circuit board, or the Auxiliary Gauge Switch Pack (AGSP).

The service tool (EZ-Tech) running the Diamond Logic® Builder (DLB) diagnostic software, can be used to check operation of the gauge. See the diagnostic software manual for details on using the software.

Problems with the ammeter gauge can be caused by a malfunctioning gauge, a malfunction in EGC (or AGSP) circuitry, an incorrect connection inside the EGC (or AGSP), a loss of programming, a problem in the PAM or a problem with wiring to and from the PAM.

Table 102 Ammeter Gauge Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the ammeter gauge operate during the gauge sweep?		Gauge performs during gauge sweep.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC (or AGSP) circuit board. Refer to Remove and Install.
2.	On	Check for Diagnostic Trouble Codes (DTC's) related to the PAM, the ammeter, or the gauge location in the gauge cluster. Refer to DTC list (See DIAGNOSTIC TROUBLE CODE (DTC) LIST, page 1039).	Read display on odometer.	Ammeter gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 307)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the DLB programming software. Verify gauge and gauge inputs are programmed correctly.		Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the DLB software. Refer to the DLB programming software manual for details.
4.	On	Attempt to exercise the gauge with the DLB diagnostic software.		Gauge responds to DLB diagnostic input.	Go to next step.	Insure gauge operates during gauge sweep. Insure jumper harness between gauge and circuit board is in correct location. If jumper is correct, replace EGC (or AGSP) circuit board.
5.	Troubleshoot pyrometer/ammeter module and sensor inputs. Pyrometer/ Ammeter Module (PAM)(See PYROMETER/AMMETER MODULE (PAM), page 804)					

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Because the location of the ammeter is optional, some of the DTC’s that may be related to the ammeter are described in the DTC list(See DIAGNOSTIC TROUBLE CODE (DTC) LIST, page 1039) by “gauge location”.

Table 103 Ammeter Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
Refer to DTC list (See DIAGNOSTIC TROUBLE CODE (DTC) LIST, page 1039).	

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A short in the ammeter gauge circuits will be apparent when the ammeter gauge points straight down.

Problems in the ammeter circuits could be the result of an open or shorted gauge, open circuits, shorted circuits, a failure in the ESC, a problem in the PAM or a problem with wiring to and from the PAM.

Refer to the Pyrometer/Ammeter Module Circuits (See PYROMETER/AMMETER MODULE (PAM), page 804).

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Figure 152 Unused Figure

Table 104 Unused Table

Test Points	Spec.	Comments
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4.49. FUEL PRESSURE GAUGE

Circuit Function

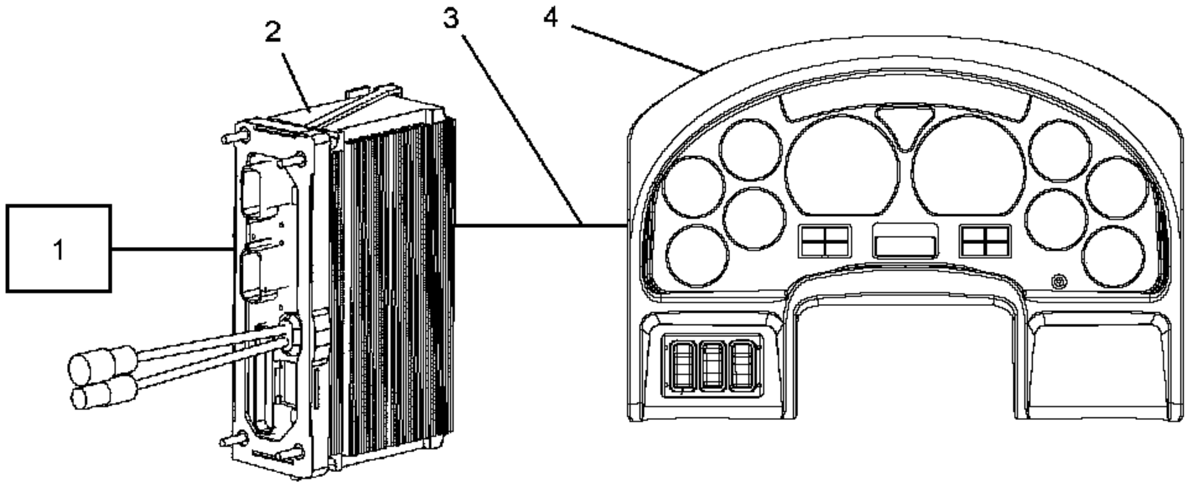

Figure 153 Fuel Pressure Gauge Function Diagram

1. FUEL PRESSURE SENSOR
2. ELECTRICAL SYSTEM CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving the fuel pressure gauge is provided on the Drivetrain 1939 data link from the ESC. The ESC generates this information based on input from a sensor connected to the fuel system.

Diagnostics

Problems with the fuel pressure gauge can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, an incorrect connection inside the EGC, a loss of programming, a problem in the ESC, a problem with the fuel pressure sensor or a problem with wiring to the sensor.

Table 105 Fuel Pressure Gauge Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.	Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
2.	On	Attempt to exercise the gauge with the "INTUNE" diagnostic software.	Gauge responds to "INTUNE" diagnostic input.	Go to next step.	Insure gauge operates during gauge sweep. Insure jumper harness between gauge and circuit board is in correct location. If jumper is correct, replace EGC circuit board.
3.	On	Attempt to exercise the gauge with the "INTUNE" diagnostic software.	Gauge responds to ESC diagnostic input.	Consider replacing ESC.(See ESC REPLACEMENT, page 123)	Replace EGC.

