TRUCK SERVICE MANUAL

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

Truck Model: 3200
Start Date: 05/20/2003

Truck Model: 4200
Start Date: 05/20/2003

Truck Model: 4300
Start Date: 05/20/2003

Truck Model: 4400
Start Date: 05/20/2003

Truck Model: 7300
Start Date: 05/20/2003

Truck Model: 7400
Start Date: 05/20/2003

Truck Model: 7500
Start Date: 05/20/2003

Truck Model: 7600
Start Date: 05/20/2003

Truck Model: 8500
Start Date: 05/20/2003

Truck Model: 8600
Start Date: 05/20/2003

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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.

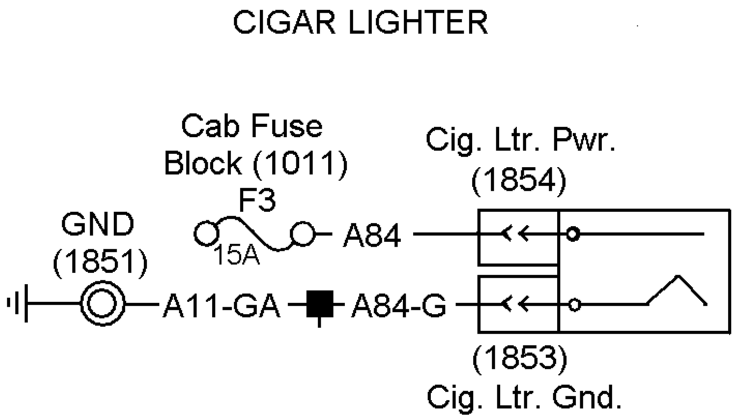


Figure 1 Sample Circuit Diagram

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.

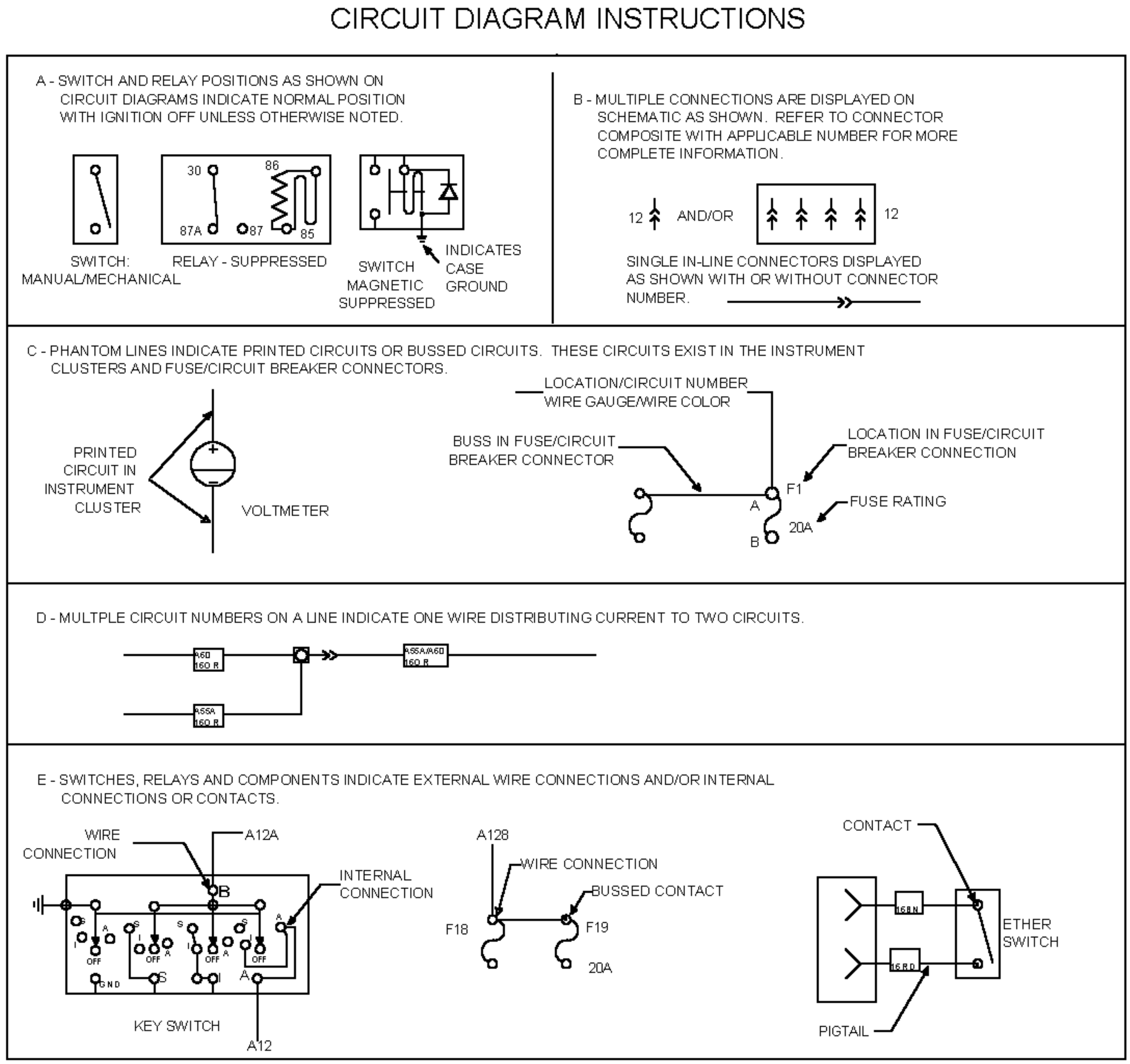


Figure 2 Sample Circuit Diagram Instructions

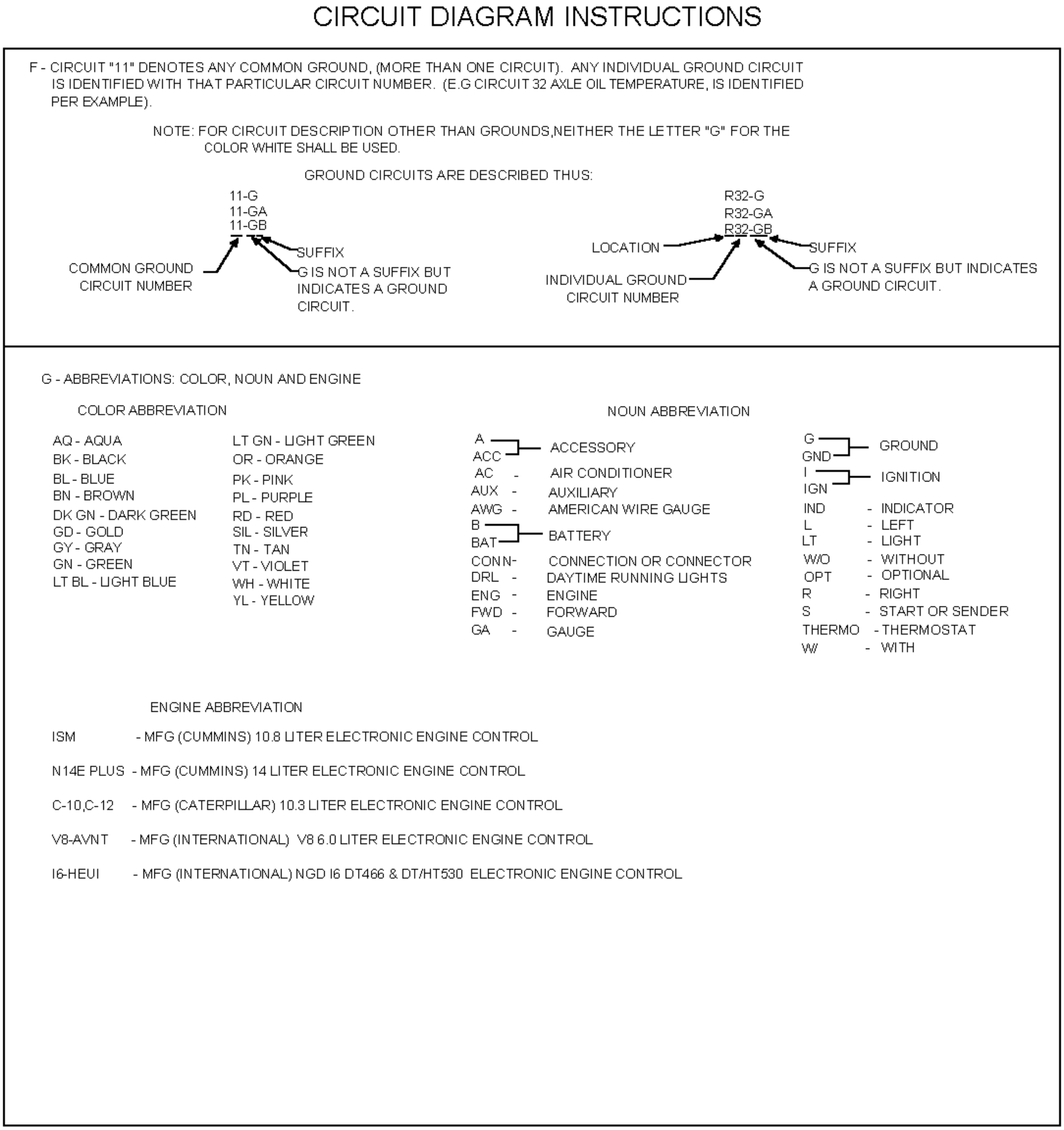


Figure 3 Sample Circuit Diagram Instructions and Abbreviations

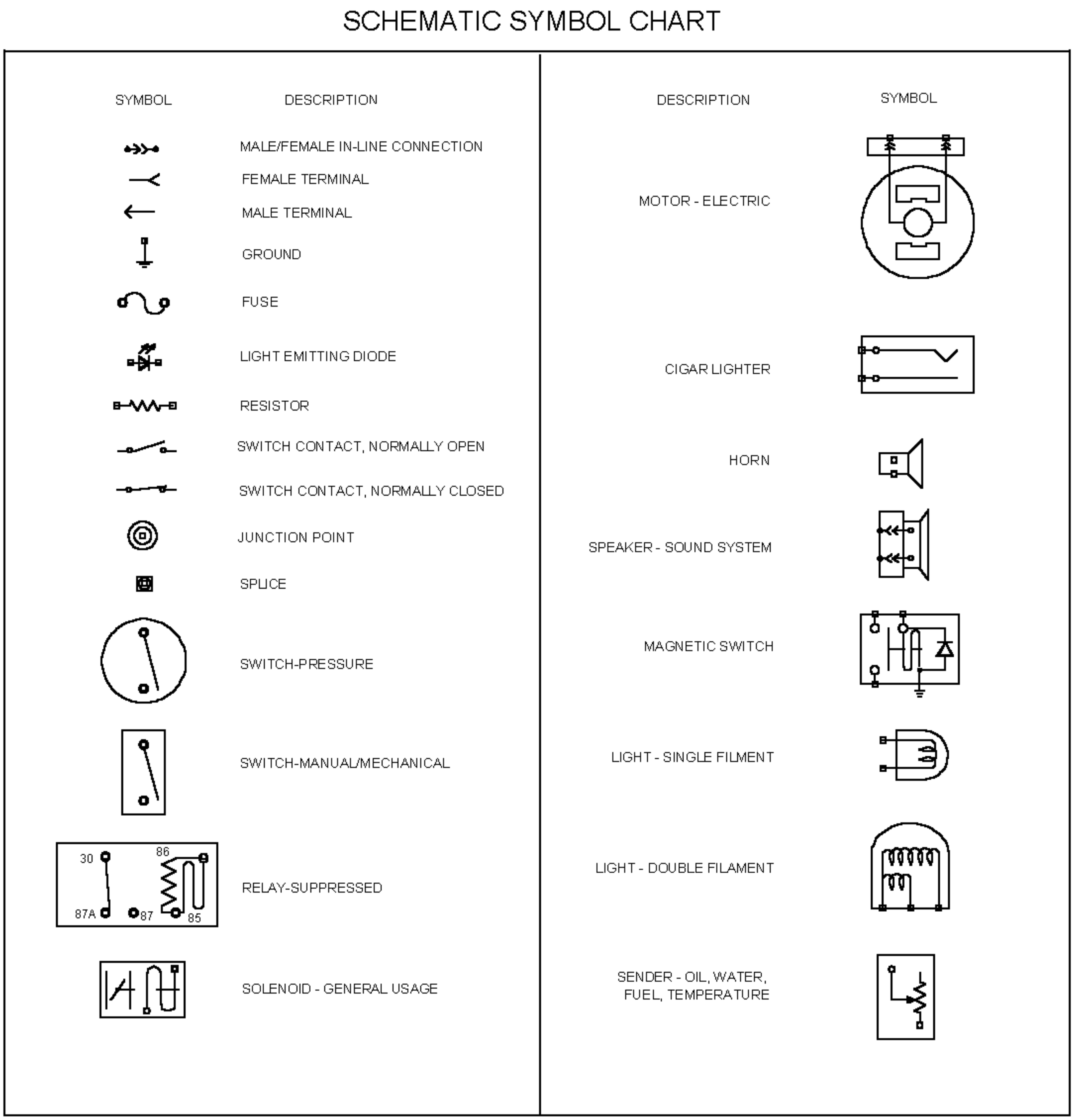


Figure 4 Sample Schematic Symbol Chart

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.

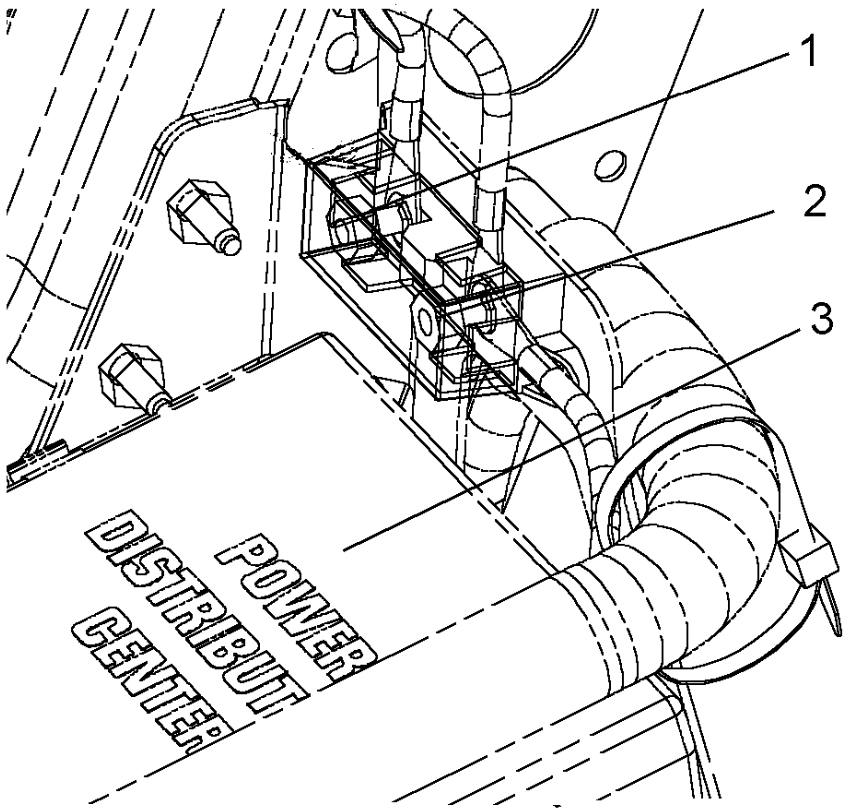


Figure 5 Sample Component Location Illustration

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

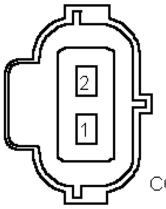
Connector end views found in the Circuit Diagram book provide information on the location of the various connectors.

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)

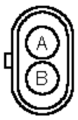


CAV	CIR	GAUGE	COLOR	TERM	SEAL	NOTES
1	R32	18	TN	3536865C1	3536866C1	
2	R9	18	GY	3536865C1	3536866C1	W/TANDEM
2	R9C	18	GY	3536865C1	3536866C1	N/TANDEM

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.

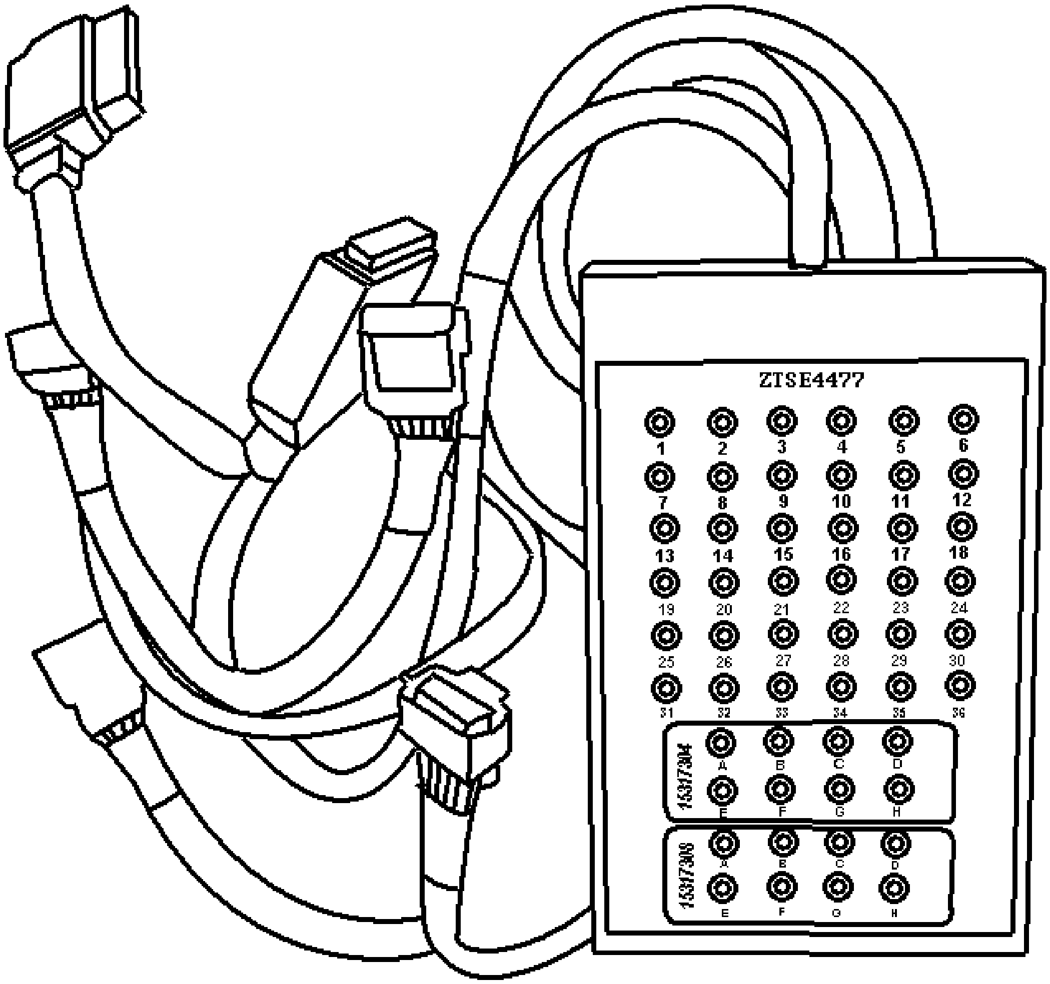


Figure 7 ESC Breakout Box

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.

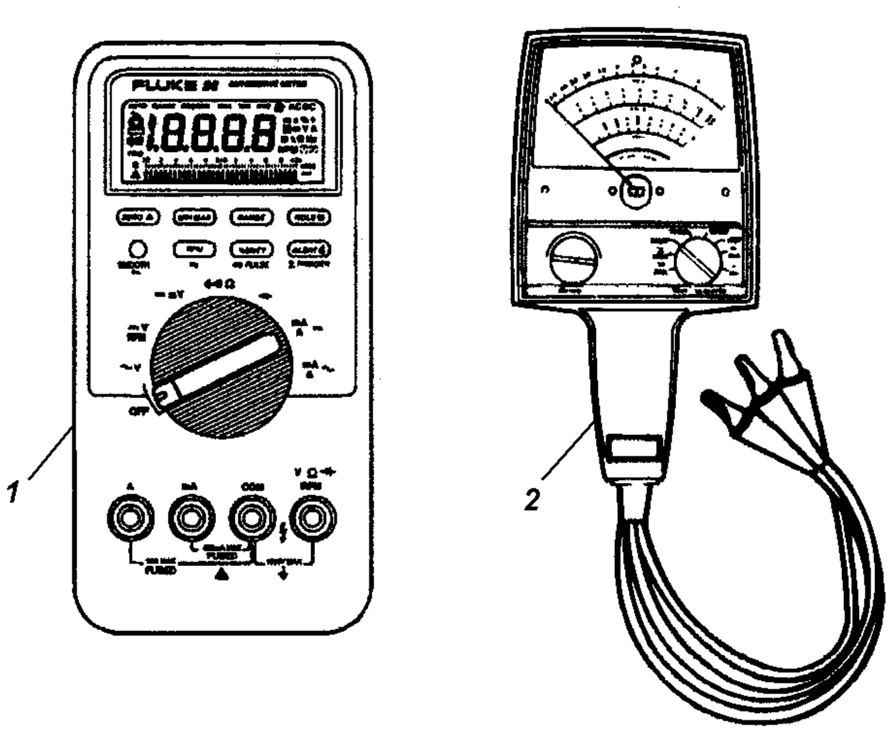


Figure 8 Digital and Analog Meters

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.

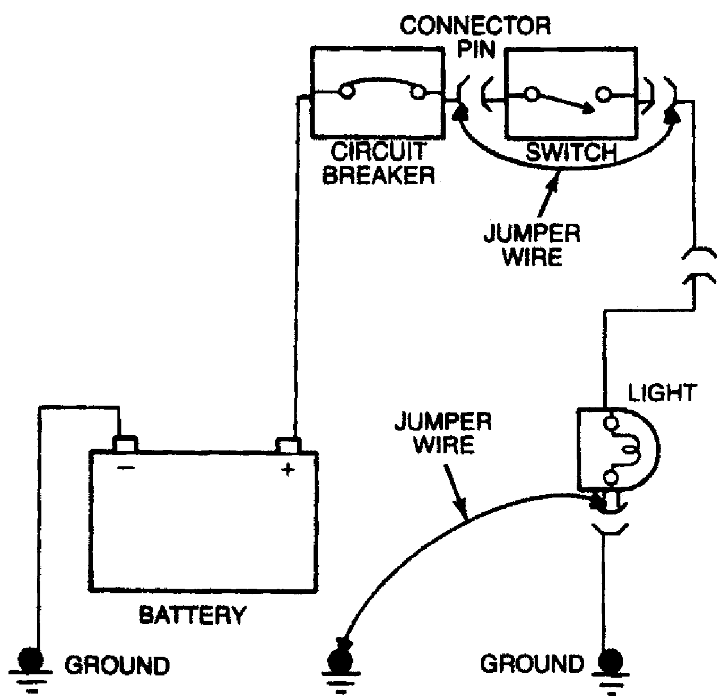


Figure 9 Jumpers in Circuits

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

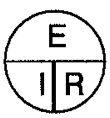
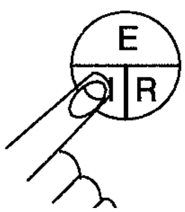
Ohms Law	
	Where: I = Current (Amperes) E = Voltage (Volts) R = Resistance (Ohms)
I = E/R	This formula states that current flow (I) = Voltage (E) applied to a circuit divided by total resistance (R) in the circuit. This shows that an increase in voltage or a decrease in resistance increases current flow.

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.

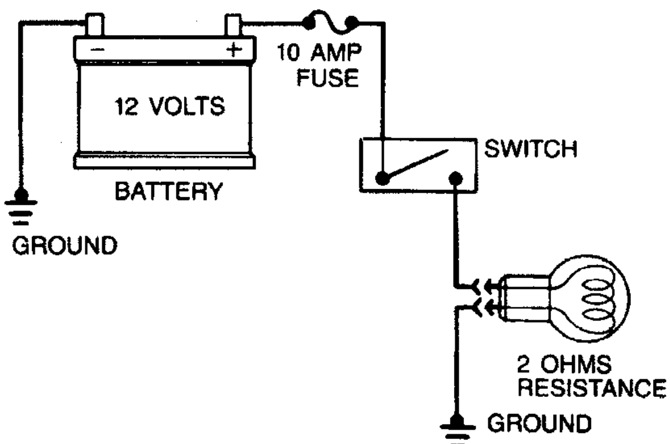


Figure 10 Typical Circuit

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.

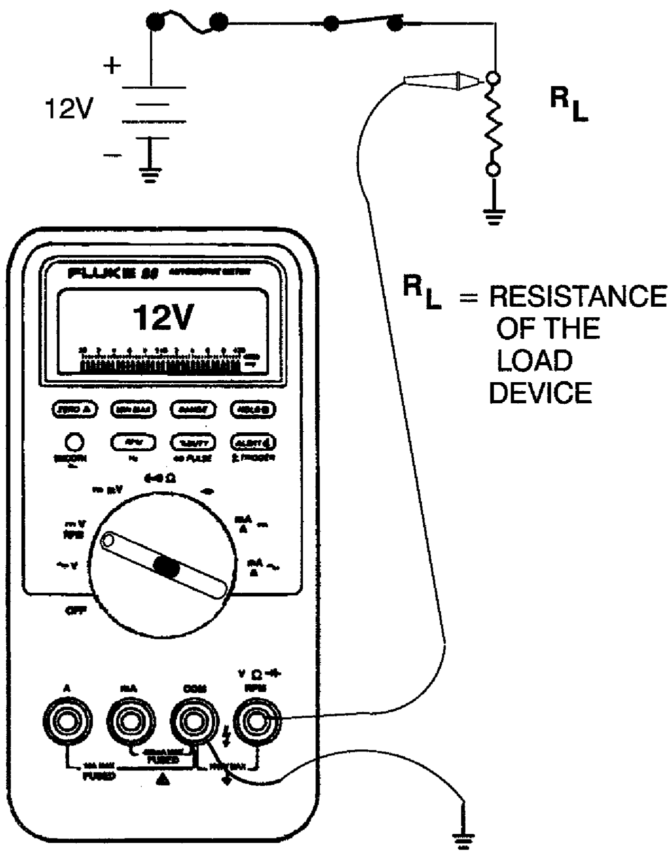


Figure 11 Voltmeter Lead Connections Diagram

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.

