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1. FAN WIRING — INTERNATIONAL ENGINES

1.1. FAN SOLENOID CIRCUIT FUNCTIONS

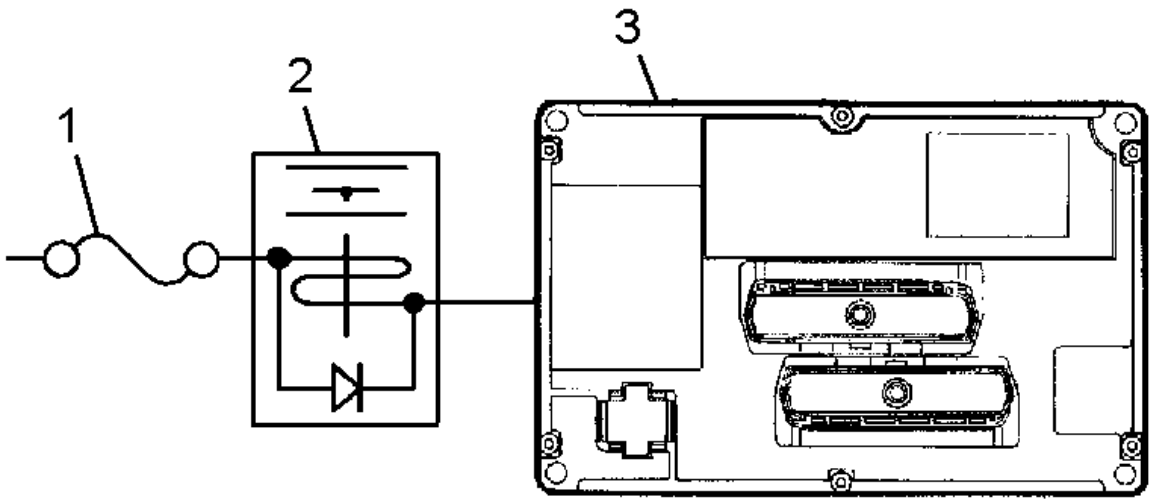

Figure 129 Fan Solenoid Function Diagram

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 80 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 267)	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 SOLENOID, page 268)or FAULT DETECTION MANAGEMENT V8–AVNT WITH FAN CLUTCH

Table 80 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 81 Fan Solenoid Codes

FAULT CODE	FAULT DESCRIPTION
246	Fan Output 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 SOLENOID, page 268) or FAULT DETECTION MANAGEMENT I6 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.