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

The pointer in a small gauge, pointing to the six o’clock position, indicates that there is a sensor error for that gauge. A gauge pointing to 10 o’clock is connected to an unprogrammed connector on the EGC circuit board.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the gauge.

4.50. SUSPENSION AIR GAUGE

Circuit Function

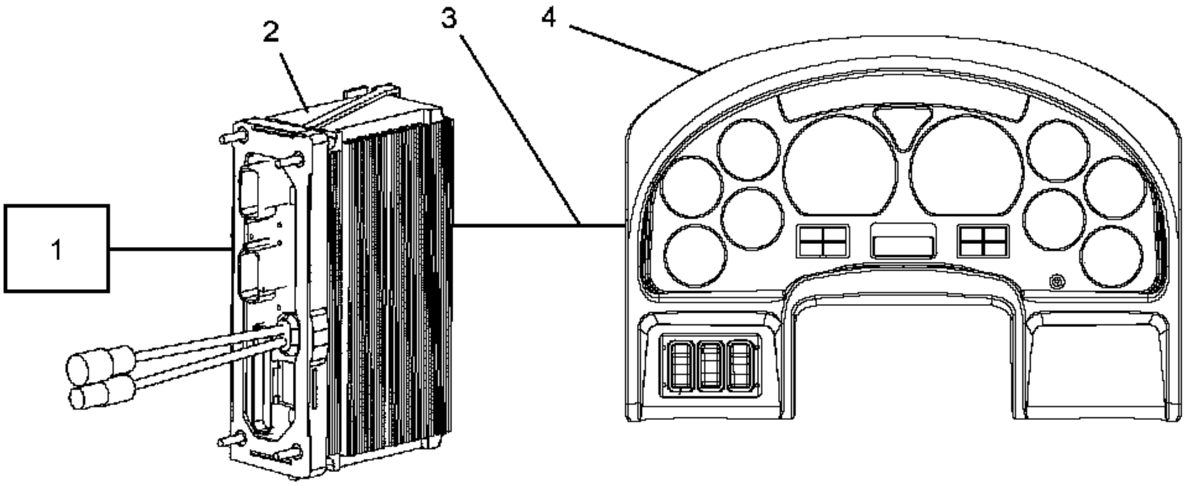

Figure 154 Suspension Air Gauge Function Diagram

1. SUSPENSION AIR SENSOR
2. ELECTRICAL SYSTEM CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving the suspension air gauge is provided on the Drivetrain 1939 data link from the ESC. The ESC generates this information based on input from a sensor connected to the air suspension system.

The pointer in a small gauge, pointing to the six o'clock position, indicates that there is a sensor error for that gauge. A gauge pointing to 10 o'clock is connected to an unprogrammed connector on the EGC circuit board.

Diagnostics

Problems with the air suspension gauge can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, an incorrect connection inside the EGC, a loss of programming, a problem in the ESC, a problem with the suspension air transducer or a problem with wiring to the transducer.

Table 106 Air Suspension Gauge Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the air suspension gauge perform during the gauge sweep?		Gauge performs during gauge sweep.	Go to next step.	Replace gauge and check jumper harness . If problem persists, replace EGC circuit board. Refer to Remove and Install.

Table 106 Air Suspension Gauge Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
2.	On	Check for air suspension gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 311)	Read display on odometer.	Suspension gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 312)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.		Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
4.	On	Attempt to exercise the gauge with the "INTUNE" diagnostic software.		Gauge responds to "INTUNE" diagnostic input.	Go to next step.	Insure gauge operates during gauge sweep. Insure jumper harness between gauge and circuit board is in correct location. If jumper is correct, replace EGC circuit board.
5.	Consider replacing ESC . (See ESC REPLACEMENT, page 123)					

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 107 Air Suspension Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
TBD	Air Suspension Gauge out of range low Short to ground, open circuit or missing 5 volts from ESC
TBD	Air Suspension Gauge out of range high Shorted high

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the gauge.

Refer to Air Suspension Solenoid Circuits in the Chassis Features section.

