Table of Contents

1. DESCRIPTION

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

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

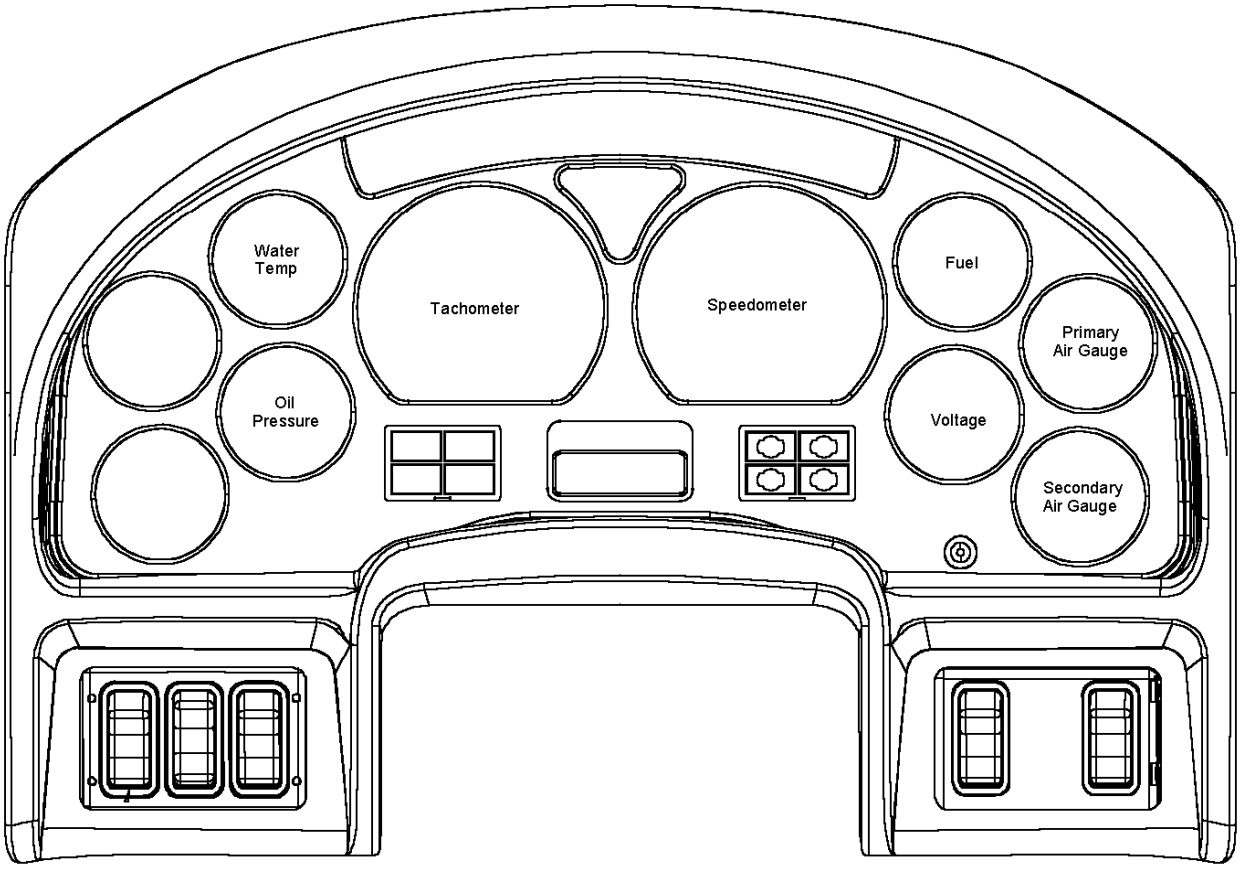


Figure 85 Electronic Gauge Cluster

1.1. GAUGES

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

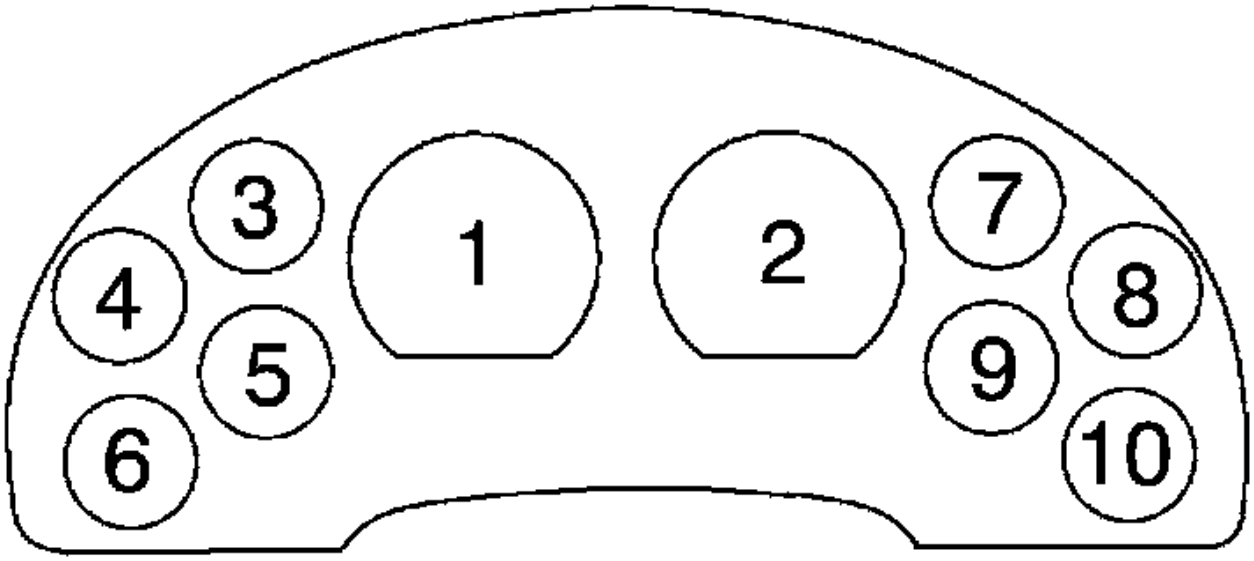


Figure 86 Gauge Locations

Table 29 Gauge Table

Gauge Type	Standard/ Optional	Location	Gauge Min./ Gauge Max.	Warning Light Trip Point	Parameter Group Description	Troubleshooting Cross Reference
Voltmeter Gauge with Integral Warning Light	Standard	9	10/16 Volts	<12 or >15.0 VDC and Engine Speed >325 RPM	Vehicle electric power: Electrical potential (voltage)	Voltmeter
Engine Coolant Temperature Gauge with Integral Warning Light	Standard	3	140/260 °F (60/126°C)	>230 °F (>110 °C)	Engine temperature: Engine coolant temperature	Engine Coolant Temperature Gauge (See ENGINE COOLANT TEMPERATURE GAUGE, page 218)
Pyrometer Gauge					Inlet/exhaust conditions: Exhaust gas temperature	This feature was not available at the time of publication.

Table 29 Gauge Table (cont.)

Gauge Type	Standard/ Optional	Location	Gauge Min./ Gauge Max.	Warning Light Trip Point	Parameter Group Description	Troubleshooting Cross Reference
Speedometer	Standard	2	0/85 MPH (0/137 KPH)	N/A	Cruise control/vehicle speed: wheelbased vehicle speed.	Speedometer (See SPEEDOMETER, page 224)
Tachometer	Standard	1	0/3000 RPM	N/A	Electronic engine controller #1: Engine speed	Tachometer (See TACHOMETER, page 228)
Fuel Level Gauge with Integral Warning Light	Standard	7	Empty/ Full	<12.8%	Dash display: Fuel level	Fuel Level Gauge (See FUEL LEVEL GAUGE, page 231)
Primary Air Pressure Gauge with Integral Warning Light	Optional	8	0/150 PSI (1034 KPa)	<70 PSI (482 KPa)	Brakes: brake primary pressure	Primary Air Pressure Gauge (See PRIMARY AIR PRESSURE GAUGE, page 239)
Secondary Air Pressure Gauge with Integral Warning Light	Optional	10	0/150 PSI (1034 KPa)	<70 PSI (482 KPa)	Brakes: brake secondary pressure	Secondary Air Pressure Gauge (See SECONDARY AIR PRESSURE GAUGE, page 246)
Boost Pressure Gauge with Integral Warning Light	Optional	Varies	0/50 PSI	N/A	Inlet/ exhaust conditions: boost pressure	Boost Pressure Gauge (See BOOST PRESSURE GAUGE, page 253)

Table 29 Gauge Table (cont.)

Gauge Type	Standard/ Optional	Location	Gauge Min./ Gauge Max.	Warning Light Trip Point	Parameter Group Description	Troubleshooting Cross Reference
Ammeter Gauge with Integral Warning Light	Optional	Varies	-150/+150 Amps	N/A	Vehicle electrical power: Net battery current or Vehicle electrical power: alternator current	Ammeter Gauge (See AMMETER GAUGE, page 255)
Ammeter Gauge (High Resolution) with Integral Warning Light	Optional	Varies	-300/+300 Amps	N/A	Vehicle electrical power: Net battery current or Vehicle electrical power: alternator current	Ammeter Gauge (See AMMETER GAUGE, page 255)

1.2. WARNING LIGHTS

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

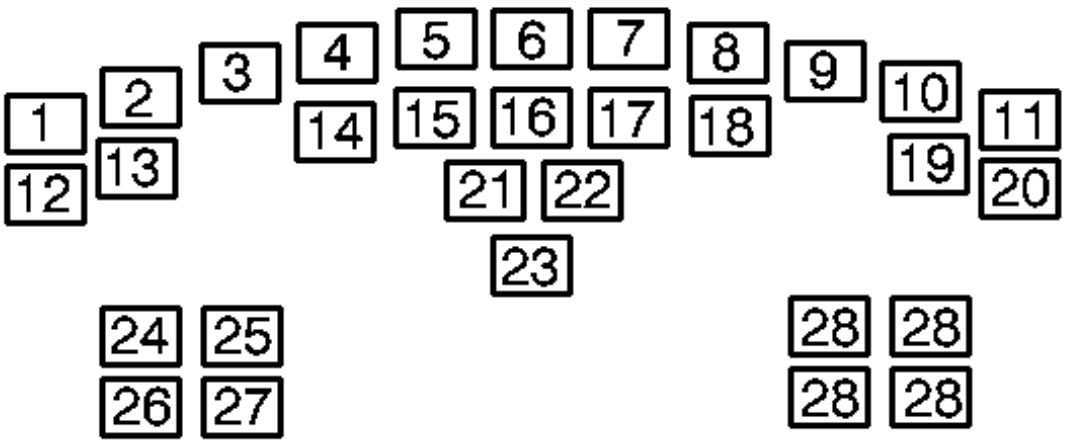


Figure 87 Warning and Indicator Lamps

Table 30 Warning Lamp Table

WARNING LIGHT	REPRESEN-TATION	COLOR	DRIVEN BY	Loc. Num.	Troubleshooting Cross Reference
Range inhibited	RANGE INHIBITED	Yellow	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from transmission controller.	1	Range inhibited (See RANGE INHIBITED WARNING LAMP, page 169)
Economy Mode	ECONOMY (ECON) [icon]	Yellow	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from transmission controller.	2	Economy Mode(See ECONOMY MODE WARNING LAMP, page 171)
Fuel Filter	FUEL FILTER	Yellow	ON when fuel filter input to ESC from fuel filter.	3	Fuel Filter
Warn Engine	ENGINE	Yellow	Status transmitted on Drivetrain 1939 data link from engine controller.	4	Warn Engine (See “YELLOW” ENGINE WARNING LAMP, page 173)
Stop Engine	ENGINE	Red	Status transmitted on Drivetrain 1939 data link from engine controller.	5	Stop Engine (See “RED” ENGINE WARNING LAMP, page 174)
Brake Pressure	BRAKE PRESSURE	Red	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from Hydromax hydraulic brake monitor.	6	Brake Pressure (See BRAKE FLUID WARNING LAMP, page 176)
Brake Fluid	BRAKE FLUID	Red	This warning lamp is not implemented at this time.	7	
Wait to Start	WAIT TO START	Yellow	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from engine controller.	8	Wait to Start (See WAIT TO START WARNING LAMP, page 210)
Check Transmission	CHECK TRANS	Yellow	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from transmission controller.	9	Check Transmission (See CHECK TRANSMISSION LAMP, page 181)
Lift Gate is not parked	LIFT GATE	Yellow	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from lift gate proximity switch.	10	Lift Gate(See CIRCUIT FUNCTIONS, page 574)

Table 30 Warning Lamp Table (cont.)

WARNING LIGHT	REPRESEN-TATION	COLOR	DRIVEN BY	Loc. Num.	Troubleshooting Cross Reference
Washer Fluid Low	WASHER FLUID	Yellow	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from washer reservoir probe.	11	Washer Fluid Low
Left Turn	Left Turn Signal Icon	Green	Status transmitted from ESC on Drivetrain 1939 data link. Input to ESC from turn signal switch.	12	
Traction Control	TRAC CTRL	Green	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from ABS controller.	13	Traction Control (See TRACTION CONTROL LAMP, page 179)
Water in Fuel	WATER IN FUEL	Yellow	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from fuel filter.	14	Water in Fuel (See WATER IN FUEL WARNING LAMP, page 183)
Service Park Brake	SERVICE PARK BRAKE (SERVICE) [icon]	Red	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from SAAR park brake.	15	Service Park Brake (See SERVICE PARK BRAKE WARNING LAMP, page 202)
Check Electrical System	CHECK ELEC SYS	Yellow	On when there is no communication on drivetrain 1939 data link from engine controller or ESC is inactive for more than 10 seconds. Will also come on for one minute when an active fault occurs.	16	Check Electrical System (See CHECK ELECTRICAL SYSTEM WARNING LAMP, page 168)
Park Brake	PARK BRAKE	Red	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from park brake switch.	17	Park Brake (See Fault Detection/ Management, page 191)
Cruise Control Active	CRUISE	Green	Active Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from cruise switch.	18	Cruise Control (See CRUISE CONTROL LAMP, page 206)
Antilock Braking system	ABS Icon	Yellow	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from ABS controller.	19	ABS (See ABS WARNING LAMP, page 208)

Table 30 Warning Lamp Table (cont.)

WARNING LIGHT	REPRESEN-TATION	COLOR	DRIVEN BY	Loc. Num.	Troubleshooting Cross Reference
Right Turn	Right Turn Signal Icon	Green	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from turn signal switch.	20	
Coolant Level	COOLANT LEVEL	Red	Status transmitted on Drivetrain 1939 data link from ESC. On when Coolant Level < 25%. Input to ESC from surge tank.	21	Coolant Level (See COOLANT LEVEL WARNING LAMP , page 187)
Emergency Exit	EMERG EXIT	Red	Status transmitted on Drivetrain 1939 data link from ESC.	22	Emergency Exit Controls
High Beam	High Beam Icon	Blue	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from high beam switch.	23	Headlight System
Amber Flasher	AMBER FLSHR	Yellow	Status transmitted on Drivetrain 1939 data link from ESC.	24	Red & Amber Pupil Warning Lights
Red Flasher	RED FLSHR	Red	Status transmitted on Drivetrain 1939 data link from ESC.	25	Red & Amber Pupil Warning Lights
Retard Over Heat	RETARD OVRHEAT	Red	Status transmitted on Drivetrain 1939 data link from ESC. Input to ESC from transmission controller.	26	Retard Over Heat (See RETARD OVERHEAT WARNING LAMP, page 212)
Optional Warning Lamps	Varies	Yellow	These are optional hard wired warning lamps. Example: Alternator Warning, Snow Valve, Optimized Idle or Differential locks.	28	Refer to the applicable section for the feature associated with the warning lamp.

1.3. DIGITAL DISPLAY

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

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

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

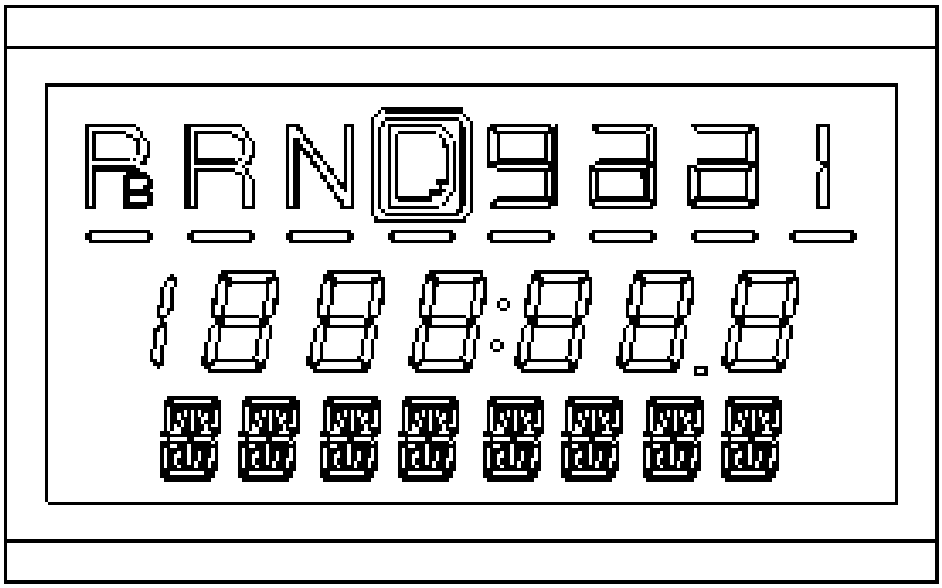


Figure 88 Electronic Gauge Cluster Display

EGC DISPLAY WITH ALLISON TRANSMISSIONS

Select/Reset Switch

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

Total Vehicle Distance

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

Trip Distance

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

Default Odometer Turn On Mode

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

Hours Functions

The EGC display provides several engine hours modes.

Total Engine Hours

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

Trip Hours

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

Change Oil

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

Diagnostic Message

The LCD is capable of displaying a diagnostic trouble code (DTC) message when requested by the ESC or service tool (EZ-Tech®). Refer to On-Line Diagnostics. (See ON-LINE DIAGNOSTICS, page 158)

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

Digital Display Lighting

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

1.4. AUDIBLE ALARM

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

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

One-time Five-short-beeps Alarm

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

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

- Boost pressure
- Fuel pressure
- Auxiliary air pressure
- Service Park Brake

Repetitive One-long-beep Alarm

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

- Primary air pressure
- Secondary air pressure

One-time Ten-short-beeps Alarm

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

One-time Three-long-beeps Alarm

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

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

Repetitive Short Duration Blips

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

1.5. ELECTRONIC GAUGE CLUSTER SWITCHES

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

Head Lamp/Park Lamp Switch

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

Panel Dimmer

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

Mode and Select/Reset Switch

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

1.6. FAIL SAFE STRATEGIES

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

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

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

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

2. PROGRAMMING

When gauge configurations are changed, or the ESC is replaced, the ESC must be programmed with the “ICAP” programming software. The ESC will store the current configuration and update the configuration after changes are made. The new configuration will have to be uploaded to IC Corporation. This is accomplished by dialing in and uploading the updated programming. A copy of the programming is stored at IC Corporation and updated each time there is a change. This is required in case there is a need to download the programming for ESC replacement. Refer to Programming in the Electrical System Controller section of this manual. (See PROGRAMMING, page 115)

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

3. DIAGNOSTICS

3.1. GAUGE SWEEP

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

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

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

3.2. ON-LINE DIAGNOSTICS

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

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

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

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

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

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

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

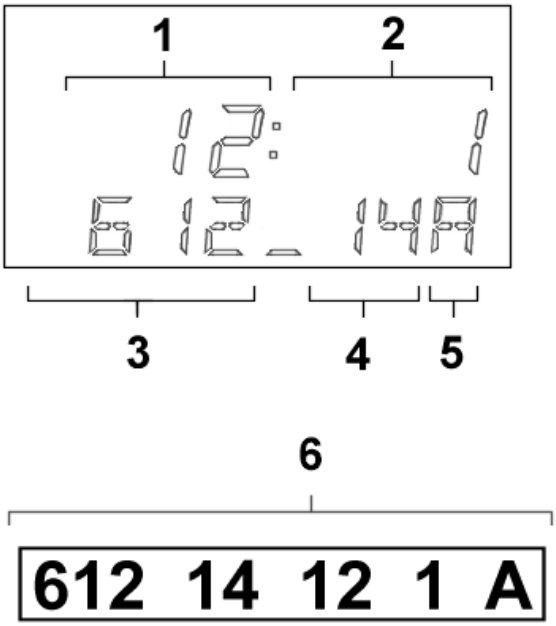


Figure 89 Diagnostic Trouble Code Display

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

Refer to the Diagnostic Trouble Code List.(See DIAGNOSTIC TROUBLE CODE (DTC) LIST, page 1193)

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

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

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

3.3. GAUGE DATA

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

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

- Go immediately to the zero position

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

3.4. LOSS OF DATA LINK

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

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

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

3.5. THE "DIAMOND LOGIC BUILDER™" DIAGNOSTIC SOFTWARE

The "Diamond Logic Builder™" diagnostic software can be run on the EZ–Tech®. An interface cable is required to connect the EZ–Tech® to the diagnostic connector of the truck.

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

The "Diamond Logic Builder™" diagnostic software can also be used to check programmed cluster gauge locations.

4. TROUBLESHOOTING

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

B. Check any light or indicator lamp filaments that are suspected of being open (burned out). This is done to avoid unnecessary extensive circuit checks.

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

D. When the technician determines that a fuse is blown, while checking its condition, he is directed to locate the cause of the overload condition and to repair it. While no further instruction on this procedure is listed in the diagnostic tables, the common procedure is as follows: isolate sections of the circuit, by disconnecting connectors, and measure the resistance to ground to find the circuit that is shorted to ground. Then locate the damaged spot in the wire or connector and repair.

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

4.1. IMPORTANT STEPS BEFORE TESTING

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

a. What happened, and when?

b. Under what conditions?

c. When did the symptoms begin?

d. What else occurred at that time?

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

3. **Check for and record** any logged diagnostic trouble codes.

   a. Do the logged codes correlate to probable causes?

4. Were the codes logged about the same time as the symptoms appeared? Were the codes logged repeatedly? (This can only be checked with the EZ-Tech®.)

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

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

4.2. INSPECTING ELECTRICAL CONNECTORS

Visual Inspection

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

1. **Check the connector lock mechanism or retaining screw.** Make sure the connector is capable of properly locking the connector together.

2. **Perform a 10 pound pull-test on each terminal/wire in the connector.** Each terminal/wire assembly should easily withstand 10 pounds of pull and remain in the connector. This test determines (A) if the wire is properly in the terminal and (B) if the terminal is properly inserted into the connector. Correct any faults noted.

3. **Visually inspect wiring.** Inspect for worn or damaged wires. Check for pinched or damaged harness.

4. **Visually inspect connectors.** Verify that pins and sockets are free of corrosion, dirt or any other contaminants, and damage. Verify correct alignment and location of terminals in the connector.

5. **Check individual pins and sockets.** This is especially important with an intermittent symptom. Using a new pin, insert the pin into each socket, one at a time, checking for a good grip on the pin by the socket. Repeat for each pin on the mating side of the connector, using a new female terminal for the test.

6. **Inspect Engine Ground Stud.** Inspect this ground and other related grounds for clean, tight connections that are free of corrosion and/or other faulty conditions.

Replacing IC Corporation Components

When replacing electrical switches, connectors (including pins and sockets), relays or other components, use only approved IC Corporation replacement parts. Many of the switches have gold or silver plated contacts and

some of the connectors have gold plated terminals. By using correct replacement parts, you maintain the design integrity of the system.

4.3. EGC PRELIMINARY SYSTEM CHECK

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

EGC Preliminary System Check

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

Table 31 EGC Preliminary System Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/ On	Turn key to ignition position while observing the EGC. Did the EGC have any response to key on?	EGC responds to key on.	Go to next step.	Go to EGC power and ground troubleshooting. (See EGC POWER AND DATA LINK CIRCUITS, page 163)
2.	Off/ On	Turn key to ignition position while observing the EGC. Does the gauge sweep perform without any errors? See gauge sweep (See GAUGE SWEEP, page 157)	EGC gauge sweep performs without any errors.	Go to next step.	Go to troubleshooting malfunctioning EGC (See MALFUNCTIONING EGC , page 165)
3.	On	After the gauge sweep is finished and most warning lamps have gone out, does the check electrical system light illuminate for 1 second or remain illuminated?	Check electrical system light illuminate for 1 second or remain lit.	Go to next step.	Go to troubleshooting for the check electrical system light. (See CHECK ELECTRICAL SYSTEM WARNING LAMP, page 168)
4.	On	After the gauge sweep is finished, do any other warning lights remain illuminated for more than 15 seconds, without turning off?	No warning lamps illuminated.	Go to next step.	Go to troubleshooting for specific warning light. Cross reference from Warning Light Table. (See Table 30, page 151)
5.	On	After the gauge sweep or during vehicle operation, do any gauges point to the 6 o'clock position or provide an incorrect reading?	Gauges operate correctly.	Go to next step.	Go to troubleshooting for specific gauge. Cross reference from Gauge Table. (See Table 29, page 148)

Table 31 EGC Preliminary System Check (cont.)

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
6.	On	Does Select/Reset button function correctly?	Select/ Reset button functions correctly?	Go to next step.	Go to troubleshooting for the Select/Reset switch. (See “YELLOW” ENGINE WARNING LAMP, page 173)
7.	On	Do the headlight and dimmer switch work correctly?	Headlight and dimmer switch works correctly?	Go to next step.	Go to troubleshooting for the headlight and dimmer switch (See “RED” ENGINE WARNING LAMP, page 174)
8.	On	Does the audible alarm sound when a turn signal has been left on after traveling more than one mile?	Alarm sounds when a turn signal has been left on after traveling more than one mile?	EGC alarm is working correctly.	Go to troubleshooting for the alarm. (See MALFUNCTIONING EGC , page 165)

4.4. EGC POWER AND DATA LINK CIRCUITS

Circuit function

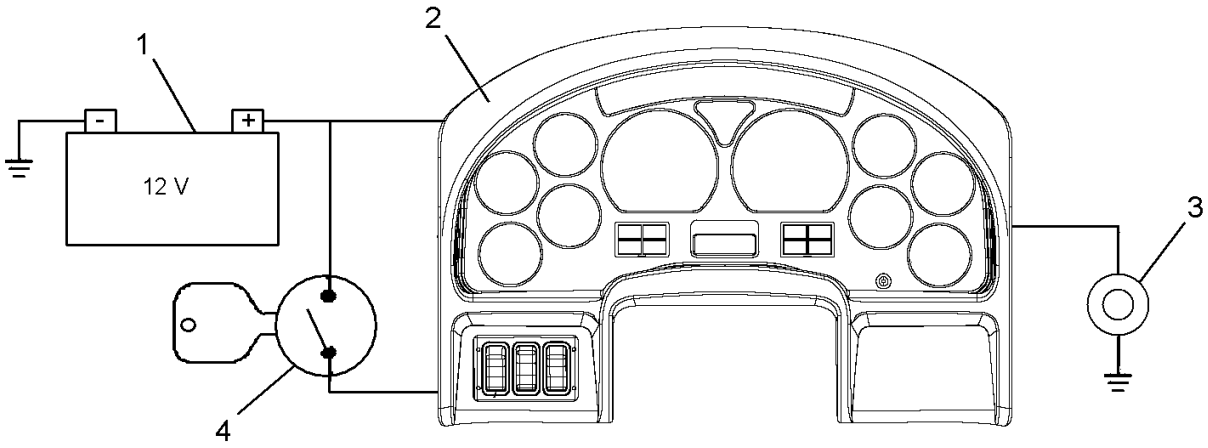


Figure 90 EGC Power And Ground Function Diagram

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

Refer to EGC Power And Ground Function Diagram.

The EGC receives battery power through fuse block (1011). Switched ignition power is supplied from the ignition relay in fuse block (1011).

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

Fault Detection/Management

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

Refer to EGC Power And Ground Simplified Diagram.

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

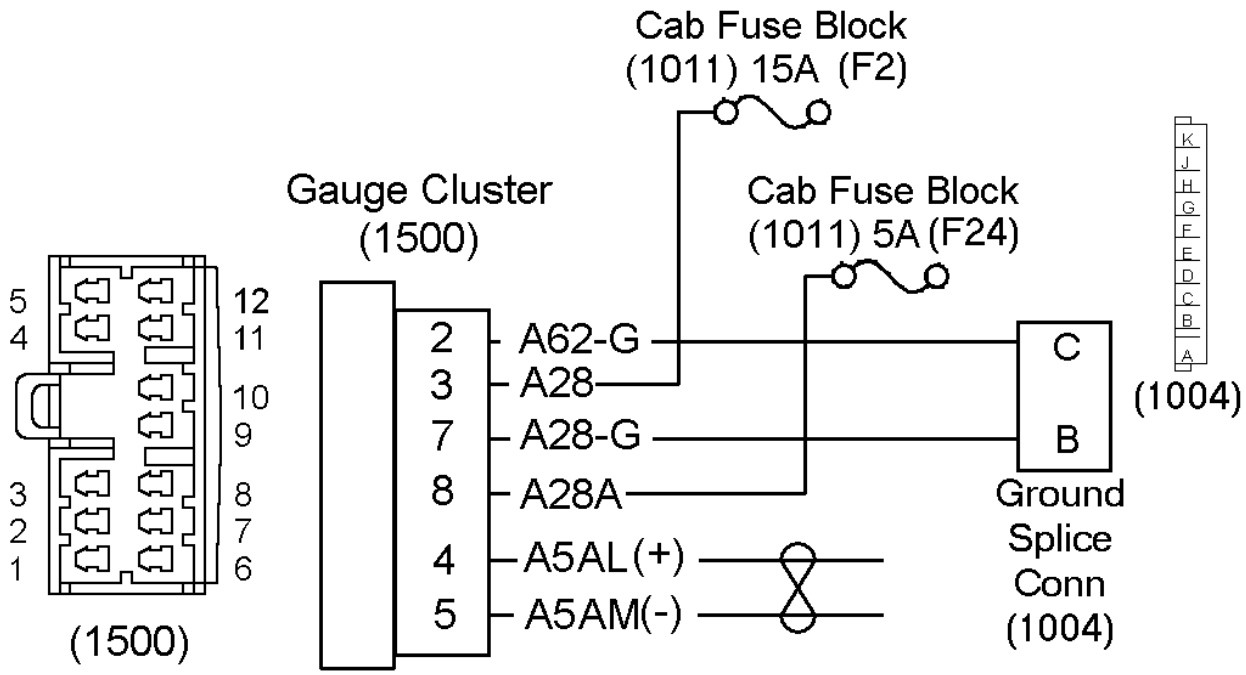


Figure 91 EGC Power And Ground Simplified Diagram – Always Refer To Circuit Diagram Book For Latest Circuit Information

F2 BATTERY FUSE (1011)
F24 IGNITION FUSE (1011)
(1004) GROUND SPLICE CONNECTION
(1500) ELECTRONIC GAUGE CLUSTER CONNECTOR

Table 32 EGC Power Voltage Check Chart

EGC Connector (1500) Voltage Checks (Check with EGC connector Disconnected and Ignition Key "On") This chart assumes there is power to fuse block (1011) F2 and (1011) F24 from the mega fuse and ignition relay is functioning properly.		
Test Points	Spec.	Comments
(1500) Cavity 3 to ground.	12 ± 1.5 volts	If voltage is incorrect, check for blown fuse (F2) or an open or short in circuit A28.
(1500) Cavity 8 to ground.	12 ± 1.5 volts	If voltage is incorrect, check for blown fuse (F24) or an open or short in circuit A28A.
(1500) Cavity 8 to 7.	12 ± 1.5 volts	If voltage is incorrect, check for an open in circuit A28-G and check for proper grounding of splice (1004). If all voltages are correct and the EGC does not power up, the EGC should be replaced.
EGC Connector (1500) Data Link Voltage Checks (Check with EGC connector Disconnected and Ignition Key "On")		
Test Points	Spec.	Comments
(1500) Cavity 4 to ground.	Approximately 2.5 volts.	If voltage is missing check for short to ground or open in circuit A5AL(+) to the cab harness.
(1500) Cavity 5 to ground.	Approximately 2.5 volts.	If voltage is missing check for short to ground or open in circuit A5AM(-) to the cab harness.
If voltages are missing and the circuits are not shorted to ground or open, refer to Drivetrain Data Link Circuits.		

Extended Description

Battery voltage to the instrument cluster connector (1500), terminal 3, is provided on circuit A28 from fuse (1011) F2.

Switched ignition voltage to the instrument cluster connector (1500), terminal 8, is provided on circuit A28A from (1011) F24.

System ground to EGC connector (1500), terminal 7, is provided on circuit A28–G to the ground splice connection (1004).

4.5. MALFUNCTIONING EGC

Fault Detection/Management

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

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

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

Table 33 Troubleshooting Malfunctioning EGC

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?	Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See EGC PRELIMINARY SYSTEM CHECK, page 162)
2.	Off	Did all gauges sweep correctly?	All gauges swept correctly.	Go to step 4.	Go to next step.
3.	Off/ On	Swap a working gauge, from the same side of the cluster, with the inoperative gauge. Perform gauge sweep.	The gauge that worked previously still works in the new position.	Replace the faulty gauge.	Replace the circuit board assembly.
4.	On	Connect the EZ-Tech® and run the cluster the "Diamond Logic Builder™" diagnostic software. Check if the malfunctioning gauge is programmed.	Gauge is programmed.	Go to next step	Insure the gauge is supposed to be installed. Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
5.	On	Did all warning lamps, for installed features, light during gauge sweep.	Warning lamps on during gauge sweep.	Go to step 7.	Go to next step.
6.	Off	Replace the suspect warning lamp bulb.	Warning lamp works.	Go to next step.	Replace the EGC circuit board assembly.
7.	On	Did the panel lights illuminate while the gauges swept?	Panel lights illuminate during gauge sweep.	Go to step 9.	Go to next step.
8.	On	Replace the suspect panel light bulb.	Panel light works.		Replace the circuit board assembly.
9.	On	Did all LCD segments display while the gauges swept?	All LCD elements displayed during gauge sweep.	EGC is working correctly.	Go to next step.
If the LCD is the only problem, the LCD is probably bad. If other problems occur along with the LCD, the circuit board assembly probably needs to be replaced.					
10.	On	Replace the LCD display. Perform gauge sweep	LCD display works during gauge sweep.	EGC is working correctly.	Replace the circuit board assembly.

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble codes are present, the cluster odometer will display “NO FAULT”. If diagnostic trouble codes are present, the gauge cluster will display the total number of faults and cycle to the next diagnostic trouble code after 10 seconds. To manually cycle through the diagnostic trouble code list, press the cluster display select/reset

button. The last character of the diagnostic trouble code will end in “A” for active diagnostic trouble codes or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

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

Table 34 EGC Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
614 14 1 1	Electronic Gauge Cluster #1 checksum error fixed by reteach. The configuration checksum in the cluster did not match the teach/reteach checksum in the ESC. This situation was corrected by the teach/reteach operation.
614 14 1 2	Electronic Gauge Cluster #1 checksum error could not be fixed. The configuration checksum in the cluster did not match the teach/reteach checksum in the ESC. This situation could not be corrected by the teach/reteach operation.
614 14 23 1	Electronic Gauge Cluster #1 checksum error fixed by reteach. The configuration checksum in the cluster did not match the teach/reteach checksum in the ESC. This situation was corrected by the teach/reteach operation.
614 14 23 2	Electronic Gauge Cluster #1 checksum error could not be fixed. The configuration checksum in the cluster did not match the teach/reteach checksum in the ESC. This situation could not be corrected by the teach/reteach operation.
639 14 33 239	EGC not communicating with ESC or AGSP not communicating with the ESC.
1705 14 150 1	ESC not communicating with the EGC.
1705 14 150 2	Engine Controller not communicating with the EGC.
2023 14 150 1 or 2023 14 250 1	Loss of data from ESC to primary EGC (150) or secondary (250). Loss of communication in excess of 10 seconds.
2023 14 150 2 or 2023 14 250 2	Engine Controller not communicating with the primary EGC (150) or secondary EGC (250). Loss of communication in excess of 10 seconds.

4.6. CHECK ELECTRICAL SYSTEM WARNING LAMP

Circuit Function

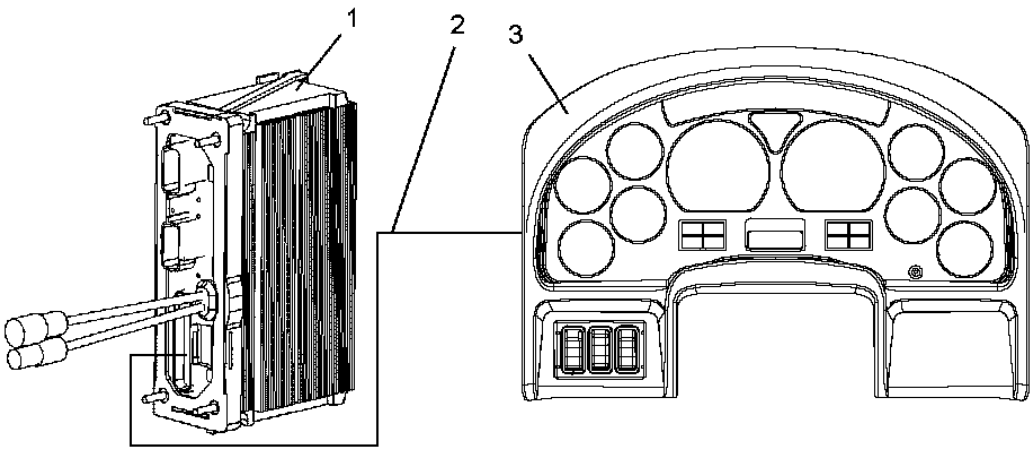


Figure 92 Check Electrical System Warning Lamp Function Diagram

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

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

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

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

Fault Detection/Management

If the light stays on continuously and none of the gauges are working correctly after the gauge sweep, the EGC is not communicating on the Drivetrain 1939 Data Link or there is a problem with the data link. Refer to Drivetrain 1939 Data Link. (See DRIVETRAIN 1939 DATA LINK, page 73)

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

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

4.7. RANGE INHIBITED WARNING LAMP

System Function

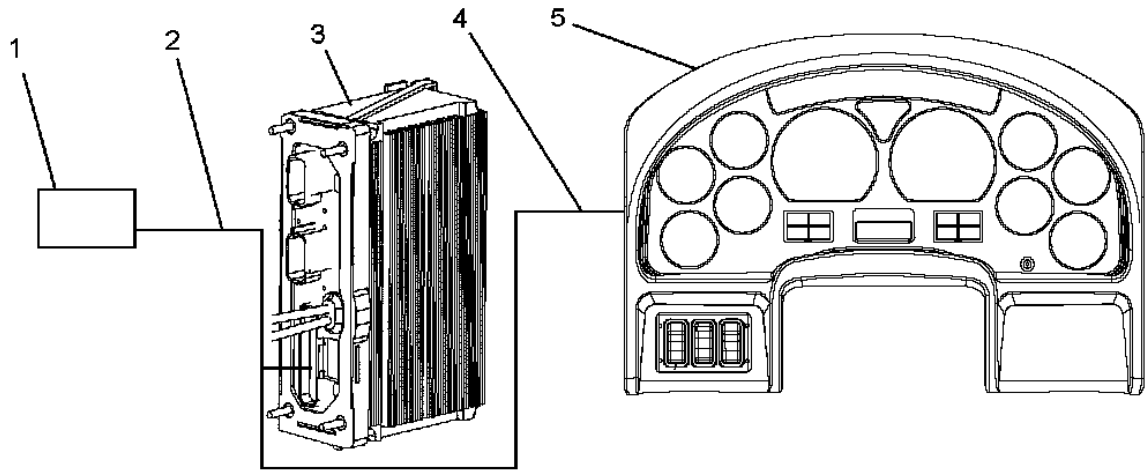


Figure 93 Range Inhibited Warning Lamp Function Diagram

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

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

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

This may be due to a problem in the transmission.

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

Diagnostics

The service tool (EZ-Tech®) running the "Diamond Logic Builder™" diagnostic software can be used to check operation of the warning lamp.

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

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

Table 35 Range Inhibited Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	On	Verify range inhibited warning lamp is malfunctioning.	Range inhibited warning lamp is on only when transmission range is inhibited.	Problem does not exist or is intermittent.	Go to next step.
2.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 115)
3.	On	Attempt to exercise the range inhibited warning lamp with the "Diamond Logic Builder™" diagnostic software.	Range inhibited warning lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
4.	On	Use "Diamond Logic Builder™" diagnostic software to verify range inhibited commands from the transmission controller are being generated and match transmission status.	Commands from the transmission controller are being generated and match transmission status.	Go to next step.	Message from transmission controller is not being transmitted. Refer to the troubleshooting manual for the transmission installed in the vehicle.
5.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 125)

4.8. ECONOMY MODE WARNING LAMP

System Function

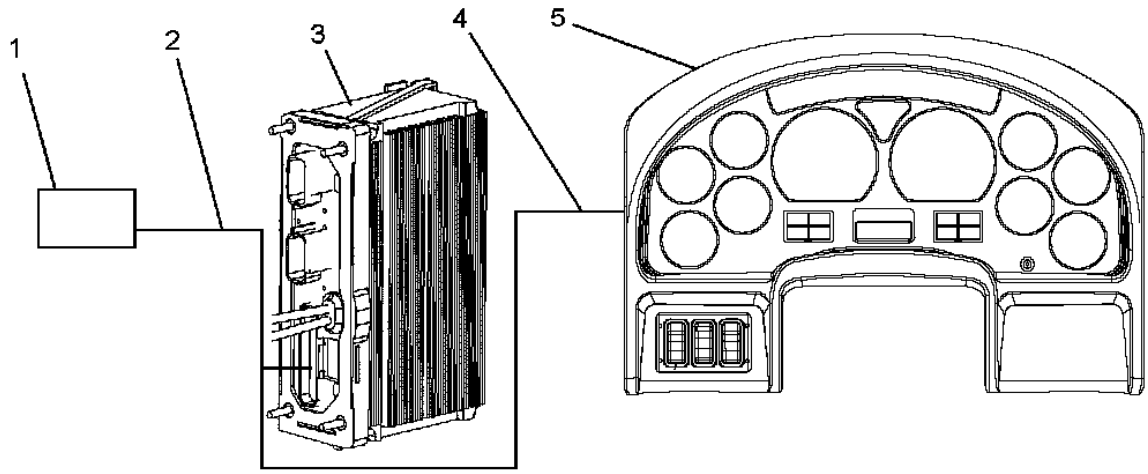


Figure 94 Economy Mode Function Diagram

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

The "ECON" lamp indicates the transmission is using its secondary shift schedule. The operator selects this shift schedule using a switch on the EGC.

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

The economy mode warning lamp lights when the transmission is using its secondary shift schedule.

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

Fault Detection/Management

The service tool (EZ-Tech®) running the "Diamond Logic Builder™" diagnostic software can be used to check operation of the warning lamp.

The MODE button is used. The activation of the button is communicated over existing shifter wiring. If the lamp does not turn on when requested, make sure the ECM is communicating to the ESC (fault code for missing trans message?), make sure the ESC is communicating to the cluster (fault code for missing cluster or ESC message?), and make sure the lamp in the cluster works (bulb check at gauge sweep or use diagnostic tool).

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

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

Table 36 Economy Mode Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	On	Verify Economy Mode lamp is malfunctioning.	Economy Mode lamp is on when running engine is cold.	Go to next step.	Problem does not exist or is intermittent.
2.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programing in the Electrical System Controller section of this manual. (See PROGRAMMING, page 115)
3.	On	Attempt to exercise the warning lamp with the "Diamond Logic Builder™" diagnostic software.	Warning lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
4.	On	Use "Diamond Logic Builder™" diagnostic software to verify Economy Mode commands from the transmission controller are being generated and match transmission status.	Commands from the transmission controller are being generated and match transmission status.	Go to next step.	Message from transmission controller is not being transmitted. Refer to the troubleshooting manual for the transmission installed in the vehicle.
5.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 125)

4.9. “YELLOW” ENGINE WARNING LAMP

Circuit Function

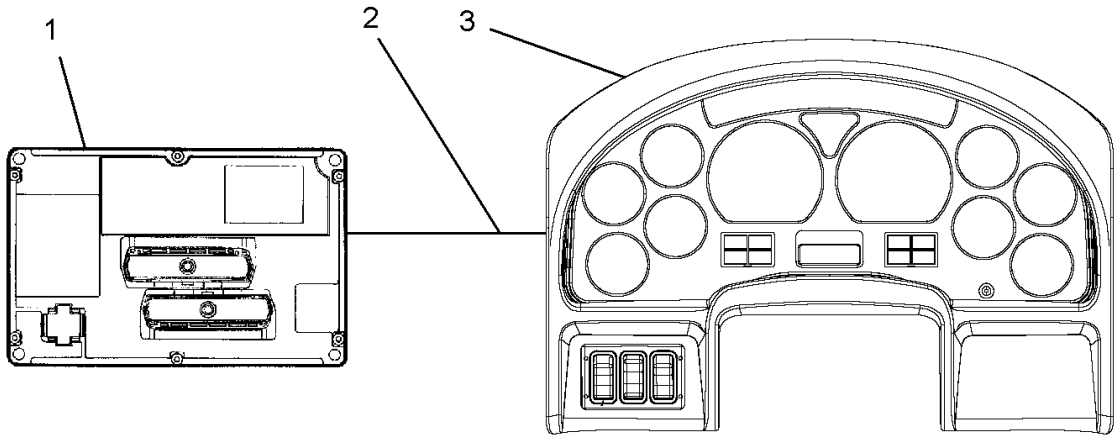


Figure 95 Yellow Engine Lamp Function Diagram

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

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

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

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

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

The service tool (EZ-Tech®) running the "Diamond Logic Builder™" diagnostic software will **not** check operation of the light.

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

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

Diagnostics

Table 37 Yellow Engine Lamp Preliminary Check

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

4.10. “RED” ENGINE WARNING LAMP

Circuit Function

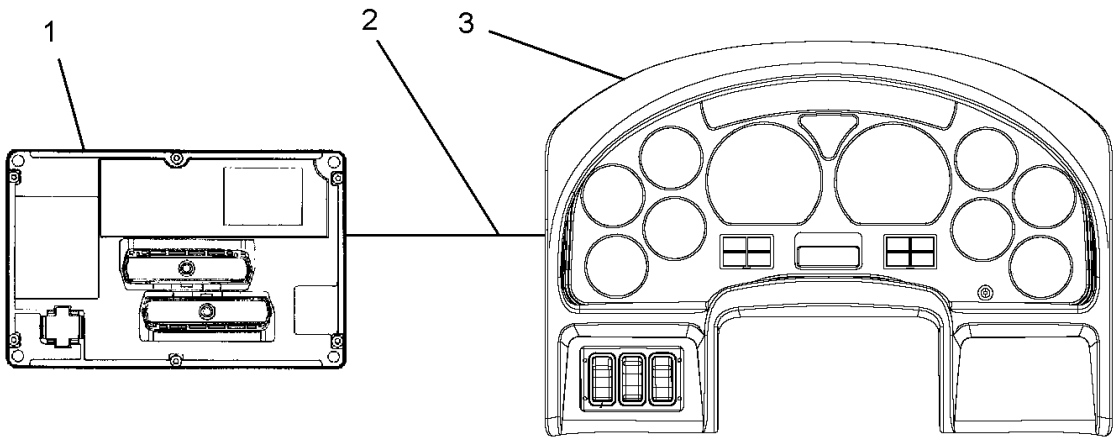


Figure 96 “Red” Engine Warning Lamp Function Diagram

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

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

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

The EGC activates the "red" engine warning indicator when it receives a message on the Drivetrain 1939 data link from the engine controller. The engine controller will send this message when warning thresholds for

coolant temperature, coolant level and/or low engine oil pressure have been exceeded. The indicator lamp will be accompanied by a message on the odometer display and the EGC alarm will sound.