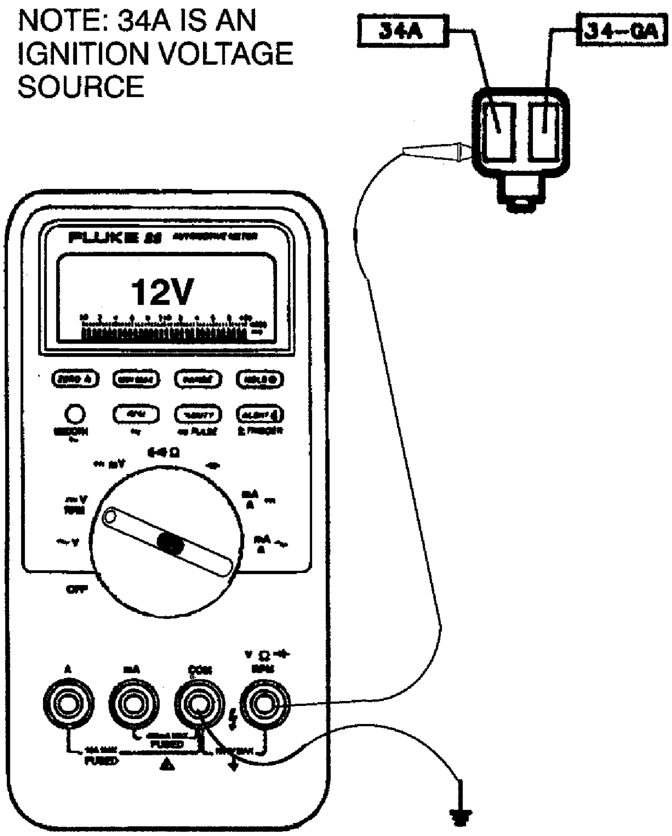


Figure 12 Connecting the Meter in Series Diagram

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.

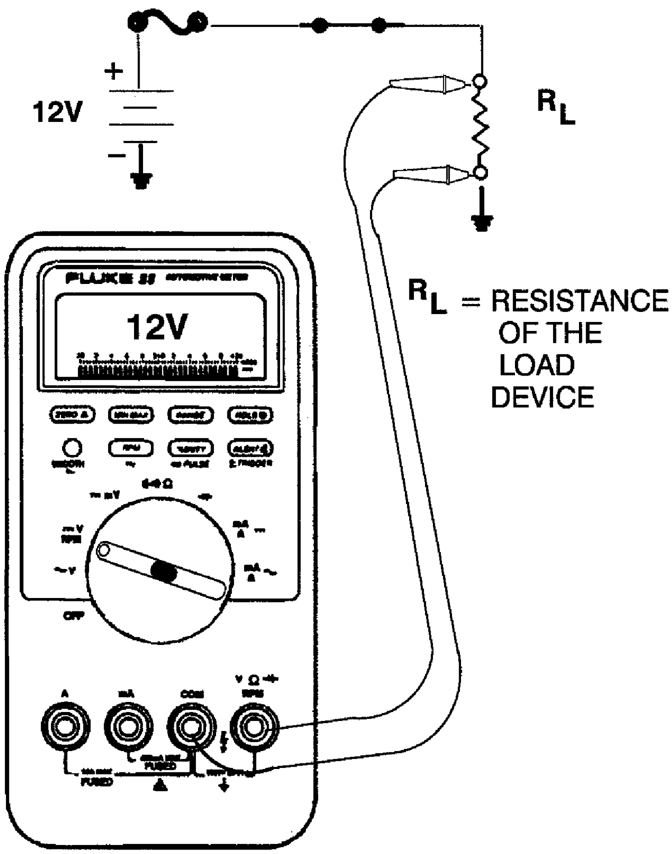


Figure 13 Checking Voltage Drop Across a Load Device Diagram

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.

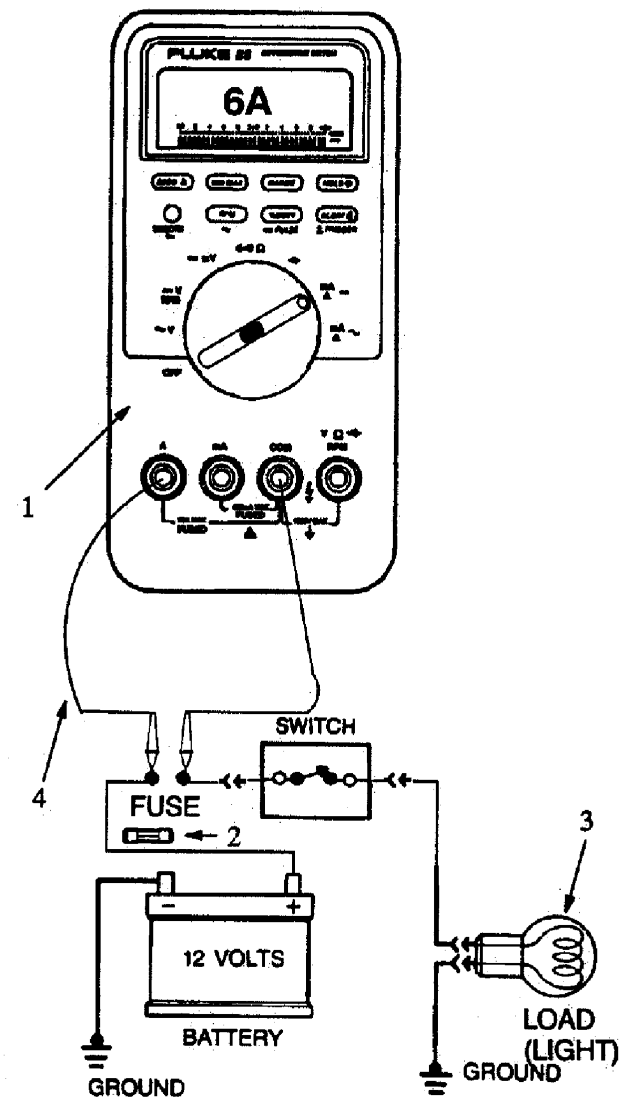


Figure 14 Measuring Current Flow Diagram

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.

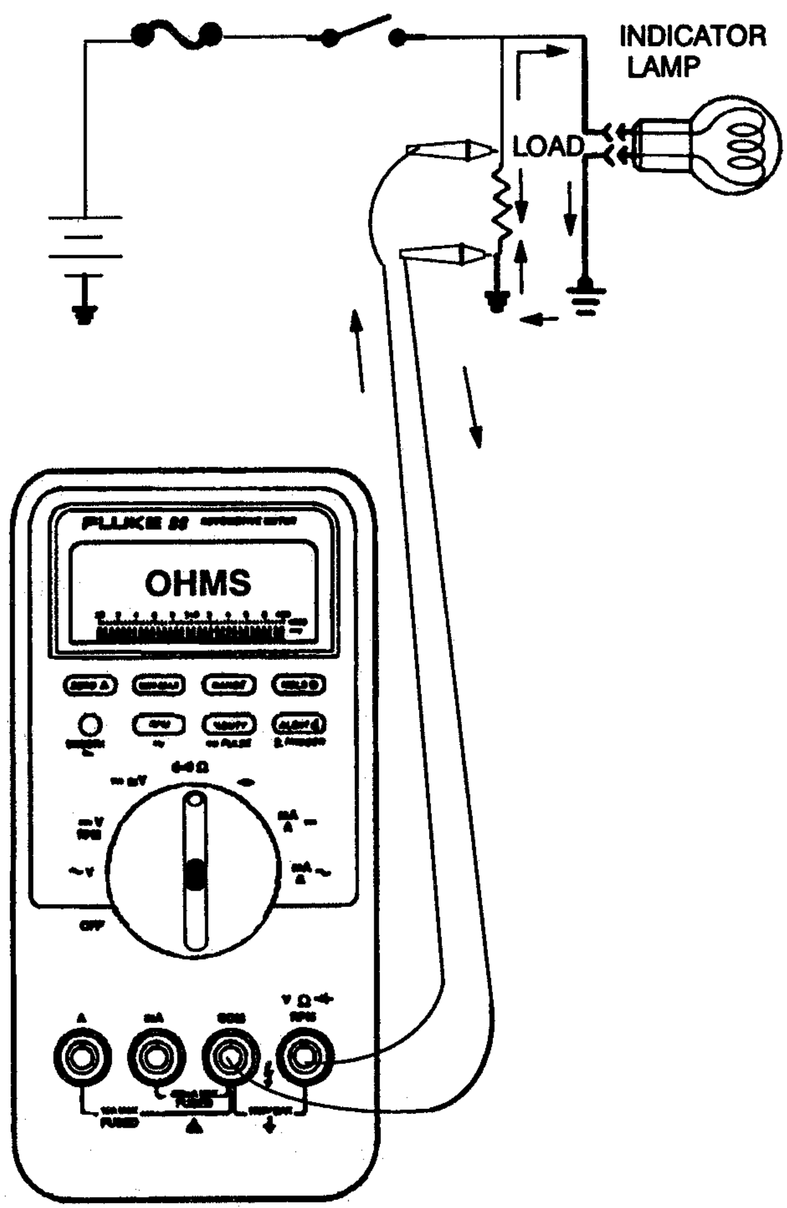


Figure 15 Measuring Resistance Diagram

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.

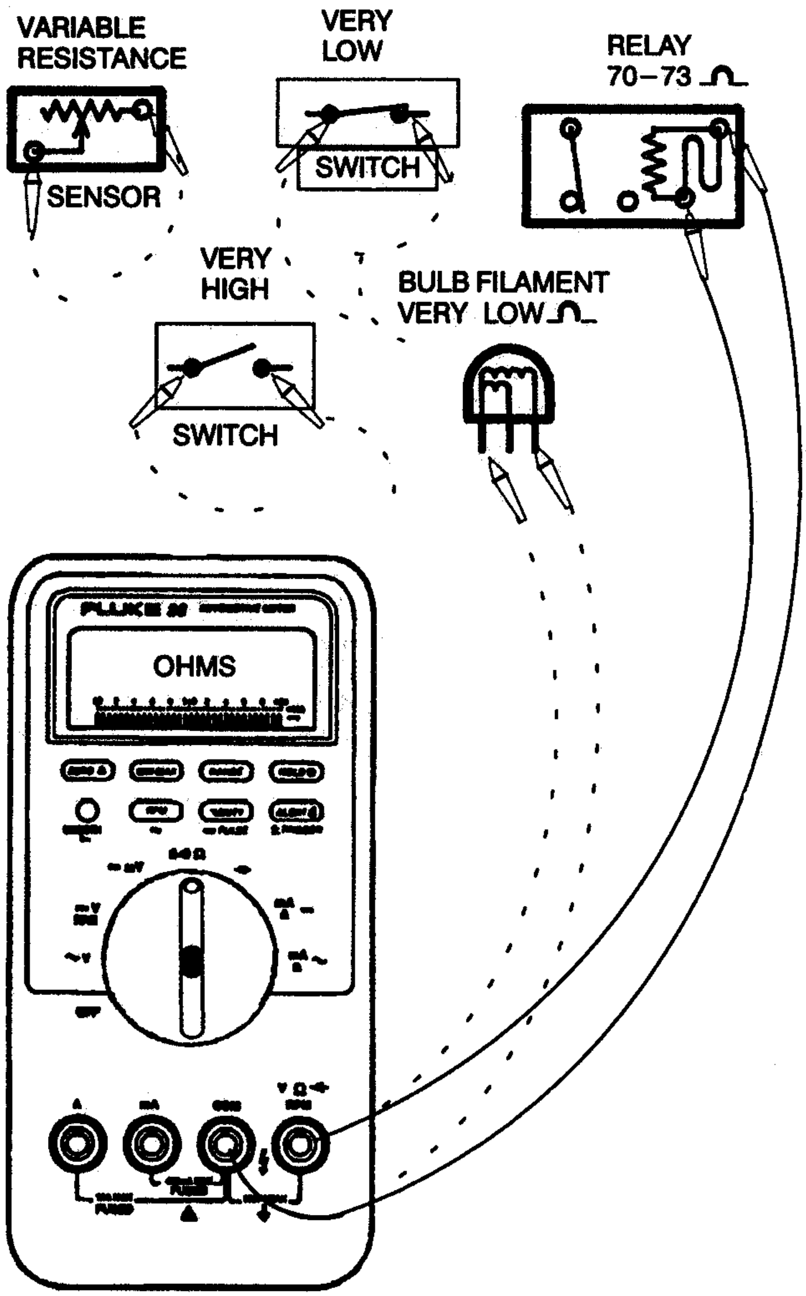


Figure 16 Placing Ohmmeter Leads Across a Component or Circuit Diagram

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.

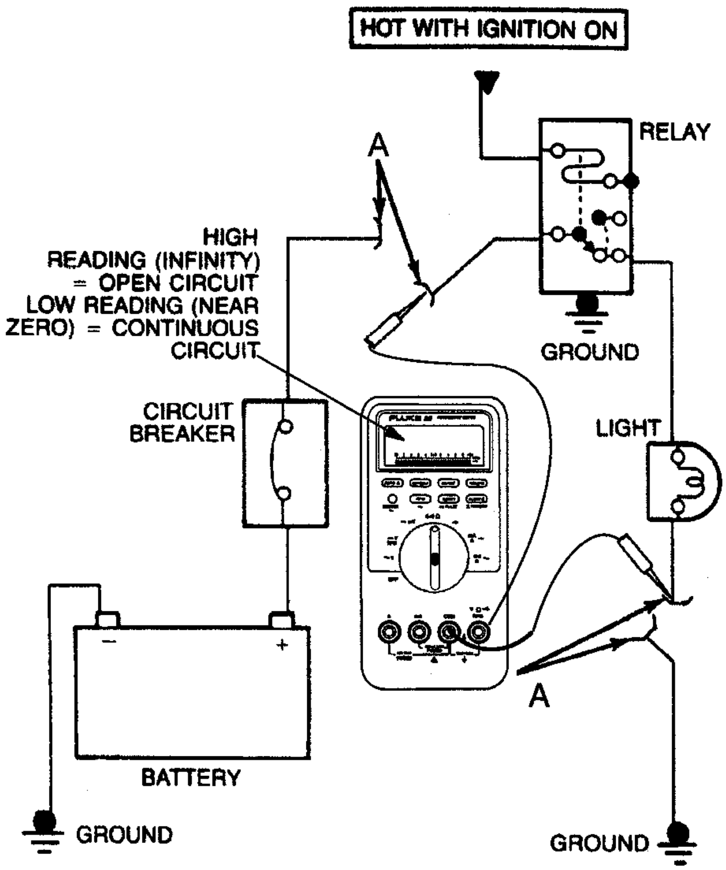


Figure 17 Checking For Open Circuits

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.

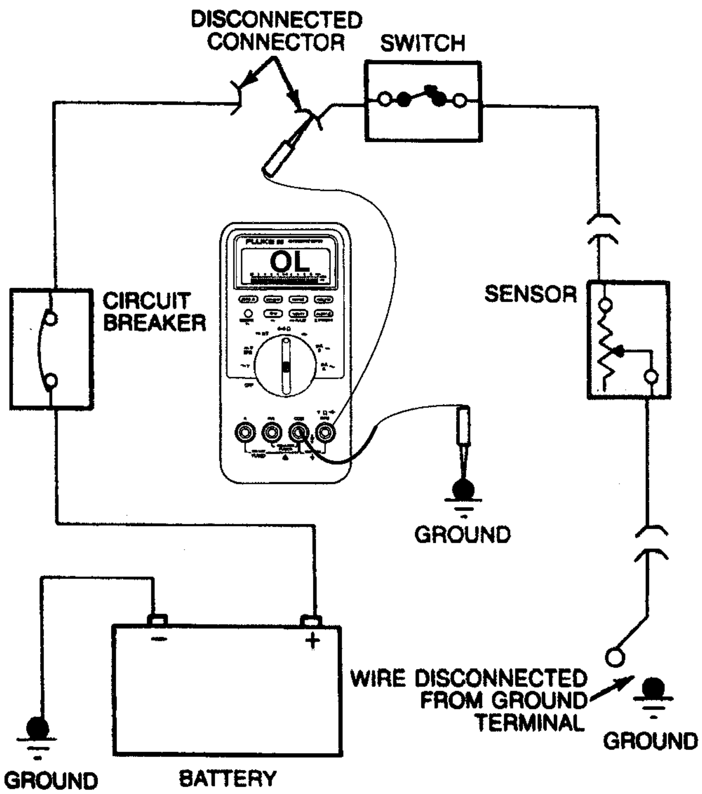


Figure 18 Checking For Short Circuits

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.

RELAY FUNCTIONS AND WIRING GUIDE

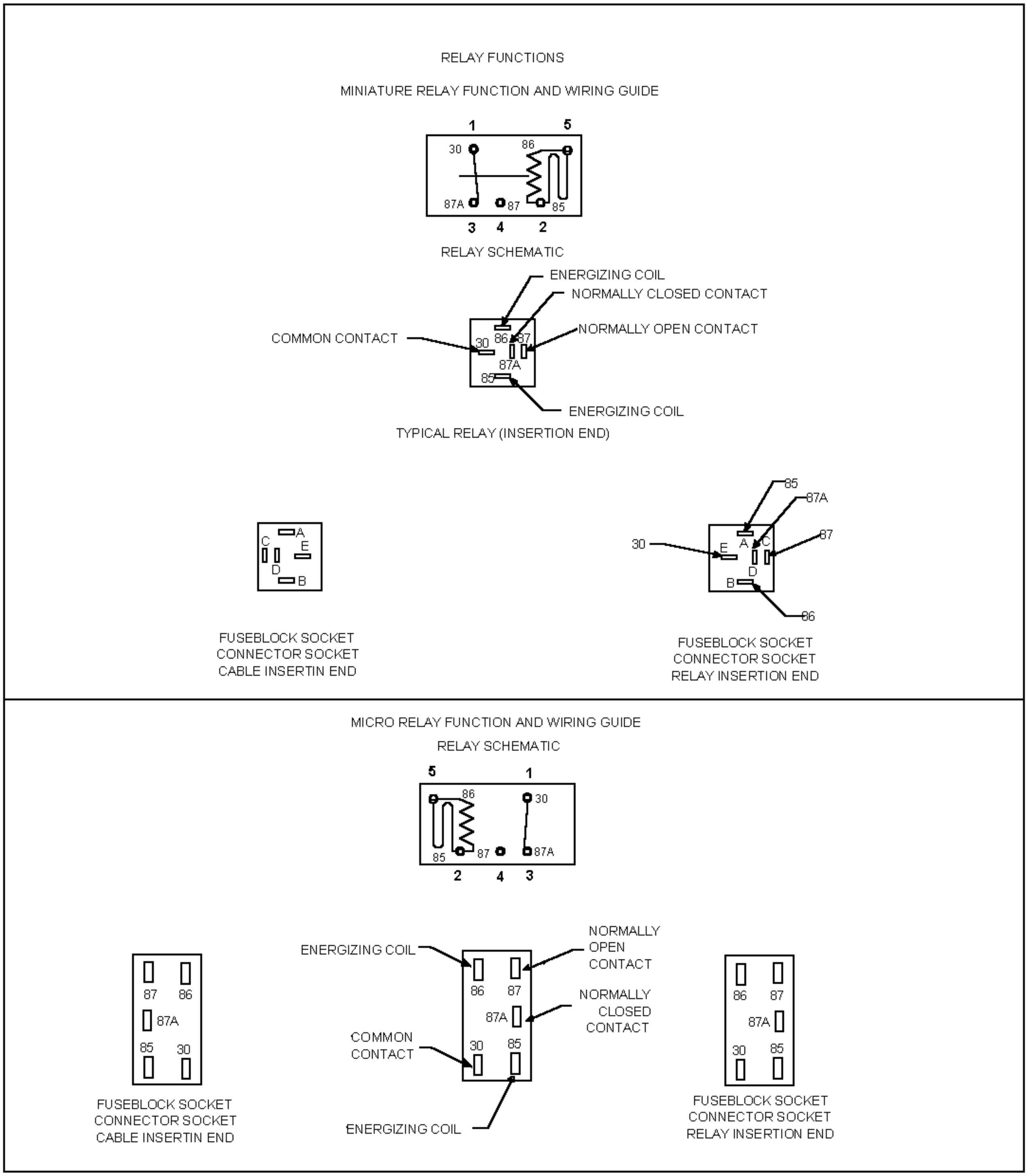


Figure 19 Relay Schematic

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.

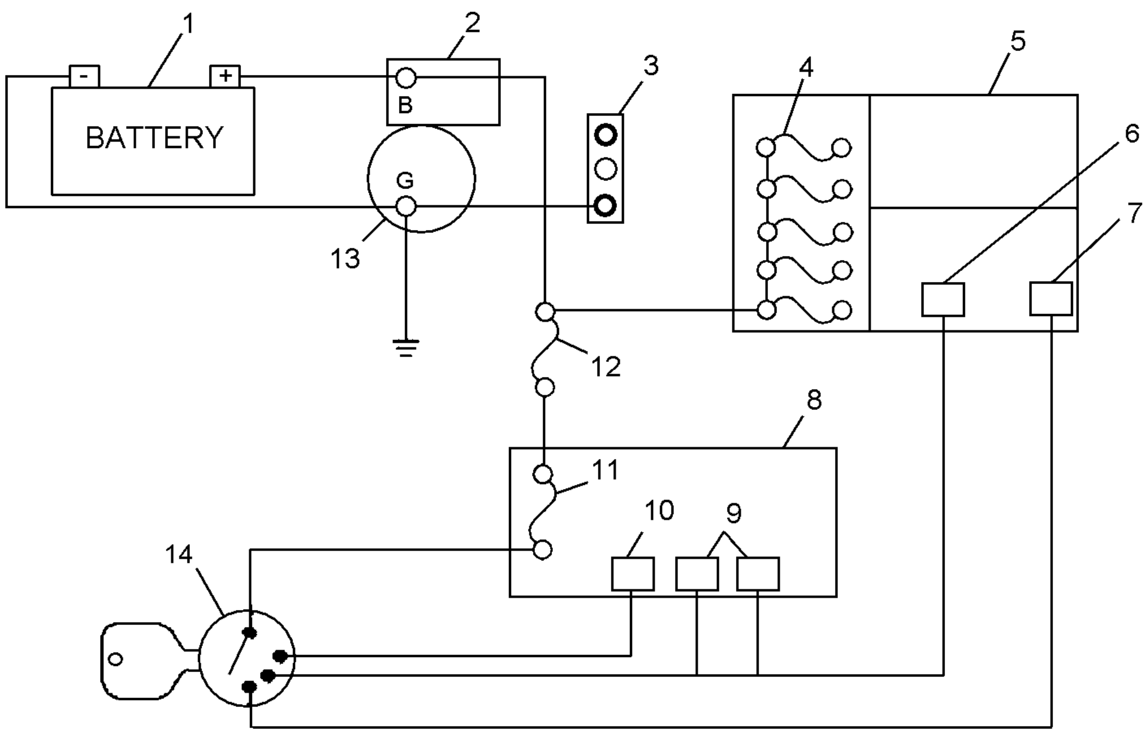


Figure 20 Power Distribution Function Diagram

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.

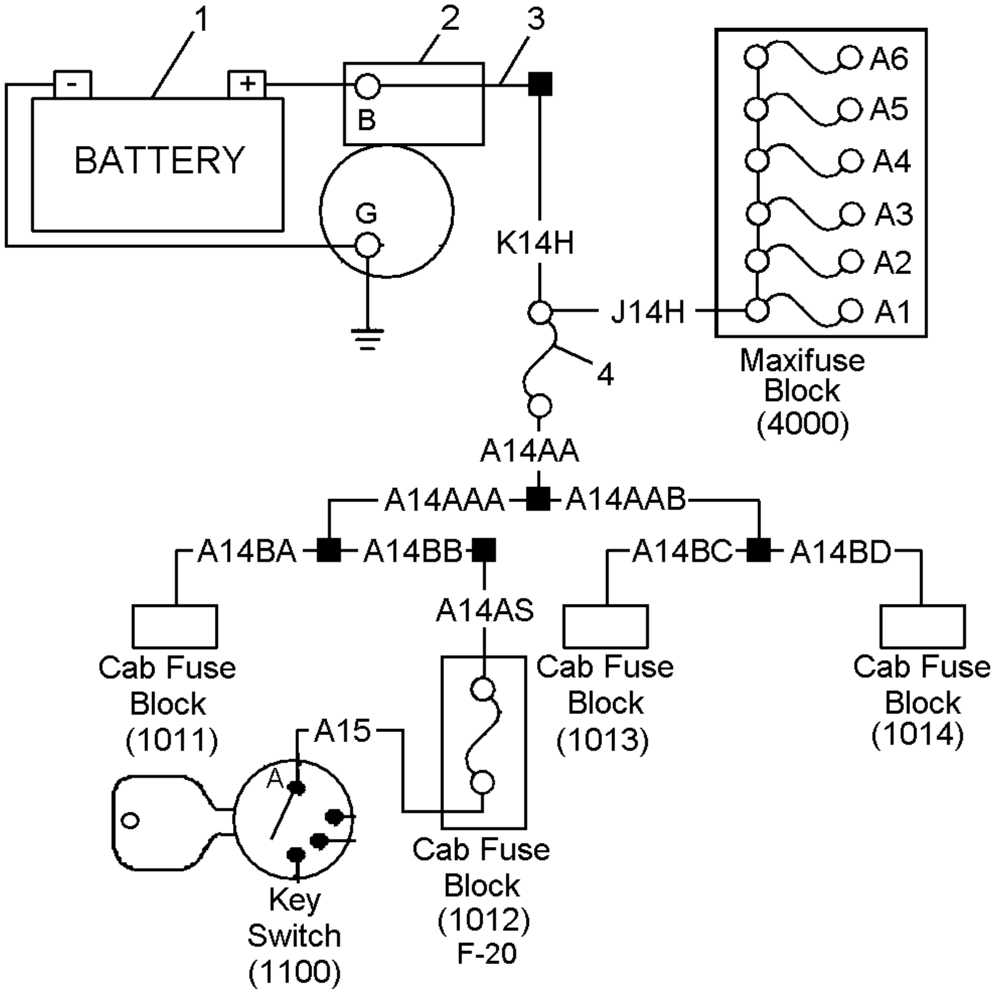


Figure 21 Battery Power Distribution Diagram

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.