4.51. AIR APPLICATION GAUGE

Circuit Function

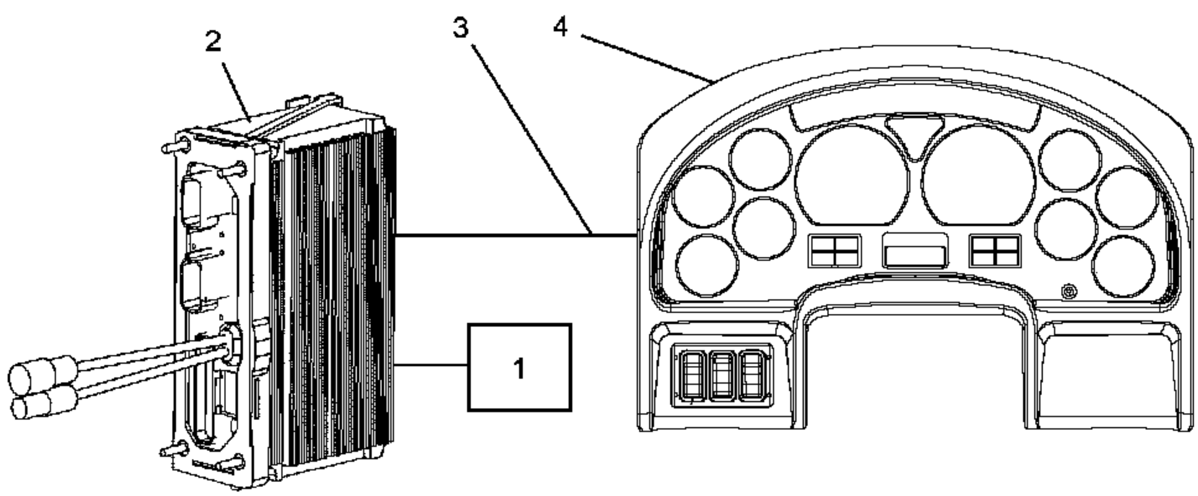

Figure 155 Air Application Gauge Function Diagram

1. AIR APPLICATION TRANSDUCER
2. ELECTRICAL SYSTEM CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving the air application gauge is provided on the Drivetrain 1939 data link from the ESC. The ESC generates this information based on input from a transducer connected to the air application system.

The pointer in a small gauge, pointing to the six o'clock position, indicates that there is a sensor error for that gauge. A gauge pointing to 10 o'clock is connected to an unprogrammed connector on the EGC circuit board.

Diagnostics

Problems with the air application gauge can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, an incorrect connection inside the EGC, a loss of programming, a problem in the ESC, a problem with the air brake application transducer or a problem with wiring to the sensor.

Table 108 Air Application Gauge Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the air application gauge perform during the gauge sweep?		Gauge performs during gauge sweep.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install.
2.	On	Check for air application gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 314)	Read display on odometer.	Air application gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 314)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.		Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the "ICAP" software. Refer to the ICAP programming software manual for details.
4.	On	Attempt to exercise the gauge with the "INTUNE" diagnostic software.		Gauge responds to "INTUNE" diagnostic input.	Go to next step.	Insure gauge operates during gauge sweep. Insure jumper harness between gauge and circuit board is in correct location. If jumper is correct, replace EGC circuit board.
5.	Consider replacing ESC. (See ESC REPLACEMENT, page 123)					

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

The previously active diagnostic trouble codes may be cleared, while in the diagnostic mode, by turning on the left turn signal and pressing the cruise on and set switches simultaneously.

Table 109 Air Application Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
612 14 35 1	Brake application air out of range low Short to ground or open circuit.
612 14 35 2	Brake application air out of range high Shorted high

Fault Detection/ Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

The service tool (EZ-Tech) running the "INTUNE" diagnostic software can be used to check operation of the gauge.

Refer to Air Application Gauge Transducer Circuits.

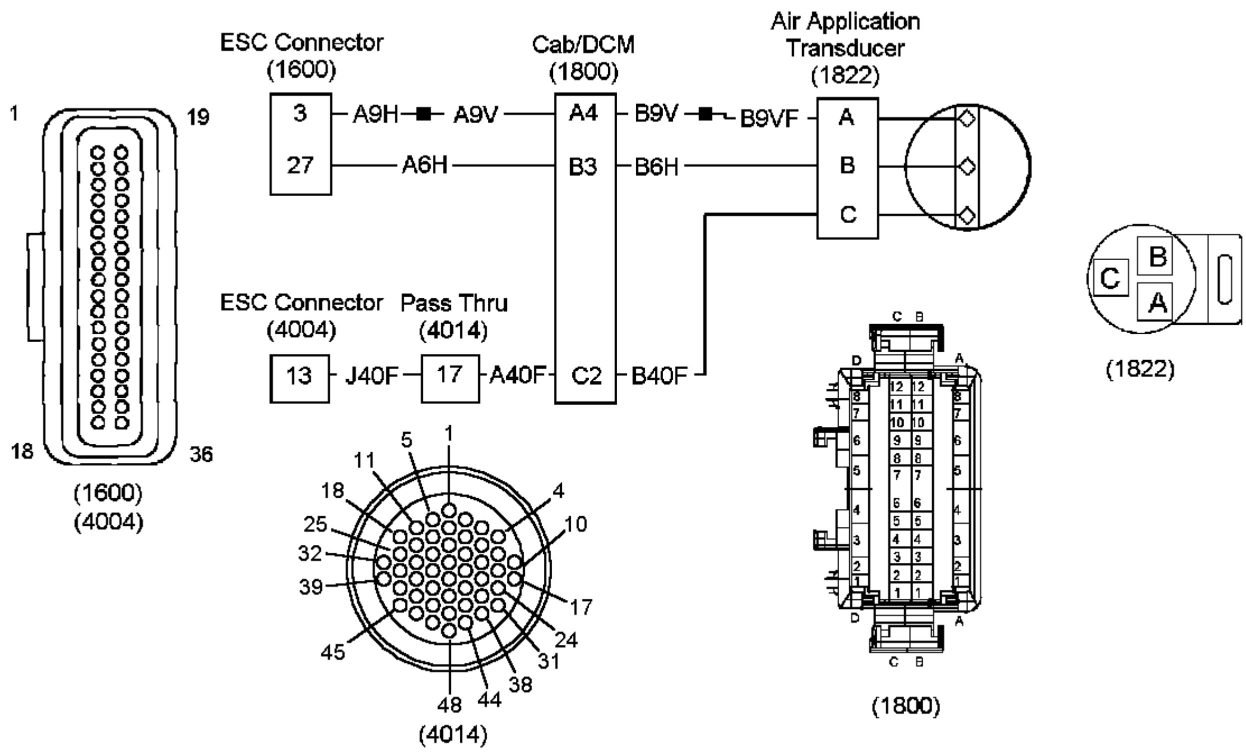

Figure 156 Air Application Gauge Transducer Circuits—Always Refer To Circuit Diagram Book For Latest Circuit Information