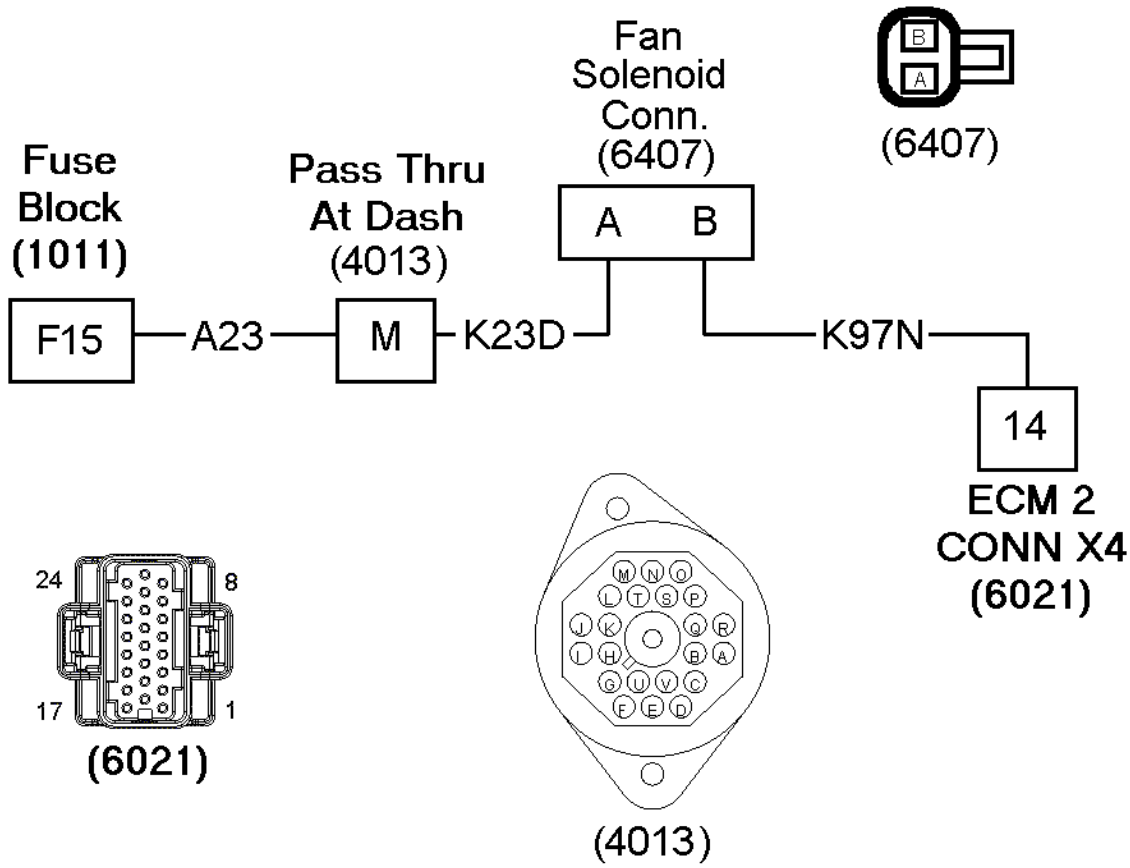

Figure 130 I6 with Fan Solenoid Circuits — Always Refer To Circuit Diagram Book For Latest Circuit Information

(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 82 I6 with Fan Solenoid Wiring Harness Connector Checks

International 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.**	
Key on Engine Off - Voltage Checks at Fan Air Solenoid Connector (6407) Check with fan solenoid Disconnected, Ignition Key ON (Engine Off). **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
B to Ground.	0 v	If voltage present, check for short to power.
A to Ground.	12 ± 1.5 volts	If voltage is missing, check fuse and/or circuit or open/shorts on circuits K23D and A23.
NOTE: Normal fan on temperature is 212°F (100°C). Normal fan off temperature is 207.5°F (97.5°C).		

1.5. EXTENDED DESCRIPTION

The engine controller will supply a ground to connector (6407) to energize the fan.

1.6. 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.