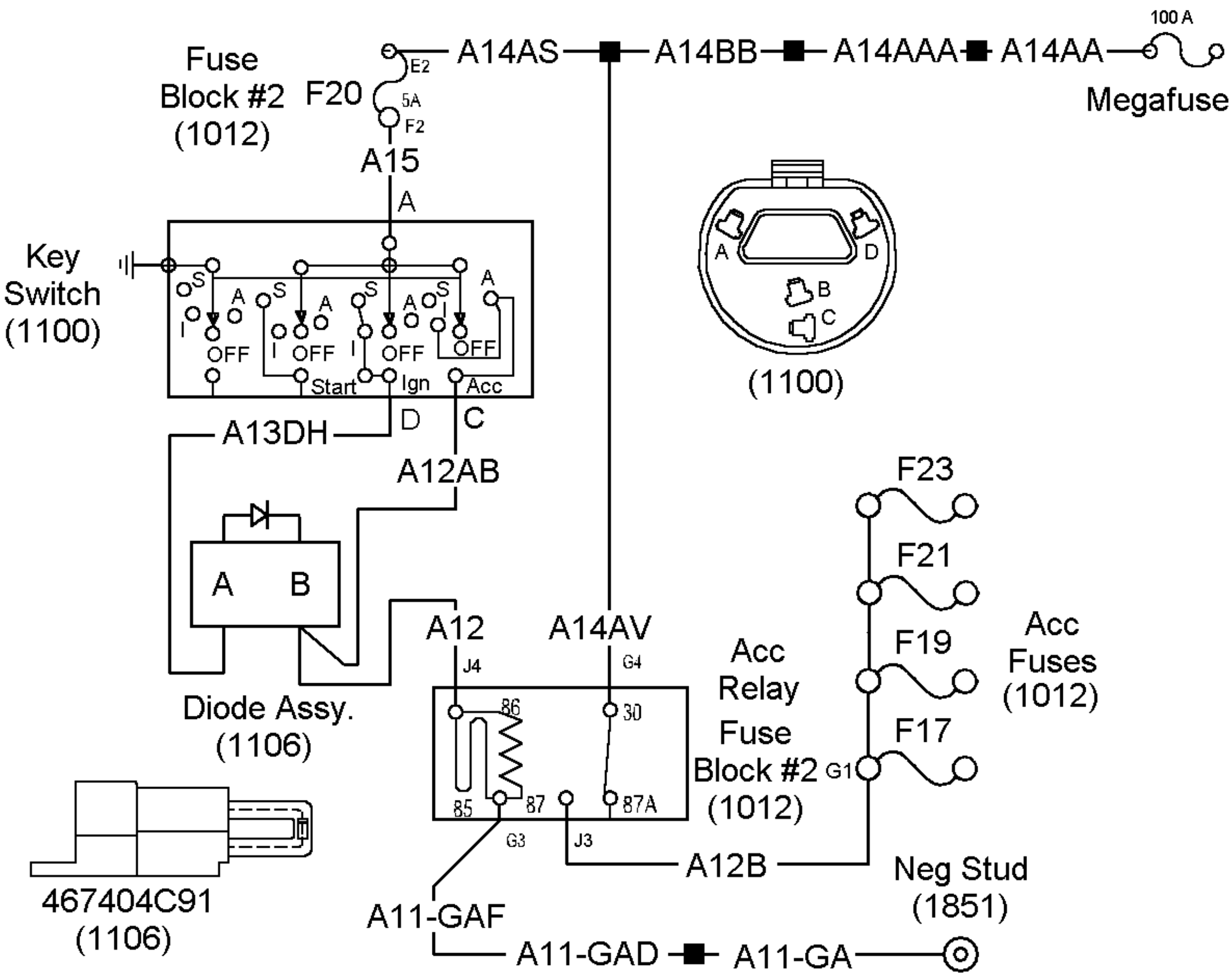


Figure 22 Accessory Power Distribution Diagram—Always Refer to Circuit Diagram Book for Latest Circuit Information

(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
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.

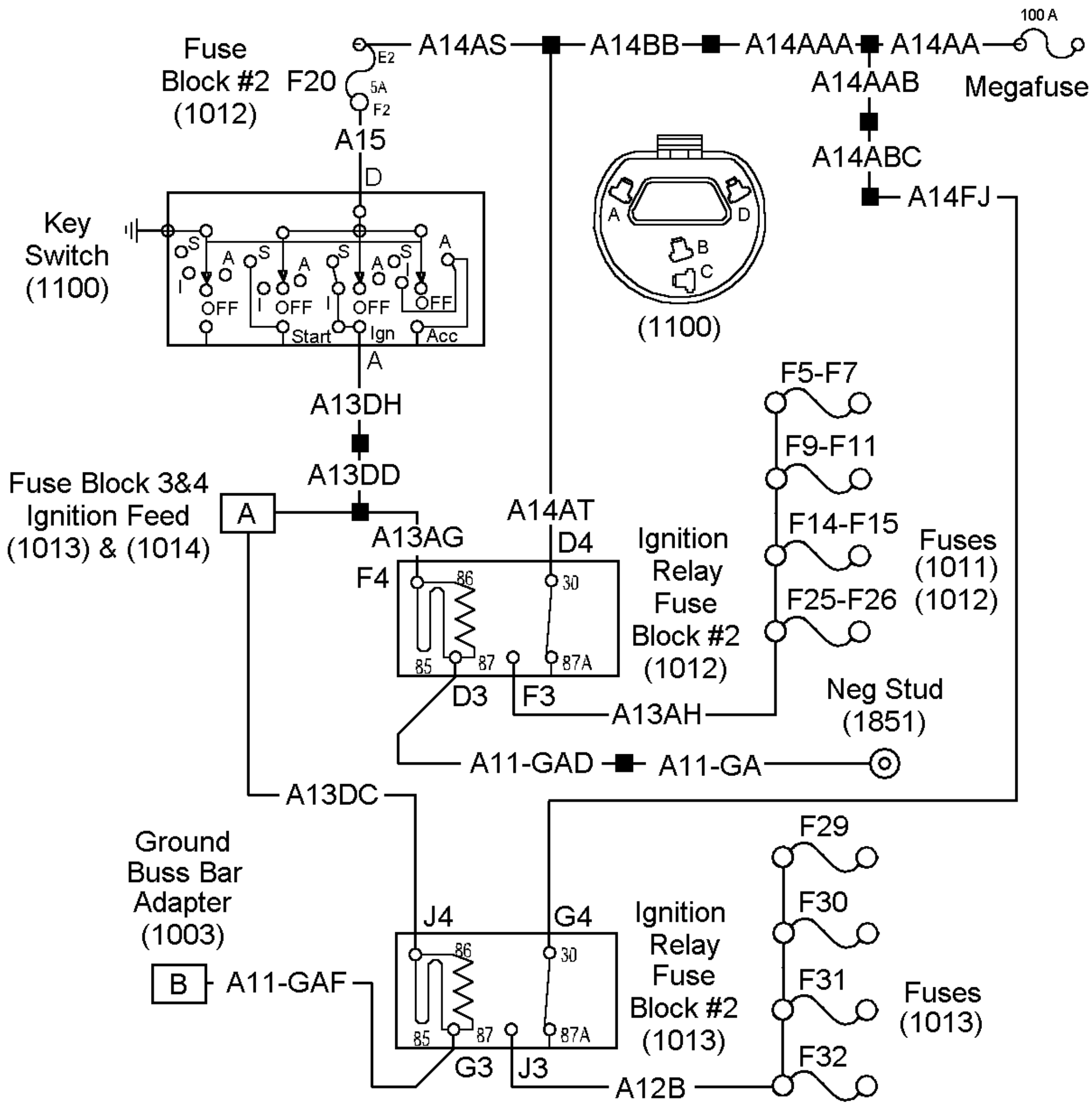


Figure 23 Cab Ignition Power Distribution Diagram—Always Refer to Circuit Diagram Book for Latest Circuit Information

(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.

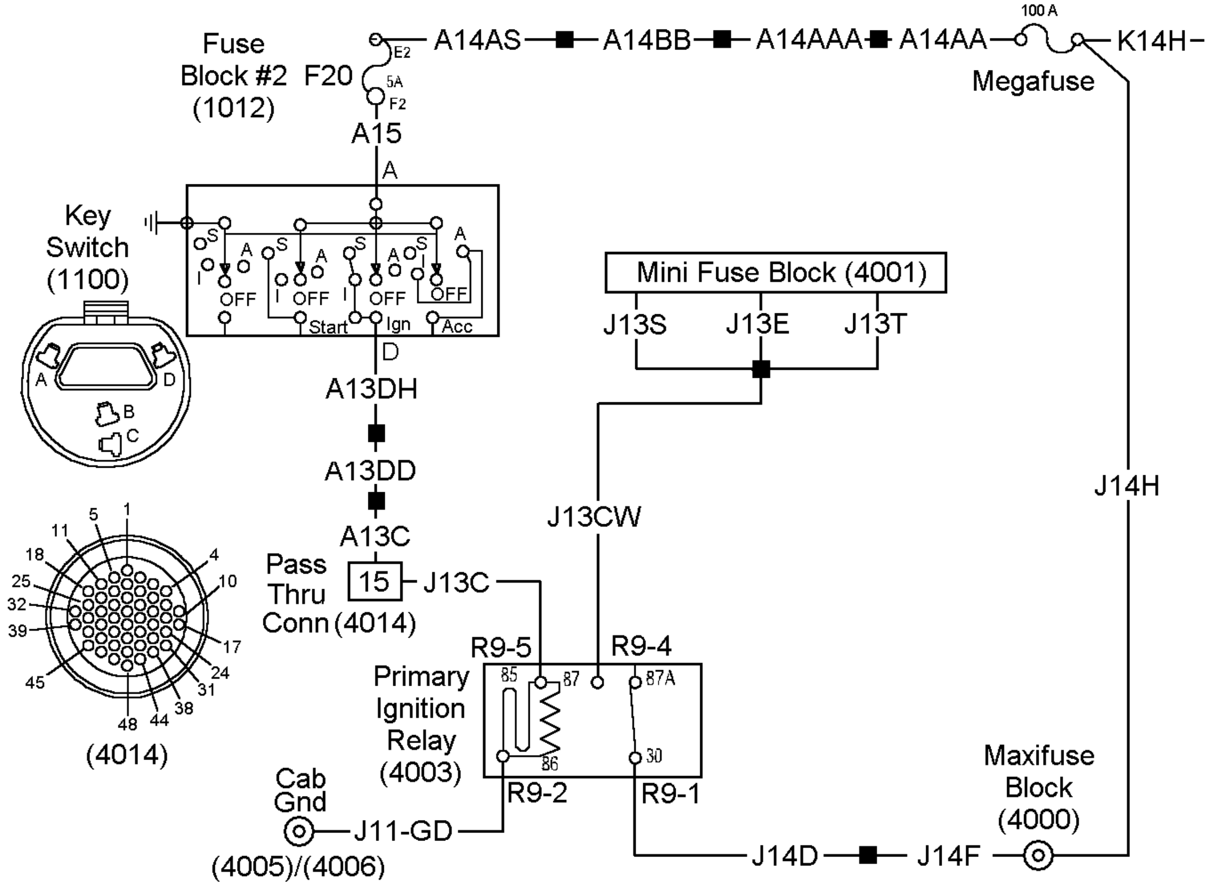


Figure 24 Chassis Ignition Power Distribution Diagram

(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

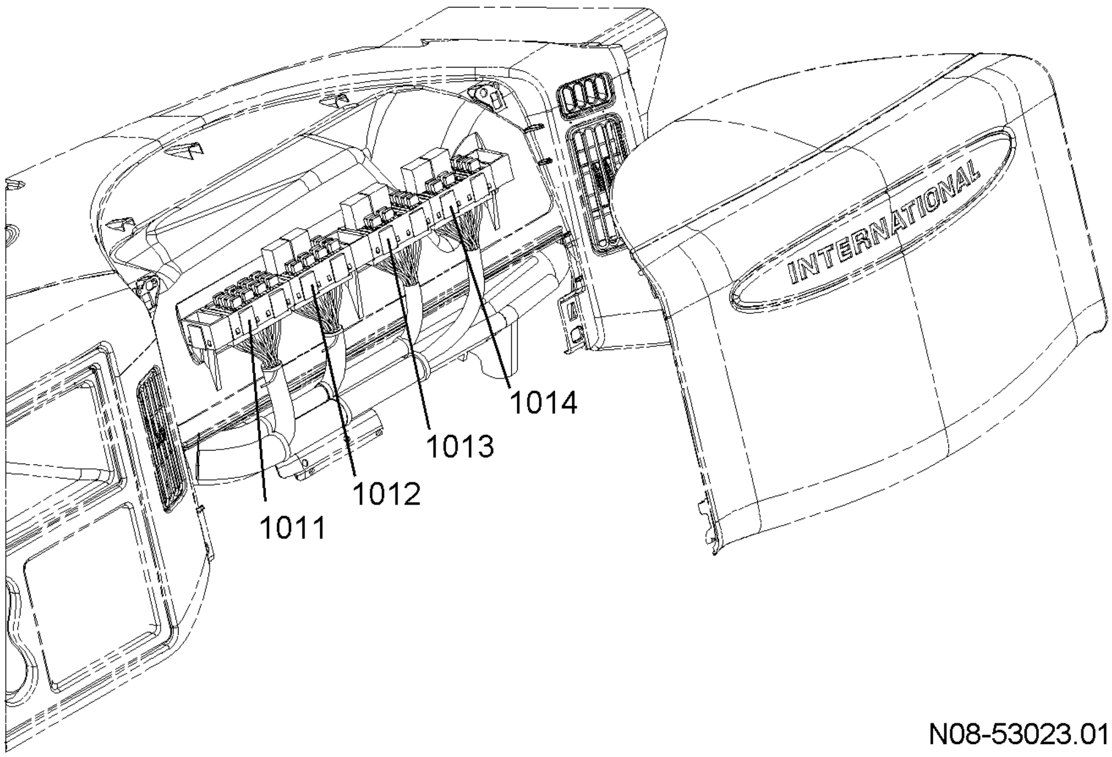


Figure 25 In-Cab Power Distribution Panel (Located on Passenger Side of Instrument Panel Behind Closeout Panel)

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

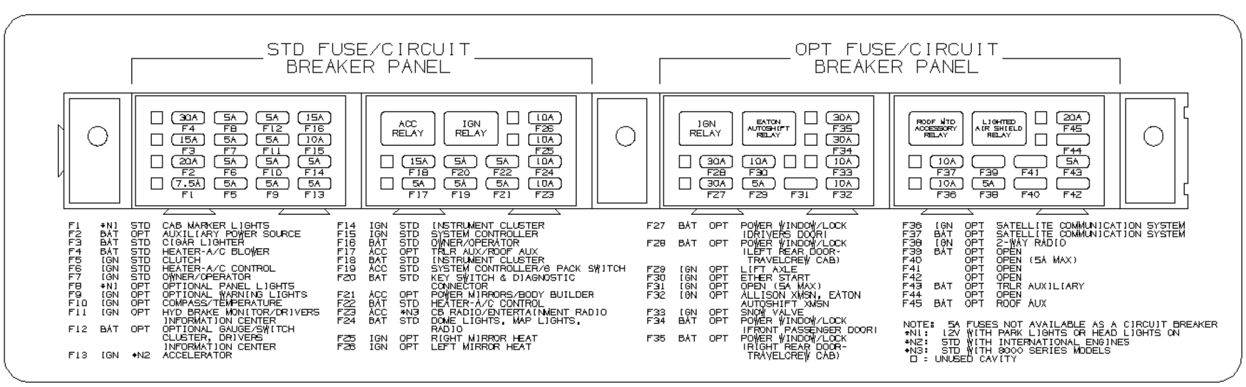


Figure 26 In-Cab Power Distribution Panel Graphic (Located on Back of Passenger Instrument panel Cover

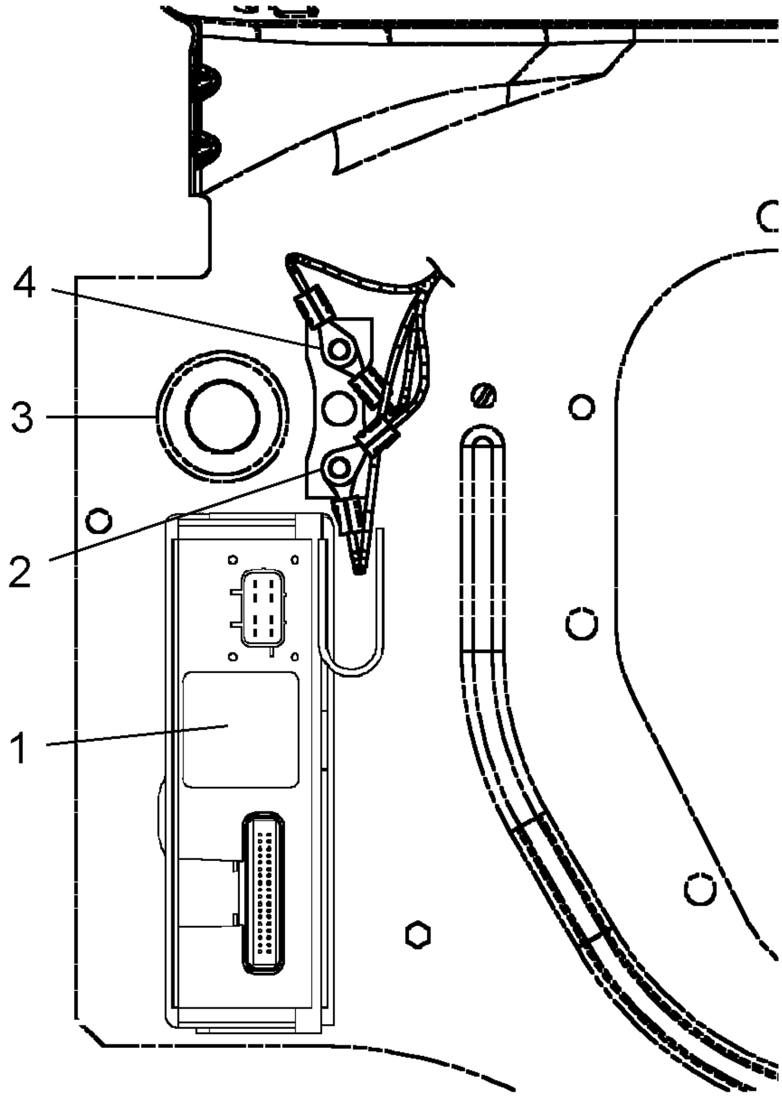


Figure 27 ESC and Ground Stud Location (Viewed From Inside of Cab with Cover Removed)

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

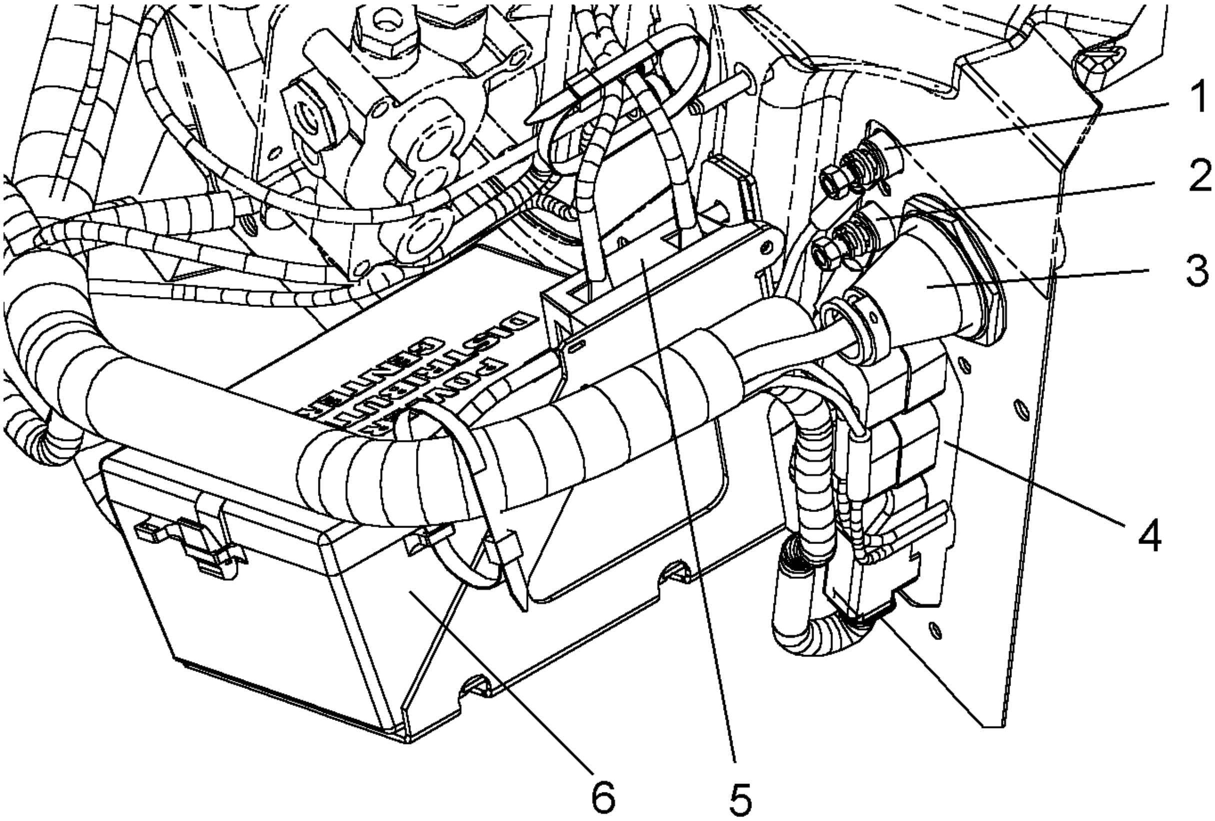


Figure 28 Engine Ground Stud Location (Viewed From Engine Compartment)

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

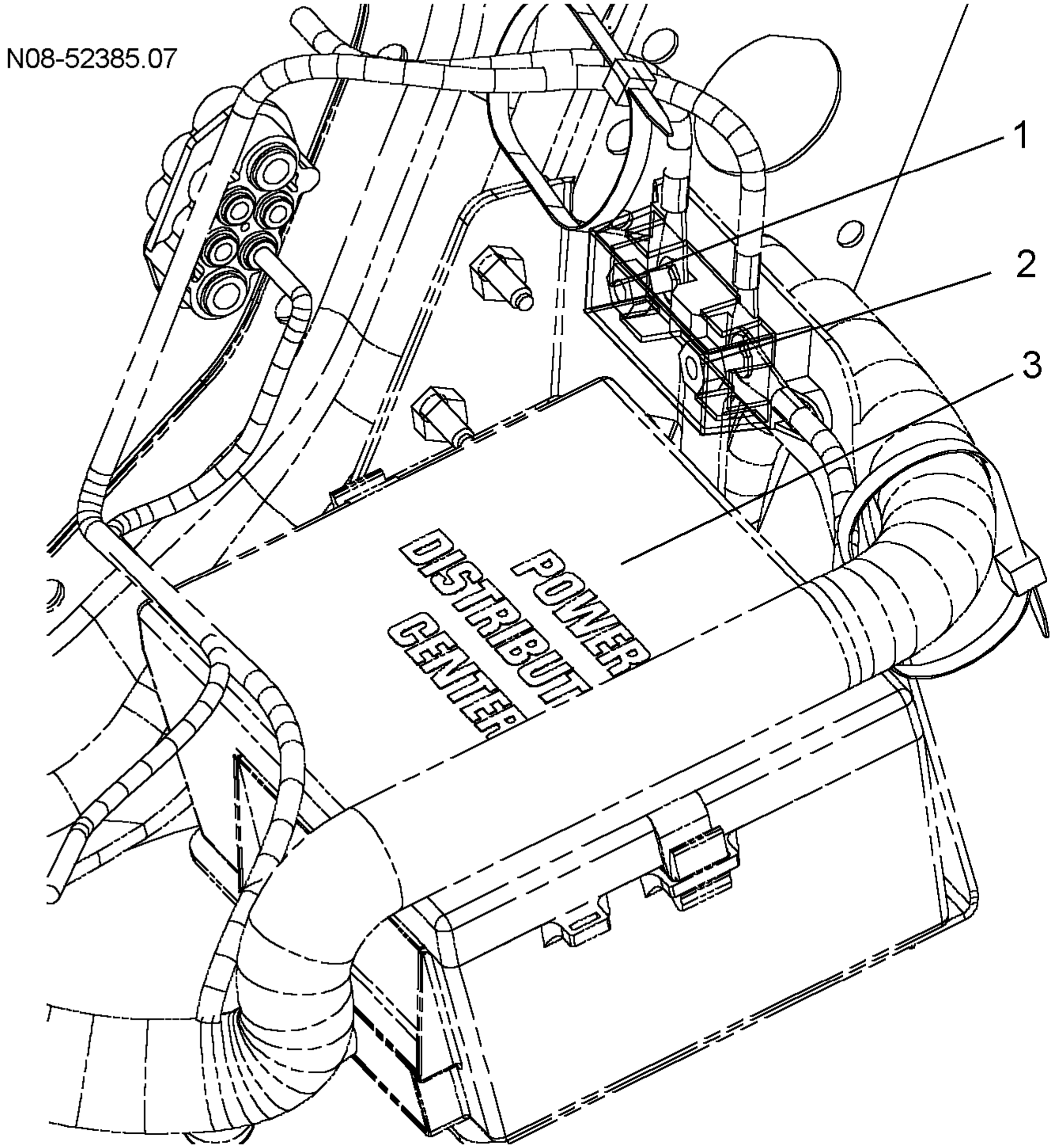


Figure 29 Engine Compartment Wiring

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

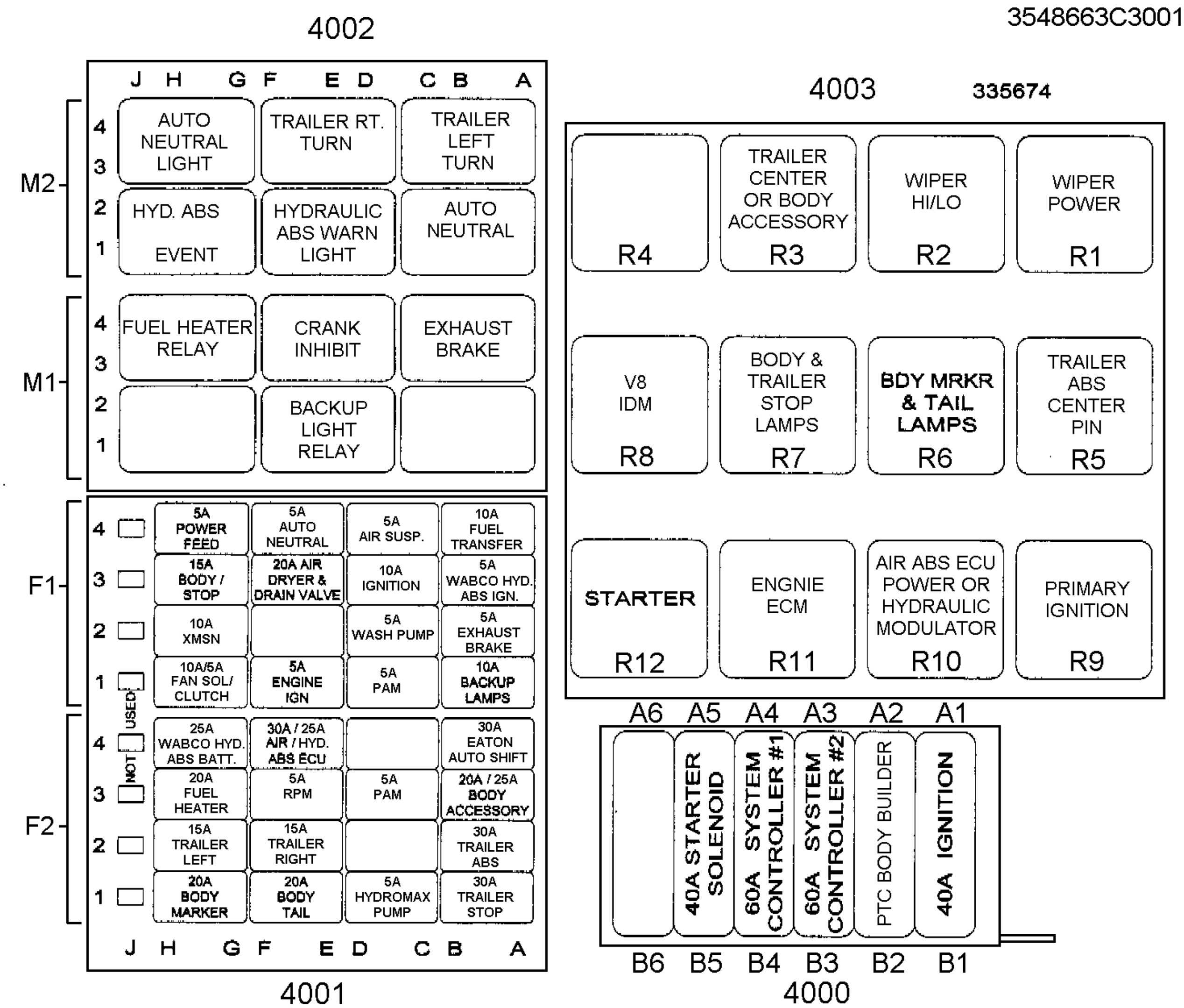


Figure 30 Typical Engine Power Distribution Center – Refer to the Label on the PDC Lid for Specific Configuration