(1600) ELECTRICAL SYSTEM CONTROLLER CONNECTOR
LOCATED IN DASH COMPARTMENT SIDE OF ESC
(1800) CAB/DCM CONNECTOR
LOCATED BEHIND CLUSTER
(1822) AIR APPLICATION GAUGE TRANSDUCER CONNECTOR
LOCATED TO LEFT OF LOWER STEERING COLUMN
(4004) ELECTRICAL SYSTEM CONTROLLER CONNECTOR
LOCATED IN CAB SIDE OF ESC
(4014) DASH PASS THRU CONNECTOR
LOCATED ABOVE ESC

Table 110 Air Application Gauge Tests

Diagnostic Trouble Codes	
612 14 35 1	Brake application air out of range low Short to ground or open circuit.
612 14 35 2	Brake application air out of range high Shorted high.

Table 110 Air Application Gauge Tests (cont.)

Air Application Gauge Voltage Checks		
Check with ignition on and (1822) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.** **Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**		
Test Points	Spec.	Comments
(1822) cavity B to ground.	5 ± .5 volts	If voltage is missing, check for open or shorts in circuit B6HC, B6H or A6H to ESC connector (1600) cavity 27. If circuits check good, check for missing 5 volt signal from ESC.
(1822) cavity B to cavity A.	5 ± .5 volts	If voltage is missing, check for open in circuits B9VF, B9V, A9V or A9H to ESC connector (1600) cavity 3. If circuits check good, check for missing zero volt reference from ESC.
(1822) cavity B to cavity C.	5 ± .5 volts	If voltage is incorrect, check for open or short to voltage in circuits B40F, A40F or J40F to ESC connector (4004) cavity 13. If voltage is present, circuits to transducer are good. Replace transducer

Extended Description

The 5 volt sensor supply signal is supplied to air application transducer connector (1822) pin B from ESC connector (1600) pin 27.

The zero volt reference signal is supplied to air application transducer connector (1822) pin A from ESC connector (1600) pin 3.

The pressure transducer acts like a potentiometer. The transducer will provide a voltage to ESC connector (4004) pin 13, which will vary with changes in applied pressure.

Component Locations

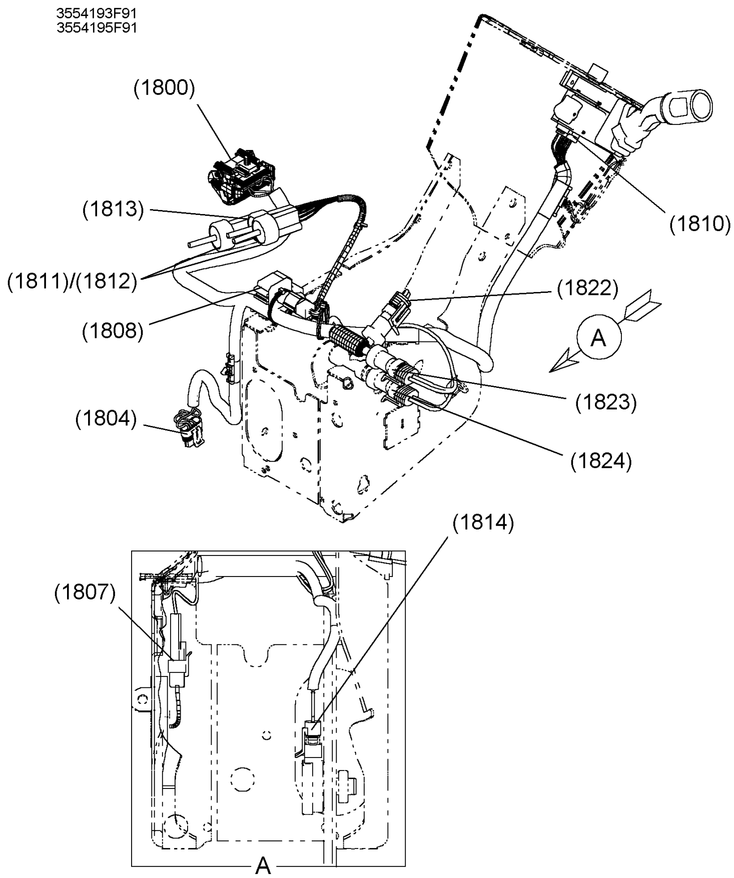

Figure 157 Air Application Gauge Transducer Location (Steering Column Support View)

(1800) DRIVER CONTROL MODULE (DCM) CONNECTOR
(1811) PRIMARY AIR TRANSDUCER
(1812) SECONDARY AIR TRANSDUCER
(1822) AIR APPLICATION TRANSDUCER