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

The service tool (EZ-Tech®) running the "Diamond Logic Builder™" diagnostic software can be used to turn on all of the warning lamps

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

Diagnostics

Table 38 “Red” Engine Warning Lamp Preliminary Check

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

4.11. BRAKE FLUID WARNING LAMP

Circuit Function

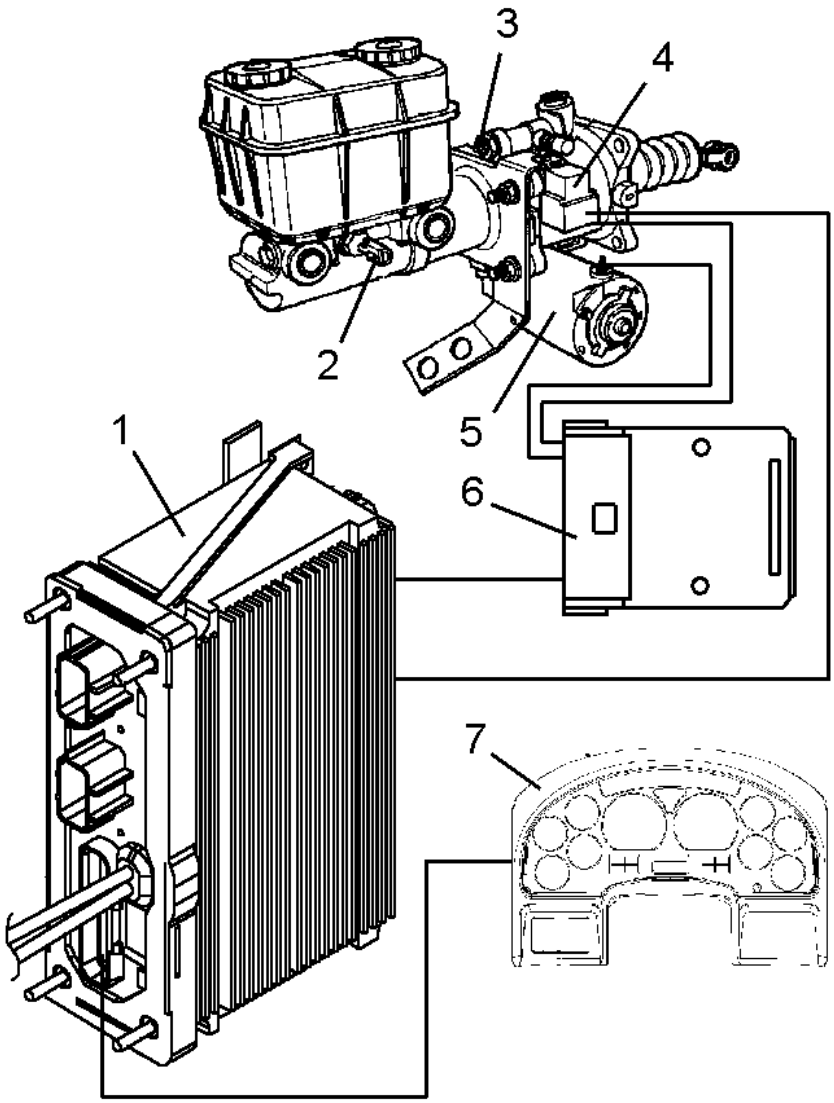


Figure 97 Brake Fluid Warning Lamp Function Diagram

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

The brake fluid warning lamp is only used with the hydraulic brake system. The EGC activates the brake fluid warning lamp when it receives a message on the Drivetrain 1939 data link from the ESC. An alarm should sound while the lamp is illuminated.

The light will go out when the condition is resolved.

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

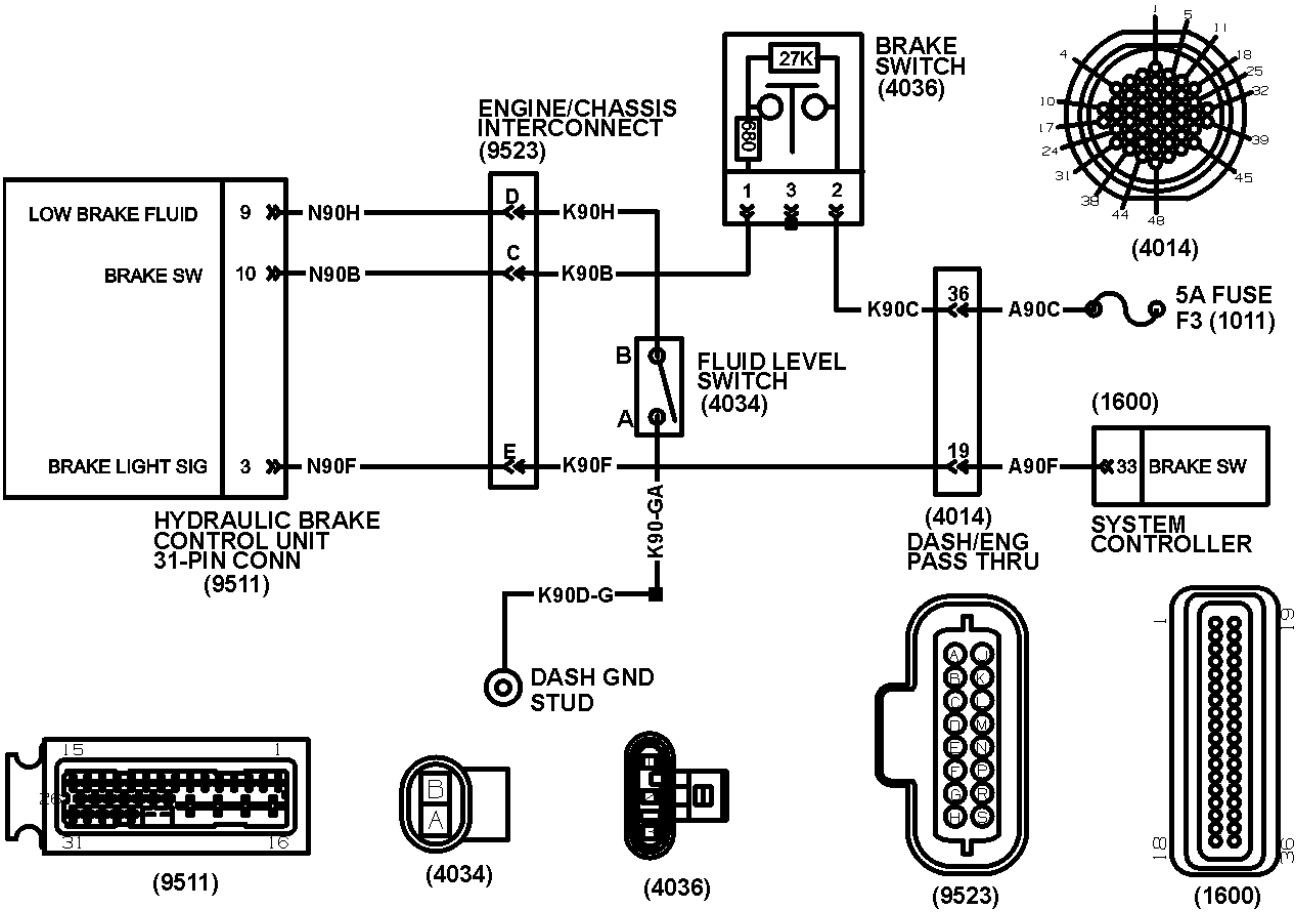


Figure 98 Hydraulic Brake Monitor Module And Warning Circuits — Always Refer To Circuit Diagram Book For Latest Circuit Information

(1011) FUSE BLOCK
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(1600) SYSTEM CONTROLLER CONNECTOR
LOCATED AT INSIDE RIGHT SIDE DASH PANEL
(4014) DASH/ENGINE PASS THROUGH CONNECTOR
LOCATED AT INSIDE LEFT SIDE DASH PANEL
(4034) HYDRAULIC FLUID LEVEL SWITCH
LOCATED AT HYDRAULIC MASTER CYLINDER
(4036) HYDRAULIC BRAKE SWITCH
LOCATED AT HYDRAULIC MASTER CYLINDER
(9523) ENGINE/CHASSIS INTERCONNECT
LOCATED AT INSIDE LEFT FRAME RAIL BEHIND ENGINE
(9511) HYDRAULIC BRAKE CONTROL UNIT — HCU
LOCATED AT INSIDE LEFT FRAME RAIL AT HCU

Diagnostics

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

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

Table 39 Brake Pressure Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/ On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 115)
2.	On	Attempt to exercise the warning lamp with the "Diamond Logic Builder™" diagnostic software.	Warning lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
3.	On	Monitor the inputs to the ESC for the warning lamp with the "Diamond Logic Builder™" diagnostic software.	Inputs are correct.	Go to next step.	Refer to Monitor Module and Warning Circuit Inputs To ESC. (See e-stroke module, page 645)
4.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 125)

4.12. TRACTION CONTROL LAMP

Circuit Function

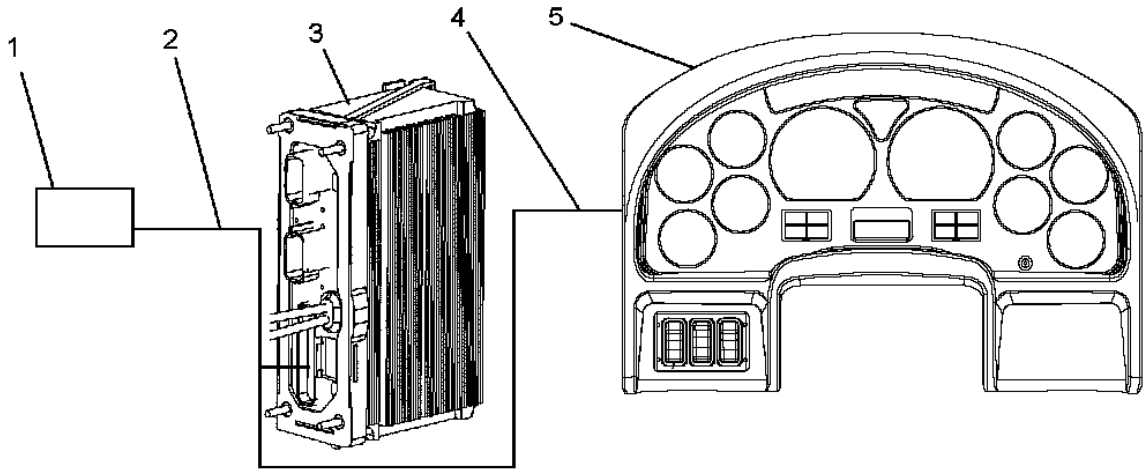


Figure 99 Traction Control Lamp Function Diagram

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

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

The lamp should go out after the traction control event is corrected and cleared.

If the lamp stays on continuously or does not come on when commanded by the ESC, the problem may be in ESC/EGC programming, ESC/EGC hardware or problems with the sensors or sensor wiring to the traction control module.

See the appropriate section in this manual to troubleshoot the traction control module.

Diagnostics

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

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

Table 40 Traction Control Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/ On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programingin the Electrical System Controller section of this manual. (See PROGRAMMING, page 115)
2.	On	Attempt to exercise the warning lamp with the "Diamond Logic Builder™" diagnostic software.	Warning lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
3.	On	Monitor the commands to the ESC from the ABS controller with the "Diamond Logic Builder™" diagnostic software.	Commands are correct.	Go to next step.	Refer to the troubleshooting manual for the specific ABS controller.
4.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 125)

4.13. CHECK TRANSMISSION LAMP

Circuit Function

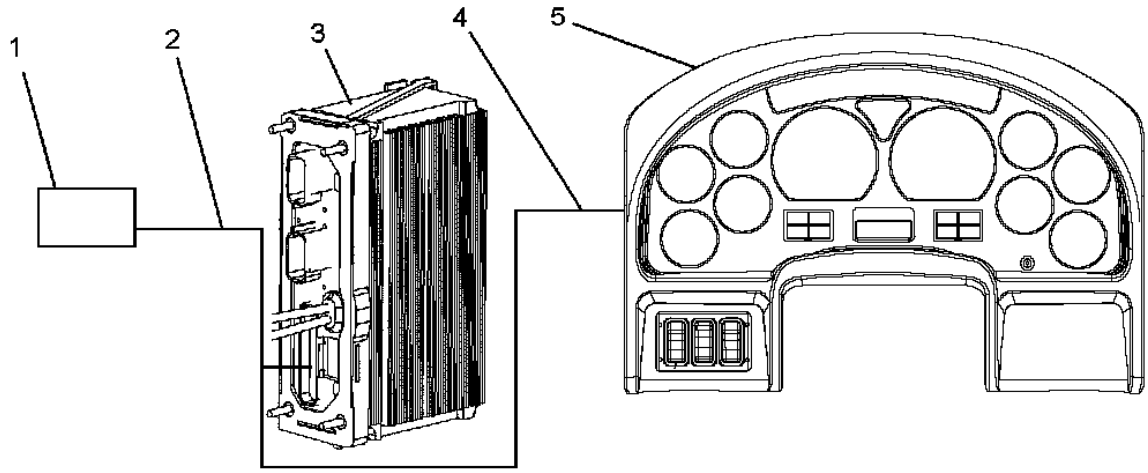


Figure 100 Check Transmission Lamp Function Diagram

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

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

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

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

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

Diagnostics

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

Table 41 Check Transmission Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	On	Check for transmission diagnostic codes. Refer to On-Line Diagnostics.(See ON-LINE DIAGNOSTICS, page 158)	**No** transmission diagnostic codes are present.	Go to next step.	Refer to the Transmission section of this manual.
2.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programing in the Electrical System Controller section of this manual. (See PROGRAMMING, page 115)
3.	On	Attempt to exercise the warning lamp with the "Diamond Logic Builder™" diagnostic software.	Warning Lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
4.	On	Monitor command from transmission controller to ESC with the "Diamond Logic Builder™" diagnostic software.	Commands are correct.	Go to next step.	Refer to the troubleshooting manual for the specific transmission installed on the truck.
5.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 125)

4.14. WATER IN FUEL WARNING LAMP

Circuit Function

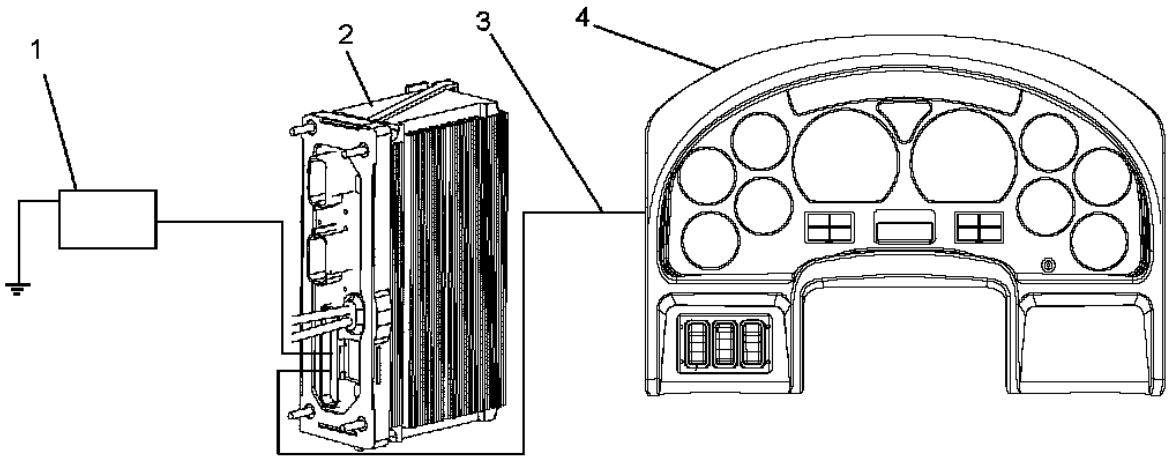


Figure 101 Water In Fuel Warning Lamp Function Diagram

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

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

A short in the water in fuel probe or wiring to the ESC can also cause the lamp to light.

Diagnostics

There are no diagnostic trouble codes associated with this feature.

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

If the lamp stays on continuously or does not come on when commanded by the ESC, the problem may be in ESC/EGC programming, EGC hardware or problems with the input circuits to the ESC from water probe.

Table 42 Water in Fuel Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programing in the Electrical System Controller section of this manual. (See PROGRAMMING, page 115)
2.	On	Attempt to exercise the warning lamp with the "Diamond Logic Builder™" diagnostic software.	Warning Lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
3.	On	Monitor inputs from the water in fuel module with the "Diamond Logic Builder™" diagnostic software.	Inputs are correct.	Go to next step.	Go to Fault Detection Management. (See Fault Detection/Management, page 184)
4.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 125)

Fault Detection/Management

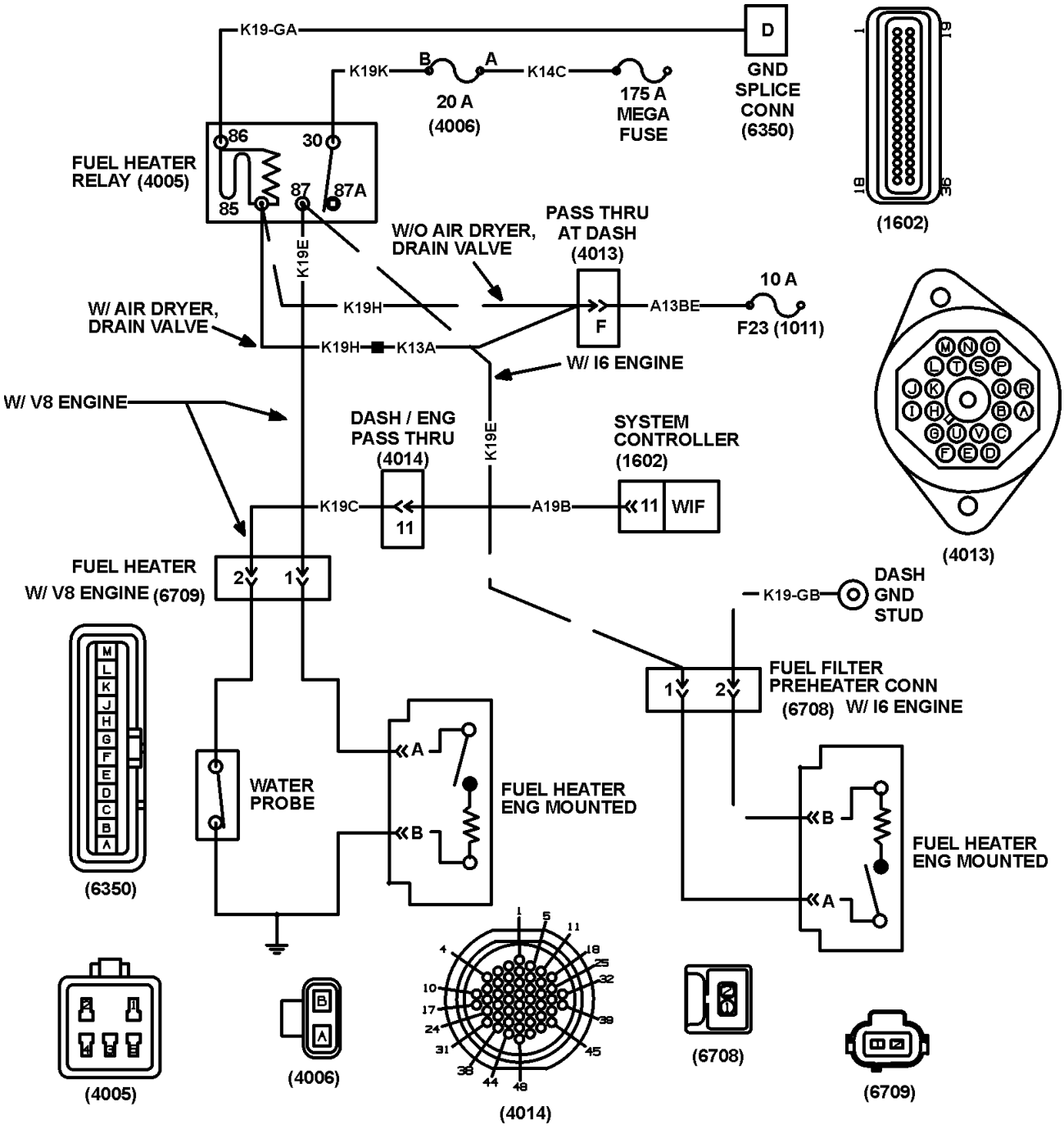


Figure 102 Water in Fuel Circuits — Always Refer to Circuit Diagram Book for Latest Circuit Information

(1011) FUSE BLOCK
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(1602) SYSTEM CONTROLLER
LOCATED AT INSIDE RIGHT SIDE DASH PANEL
(4000) 175 AMP MEGA FUSE
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(4005) FUEL HEATER RELAY
LOCATED AT OUTSIDE CENTER TOP DASH PANEL
(4006) FUEL HEATER FUSE
LOCATED AT OUTSIDE CENTER TOP DASH PANEL
(4013) PASS THRU AT DASH
LOCATED AT INSIDE LEFT SIDE DASH PANEL
(4014) DASH/ENGINE PASS THRU
LOCATED AT INSIDE LEFT SIDE DASH PANEL
(4016) AIR DRYER/DRAIN VALVE RELAY
LOCATED AT OUTSIDE CENTER TOP DASH PANEL
(6350) GROUND SPLICE PACK
LOCATED AT ENGINE COMPARTMENT NEAR STARTER
(6708) FUEL FILTER PREHEATER (I-6 ONLY)
LOCATED AT ENGINE COMPARTMENT FUEL FILTER
(6709) FUEL HEATER (V8 ONLY)
LOCATED AT ENGINE COMPARTMENT FUEL FILTER

The service tool (EZ-Tech®) running the "Diamond Logic Builder™" diagnostic software can be used to check operation of the light.

To quickly verify operation of the water in fuel circuits with the V8 engine, remove the connector from the fuel heater (6709). When the key is on the WIF warning lamp should not be illuminated. Connect a jumper from the harness connector cavity 2 to ground. When the key is on the WIF lamp should illuminate. If both of these checks work, the problem is in the sensor.

If the lamp stays on continuously or does not come on when there is water in the fuel, the problem may be in ESC/EGC programming, ESC/EGC hardware, water in fuel probe, or wiring to the ESC.

Table 43 Water in Fuel Warning Lamp Circuits Voltage Check Chart

Fuel Heater (6709) (V8 Only) Voltage Checks (Check with Fuel Heater Disconnected, Fuel Heater Relay (4005) Installed and the Ignition Key “On”) **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**		
Test Points	Spec.	Comments
(4035) harness connector, cavity 1 to ground.	12 ± 1.5 volts	If voltage is incorrect, check circuit K19E for an open or short circuit. Also bench test Fuel Heater Relay (4005) and check circuits K19K and K14C and check for blown fuses (4006) and (4000).
(4035) harness connector, cavity 2 to cavity ground.	12 ± 1.5 volts	If voltage is incorrect, check circuits A19B and K19C for an open or short circuit. If no opens exist, check signal from ESC.
There are no diagnostic trouble codes associated with this feature.		

Extended Description

With the key on, 12 volts from fuel heater fuse (4006) is supplied on circuit K19K to K19E to the fuel heater connector (6709) terminal 1.

The ground path for the fuel heater (6709) is not a dedicated circuit. The fuel filter housing is grounded through its mounting bracket and whenever water builds up to an unacceptable level in the filter, the water completes the circuit between the probe contacts and the housing. This energizes the water-in-fuel circuit.

When the water-in-fuel circuit becomes energized, a ground signal is supplied on circuit K19C through the pass through (4014) to the ESC connector (1602) terminal 11. This will cause the ESC to send a message to the EGC to illuminate the warning lamp.

4.15. COOLANT LEVEL WARNING LAMP

Circuit Function

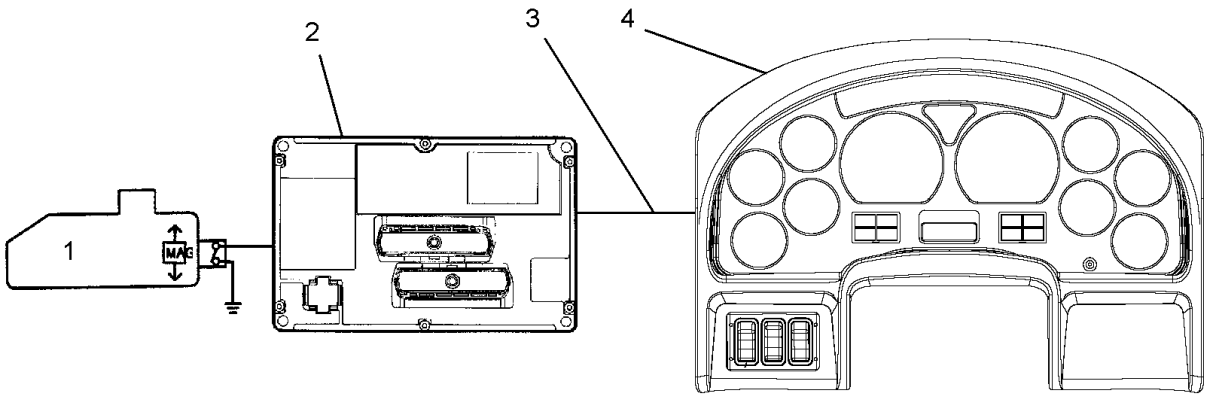


Figure 103 Coolant Level Warning Lamp Diagram

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

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

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

Diagnostics

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

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

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

Table 44 Coolant Level Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	On	Verify coolant warning lamp is malfunctioning. Check level in coolant tank.	Coolant warning lamp is on when coolant level is not low or lamp is off when coolant is low.	Go to next step.	Problem does not exist or is intermittent.
2.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programing in the Electrical System Controller section of this manual. (See PROGRAMMING, page 115)
3.	On	Attempt to exercise the coolant warning lamp with the "Diamond Logic Builder™" diagnostic software.	Coolant warning lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
4.	On	Use "Diamond Logic Builder™" diagnostic software to verify coolant level commands from the engine controller are being generated and match coolant level.	Commands from the engine controller are being generated and match coolant level.	Go to next step.	Message from engine controller is not being transmitted. Refer to the engine troubleshooting manual for the engine installed in the vehicle.
5.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 125)

4.16. PARK BRAKE WARNING LAMP

Circuit Function

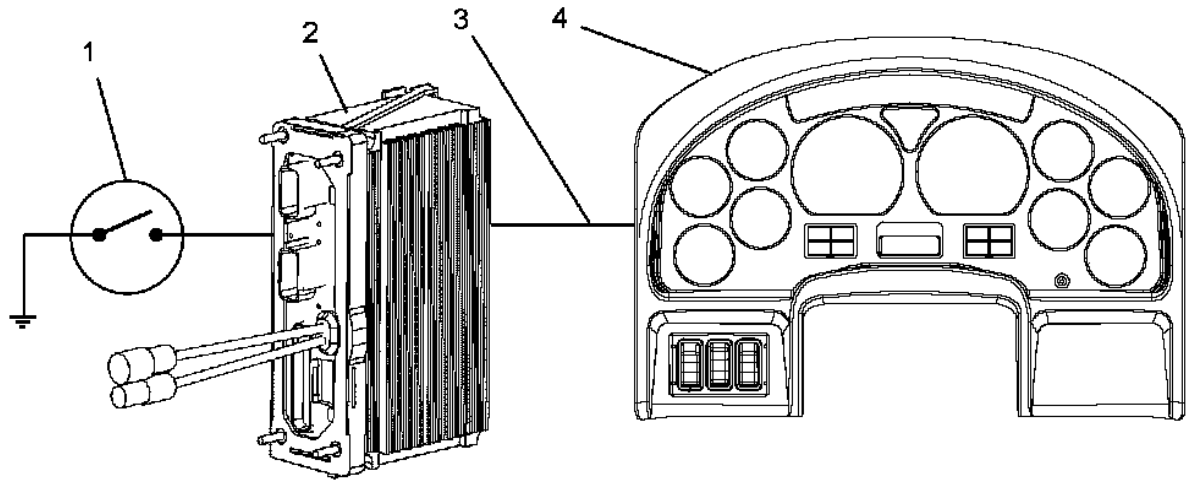


Figure 104 Park Brake Warning Lamp Function Diagram

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

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

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

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

Diagnostics

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

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

Table 45 Park Brake Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programing in the Electrical System Controller section of this manual. (See PROGRAMMING, page 115)
2.	On	Attempt to exercise the warning lamp with the "Diamond Logic Builder™" diagnostic software.	Warning Lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
3.	On	Check for Park Brake Warning Lamp diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 190) Read display on odometer.	Park Brake Warning Lamp diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 191)	Go to next step
4.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 125)

Diagnostic Trouble Codes (DTC)

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

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

Table 46 Park Brake Warning Lamp Diagnostic Trouble Codes

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

Fault Detection/ Management

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

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

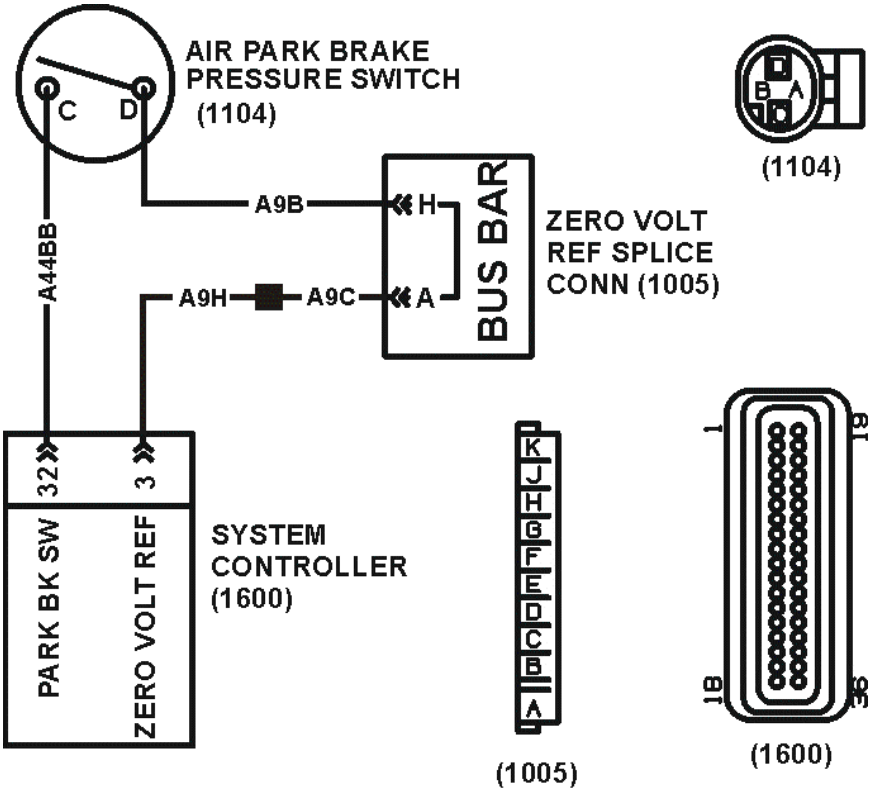


Figure 105 Air Park Brake Circuits — Always Refer to Circuit Diagram Book for Latest Circuit Information

(1005) ZERO VOLT REFERENCE SPLICE CONNECTION
LOCATED RIGHT SIDE INSTRUMENT PANEL
(1104) AIR PARK BRAKE PRESS SWITCH
LOCATED AT INSTRUMENT WING PANEL
(1600) SYSTEM CONTROLLER
LOCATED AT INSIDE RIGHT SIDE DASH PANEL

Table 47 Air Park Brake Lamp Circuits Voltage Check Chart

Air Park Brake Pressure Switch Connector (1104) Voltage Checks Check with ignition in key switch position on and air park brake pressure switch connector (1104) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.** **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**		
Test Points	Spec.	Comments
(1104) harness connector cavity D to ground.	0 volts	If voltage is incorrect, check for open or short on circuits A9B, A9C and A9H. Also ensure proper zero volt reference signal from system controller (1600) pin 3.

Table 47 Air Park Brake Lamp Circuits Voltage Check Chart (cont.)

Air Park Brake Pressure Switch Connector (1104) Voltage Checks Check with ignition in key switch position on and air park brake pressure switch connector (1104) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.** **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**		
Test Points	Spec.	Comments
		NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.
(1104) harness connector cavity D to cavity C.	0 volts	If voltage is incorrect, check for open or short on circuit A44BB. Also ensure proper input signal from system controller (1600) pin 32. **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.** If circuits check good and failure is still present, replace air park brake pressure switch.
There are no diagnostic trouble codes associated with this feature.		

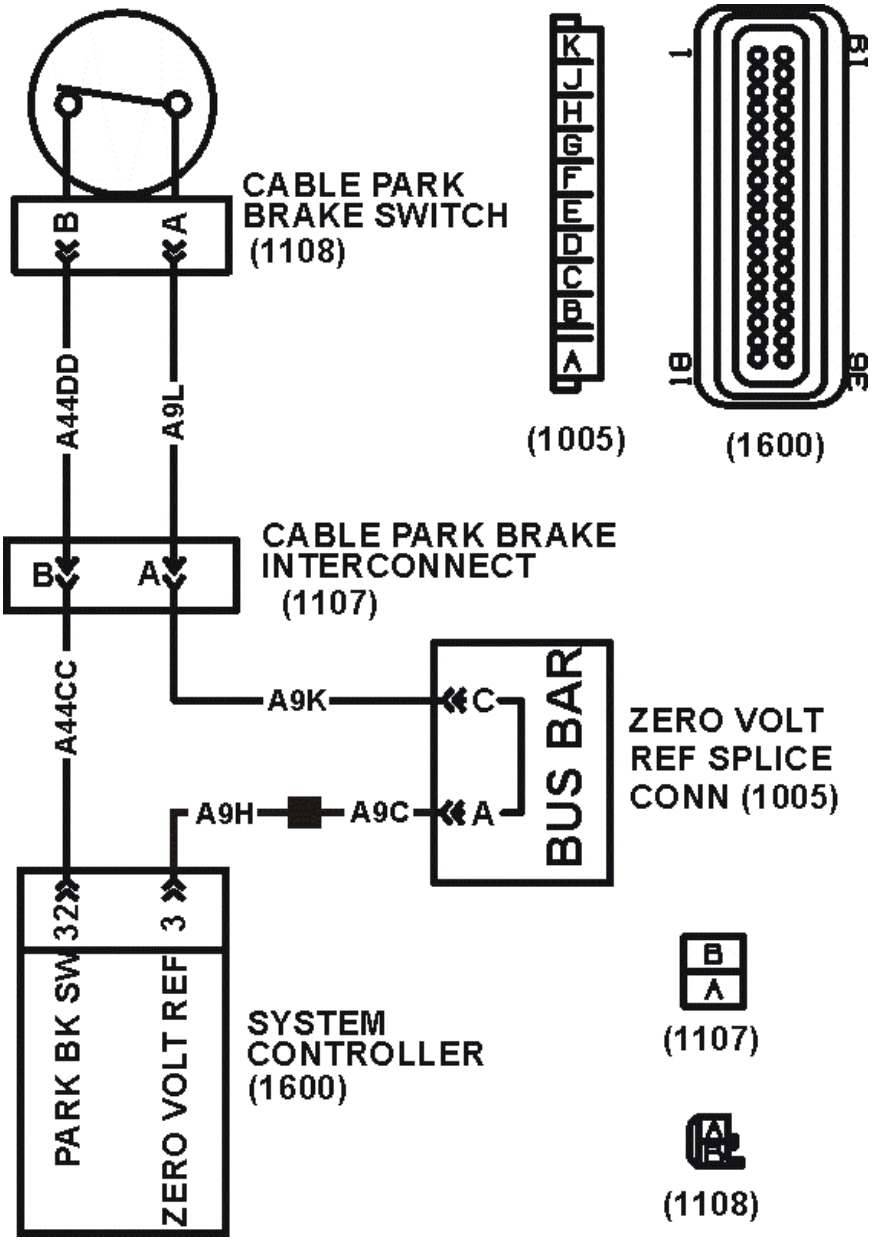


Figure 106 Cable Park Brake Circuits — Always Refer to Circuit Diagram Book for Latest Circuit Information

(1005) ZERO VOLT REFERENCE SPLICE CONNECTION
LOCATED RIGHT SIDE INSTRUMENT PANEL
(1107) CABLE PARK BRAKE INTERCONNECT
LOCATED ABOVE ACCELERATOR PEDAL
(1108) CABLE PARK BRAKE SWITCH
LOCATED NEAR DRIVERS SEAT
(1600) SYSTEM CONTROLLER
LOCATED AT INSIDE RIGHT SIDE DASH PANEL

Table 48 Cable Park Brake Lamp Circuits Voltage Check Chart

Cable Park Brake Switch Connector (1108) Voltage Checks Check with ignition in key switch position on and cable park brake switch connector (1108) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.** **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**		
Test Points	Spec.	Comments
Cable park brake switch connector (1108) cavity A to ground.	0 volts	If voltage is incorrect, check for open or short on circuits A9L, A9K, A9C and A9H. Also ensure proper zero volt reference signal from system controller (1600) pin 3. **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**
Cable park brake switch connector (1108) cavity A to cavity B.	0 volts	If voltage is incorrect, check for open or short on circuit A44DD and A44CC. Also ensure proper input signal from system controller (1600) pin 32. **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.** If circuits check good and failure is still present, replace cable park brake switch.
There are no diagnostic trouble codes associated with this feature.		

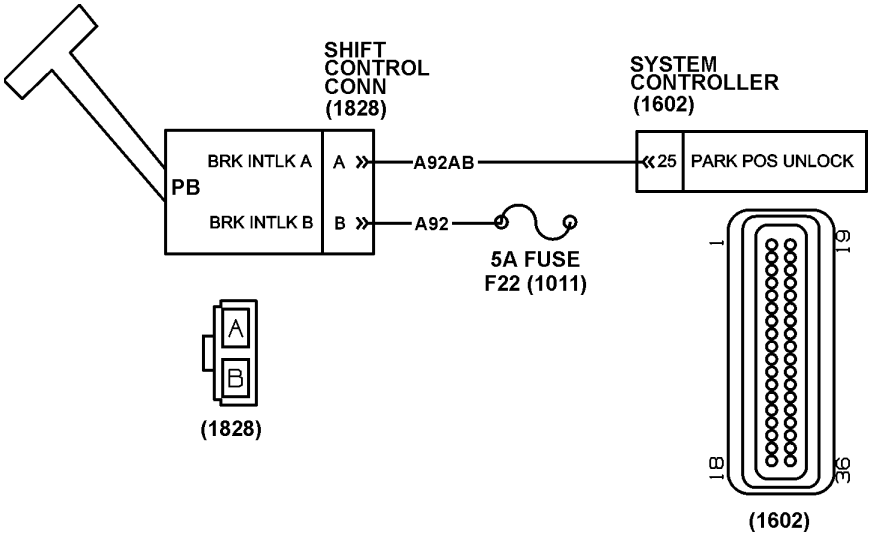


Figure 107 Hydraulic Park Brake Circuits (w/Full Power Brakes) — Always Refer to Circuit Diagram Book for Latest Circuit Information

(1011) FUSE BLOCK
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(1602) SYSTEM CONTROLLER
LOCATED AT INSIDE RIGHT SIDE DASH PANEL
(1828) LCT SHIFT CONTROL
LOCATED AT INSTRUMENT WING PANEL

Table 49 Hydraulic Park Brake Lamp Circuits Voltage Check Chart

Shift Control Connector (1828)) Voltage Checks Check with ignition in key switch position on and hydraulic park brake switch connector (1128) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.** **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**		
Test Points	Spec.	Comments
Shift control connector (1828) pin B to ground.	12 ± 1.5 volts	If voltage is incorrect, check for blown fuse F22. Also check for open or short in circuit A92.
Shift control connector (1828) pin B to pin A.	12 ± 1.5 volts	**NOTE – Park Brake Light should illuminate.** If voltage is correct check for open on circuit A92AB. If circuits check good and Park brake light still fails, the problem could be a faulty EGC or faulty ESC. Refer to their respective sections in this manual for troubleshooting guides.
There are no diagnostic trouble codes associated with this feature.		

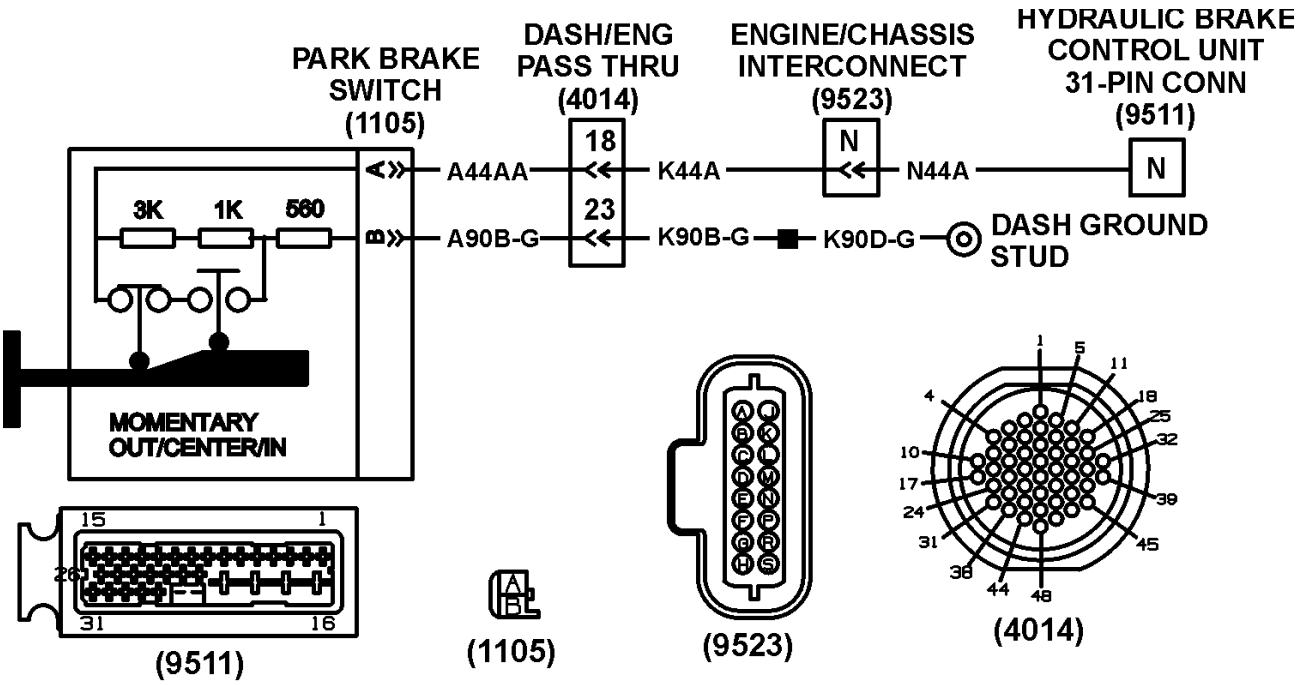


Figure 108 Hydraulic Park Brake Circuits (w/Momentary Switch) — Always Refer to Circuit Diagram Book for Latest Circuit Information

(1105) HYDRAULIC PARK BRAKE SWITCH
LOCATED AT INSTRUMENT WING PANEL
(4014) DASH ENGINE PASS THRU
LOCATED AT INSIDE LEFT SIDE DASH PANEL
(9511) HYDRAULIC BRAKE CONTROL UNIT
LOCATED AT INSIDE LEFT FRAME RAIL AT HCU
(9523) ENGINE/CHASSIS INTERCONNECT
LOCATED AT INSIDE LEFT FRAME RAIL BEHIND ENGINE

Table 50 Hydraulic Park Brake Circuits (w/Momentary Switch) Voltage Check Chart

Hydraulic Park Brake Switch (1105) Resistance Checks Check with hydraulic park brake switch connector (1105) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Park brake switch connector (1105) cavity A to cavity B (with switch in “middle” position).	approx. 1.56 Kohms	If resistance is incorrect, replace park brake switch.
Park brake switch connector (1105) cavity A to cavity B (with switch in “out” position).	approx. 4.56 Kohms	If resistance is incorrect, replace park brake switch.

Table 50 Hydraulic Park Brake Circuits (w/Momentary Switch) Voltage Check Chart (cont.)

Hydraulic Park Brake Switch (1105) Resistance Checks Check with hydraulic park brake switch connector (1105) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Park brake switch connector (1105) cavity A to cavity B (with switch in “in” position).	approx. 560 ohms	If resistance is incorrect, replace park brake switch. If switch resistances are correct and failure still exists, the check for open of short on circuits N44A, K44A, A44AA, A90B-G, K90B-G and K90D-G. If all circuits check good, then hydraulic brake control unit may need replaced or reprogrammed.
There are no diagnostic trouble codes associated with this feature.		

Extended Description

On vehicles with a hydraulic park brake, a 12 volt signal from fuse F22 is applied to the System Controller at connector (1602) pin 25 with the shifter is in the “PB” position. This tells the ESC that the park brake is engaged.

On vehicles with an air or cable park brake, the zero volt reference level is supplied from ESC connector (1600) terminal 3 to the zero volt reference splice connection (1005) to the park brake switch connector (1104) terminal D.