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

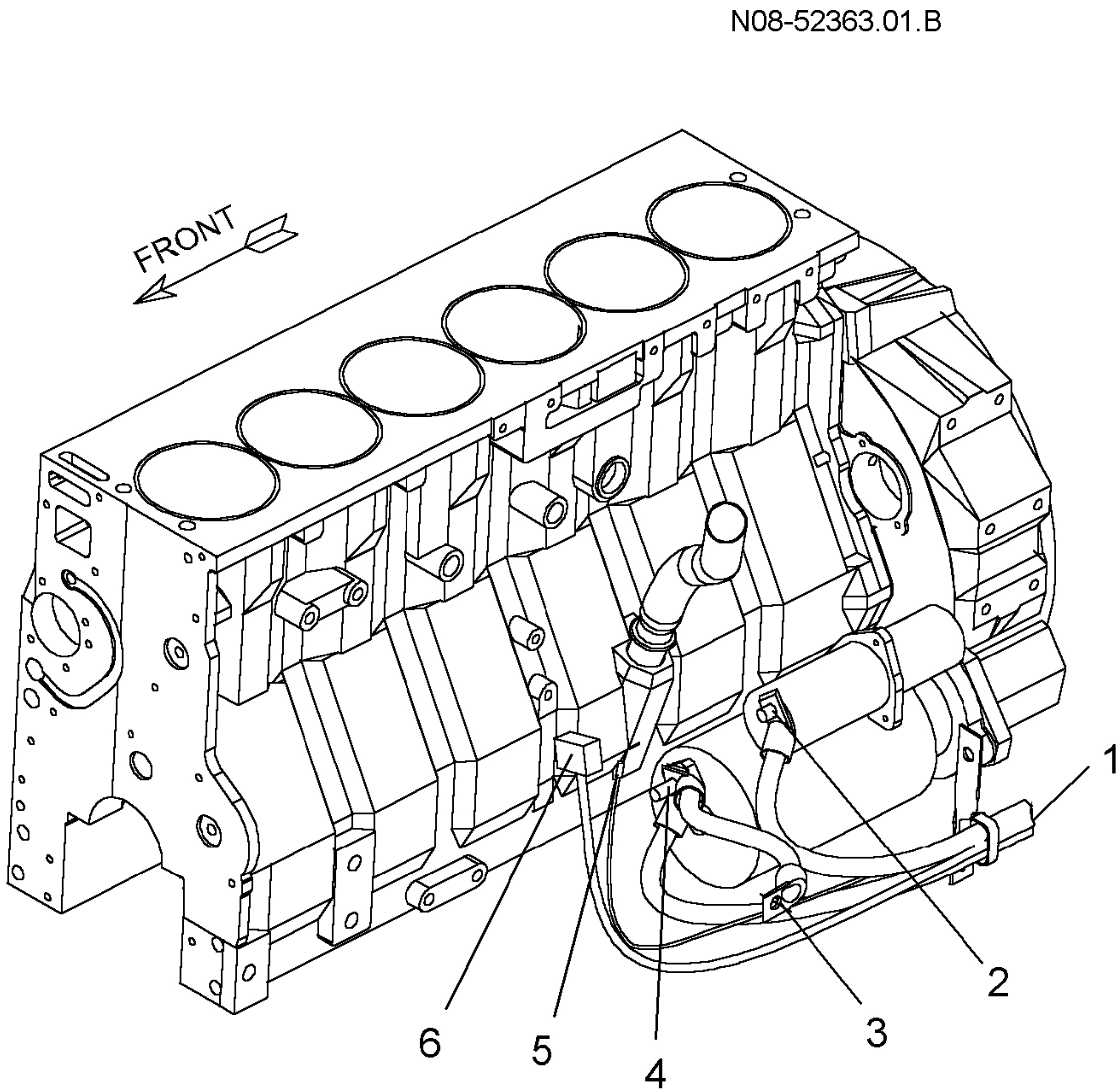


Figure 31 Starter Wiring

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

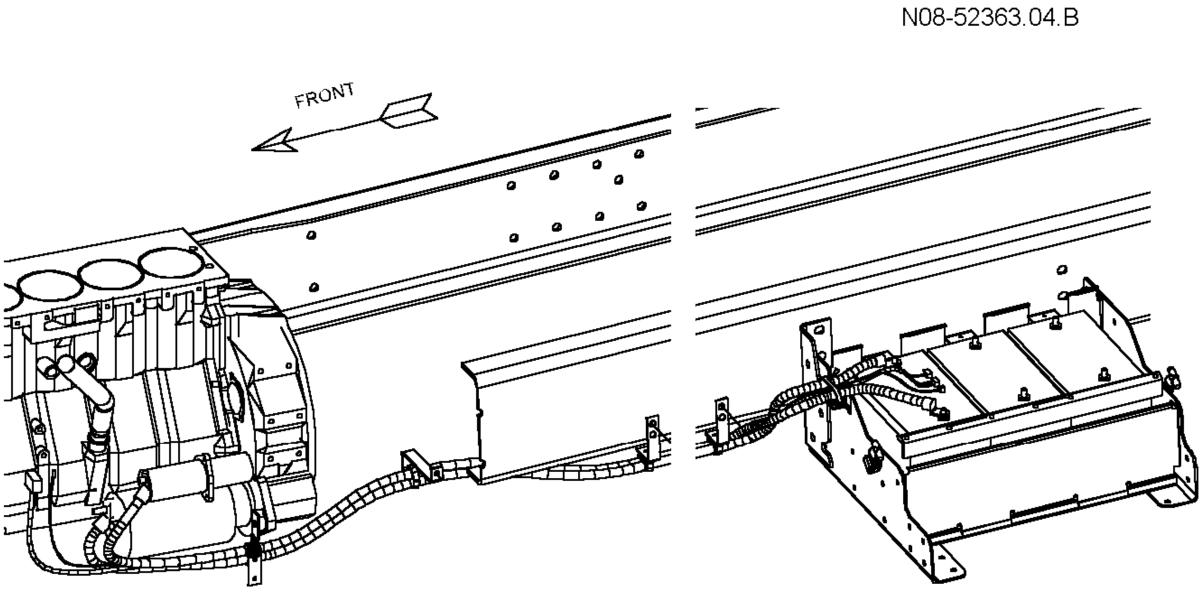


Figure 32 Battery Cable Wiring — Typical, Location And Number Of Batteries May Change Depending On Model And Options

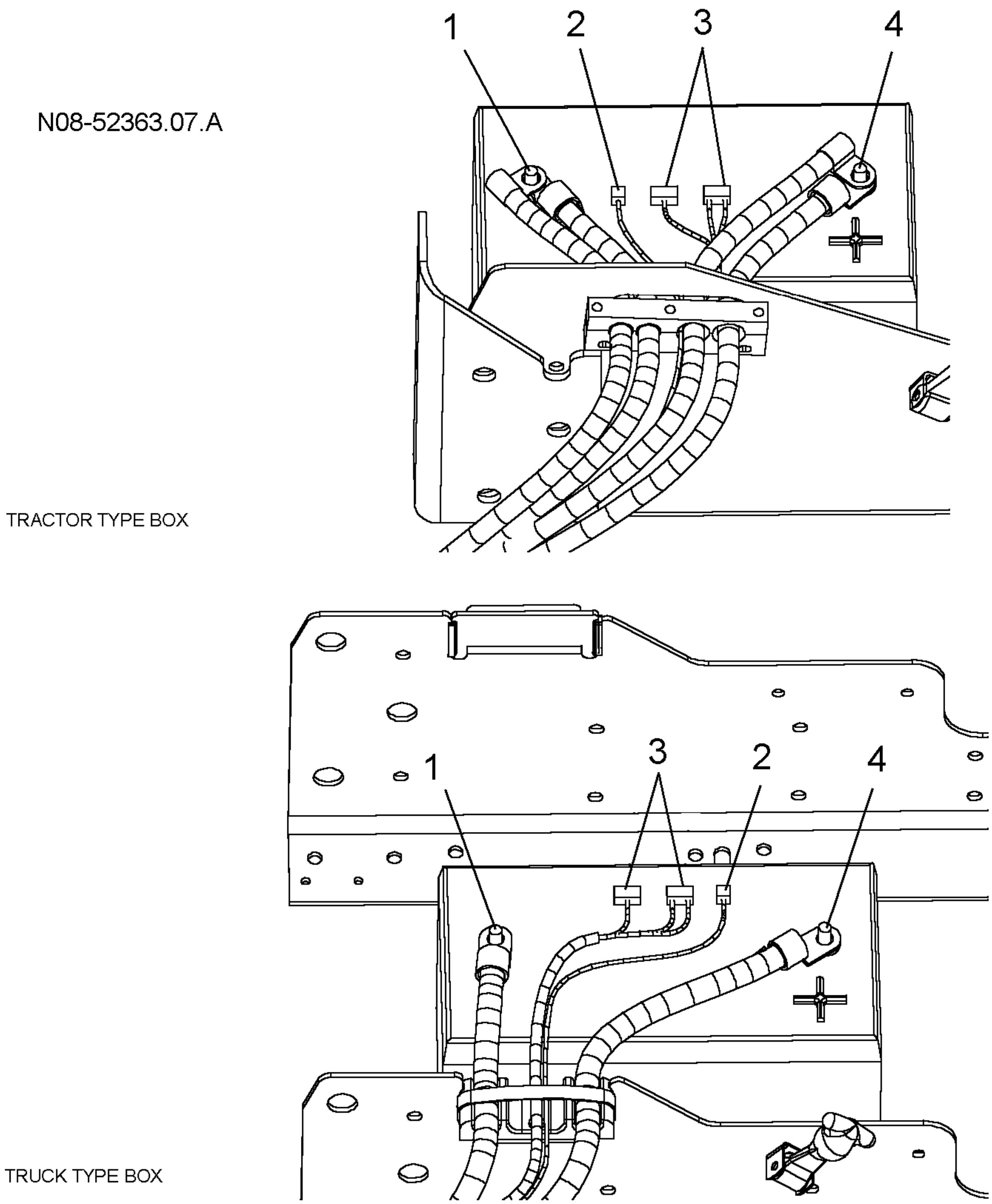


Figure 33 Battery Cable Wiring — Typical (Location And Number Of Batteries May Change Depending On Model And Options)

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.

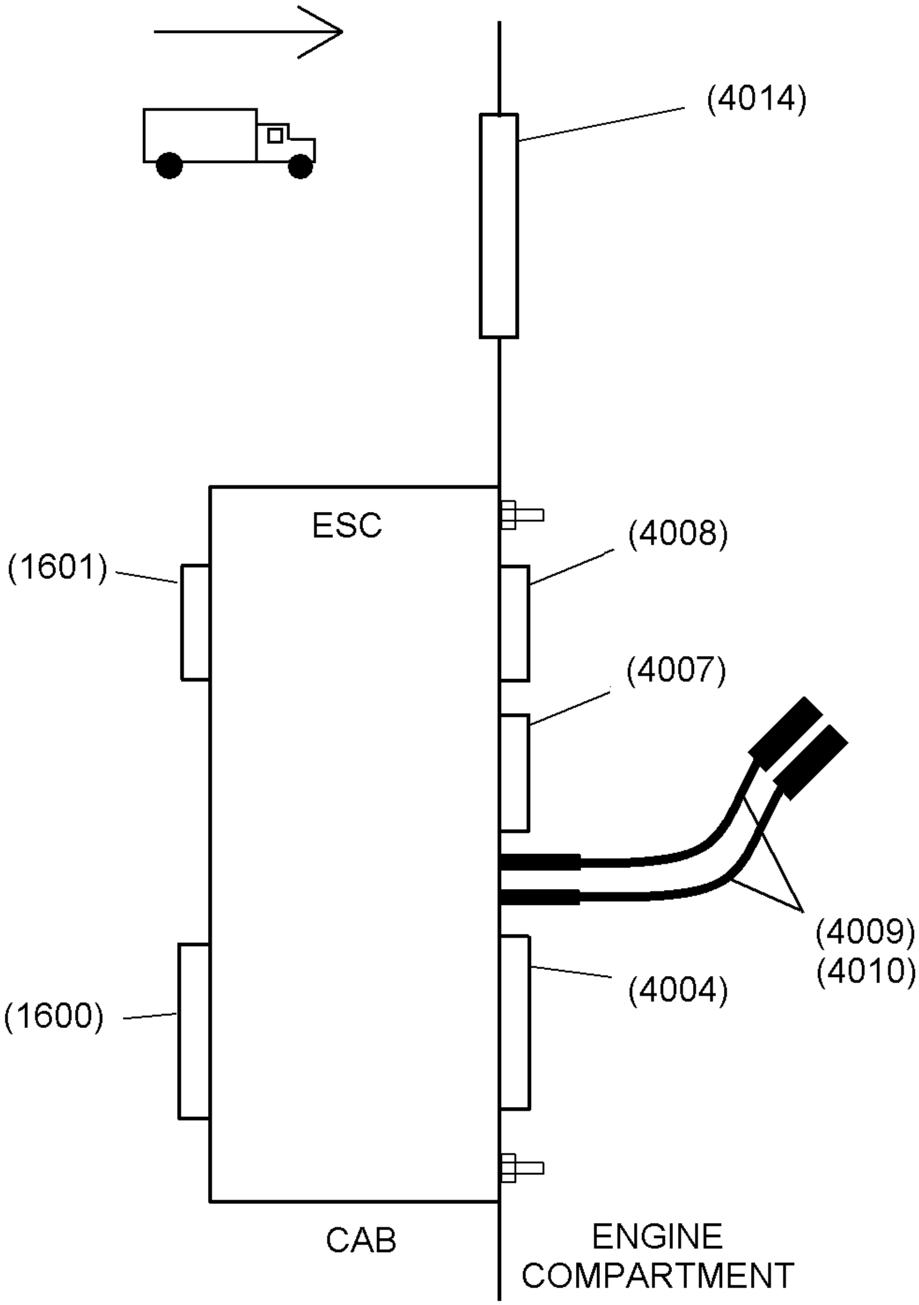


Figure 34 Electrical System Controller (ESC)

(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

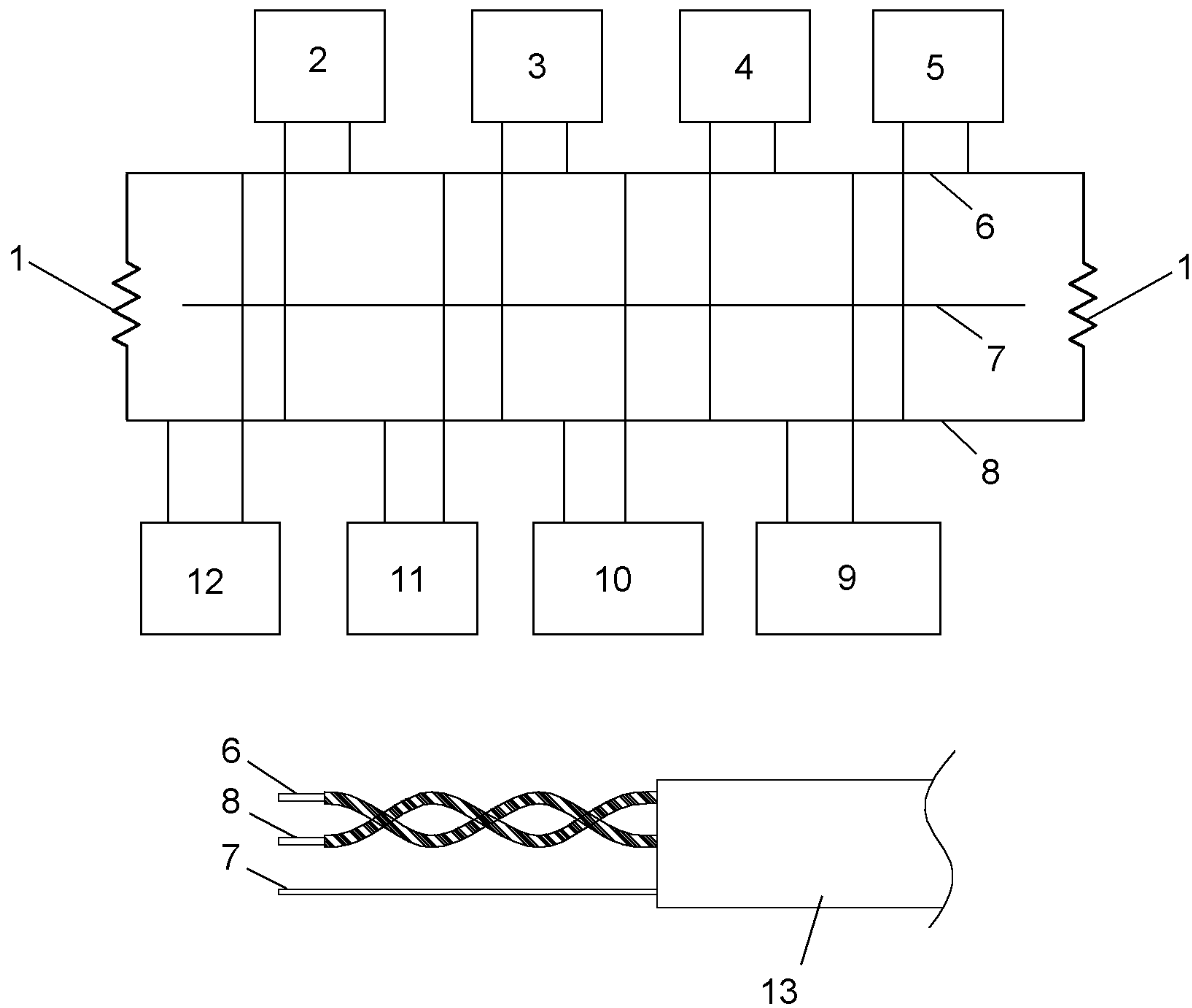


Figure 35 Drivetrain 1939 Data Link Functional Diagram

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.

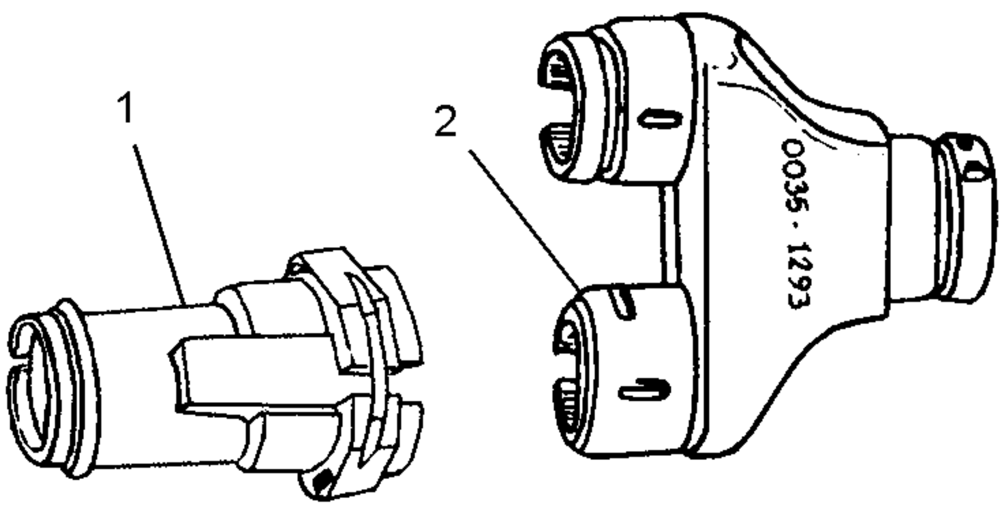


Figure 36 J1939 Termination Resistor and "Y" Connector

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 1045)

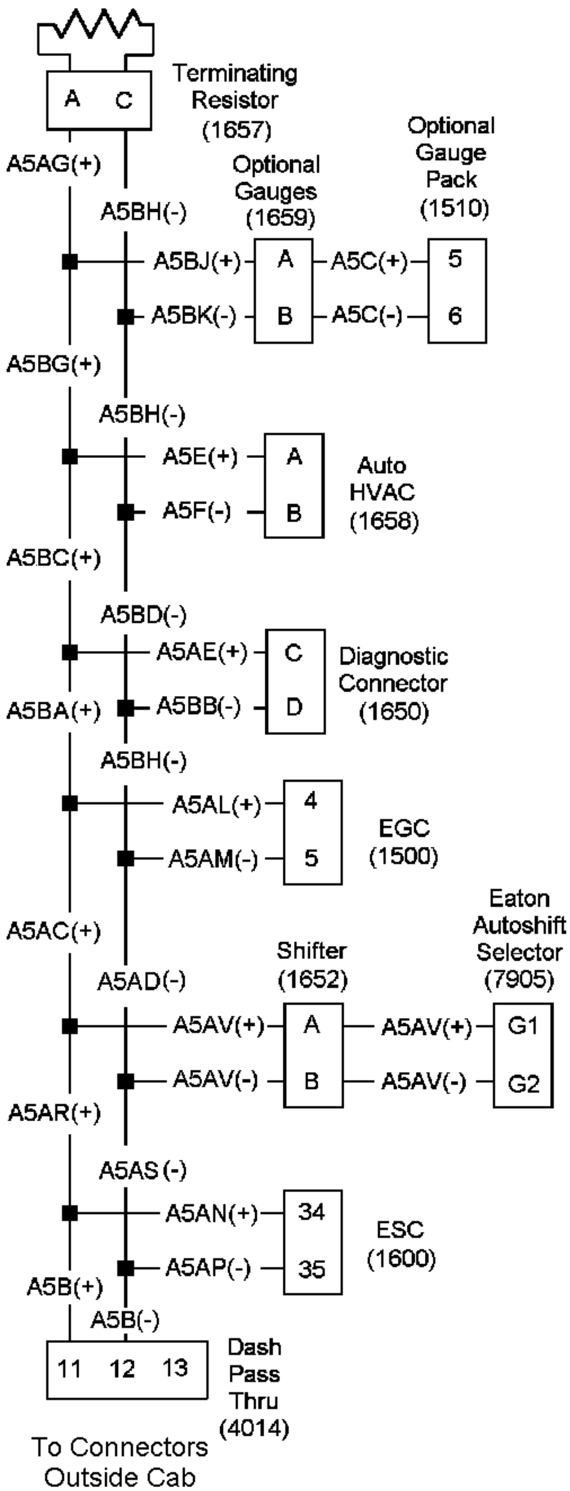


Figure 37 Typical (In Cab) Drivetrain 1939 Data Link connectors Diagram (Connectors Used Will Vary Depending On Features Installed In Vehicle)

(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)

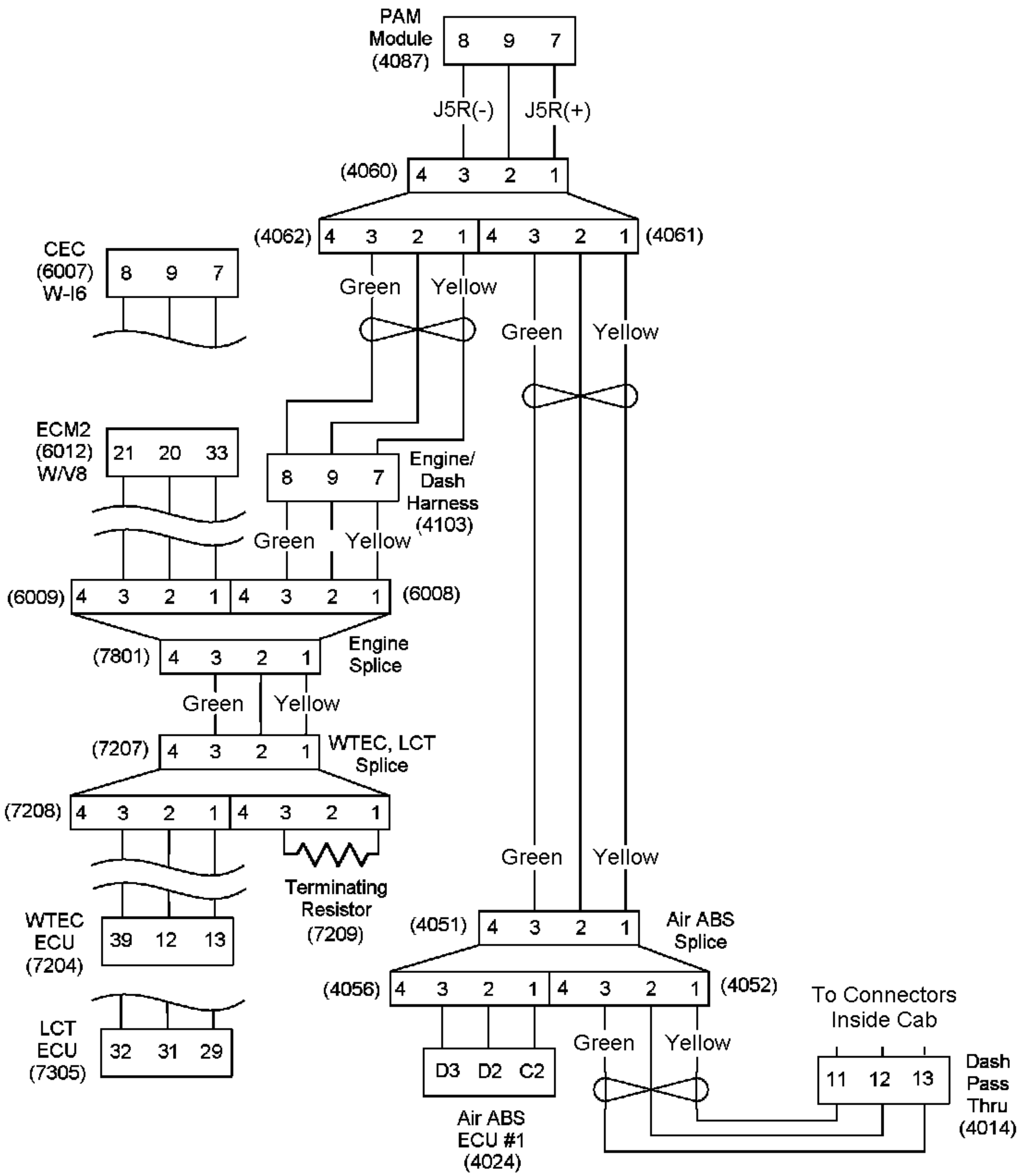


Figure 38 Typical (Outside Of Cab) Drivetrain 1939 Data Link Connectors Diagram (Connectors Used Will Vary Depending On Features Installed On Vehicle)

(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

<table>
<tr><td colspan="3">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.</td></tr>
<tr><td>Test Points</td><td>Spec.</td><td>Comments</td></tr>
<tr><td>(1650) Diagnostic connector pin C, or any other yellow drivetrain 1939 data link circuit, to ground</td><td>Approximately 2.5 volts</td><td>If voltage is missing, check for open or short to ground in yellow data link circuits.</td></tr>
<tr><td>(1650) Diagnostic connector pin D, or any other green drivetrain 1939 data link circuit, to ground</td><td>Approximately 2.5 volts</td><td>If voltage is missing, check for open or short to ground in green data link circuits.</td></tr>
<tr><td colspan="3">Drivetrain 1939 Circuit Resistance Checks

Check with battery disconnected.