4.52. AUDIBLE ALARM

Circuit Function

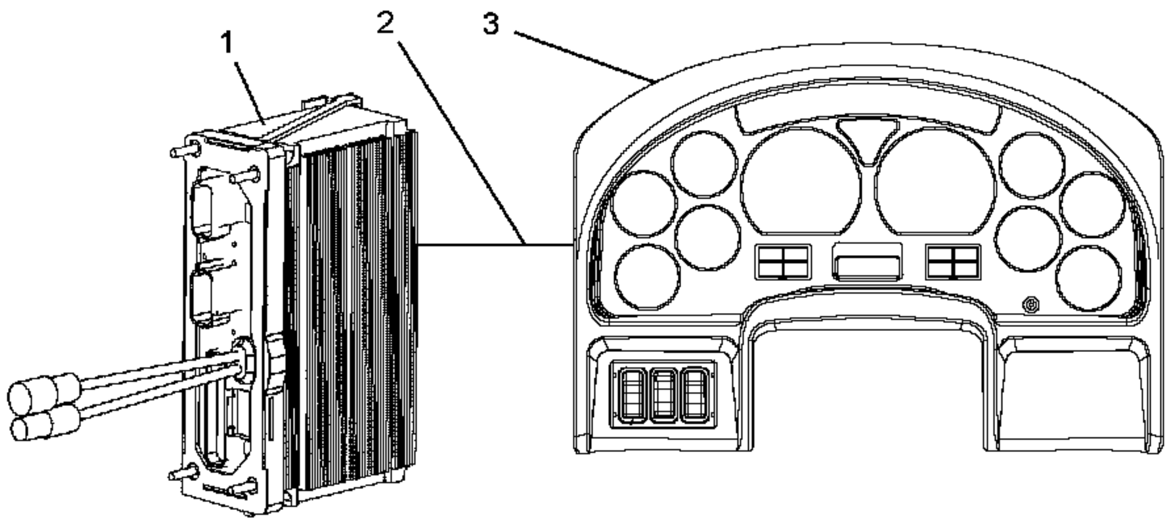

Figure 158 Audible Alarm Function Diagram

1. ELECTRICAL SYSTEM CONTROLLER
2. DRIVE TRAIN 1939 DATA LINK
3. ELECTRONIC GAUGE CLUSTER (EGC)

The audible alarm is controlled by the EGC.

The EGC will activate the alarm based on the data communicated on the Drivetrain 1939 data link from the ESC and the engine controller.

Diagnostics

An inoperative alarm can be caused by a malfunctioning alarm or a malfunction in EGC circuitry.

Table 111 Audible Alarm Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	On	Test alarm by disconnecting fuel sender connector.	Alarm operates.	Alarm is working.	Replace the alarm. If problem persists, replace circuit board.

4.53. SELECT/RESET SWITCH

Circuit Function

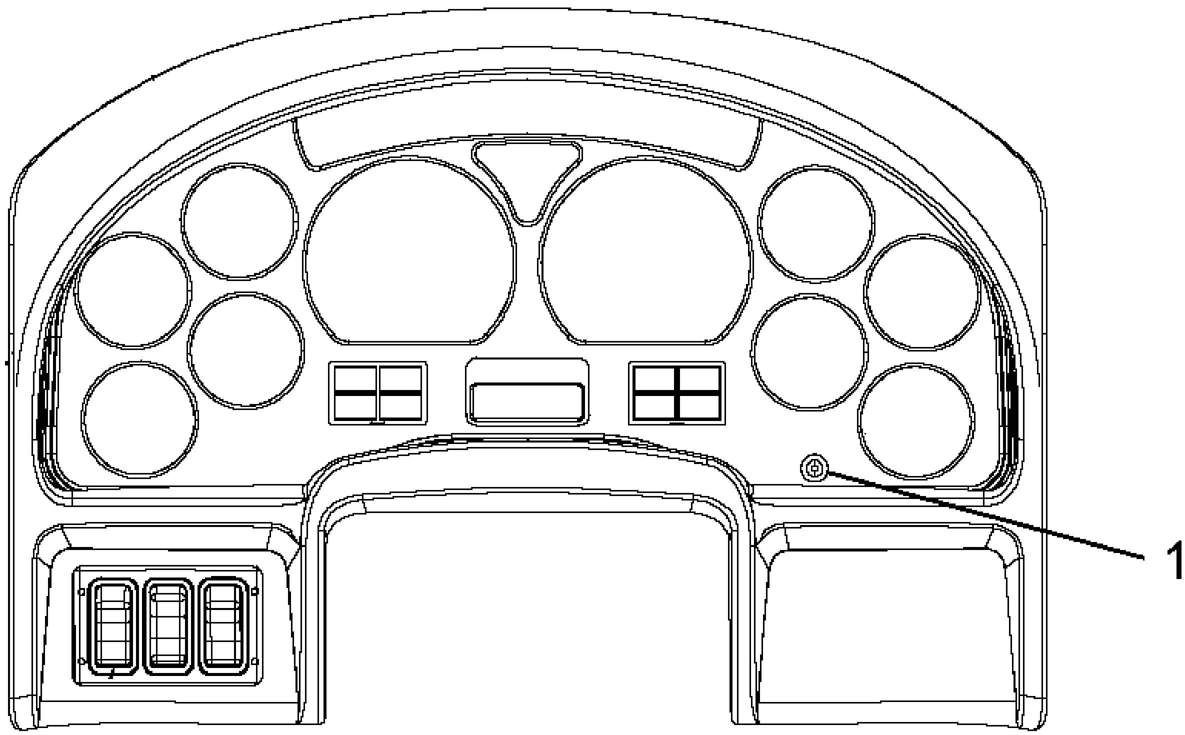

Figure 159 Select/Reset Switch Function Diagram

1. SELECT/RESET SWITCH

The Select/Reset switch controls the digital display.

The switch allows the user to select modes within each major functional area of the display and perform reset functions. Each time the switch is momentarily depressed it will scan through a different mode. Depressing the switch for three seconds or more will clear the display or toggle between options depending upon the current mode. The reset function has no effect if the parameter cannot be reset.