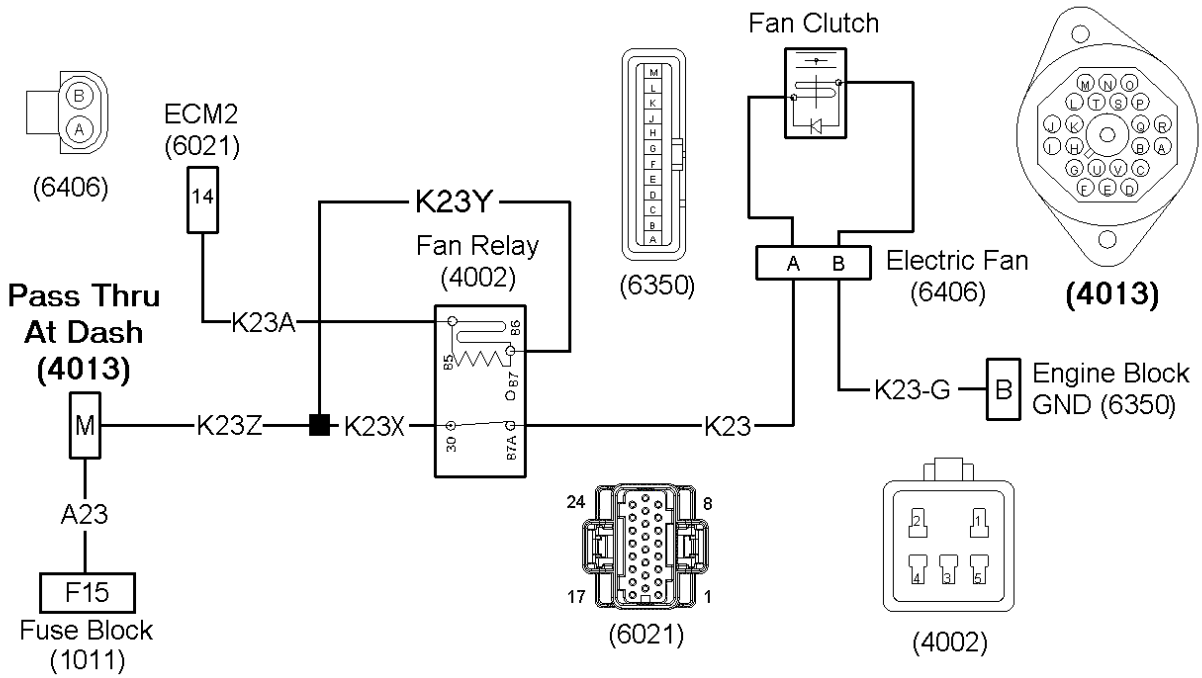

Figure 131 I6 with Fan Clutch Circuits — Always Refer To Circuit Diagram Book For Latest Circuit Information

(1011) FUSE BLOCK
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(4002) FAN RELAY
LOCATED AT OUTSIDE CENTER TOP DASH PANEL
(4013) PAS 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 83 I6 with Fan Clutch Wiring Harness Connector Checks

International 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.**	
I6 with Fan Clutch Voltage Checks Check with Ignition key ON and fan clutch connector disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
B to Ground.	0 v	If voltage present, check for short to power.
A to Ground.	12 ± 1.5 volts	If voltage is missing, check fuse and/or circuit or open/shorts in circuits K23, K23X K23Z, and A23. 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.
NOTE: Normal fan on temperature is 212°F (100°C). Normal fan off temperature is 207.5°F (97.5°C).		

1.7. EXTENDED DESCRIPTION

When the key is on, the fan clutch is supplied battery voltage at connector (6406) through closed contacts of the de-energized fan relay (4002) from a 5 amp fuse in the engine compartment power distribution center and powered the through closed contacts of the energized primary ignition relay (4003).

The engine controller will supply a ground to energize fan relay (4002) opening the contacts of the fan relay (4002), removing power from connector (6406) to de-energize the clutch, turning off the fan.