This procedure checks for open circuits or missing terminating resistors in the data link backbone.</td></tr>
<tr><td>Test Points</td><td>Spec.</td><td>Comments</td></tr>
<tr><td>(1650) Diagnostic connector Pin C to D</td><td>60 ± 10 ohms</td><td>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.</td></tr>
<tr><td>(1650) Diagnostic connector Pin C to ground</td><td>>100K ohms</td><td>If resistance is low check for short to ground in yellow data link circuits</td></tr>
<tr><td>(1650) Diagnostic connector Pin D to ground</td><td>>100K ohms</td><td>If resistance is low check for short to ground in green data link circuits</td></tr>
<tr><td colspan="3">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.</td></tr>
</table>

3.3. COMPONENT LOCATIONS

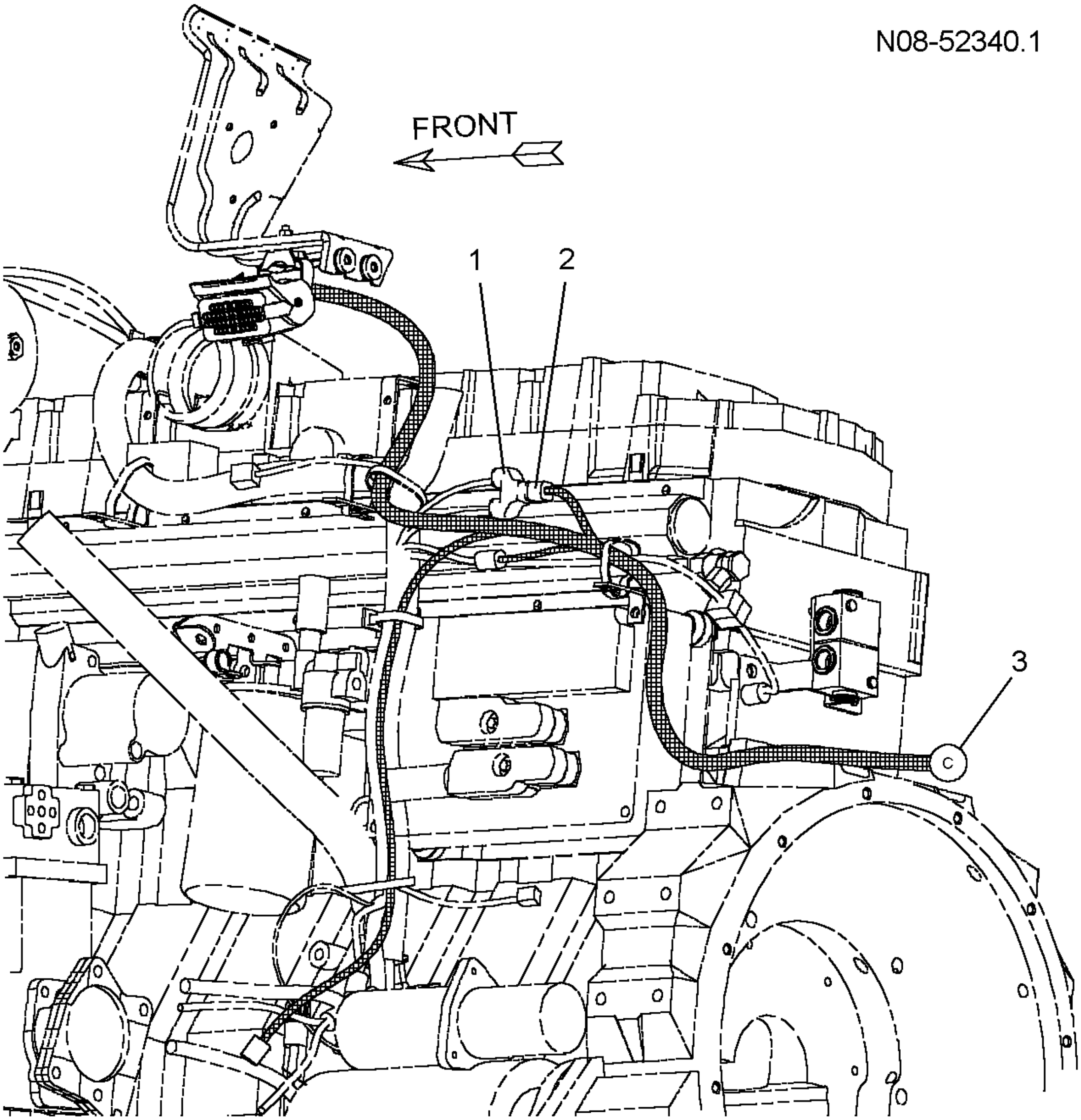


Figure 39 Drivetrain 1939 Data Link Engine Splice (I6 Engine Shown)

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

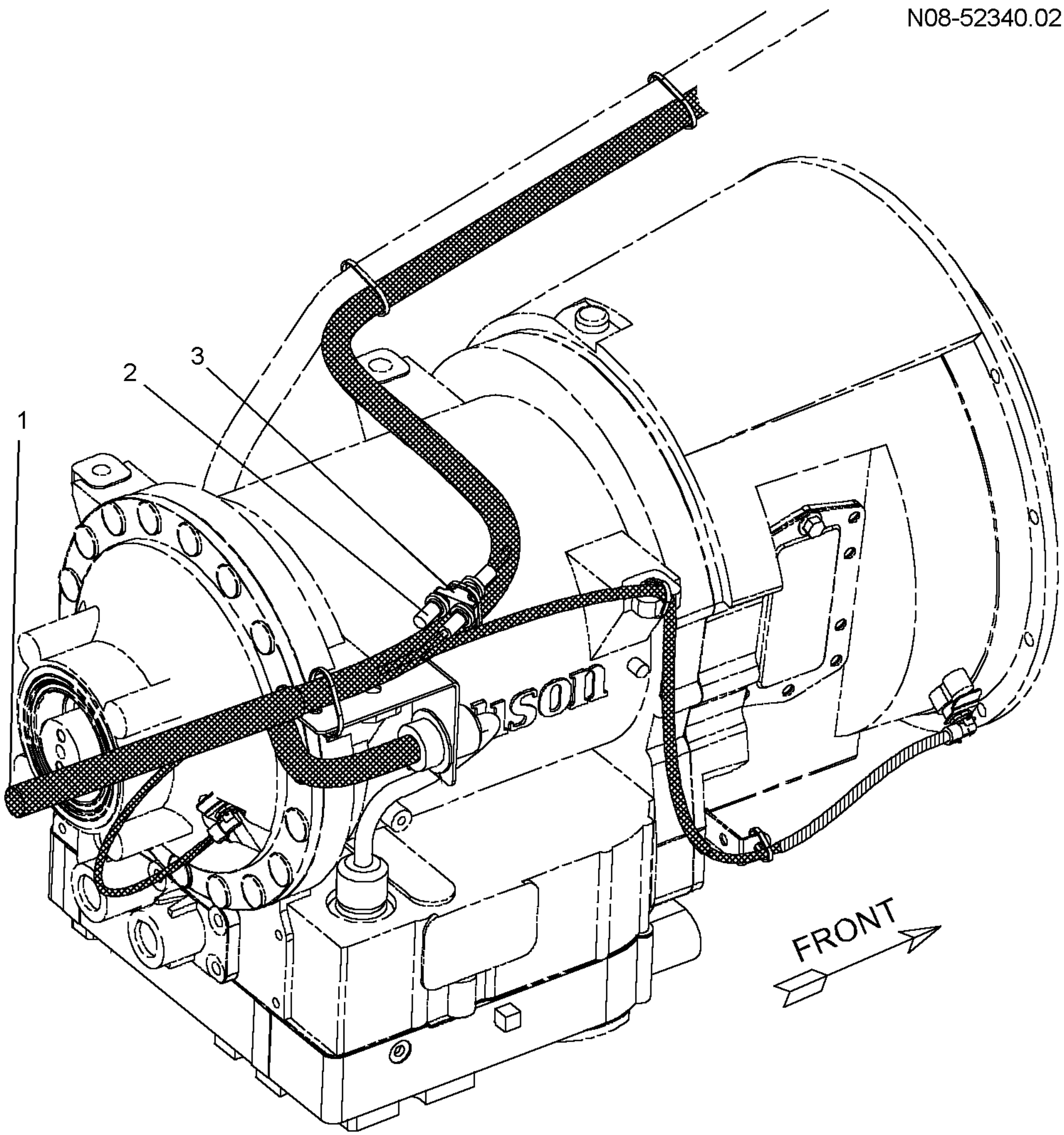


Figure 40 Drivetrain 1939 Data Link Transmission Splice (MD Transmission Shown)

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

4. BODY BUILDER DATA LINK

4.1. CIRCUIT FUNCTION

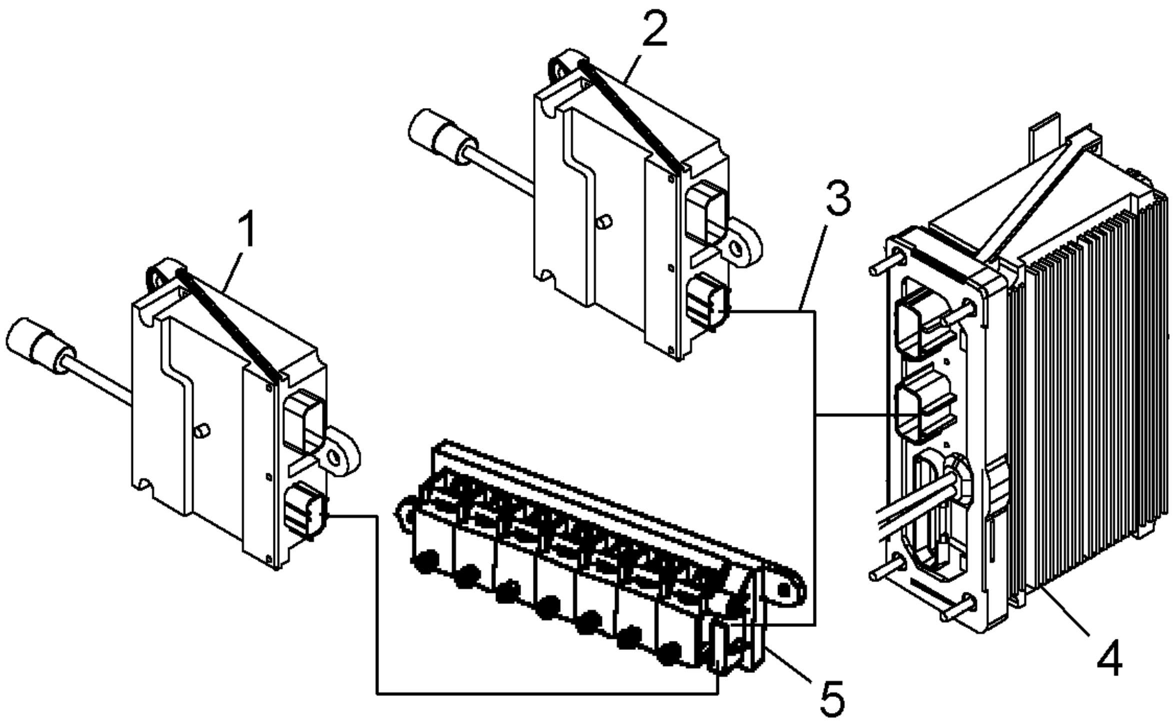


Figure 41 Typical Body Builder Data Link Function Diagram

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.

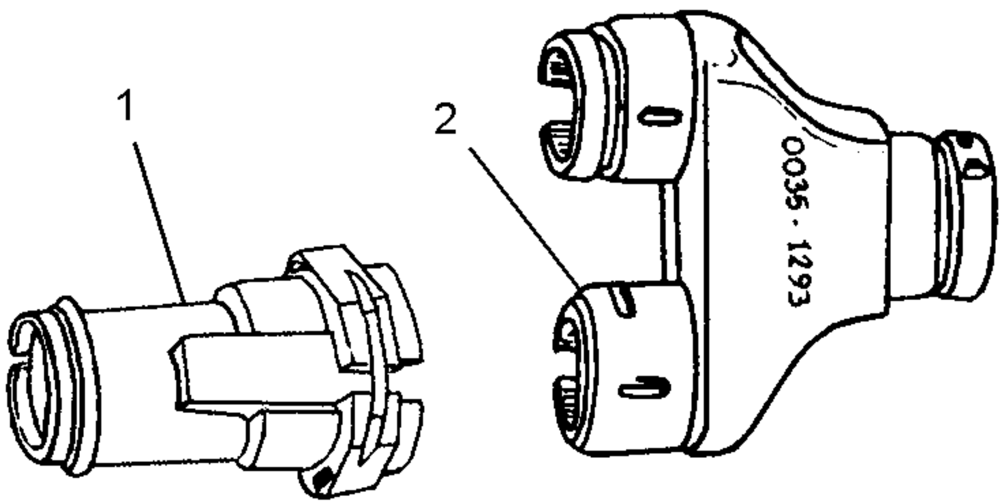


Figure 42 J1939 Termination Resistor and “Y” Connector

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 1045)

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 1045)

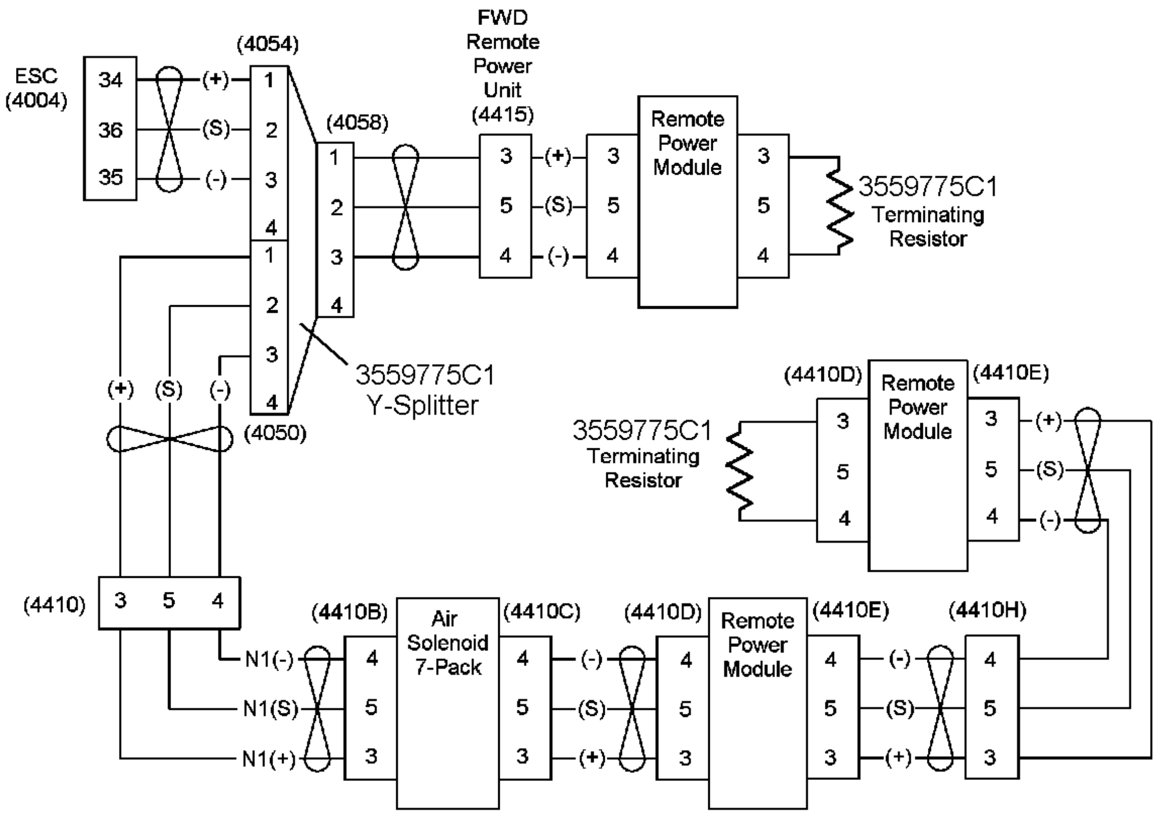


Figure 43 Typical Body Builder Data Link Connector Diagram (Devices Used Determined by Features Installed on Vehicle)

(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

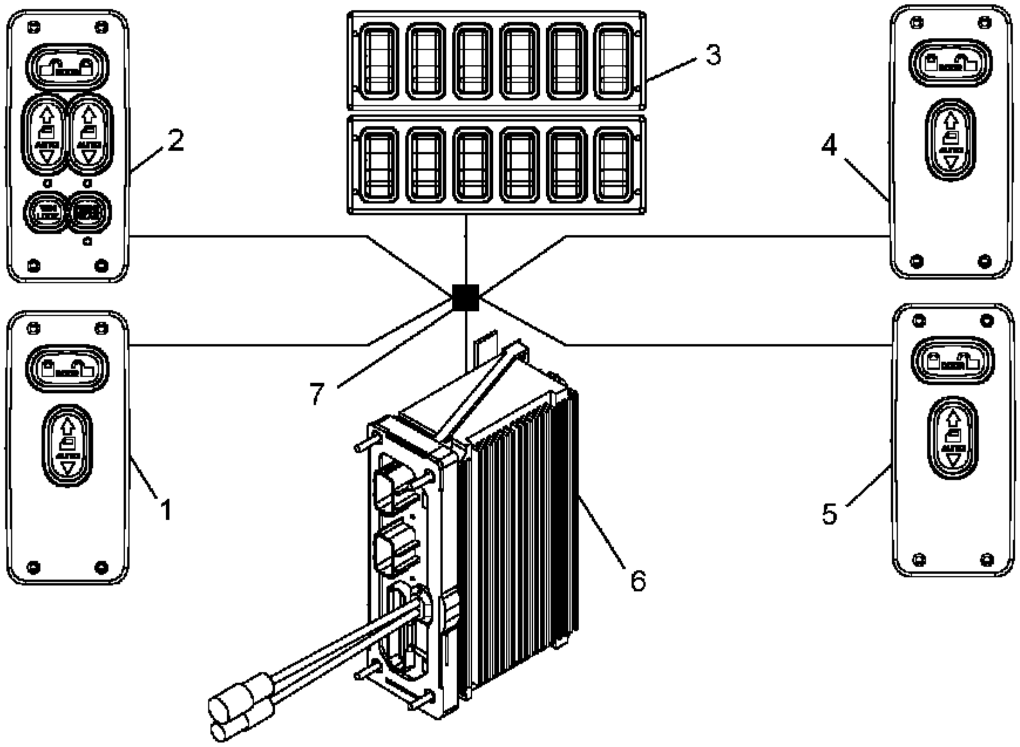


Figure 44 Typical Switch Data Link Function Diagram

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.

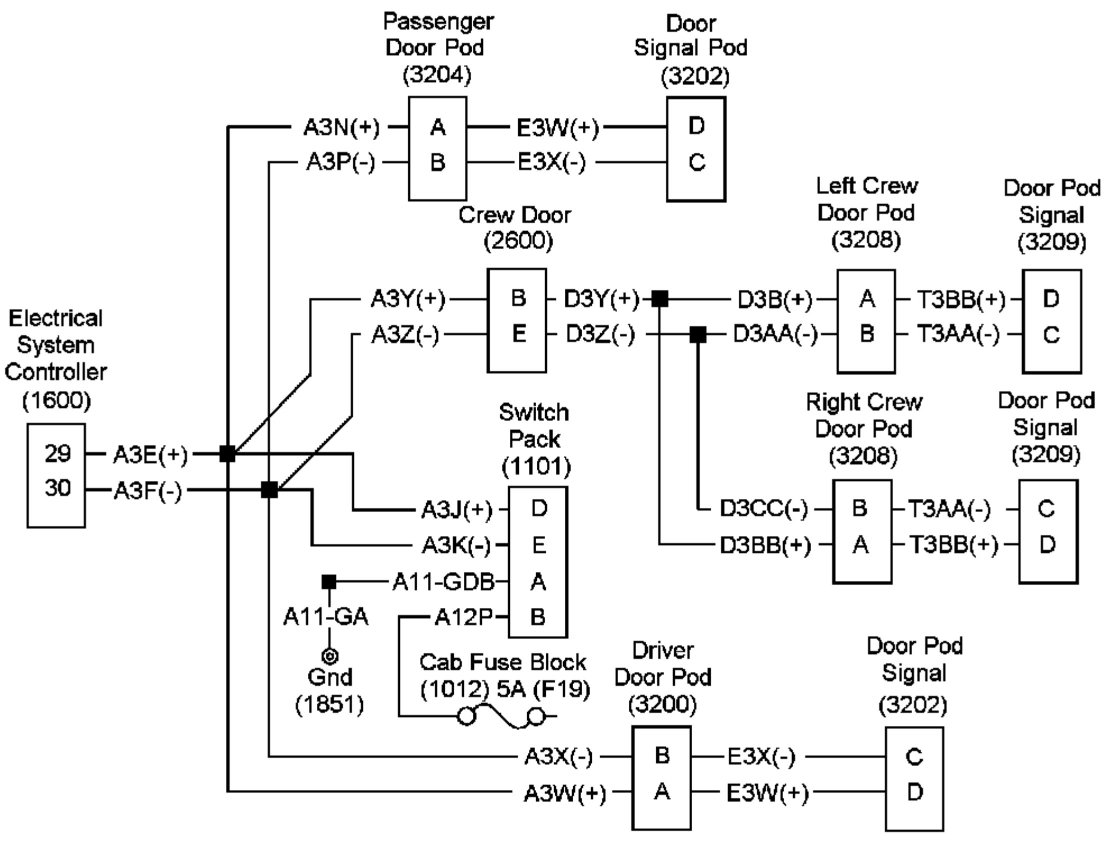


Figure 45 Typical Switch Data Link Function Diagram

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

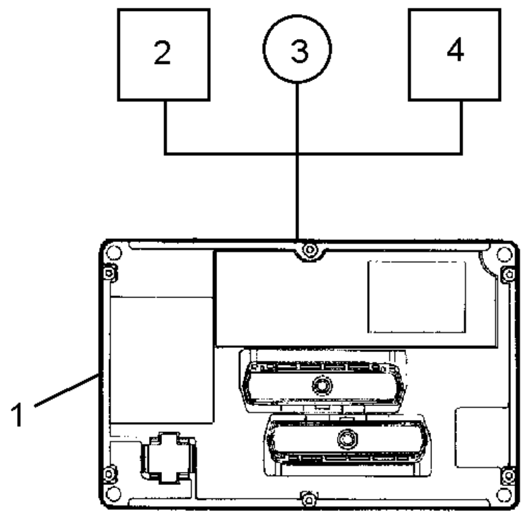


Figure 46 Typical 1708 Data Link Function Diagram

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.