Diagnostics

Problems with the Select/Reset switch can be caused by a faulty switch, loose connection between the switch and the circuit board, or a faulty circuit board.

Table 112 Select/Reset Switch Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	On	Verify operation of the switch by observing odometer display while pushing button.	Display changes when button is pushed.	Switch is working correctly.	Go to next step.
2.	Off	Remove the Select/Reset switch and test with an ohmmeter.	Switch contacts should close while switch is pushed.	Replace circuit board.	Replace the Select/Reset switch.

Fault Detection/ Management

A fault with Select/Reset switch operation will be apparent if the odometer display does not change when the button is pushed.

Check continuity through switch while button it is pressed.

If continuity is good replace circuit board

If there is no continuity, replace switch.

4.54. HEAD LAMP/PARK LAMP SWITCH

See Headlight System in the Light Section of this manual. (See HEADLIGHT SYSTEM, page 872)

4.55. PANEL LIGHT SWITCH

See Panel Light in the Light Section of this manual. (See PANEL LIGHTS, page 889)

4.56. WORK LIGHT SWITCH

See Work Light in the Light Section of this manual. (See WORK LIGHTS, page 932)

4.57. DIGITAL DISPLAY

Circuit Function

The EGC has an integral liquid crystal display (LCD).

The three lines of the digital display provide a PRNDL display, a numeric display, and a line to indicate the mode of the display.

Diagnostics

Problems with the digital display can be caused by loose connections between the display and the circuit board, a failed display or a failed EGC circuit board.

Table 113 **Digital Display Preliminary Check**

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	During the gauge sweep all LCD elements of the display should be activated and the backlighting should illuminate.	Display elements are active and backlights work during gauge sweep.	Digital display is working. If problems continue, replace EGC circuit board.	Replace LCD display.

5. REMOVE AND INSTALL

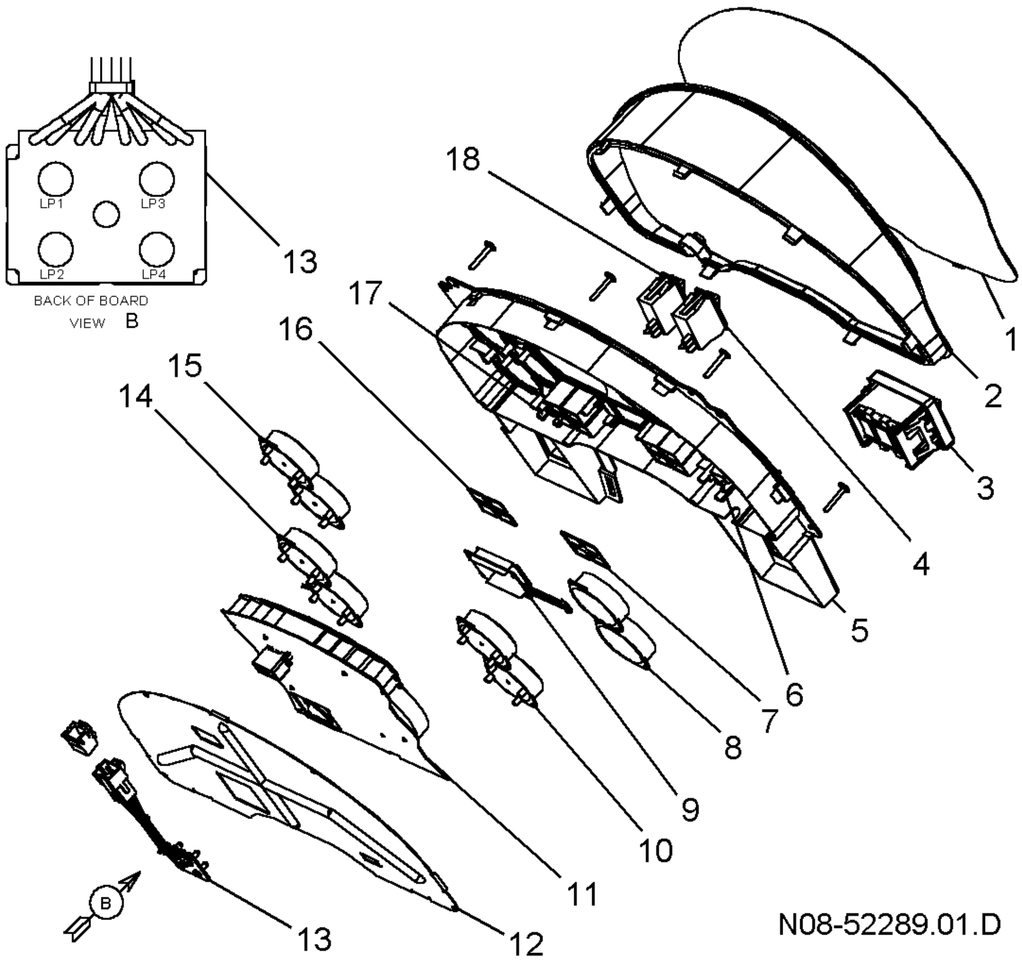

Figure 160 EGC Exploded View

1. GAUGE CLUSTER BEZEL
2. GAUGE CLUSTER SHIELD
3. 3-SWITCH PACK
4. ETHER START SWITCH
5. GAUGE CLUSTER HOUSING
6. BUZZER LOCATION
7. WARNING LAMP LENS
8. OPTIONAL SMALL GAUGES
9. LCD DISPLAY
10 . STANDARD SMALL GAUGES
11. GAUGE CLUSTER CIRCUIT BOARD
12. GAUGE CLUSTER BACK PLATE
13. OPTIONAL (HARD WIRED) GAUGE CIRCUIT BOARD
14. STANDARD SMALL GAUGES
15. OPTIONAL SMALL GAUGES
16. OPTIONAL WARNING LAMP LENS
17. SET/RESET SWITCH LOCATION
18. ROCKER START SWITCH

5.1. EGC FRONT BEZEL

Refer to EGC Exploded View. (See Figure 160, page 322)

Bezel removal is not required to remove or replace any other EGC components. Removal should only be required to replace a damaged bezel.