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

Component Locations

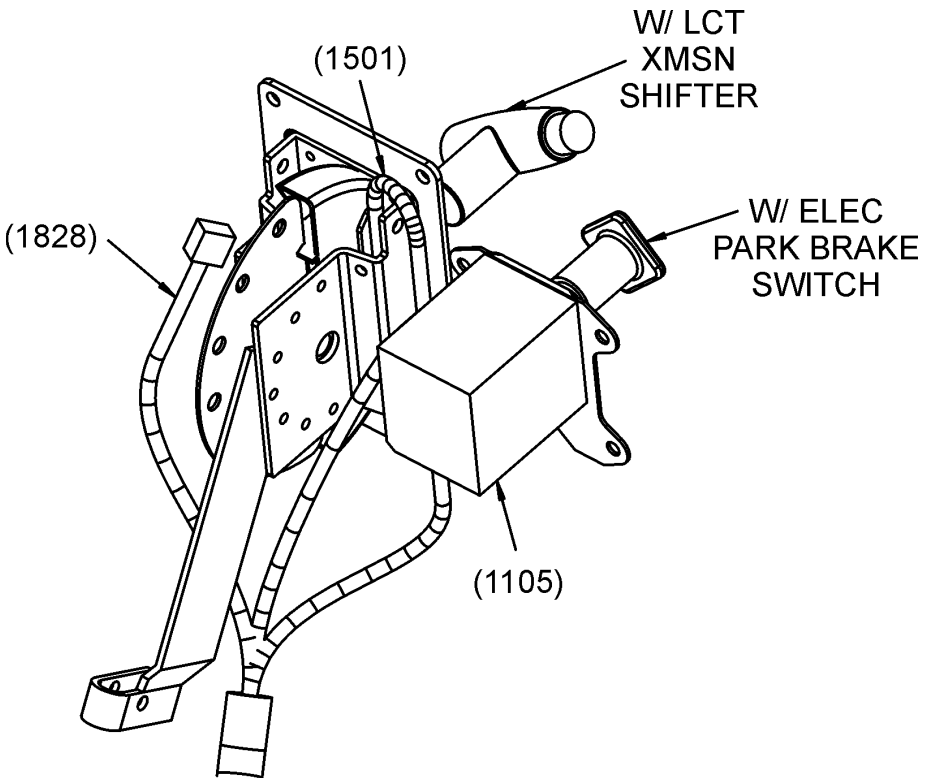


Figure 109 Park Brake Switch Location (With Hydraulic Brakes)

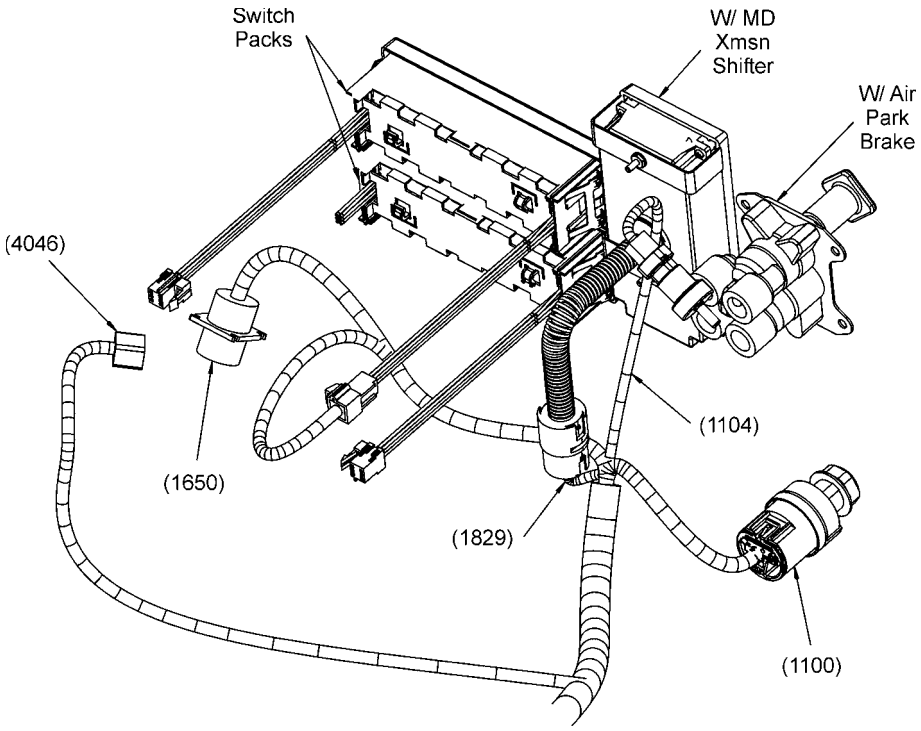


Figure 110 Air Park Brake Switch Location (Steering Column Support View)

(1104) AIR PARK BRAKE PRESS SWITCH

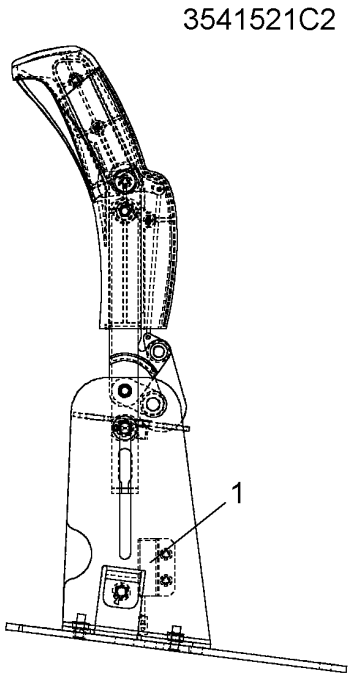


Figure 111 Cable Park Brake Switch Location

1. CABLE PARK BRAKE PRESS SWITCH

4.17. SERVICE PARK BRAKE WARNING LAMP

Circuit Function

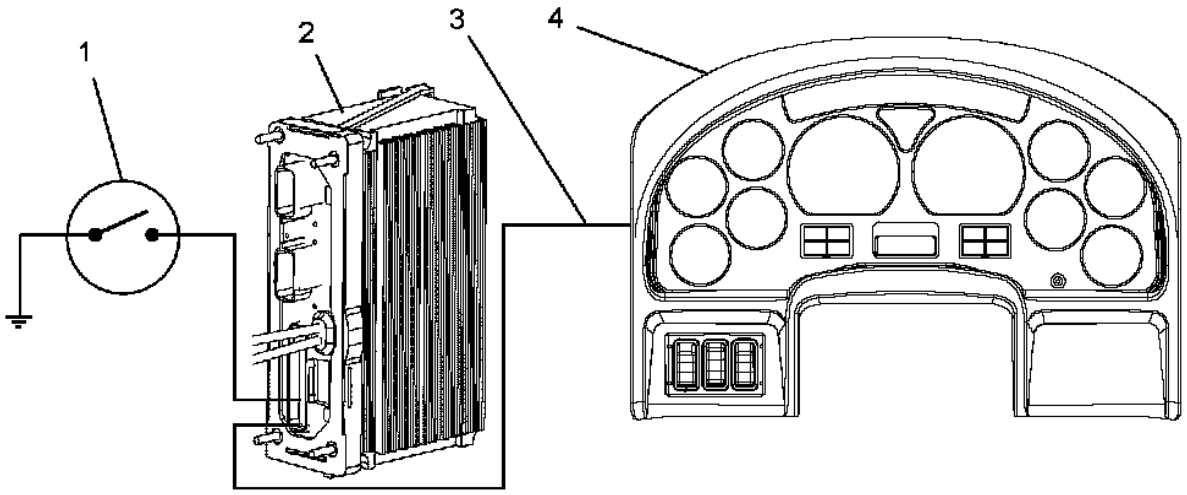


Figure 112 Service Park Brake Warning Lamp Function Diagram

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

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

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

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

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

Outputs:

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

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

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

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

Diagnostics

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

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

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

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

Table 51 Service Park Brake Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programming in the Electrical System Controller section of this manual. (See PROGRAMMING, page 115)
2.	On	Attempt to exercise the warning lamp with the "Diamond Logic Builder™" diagnostic software.	Warning Lamp responds to EGC diagnostic input.	Lamp circuits from data link to EGC are working correctly.	Insure bulb is not burned out. Replace EGC circuit board.
3.	On	Check for Service Park Brake Warning Lamp diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 205) Read display on odometer.	Service Park Brake Warning Lamp diagnostic trouble codes are active.	Go to the Air Actuated Park Brake in the Chassis Features section of the manual.(See Air Actuated Park Brake, page 705)	Go to next step
4.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 125)

Diagnostic Trouble Codes (DTC)

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

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

Table 52 Service Park Brake Warning Lamp Diagnostic Trouble Codes

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

4.18. CRUISE CONTROL LAMP

Circuit Function

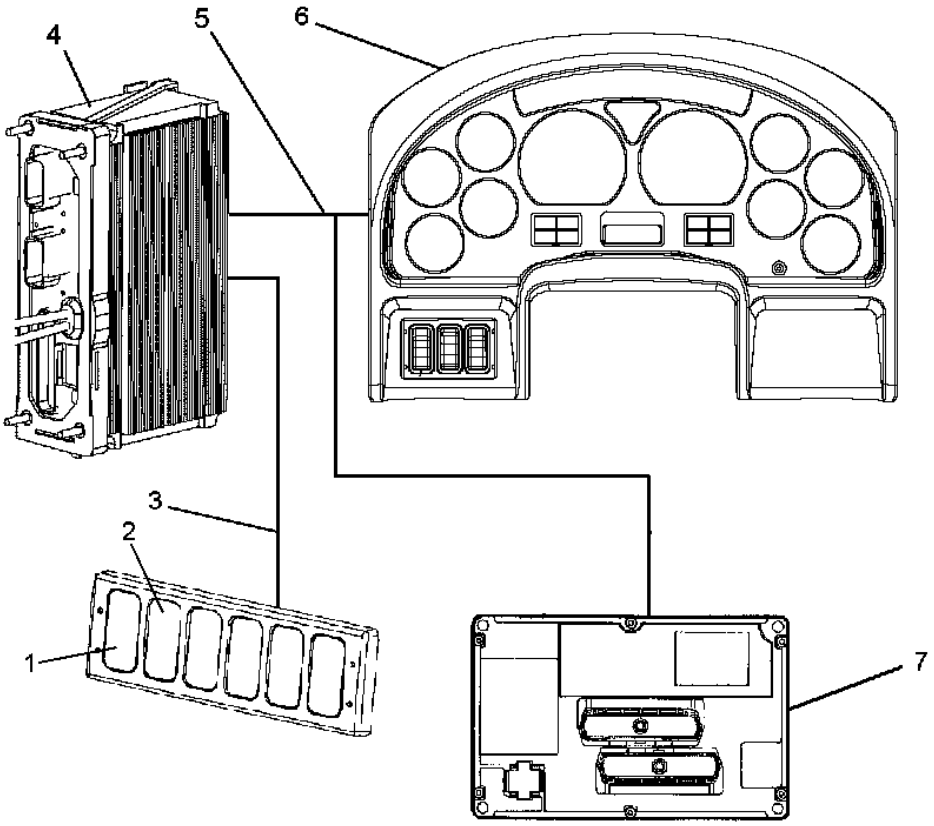


Figure 113 Cruise Control Lamp Function Diagram

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

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

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

Diagnostics

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

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

For problems with the cruise control activating refer to Cruise Control. (See CRUISE CONTROL, page 349)

There are no diagnostic trouble codes for cruise control circuits.

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

Table 53 Cruise Control Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	On	Verify cruise control is functioning. Insure the brake and clutch are released, there are no active brake or clutch DTC's and no ABS/ATC events.	Cruise control is functioning.	Go to next step.	Go to Cruise Control. (See CRUISE CONTROL, page 349)
2.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programing in the Electrical System Controller section of this manual. (See PROGRAMMING, page 115)
3.	On	Attempt to exercise the cruise lamp with the "Diamond Logic Builder™" diagnostic software.	Cruise lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.

Table 53 Cruise Control Lamp Preliminary Check (cont.)

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
4.	Off/On	Temporarily swap a known good cluster with the current cluster and check operation of the lamp. Activate cruise control and verify lamp operation.	Lamp operates correctly.	Message from ESC is being transmitted. Replace circuit board on original EGC.	Go to next step.
5.	On	Use "Diamond Logic Builder™" diagnostic software to verify cruise commands from the engine controller are being generated.		Message from ESC is not being transmitted. Consider replacing ESC . (See ESC REPLACEMENT, page 125)	Message from engine controller is not being transmitted. Refer to the engine troubleshooting manual for the engine installed in the vehicle.

4.19. ABS WARNING LAMP

Circuit Function

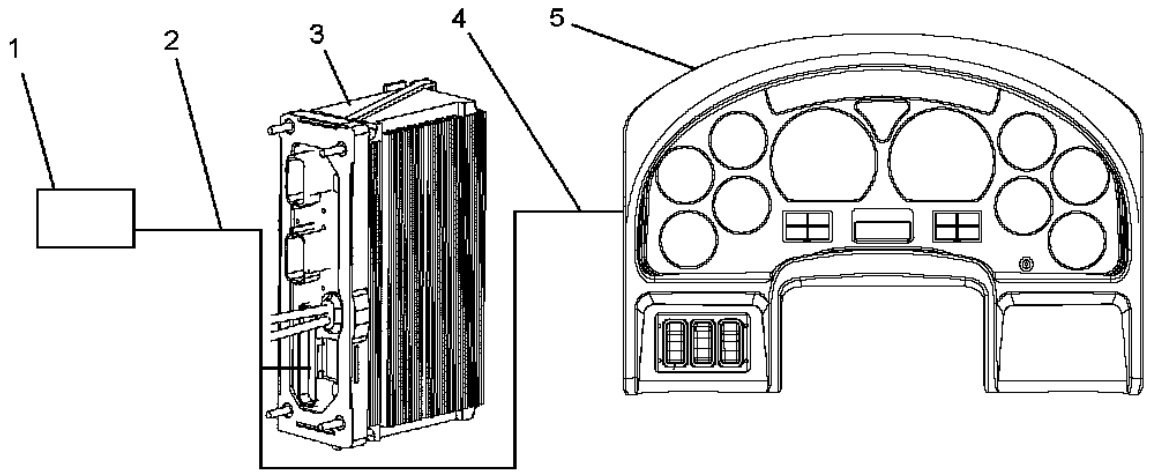


Figure 114 ABS Warning Lamp Function Diagram

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

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

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

See the appropriate ABS manual for details.

Diagnostics

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

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

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

Table 54 ABS Warning Lamp preliminary check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programing in the Electrical System Controller section of this manual. (See PROGRAMMING, page 115)
2.	On	Attempt to exercise the warning lamp with the "Diamond Logic Builder™" diagnostic software.	Warning lamp responds to EGC diagnostic input.	Lamp circuits from data link to EGC are working correctly. Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
3.	On	Check for ABS Warning Lamp diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 209) Read display on odometer.	ABS Warning Lamp diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 210)	Go to next step
4.	On	Monitor the inputs for the warning lamp with the "Diamond Logic Builder™" diagnostic software.	Inputs are correct.	Go to next step.	Refer to the troubleshooting manual for the specific ABS installed on the bus.

Diagnostic Trouble Codes (DTC)

To display diagnostic codes, put the vehicle in diagnostic mode. Set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch. If no diagnostic trouble

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

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

Table 55 ABS Warning Lamp Diagnostic Trouble Codes

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

Fault Detection/ Management

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

4.20. WAIT TO START WARNING LAMP

Circuit Function

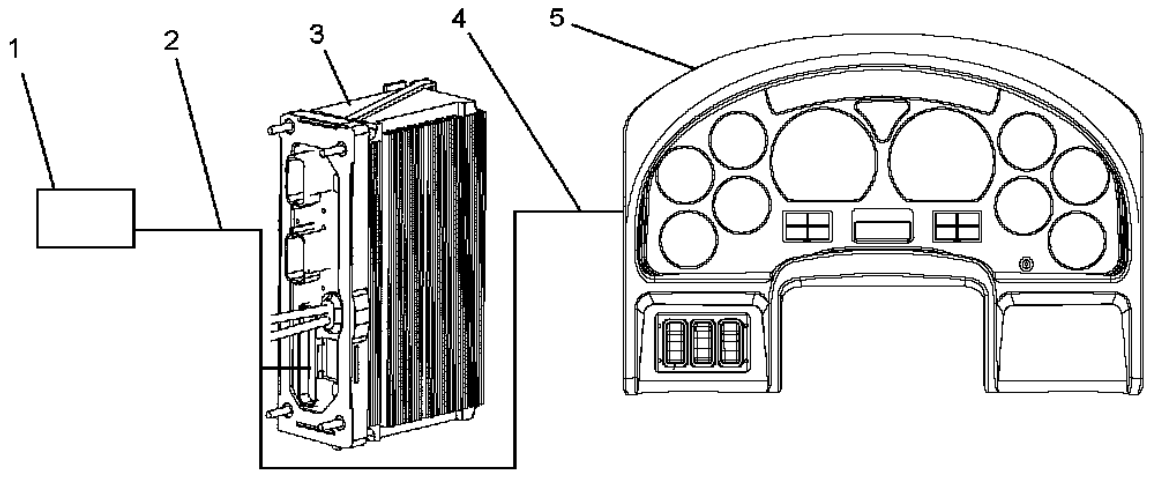


Figure 115 “Wait To Start” Warning Lamp Function Diagram

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

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

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

Fault Detection/Management

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

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

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

Diagnostics

Table 56 Wait To Start Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programming in the Electrical System Controller section of this manual. (See PROGRAMMING, page 115)
2.	On	Attempt to exercise the warning lamp with the "Diamond Logic Builder™" diagnostic software.	Warning Lamp responds to diagnostic input.	Lamp circuits from data link to EGC are working correctly.	Insure bulb is not burned out. Replace EGC circuit board.

4.21. RETARD OVERHEAT WARNING LAMP

Circuit Function

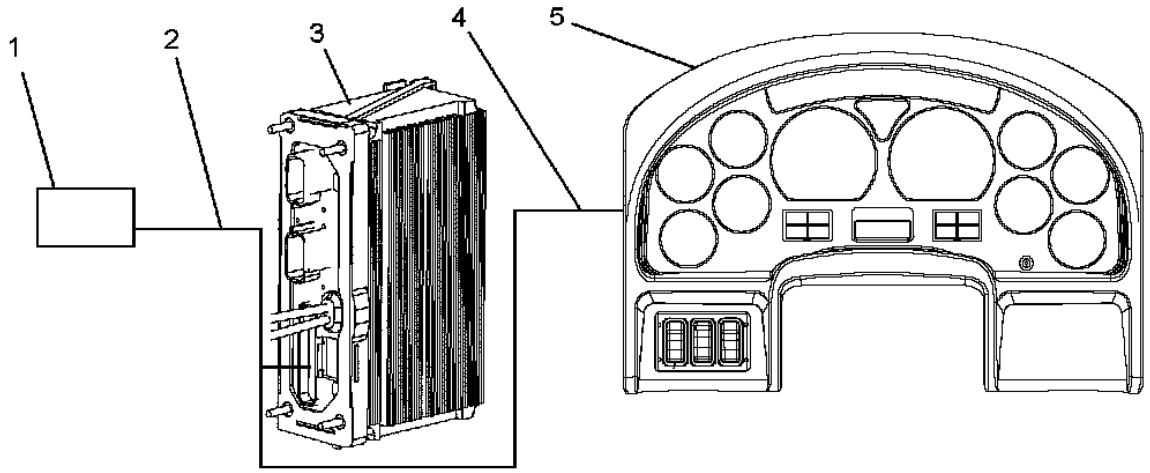


Figure 116 Retard Overheat Warning Lamp Function Diagram

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

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

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

Diagnostics

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

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

See the appropriate transmission manual for details.

Table 57 Retard Overheat Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programing in the Electrical System Controller section of this manual. (See PROGRAMMING, page 115)
2.	On	Attempt to exercise the warning lamp with the "Diamond Logic Builder™" diagnostic software.	Warning lamp responds to EGC diagnostic input.	Lamp circuits from data link to EGC are working correctly.	Insure bulb is not burned out. Replace EGC circuit board.

Diagnostics

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

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

See the appropriate engine manual for details on PTO operation.

Table 58 Retard Overheat Warning Lamp Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify warning lamp and warning lamp inputs are programmed to operate.	Warning lamp and warning lamp inputs are programmed to operate.	Go to next step.	Program the warning lamp with the "ICAP" software. Refer to Programing in the Electrical System Controller section of this manual. (See PROGRAMMING, page 115)

Table 58 Retard Overheat Warning Lamp Preliminary Check (cont.)

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
2.	On	Attempt to exercise the warning lamp with the "Diamond Logic Builder™" diagnostic software.	Warning lamp responds to EGC diagnostic input.	Go to next step.	Insure bulb is not burned out. Replace EGC circuit board.
3.	On	Attempt to exercise the warning lamp with the "Diamond Logic Builder™" diagnostic software.	Warning lamp responds to EGC diagnostic input.	Lamp circuits from data link to EGC are working correctly.	Insure bulb is not burned out. Replace EGC circuit board.

4.23. ALTERNATOR WARNING LAMP

Circuit Function

Refer to Alternator Warning Lamp Function Diagram.

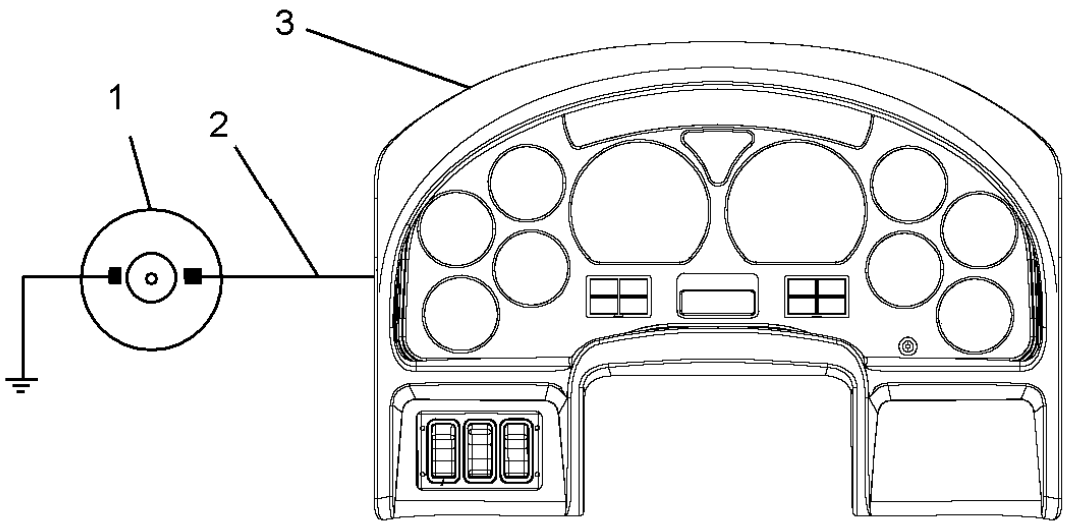


Figure 117 Alternator Warning Lamp Function Diagram

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

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

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

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

4.24. VOLTMETER

Circuit Function

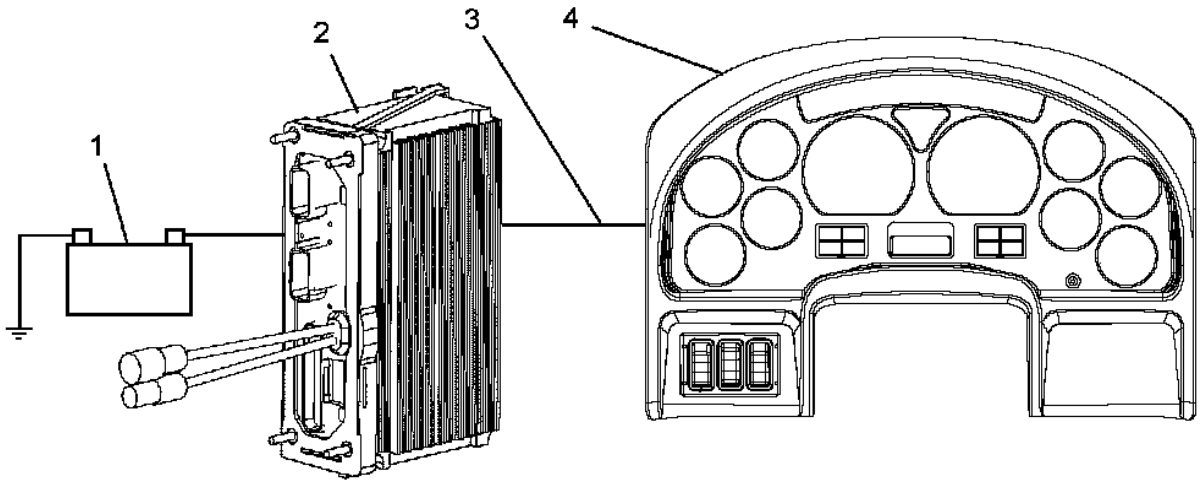


Figure 118 Voltmeter Function Diagram

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

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

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

Diagnostics

The service tool (EZ-Tech®) running the "Diamond Logic Builder™" diagnostic software can be used to check operation of the gauge.

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

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

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

Table 59 Voltmeter Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the gauge operate correctly during gauge sweep?	Gauge sweeps from minimum to maximum and back.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install. page 261
2.	On	Check for Voltmeter gauge diagnostic trouble codes. Read display on odometer.	Voltmeter gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 227)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.	Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
4.	On	Attempt to exercise the gauge with the "Diamond Logic Builder™" diagnostic software.	Gauge responds to "Diamond Logic Builder™" diagnostic input.	If gauge responds to diagnostic tool, but does not work during normal operations, replace the ESC.	Verify jumper harness between gauge and circuit board is in correct locations. If jumper locations are correct, replace EGC circuit board.
5.	Consider replacing ESC. (See ESC REPLACEMENT, page 125)				

Diagnostic Trouble Codes (DTC)

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

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

Table 60 Voltmeter Gauge Diagnostic Trouble Codes

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

Fault Detection/ Management

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

4.25. ENGINE COOLANT TEMPERATURE GAUGE

Circuit Function

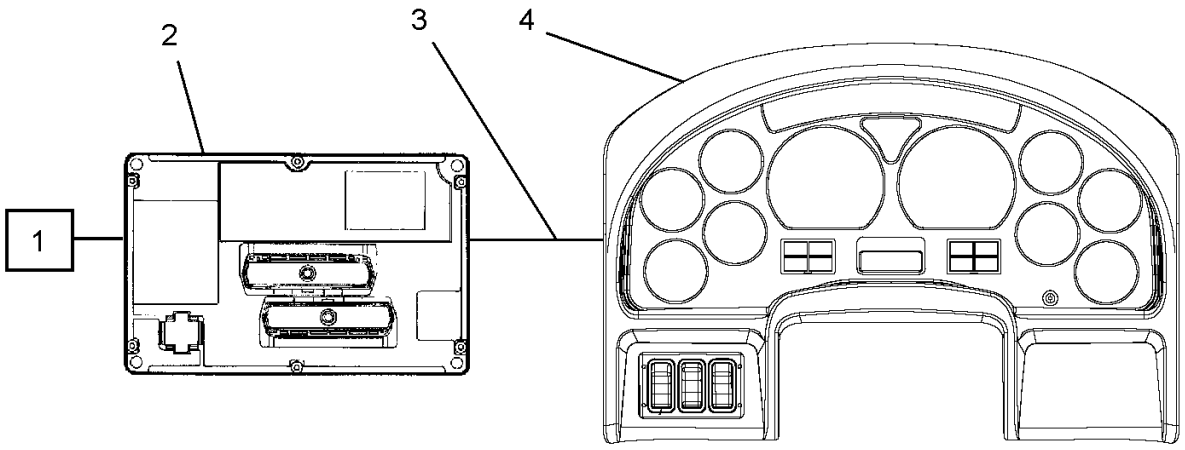


Figure 119 Engine Coolant Temperature Gauge Function Diagram

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

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

Diagnostics

The service tool (EZ-Tech®) running the "Diamond Logic Builder™" diagnostic software can be used to check operation of the gauge.

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

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

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

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

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

Table 61 Engine Coolant Temperature Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the gauge operate correctly during gauge sweep?	Gauge sweeps from minimum to maximum and back.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install. page 261
2.	On	Check for Engine Coolant Temperature gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 219) Read display on odometer.	Engine Coolant Temperature gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 220)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.	Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
4.	On	Attempt to exercise the gauge with the "Diamond Logic Builder™" diagnostic software.	Gauge responds to "Diamond Logic Builder™" diagnostic input.	If gauge responds to diagnostic tool, but does not work during normal operations, replace the ESC.	Verify jumper harness between gauge and circuit board is in correct locations. If jumper locations are correct, replace EGC circuit board.
5.	Engine coolant temperature message is not being generated by the engine controller. Refer to the applicable engine troubleshooting manual for this vehicle.				
6.	Consider replacing ESC.(See ESC REPLACEMENT, page 125)				

Diagnostic Trouble Codes (DTC)

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

or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

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

Table 62 Engine Coolant Temperature Gauge Diagnostic Trouble Codes

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

Fault Detection/ Management

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

4.26. ENGINE OIL PRESSURE GAUGE

Circuit Function

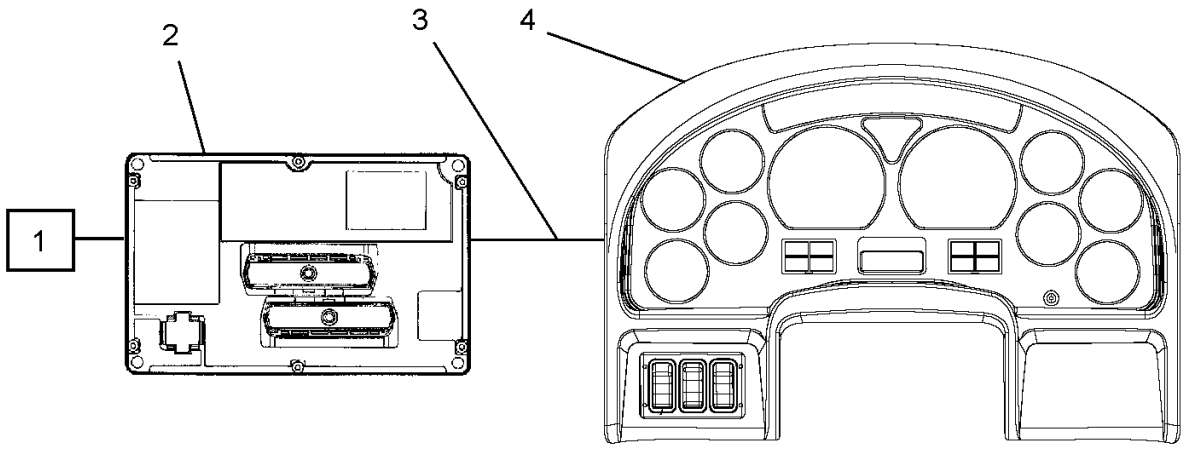


Figure 120 Engine Oil Pressure Gauge Function Diagram

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

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

Diagnostics

The service tool (EZ-Tech®) running the "Diamond Logic Builder™" diagnostic software can be used to check operation of the gauge.

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

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

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

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

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

Table 63 Engine Oil Pressure Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the gauge operate correctly during gauge sweep?	Gauge sweeps from minimum to maximum and back.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install.page 261
2.	On	Check for Engine Oil Pressure gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 222) Read display on odometer.	Engine Oil Pressure gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 223)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.	Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
4.	On	Attempt to exercise the gauge with the "Diamond Logic Builder™" diagnostic software.	Gauge responds to "Diamond Logic Builder™" diagnostic input.	If gauge responds to diagnostic tool, but does not work during normal operations, replace the ESC.	Verify jumper harness between gauge and circuit board is in correct locations. If jumper locations are correct, replace EGC circuit board.
5.	Engine oil pressure message is not being generated by the engine controller. Refer to the applicable engine troubleshooting manual for this vehicle.				
6.	Consider replacing ESC. (See ESC REPLACEMENT, page 125)				

Diagnostic Trouble Codes (DTC)

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

or “P” for previously active diagnostic trouble codes. Turning the ignition key off or releasing the park brake will take the ESC and the gauge cluster out of the diagnostic mode.

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

Table 64 Engine Oil Pressure Gauge Diagnostic Trouble Codes

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

Fault Detection/ Management

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

4.27. PYROMETER GAUGE – (THIS FEATURE IS NOT CURRENTLY AVAILABLE)

This figure is no longer used and was intentionally left blank.

Figure 121 Unused Figure

Table 65 Unused Table

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
This table is no longer used and was intentionally left blank.						

4.28. SPEEDOMETER

Circuit Function

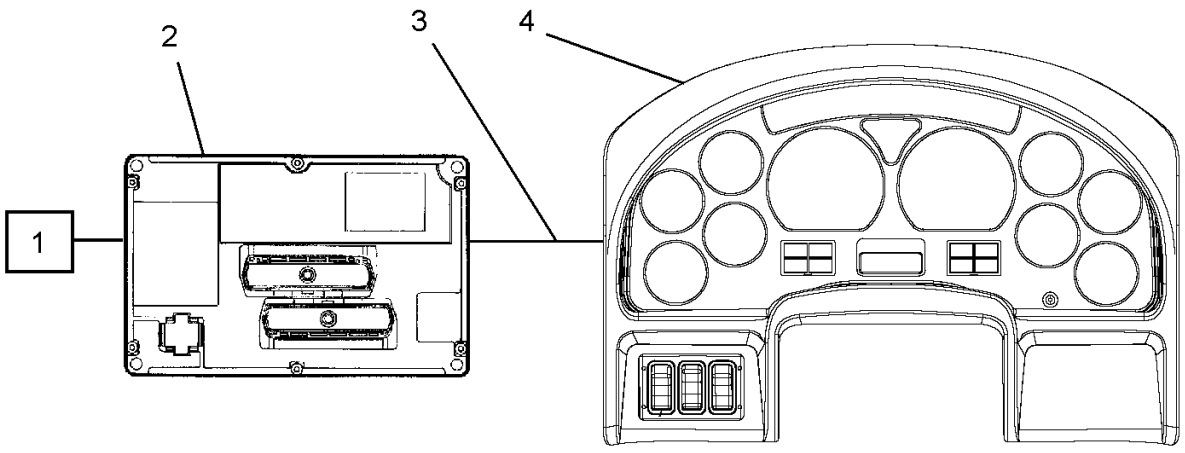


Figure 122 Speedometer Function Diagram

1. VEHICLE SPEED SIGNAL (VSS)
2. ELECTRONIC ENGINE CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving the speedometer is provided on the Drivetrain 1939 data link from the engine controller. The engine controller generates this information based on the vehicle speed signal from a sensor on the transmission or from the transmission control module.

Diagnostics

If the speedometer go to zero, sweep up to 50% and return to zero three times, there is a sensor error.

The service tool (EZ-Tech®) running the "Diamond Logic Builder™" diagnostic software can be used to check operation of the gauge.

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

Problems with the speedometer can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, a loss of programming, a problem in the engine controller or missing signal from the vehicle speed sensor (VSS) or transmission controller.

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

Table 66 Speedometer Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the gauge operate correctly during gauge sweep?	Gauge sweeps from minimum to maximum and back.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install. page 261
2.	On	Check for Speedometer gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 226) Read display on odometer.	Speedometer gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 227)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.	Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.

Table 66 Speedometer Preliminary Check (cont.)

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
4.	On	Attempt to exercise the gauge with the "Diamond Logic Builder™" diagnostic software.	Gauge responds to "Diamond Logic Builder™" diagnostic input.	If gauge responds to diagnostic tool, but does not work during normal operations, replace the ESC.	Verify jumper harness between gauge and circuit board is in correct locations. If jumper locations are correct, replace EGC circuit board.
5.	Speedometer signal is not being transmitted from the engine controller. Refer to the applicable engine troubleshooting manual for this vehicle. Also refer to the appropriate transmission troubleshooting manual. Manual transmissions use the traditional vehicle speed sensor (VSS). Automatic transmissions transmit the signal from the transmission ECU.				
6.	Consider replacing ESC. (See ESC REPLACEMENT, page 125)				

Diagnostic Trouble Codes (DTC)

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

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

Table 67 Speedometer Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
1705 14 102 3 (EGC Version 8.7)	EGC gauge location 2 (Speedometer) out of range high Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 102 4 (EGC Version 8.7)	EGC gauge location 2 (Speedometer) out of range low Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 102 5 (EGC Version 8.7)	EGC gauge location 2 (Speedometer) sensor fault There is a problem with the sensor that provides the data for this gauge.
1705 14 102 6 (EGC Version 8.7)	EGC gauge location 2 (Speedometer) data unavailable The data that this gauge displays should be, but is not available at this time.

Table 67 Speedometer Gauge Diagnostic Trouble Codes (cont.)

2023 14 102 5 or 2023 14 202 5 (EGC Version 9.3 and later)	Speedometer sensor fault to primary EGC (102) or secondary EGC (202) There is a problem with the sensor that provides the data for this gauge.
2023 14 102 6 or 2023 14 202 6 (EGC Version 9.3 and later)	Speedometer gauge data unavailable to primary EGC (102) or secondary EGC (202) The data that this gauge displays should be, but is not available at this time.
2023 14 102 7 or 2023 14 202 7 (EGC Version 9.3 and later)	Speedometer gauge data missing to primary EGC (102) or secondary EGC (202) The data for this gauge is not being transmitted on the datalink.

Fault Detection/ Management

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

4.29. TACHOMETER

Circuit Function

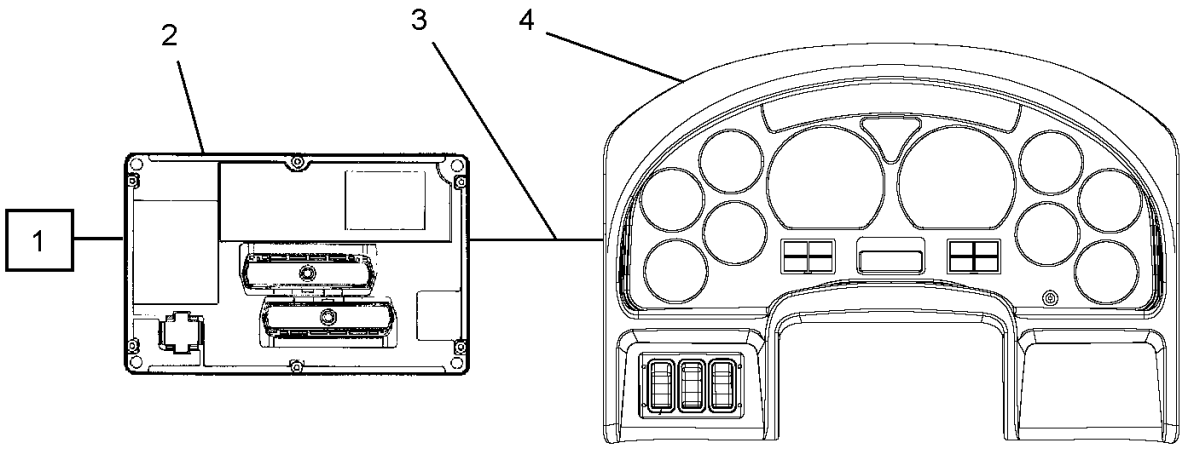


Figure 123 Tachometer Function Diagram

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

Information driving the tachometer is provided on the Drivetrain 1939 data link from the engine controller.

Diagnostics

If the tachometer goes to zero, sweeps up to 50% and returns to zero three times, there is a sensor error.

The service tool (EZ-Tech®) running the "Diamond Logic Builder™" diagnostic software can be used to check operation of the gauge.

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

Problems with the tachometer can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, a loss of programming, a problem in the engine controller, a problem with the engine tachometer sensor or a problem with wiring to the sensor.

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

Table 68 Tachometer Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the gauge operate correctly during gauge sweep?	Gauge sweeps from minimum to maximum and back.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install. page 261
2.	On	Check for Tachometer gauge diagnostic trouble codes. Read display on odometer.	Tachometer gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 230)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.	Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
4.	On	Attempt to exercise the gauge with the "Diamond Logic Builder™" diagnostic software.	Gauge responds to "Diamond Logic Builder™" diagnostic input.	If gauge responds to diagnostic tool, but does not work during normal operations, replace the ESC.	Verify jumper harness between gauge and circuit board is in correct locations. If jumper locations are correct, replace EGC circuit board.
5.	Tachometer signal is not being transmitted from the engine controller. Refer to the applicable engine troubleshooting manual for this vehicle.				
6.	Consider replacing ESC. (See ESC REPLACEMENT, page 125)				

Diagnostic Trouble Codes (DTC)

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

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

Table 69 Tachometer Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
1705 14 101 3 (EGC Version 8.7)	EGC gauge location 1 (Tachometer) out of range high Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 101 4 (EGC Version 8.7)	EGC gauge location 1 (Tachometer) out of range low Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 101 5 (EGC Version 8.7)	EGC gauge location 1 (Tachometer) sensor fault There is a problem with the sensor that provides the data for this gauge.
1705 14 101 6 (EGC Version 8.7)	EGC gauge location 1 (Tachometer) data unavailable The data that this gauge displays should be, but is not available at this time.
2023 14 101 5 or 2023 14 201 5 (EGC Version 9.3 and later)	Tachometer sensor fault to primary EGC (101) or secondary EGC (201) There is a problem with the sensor that provides the data for this gauge.
2023 14 101 6 or 2023 14 201 6 (EGC Version 9.3 and later)	Tachometer gauge data unavailable to primary EGC (101) or secondary EGC (201) The data that this gauge displays should be, but is not available at this time.
2023 14 101 7 or 2023 14 201 7 (EGC Version 9.3 and later)	Tachometer gauge data missing to primary EGC (101) or secondary EGC (201) The data for this gauge is not being transmitted on the datalink.

Fault Detection/ Management

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

4.30. FUEL LEVEL GAUGE

Circuit Function

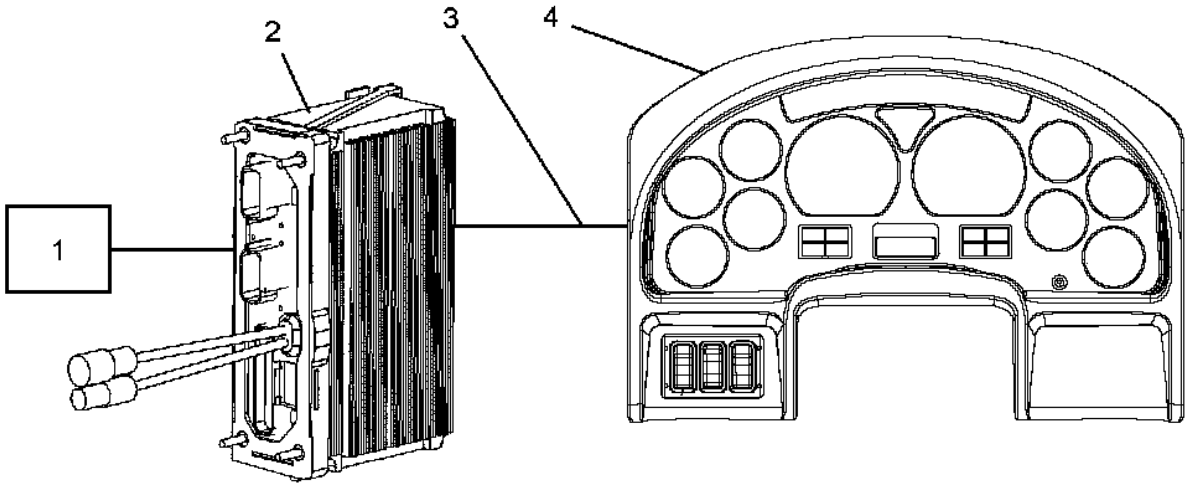


Figure 124 Fuel Level Gauge Function Diagram

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

Information driving the fuel level gauge is provided on the Drivetrain 1939 data link from the ESC. The ESC generates this information based on input from the fuel level sensor.

Diagnostics

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

The service tool (EZ-Tech®) running the "Diamond Logic Builder™" diagnostic software can be used to check operation of the gauge.

Problems with the fuel level gauge can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, an incorrect connection inside the EGC, a loss of programming, a problem in the ESC, a problem with the fuel level sensor or a problem with wiring to the sensor. The following procedures will provide guidance for determining why the gauge is malfunctioning.

Table 70 Fuel Level Gauge Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the fuel level gauge operate during the gauge sweep?		Gauge performs during gauge sweep.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install. page 261
2.	On	Check for fuel level gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 232)	Read display on odometer.	Fuel level gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 234)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.		Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
4.	On	Attempt to exercise the gauge with the "Diamond Logic Builder™" diagnostic software.		Gauge responds to "Diamond Logic Builder™" diagnostic input.	Go to next step.	Insure gauge operates during gauge sweep. Insure jumper harness between gauge and circuit board is in correct location. If jumper is correct, replace EGC circuit board.
5.	Consider replacing ESC. (See ESC REPLACEMENT, page 125)					

Diagnostic Trouble Codes (DTC)

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

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

Table 71 Fuel Level Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
612 14 23 1	Storage tank, fuel level sensor out of range low This code is associated with a short to ground on the fuel level sensor on the storage tank for dual tank vehicles. Short to ground
612 14 23 2	Storage tank, fuel sensor out of range high This code is associated with a short to accessory or open circuit on the fuel level sensor on the storage tank for dual tank vehicles. Shorted high or open circuit
612 14 25 1	Draw tank, fuel level sensor out of range low This code is associated with a short to ground on the fuel level sensor on the draw tank for both single tank and dual tank vehicles. Short to ground
612 14 25 2	Draw tank, fuel sensor out of range high This code is associated with a short to accessory or open circuit on the fuel level sensor on the draw tank for both single tank and dual tank vehicles. Shorted high or open circuit
1705 14 107 3 (EGC Version 8.7)	EGC gauge location 7 (fuel level) out of range high Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 107 4 (EGC Version 8.7)	EGC gauge location 7 (fuel level) out of range low Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 107 5 (EGC Version 8.7)	EGC gauge location 7 (fuel level) sensor fault There is a problem with the sensor that provides the data for this gauge.
1705 14 107 6 (EGC Version 8.7)	EGC gauge location 7 (fuel level) data unavailable The data that this gauge displays should be, but is not available at this time.

Table 71 Fuel Level Gauge Diagnostic Trouble Codes (cont.)

2023 14 107 5 or 2023 14 207 5 (EGC Version 9.3 and later)	Fuel gauge sensor fault to primary EGC (107) or secondary EGC (207) There is a problem with the sensor that provides the data for this gauge.
2023 14 107 6 or 2023 14 207 6 (EGC Version 9.3 and later)	Fuel gauge data unavailable to primary EGC (107) or secondary EGC (207) The data that this gauge displays should be, but is not available at this time.
2023 14 107 7 or 2023 14 207 7 (EGC Version 9.3 and later)	Fuel gauge data missing to primary EGC (107) or secondary EGC (207) The data for this gauge is not being transmitted on the datalink.

Fault Detection/ Management

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

A fault in the fuel sensor circuits will be apparent when the fuel gauge points straight down. Fuel sensor diagnostic trouble codes will also be present.

Problems in sensor circuits could be the result of open or shorted sensors, open circuits, shorted circuits, or a failure in the ESC.

Refer to Fuel Sensor Circuits.