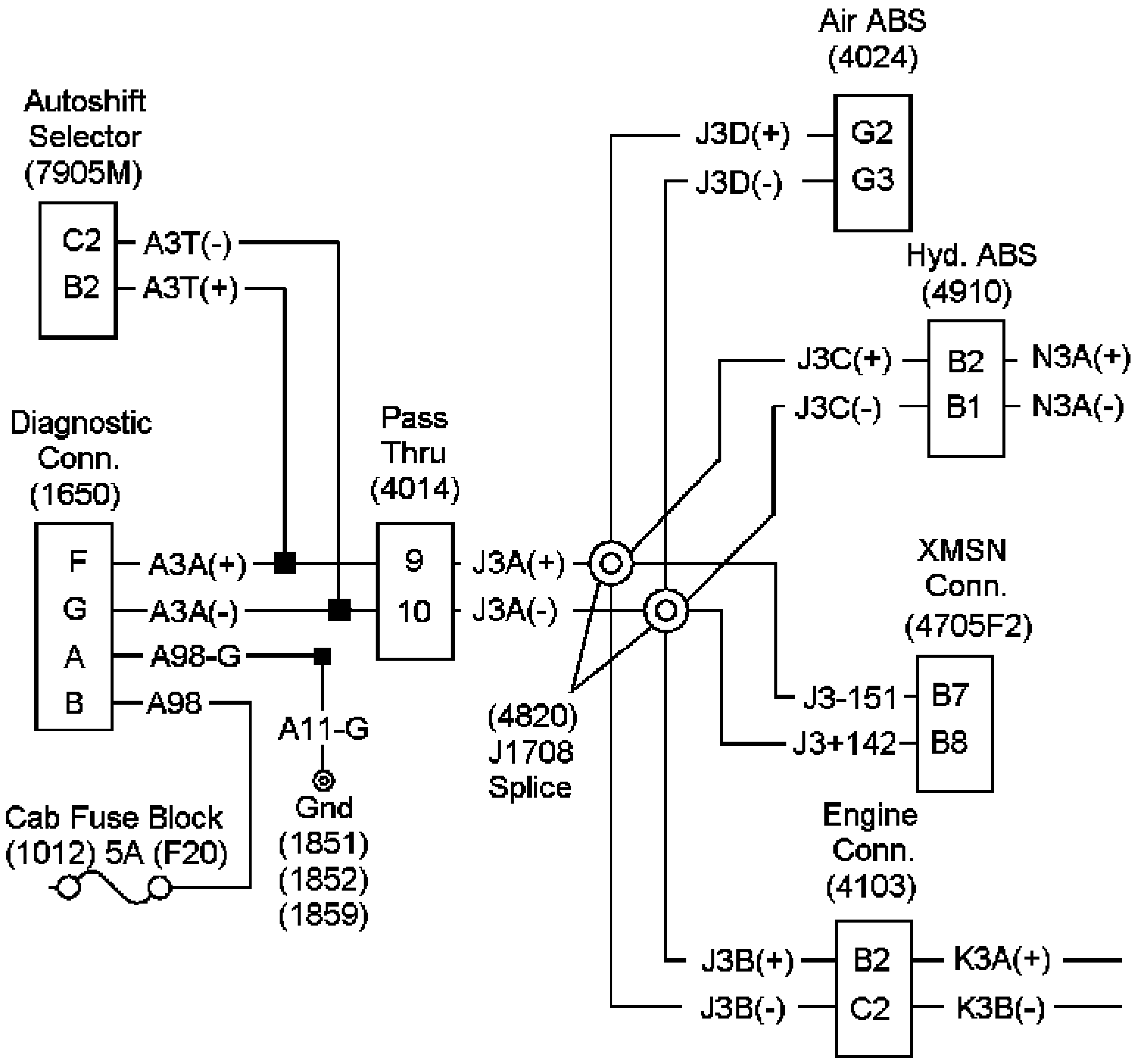


Figure 47 Typical 1708 Data Link Function Diagram

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.

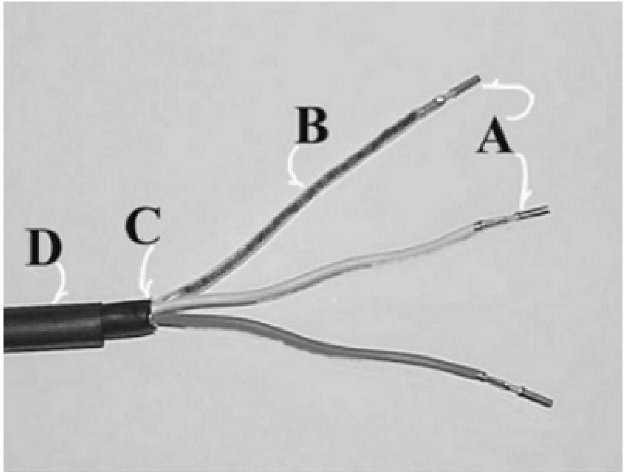


Figure 48

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.

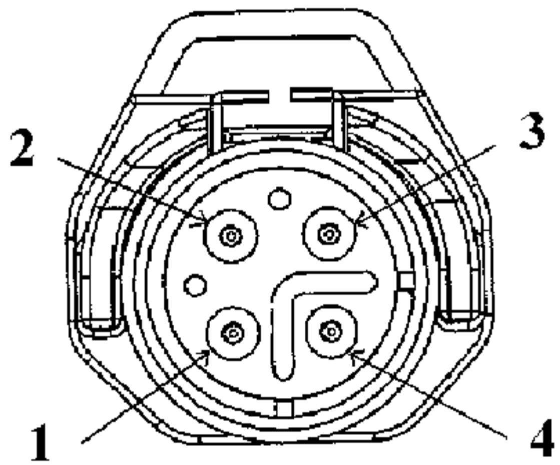


Figure 49 J1939 Connector

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.

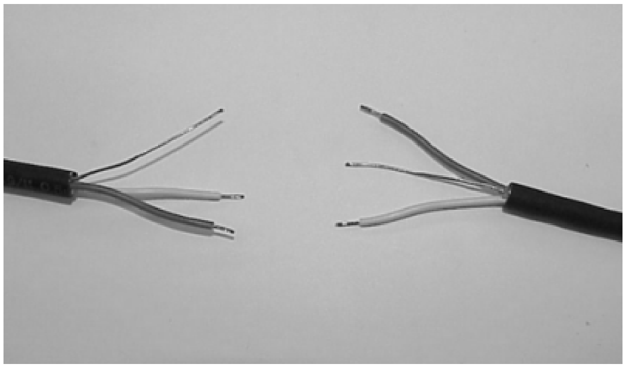


Figure 51

2. Re-twist any loose wire strands
3. Slide 2 inch pieces of heat shrink tube over wire for later use per

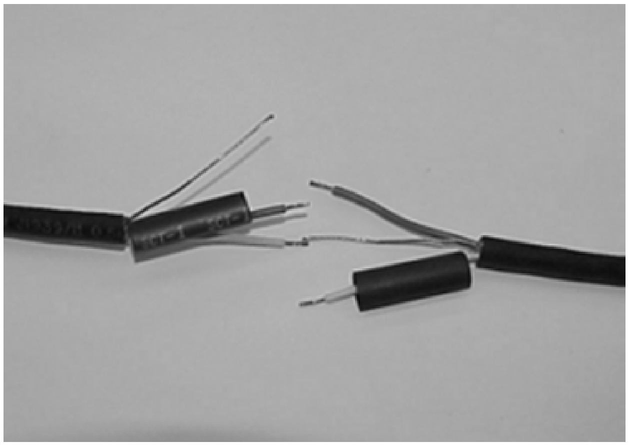


Figure 52

4. Insert ends of wires into splice joint and crimp.
5. Solder the wires and crimp joint together.

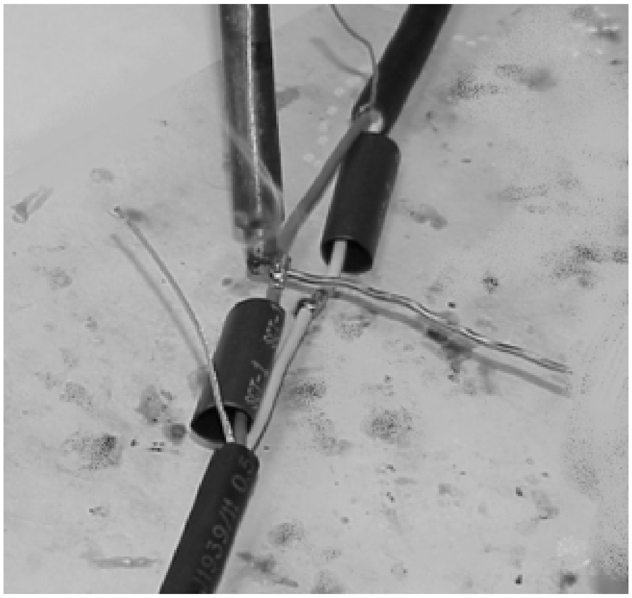


Figure 53

6. Center heat shrink tube over splice and shrink.

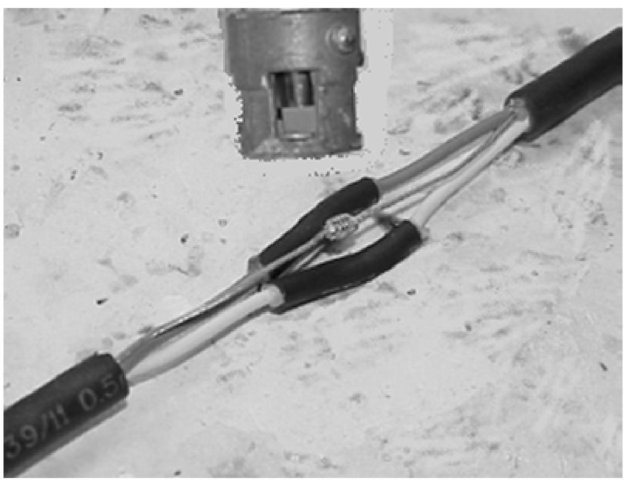


Figure 54

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

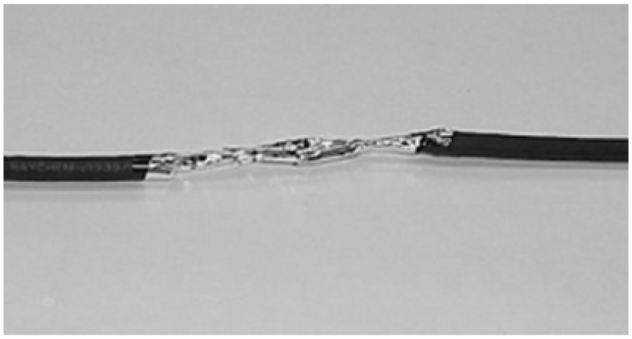


Figure 55

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

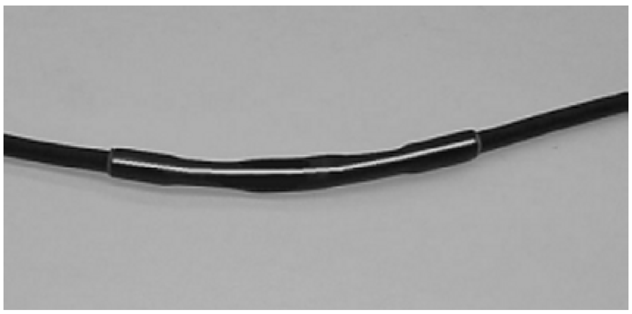


Figure 56

Table of Contents

1. ELECTRICAL SYSTEM CONTROLLER

1.1. DESCRIPTION

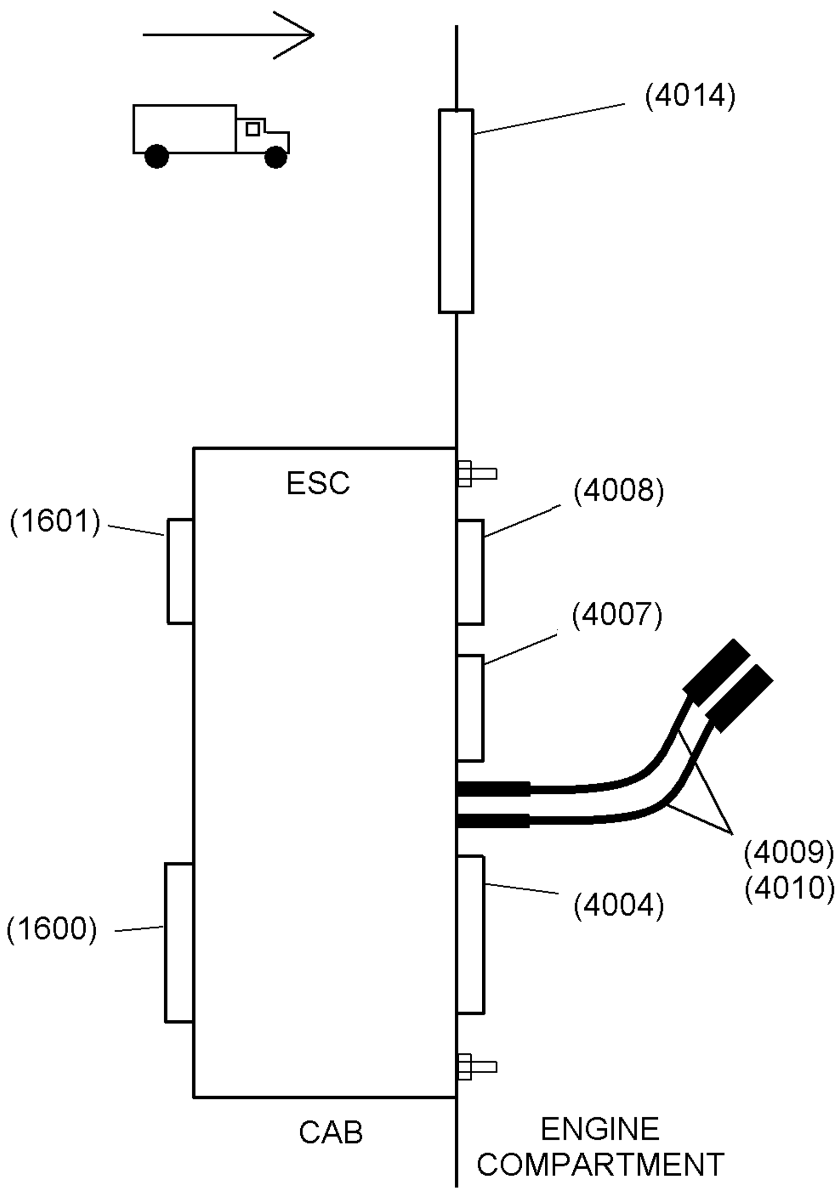


Figure 57

(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)	

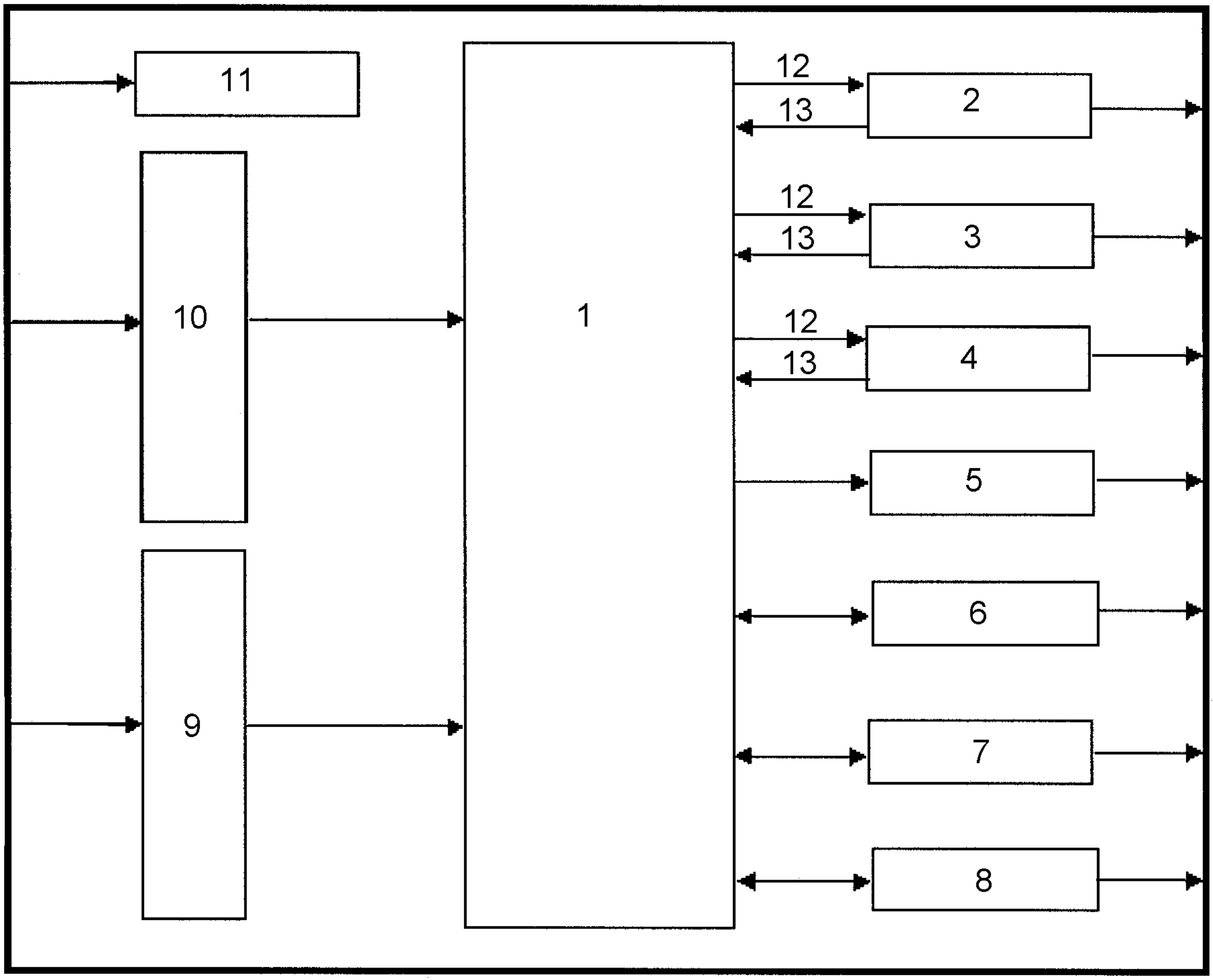


Figure 58 Electrical System Controller Block Diagram

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 124)	

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).

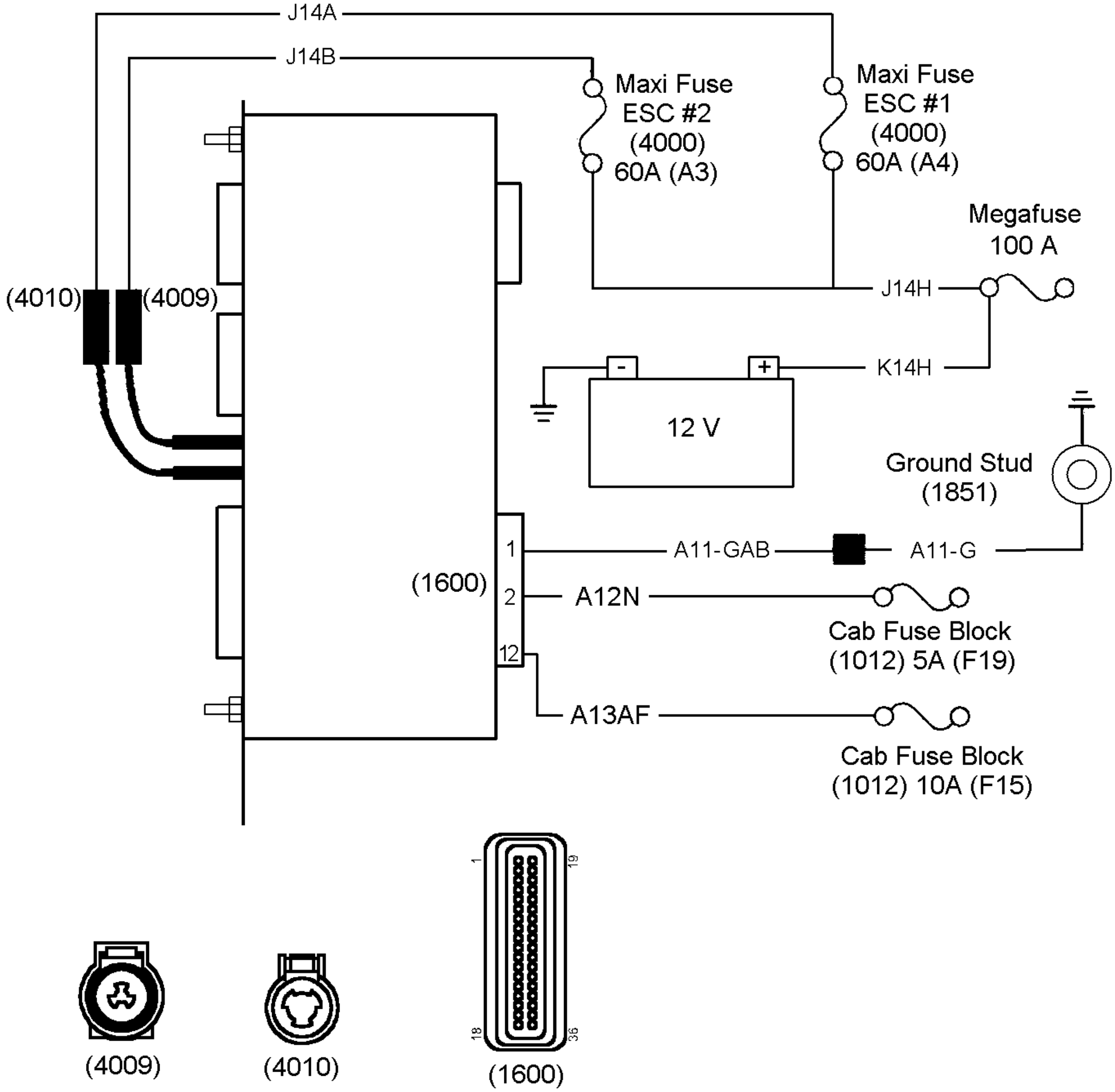


Figure 59 ESC Power and Ground Diagram

(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).

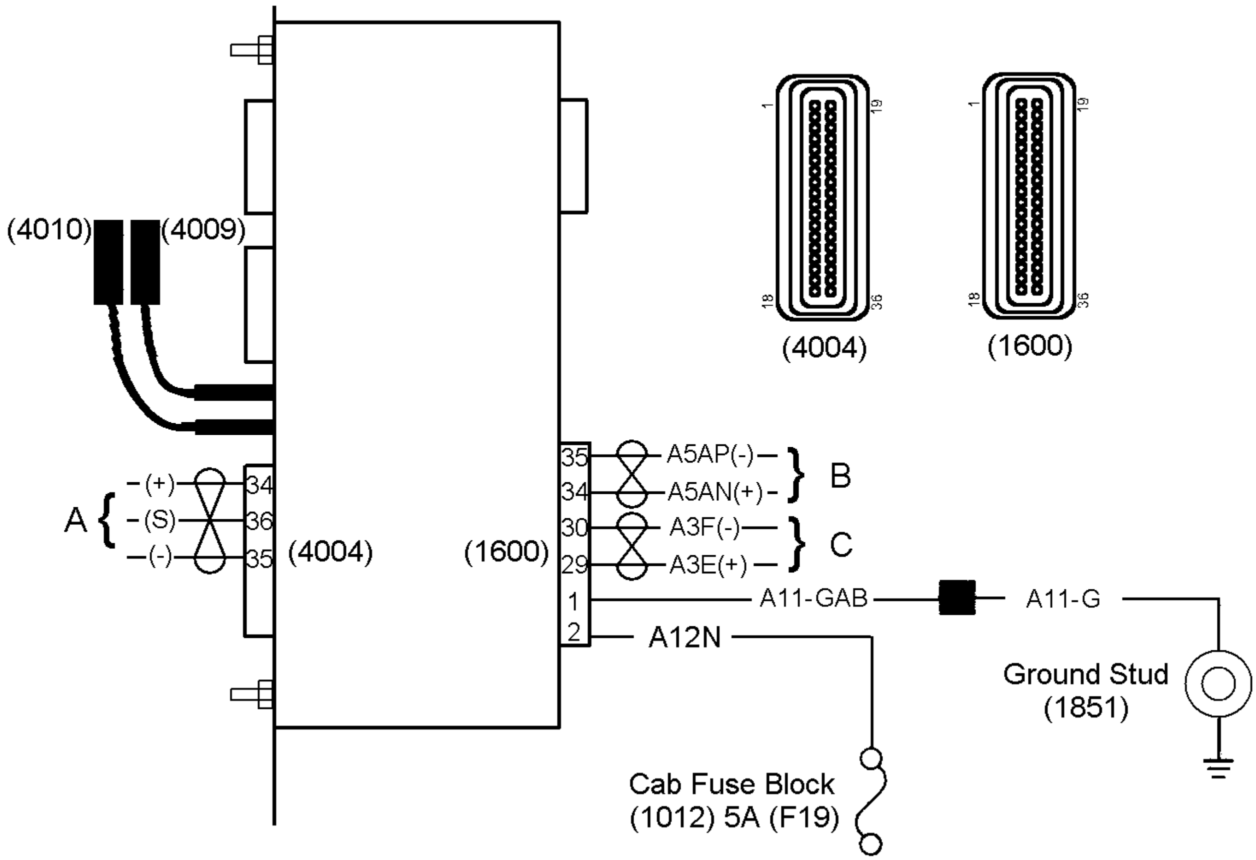


Figure 60 ESC Data Link Diagram

(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

Test Points	Spec.	Comments
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**

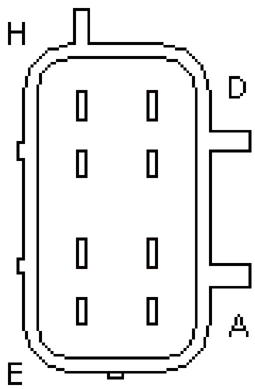
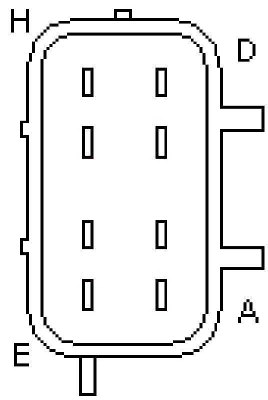
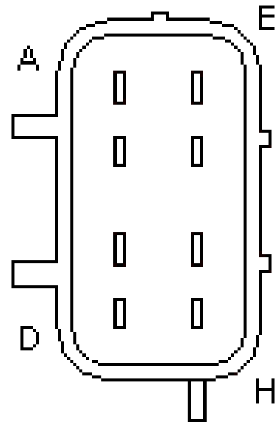
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK (*).								
								
Connector on ESC			Connector on ESC			Connector on ESC		
(4007) Brown Front End Output		Engine Side Bottom 8-way Connector	(4008) Blue Chassis Output		Engine Side Top 8-way Connector	(1601) Brown 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.)