The bezel can be removed by cutting the seven retaining clips off with a razor blade, being careful not to scratch the gauge cluster housing. Installation of the bezel is accomplished by inserting the new bezel clips into the notches on the housing.

The front bezel snaps to the EGC body. To remove the bezel, remove the EGC shroud from the instrument panel. The bezel can be removed by gently pressing the seven clips on the bezel outer housing.

Installation of the bezel is accomplished by reversing the removal process.

5.2. REMOVE ELECTRONIC GAUGE CLUSTER

Refer to EGC Exploded View. (See Figure 160, page 322)

A. Remove EGC shroud from instrument panel.

B. Remove four screws which hold the EGC in place.

C. Tilt the EGC forward to gain access to the back of the EGC.

D. Remove the 12–way connector from the center of the EGC.

E. Remove any additional connectors from the EGC.

Installation of the gauge cluster is the reverse of the removal procedure.

5.3. FUEL, VOLTS, WATER OR ENGINE OIL GAUGES

Refer to EGC Exploded View. (See Figure 160, page 322)

The Fuel, Volts, Water and Engine Oil Gauges may be integral components of the EGC circuit board. If they are not separate gauges they can be removed and replaced by scoring the perforated line between the gauges and the main circuit board and snapping the circuit board. The replacement gauge is fastened to the EGC body with two screws and connected to the main circuit board with the supplied cable with connectors.