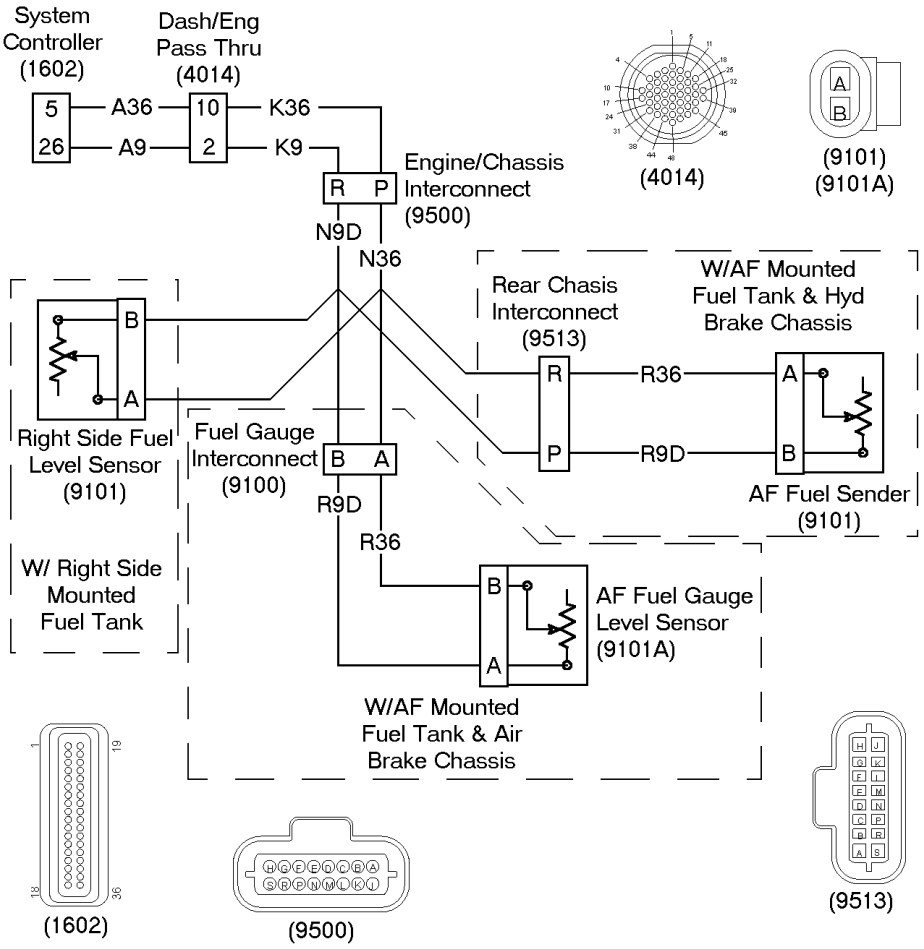


Figure 125 Fuel Sensor Circuits — Always Refer to Circuit Diagram Book for Latest Circuit Information

(1602) SYSTEM CONTROLLER
LOCATED AT INSIDE RIGHT SIDE DASH PANEL
(4014) DASH/ENGINE PASS THRU
LOCATED AT INSIDE LEFT SIDE DASH PANEL
(9100) FUEL GAUGE INTERCONNECT
LOCATED AT INSIDE LEFT FRAME RAIL BEHIND HCU
(9101) AF FUEL SENDER
LOCATED AT REAR MOUNTED FUEL TANK
(9101) RIGHT SIDE FUEL GAUGE LEVEL SENSOR
LOCATED AT OUTSIDE RIGHT FRAME RAIL
(9500) ENGINE/CHASSIS INTERCONNECT
LOCATED AT INSIDE LEFT FRAME RAIL BEHIND ENGINE
(9513) REAR CHASSIS INTERCONNECT
LOCATED AT INSIDE LEFT FRAME RAIL BEHIND HCU

Table 72 Fuel Level Gauge Diagnostic Trouble Codes

612 14 23 1	Driver fuel level sensor out of range low Short to ground
612 14 23 2	Driver fuel sensor out of range high Shorted high or open circuit
1705 14 107 3 (EGC Version 8.7)	EGC gauge location 7 (fuel level) out of range high Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 107 4 (EGC Version 8.7)	EGC gauge location 7 (fuel level) out of range low Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 107 5 (EGC Version 8.7)	EGC gauge location 7 (fuel level) sensor fault There is a problem with the sensor that provides the data for this gauge.
1705 14 107 6 (EGC Version 8.7)	EGC gauge location 7 (fuel level) data unavailable The data that this gauge displays should be, but is not available at this time.
2023 14 107 5 or 2023 14 207 5 (EGC Version 9.3 and later)	Fuel gauge sensor fault to primary EGC (107) or secondary EGC (207) There is a problem with the sensor that provides the data for this gauge.
2023 14 107 6 or 2023 14 207 6 (EGC Version 9.3 and later)	Fuel gauge data unavailable to primary EGC (107) or secondary EGC (207) The data that this gauge displays should be, but is not available at this time.
2023 14 107 7 or 2023 14 207 7 (EGC Version 9.3 and later)	Fuel gauge data missing to primary EGC (107) or secondary EGC (207) The data for this gauge is not being transmitted on the datalink.

Table 73 Fuel Level Gauge Tests

Fuel Level Gauge Voltage Checks Check with ignition on and fuel level sensor disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.** **Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**		
Test Points	Spec.	Comments
(9100) and (9101) cavity A or (9513) cavity R to ground.	10 ± 1 volts	If voltage is missing, check for open or shorts in circuit N36, K36 or A36 to ESC connector (1602) cavity 5. If circuits check good, check for missing 10 volt signal from ESC.
(9100) and (9101) cavity A to B or (9513) cavity R to P.	10 ± 1 volts	If voltage is present replace or repair fuel sensor. If voltage is missing, check for open in circuits N9D, K9, or A9 to ESC connector (1602) cavity 26. If circuits check good, check for missing zero volt reference from ESC.

Extended Description

A zero volt reference signal from ESC connector (1602) terminal 26 is supplied to fuel sensor connector (9100), (9101) terminal B or (9513) terminal P through circuit A9, Dash/Engine Pass Thru (4014), circuit K9, Engine/Chassis Interconnect (9500), and circuit N9D.

The signal from the fuel sensor is supplied from fuel sensor connector (9100), (9101) terminal A or (9513) terminal R to ESC connector (1602) terminal 5 through circuit N36, Engine/Chassis Interconnect (9500) terminal P, circuit K36, Dash/Engine Pass Thru (4010), and circuit A36.

Component Locations

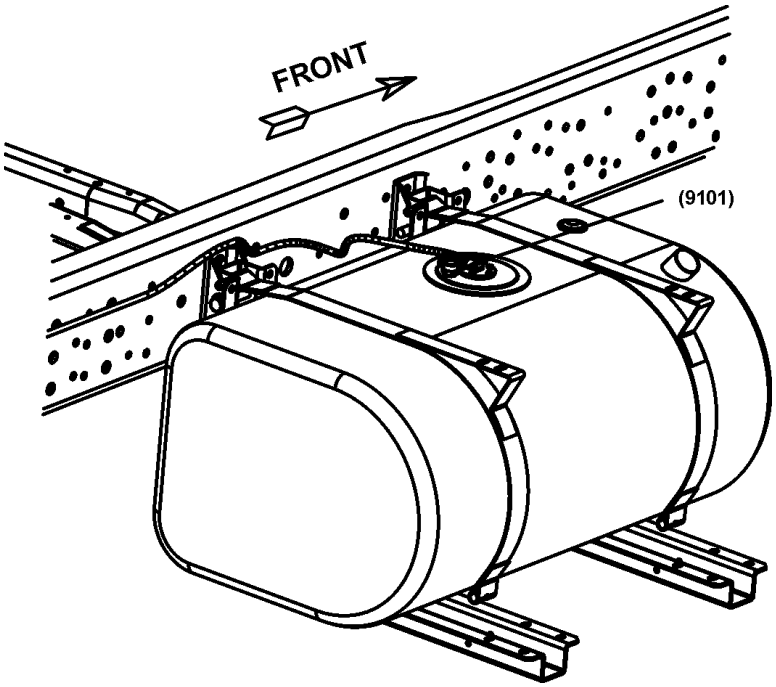


Figure 126 Fuel Sensor Connector Locations (Right Side Mount Fuel Tank Shown)

(9101) FUEL LEVEL SENSOR CONNECTOR

4.31. PRIMARY AIR PRESSURE GAUGE

Circuit Functions

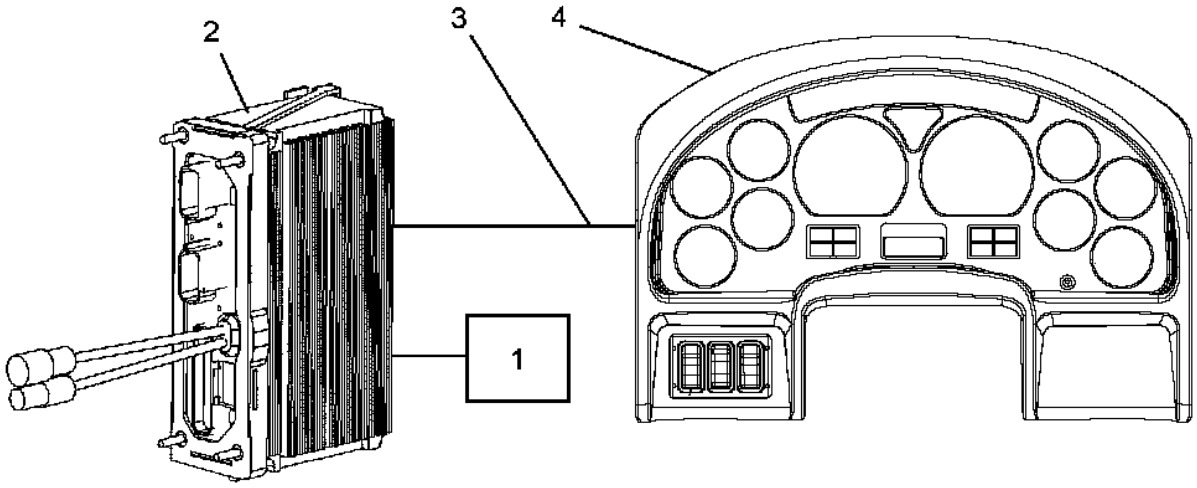


Figure 127 Primary Air Pressure Gauge Function Diagram

1. PRIMARY AIR PRESSURE SENSOR
2. ELECTRICAL SYSTEM CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving the primary air pressure gauge is provided on the Drivetrain 1939 data link from the ESC. The ESC generates this information based on input from a transducer connected to the air line.

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

Diagnostics

Problems with the primary air pressure gauge can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, an incorrect connection inside the EGC, a loss of programming, a problem in the ESC, a problem with the air brake application transducer or a problem with wiring to the sensor.

Table 74 Primary Air Pressure Gauge Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the primary air pressure gauge perform during the gauge sweep?		Gauge performs during gauge sweep.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install. page 261

Table 74 Primary Air Pressure Gauge Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
2.	On	Check for primary air pressure gauge diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 240)	Read display on odometer.	Primary air pressure gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 241)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.		Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
4.	On	Attempt to exercise the gauge with the "Diamond Logic Builder™" diagnostic software.		Gauge responds to "Diamond Logic Builder™" diagnostic input.	Go to next step.	Insure gauge operates during gauge sweep. Insure jumper harness between gauge and circuit board is in correct location. If jumper is correct, replace EGC circuit board.
5.	Consider replacing ESC. (See ESC REPLACEMENT, page 125)					

Diagnostic Trouble Codes (DTC)

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

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

Table 75 Primary Air Pressure Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
612 14 4 1	Primary air sensor/auxiliary air sensor out of range low Short to ground, open circuit or missing 5 volts from ESC
612 14 4 2	Primary air sensor/ auxiliary air sensor out of range high Shorted high
1705 14 108 3 (EGC Version 8.7)	EGC gauge location 8 (primary air pressure) out of range high Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 108 4 (EGC Version 8.7)	EGC gauge location 8 (primary air pressure) out of range low Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 108 5 (EGC Version 8.7)	EGC gauge location 8 (primary air pressure) sensor fault There is a problem with the sensor that provides the data for this gauge.
1705 14 108 6 (EGC Version 8.7)	EGC gauge location 8 (primary air pressure) data unavailable The data that this gauge displays should be, but is not available at this time.
2023 14 108 5 or 2023 14 208 5 (EGC Version 9.3 and later)	Primary air pressure gauge sensor fault to primary EGC (108) or secondary EGC (208) There is a problem with the sensor that provides the data for this gauge.
2023 14 108 6 or 2023 14 208 6 (EGC Version 9.3 and later)	Primary air pressure gauge data unavailable to primary EGC (108) or secondary EGC (208) The data that this gauge displays should be, but is not available at this time.
2023 14 108 7 or 2023 14 208 7 (EGC Version 9.3 and later)	Primary air pressure gauge data missing to primary EGC (108) or secondary EGC (208) The data for this gauge is not being transmitted on the datalink.

Fault Detection/ Management

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

The service tool (EZ-Tech®) running the "Diamond Logic Builder™" diagnostic software can be used to check operation of the gauge.

Refer to Primary Air Pressure Transducer Circuits.

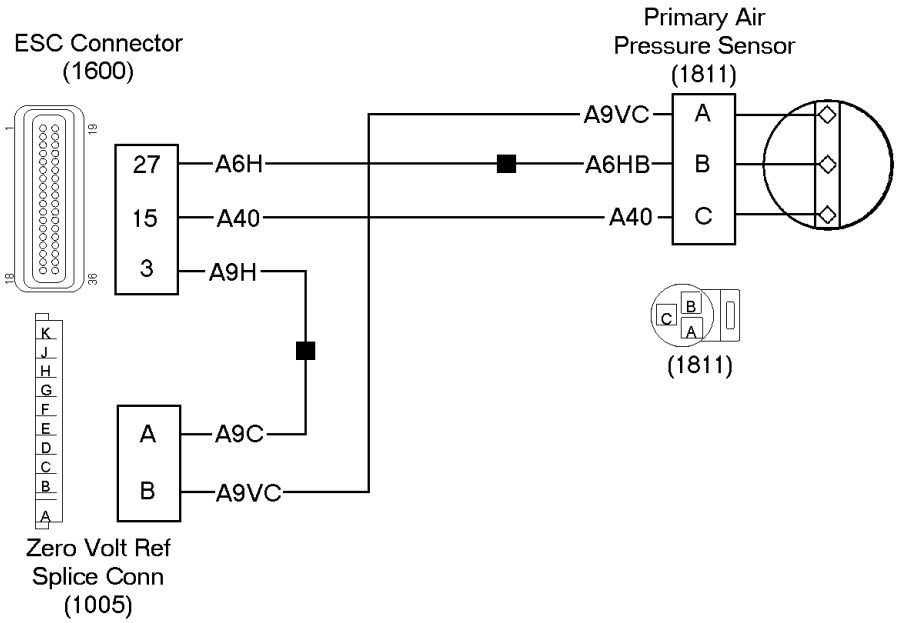


Figure 128 Primary Air Pressure Transducer Circuits — Always Refer To Circuit Diagram Book For Latest Circuit Information

(1005) ZERO VOLT REF SPLICE CONN
LOCATED RIGHT SIDE INSTRUMENT PANEL
(1600) SYSTEM CONTROLLER
LOCATED AT INSIDE RIGHT SIDE DASH PANEL
(1811) PRIMARY AIR PRESSURE SENSOR
LOCATED NEAR BRAKE PEDAL

Table 76 Primary Air Pressure Gauge Tests

Diagnostic Trouble Codes	
612 14 4 1	Primary Air Pressure out of range low. Short to ground, open circuit or missing 5 volts from ESC.
612 14 4 2	Primary Air Pressure out of range high. Shorted to high.
1705 14 108 3 (EGC Version 8.7)	EGC gauge location 8 (primary air pressure) out of range high. Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.

Table 76 Primary Air Pressure Gauge Tests (cont.)

Diagnostic Trouble Codes	
1705 14 108 4 (EGC Version 8.7)	EGC gauge location 8 (primary air pressure) out of range low. Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 108 5 (EGC Version 8.7)	EGC gauge location 8 (primary air pressure) sensor fault. There is a problem with the sensor that provides the data for this gauge.
1705 14 108 6 (EGC Version 8.7)	EGC gauge location 8 (primary air pressure) data unavailable The data that this gauge displays should be, but is not available at this time.
2023 14 108 5 or 2023 14 208 5 (EGC Version 9.3 and later)	Primary air pressure gauge sensor fault to primary EGC (108) or secondary EGC (208) There is a problem with the sensor that provides the data for this gauge.
2023 14 108 6 or 2023 14 208 6 (EGC Version 9.3 and later)	Primary air pressure gauge data unavailable to primary EGC (108) or secondary EGC (208) The data that this gauge displays should be, but is not available at this time.
2023 14 108 7 or 2023 14 208 7 (EGC Version 9.3 and later)	Primary air pressure gauge data missing to primary EGC (108) or secondary EGC (208) The data for this gauge is not being transmitted on the datalink.

Primary Air Pressure Gauge Voltage Checks

Check with ignition on and (1811) disconnected.

NOTE – Always check connectors for damage and pushed–out terminals.

Always use breakout box ZTSE 4477 to take measurements on ESC connectors.

Test Points	Spec.	Comments
(1811) cavity B to ground.	5 ± .5 volts	If voltage is missing, check for open or shorts in circuit A6HB, or A6H to ESC connector (1600) cavity 27. If circuits check good, check for missing 5 volt signal from ESC.

Table 76 Primary Air Pressure Gauge Tests (cont.)

Diagnostic Trouble Codes		
(1811) cavity B to cavity A.	5 ± .5 volts	If voltage is missing, check for open in circuit A9VC to zero volt reference splice connector (1005) or A9C and A9H to ESC connector (1600) cavity 3. If circuits check good, check for missing zero volt reference from ESC.
(1811) cavity B to cavity C.	5 ± .5 volts	If voltage is incorrect, check for open or short to voltage in circuit A40 to ESC connector (1600) cavity 15. If voltage is present, circuits to transducer are good. Replace transducer

Extended Description

The 5 volt sensor supply signal is supplied to primary air pressure transducer connector (1811) pin B from ESC connector (1600) pin 27.

The zero volt reference signal is supplied to air brake application transducer connector (1811) pin A from the zero volt reference splice connector (1005) terminal B. The zero volt reference splice connector (1005) is supplied a zero volt signal on terminal A from ESC connector (1600) pin 3.

The pressure transducer acts like a potentiometer. The transducer will provide a voltage to ESC connector (1600) pin 15, which will vary with changes in applied pressure.

Component Locations

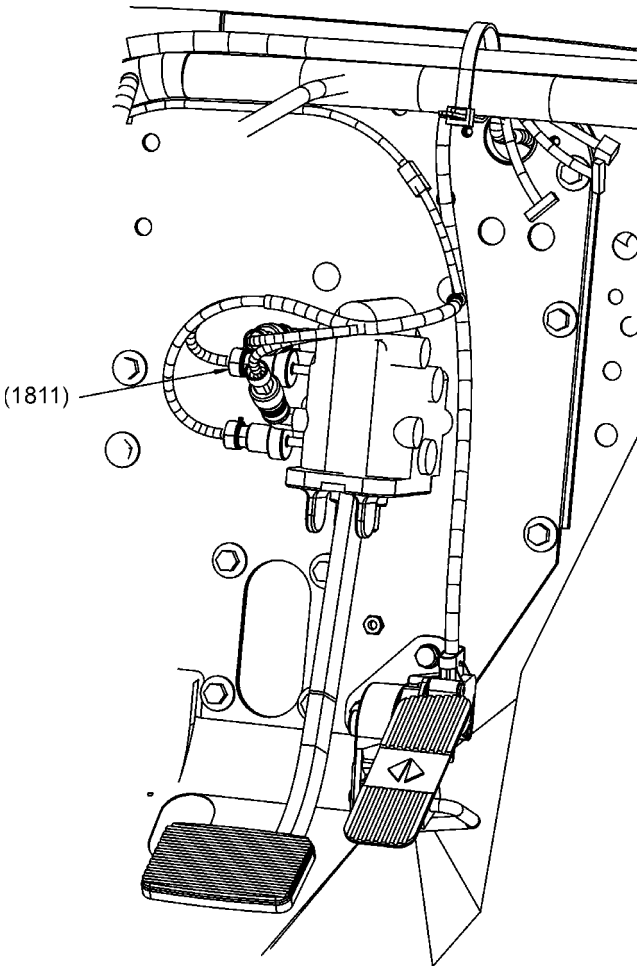


Figure 129 Primary Air Gauge Transducer Location (Steering Column Support View)

(1811) PRIMARY AIR PRESSURE SENSOR

4.32. SECONDARY AIR PRESSURE GAUGE

Circuit Function

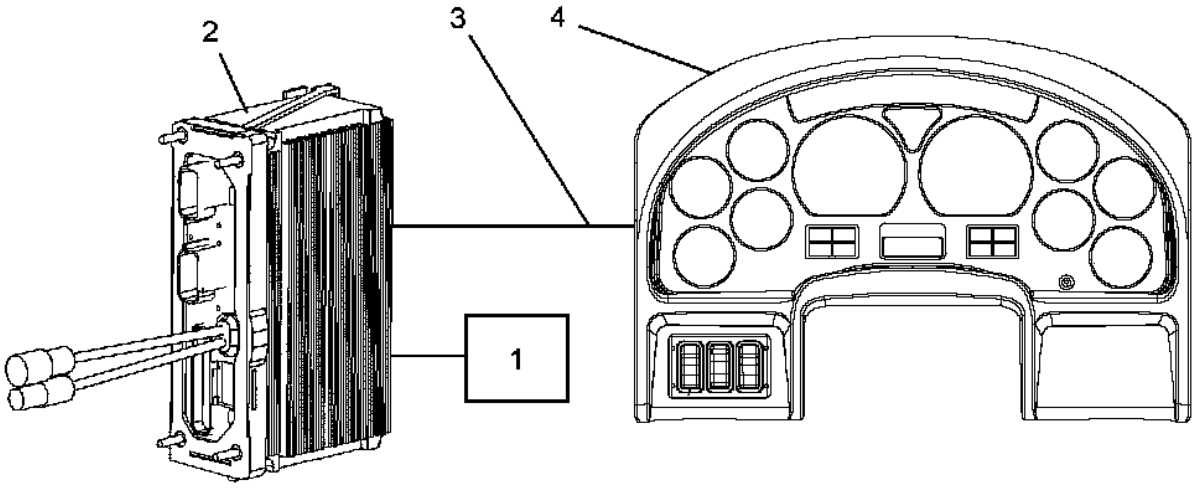


Figure 130 Secondary Air Pressure Gauge Function Diagram

1. SECONDARY AIR PRESSURE SENSOR
2. ELECTRICAL SYSTEM CONTROLLER
3. DRIVE TRAIN 1939 DATA LINK
4. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving the secondary air pressure gauge is provided on the drivetrain 1939 data link from the ESC. The ESC generates this information based on input from a transducer connected to the air line.

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

Diagnostics

Problems with the secondary air pressure gauge can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, an incorrect connection inside the EGC, a loss of programming, a problem in the ESC, a problem with the air brake application transducer or a problem with wiring to the sensor.

Table 77 Secondary Air Pressure Gauge Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the secondary air pressure gauge perform during the gauge sweep?		Gauge performs during gauge sweep.	Go to next step.	Replace gauge and check jumper harness . If problem persists, replace EGC circuit board. Refer to Remove and Install. page 261

Table 77 Secondary Air Pressure Gauge Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
2.	On	Check for secondary air pressure gauge diagnostic trouble codes.	Read display on odometer.	Secondary air pressure gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 248)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.		Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
4.	On	Attempt to exercise the gauge with the "Diamond Logic Builder™" diagnostic software.		Gauge responds to "Diamond Logic Builder™" diagnostic input.	Go to next step.	Insure gauge operates during gauge sweep. Insure jumper harness between gauge and circuit board is in correct location. If jumper is correct, replace EGC circuit board.
5.	Consider replacing ESC. (See ESC REPLACEMENT, page 125)					

Diagnostic Trouble Codes (DTC)

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

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

Table 78 Secondary Air Pressure Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
612 14 3 1	Secondary Air Pressure out of range low. Short to ground, open circuit or missing 5 volts from ESC.
612 14 3 2	Secondary Air Pressure out of range high. Shorted high.
1705 14 110 3 (EGC Version 8.7)	EGC gauge location 10 (secondary air pressure) out of range high. Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 110 4 (EGC Version 8.7)	EGC gauge location 10 (secondary air pressure) out of range low. Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 110 5 (EGC Version 8.7)	EGC gauge location 10 (secondary air pressure) sensor fault. There is a problem with the sensor that provides the data for this gauge.
1705 14 110 6 (EGC Version 8.7)	EGC gauge location 10 (secondary air pressure) data unavailable. The data that this gauge displays should be, but is not available at this time.
2023 14 110 5 or 2023 14 210 5 (EGC Version 9.3 and later)	Secondary air pressure gauge sensor fault to primary EGC (110) or secondary EGC (210). There is a problem with the sensor that provides the data for this gauge.
2023 14 110 6 or 2023 14 210 6 (EGC Version 9.3 and later)	Secondary air pressure gauge data unavailable to primary EGC (110) or secondary EGC (210). The data that this gauge displays should be, but is not available at this time.
2023 14 110 7 or 2023 14 210 7 (EGC Version 9.3 and later)	Secondary air pressure gauge data missing to primary EGC (110) or secondary EGC (210). The data for this gauge is not being transmitted on the datalink.

Fault Detection/ Management

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

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

The service tool (EZ-Tech®) running the "Diamond Logic Builder™" diagnostic software can be used to check operation of the gauge.

Refer to Secondary Air Pressure Transducer Circuits.

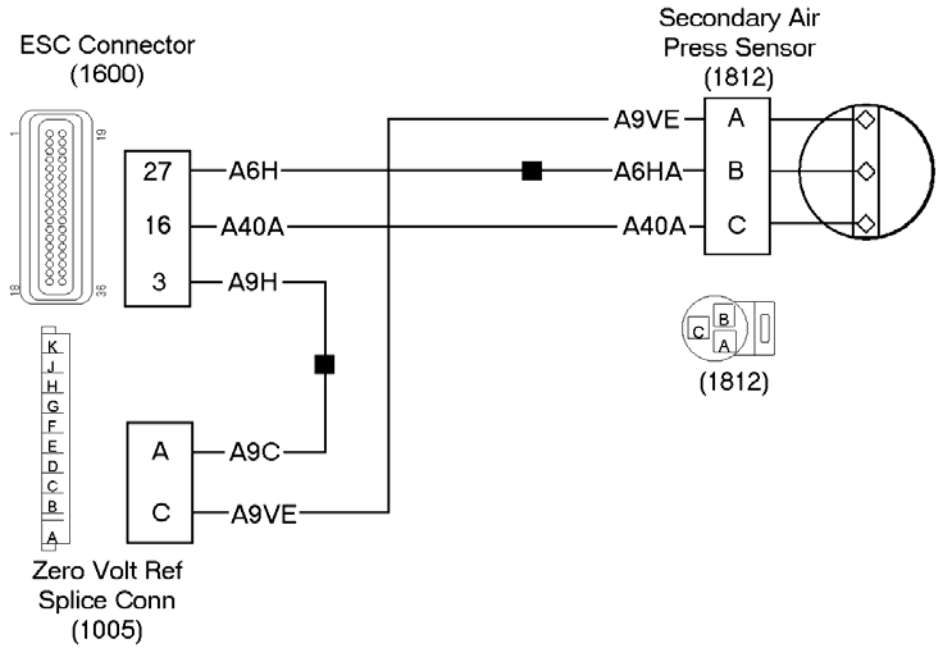


Figure 131 Secondary Air Pressure Transducer Circuits — Always Refer To Circuit Diagram Book For Latest Circuit Information

(1005) ZERO VOLT REF SPLICE CONNECTOR
LOCATED RIGHT SIDE INSTRUMENT PANEL
(1600) SYSTEM CONTROLLER
LOCATED AT INSIDE RIGHT SIDE DASH PANEL
(1812) SECONDARY AIR PRESSURE SENSOR
LOCATED NEAR BRAKE PEDAL

Table 79 Secondary Air Pressure Gauge Tests

Diagnostic Trouble Codes	
612 14 3 1	Secondary Air Pressure out of range low. Short to ground, open circuit or missing 5 volts from ESC.
612 14 3 2	Secondary Air Pressure out of range high. Shorted to high.

Table 79 Secondary Air Pressure Gauge Tests (cont.)

Diagnostic Trouble Codes	
1705 14 110 3 (EGC Version 8.7)	EGC gauge location 10 (secondary air pressure) out of range high. Data for this gauge is above the value that the gauge can display. For example: a value exceeding the gauge maximum scale value.
1705 14 110 4 (EGC Version 8.7)	EGC gauge location 10 (secondary air pressure) out of range low. Data for this gauge is below the minimum value the gauge can display. For example: the lowest scale value on the gauge.
1705 14 110 5 (EGC Version 8.7)	EGC gauge location 10 (secondary air pressure) sensor fault. There is a problem with the sensor that provides the data for this gauge.
1705 14 110 6 (EGC Version 8.7)	EGC gauge location 10 (secondary air pressure) data unavailable. The data that this gauge displays should be, but is not available at this time.
2023 14 110 5 or 2023 14 210 5 (EGC Version 9.3 and later)	Secondary air pressure gauge sensor fault to primary EGC (110) or secondary EGC (210). There is a problem with the sensor that provides the data for this gauge.
2023 14 110 6 or 2023 14 210 6 (EGC Version 9.3 and later)	Secondary air pressure gauge data unavailable to primary EGC (110) or secondary EGC (210). The data that this gauge displays should be, but is not available at this time.
2023 14 110 7 or 2023 14 210 7 (EGC Version 9.3 and later)	Secondary air pressure gauge data missing to primary EGC (110) or secondary EGC (210). The data for this gauge is not being transmitted on the datalink.
Secondary Air Pressure Gauge Voltage Checks Check with ignition on and (1812) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.** **Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**	

Test Points	Spec.	Comments

Table 79 Secondary Air Pressure Gauge Tests (cont.)

Diagnostic Trouble Codes		
(1812) cavity B to ground.	5 ± 0.5 volts	If voltage is missing, check for open or shorts in circuits A6HA, or A6H to ESC connector (1600) cavity 27. If circuits check good, check for missing 5 volt signal from ESC.
(1812) cavity B to cavity A.	5 ± 0.5 volts	If voltage is missing, check for open in circuit A9EC to zero volt reference splice connector (1005) or A9C and A9H to ESC connector (1600) cavity 3. If circuits check good, check for missing zero volt reference from ESC.
(1812) cavity B to cavity C.	5 ± 0.5 volts	If voltage is incorrect, check for open or short to voltage in circuit A40A to ESC connector (1600) cavity 16. If voltage is present, circuits to transducer are good. Replace transducer

Extended Description

The 5 volt sensor supply signal is supplied to primary air pressure transducer connector (1812) pin B from ESC connector (1600) pin 27.

The zero volt reference signal is supplied to air brake application transducer connector (1812) pin A from the zero volt reference splice connector (1005) terminal C. The zero volt reference splice connector (1005) is supplied a zero volt signal on terminal A from ESC connector (1600) pin 3.

The pressure transducer acts like a potentiometer. The transducer will provide a voltage to ESC connector (1600) pin 16, which will vary with changes in applied pressure.

Component Locations

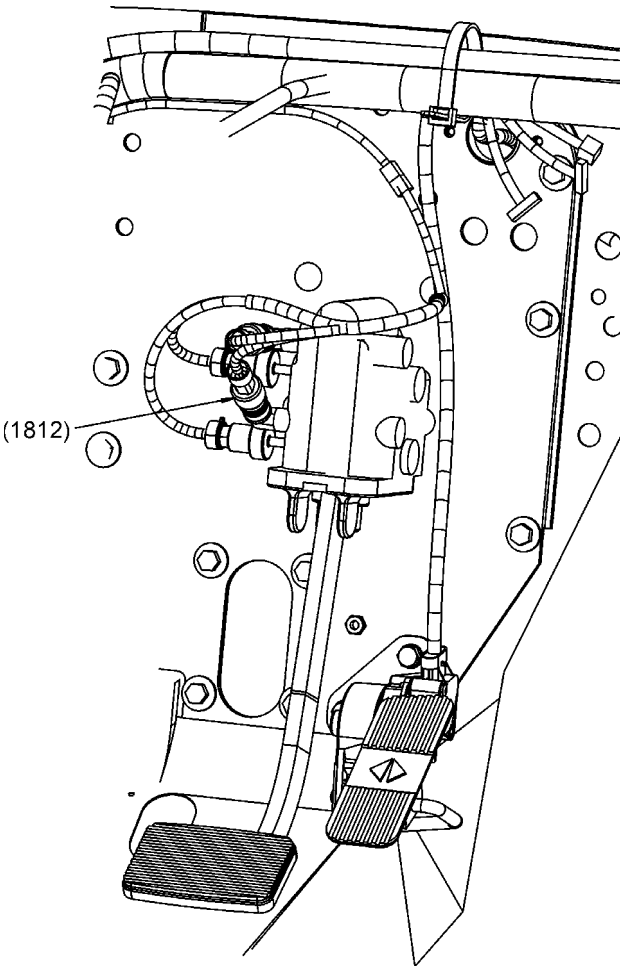


Figure 132 Secondary Air Pressure Gauge Transducer Location (Steering Column Support View)

(1812) SECONDARY AIR PRESSURE SENSOR

4.33. BOOST PRESSURE GAUGE

Circuit Function

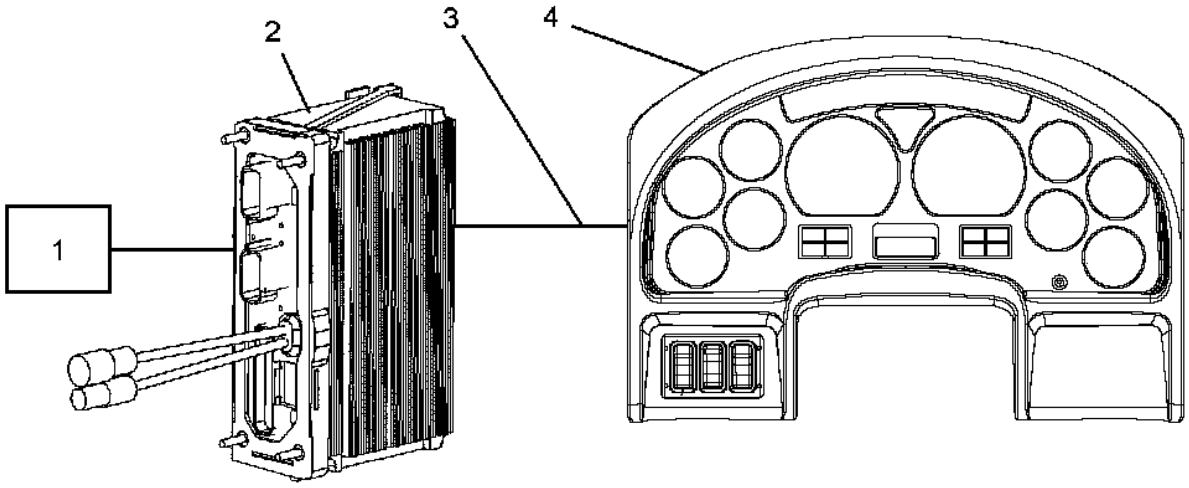


Figure 133 Boost Pressure Gauge Function Diagram

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

Information driving the boost pressure gauge is provided on the Drivetrain 1939 data link from the ESC. The ESC generates this information based on input from a sensor connected to the turbo charger.

Diagnostics

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

The service tool (EZ-Tech®) running the "Diamond Logic Builder™" diagnostic software can be used to check operation of the gauge.

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

Table 80 Boost Pressure Gauge Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the turbo boost gauge operate during the gauge sweep?		Gauge performs during gauge sweep.	Go to next step.	Replace gauge and check jumper harness . If problem persists, replace EGC circuit board. Refer toRemove and Install.page 261

Table 80 Boost Pressure Gauge Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
2.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the "ICAP" programming software. Verify gauge and gauge inputs are programmed correctly.		Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the “ICAP” software. Refer to the ICAP programming software manual for details.
3.	On	Attempt to exercise the gauge with the "Diamond Logic Builder™" diagnostic software.		Gauge responds to "Diamond Logic Builder™" diagnostic input.	Go to next step.	Insure gauge operates during gauge sweep. Insure jumper harness between gauge and circuit board is in correct location. If jumper is correct, replace EGC circuit board.
4.	Consider replacing ESC. (See ESC REPLACEMENT, page 125)					

4.34. AMMETER GAUGE

Circuit Function

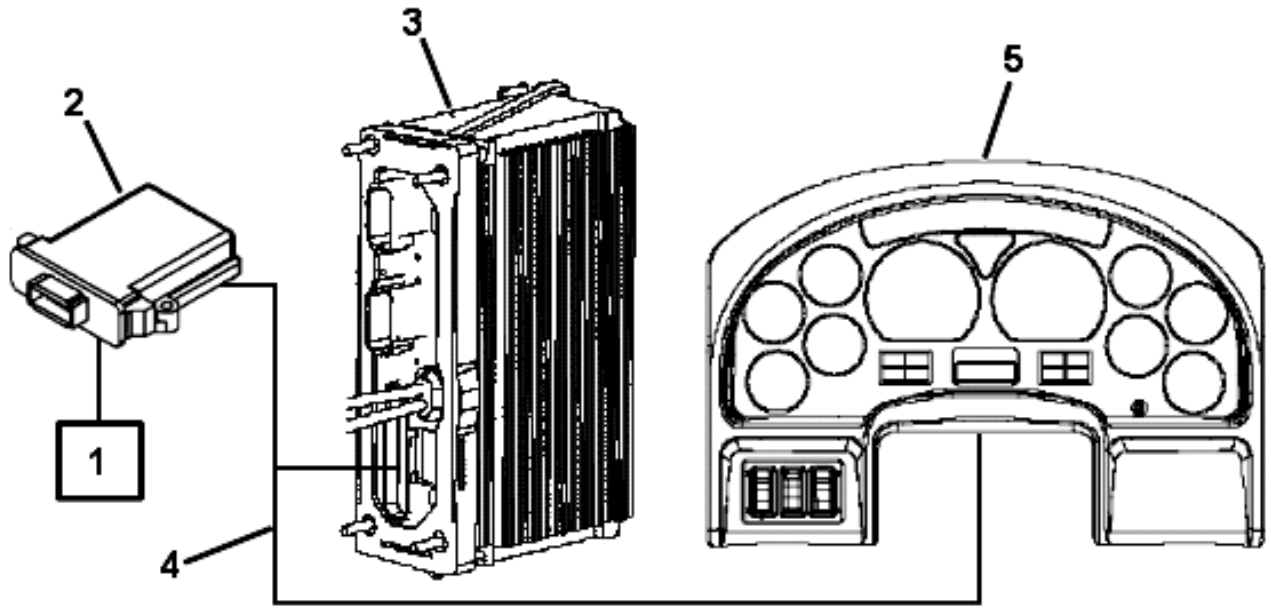


Figure 134 Ammeter Gauge Diagram

1. AMMETER SENSE CIRCUITS
2. PYROMETER/AMMETER MODULE (PAM)
3. ELECTRICAL SYSTEM CONTROLLER (ESC)
4. DRIVE TRAIN 1939 DATA LINK
5. ELECTRONIC GAUGE CLUSTER (EGC)

Information driving theammeter gauge is provided on the Drivetrain 1939 data link from the pyrometer/ammeter module (PAM). The PAM determines the net battery current flow by measuring the differential voltage between the starter ground stud and the negative battery stud.

Either of two ammeter gauges are available. The ranges are, -150/+150 amps and -300/+300 amps (high resolution).

Diagnostics

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

The service tool (EZ-Tech®) running the Diamond Logic® Builder (DLB) diagnostic software, can be used to check operation of the gauge. See the diagnostic software manual for details on using the software.

Problems with the ammeter gauge can be caused by a malfunctioning gauge, a malfunction in EGC circuitry, an incorrect connection inside the EGC, a loss of programming, a problem in the PAM or a problem with wiring to and from the PAM.

Table 81 Ammeter Gauge Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	Does the ammeter gauge operate during the gauge sweep?		Gauge performs during gauge sweep.	Go to next step.	Replace gauge and check jumper harness. If problem persists, replace EGC circuit board. Refer to Remove and Install. page 261
2.	On	Check for Diagnostic Trouble Codes (DTC's) related to the PAM, the ammeter, or the gauge location in the gauge cluster. Refer to DTC list (See DIAGNOSTIC TROUBLE CODE (DTC) LIST, page 1193).	Read display on odometer.	Ammeter gauge diagnostic trouble codes are active.	Go to fault detection management. (See Fault Detection/ Management, page 257)	Go to next step.
3.	Off/On	Connect diagnostic tool (EZ-Tech®) to the diagnostic connector. Turn key to accessory position. Start the DLB programming software. Verify gauge and gauge inputs are programmed correctly.		Gauge and gauge inputs are programmed correctly.	Go to next step.	Program the gauge with the DLB software. Refer to the DLB programming software manual for details.
4.	On	Attempt to exercise the gauge with the DLB diagnostic software.		Gauge responds to DLB diagnostic input.	Go to next step.	Insure gauge operates during gauge sweep. Insure jumper harness between gauge and circuit board is in correct location. If jumper is correct, replace EGC circuit board.
5.	Troubleshoot pyrometer/ammeter module and sensor inputs. Pyrometer/ Ammeter Module (PAM) (See PYROMETER/AMMETER MODULE (PAM), page 699).					

Diagnostic Trouble Codes (DTC)

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

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

Because the location of the ammeter is optional, some of the DTC’s that may be related to the ammeter are described in the DTC list (See DIAGNOSTIC TROUBLE CODE (DTC) LIST, page 1193) by “gauge location”.

Table 82 Ammeter Gauge Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
Refer to DTC list (See DIAGNOSTIC TROUBLE CODE (DTC) LIST, page 1193).	

Fault Detection/ Management

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

A short in the ammeter gauge circuits will be apparent when the ammeter gauge points straight down.

Problems in the ammeter circuits could be the result of an open or shorted gauge, open circuits, shorted circuits, a failure in the ESC, a problem in the PAM or a problem with wiring to and from the PAM.

Refer to Pyrometer/ Ammeter Module (PAM) (See PYROMETER/AMMETER MODULE (PAM), page 699).

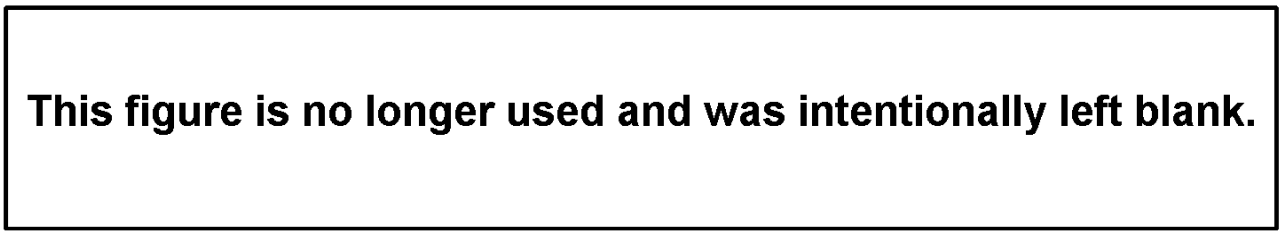


Figure 135 Unused Figure

Table 83 Unused Table

Test Points	Spec.	Comments
This table is no longer used and was intentionally left blank.		

4.35. AUDIBLE ALARM

Circuit Function

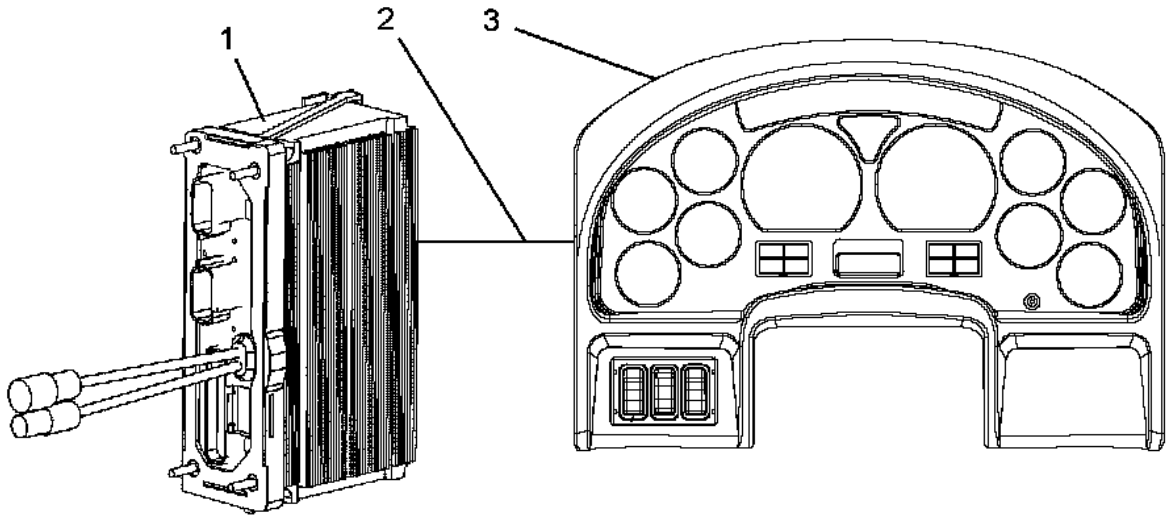


Figure 136 Audible Alarm Function Diagram

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

The audible alarm is controlled by the EGC.

The EGC will activate the alarm based on the data communicated on the Drivetrain 1939 data link from the ESC and the engine controller.

Diagnostics

An inoperative alarm can be caused by a malfunctioning alarm or a malfunction in EGC circuitry.

Table 84 Audible Alarm Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	On	Test alarm by disconnecting fuel sender connector.	Alarm operates.	Alarm is working.	Replace the alarm. If problem persists, replace circuit board.

4.36. SELECT/RESET SWITCH

Circuit Function

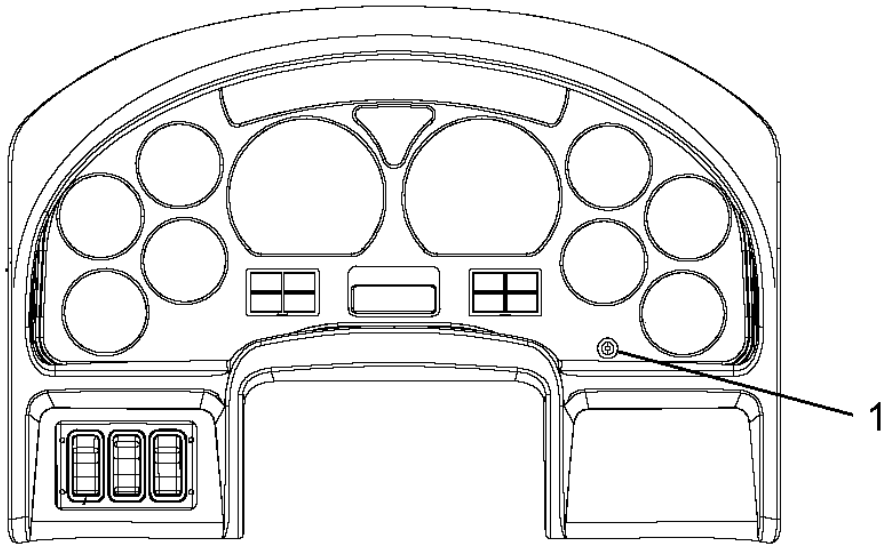


Figure 137 Select/Reset Switch Function Diagram

1. SELECT/RESET SWITCH

The Select/Reset switch controls the digital display.