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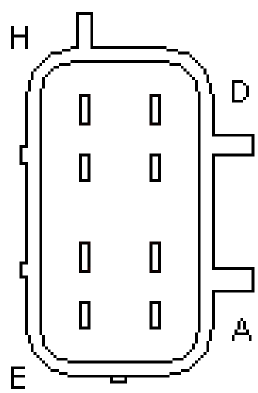
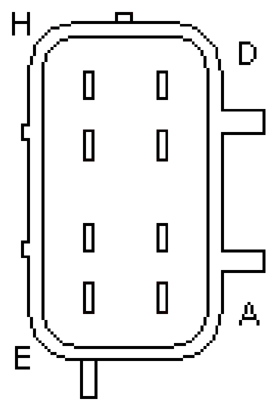
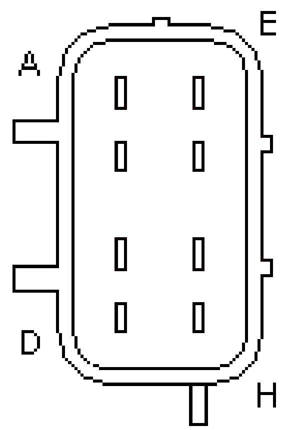
<tr><td colspan="3"></td><td colspan="3"></td><td colspan="3"></td></tr>
<tr><td colspan="3">Connector on ESC</td><td colspan="3">Connector on ESC</td><td colspan="3">Connector on ESC</td></tr>
<tr><td colspan="2">(4007) Brown Front End Output</td><td>Engine Side Bottom 8-way Connector</td><td colspan="2">(4008) Blue Chassis Output</td><td>Engine Side Top 8-way Connector</td><td colspan="2">(1601) Brown Inside Cab Output</td><td>Inside Cab 8-way Connector</td></tr>
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(Circuit)</td><td>Pin</td><td>Source</td><td>Description
(Circuit)</td><td>Pin</td><td>Source</td><td>Description
(Circuit)</td></tr>
<tr><td>Fleet</td><td>10 Amp FET</td><td>Work Light
(J65)</td><td>Fleet</td><td>20 Amp FET</td><td>Wiper Control
(J82F)</td><td>Fleet</td><td>10 Amp FET</td><td>Spare</td></tr>
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(J52A)</td><td>G</td><td>10 Amp FET</td><td>AC Clutch
(J77B)</td><td>G</td><td>20 Amp FET</td><td>Mirror Heat
(A78)</td></tr>
<tr><td>H</td><td>20 Amp FET</td><td>Park Lights
(J58A)</td><td>H</td><td>Ground</td><td>Ground
Plug</td><td>H</td><td>20 Amp FET</td><td>Park Lights
(A58F)</td></tr>
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Table 17 Electronic System Controller Module Power Connectors

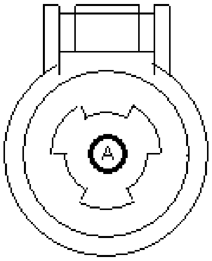
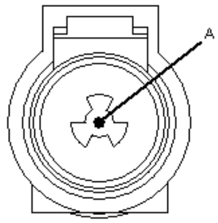
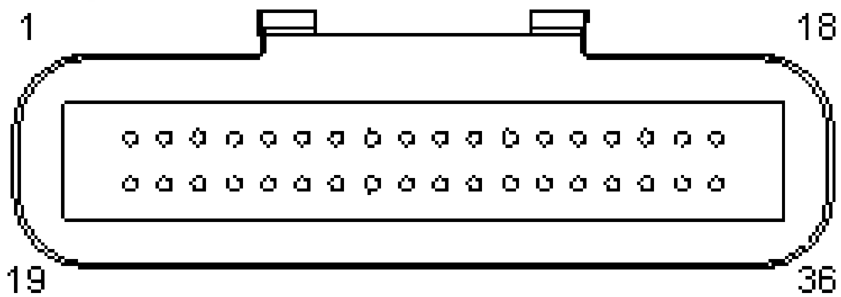
<table>
<tr><td colspan="3"></td><td colspan="3">
</td></tr>
<tr><td colspan="3">View in Direction of ESC</td><td colspan="3">View in Direction of ESC</td></tr>
<tr><td colspan="3">#4009 Engine Side Input Power Feed
#2 (Circuit J14B)</td><td colspan="3">#4010 Engine Side Input Power Feed
#1 (Circuit J14A)</td></tr>
<tr><td>Pin</td><td>Source</td><td>Description</td><td>Pin</td><td>Source</td><td>Description</td></tr>
<tr><td>A</td><td>Maxi Fuse Block</td><td>60 Amp Power Source</td><td>A</td><td>Maxi Fuse Block</td><td>60 Amp Power Source</td></tr>
</table>

Table 18 ESC Module Connector (1600)

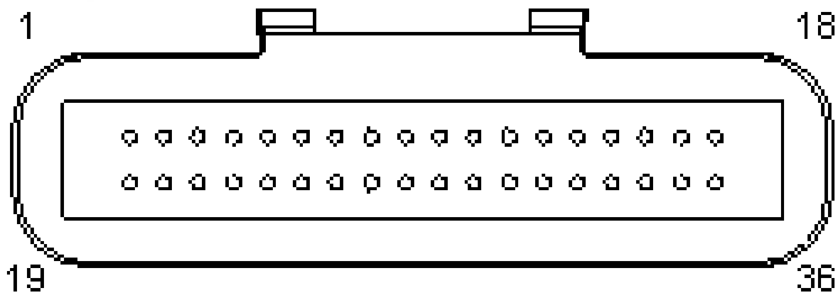
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK (*).



(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*
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*

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

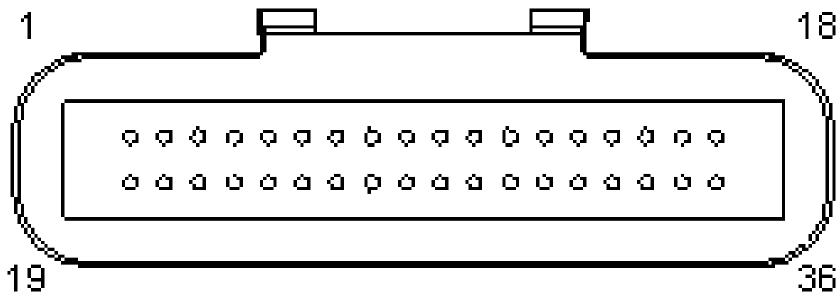
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK (*).



(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
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
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*

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

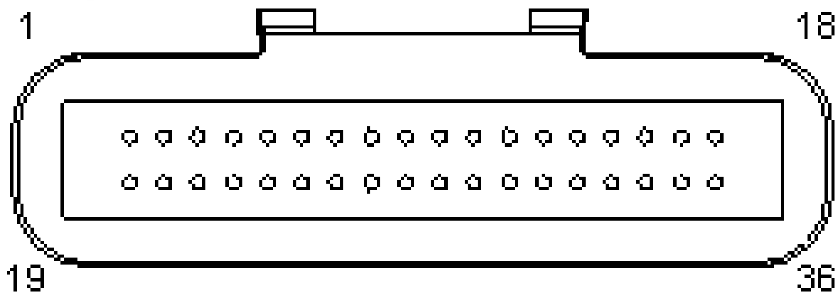
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK (*).



(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
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
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*

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

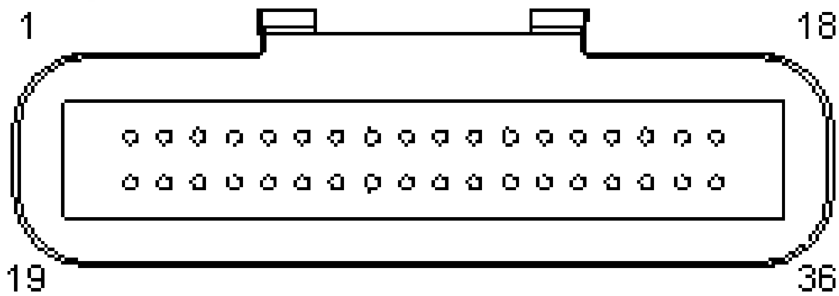
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK (*).



(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
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*
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*

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

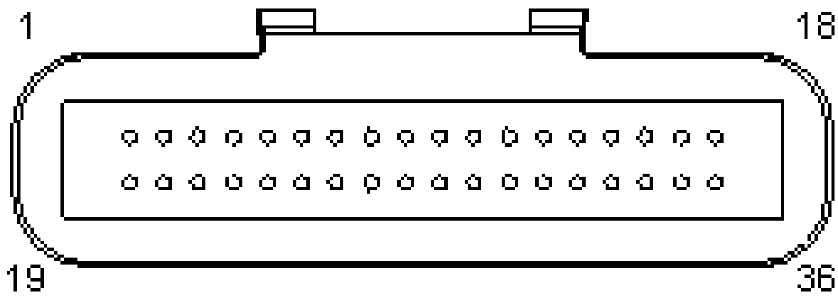
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK (*).



(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
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*
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-

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
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.

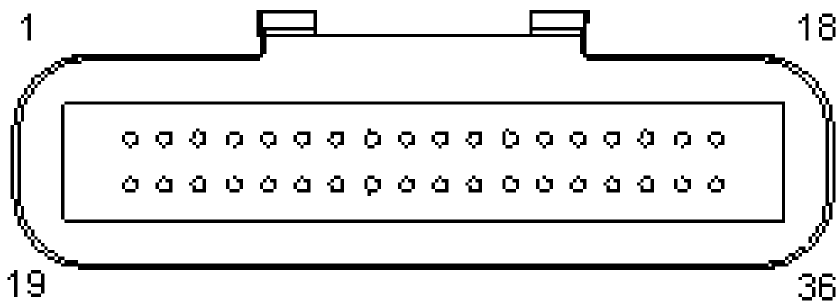
NOTE: All outputs will handle up to a 500 milliamp load unless stated otherwise.

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

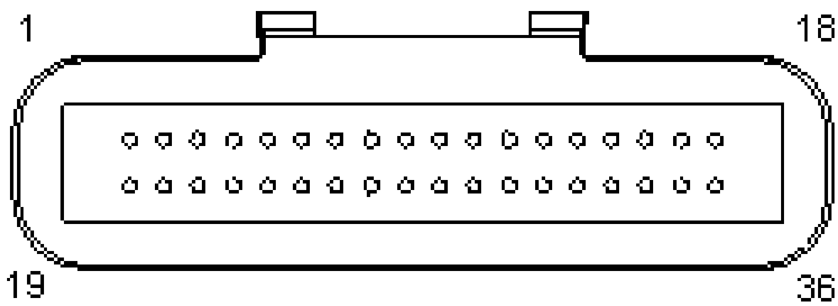
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK(*).



#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.)

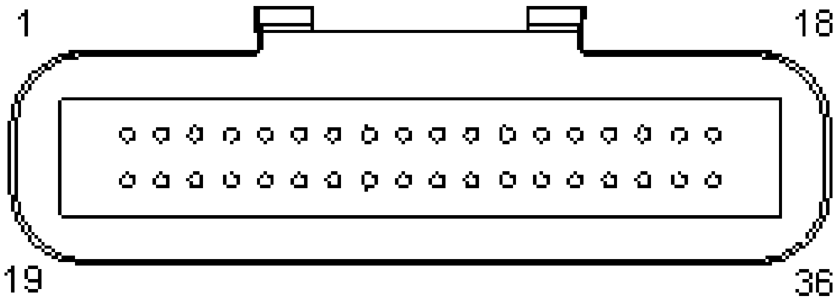
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK(*).



#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.)

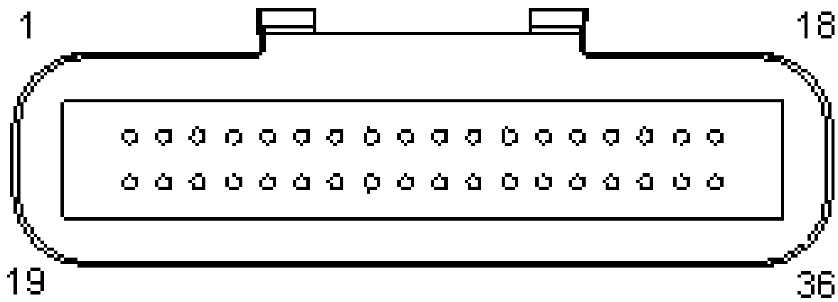
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK(*).



#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.)

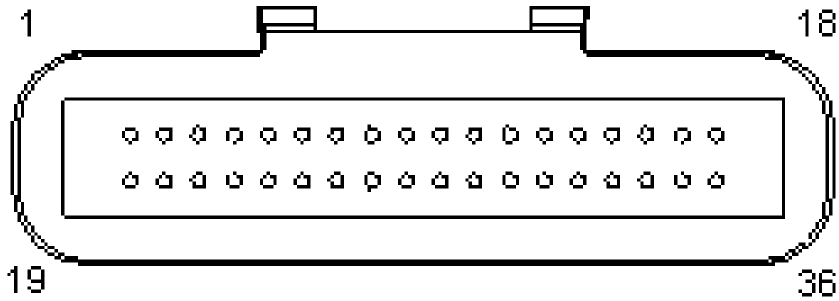
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK(*).



#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.)

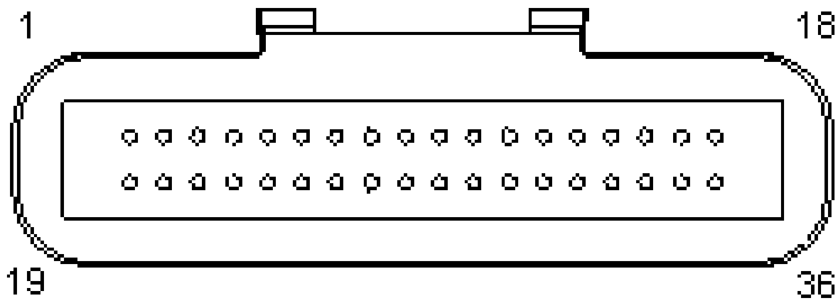
NOTE – NO CONNECTIONS OR SPLICES ARE ALLOWED ON ANY SIGNALS MARKED WITH AN ASTERISK(*).



#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

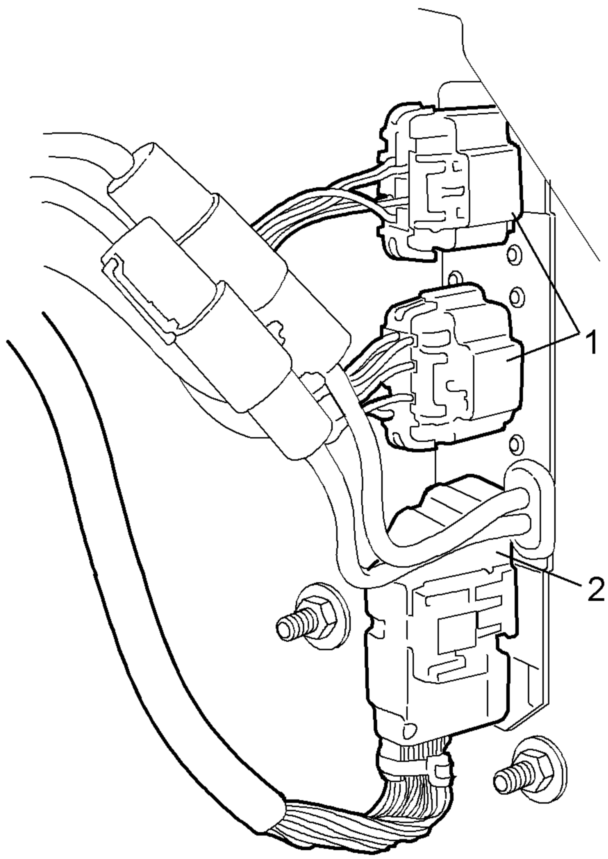


Figure 61 ESC Connectors (Viewed From Engine Compartment)

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.

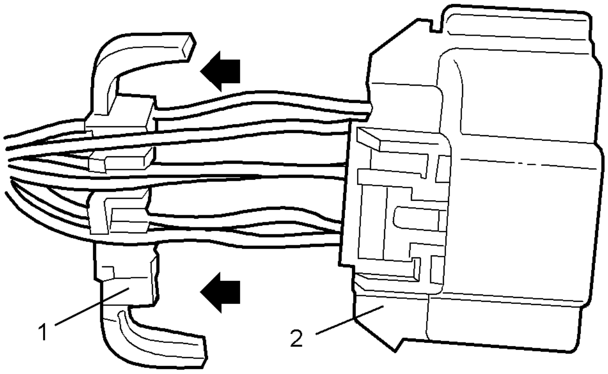


Figure 62 8-Way connector and Secondary Lock

1. SECONDARY LOCK
2. CONNECTOR SHELL

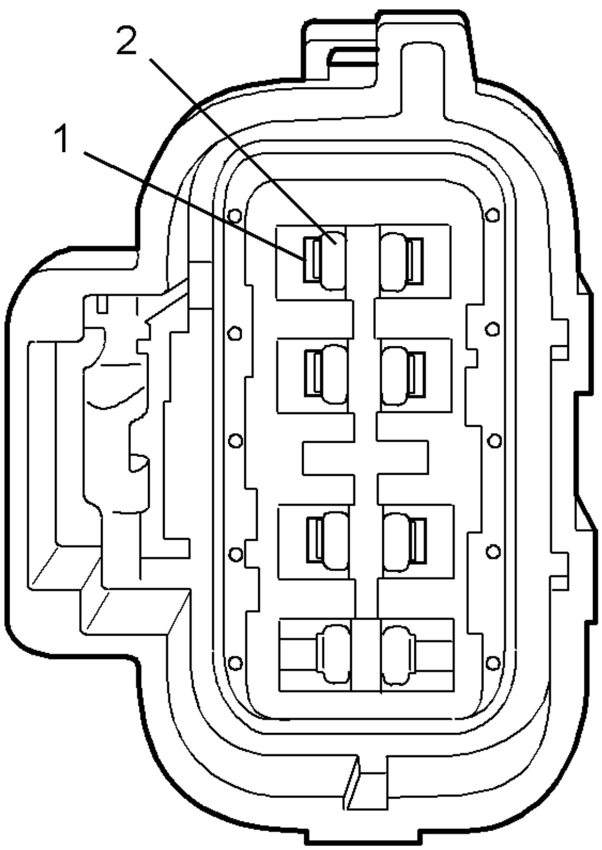


Figure 63 8–Way Connector Face

1. TERMINAL LOCK
2. TERMINAL

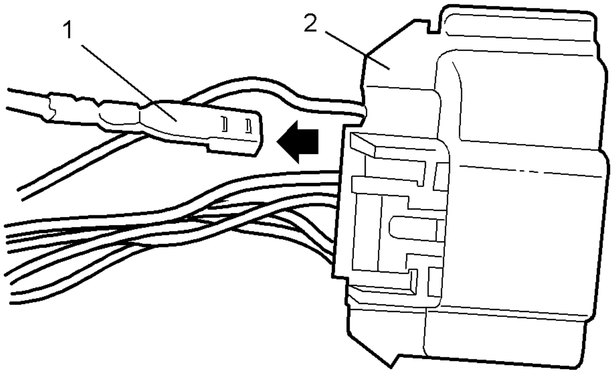


Figure 64 Terminal Removal

1. TERMINAL
2. CONNECTOR SHELL

36–Way Connectors

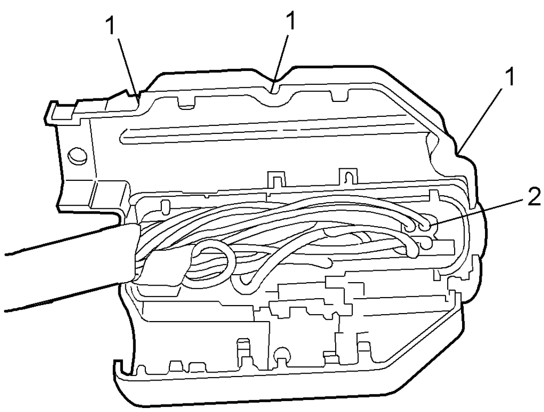


Figure 65 36–Way Connector (Shell Opened)

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.

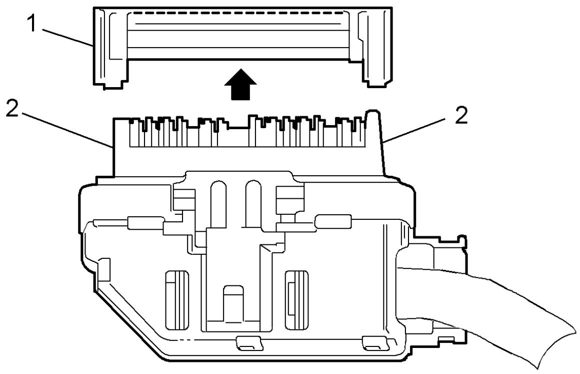


Figure 66 Secondary Lock

1. SECONDARY LOCK
2. LOCKING TABS

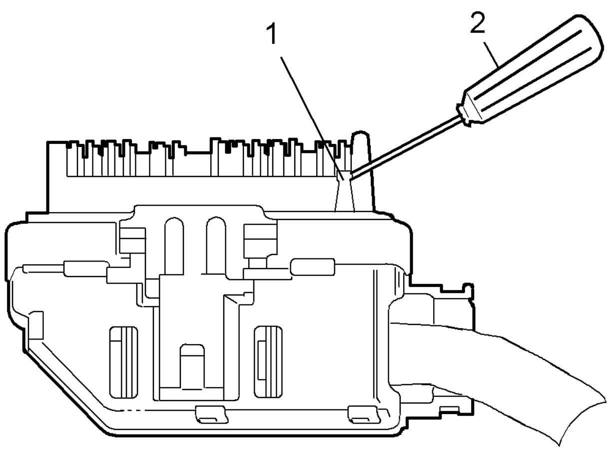


Figure 67 Primary Terminal Lock

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

Table 20 ESC Programmable Parameters (cont.)

PDL_Warning_Spd	Dealer, TEM	Sets the maximum vehicle speed at which the PDL warning light is illuminated.
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.

Table 20 ESC Programmable Parameters (cont.)

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.
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.

Table 20 ESC Programmable Parameters (cont.)

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.
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.

Table 20 ESC Programmable Parameters (cont.)

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.
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

Table 20 ESC Programmable Parameters (cont.)

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.