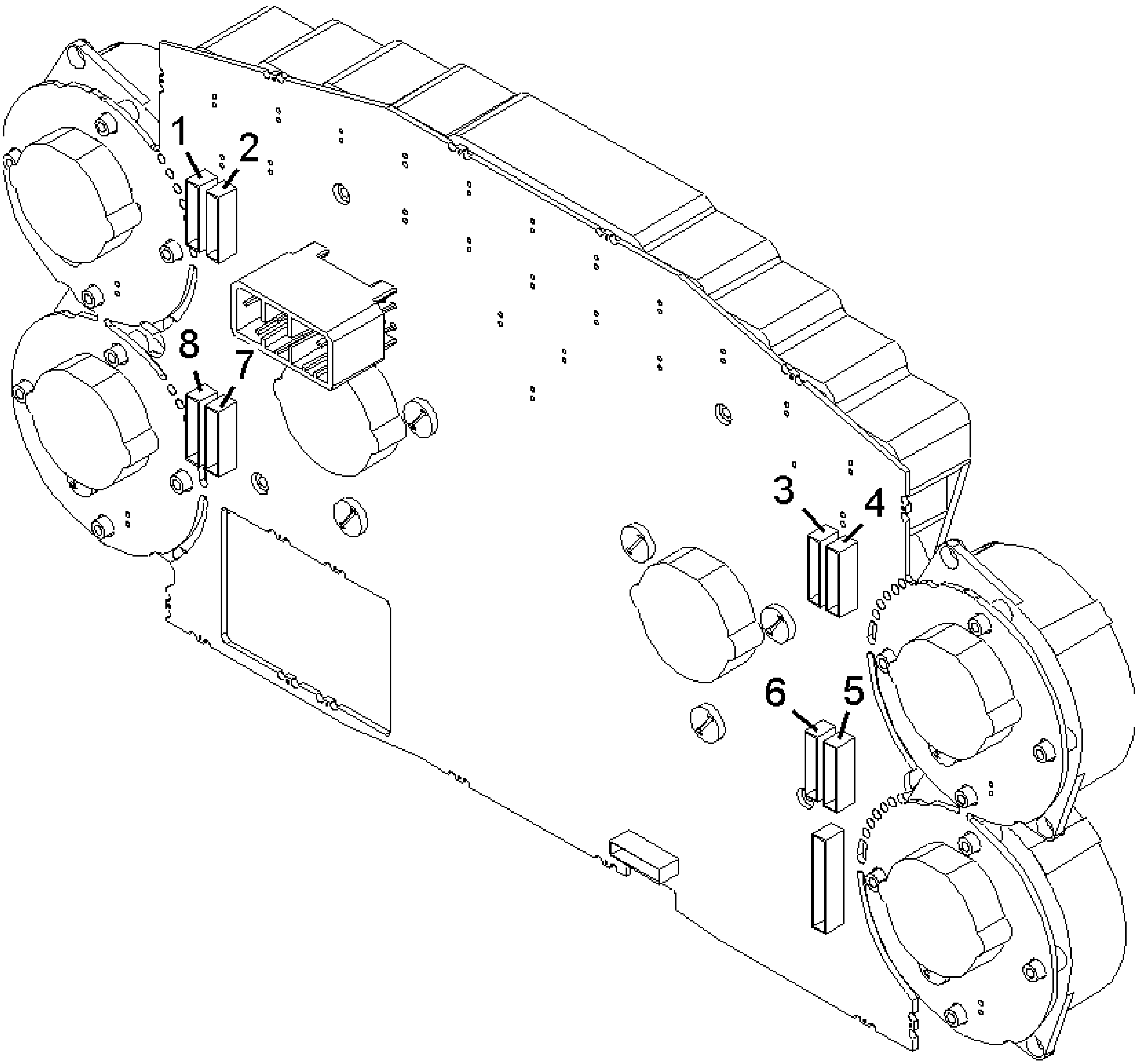

Figure 161 Typical EGC Circuit Board Gauge Connector Location

1. FUEL GAUGE CONNECTOR LOCATION
2. TOP OUTSIDE GAUGE LOCATION
3. TOP OUTSIDE GAUGE LOCATION
4. WATER TEMPERATURE GAUGE CONNECTOR LOCATION
5. OIL PRESSURE GAUGE CONNECTOR LOCATION
6. BOTTOM OUTSIDE GAUGE LOCATION
7. BOTTOM OUTSIDE GAUGE LOCATION
8. VOLTAGE GAUGE CONNECTOR LOCATION

The speedometer and tachometer cannot be individually replaced. If the speedometer or tachometer fail, the entire circuit board must be replaced.

5.4. OPTIONAL GAUGES

Refer to EGC Exploded View. (See Figure 160, page 322)

Refer to Typical EGC Circuit Board Gauge Connector Location (See Figure 161, page 324)

Optional Gauges

A. Remove the EGC from the instrument panel.

B. Remove six screws holding the back cover of the EGC in place.

C. Disconnect connectors for the optional gauge.

D. Remove two screws holding the gauge to EGC body and remove the gauge.

Installation of the optional gauge is accomplished by reversing the removal procedure.

NOTE – When adding a gauge that was not previously installed in the cluster, the electrical system controller must be programmed to recognize the gauge before the gauge will function. Refer to the ICAP programming software manual for details

5.5. CIRCUIT BOARD

Refer to EGC Exploded View. (See Figure 160, page 322)

A. Remove six screws holding the back of the EGC in place.

B. Disconnect all connectors connected to the circuit board.

C. Remove six screws holding circuit board to EGC body.

Installation of the circuit board is accomplished by reversing the removal procedure.

NOTE – The replacement circuit board will not have any of the standard smaller gauges attached to it. It may be necessary to replace the smaller gauges when the circuit board is replaced.

5.6. LCD DISPLAY

Refer to EGC Exploded View. (See Figure 160, page 322)

A. Remove six screws holding the back of the EGC in place.

B. Remove the center circuit board.

C. Remove four screws holding LCD to the EGC body and remove the display.

5.7. SELECT/RESET SWITCH

Refer to EGC Exploded View. (See Figure 160, page 322)

A. Remove six screws holding the back of the EGC in place.

B. Remove the connector for the switch from the center circuit board.

C. Remove two screws holding the switch and remove the switch.

To install the switch, reverse the removal procedure.

5.8. AUDIBLE ALARM

Refer to EGC Exploded View. (See Figure 160, page 322)

A. Remove six screws holding the back of the EGC in place.

B. Remove the connector for the audible alarm from the center circuit board.

C. Remove two screws holding the audible alarm and remove the alarm.

5.9. EGC PANEL LAMPS AND GAUGE BACKLIGHTING LAMPS

Refer to EGC Exploded View. (See Figure 160, page 322)

The EGC panel lamps are twist in lamps. To replace the lamps the failed lamp must be removed and replaced with a good lamp.

A. Remove the EGC from the instrument panel.

B. Remove six screws holding the back of the EGC in place and remove the back cover.

C. Locate the failed lamp and remove it by twisting it out of the circuit board.

D. Replace the removed lamp with a good twist in indicator lamp.

5.10. EGC WARNING LAMPS AND GAUGE WARNING LAMPS

Refer to EGC Exploded View. (See Figure 160, page 322)

The EGC warning lamps and warning lamps are integral parts of the EGC circuit board. To replace the lamps the failed lamp must be cut out of the circuit board and a twist in lamp must be used to replace it.

A. Remove the EGC from the instrument panel.

B. Remove six screws holding the back of the EGC in place and remove the back cover.

C. Locate the failed lamp and cut it out of the circuit board.

D. Replace the removed lamp with a twist in indicator lamp.

5.11. EGC SWITCH PACK

Refer to EGC Exploded View. (See Figure 160, page 322)

After the instrument panel shroud around the EGC has been removed, The EGC switch pack can be removed by using two DIN removal tools on each side of the switch pack. After the unit is removed from the cluster the connector on the switch pack may be removed. Removal may be easier if the back cover of the switch pack is removed. The back cover is removed by prying it off.

The switch pack is installed by simply reversing the removal process.

5.12. EGC SWITCH PACK SWITCHES

Refer to EGC Exploded View. (See Figure 160, page 322)

Switches are removed through the front of the switch pack. To remove a switch:

A. Remove the back cover from the switch pack.

B. Squeeze the switch release tabs, behind the switch pack.

C. Push the switch out of the switch pack body.

To install a switch reverse the removal process.

5.13. EGC SWITCH PACK LAMPS

EGC switch pack lamps are accessed by removing the switch pack and the back cover of the switch pack. The lamps that are replaceable are removed by twisting the lamp and pulling it out. The backlight lamps for the headlight and dimmer switches are not replaceable. If these LED's fail, the switch pack will need to be replaced.