The switch allows the user to select modes within each major functional area of the display and perform reset functions. Each time the switch is momentarily depressed it will scan through a different mode. Depressing the switch for three seconds or more will clear the display or toggle between options depending upon the current mode. The reset function has no effect if the parameter cannot be reset.

Diagnostics

Problems with the Select/Reset switch can be caused by a faulty switch, loose connection between the switch and the circuit board, or a faulty circuit board.

Table 85 Select/Reset Switch Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	On	Verify operation of the switch by observing odometer display while pushing button.	Display changes when button is pushed.	Switch is working correctly.	Go to next step.
2.	Off	Remove the Select/Reset switch and test with an ohmmeter.	Switch contacts should close while switch is pushed.	Replace circuit board.	Replace the Select/Reset switch.

Fault Detection/ Management

A fault with Select/Reset switch operation will be apparent if the odometer display does not change when the button is pushed.

Check continuity through switch while button it is pressed. If continuity is good replace circuit board. If there is no continuity, replace switch.

4.37. HEAD LAMP/PARK LAMP SWITCH

See Headlight System in the Light Section of this manual. (See HEADLIGHT SYSTEM, page 813)

4.38. PANEL LIGHT SWITCH

See Panel Light in the Light Section of this manual. (See PANEL LIGHTS, page 828)

4.39. DIGITAL DISPLAY

Circuit Function

The EGC has an integral liquid crystal display (LCD). The three lines of the digital display provide a PRNDL display, a numeric display, and a line to indicate the mode of the display.

Diagnostics

Problems with the digital display can be caused by loose connections between the display and the circuit board, a failed display or a failed EGC circuit board.

Table 86 Digital Display Preliminary Check

STEP	KEY	ACTION	SPEC.	YES-IN SPEC.	NO-OUT OF SPEC.
1.	Off/On	During the gauge sweep all LCD elements of the display should be activated and the backlighting should illuminate.	Display elements are active and backlights work during gauge sweep.	Digital display is working. If problems continue, replace EGC circuit board.	Replace LCD display.

5. REMOVE AND INSTALL

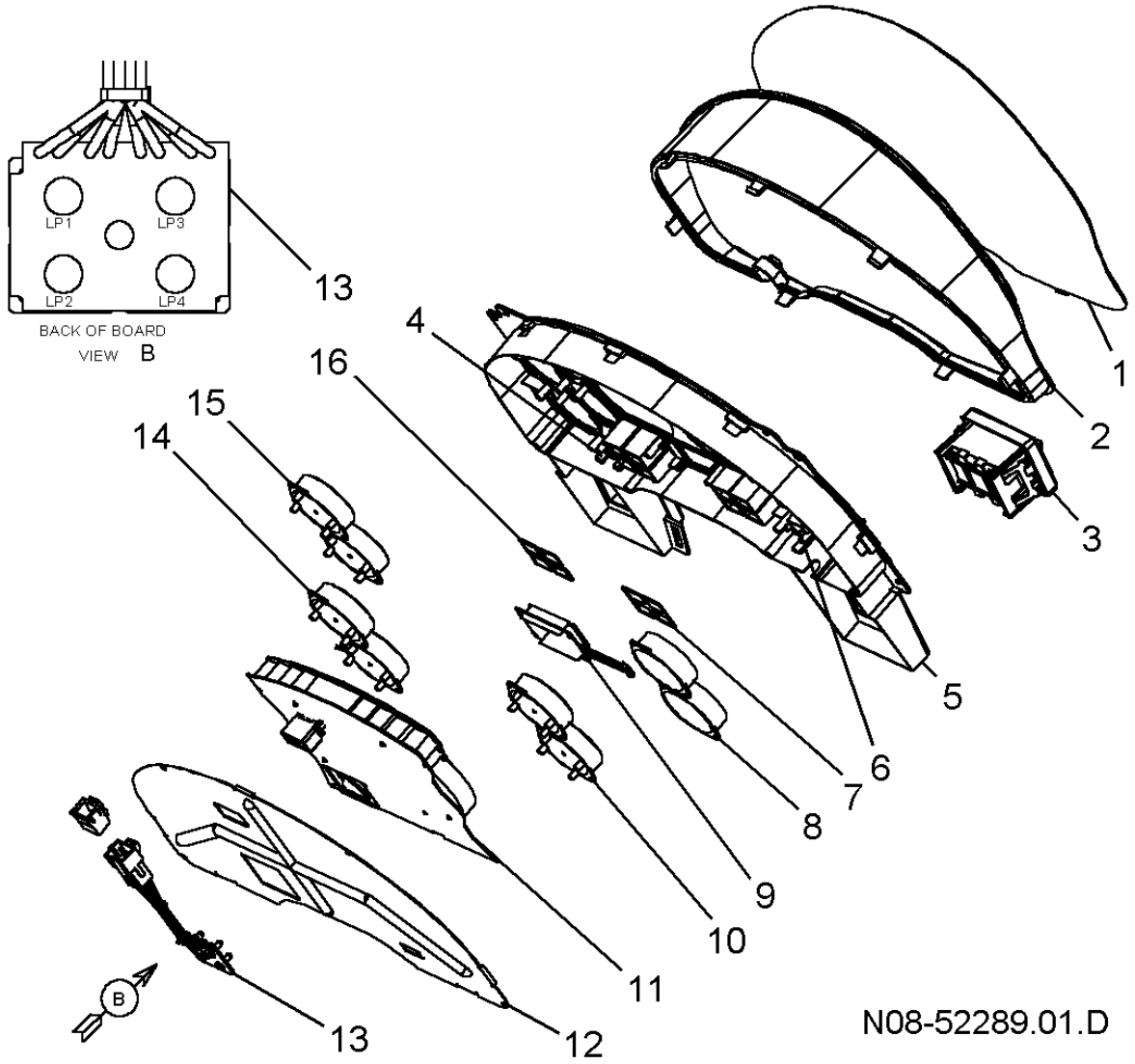


Figure 138 EGC Exploded View

1. GAUGE CLUSTER BEZEL
2. GAUGE CLUSTER SHIELD
3. 3-SWITCH PACK
4. SET/RESET SWITCH LOCATION
5. GAUGE CLUSTER HOUSING
6. BUZZER LOCATION
7. WARNING LAMP LENS
8. OPTIONAL SMALL GAUGES
9. LCD DISPLAY
10. STANDARD SMALL GAUGES
11. GAUGE CLUSTER CIRCUIT BOARD
12. GAUGE CLUSTER BACK PLATE
13. OPTIONAL (HARD WIRED) GAUGE CIRCUIT BOARD
14. STANDARD SMALL GAUGES
15. OPTIONAL SMALL GAUGES
16. OPTIONAL WARNING LAMP LENS

5.1. EGC FRONT BEZEL

Refer to EGC Exploded View. (See Figure 138, page 261)

Bezel removal is not required to remove or replace any other EGC components. Removal should only be required to replace a damaged bezel.

The front bezel can be removed by cutting the seven retaining clips off with a razor blade, being careful not to scratch to gauge cluster housing. Installation of the bezel is accomplished by inserting the new bezel clips into the notches on the housing.

The front bezel snaps to the EGC body. To remove the bezel, remove the EGC shroud from the instrument panel. The bezel can be removed by gently pressing the seven clips on the bezel outer housing.

Installation of the bezel is accomplished by reversing the removal process.

5.2. REMOVE ELECTRONIC GAUGE CLUSTER

Refer to EGC Exploded View. (See Figure 138, page 261)

A. Remove EGC shroud from instrument panel.
B. Remove four screws which hold the EGC in place.
C. Tilt the EGC forward to gain access to the back of the EGC.
D. Remove the 12–way connector from the center of the EGC.
E. Remove any additional connectors from the EGC.

Installation of the gauge cluster is the reverse of the removal procedure.

5.3. FUEL, VOLTS, WATER OR ENGINE OIL GAUGES

Refer to EGC Exploded View.

The Fuel, Volts, Water and Engine Oil Gauges may be integral components of the EGC circuit board. If they are not separate gauges they can be removed and replaced by scoring the perforated line between the gauges and the main circuit board and snapping the circuit board. The replacement gauge is fastened to the EGC body with two screws and connected to the main circuit board with the supplied cable with connectors.

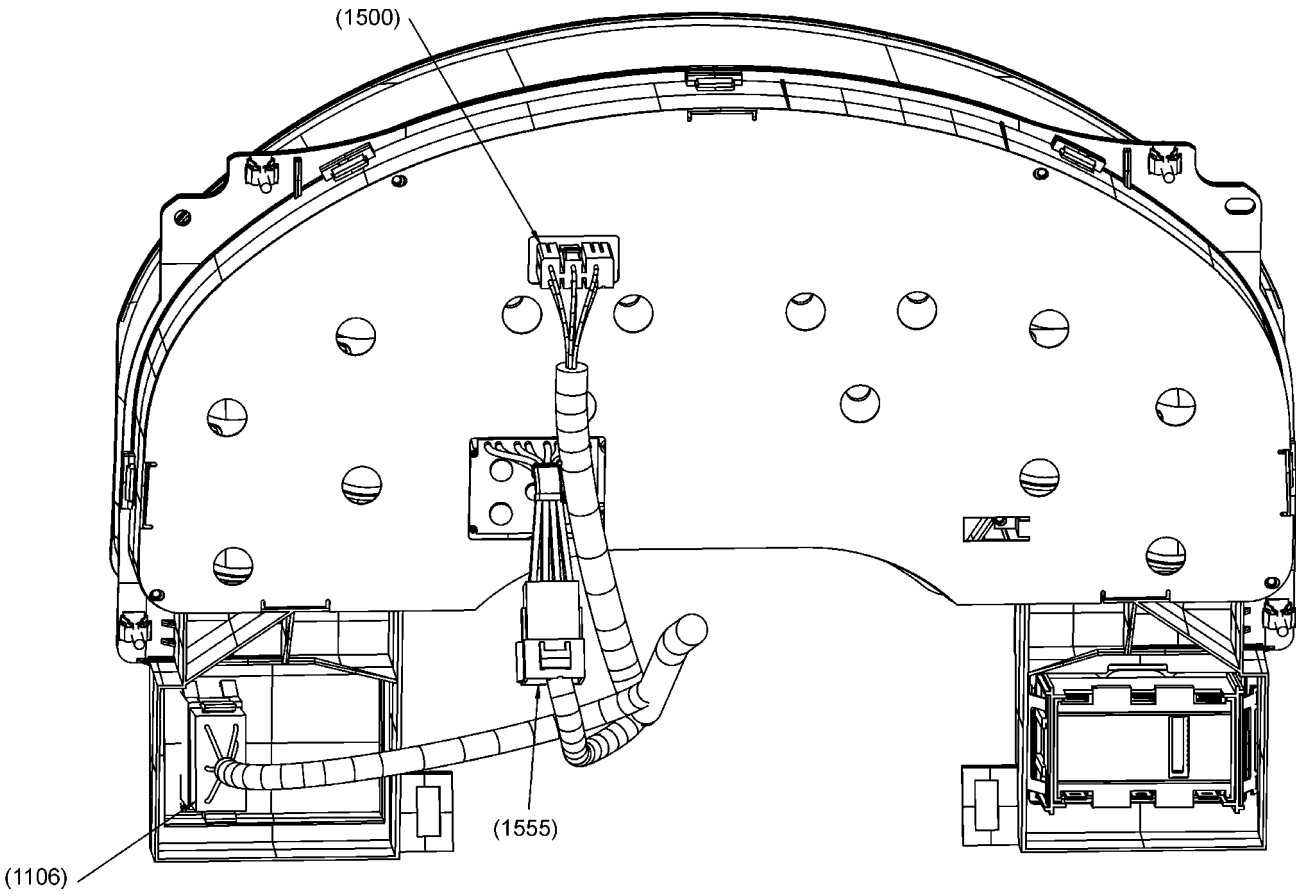


Figure 139 Typical EGC Circuit Board Gauge Connector Location

(1106) ECONOMY SWITCH CONNECTOR
(1500) INSTRUMENT PANEL CONNECTOR
(1555) WARNING LIGHTS CONNECTOR

The speedometer and tachometer cannot be individually replaced. If the speedometer or tachometer fail, the entire circuit board must be replaced.

5.4. OPTIONAL GAUGES

Refer to EGC Exploded View. (See Figure 138, page 261)

Refer to Typical EGC Circuit Board Gauge Connector Location. (See Figure 139, page 263)

Optional Gauges

A. Remove the EGC from the instrument panel.
B. Remove six screws holding the back cover of the EGC in place.
C. Disconnect connectors for the optional gauge.
D. Remove two screws holding the gauge to EGC body and remove the gauge.

Installation of the optional gauge is accomplished by reversing the removal procedure.

NOTE – When adding a gauge that was not previously installed in the cluster, the electrical system controller must be programmed to recognize the gauge before the gauge will function. Refer to the ICAP programming software manual for details

5.5. CIRCUIT BOARD

Refer to EGC Exploded View. (See Figure 138, page 261)

A. Remove six screws holding the back of the EGC in place.
B. Disconnect all connectors connected to the circuit board.
C. Remove six screws holding circuit board to EGC body.

Installation of the circuit board is accomplished by reversing the removal procedure.

NOTE – The replacement circuit board will not have any of the standard smaller gauges attached to it. It may be necessary to replace the smaller gauges when the circuit board is replaced.

5.6. LCD DISPLAY

Refer to EGC Exploded View. (See Figure 138, page 261)

A. Remove six screws holding the back of the EGC in place.
B. Remove the center circuit board.
C. Remove four screws holding LCD to the EGC body and remove the display.

5.7. SELECT/RESET SWITCH

Refer to EGC Exploded View. (See Figure 138, page 261)

A. Remove six screws holding the back of the EGC in place.
B. Remove the connector for the switch from the center circuit board.
C. Remove two screws holding the switch and remove the switch.

To install the switch, reverse the removal procedure.

5.8. AUDIBLE ALARM

Refer to EGC Exploded View. (See Figure 138, page 261)

A. Remove six screws holding the back of the EGC in place.
B. Remove the connector for the audible alarm from the center circuit board.
C. Remove two screws holding the audible alarm and remove the alarm.

5.9. EGC PANEL LAMPS AND GAUGE BACKLIGHTING LAMPS

Refer to EGC Exploded View. (See Figure 138, page 261)

The EGC panel lamps are twist in lamps. To replace the lamps the failed lamp must be removed and replaced with a good lamp.

A. Remove the EGC from the instrument panel.
B. Remove six screws holding the back of the EGC in place and remove the back cover.
C. Locate the failed lamp and remove it by twisting it out of the circuit board.
D. Replace the removed lamp with a good twist in indicator lamp.

5.10. EGC WARNING LAMPS AND GAUGE WARNING LAMPS

Refer to EGC Exploded View. (See Figure 138, page 261)

The EGC warning lamps and warning lamps are integral parts of the EGC circuit board. To replace the lamps the failed lamp must be cut out of the circuit board and a twist in lamp must be used to replace it.

A. Remove the EGC from the instrument panel.
B. Remove six screws holding the back of the EGC in place and remove the back cover.
C. Locate the failed lamp and cut it out of the circuit board.
D. Replace the removed lamp with a twist in indicator lamp.

5.11. EGC SWITCH PACK

Refer to EGC Exploded View. (See Figure 138, page 261)

After the instrument panel shroud around the EGC has been removed, The EGC switch pack can be removed by using two DIN removal tools on each side of the switch pack. After the unit is removed from the cluster the connector on the switch pack may be removed. Removal may be easier if the back cover of the switch pack is removed. The back cover is removed by prying it off.

The switch pack is installed by simply reversing the removal process.

5.12. EGC SWITCH PACK SWITCHES

Refer to EGC Exploded View. (See Figure 138, page 261)

Switches are removed through the front of the switch pack. To remove a switch:

A. Remove the back cover from the switch pack.
B. Squeeze the switch release tabs, behind the switch pack.
C. Push the switch out of the switch pack body.

To install a switch reverse the removal process.

5.13. EGC SWITCH PACK LAMPS

EGC switch pack lamps are accessed by removing the switch pack and the back cover of the switch pack. The lamps that are replaceable are removed by twisting the lamp and pulling it out. The backlight lamps for the headlight and dimmer switches are not replaceable. If these LED's fail, the switch pack will need to be replaced.

Table of Contents

1. FAN WIRING — INTERNATIONAL ENGINES

1.1. FAN SOLENOID CIRCUIT FUNCTIONS

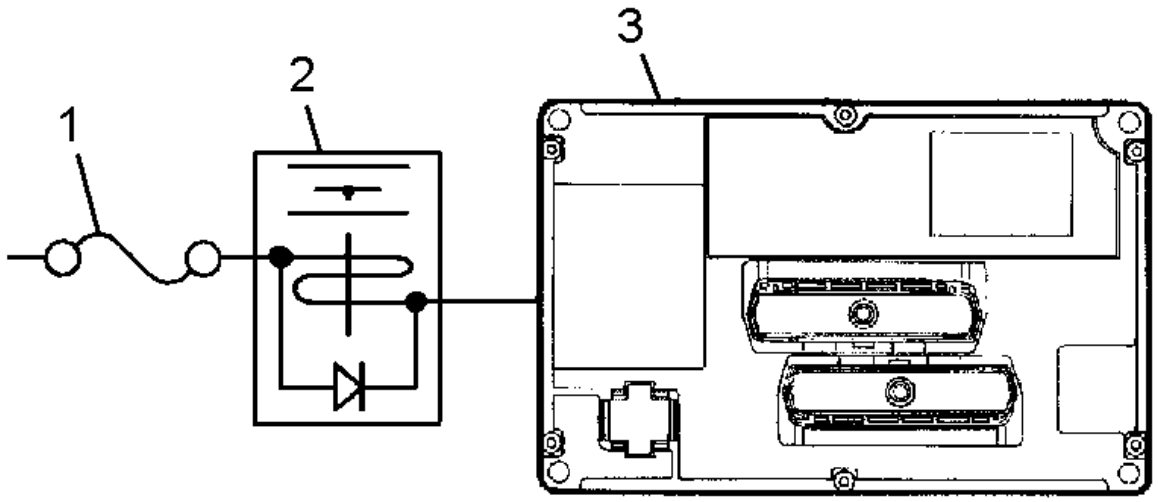


Figure 140 Fan Solenoid Function Diagram

1. 10 AMP FUSE W/SOLENOID OR 5 AMP FUSE W/CLUTCH IN ENGINE POWER DISTRIBUTION CENTER
2. FAN SOLENOID
3. ENGINE CONTROLLER

On vehicles with optional air activated fans (The majority of the vehicles are built with standard viscous drive fans that have no electrical controls). The engine controller monitors engine coolant, intake manifold temperature, and air conditioning head pressure. When any of these systems operate beyond their set parameters, the engine controller will control turning the fan off by energizing a solenoid to control air pressure to the fan. In the event of a solenoid circuit fault the fan will remain on continuously.

The engine controller turns the fan on under the following conditions:

If the engine speed is less than 2250 RPM or the engine is running **and any of the following conditions exists:**

Coolant temperature sensor is greater than 96°C (205°F) **or**

There is an active engine diagnostic code for the coolant temperature sensor **or**

The retarder solenoid signal is active (high mode) for more than 10 seconds with coolant temperature sensor greater than 80°C (176°F) **or**

The ESC sends a command, on the drivetrain 1939 data link, to the engine controller (required when high AC compressor pressure is sensed).

The engine controller turns the fan off under the following conditions:

Engine speed is greater than 2300 RPM **and all of the following conditions exists:**

Coolant temperature sensor is less than 92°C (198°F) **and**

No active coolant temperature sensor diagnostic code **and**

Retarder solenoid signal is active (high mode) with coolant temperature sensor less than 75°C (167°F) **and**

The ESC is not sending a command to the engine controller (high AC compressor pressure is not sensed) **and**

The engine has been running at least two seconds.

NOTE – Once the engine controller has turned the fan on, the fan will remain on for a minimum of 180 seconds to avoid unnecessary fan clutch cycling (except at engine start-up — it will run for only two seconds after the engine starts). The 180 second time interval is a programmable feature in the engine controller.

1.2. DIAGNOSTICS

Should the fan solenoid fail to shut off the fan when expected, the problem could be attributed to open or shorted wiring in the power circuits from the fuse, an open or short in the circuit between the fan air solenoid and the Engine controller, a blown fuse, a failed solenoid or a missing signal from the engine controller.

The ESC will not log any faults for the fan solenoid circuits. However, an open circuit or short to ground in the fan solenoid circuitry can be detected by the engine controller while retrieving “flash codes”.

Fan Solenoid Preliminary Check

Table 87 Fan Solenoid Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Test drive vehicle to insure fan is not shutting off as expected.	Check fan operation.	Fan is not operating correctly.	Go to next step.	Fan is operating correctly. Problem does not exist or is intermittent.
2.	On	Retrieve “flash codes” and check for code 246. Go to Engine Controller Diagnostic Trouble Codes. (See ENGINE CONTROLLER DIAGNOSTIC TROUBLE CODES , page 271)	Count flashes on check engine warning lamp.	“Flash code” 246 is not active.	Go to next step.	“Flash code” is active. Go to FAULT DETECTION MANAGEMENT I6 WITH FAN SOLENOID. (See FAULT DETECTION MANAGEMENT I6 with Fan Clutch, page 274) or FAULT DETECTION MANAGEMENT V8–AVNT WITH FAN CLUTCH. .

Table 87 Fan Solenoid Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
3.	On	Are other engine diagnostic trouble codes are active?	Check warning lamps for other diagnostic trouble codes.	No other engine diagnostic trouble codes are active.	Go to next step.	Refer to the appropriate engine manual to troubleshoot condition setting the code.
4.	On	If the fan never shuts off and no diagnostic trouble codes are active, check for air pressure to solenoid and through solenoid when it is energized.	Check air pressure through solenoid.			

1.3. ENGINE CONTROLLER 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. The diagnostic trouble codes are read by counting the number of light flashes. The following sequence occurs:

The red "ENGINE" light will flash one time. This indicates the beginning of Active diagnostic trouble codes.

The yellow "ENGINE" light will flash repeatedly signaling the active diagnostic trouble codes. All codes are three digits. The number of flashes should be counted in sequence. At the end of each digit of the code there will be a short pause. For example, the code 246 will be sent as two flashes, (a pause), four flashes, (a pause), and six flashes.

After each active code is displayed, the red "ENGINE" light will flash once to indicate the next active code.

Once all active codes have been displayed, the red "ENGINE" light will flash twice to indicate the beginning of Inactive codes.

Inactive codes will be displayed in the same manner as active codes. Once the Inactive codes have been displayed, the red "ENGINE" light will flash three times to indicate that all the stored diagnostic trouble codes have been displayed.

After all repairs have been made, the engine 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 88 Fan Solenoid Codes

FAULT CODE	FAULT DESCRIPTION
246	Fan Output Circuit Check Fault

Table 88 Fan Solenoid Codes (cont.)

256	Radiator Shutter Circuit Check Fault
This fault is logged when there is a short to ground or an open in the in the circuits from the engine controller, through the fan solenoid to battery voltage. Go to FAULT DETECTION MANAGEMENT I6 WITH FAN SOLENOID (See FAULT DETECTION MANAGEMENT I6 with Fan Clutch, page 274) or FAULT DETECTION MANAGEMENT V8–AVNT WITH FAN CLUTCH .	

1.4. FAULT DETECTION MANAGEMENT I6 WITH FAN SOLENOID

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 failure in the I6 fan solenoid circuits will be apparent when the fan does not turn off as expected. The ESC will not log any faults for the fan solenoid circuits. However, an open circuit or short to ground in the fan solenoid circuits can be detected by the engine controller during an “on demand” engine standard test. See the appropriate engine manual for details.

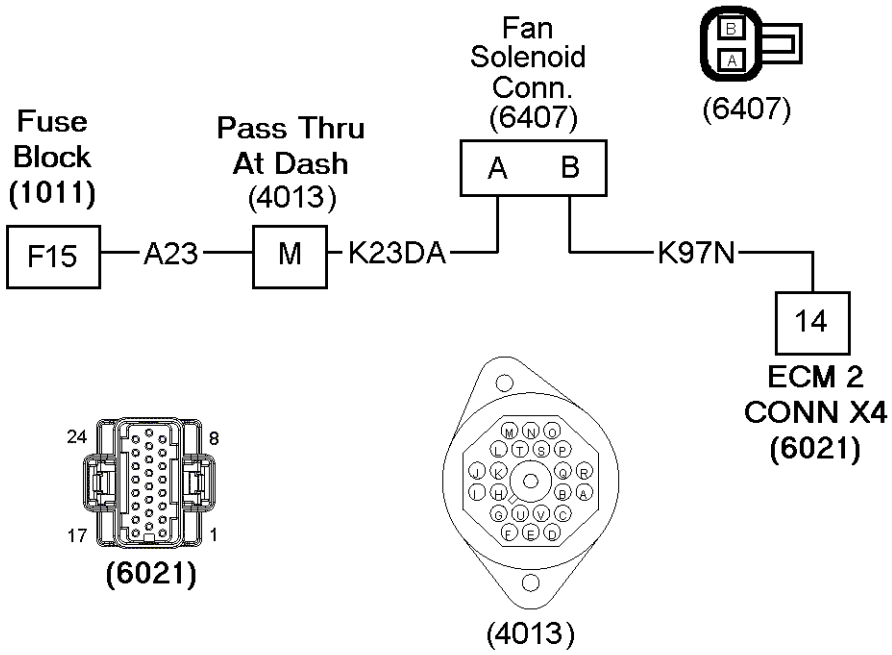


Figure 141 I6 with Fan Solenoid Circuits — Always Refer To Circuit Diagram Book For Latest Circuit Information

(1011) FUSE BLOCK
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(4013) PASS THRU AT DASH
LOCATED AT INSIDE LEFT SIDE DASH PANEL
(6021) ECM2 CONN — X4 (V-8 ONLY)
LOCATED AT ENGINE COMPARTMENT AT ECM
(6407) FAN AIR SOLENOID
LOCATED AT OUTSIDE LEFT SIDE DASH PANEL

Table 89 I6 with Fan Solenoid Wiring Harness Connector Checks

IC Corporation Engine Controller Diagnostic Trouble Codes		
246	The Engine Fan Control relay failed the output circuit check during a Key On Engine Off Standard Test. **NOTE: For test purposes EFC solenoid can be turned On/Off through the Output State Test.**	
Fan Air Solenoid (6407) Voltage Test Check with ignition key ON and fan air solenoid (6407) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments

Table 89 I6 with Fan Solenoid Wiring Harness Connector Checks (cont.)

Fan air solenoid (6407) cavity A to ground.	12 ± 1.5 volts if fan has kicked on. 0 volts if fan has not been activated.	If voltage is incorrect, check for blown fuse F15. Also check for open or short on circuits K23DA and A23.
Fan air solenoid (6407) cavity A to B.	12 ± 1.5 volts if fan has kicked on. 0 volts if fan has not been activated.	If voltage is incorrect, check for proper ground or open signal on engine controller connector (6021) cavity 14. Also check for open or short on circuit K97N. If circuits check good and fan solenoid is still faulty, replace fan solenoid.
NOTE – NOTE: Normal fan on temperature is 212°F (100°C). Normal fan off temperature is 207.5°F (97.5°C)		

1.5. FAULT DETECTION MANAGEMENT I6 WITH FAN CLUTCH

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 failure in the I6 fan clutch circuits will be apparent when the fan does not turn off as expected. The ESC will not log any faults for the fan solenoid circuits. However, an open circuit or short to ground in the fan solenoid circuits can be detected by the engine controller during an “on demand” engine standard test. See the appropriate engine manual for details.

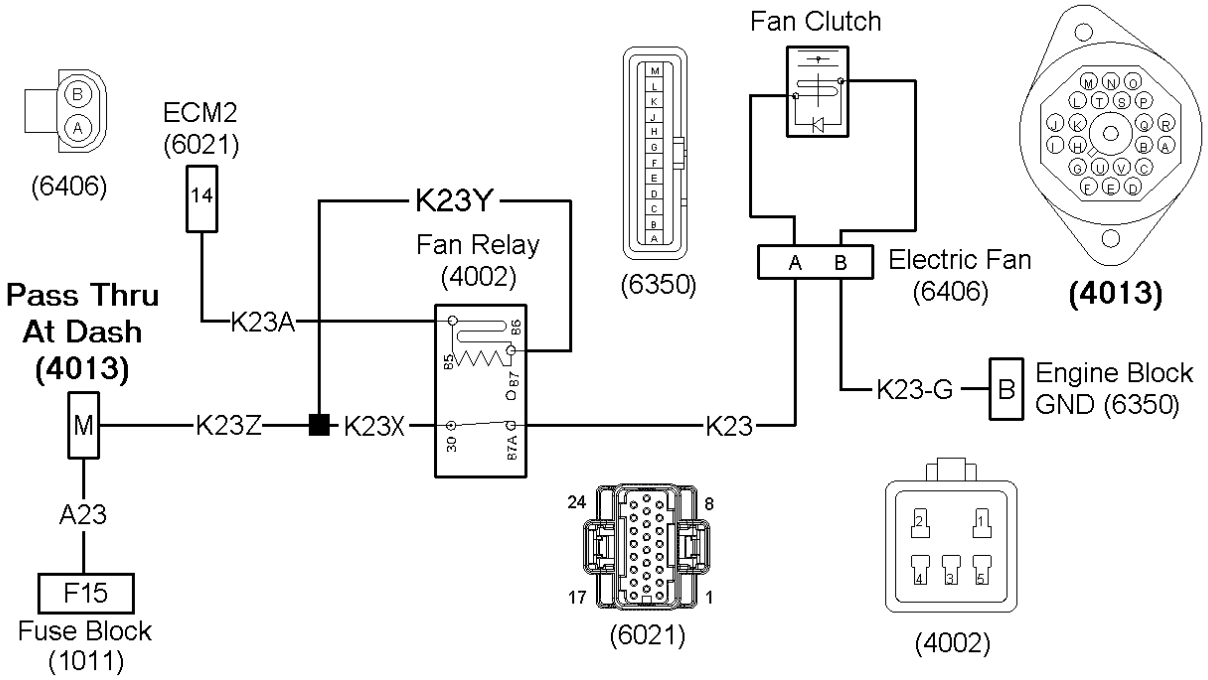


Figure 142 I6 with Fan Clutch Circuits — Always Refer To Circuit Diagram Book For Latest Circuit Information

(1011) FUSE BLOCK
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(4002) FAN RELAY
LOCATED AT OUTSIDE CENTER TOP DASH PANEL
(4013) PASS THRU AT DASH
LOCATED AT INSIDE LEFT SIDE DASH PANEL
(6021) ECM2 CONNECTOR — X4
LOCATED AT ENGINE COMPARTMENT AT ECM
(6350) GROUND SPLICE PACK
LOCATED AT ENGINE COMPARTMENT NEAR STARTER
(6406) ELECTRIC FAN
LOCATED AT OUTSIDE RIGHT SIDE DASH PANEL

Table 90 I6 with Fan Clutch Wiring Harness Connector Checks

IC Corporation Engine Controller Diagnostic Trouble Codes	
246	The Engine Fan Control relay failed the output circuit check during a Key On Engine Off Standard Test. **NOTE: For test purposes EFC solenoid can be turned On/Off through the Output State Test.**

Table 90 I6 with Fan Clutch Wiring Harness Connector Checks (cont.)

Fan Relay (4002) Voltage Test Check with ignition key ON and fan relay (4002) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.** **NOTE – Allow engine to cool below 200.0°F (93.3°C) before performing this test.** Bench test relay. If relay fails bench test, replace and check for faults.		
Test Points	Spec.	Comments
Fan relay (4002) cavity 30 to ground.	12 ± 1.5 volts	If voltage missing, check for blown fuse F15. Also check for open or short on circuits K23X, K23Z and A23.
Fan relay (4002) cavity 30 to 87a.	12 ± 1.5 volts	If voltage is missing, check for open or short in circuits K23 and K23–G. If voltage still not present, check for ground signal at ECM connector (cavity 14) and circuits K23A and K23Y for opens or shorts to power.
Fan relay (4002) cavity 86 to ground.	12 ± 1.5 volts	If voltage missing, check for blown fuse F15. Also check for open or short on circuits K23Y, K23Z and A23.
Fan relay (4002) cavity 86 to 85.	12 ± 1.5 volts if fan has kicked on. 0 volts if fan has not been activated.	If voltage is incorrect, check for proper ground or open circuit signal at ECM connector (6021) cavity 14. Also check for open or short on circuit K23A.
Fan Clutch (6406) Voltage Test Check with ignition key ON, fan relay (4002) installed and fan clutch (6406) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Fan clutch (6406) cavity A to ground.	12 ± 1.5 volts if fan has kicked on. 0 volts if fan has not been activated.	If voltage is incorrect, check for open or short on circuit K23.

Table 90 I6 with Fan Clutch Wiring Harness Connector Checks (cont.)

Fan clutch (6406) cavity A to B.	12 ± 1.5 volts if fan has kicked on. 0 volts if fan has not been activated.	If voltage is incorrect, check for open or short on circuit K23–G. Also check for proper ground connection to ground connector (6350). If circuits check good and fan solenoid is still faulty, replace fan solenoid.
NOTE – NOTE: Normal fan on temperature is 212°F (100°C). Normal fan off temperature is 207.5°F (97.5°C)		

1.6. FAULT DETECTION MANAGEMENT I6 WITH SHUTTERS

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 failure in the I6 shutters circuits will be apparent when the shutters do not operate as expected. The ESC will not log any faults for the shutter solenoid circuits. However, an open circuit or short to ground in the shutter solenoid circuits can be detected by the engine controller during an “on demand” engine standard test. See the appropriate engine manual for details.

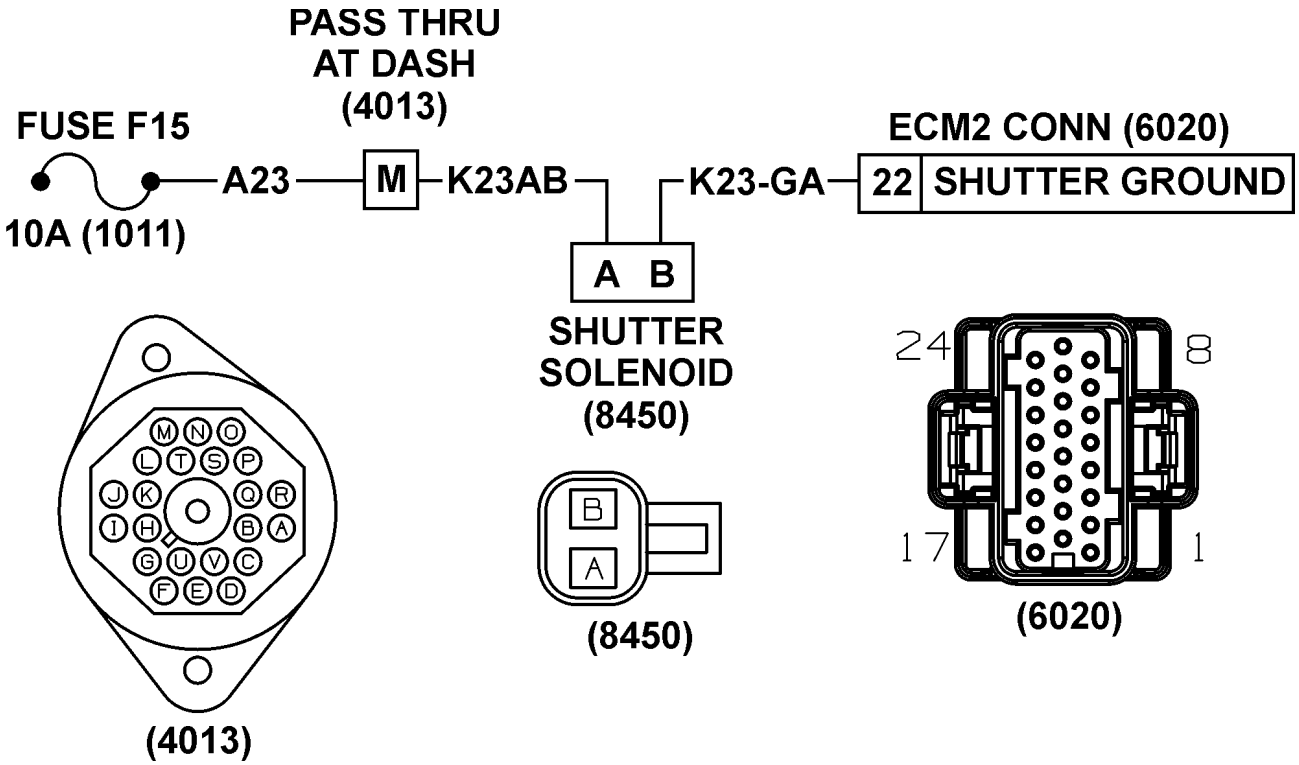


Figure 143 I6 with Shutters Circuits — Always Refer To Circuit Diagram Book For Latest Circuit Information

(1011) FUSE BLOCK
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(4013) PASS THRU AT DASH
LOCATED AT INSIDE LEFT SIDE DASH PANEL
(6020) ECM2 CONNECTOR — X3
LOCATED AT ENGINE COMPARTMENT AT ECM
(8450) SHUTTER SOLENOID
LOCATED ON LEFT FRAME RAIL NEAR HOOD HARNESS

Table 91 I6 with Shutters Wiring Harness Connector Checks

IC Corporation Engine Controller Diagnostic Trouble Codes		
256	The Radiator Shutter Solenoid failed the output circuit check during a Key On Engine Off Standard Test. **NOTE: For test purposes RS solenoid can be turned On/Off through the Output State Test.**	
Shutter Solenoid (8450) Voltage Test Check with ignition key ON and Shutter Solenoid connector (8450) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments

Table 91 I6 with Shutters Wiring Harness Connector Checks (cont.)

Shutter solenoid (8450) cavity A to ground.	12 ± 1.5 volts	If voltage missing, check for blown fuse F15. Also check for open or short in circuits K23AB and A23.
Shutter solenoid (8450) cavity A to B.	12 ± 1.5 volts if shutter has kicked on. 0 volts if shutter has not been activated.	If voltage is incorrect, check for proper ground or open signal on engine controller connector (6020) cavity 22. Also check for open or short on circuit K23–GA. If circuits check good and shutter solenoid is still faulty, replace shutter solenoid.

1.7. FAULT DETECTION MANAGEMENT I6 WITH FAN SOLENOID WITH SHUTTERS

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 failure in the I6 shutters circuits will be apparent when the shutters do not operate as expected. The ESC will not log any faults for the shutter solenoid circuits. However, an open circuit or short to ground in the shutter solenoid circuits can be detected by the engine controller during an “on demand” engine standard test. See the appropriate engine manual for details.

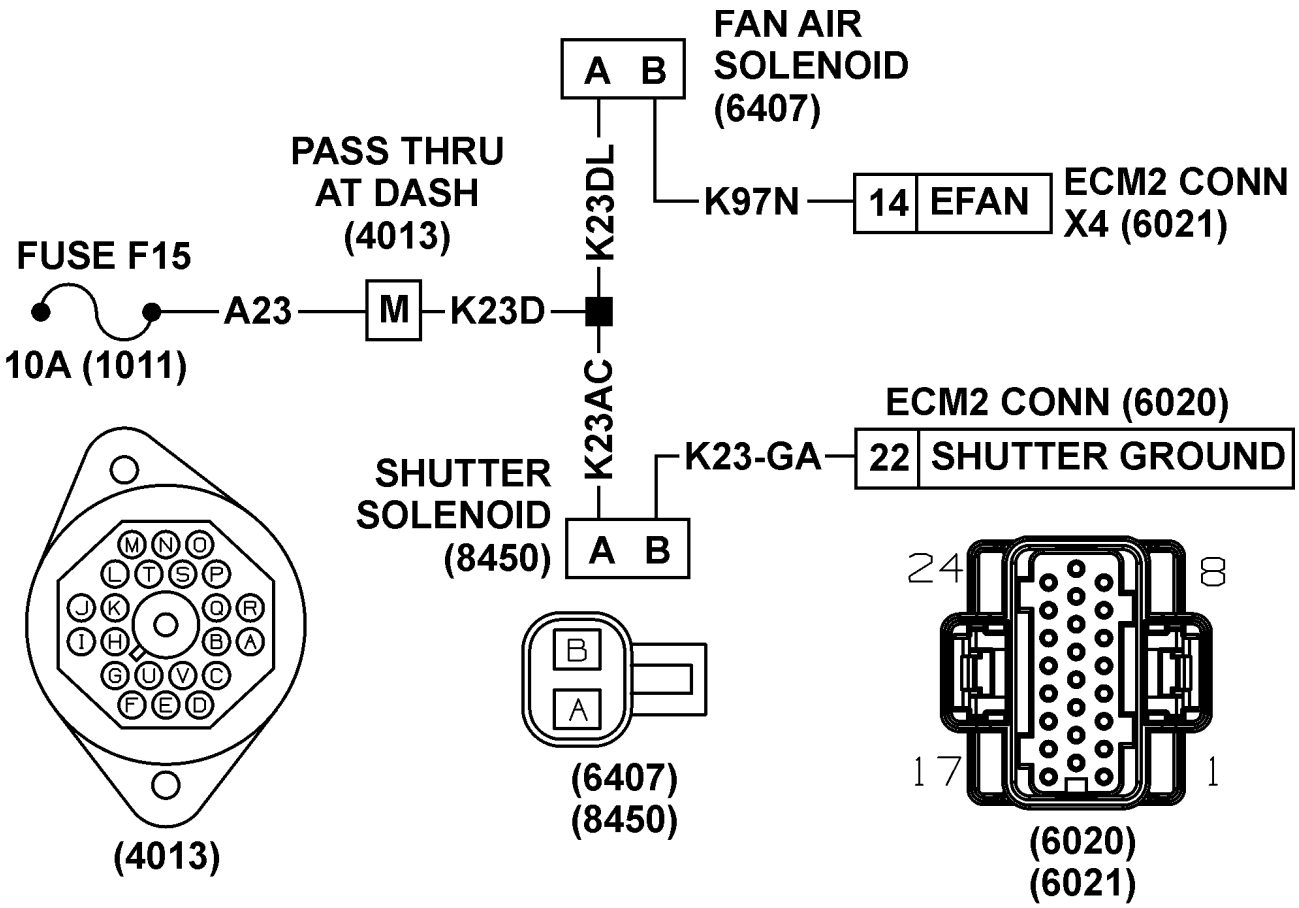


Figure 144 I6 with Fan Solenoid and with Shutters Circuits — Always Refer To Circuit Diagram Book For Latest Circuit Information

(1011) FUSE BLOCK
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(4013) PASS THRU AT DASH
LOCATED AT INSIDE LEFT SIDE DASH PANEL
(6020) ECM2 CONNECTOR — X3
LOCATED AT ENGINE COMPARTMENT AT ECM
(6021) ECM2 CONNECTOR — X4
LOCATED AT ENGINE COMPARTMENT AT ECM
(6407) FAN AIR SOLENOID
LOCATED AT OUTSIDE LEFT SIDE DASH PANEL
(8450) SHUTTER SOLENOID
LOCATED ON LEFT FRAME RAIL NEAR HOOD HARNESS

Table 92 I6 with Shutters Wiring Harness Connector Checks

IC Corporation Engine Controller Diagnostic Trouble Codes	
246	The Engine Fan Control relay failed the output circuit check during a Key On Engine Off Standard Test. **NOTE: For test purposes EFC solenoid can be turned On/Off through the Output State Test.**

Table 92 I6 with Shutters Wiring Harness Connector Checks (cont.)

256	The Radiator Shutter Solenoid failed the output circuit check during a Key On Engine Off Standard Test. **NOTE: For test purposes RS solenoid can be turned On/Off through the Output State Test.**	
Shutter Solenoid (8450) Voltage Test Check with ignition key ON and Shutter Solenoid connector (8450) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Shutter solenoid (8450) cavity A to ground.	12 ± 1.5 volts	If voltage missing, check for blown fuse F15. Also check for open or short in circuits K23AC, K23D and A23.
Shutter solenoid (8450) cavity A to B.	12 ± 1.5 volts if shutter has kicked on. 0 volts if shutter has not been activated.	If voltage is incorrect, check for proper ground or open signal on engine controller connector (6020) cavity 22. Also check for open or short on circuit K23–GA. If circuits check good and shutter solenoid is still faulty, replace shutter solenoid.
Fan Air Solenoid (6407) Voltage Test Check with ignition key ON and fan air solenoid (6407) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Fan air solenoid (6407) cavity A to ground.	12 ± 1.5 volts if fan has kicked on. 0 volts if fan has not been activated.	If voltage is incorrect, check for blown fuse F15. Also check for open or short on circuits K23DL, K23D and A23.
Fan air solenoid (6407) cavity A to B.	12 ± 1.5 volts if fan has kicked on. 0 volts if fan has not been activated.	If voltage is incorrect, check for proper ground or open signal on engine controller connector (6021) cavity 14. Also check for open or short on circuit K97N. If circuits check good and fan solenoid is still faulty, replace fan solenoid.
NOTE – NOTE: Normal fan on temperature is 212°F (100°C). Normal fan off temperature is 207.5°F (97.5°C)		

1.8. EXTENDED DESCRIPTION

When the key is on, voltage is supplied to the fan air solenoid (6407) or the shutter solenoid (8450) on pin A from the 10 amp fuse F15.

The engine controller will supply a ground to energize the fan air solenoid (6407) on pin B from engine controller connector (6021) pin 14.

The engine controller will supply a ground to energize the shutter solenoid (8450) on pin B from engine controller connector (6020) pin 22.