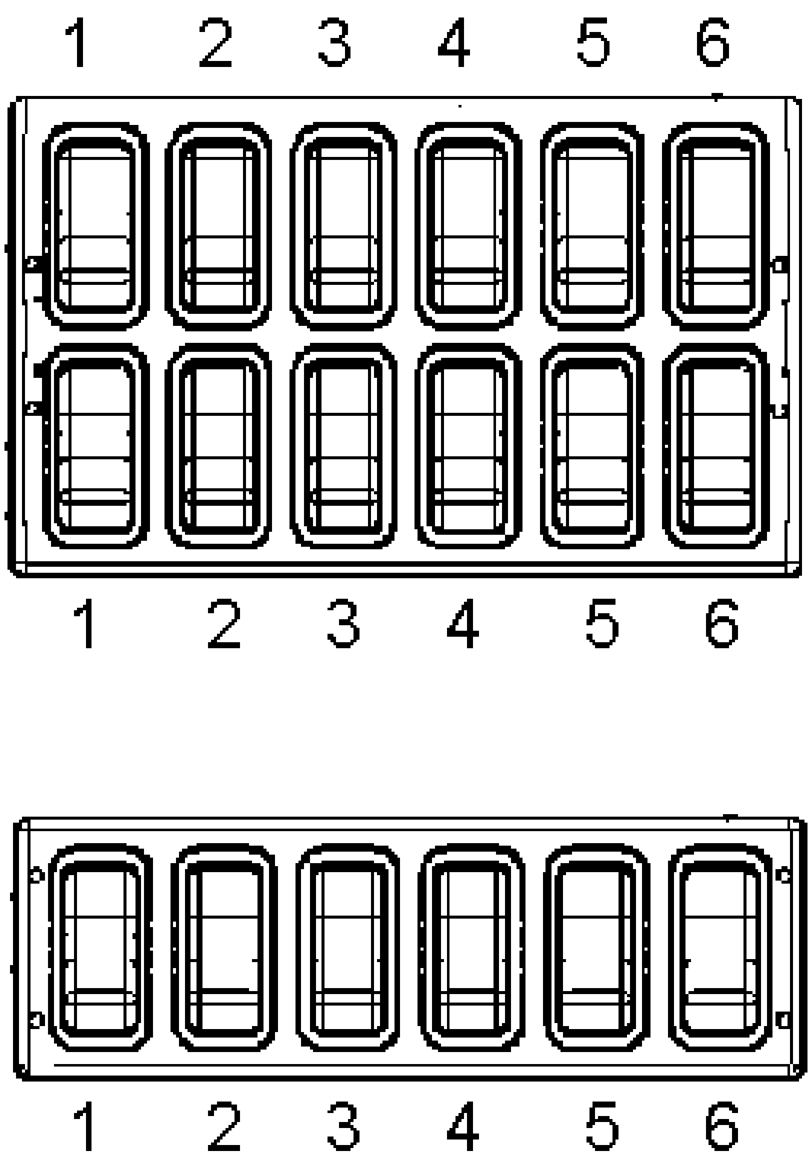


Figure 68 Switch Pack Templates

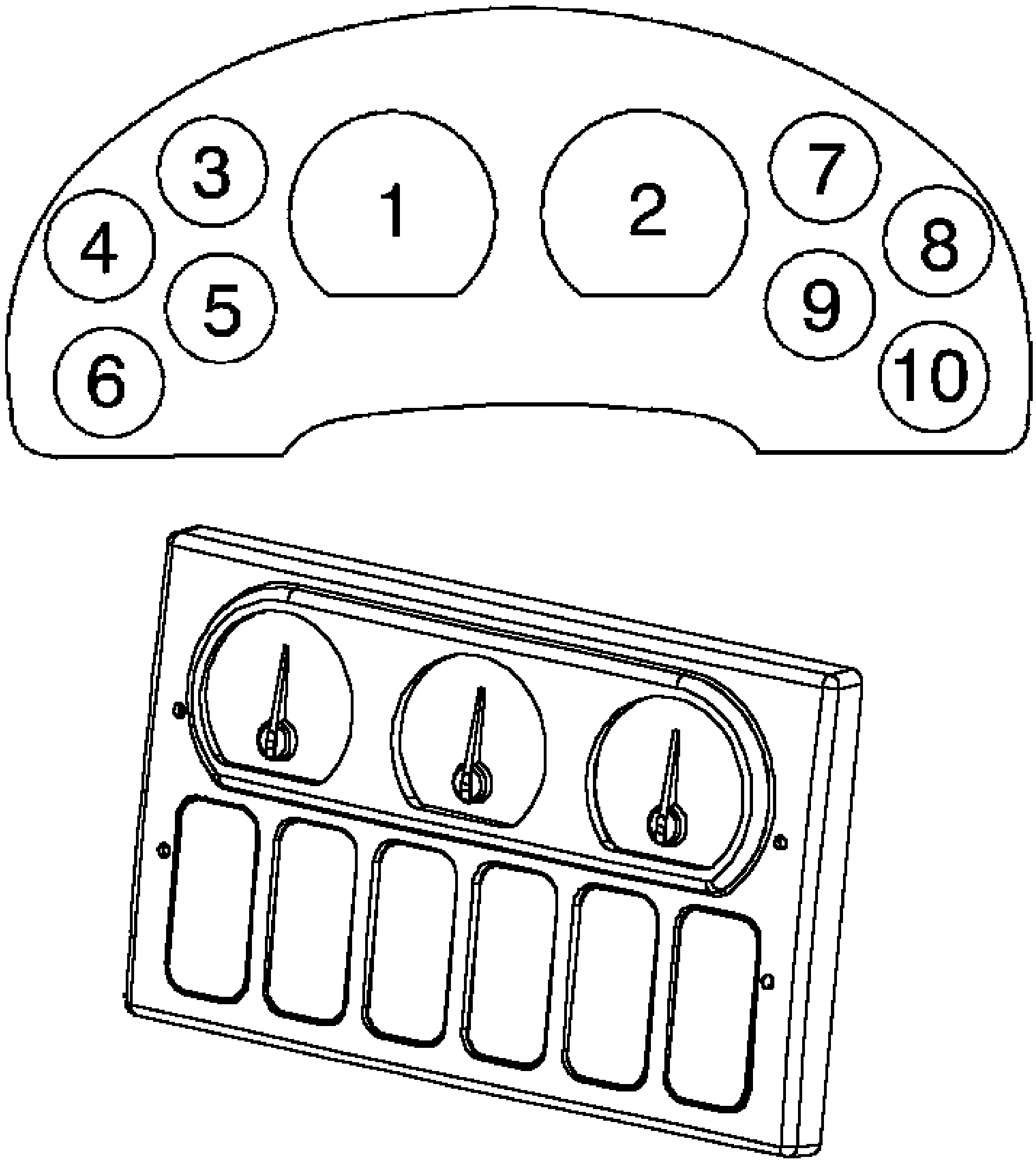


Figure 69 Gauge and AGSP Location Templates

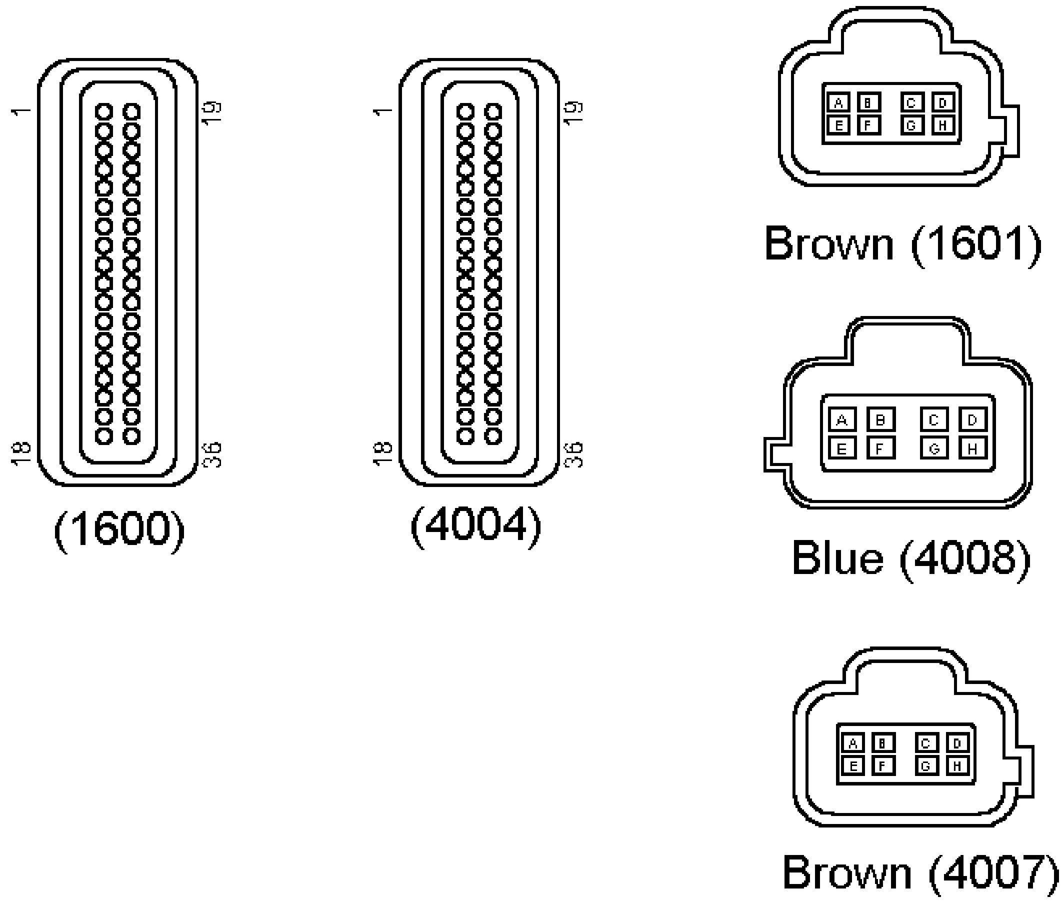


Figure 70 ESC Harness Connector Templates (Mating Views Shown)

(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

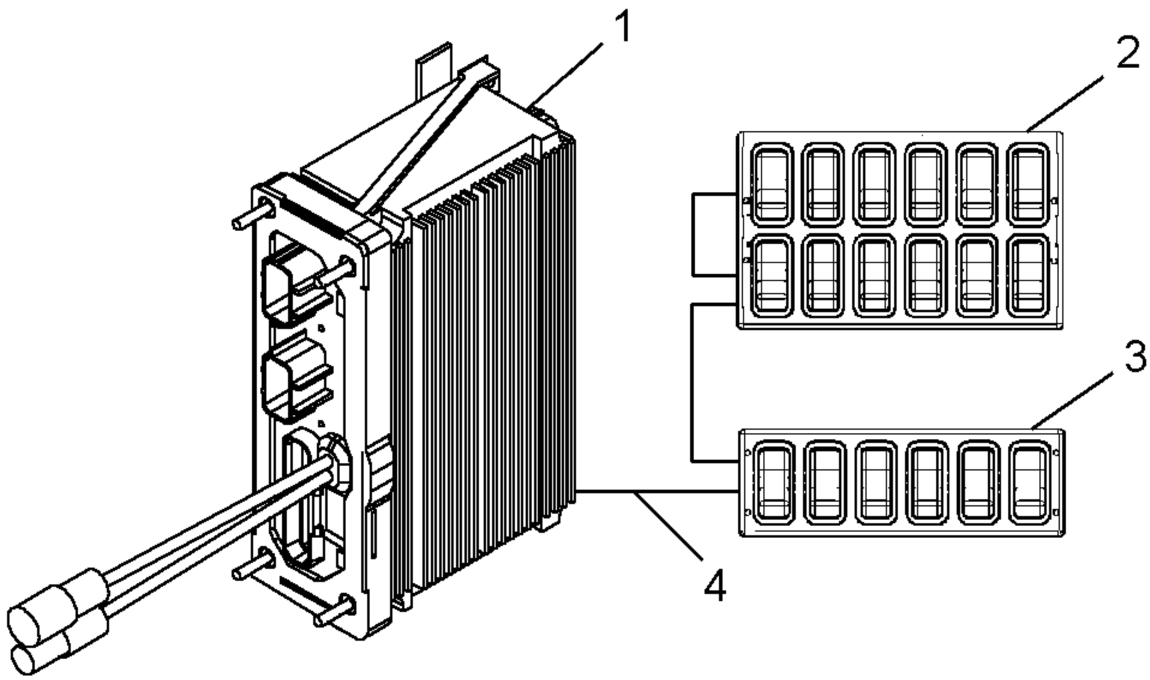


Figure 71 Switch Pack Function Diagram

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 121)

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 1045) 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 1045) 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 128)
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 1045) 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 128)	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 130)	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.

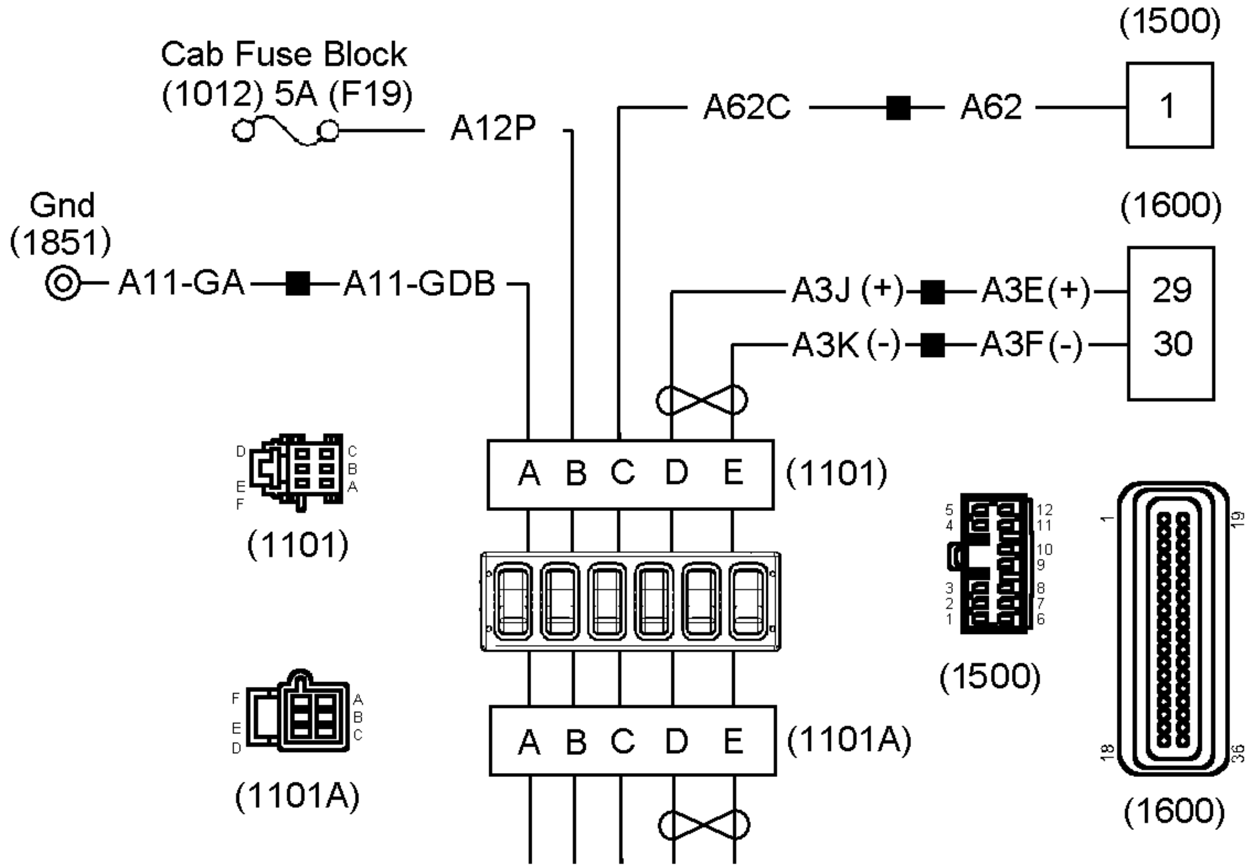


Figure 72 Switch Pack Circuits

(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

<table>
<tr><th colspan="3">Switch Pack Connector (1101) Voltage Checks

This chart assumes there is power to cab fuse block (1012) from the mega fuse.</th></tr>
<tr><td>Test Points</td><td>Spec.</td><td>Comments</td></tr>
<tr><td>(1101) Pin B to ground</td><td>12 ± 1.5 volts</td><td>If voltage is missing, check for blown fuse or open or short in circuits A12P.</td></tr>
<tr><td>(1101) Pin A to ground</td><td>0 volts</td><td>Ground circuit to pod.</td></tr>
<tr><td>(1101) Pin D to ground</td><td>Approximately 4.5 volts</td><td>(+) data link circuit. If voltage is low check for open or short in circuit A3J(+) or shorted components on data link.</td></tr>
<tr><td>(1101) Pin E to ground</td><td>Approximately .2 volt</td><td>(-) 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.</td></tr>
<tr><td colspan="3">If voltage and data link circuits to the pod are good, and a communication fault is still active, the switch pack should be replaced.</td></tr>
<tr><td>(1101) Pin C to pin A</td><td>12 ± 1.5 volts (with park lights on and panel dimmer at maximum).</td><td>Panel dimmer voltage from electronic gauge cluster (EGC).

If voltage is missing check circuits between switch pack and EGC.</td></tr>
<tr><td colspan="3">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.</td></tr>
</table>

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 .

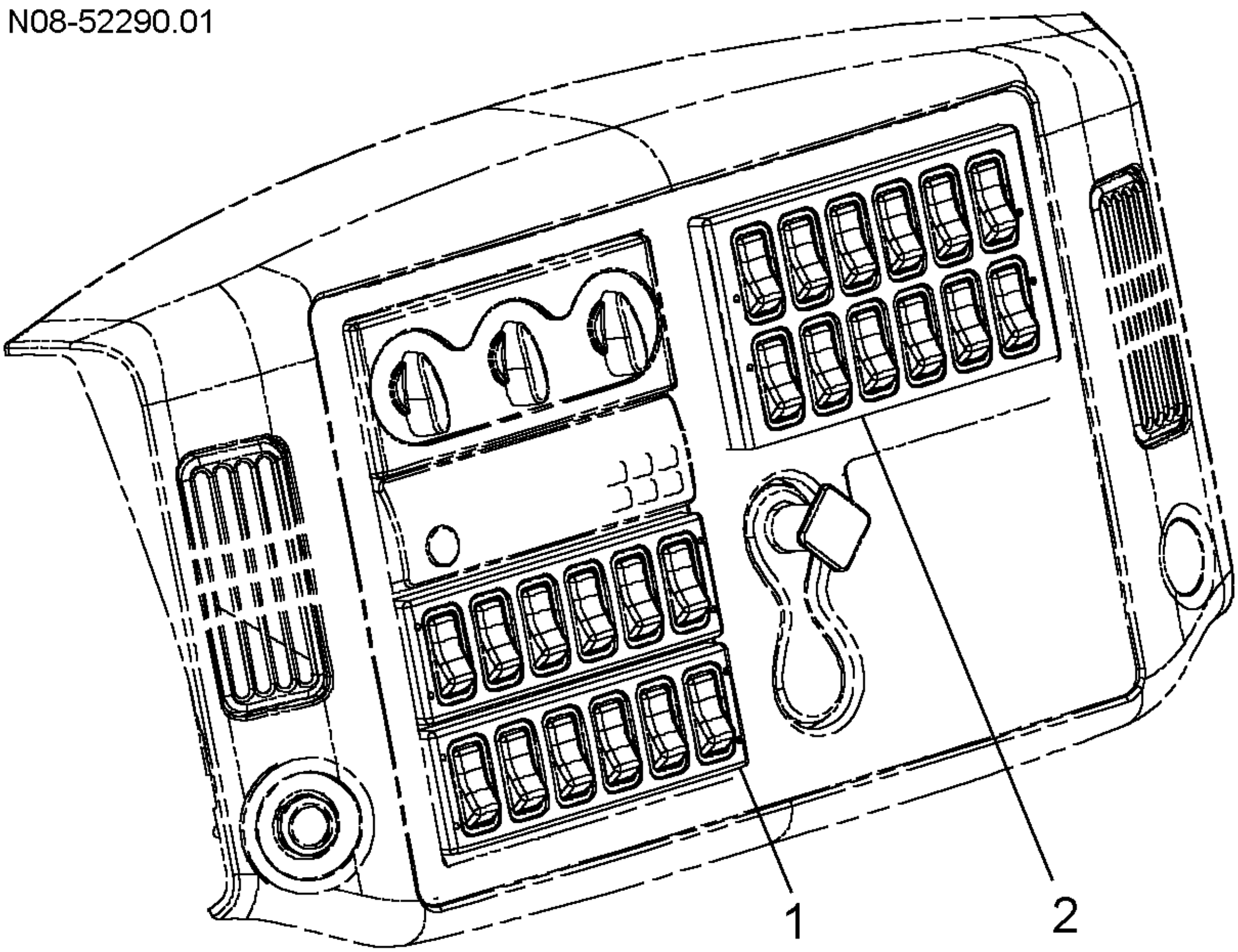


Figure 73 Typical Switch Pack Locations

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

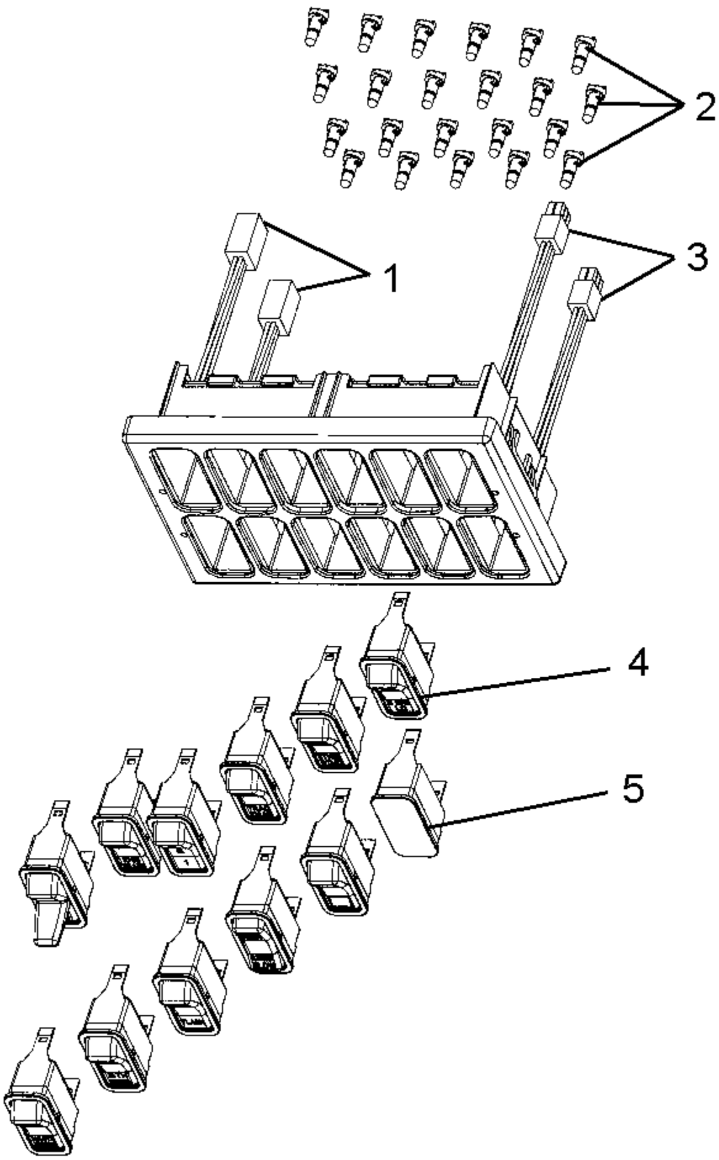


Figure 74 Switch Pack Exploded View (12 Pack Shown)

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.

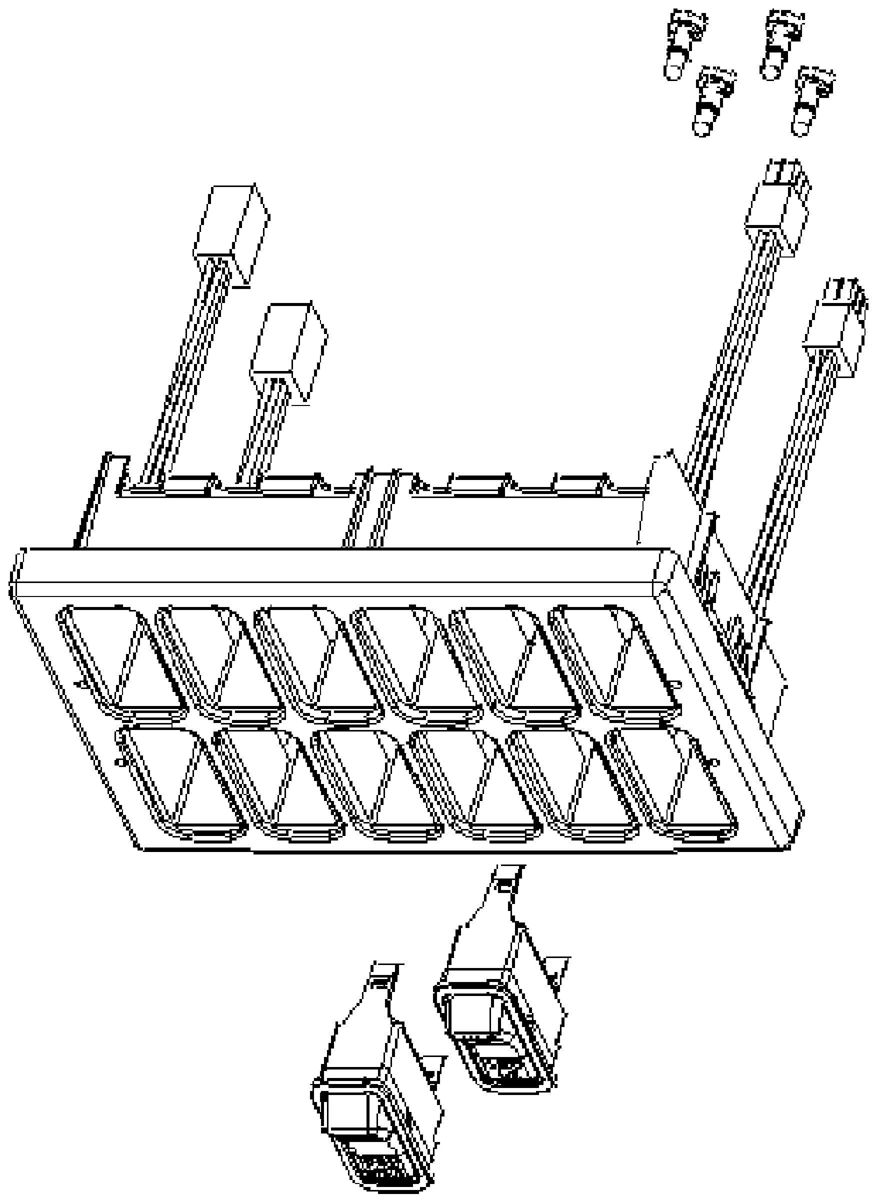


Figure 75 “Twelve Pack” Switch Module with L.E.D. bulbs and Switches

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 134)

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.

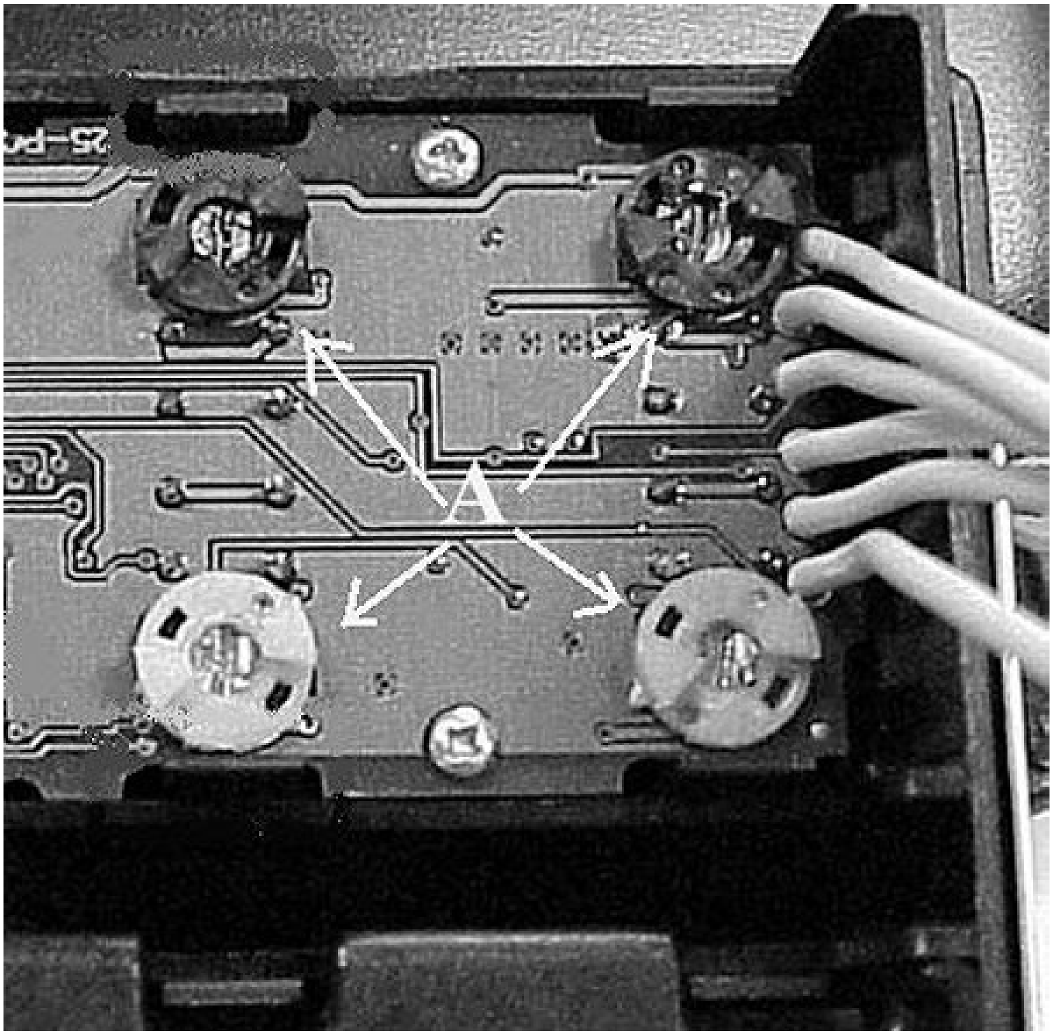


Figure 76 Back Side Of Panel

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 135)

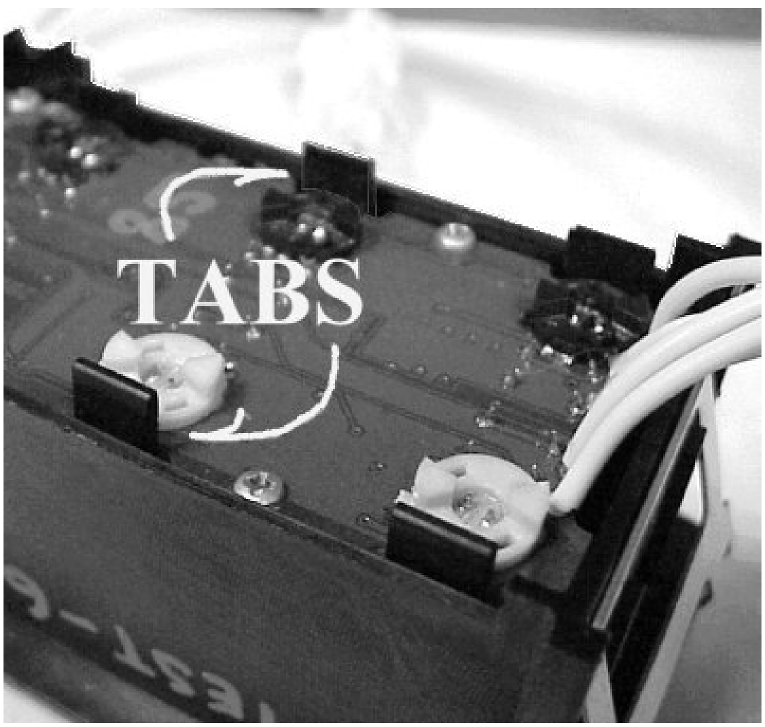


Figure 77 NOTE Tabs

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 136)

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.