1.9. COMPONENT LOCATIONS

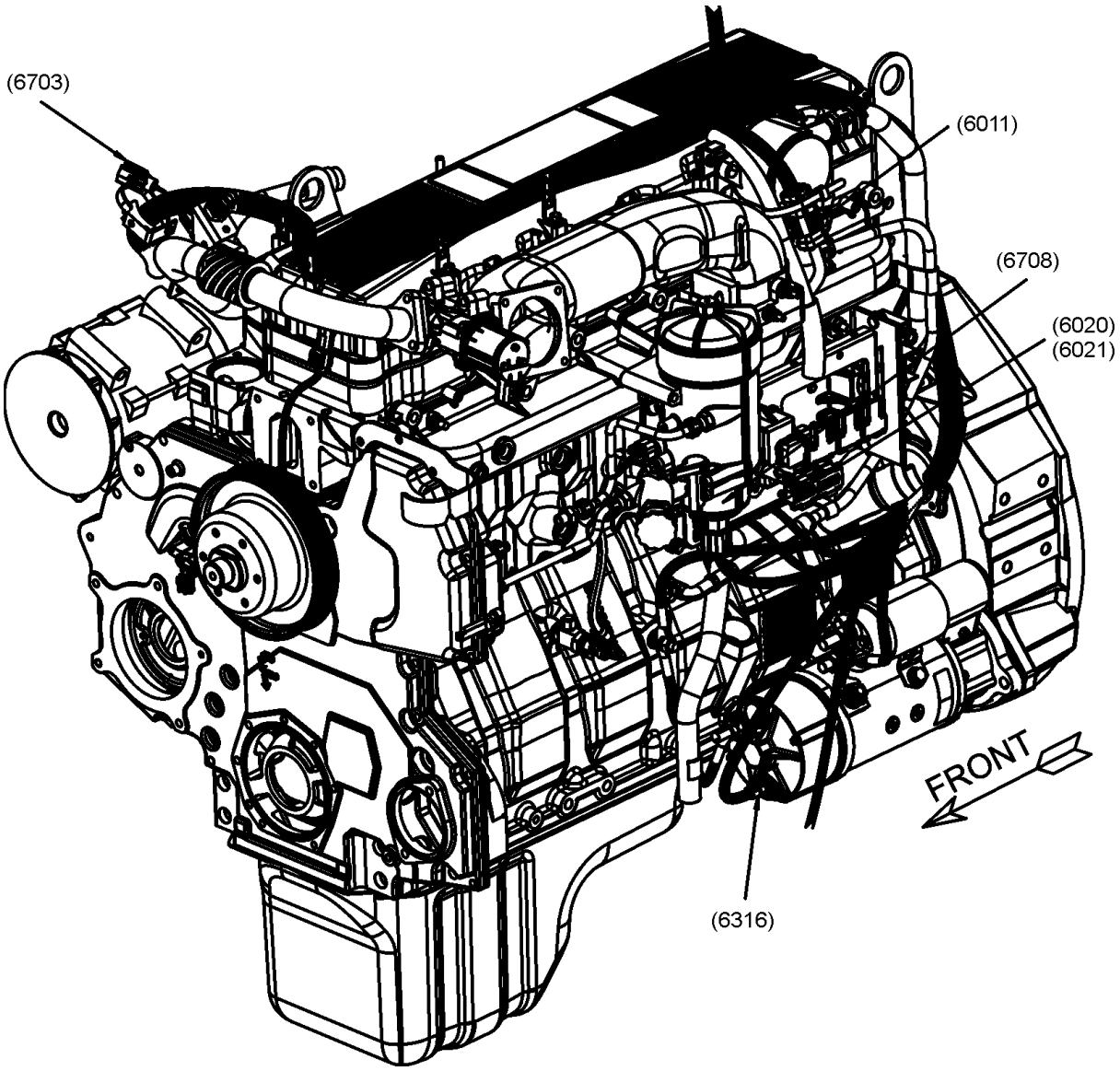


Figure 145 I-6 Engine Wiring

(6011) IDM2 CONNECTOR
(6020) ECM2 CONNECTOR — X3
(6021) ECM2 CONNECTOR — X4
(6316) THERMAL OVERCRANK PROTECTION CONNECTOR
(6703) INTAKE AIR TEMPERATURE SENSOR CONNECTOR
(6708) FUEL FILTER PREHEATER CONNECTOR

Table of Contents

1. BATTERY

Use with the applicable circuit diagram book for the vehicle being serviced.

1.1. BATTERY POWER

There are three main functions of the storage battery:

A. To supply power to the starter and ignition system so the engine can be cranked and started.

B. To supply extra power required when the vehicle's load requirements exceed the supply from the charging system.

C. To act as a voltage stabilizer by smoothing out or reducing temporary high voltage within the electrical system.

Vehicle batteries are connected in parallel with the positive battery cable connected to the cranking motor solenoid (B) terminal. Depending upon battery quantity and box location, some vehicles have two positive cables to the cranking motor solenoid. The additional cable reduces voltage drop during cranking.

The negative battery terminals are connected to the cranking motor ground stud (G).

In some cases, the negative battery terminals are also connected directly to the frame rail. The engine block ground, the cab, and the frame are also connected by ground cables or circuits to the cranking motor ground.

Remote Start Terminal

The remote starter terminal allows an external battery power source to either charge the vehicle batteries or assist in cranking the engine. Connect the external source positive cable to the remote start terminal and the external source negative cable to vehicle frame rail.

1.2. BATTERIES AND CABLES

Battery systems for these vehicles consist of two 12 volt maintenance free batteries or three 12 volt maintenance free batteries. Any optional batteries installed are also the maintenance free type.

WARNING – When handling batteries, always wear face or eye protection, have water supply available, assure good ventilation, and be sure no open flames are present.

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 CTS-5000 Master Service Manual.

D. When the technician determines that a fuse is blown, while checking its condition, he is directed to locate the cause of the overload condition and to repair it. While no further instruction on this procedure is listed in the diagnostic tables, the common procedure is as follows: isolate sections of the circuit, by disconnecting connectors, and measure the resistance to ground to find the circuit that is shorted to ground. Then locate the damaged spot in the wire or connector and repair.

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

Battery Test Procedure

Test each battery separately.

1. Disconnect both battery terminal cables at each battery. Check each battery visually.

2. Examine the hydrometer eye (if no eye go to step 3).
   a. Eye shows green - go to step 4.
   b. Eye shows dark - recharge, then go to step 4.
   c. Eye shows yellow - replace battery.

3. Apply a 300A load for 15 seconds. Turn off load and wait one minute.
   a. If 12.4 volts or more - go to step 4.
   b. If less than 12.4 volts - recharge, then repeat step 3. If battery will not store charge above 12.4 volts, replace it.

4. Apply a test load equal to 50% of the battery CCA rating at –17.8°C (0°F). After 15 seconds, **with the load still applied**, measure and record terminal voltage _____. Turn the load off.

5. Estimate the battery temperature. If measured voltage does not meet or exceed the value shown in the following table, replace the battery.

Table 93 Battery Temperature Table

Temp.	21.1°C	10°C	–1.1°C	–9.4°C	-17.8° C
Temp.	70°F	50°F	30°F	15°F	0°F
Min. Volts	9.6	9.4	9.1	8.8	8.5

6. Clean all cable ends and terminals of the battery with a wire brush And reconnect battery.

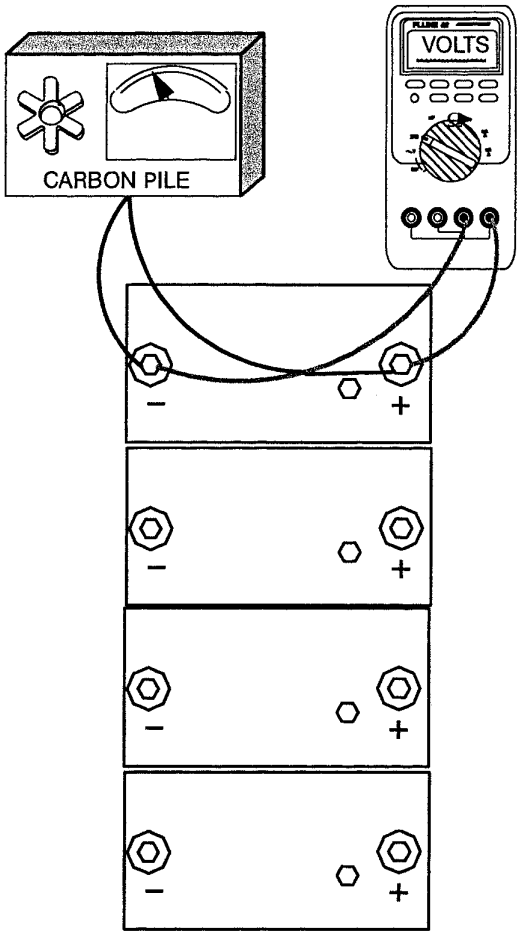


Figure 146 Battery Test Configuration

Battery Cable Voltage Loss Test

Slow cranking is often caused by high resistance in the battery cables or connections, especially in cold weather. After all batteries check good (Battery Test Procedure) and terminals are clean and tight, check the battery cables. To check battery cables place a specific load on the batteries at the starter and measure the voltage drop in each cable. This load will be supplied by the adjustable carbon pile.

The voltage drop in the positive cable plus the voltage drop in the negative cable equals the difference between the battery voltage and the starter voltage due to the cables. The maximum acceptable loss has been calculated only for the specific load specified in the test.

1. Tighten nuts holding battery cables to the solenoid and starter terminals.

   NOTE – The solenoid BAT terminal is at battery voltage when batteries are connected.

2. Connect carbon pile positive lead to start solenoid BAT terminal and negative lead to starter ground terminal.

3. Connect voltmeter from the starter solenoid “B” terminal to battery positive post.

4. Turn carbon pile on and adjust load to 500A. Read and record positive cable voltage drop. Turn off the load and allow carbon pile to cool.

5. Connect voltmeter from negative battery post to starter ground terminal. Attach leads directly to ground studs and not the cables.

6. Turn carbon pile on and adjust load to 500A. Read and record negative cable voltage drop. Turn off the load.

Positive Cable Voltage Loss (step 4) _____

plus Negative Cable Voltage Loss (step 6) _____

equals Total Cable Loss _____.

If system loss **is 0.6V or less**, go to Starting Motor System Circuits And Components.

If system loss **is greater than 0.6V**, repair or replace cable(s) with excessive voltage loss and retest.

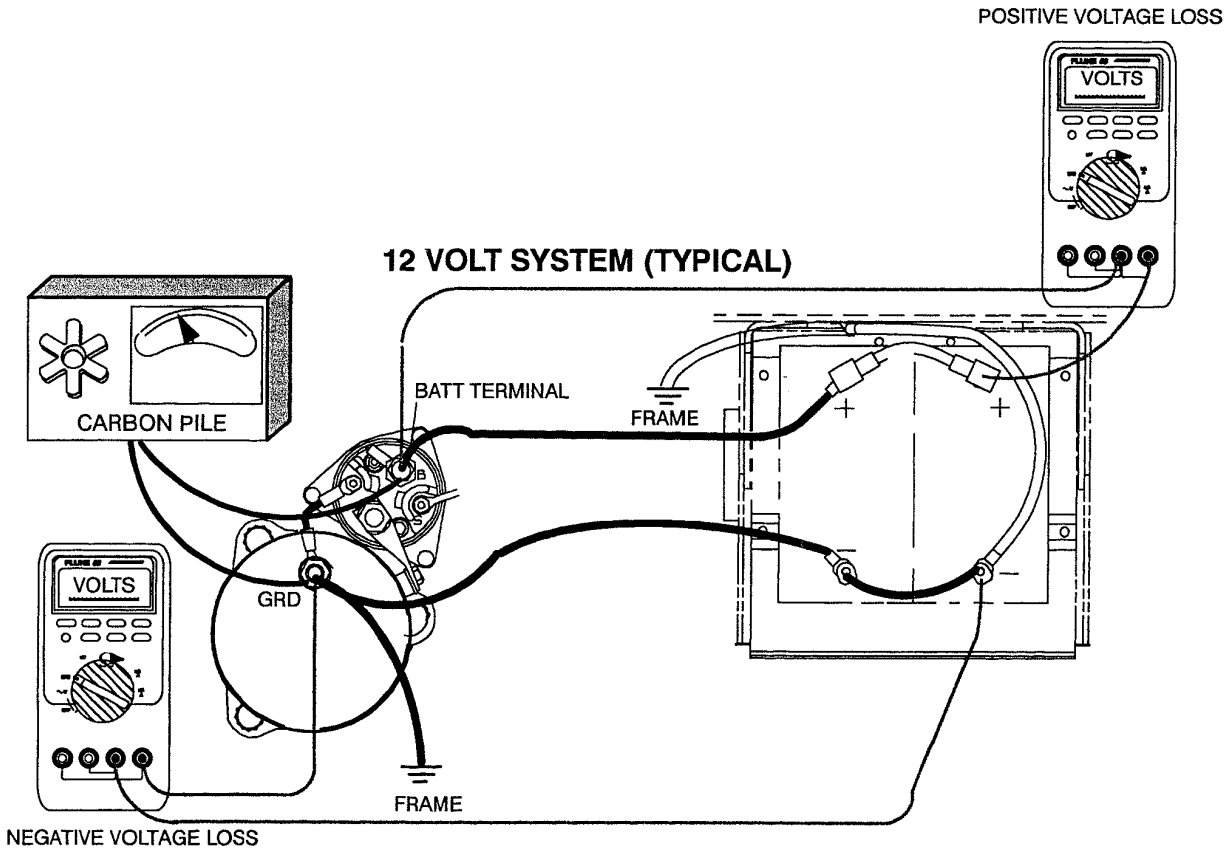


Figure 147 Battery Cable Voltage Loss Test

1.3. COMPONENT LOCATIONS

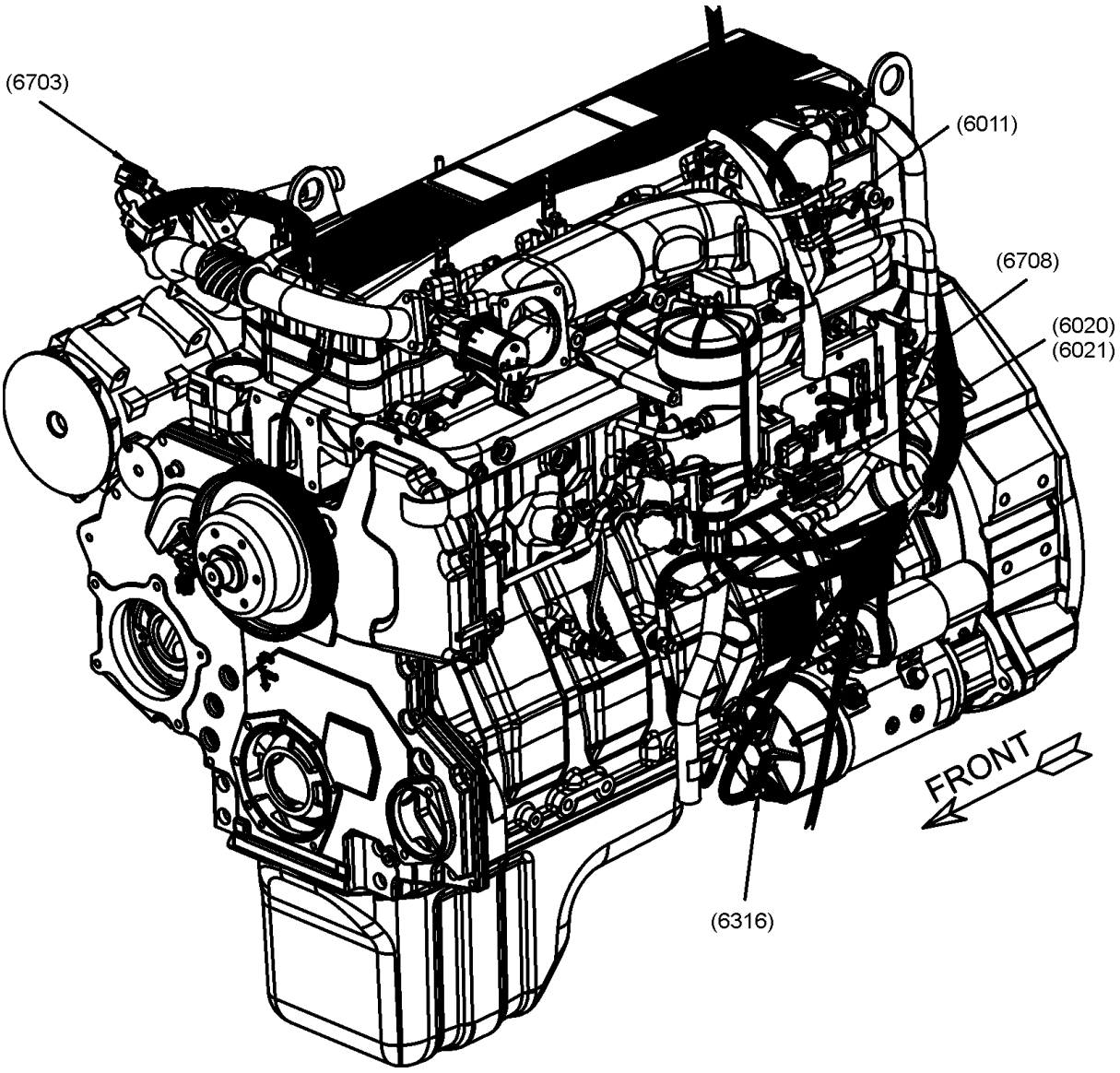


Figure 148 Cranking Motor Location (I6 Engine)

(6011) IDM2 CONNECTOR
(6020) ECM2 CONNECTOR — X3
(6021) ECM2 CONNECTOR — X4
(6316) THERMAL OVERCRANK PROTECTION CONNECTOR
(6703) INTAKE AIR TEMPERATURE SENSOR CONNECTOR
(6708) FUEL FILTER PREHEATER CONNECTOR

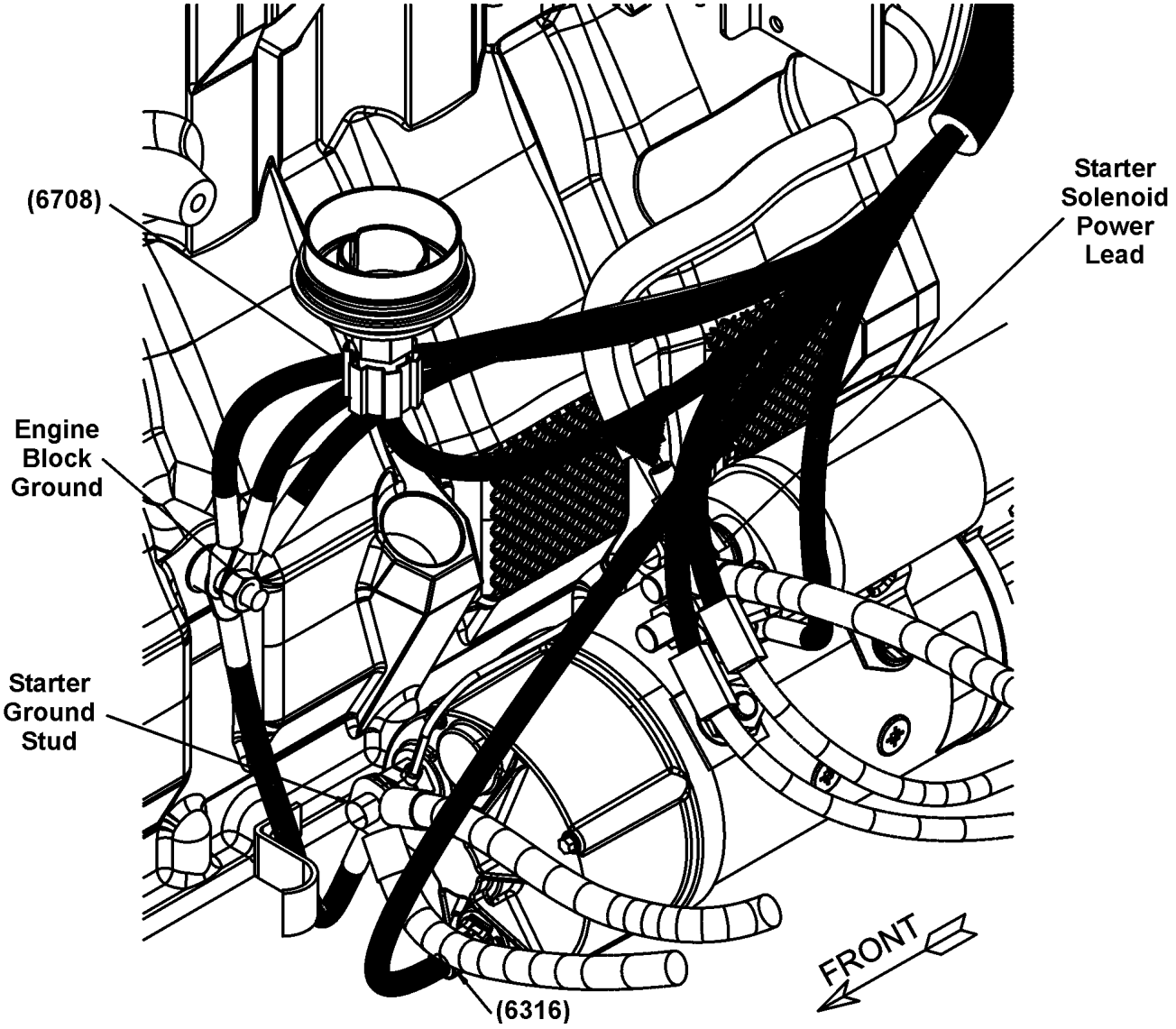


Figure 149 Cranking Motor (I6 Engine)

(6708) FUEL FILTER PREHEATER

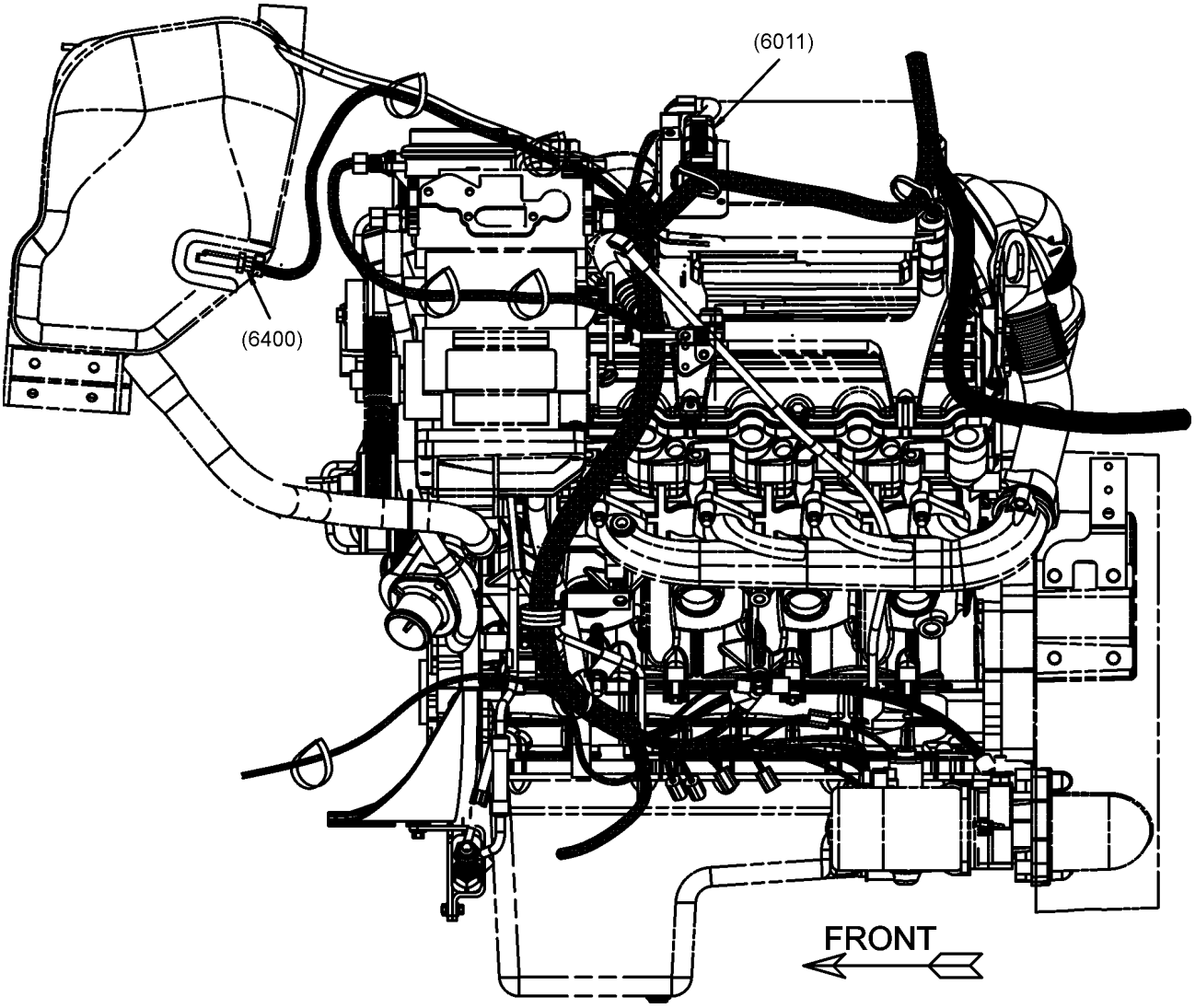


Figure 150 Cranking Motor Location (V8 Engine)

(6011) IDM2 CONNECTOR
(6400) LOW COOLANT SENSOR

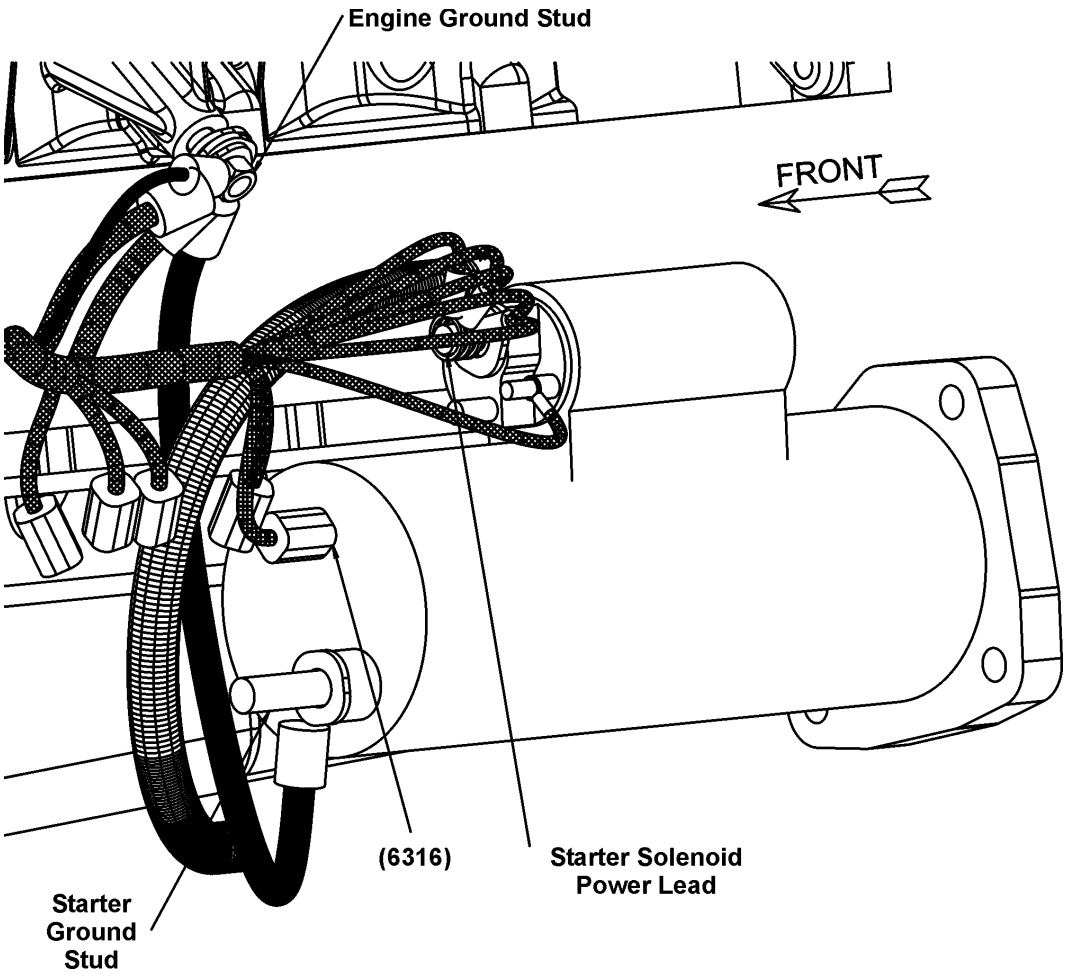


Figure 151 Cranking Motor (V8 Engine)

(6316) THERMAL OVERCRANK PROTECTION

2. CHARGING

The alternator generates alternating current which is subsequently converted to direct current. The function of the alternator is to supply power to the vehicle electrical system. Any current above the needs of the vehicle components is used to charge the batteries.

2.1. CHARGING CIRCUITS

For a complete discussion on operating principles for alternators, refer to Group 08 Electrical in the CTS-5000 Master Service Manual for the specific alternator being serviced.

International Engines

When the vehicle is running, the alternator supplies power through the alternator or (BAT) terminal, and circuit K2A to a splice. From the splice, current flows through a fusible link to the crank motor solenoid battery stud. From this stud, current flows to the batteries through the positive battery cable. Power is also applied to fuse block (1011) through fusible links K14V-FL and K14W-FL.

The alternator is grounded through the (GRD) terminal and circuit K2–G to the engine block ground (G).

2.2. VEHICLE CHARGING SYSTEM

Batteries Undercharged

Before beginning test procedures: check battery cables and alternator wiring (especially grounds) for clean, tight connections. Wires and connectors should not be damaged or corroded.

Perform the following checks before removing the alternator from the vehicle.

1. Accessories having been left on for an extended time.

2. Check alternator drive belt tension (refer to GROUP 12 - ENGINE, Cooling in the CTS-5000 Master Service Manual for belt tension specifications). As a general rule, if the alternator fan can be rotated by pulling on the fan with one finger, the belt is too loose.

3. Inspect for faulty batteries as described in Group 08 Electrical in the CTS-5000 Master Service Manual.

4. Wiring faults. Visually check wiring, clamps, and connections for clean, tight connections, free of damage and corrosion.

5. With the engine off, check voltage to ground at the BAT terminal of the alternator. A zero reading indicates an open in circuit 2, between the alternator and batteries.

6. A faulty component or wiring fault may be causing a small current drain that is less than the fuse rating for the circuit so the fuse does not open. To locate the unwanted current drain:

   NOTE – Batteries should be fully charged for the following test.

   a. KEY OFF- Turn all accessories and controls off. Disconnect circuit 2 from the alternator B terminal.

   b. To check the entire system for current drains, insert the DMM leads in the COM and 10A fused jack on the meter. Set the meter to DC amps. Connect the meter in series with the alternator. If the meter leads are not connected with correct polarity, a (-) amp reading will be present.

   c. Some current draw will be present. If the current draw is less than 0.3A move the lead from the 10A jack to the 320mA jack to read the exact current flow.

   d. Refer to the Battery Power Distribution circuit diagrams in S08285. Remove the battery feed fuses one at a time, while monitoring the meter for any change in current flow. Note that some circuits (such as clock or radio or engine computer, etc.) should be drawing some current. Look for current draw in circuits that should not be active.

7. Perform Alternator Wiring Test — Part 1 below.

Alternator Tests

The alternator output must reach the batteries and accessory loads with a minimum amount of voltage loss. Any loss slows the rate of charge to the batteries and can cause the batteries to be undercharged. Discharged batteries can damage the starter and cause vehicle electrical components to operate improperly.

Most alternators control the maximum system voltage using a voltage regulator. Maximum voltage output is available at the alternator BAT terminal, but if any voltage is lost in the wiring, something less than the maximum will reach the batteries and load devices. The greatest losses occur when the charging system is outputting at the maximum rated level (amps).

Alternator Wiring Test — Part 1

Instead of using alternator current output, this test (and Alternator Wiring Test — Part 2 below) uses the same amount of current but draws it from the batteries (must be fully charged). Using the carbon pile load, the current flows in reverse through the circuit without the engine running.

1. Without the engine running, connect the carbon pile to the alternator output terminal and ground.

   NOTE – Alternator output is at battery voltage.

2. Connect voltmeter across battery.

3. Adjust the carbon pile to alternator rated output (amps). Rated output is stamped on the case or on a tag.

4. Measure and record BATTERY VOLTAGE. Turn the carbon pile off.

5. Move the voltmeter to the alternator, but do not connect to carbon pile clamps. Adjust carbon pile to rated output (amps) of the alternator.

6. Measure and record ALTERNATOR VOLTAGE. Turn carbon pile off.

BATTERY Voltage (step 4) _____

minus ALTERNATOR Voltage (step 6) _____

equals System Loss _____

If system loss **is 0.7 volt or less**, go to Alternator Replacement Test.

If system loss **is greater than 0.7 volt** go to Alternator Wiring Test — Part 2.

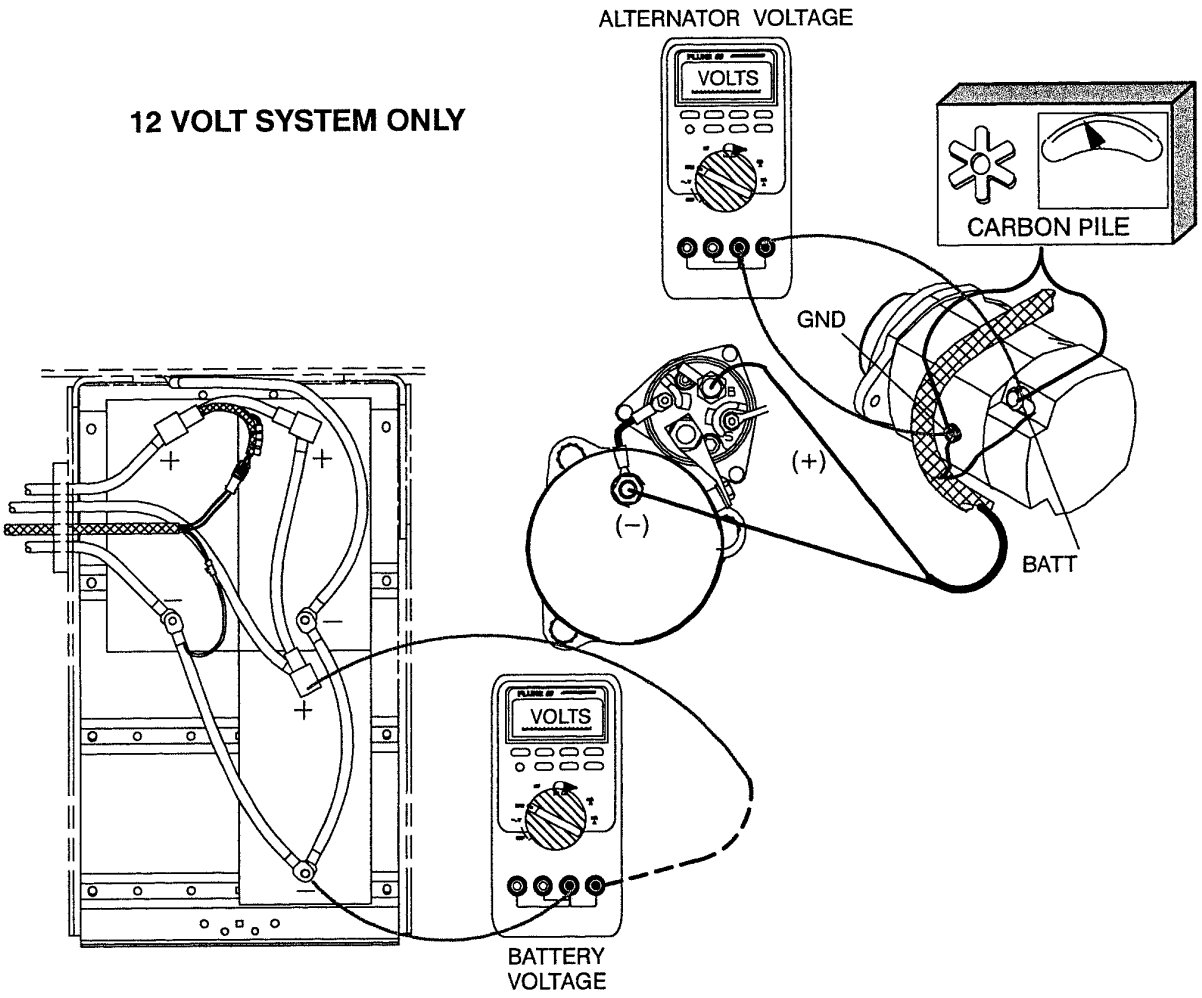


Figure 152 Alternator Wiring Test — Part 1

Alternator Wiring Test — Part 2 (12 volt System Only)

If system voltage is MORE than 0.7 volt in Alternator Wiring Test — Part 1, above, perform this test.

1. With the carbon pile still connected, connect Fluke 88 meter to alternator BAT terminal and to the positive battery terminal.

2. Adjust carbon pile to alternator rated output (amps). Measure and record POSITIVE CIRCUIT LOSS. Turn carbon pile off.

3. Connect the meter to the alternator ground and to the battery negative terminal.

4. Adjust the carbon pile to alternator rated output (amps). Measure and record NEGATIVE CIRCUIT LOSS. Turn carbon pile off.

   POSITIVE CIRCUIT LOSS (step 2) _____

plus NEGATIVE CIRCUIT LOSS (step 4) _____

equals TOTAL SYSTEM LOSS _____

If system loss **is 0.7 volt or less**, go to Alternator Replacement Test, below.

If system loss **is greater than 0.7 volt**, repair circuit(s) faults, then go to Alternator Replacement Test, below.

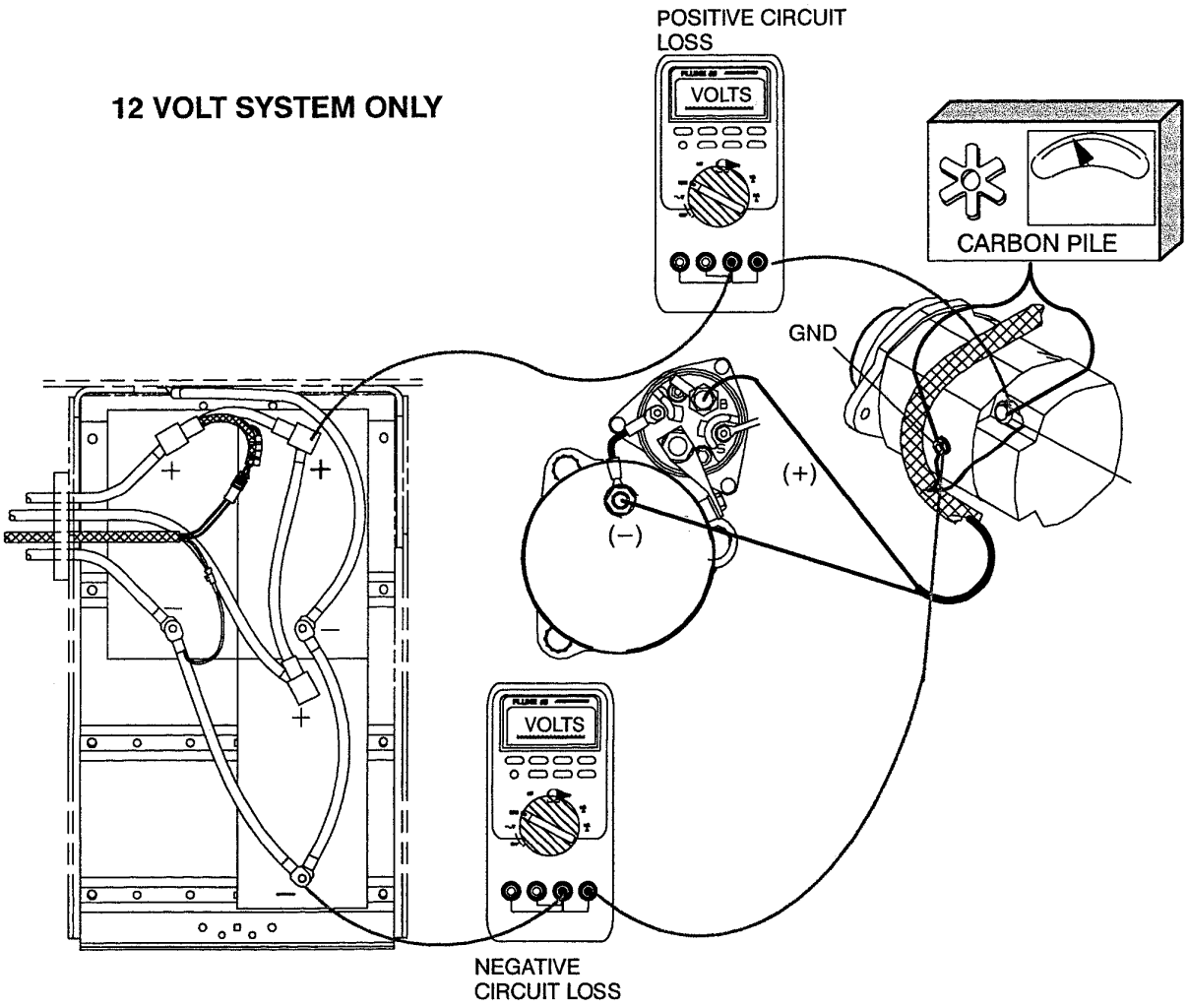


Figure 153 Alternator Wiring Test — Part 2 (12 volt System Only)

Alternator Replacement Test (12 volt System Only)

1. If the wiring tests have been performed (circuits OK), adjust alternator belt and tighten mounting bolts and ground connections.

2. With vehicle at shop temperature, connect the carbon pile and the ammeter as shown. To use an ammeter without induction clamp, connect meter leads to same terminals as the carbon pile.

3. With NO electrical loads turned on, start the engine. Fast idle until voltage stabilizes (does not increase for 2 minutes). Voltage then should not exceed 15 volts.

4. Speed up the engine and turn on the carbon pile until the ammeter shows output has reached the highest value. Record the value _____A. Turn off carbon pile and the engine.

5. Rated output is stamped on the alternator case or on a tag. If current output measured is not within 10% of rated output or the voltage exceeds 15 volts, replace the alternator.

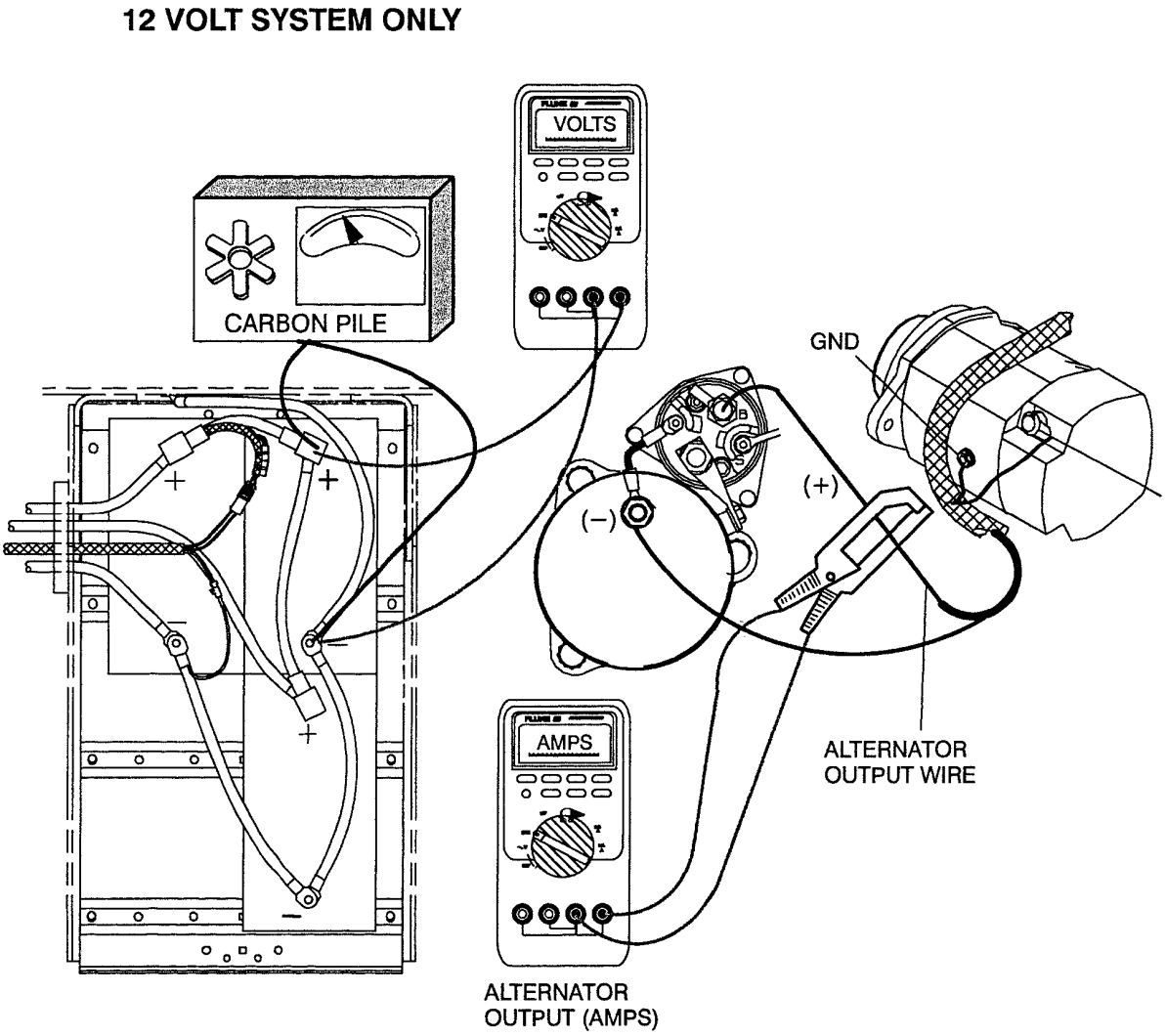
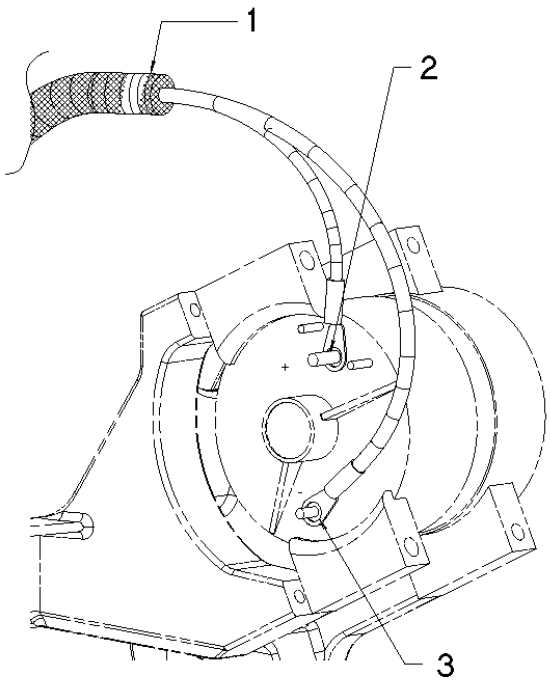


Figure 154 Alternator Replacement Test (12 Volt System Only)

2.3. COMPONENT LOCATIONS



DELCO

I6	V8	
08CDP	08GCT	130 AMP
08GDR	08GCU	145 AMP

Figure 155 Delco Alternator Wiring With International Engines

1. ENGINE HARNESS
2. POSITIVE TERMINAL, CIRCUIT K2
3. NEGATIVE TERMINAL, CIRCUIT K2–G

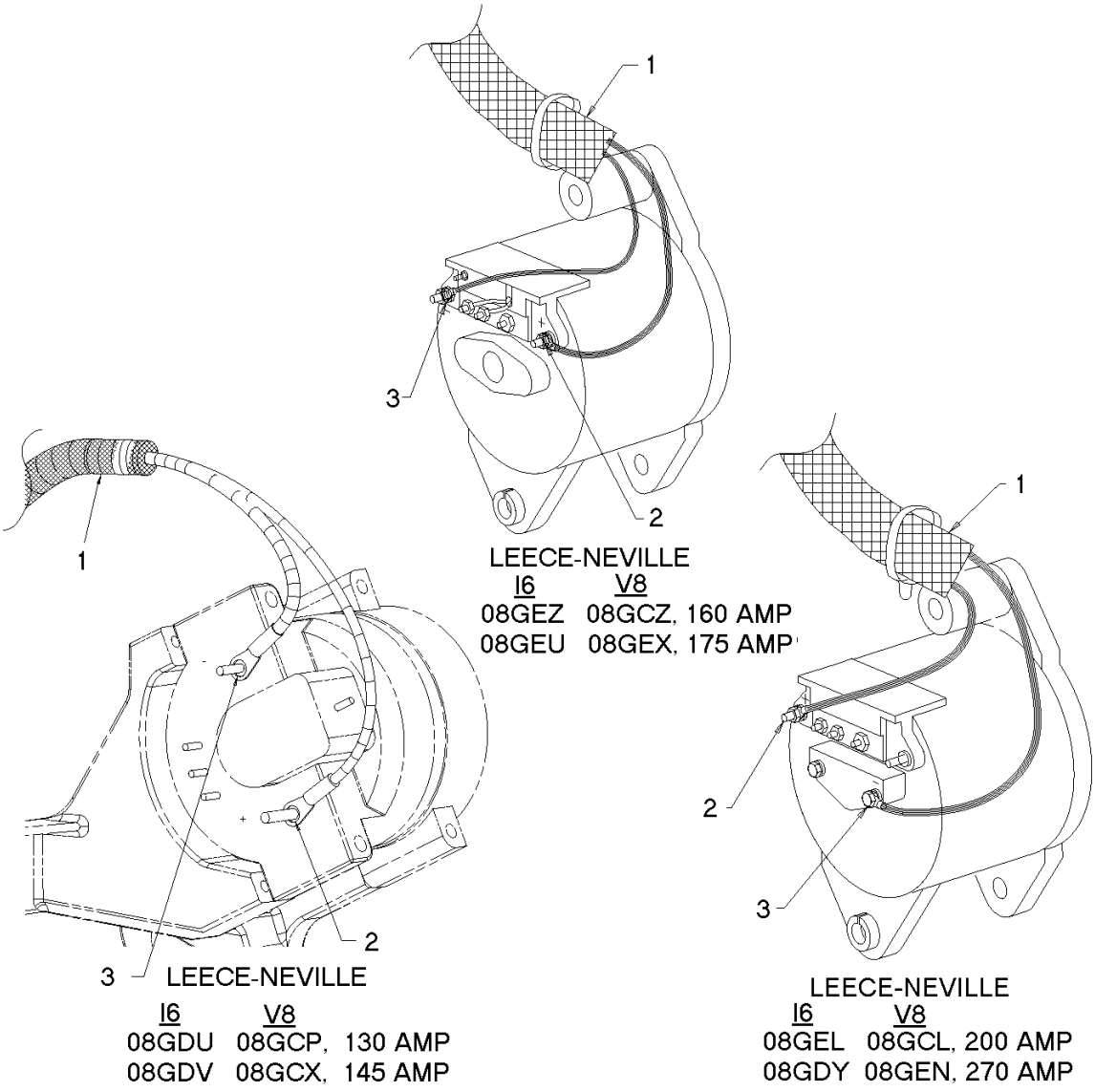


Figure 156 Leece–Neville Alternator Wiring With International Engines

1. ENGINE HARNESS
2. POSITIVE TERMINAL, CIRCUIT K2
3. NEGATIVE TERMINAL, CIRCUIT K2–G

3. ENGINE CRANKING

3.1. CIRCUIT FUNCTIONS

The cranking motor provides the rotation of the engine crankshaft, through the flywheel, that is needed to start the engine.

The cranking motor circuits provide power to the cranking motor to turn over the crankshaft of the engine. If all other systems are operational, the engine will start.

Components of the system with International engines consist of the crank motor and solenoid, the key start switch (or push button), starter ISO & power relay, the engine electronic control module (ECM), and a clutch switch with a manual transmission or a neutral position signal with an automatic transmission.

NOTE – Vehicles with the Auto Neutral feature will also use a crank inhibit relay.

When the clutch pedal is pushed, or the automatic transmission is in park or neutral the engine controller will provide a ground to the starter ISO & power relay . When the key is in the start position, 12 volts will be applied to the relay causing it to energize. The energized relay will supply 12 volts to the cranking motor solenoid causing it to energize and apply battery voltage to the cranking motor.

NOTE – Cranking motors ending in a type 50, like 350 or 450, contain thermal overcrank protection.

On vehicles using starters with thermal overcrank protection, excessive cranking will cause cranking motor temperature to reach a pre-set thermal overcrank limit. The thermal switch will then open causing the motor to disengage. When the thermal switch opens it interrupts a ground signal from the engine controller to the coil of the starter relay, preventing it from energizing. When the crank motor cools, the switch closes, permitting the crank motor to operate again.

3.2. DIAGNOSTICS

Table 94 Cranking System Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify cranking system is inoperative.	Attempt to start vehicle.	Cranking motor is turning engine.	Engine cranks. Problem may be intermittent.	Go to next step.
2.	On	Determine if any other features are malfunctioning that may have common circuits. (Example: Missing ground common to several features.)	Check for other malfunc-tioning features.	No other features are malfunc-tioning.	Go to next step.	Identify and repair condition causing several features to be inoperative.
3.	On	Measure voltage at cranking motor solenoid while key is in start position?	Cranking motor solenoid terminal “S”.	12 ± 1.5 volts	Go to next step.	Go to Starter ISO & Power Relay Circuits. (See STARTER ISO & POWER RELAY CIRCUITS, page 301)
4.	Off	Measure voltage at cranking motor solenoid while key is in off position?	Cranking motor solenoid terminal “B”.	12 ± 1.5 volts	Go to Cranking Motor System Circuits And Components. (See CRANKING MOTOR SYSTEM CIRCUITS AND COMPONENTS, page 304)	Identify and repair cause of incorrect voltage to cranking motor “B” terminal from batteries.

3.3. STARTER ISO & POWER RELAY CIRCUITS

For complete information on operation and servicing cranking motors used on these vehicles, refer to Group 08 Electrical in the CTS-5000 Master Service Manual or the manufacturers service manual.

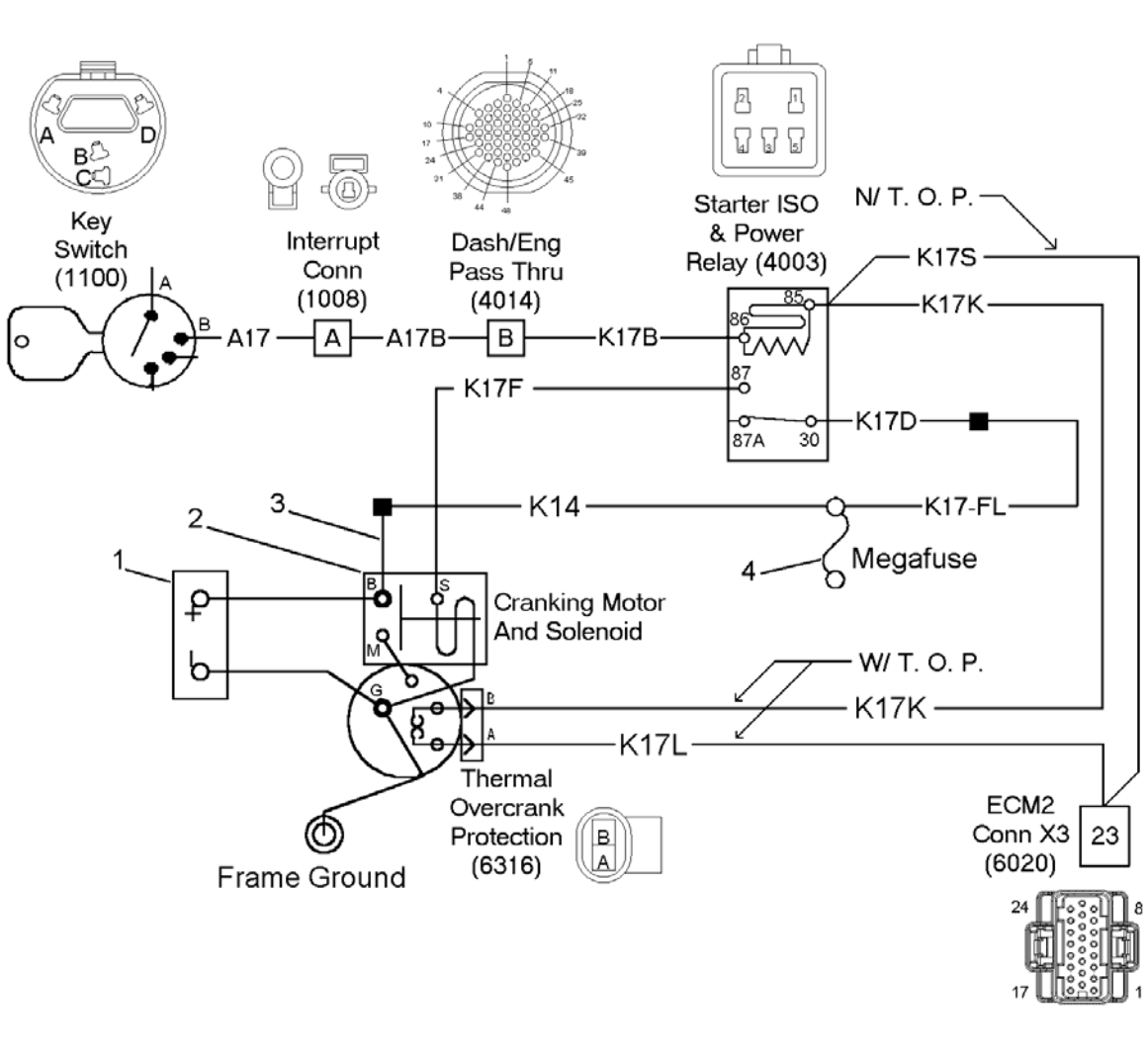


Figure 157 Starting Power Distribution Diagram

1. BATTERY
2. STARTER SOLENOID
   LOCATED ON STARTER
3. FUSIBLE LINK
4. MEGAFUSE
   LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE

(1008) STARTER INTERRUPT
   LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(1100) KEY SWITCH
   LOCATED AT INSTRUMENT WING PANEL
(4003) STARTER & ISO POWER RELAY
   LOCATED AT OUTSIDE CENTER TOP DASH PANEL
(4014) DASH/ENGINE PASS THRU
   LOCATED AT INSIDE LEFT SIDE DASH PANEL
(6020) ECM2 CONN — X3
   LOCATED AT ENGINE COMPARTMENT AT ECM
(6316) THERMAL OVERCRANK PROTECTION
   LOCATED ON STARTER

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.

Battery power is always present at the crank motor solenoid (B) terminal through the positive battery cable. Power from the (B) terminal is supplied to Starter ISO and Power relay (4003) terminal through fusible links K14W-FL and K14V-FL, and circuits K14, K17–FL, and K17D.

The ground signal for Starter ISO and Power relay (4003) is supplied from engine controller connector (6020) terminal 23. The engine controller supplies a ground when the engine is not running. The clutch switch (depressed) or transmission circuits (in neutral) apply 12 volts to (6020) pin 23. On starters with thermal over crank protection, the thermal relay will open this circuit.

The ground signal from the engine controller will be supplied when the clutch is engaged, or the automatic transmission is in neutral.

With the start relay energized, power flows through the Starter ISO & Power relay (4003) and circuit K17F to the (S) terminal of the crank motor solenoid which energizes the crank motor solenoid.

As long as the engine is running, the engine controller will not allow the cranking motor to be engaged.

Table 95 Starter ISO & Power Relay Circuit Tests

Starter ISO & Power Relay Connector (4003) Voltage Checks Check with (4003) removed, transmission in park and ignition on. Bench check relay. If relay fails, replace and check for faults. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
(4003) cavity 30 to ground	12 ± 1.5 volts	If voltage is missing, check for open or short in circuits K17D, K17–FL, K14, K14W-FL and K14V-FL.
(4003) cavity 30 to cavity 87	12 ± 1.5 volts	If voltage is missing, check for open in circuit K17F and ground through the cranking motor solenoid.
(4003) cavity 86 to ground	12 ± 1.5 volts	If voltage is missing, check for open or short in circuits K17B, A17B and A17.
(4003) cavity 86 to cavity 85	12 ± 1.5 volts	If voltage is missing, check for open in circuits K17S (without thermal overcrank protection) or K17K and K17L (with thermal overcrank protection) and engine ECM or open/short in clutch switch or transmission circuits to the engine controller. Also check for open thermal switch if overcrank feature is installed.
Information on clutch and neutral circuits to the engine controller is provided at the following areas: Refer to Neutral and Back-Up Light Circuits. (See NEUTRAL AND BACK-UP LIGHT CIRCUITS, page 1129)		

3.4. CRANKING MOTOR SYSTEM CIRCUITS AND COMPONENTS

Cranking Motor Solenoid Circuit Test - Part 1

Refer to Cranking Motor Solenoid Circuit Test - Part 1

Starter shifting in and out, or not pulling in, is often caused by high resistance in the cranking motor solenoid circuit. When the solenoid circuit has excessive voltage loss, the cranking motor pinion may not engage the flywheel. If it does engage, it may drop out too soon when battery voltage drops. The solenoid circuit includes the Starter ISO & Power relay (4003) (located in the engine power distribution center) and circuits connected to the cranking motor solenoid.

On vehicles with **overcrank protection**, refer to Testing Thermal Overcrank Protection System **before performing this test**.

1. Disconnect starter relay circuit K17F from the starter solenoid “S” terminal.

2. Connect the carbon pile positive lead to circuit K17F and the negative lead to the cranking motor ground. Connect the positive lead of a DMM voltmeter to the solenoid “B” terminal. Connect negative lead of voltmeter to switch wire lead K17F (not to carbon pile clamp). Meter will show battery voltage.

3. Have an assistant turn the key switch to the start position or push start button. Voltmeter reading should be zero. You should hear the starter relay energize with a clicking sound. If the switch does not “click,” either the starter relay switch is faulty or there is no voltage from the key switch circuit (refer to Starter ISO & power relay circuits. (See STARTER ISO & POWER RELAY CIRCUITS, page 301)

4. Turn on and adjust the carbon pile to 50 amp load (for no more than 10 seconds). Read and record _____voltage on voltmeter. Release start switch. Turn off and disconnect carbon pile and voltmeter.

If circuit loss **is 0.5 volt or less**, Starter solenoid circuitry is OK.

If circuit loss **is more than 0.5 volt**, go to Cranking Motor Solenoid Circuit Test — Part 2. (See Cranking Motor Solenoid Circuit Test - Part 2 (Wire Voltage Loss), page 305)

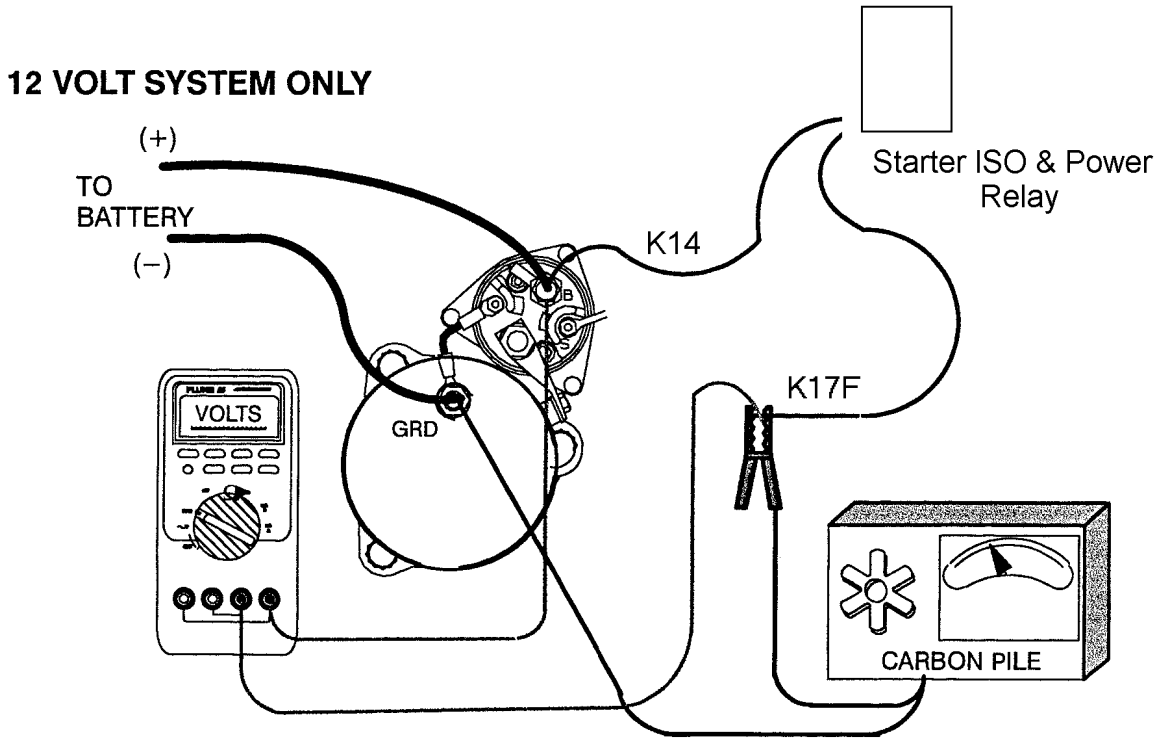


Figure 158 Cranking Motor Solenoid Circuit Test — Part 1

Cranking Motor Solenoid Circuit Test - Part 2 (Wire Voltage Loss)

Refer to Cranking Motor Solenoid Circuit Test - Part 2 (Wire Voltage Loss).

If the voltage loss in the previous Test was more than 0.5 volt, the loss is excessive. The loss may be from loose terminals, corrosion, or a worn out Starter ISO & Power relay (4003). To locate the problem:

1. Disconnect circuit K17F from “S” terminal at Cranking Motor solenoid. Connect carbon pile to circuit K17F and to cranking motor ground terminal. Turn the carbon pile on (will show 0 amps).

2. Disconnect Starter ISO & Power relay (4003) and install a jumper lead to (4003) cavity 30, circuit K17D.

   NOTE – Test lead will be at battery voltage.

   Connect DMM from solenoid BAT terminal to Starter ISO & Power relay (4003) cavity 30, circuit K17D (will show zero volts).

3. At relay connector, install other end of jumper lead to cavity 87 circuit K17F. Turn on and adjust carbon pile to 50 amp load (no more than 10 seconds). Read and record first wire voltage loss. Disconnect DMM.

4. At relay connector, connect DMM from cavity 30, K17D to circuit K17F at carbon pile. Connect to terminal and not to carbon pile clamp.

5. Turn on and adjust carbon pile to 50 amp load (no more than 10 seconds). Read and record second wire voltage loss. Disconnect and remove jumper lead and DMM.

First Wire Loss (step 3) _____

plus Second Wire Loss (step 5) _____

equals Total Wiring Loss = _____(0.4V maximum loss)

If wiring loss is **0.4 volt or less**, repair or replace wire(s), and retest per Cranking Motor Solenoid Circuit Test — Part 1, above.

If wiring loss is **more than 0.4 volt**, repair or replace wire(s), and retest per Part 1.

If retest results are still above 0.5 volt loss, replace starter relay and retest per Part 1.

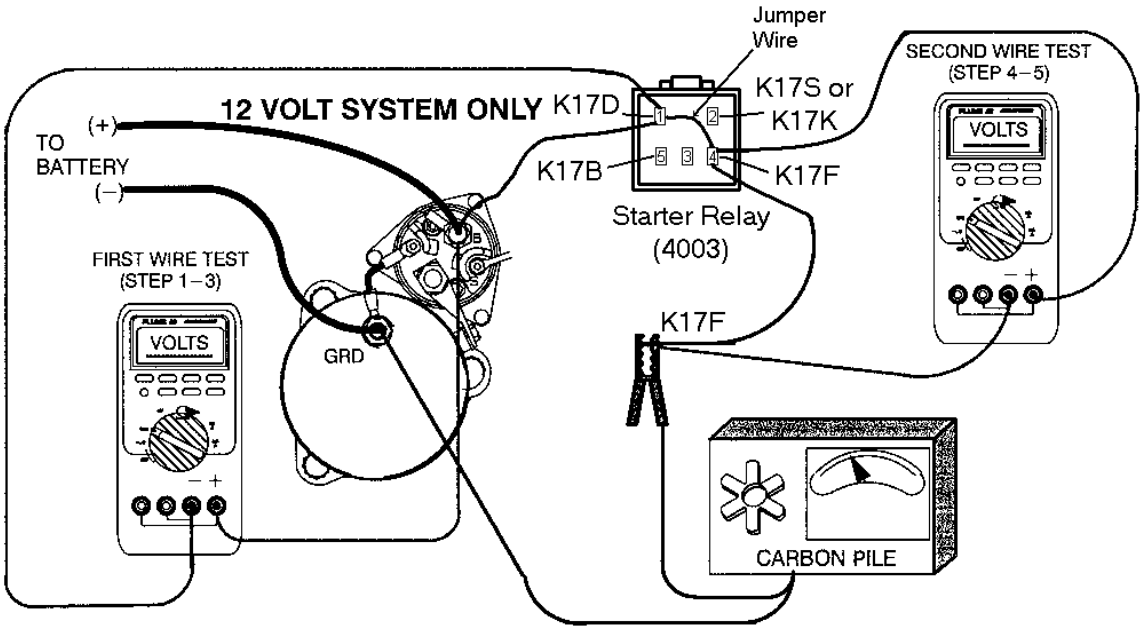


Figure 159 Cranking Motor Solenoid Circuit Test - Part 2 (Wire Voltage Loss)

Cranking Motor Replacement Test

Refer to Cranking Motor Replacement Test.

A. COLD WEATHER START MAGNETIC SWITCH PROBLEMS

The start relay can fail to “hold in” during cold weather cranking due to low voltage, even though the switches and circuits check good. This failure sounds as though the cranking motor is failing to stay engaged to the flywheel. It is caused by low system voltage releasing the relay.

If this condition exists, momentarily install jumper wire from circuit K17D to K17F at Starter ISO & Power relay connector (4003).

CAUTION – The studs or terminals are at battery voltage and the engine should crank when the jumper is connected. Remove jumper to stop cranking.

If the engine cranks properly with jumper in place, replace the relay.

B. CHECKING AVAILABLE VOLTAGE AT CRANKING MOTOR

If all previous tests have been performed, the vehicle batteries and cranking motor wiring have been checked. If the engine still cranks slowly, check available voltage at the cranking motor.

1. While cranking engine, measure voltage between the cranking motor solenoid “BAT” stud and cranking motor ground.
   a. If voltage is 9.0 volts or more, the problem must be in the cranking motor (or engine). Replace the cranking motor.
   b. If the voltage is less than 9.0 volts, go to step 2.
2. Check the interconnecting cable between the batteries. While cranking, measure the terminal voltage of each battery by touching voltmeter leads to the post of each battery.
   a. If the difference between any two battery readings in the same battery box is more than 0.5 volt or any cable is warm to the touch, replace the interconnecting cables.
   b. If cables check OK, the problem must be in the Cranking Motor (or engine). Replace the Cranking Motor.

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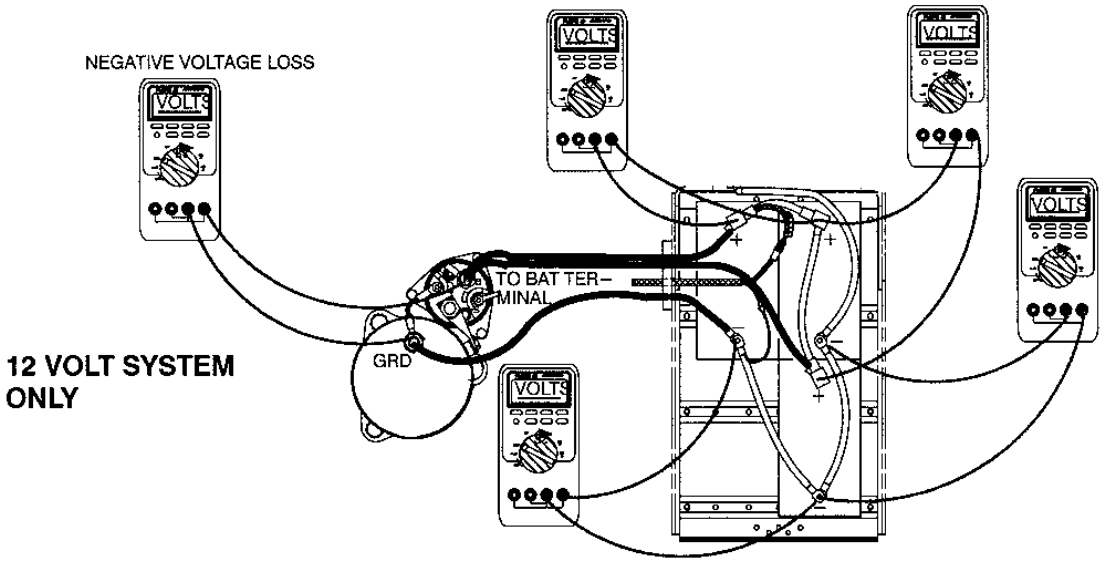

Figure 160 Cranking Motor Replacement Test

Testing Thermal Overcrank Protection System

The thermal overcrank circuit interrupts the ground signal from the engine controller to the starter ISO & power relay when the engine has been cranking too long and the starter is overheating. Problems with the circuits could be the result of a failed thermal switch or open or shorted circuits.

Table 96 Thermal Overcrank Circuit Tests

Thermal Overcrank Circuit Check with (6316) removed, key in start position, all relays installed and transmission in PARK. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Thermal overcrank connector on starter motor.	Resistance across terminals should be < 2 ohms when starter is cool.	If resistance is high, replace thermal switch. If relay passes test, go to next step.
(6316) harness connector cavity B to ground.	12 ± 1.5 volts	If voltage is missing, check for open or short in circuits K17K between (6316) and starter relay (4003).
(6316) harness connector cavity B to cavity A.	12 ± 1.5 volts	If voltage is missing, check for open in circuit K17L to engine controller. If circuit checks good refer to engine manual to troubleshoot missing ground from engine controller.

3.5. COMPONENT LOCATIONS

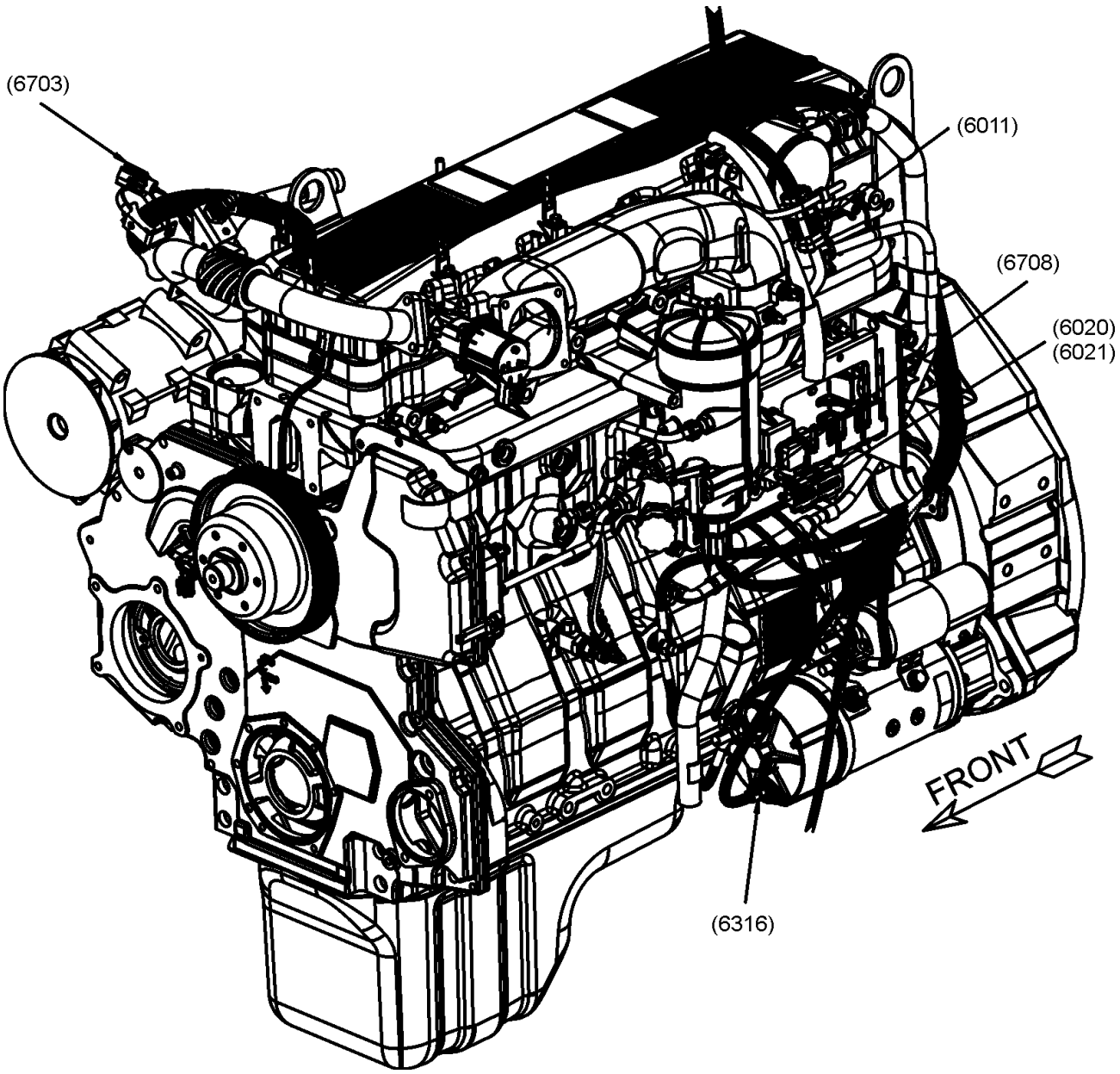

Figure 161 Cranking Motor Location (I6 Engine)

(6011) IDM2 CONNECTOR
(6020) ECM2 CONNECTOR — X3
(6021) ECM2 CONNECTOR — X4
(6316) THERMAL OVERCRANK PROTECTION CONNECTOR
(6703) INTAKE AIR TEMPERATURE SENSOR CONNECTOR
(6708) FUEL FILTER PREHEATER CONNECTOR

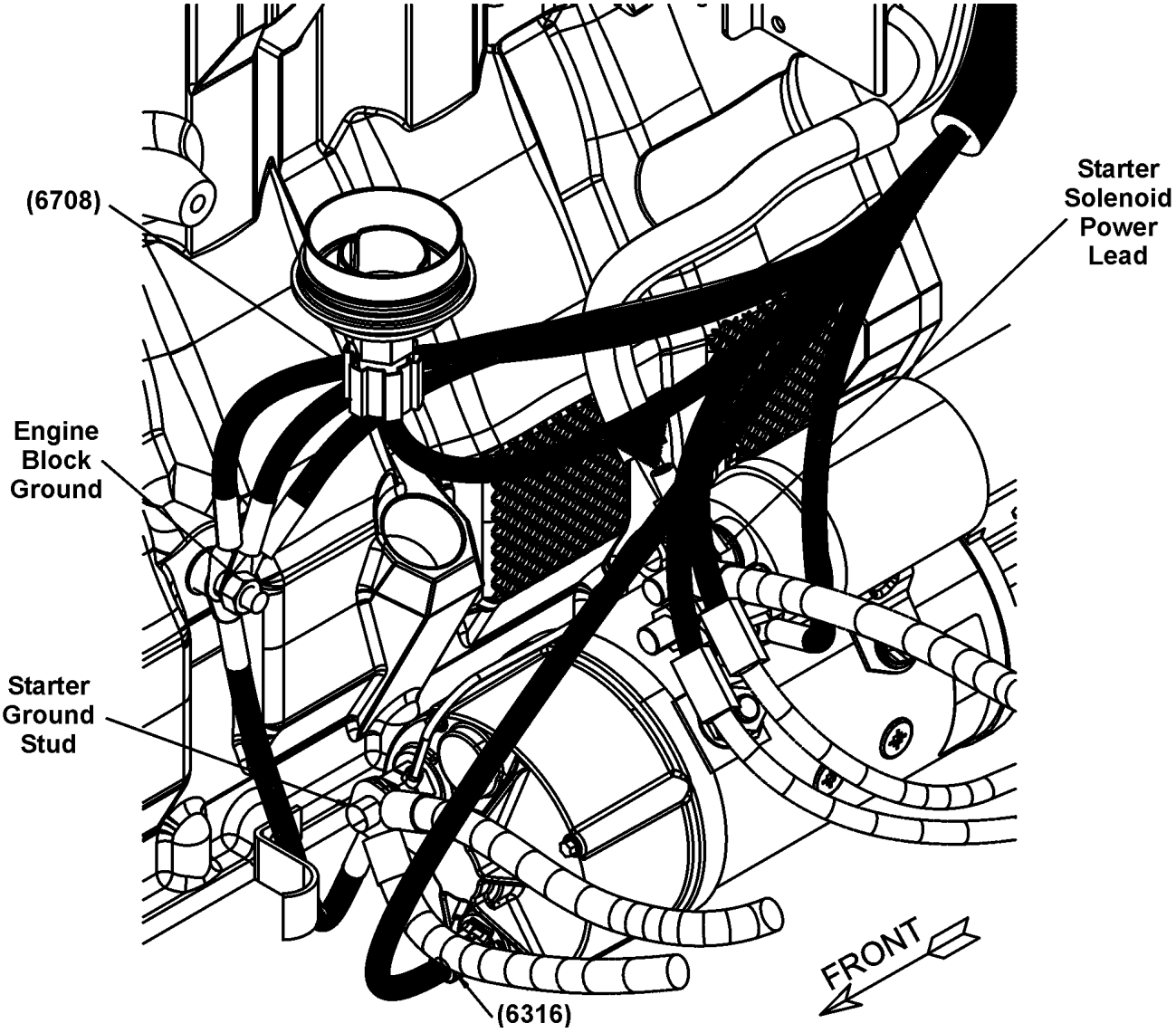

Figure 162 Cranking Motor (i6 Engine)

(6708) FUEL FILTER PREHEATER

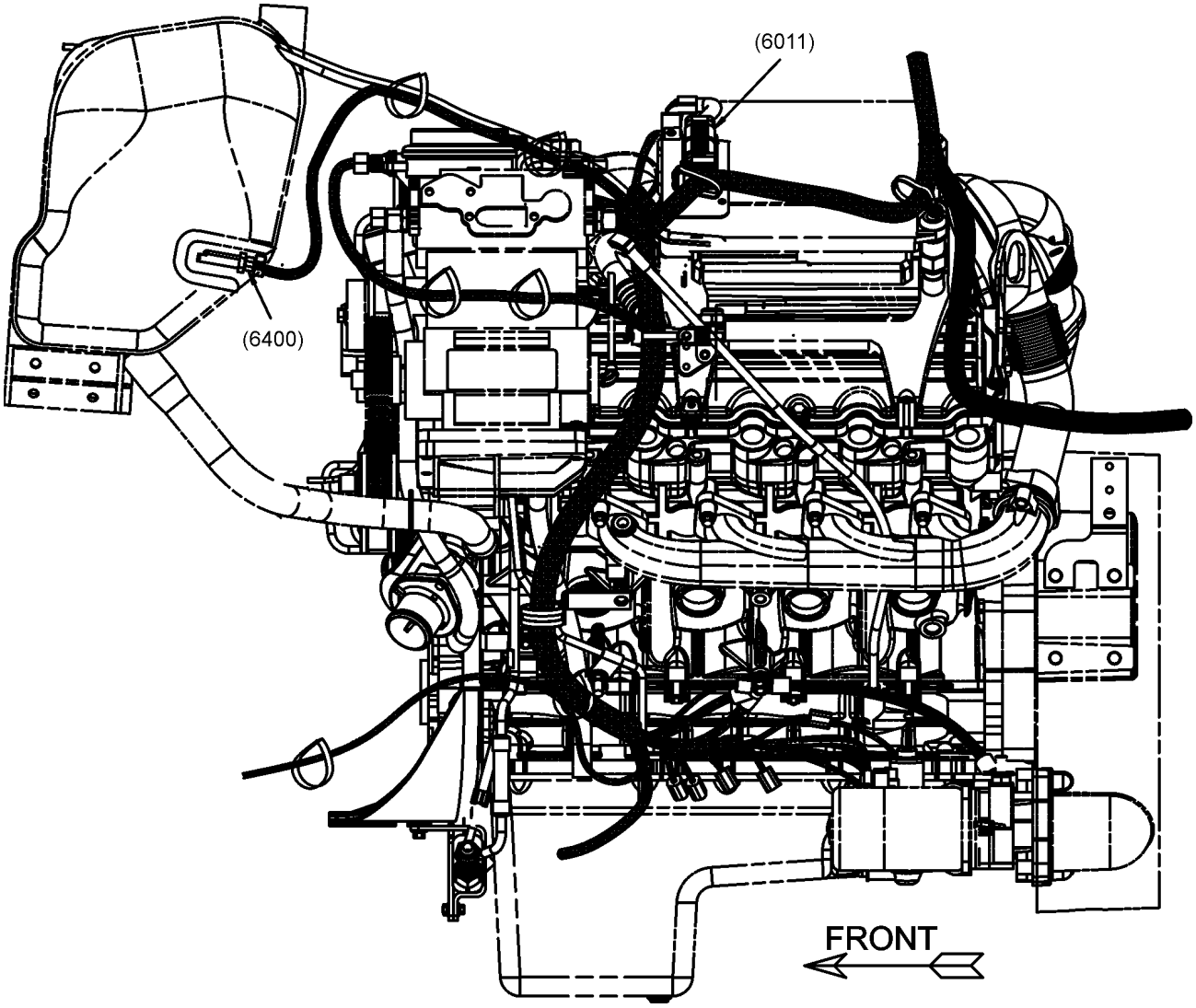

Figure 163 Cranking Motor Location (V8 Engine)

(6011) IDM2 CONNECTOR
(6400) LOW COOLANT SENSOR

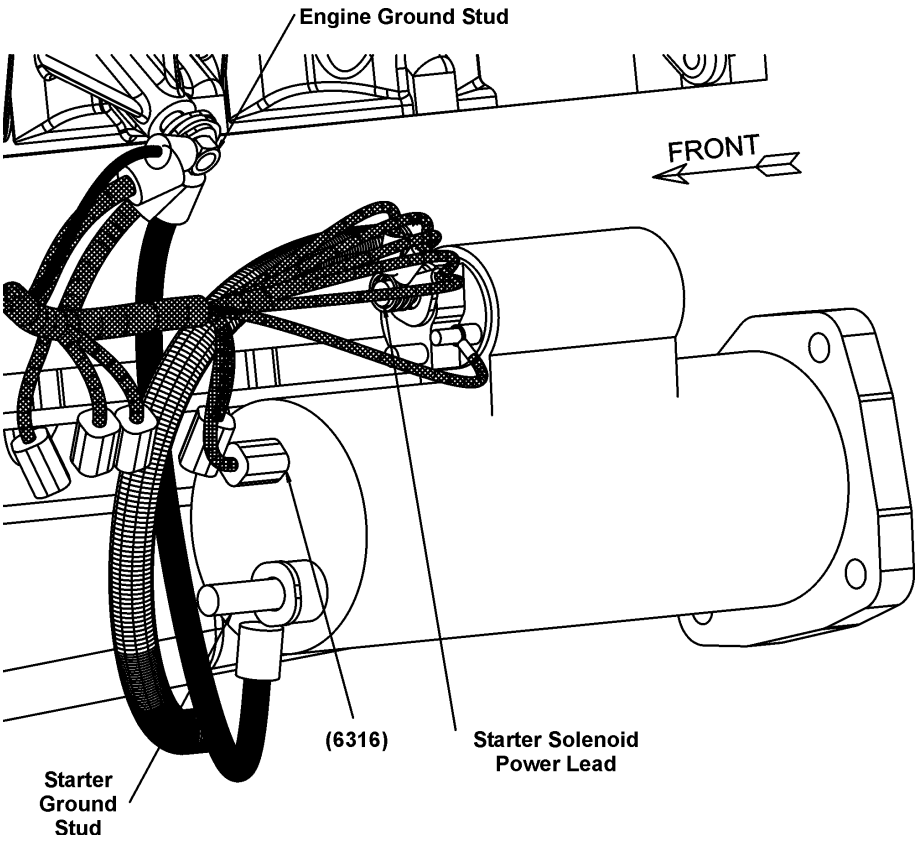

Figure 164 Cranking Motor (V8 Engine)

(6316) THERMAL OVERCRANK PROTECTION

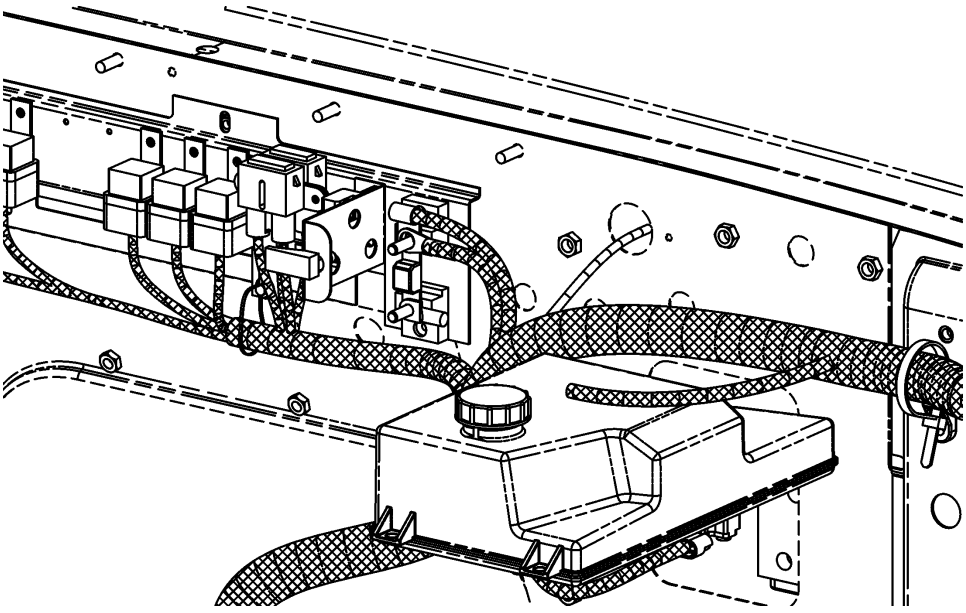

Figure 165 Engine Power Distribution Center

Table of Contents

DESCRIPTION

Discussion of the engines, in this section, is limited to the engine electronic control module (ECM) power circuits and data link connectivity. The “CHECK ELEC SYSTEM “ warming lamp will illuminate when communication with the engine controller is lost. Diagnostic trouble codes (DTC’s) will also be logged. This could be the result of a communication problem, a power problem to the engine controller or an internal engine controller problem.

The engine controllers have their own diagnostic systems. For detailed information on engine diagnostics, refer to the appropriate engine manuals.

1. I6 ENGINES

Discussion of the I6 Engine, in this section, is limited to the engine electronic control module (ECM) power circuits and data link connectivity. The engine controller has its own diagnostic system and uses flash codes displayed by the ENGINE warning lights. For detailed information on engine diagnostics, refer to IC Corporation Engine Diagnostic Manual EGES–265.

1.1. ENGINE CONTROL MODULE (ECM) POWER AND GROUND

Circuit Functions

The Electronic Engine Control Module (ECM) receives switched ignition voltage, through a 10 amp fuse (F16), from the primary ignition relay, R5, in the engine compartment power distribution panel. The (ECM) also receives 12 volt operating power, with the key switch in the ignition position, through the ECM power relay from the battery. The circuitry is protected by a 40 amp fuse that is part of the battery cable assembly. The ECM ground is from the negative post of the batteries.

Diagnostics

A problem with power to the ECM will be apparent when the vehicle will not crank and the “CHECK ELEC SYS” warning lamp in the gauge cluster is constantly on.

The problem could be attributed to open or shorted wiring between the ECM and related power circuits, a blown fuse, a failed relay or a failure inside the ECM.

Several ESC diagnostic trouble codes (DTC’s) will be logged when there is no communication on the drivetrain 1939 data link between the ECM and the ESC or the EGC.

An electronic service tool, running the "Diamond Logic Builder™" diagnostic software, can be used to view diagnostic trouble codes. Refer to the “Diamond Logic Builder™” software manual.

Table 97 Engine Electronic Control Module Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify “CHECK ELEC SYS” warning lamp is on and ECM is inoperative.	Visually check “CHECK ELEC SYS” warning lamp and attempt to start vehicle.	Engine cranks.	Go to Drivetrain 1939 Data Link(See DRIVETRAIN 1939 DATA LINK, page 73)	Go to Fault Detection Management.(See Fault Detection Management, page 318)

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 fault in the ECM power circuits will be apparent when the engine will not start and there is no communication between the ECM and the ESC or EGC. Problems in the ECM power circuits could be attributed to a blown fuse, a short or an open circuit.

Refer to ECM Power Circuits.

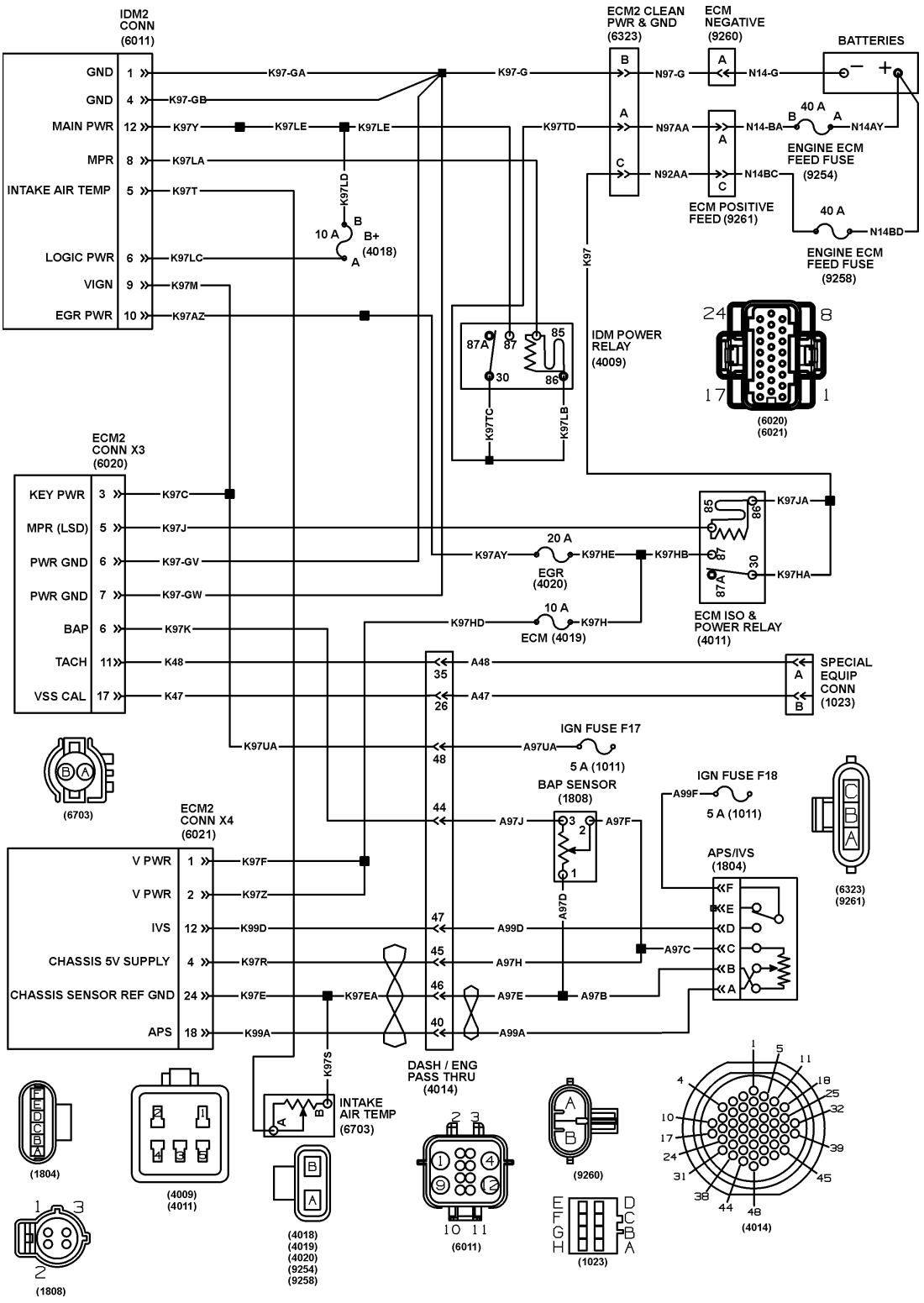

Figure 166 ECM Power Circuits

(1804) APS/IVS
LOCATED AT ACCELERATOR PEDAL
(1808) BAP SENSOR
LOCATED AT INSTRUMENT RIGHT SIDE PANEL
(4009) IDM POWER RELAY
LOCATED AT OUTSIDE CENTER TOP DASH PANEL
(4011) ECM ISO & POWER RELAY
LOCATED AT OUTSIDE CENTER TOP DASH PANEL
(4014) DASH/ENGINE PASS THRU
LOCATED AT INSIDE LEFT SIDE DASH PANEL
(4018) IDM LOGIC FUSE
LOCATED AT OUTSIDE CENTER TOP DASH PANEL
(4019) ECM POWER FUSE
LOCATED AT OUTSIDE CENTER TOP DASH PANEL
(4020) EGR POWER FUSE
LOCATED AT OUTSIDE CENTER TOP DASH PANEL
(6011) IDM2 CONN
LOCATED AT LEFT SIDE ENGINE COMPARTMENT
(6020) ECM2 CONN — X3
LOCATED AT ENGINE COMPARTMENT AT ECM
(6021) ECM2 CONN — X4
LOCATED AT ENGINE COMPARTMENT AT ECM
(6323) ECM2 CLEAN POWER & GROUND
LOCATED AT STARTER
(6703) INTAKE AIR TEMPERATURE (I6 ONLY)
LOCATED AT ALTERNATOR
(9254) ENGINE ECM FEED FUSE
LOCATED AT BATTERY CABLES
(9258) ENGINE ECM FEED FUSE
LOCATED AT BATTERY CABLES
(9260) ECM NEGATIVE
LOCATED AT BATTERY CABLES
(9261) ECM POSITIVE FEED
LOCATED AT BATTERY CABLES

Table 98 ECM Power Circuit Tests

Diagnostic Trouble Codes	
639 14 4 240	Engine speed not communicated to the ESC
1705 14 150 2 (EGC Version 8.7)	Engine Controller not communicating with the EGC. Loss of communication in excess of 10 seconds. Bad drivetrain J1939 data link.
2023 14 150 2 or 2023 14 250 2 (EGC Version 9.3 and later)	Engine Controller not communicating with the primary EGC (150) or secondary EGC (250) Loss of communication in excess of 10 seconds Bad drivetrain J1939 data link.

Table 98 ECM Power Circuit Tests (cont.)

ECM Power & Ground Connector (6323) Voltage Checks Check with (6323) disconnected.		
Test Points	Spec.	Comments
(6323) harness to battery connector, cavity A to ground	12 ± 1.5 volts	Positive battery feed to ECM If voltage is missing, check for blown fuse (9254) and short or open in circuits N97AA, N14–BA and N14AY. A blown fuse could be the result of a short in any circuits between (6020) and the fuse.
(6323) harness to battery connector, cavity C to ground	12 ± 1.5 volts	Positive battery feed to ECM If voltage is missing, check for blown fuse (9258) and short or open in circuits N97AA, N14BC and N14BD. A blown fuse could be the result of a short in any circuits between (6011), (6020), (6021) and the fuse.
(6323) harness to battery connector, cavity C to cavity B	12 ± 1.5 volts	Negative battery feed to ECM If voltage is missing, check for open in circuits N97–G and N14–G.
IDM Power relay (4009) Voltage Checks Check with relay removed, ignition key on and engine off. Bench check relay. If relay fails, replace and check for faults. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
IDM Power relay (4009) socket cavity 30 to ground.	12 ± 1.5 volts	If voltage is missing, check for open or short in circuits K97TC and K97TD.
IDM Power relay (4009) socket cavity 86 to ground.	12 ± 1.5 volts	If voltage is missing, check for open or shorts in circuits K97LB and K97THB.

Table 98 ECM Power Circuit Tests (cont.)

IDM Module Power relay (4009) socket cavity 86 to cavity 85.	12 ± 1.5 volts	Check ground to relay coil through ECM connector (6011) pin 8. If voltage is missing, check for open or short to high in circuit K97LA. If all voltages are good and the ECM is still not functioning, check for open circuits or shorts to ground at connector (6011). ECM may have failed. Refer to the Engine Diagnostic Manual EGES–265.
ECM ISO & Power relay (4011) Voltage Checks Check with relay removed, ignition key on and engine off. Bench check relay. If relay fails, replace and check for faults. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
ECM ISO & Power relay (4011) socket cavity 30 to ground.	12 ± 1.5 volts	If voltage is missing, check for open or short in circuits K97HA and K97.
ECM ISO & Power relay (4011) socket cavity 86 to ground.	12 ± 1.5 volts	If voltage is missing, check for open or short in circuits K97JA and K97.
ECM ISO & Power relay (4011) socket cavity 85 to cavity 86.	12 ± 1.5 volts	Check ground to relay coil through ECM connector (6020) pin 5. If voltage is missing, check for open or short to high in circuit K97J. If all voltages are good and the ECM is still not functioning, check for open circuits or shorts to ground at connector (6011). ECM may have failed. Refer to the Engine Diagnostic Manual EGES–265.
IDM2 Connector (6011) Voltage Checks Check with (6323) connected, ignition on, all relays installed and (6011) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments

Table 98 ECM Power Circuit Tests (cont.)

(6011) IDM2 connector, pin 9 to ground.	12 ± 1.5 volts	Ignition feed to IDM If voltage is missing, check for blown fuse F17 and short or open in circuits K97M and A97UA.
(6011) IDM2 connector, pin 10 to ground.	12 ± 1.5 volts	If voltage is missing check for blown fuse (4020). Also check for open or short in circuits K97AZ, K97AY, K97HE and K97B.
(6011) IDM2 connector, pin 6 to ground.	12 ± 1.5 volts	If voltage is missing check for blown fuse (4018). Also check for open or short in circuits K97LC, K97LD and K97LE.
(6011) IDM2 connector, pin 8 to ground.	12 ± 1.5 volts	If voltage is missing check for open or short in circuit K97LA.
(6011) IDM2 connector, pin 12 to ground.	12 ± 1.5 volts	If voltage is missing check for short or open in circuits K97Y and K97LE.
(6011) IDM2 connector, pin 12 to pin 1.	12 ± 1.5 volts	If voltage is missing check for open or short to high in circuits K97–GA, K97–G, N97–G and N14–G.
(6011) IDM2 connector, pin 12 to pin 4.	12 ± 1.5 volts	If voltage is missing check for short to high or open in circuits K97–GB, K97–G, N97–G and N14–G.
ECM2 Connector (6020) Voltage Checks Check with (6323) connected, ignition on, all relays installed and (6020) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
(6020) ECM connector, pin 5 to ground.	12 ± 1.5 volts	If voltage is missing, check for short or open in circuit K97J.
(6020) ECM connector, pin 3 to ground.	12 ± 1.5 volts	Ignition feed from fuse F17 to ECM. If voltage is missing, check for blown fuse F17 and for open or short in circuits K97C, K97UA, and A97UA.
(6020) ECM connector, pin 3 to pin 6.	12 ± 1.5 volts	If voltage is missing, check for short to high or open in circuits K97–GV, K97–G, N97–G and N14–G.
(6020) ECM connector, pin 3 to pin 7.	12 ± 1.5 volts	If voltage is missing, check for short to high or open in circuits K97–GW K97–G, N97–G and N14–G.
ECM2 Connector (6021) Voltage Checks Check with (6323) connected, ignition on, and (6021) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments

Table 98 ECM Power Circuit Tests (cont.)

(6021) ECM connector, pin 1 to ground.	12 ± 1.5 volts	If voltage is missing, check for blown fuse (4019) Also check for open or short in circuits K97F, K97HD, K97H and K97HB.
(6021) ECM connector, pin 2 to ground.	12 ± 1.5 volts	If voltage is missing, check for blown fuse (4019) Also check for open or short in circuits K97Z, K97HD, K97H and K97HB.

Extended Description

When the key is switched to the ignition position, power from the ignition fuse F17 will be applied at the IDM2 connector (6011), pin 9 and the ECM2 connector X3 (6020), pin 3. The IDM2 connector (6011) will then apply a ground at pin 8 and the ECM2 connector x3 (6020) will apply a ground at pin 5. These ground signals will allow the relays to energize. The IDM power relay (4009) will energize and apply voltage to IDM2 connector (6011) pins 12 and 6. The ECM ISO & Power relay (4011) will also energize and provide power to the ECM connector X4 (6021) at pins 1 and 2 and IDM2 connector (6020) pin 10.

Ground for the ECM is supplied from the negative terminal of the battery to IDM connector (6011) pins 1 and 4 and ECM connector (6020) pins 6 and 7.

Component Locations

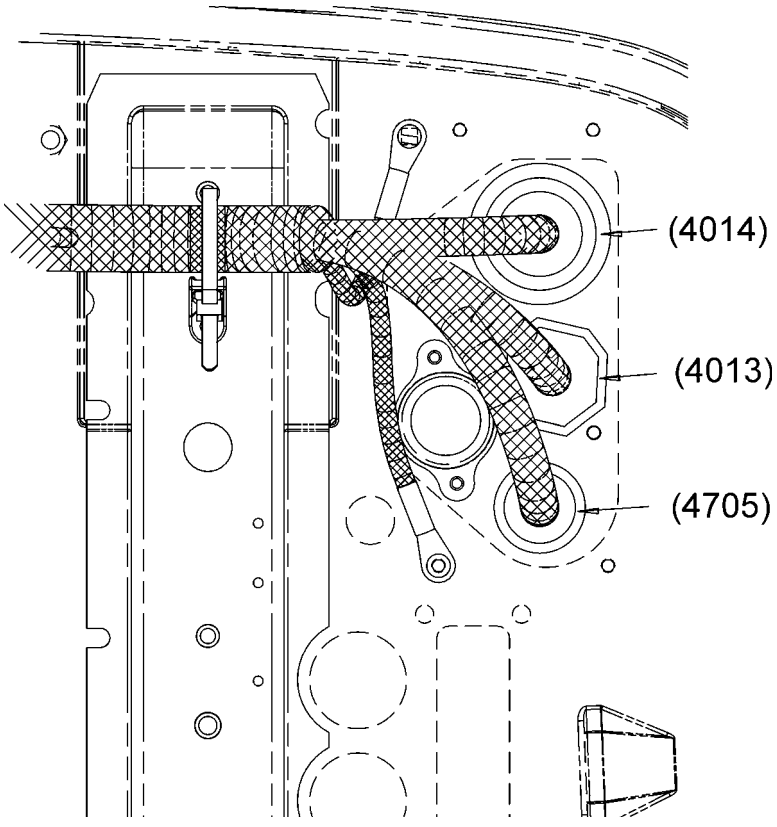

Figure 167 Pass Thru Connector Locations

(4013) PASS THRU AT DASH
(4014) DASH/ENGINE PASS THRU
(4705) PASS THRU AT DASH

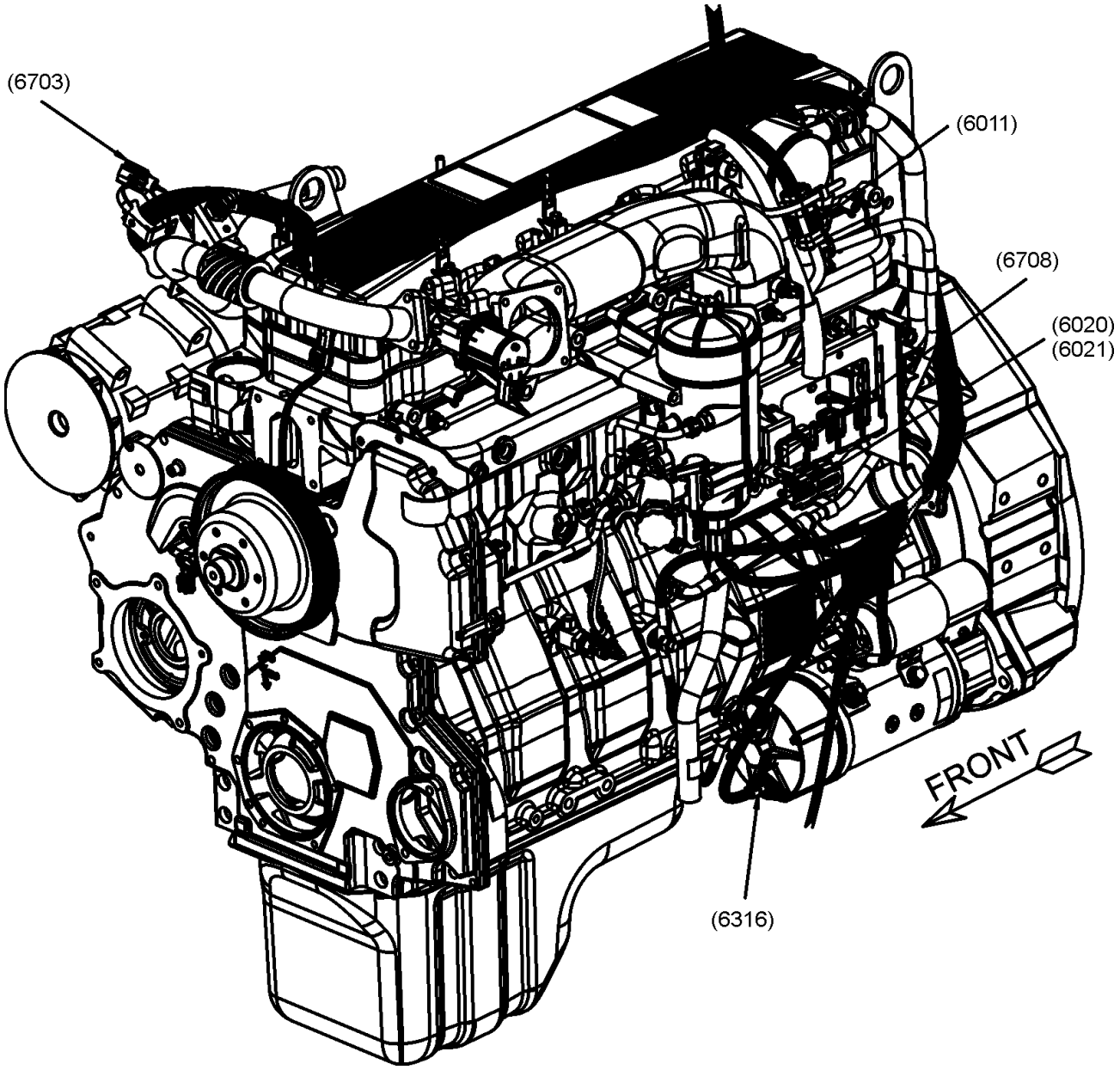

Figure 168 Engine ECM Location (I6)

(6011) IDM2 CONNECTOR
(6020) ECM2 CONNECTOR — X3
(6021) ECM2 CONNECTOR — X4
(6316) THERMAL OVERCRANK PROTECTION CONNECTOR
(6703) INTAKE AIR TEMPERATURE SENSOR CONNECTOR
(6708) FUEL FILTER PREHEATER CONNECTOR

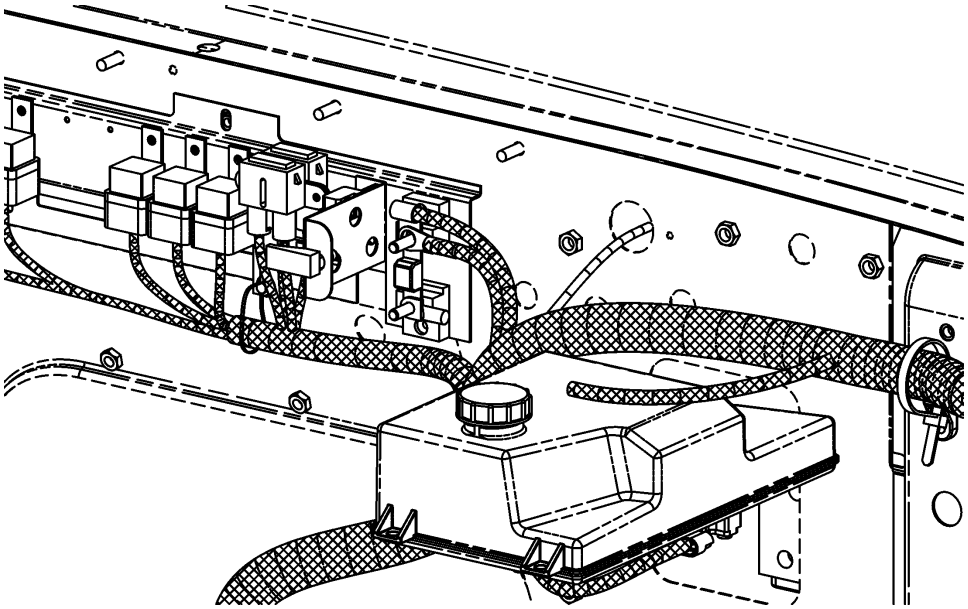

Figure 169 Engine Power Distribution Center

1.2. ENGINE DATA LINK CIRCUITS

Circuit Functions

The engine electronic control module communicates on the drivetrain 1939 data link and the 1708 data link.

Communication on the drivetrain 1939 data link allows the ECM to send and receive messages to the ESC, the EGC and other controllers on the vehicle. Refer to Drive Train 1939 Data Link in the Multiplexing (Data Links) section of this manual. (See DRIVETRAIN 1939 DATA LINK, page 73)

The 1708 data link is primarily used for diagnostics and programming. Refer to 1708 Data Link in the Multiplexing (Data Links) section of this manual. (See 1708 DATA LINK, page 83)

1.3. CRUISE CONTROL

Circuit Functions

Cruise control and engine speed for PTO operations are selected with the cruise switches that can be located on the steering wheel or in the switch packs. These switches are inputs to the ESC. The ESC generates commands to the engine controller on the Drivetrain 1939 data link.

Refer to Cruise Control Circuits in the Cab Section of this manual. (See CRUISE CONTROL, page 349)

2. V8–AVNT ENGINES

Discussion of the V8–AVNT Engine, in this section, is limited to the engine electronic control module (ECM) power circuits and data link connectivity. The engine controller has its own diagnostic system and uses flash codes displayed by the ENGINE warning lights. For detailed information on engine diagnostics, refer to the applicable IC Corporation Engine Diagnostic Manual EGES–295.

2.1. ENGINE CONTROL MODULE (ECM) POWER AND GROUND

Circuit Functions

Diagnostics

A problem with power to the ECM will be apparent when the vehicle will not crank and the “CHECK ELEC SYS” warning lamp in the gauge cluster is constantly on.

The problem could be attributed to open or shorted wiring between the ECM and related power circuits, a blown fuse, a failed relay or a failure inside the ECM.

Several diagnostic trouble codes (DTC’s) will be logged when there is no communication on the drivetrain 1939 data link between the ECM and the ESC or the EGC.

An electronic service tool, running the "Diamond Logic Builder™" diagnostic software, can be used to view diagnostic trouble codes. Refer to the “Diamond Logic Builder™” software manual.

Table 99 Engine Electronic Control Module Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify “CHECK ELEC SYS” warning lamp is on and ECM is inoperative.	Visually check “CHECK ELEC SYS” warning lamp and attempt to start vehicle.	Engine cranks.	Go to Drivetrain 1939 Data Link. (See DRIVETRAIN 1939 DATA LINK, page 73)	Go to Fault Detection Management. (See Fault Detection Management, page 327)

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 fault in the ECM power circuits will be apparent when the engine will not start and there is no communication between the ECM and the ESC or EGC. Problems in the ECM power circuits could be attributed to a blown fuse, a short or an open circuit.

Refer to ECM Power Circuits.

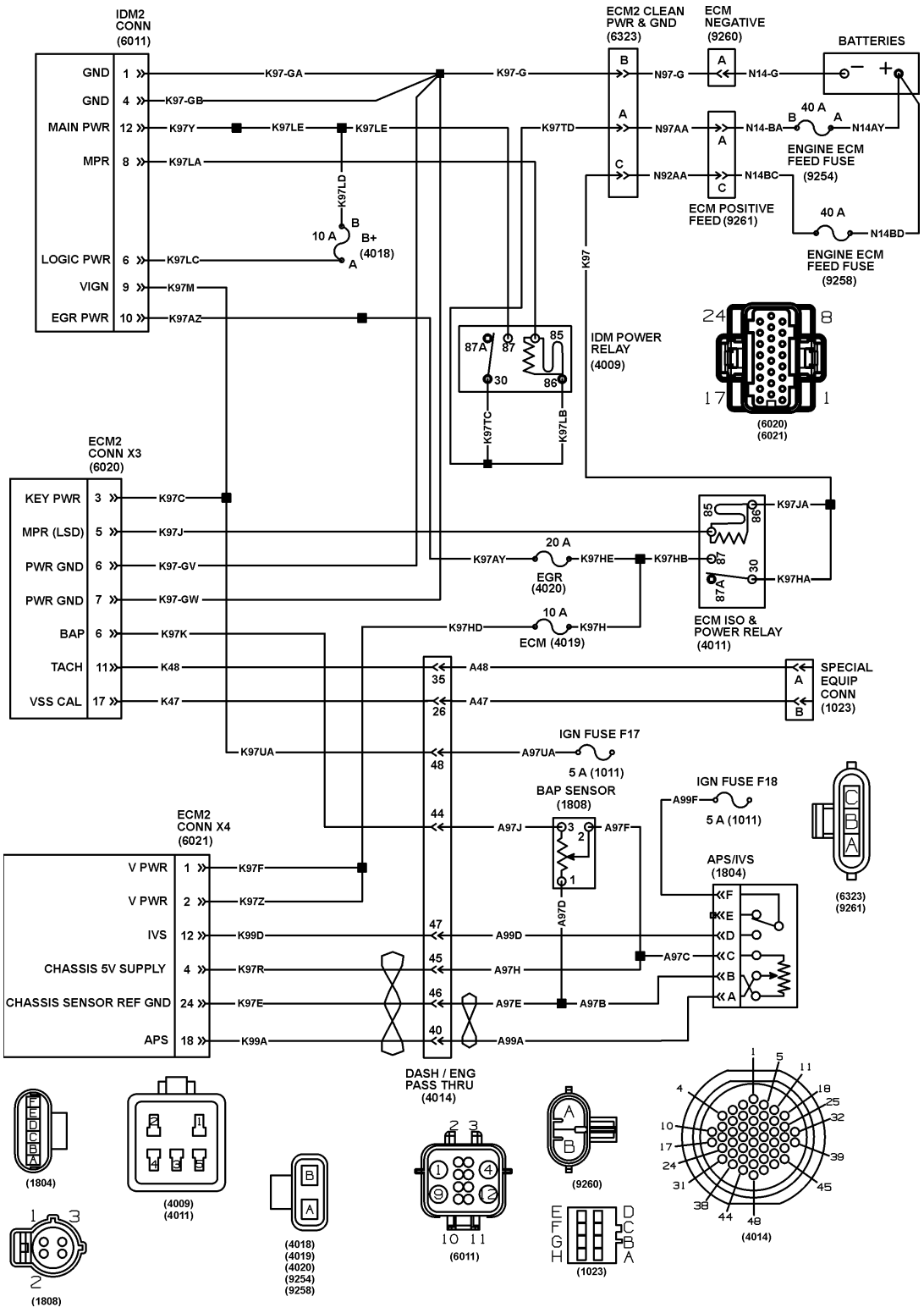

Figure 170 ECM Power Circuits for V8 Engine

(1804) APS/IVS
LOCATED AT ACCELERATOR PEDAL
(1808) BAP SENSOR
LOCATED AT INSTRUMENT RIGHT SIDE PANEL
(4009) IDM POWER RELAY
LOCATED AT OUTSIDE CENTER TOP DASH PANEL
(4011) ECM ISO & POWER RELAY
LOCATED AT OUTSIDE CENTER TOP DASH PANEL
(4014) DASH/ENGINE PASS THRU
LOCATED AT INSIDE LEFT SIDE DASH PANEL
(4018) IDM LOGIC FUSE
LOCATED AT OUTSIDE CENTER TOP DASH PANEL
(4019) ECM POWER FUSE
LOCATED AT OUTSIDE CENTER TOP DASH PANEL
(4020) EGR POWER FUSE
LOCATED AT OUTSIDE CENTER TOP DASH PANEL
(6011) IDM2 CONN
LOCATED AT LEFT SIDE ENGINE COMPARTMENT
(6020) ECM2 CONN — X3
LOCATED AT ENGINE COMPARTMENT AT ECM
(6021) ECM2 CONN — X4
LOCATED AT ENGINE COMPARTMENT AT ECM
(6323) ECM2 CLEAN POWER & GROUND
LOCATED AT STARTER
(6703) INTAKE AIR TEMPERATURE
LOCATED AT ALTERNATOR
(9254) ENGINE ECM FEED FUSE
LOCATED AT BATTERY CABLES
(9258) ENGINE ECM FEED FUSE
LOCATED AT BATTERY CABLES
(9260) ECM NEGATIVE
LOCATED AT BATTERY CABLES
(9261) ECM POSITIVE FEED
LOCATED AT BATTERY CABLES

Table 100 ECM Power Circuit Tests

Diagnostic Trouble Codes	
639 14 4 240	Engine speed not communicated to the ESC
1705 14 150 2 (EGC Version 8.7)	Engine Controller not communicating with the EGC Loss of communication in excess of 10 seconds Bad drivetrain J1939 data link.
2023 14 150 2 or 2023 14 250 2 (EGC Version 9.3 and later)	Engine Controller not communicating with the primary EGC (150) or secondary EGC (250) Loss of communication in excess of 10 seconds Bad drivetrain J1939 data link.

Table 100 ECM Power Circuit Tests (cont.)

ECM Power & Ground Connector (6323) Voltage Checks Check with (6323) disconnected.		
Test Points	Spec.	Comments
(6323) harness to battery connector, cavity A to ground	12 ± 1.5 volts	If voltage is missing, check for blown fuse (9254) and open or short in circuits N97AA, N14BA and N14AY. A blown fuse could be the result of a short in any circuits between (6011) and the fuse.
(6323) harness to battery connector, cavity C to ground	12 ± 1.5 volts	If voltage is missing, check for blown fuse (9258) and open or short in circuits N92AA, N14BC and N14BD.
(6323) harness to battery connector, cavity C to cavity B	12 ± 1.5 volts	Negative battery feed to ECM If voltage is missing, check for open in circuits N97–G and N14–G.
IDM Power Relay (4009) Voltage Checks Check with relay removed, ignition key on, and engine off. Bench check relay. If relay fails, replace and check for faults. **NOTE – Always check connectors for damage and pushed-out terminals.**		
Test Points	Spec.	Comments
IDM Power relay (4009) socket 30 to ground.	12 ± 1.5 volts	If voltage is missing, check for open or short in circuits K97TC and K97.
IDM Power relay (4009) socket 86 to ground.	12 ± 1.5 volts	Voltage to relay coil from fuse. If voltage is missing check for open or short in circuits K97LB and K97TD.
IDM Power relay (4009) socket cavity 85 to cavity 86.	12 ± 1.5 volts	Check ground to relay coil through ECM connector (6011) pin 8. If voltage is missing, check for open or short to high in circuit K97LA. If voltages are good and ECM is still not functioning, check for open circuits or shorts to ground at connector (6011). ECM may have failed. Refer to the Engine Diagnostic Manual EGES–265.

Table 100 ECM Power Circuit Tests (cont.)

ECM ISO & Power Relay (4011) Voltage Checks Check with relay removed, ignition key on and engine off. Bench check relay. If relay fails, replace and check for faults. **NOTE – Always check for damage and pushed-out terminals.**		
Test Points	Spec.	Comments
ECM ISO & Power relay (4011) socket cavity 30 to ground.	12 ± 1.5 volts	If voltage is missing, check for open or short in circuits K97HA and K97.
ECM ISO & Power relay (4011) socket cavity 86 to ground.	12 ± 1.5 volts	Voltage to relay coil from ESC. If voltage is missing, check for open or short in circuits K97JA and K97.
ECM ISO & Power relay (4011) socket cavity 85 to cavity 86.	12 ± 1.5 volts	Check ground to relay coil through ECM connector (6020) pin 5. If voltage is missing, check for open or short to high in circuit K97J. If all voltages are good and the ECM is still not functioning, check for open or short at connector (6011). ECM may have failed. Refer to the Engine Diagnostic Manual EGES–265.
IDM2 Connector (6011) Voltage Checks Check with (6323) connected, ignition on, all relays installed and (6011) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
(6011) IDM2 connector, pin 9 to ground.	12 ± 1.5 volts	Ignition feed to IDM If voltage is missing, check for blown fuse F17 and open or short in circuits K97M, K97UA and A97UA.
(6011) IDM2 connector, pin 8 to ground.	12 ± 1.5 volts	If voltage is missing, check for open or short in circuit K97LA.
(6011) IDM2 connector, pin 10 to ground.	12 ± 1.5 volts	If voltage is missing, check for blown fuse (4020). Also check for open or short in circuits K97AZ, K97AY, K97HE and K97HB.
(6011) IDM2 connector, pin 6 to ground.	12 ± 1.5 volts	If voltage is missing, check for blown fuse (4018). Also check for open or short in circuits K97LC, K97LD, and K97LE.

Table 100 ECM Power Circuit Tests (cont.)

(6011) IDM2 connector, pin 12 to ground.	12 ± 1.5 volts	If voltage is missing, check for open or short in circuits K97Y, K97T, and K97LE.
(6011) IDM2 connector, pin 12 to pin 1.	12 ± 1.5 volts	If voltage is missing check for open or short to high in circuits K97–GA and K97–G.
(6011) IDM2 connector, pin 12 to pin 4.	12 ± 1.5 volts	If voltage is missing check for open or short to high in circuits K97–GB and K97–G.
ECM2 Connector (6020) Voltage Checks Check with (6323) connected, ignition on, all relays installed and (6020) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
(6020) ECM connector, pin 5 to ground.	12 ± 1.5 volts	If voltage is missing, check for open or short in circuit K97J.
(6020) ECM connector, pin 3 to ground.	12 ± 1.5 volts	Ignition feed from fuse F17 to ECM. If voltage is missing, check for blown fuse F17 and for open or short in circuits K97C, K97UA and A97UA.
(6020) ECM connector, pin 3 to pin 6.	12 ± 1.5 volts	If voltage is missing, check for open or short to high in circuits K97–GV and K97–G.
(6020) ECM connector, pin 3 to pin 7.	12 ± 1.5 volts	If voltage is missing, check for open or short to high in circuits K97–GW and K97–G.
ECM2 Connector (6021) Voltage Checks Check with (6323) connected, ignition on and (6021) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
(6021) ECM connector, pin 1 to ground.	12 ± 1.5 volts	If voltage is missing, check for blown fuse (4019). Also check for open or short in circuits K97F, K97HD, K97H and K97HB.
(6021) ECM connector, pin 2 to ground.	12 ± 1.5 volts	If voltage is missing, check for blown fuse (4019). Also check for open or short in circuits K97Z, K97HD, K97H and K97HB.

Extended Description

When the key is switched to the ignition position, power from the ignition fuse F17 will be applied at the IDM2 connector (6011), pin 9 and the ECM2 connector X3 (6020), pin 3. The IDM2 connector (6011) will then apply a ground at pin 8 and the ECM2 connector x3 (6020) will apply a ground at pin 5. These ground signals will allow the relays to energize. The IDM power relay (4009) will energize and apply voltage to IDM2 connector (6011) pins 12 and 6. The ECM ISO & Power relay (4011) will also energize and provide power to the ECM connector X4 (6021) at pins 1 and 2 and IDM2 connector (6020) pin 10.

Ground for the ECM is supplied from the negative terminal of the battery to IDM connector (6011) pins 1 and 4 and ECM connector (6020) pins 6 and 7.

Component Locations

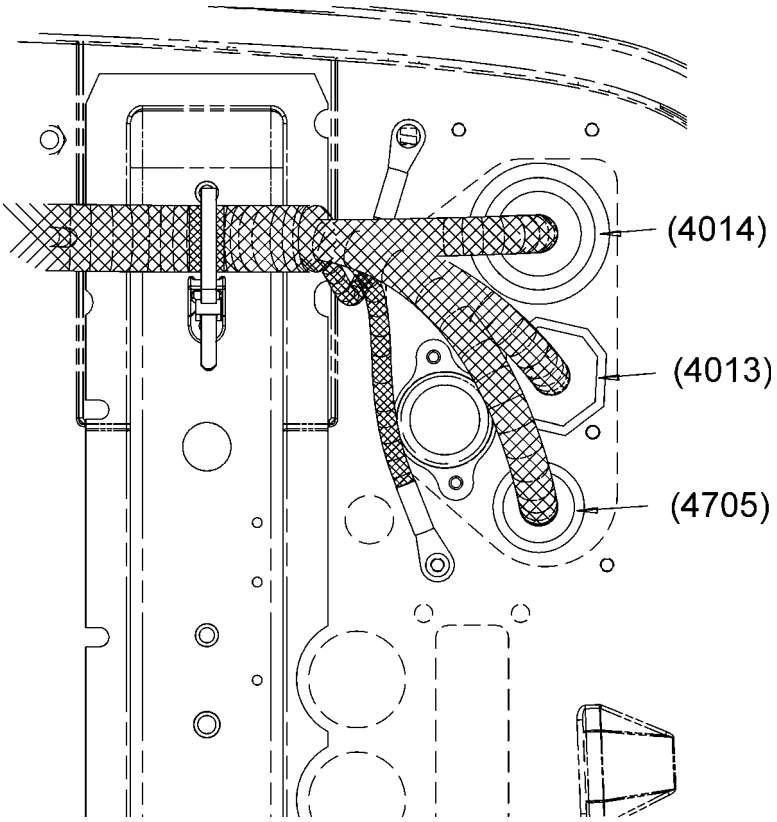

Figure 171 Pass Thru Connectors

(4013) PASS THRU AT DASH
(4014) DASH/ENGINE PASS THRU
(4705) PASS THRU AT DASH

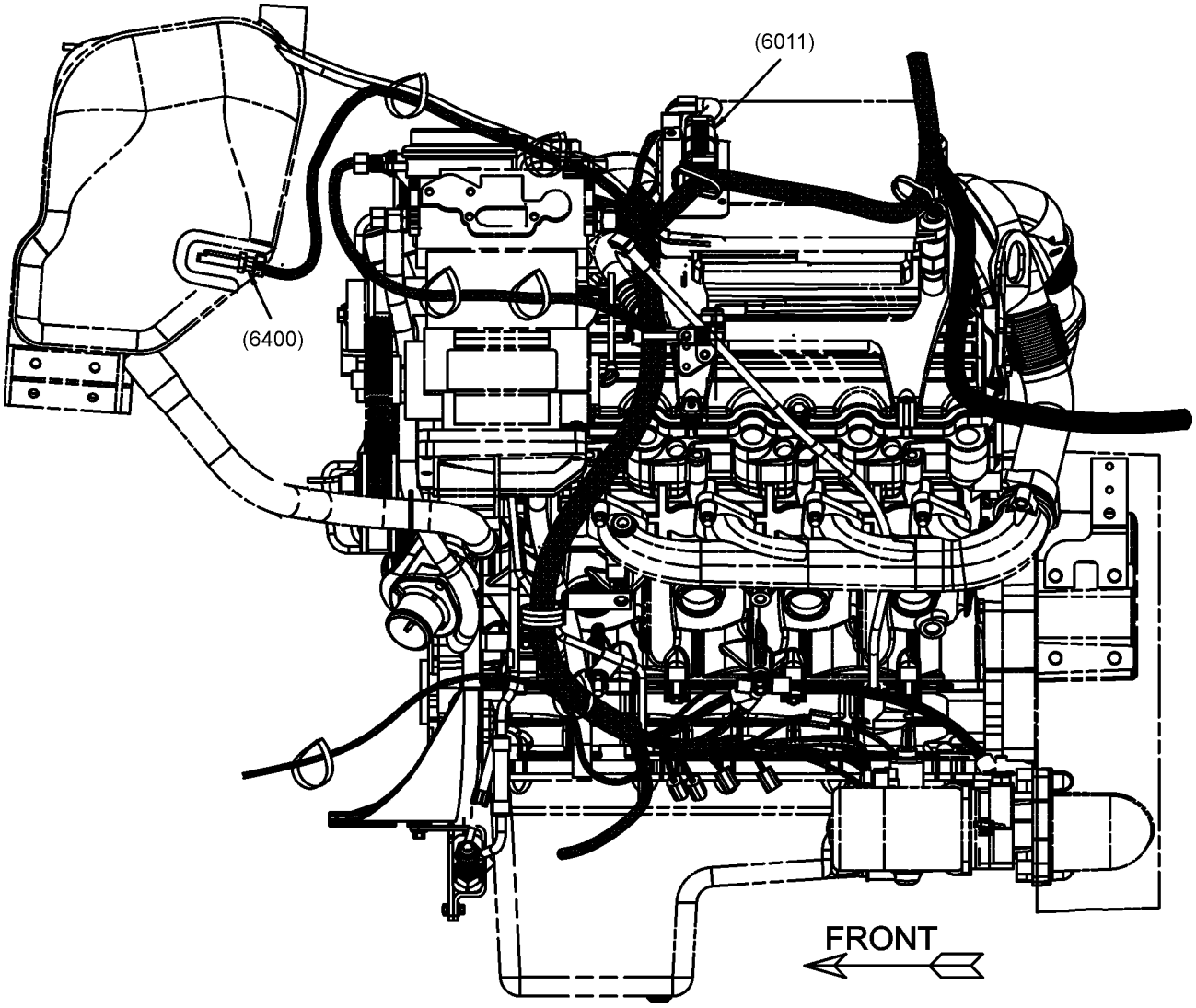

Figure 172 Engine Connector Location (V8)

(6011) IDM2 CONNECTOR
(6400) COOLANT SENSOR CONNECTOR

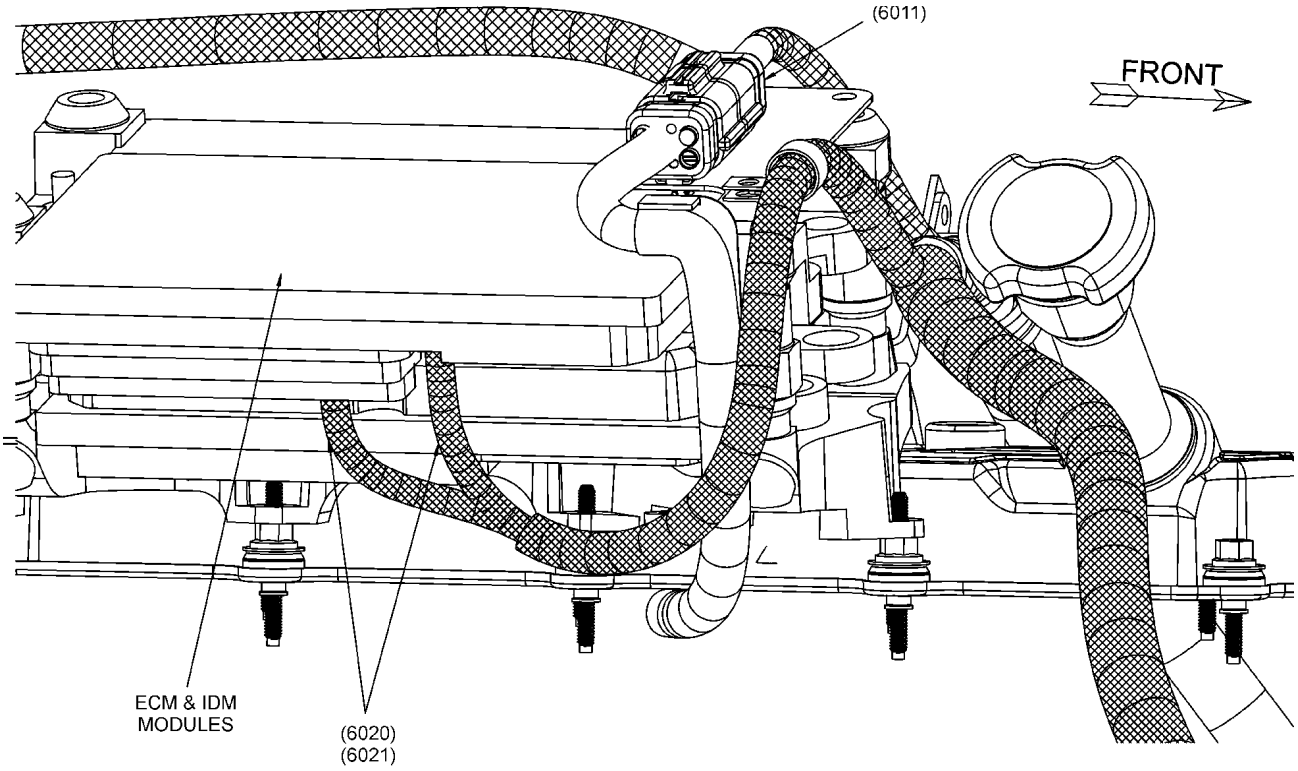

Figure 173 Engine ECM Location (V8)

(6011) IDM2 CONNECTOR
(6021) ECM2 — X3 CONNECTOR
(6021) ECM2 — X4 CONNECTOR

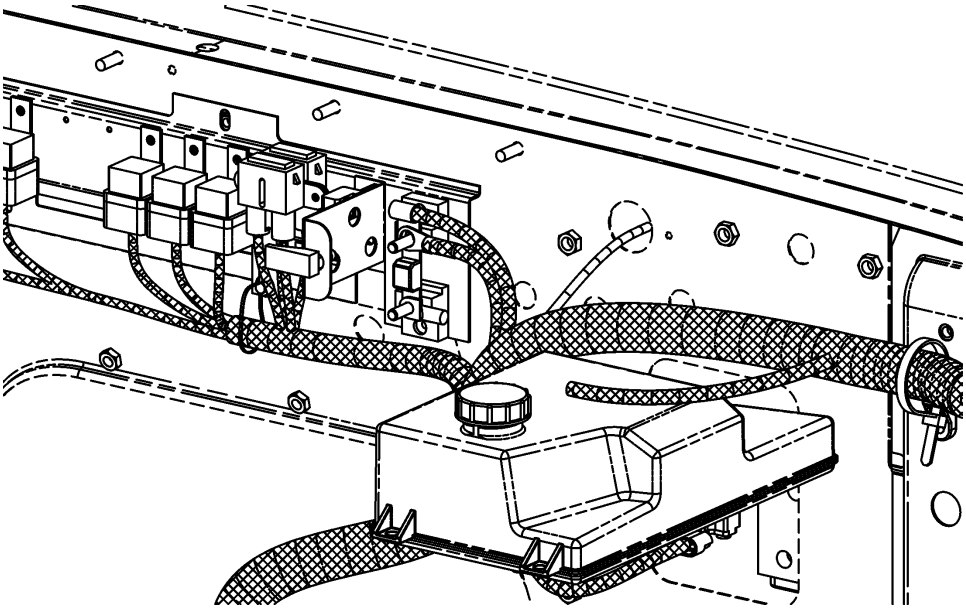

Figure 174 Engine Power Distribution Center

2.2. ENGINE DATA LINK CIRCUITS

Circuit Functions

The engine electronic control module communicates on the drivetrain 1939 data link and the 1708 data link.

Communication on the drivetrain 1939 data link allows the ECM to send and receive messages to the ESC, the EGC and other controllers on the vehicle. Refer to Drive Train 1939 Data Link in the Multiplexing (Data Links) section of this manual. (See DRIVETRAIN 1939 DATA LINK, page 73)

The 1708 data link is primarily used for diagnostics and programming. The 1708 data link connection is also used with the hydraulic ABS (hydraulic ABS does not have a J1939 interface). Refer to 1708 Data Link in the Multiplexing (Data Links) section of this manual. (See 1708 DATA LINK, page 83)

2.3. CRUISE CONTROL

Circuit Functions

Cruise control and engine speed for PTO operations are selected with the cruise switches on the switch pack. These switches are inputs to the ESC. The ESC generates commands to the engine controller on the Drivetrain 1939 data link.

Refer to Cruise Control Circuits in the Cab Section of this manual. (See CRUISE CONTROL, page 349)