1.8. COMPONENT LOCATIONS

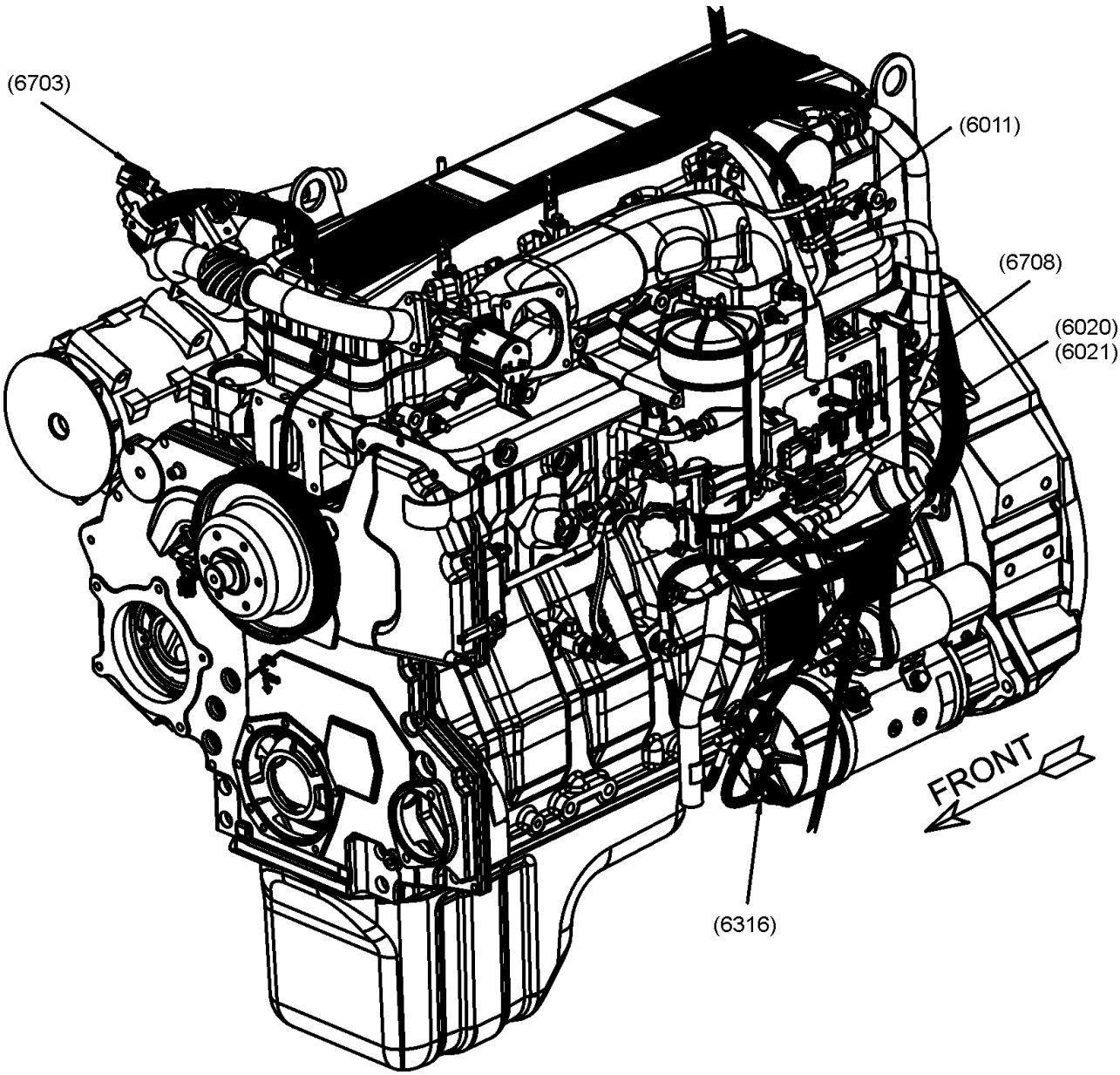

Figure 132 I-6 Engine Wiring

(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

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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 84 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.

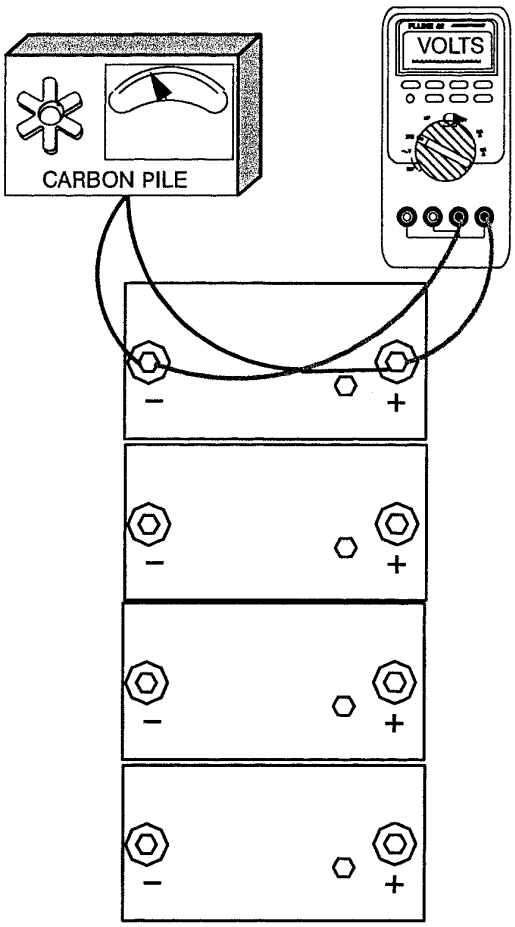


Figure 133 Battery Test Configuration

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 toStarting Motor System Circuits And Components.

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

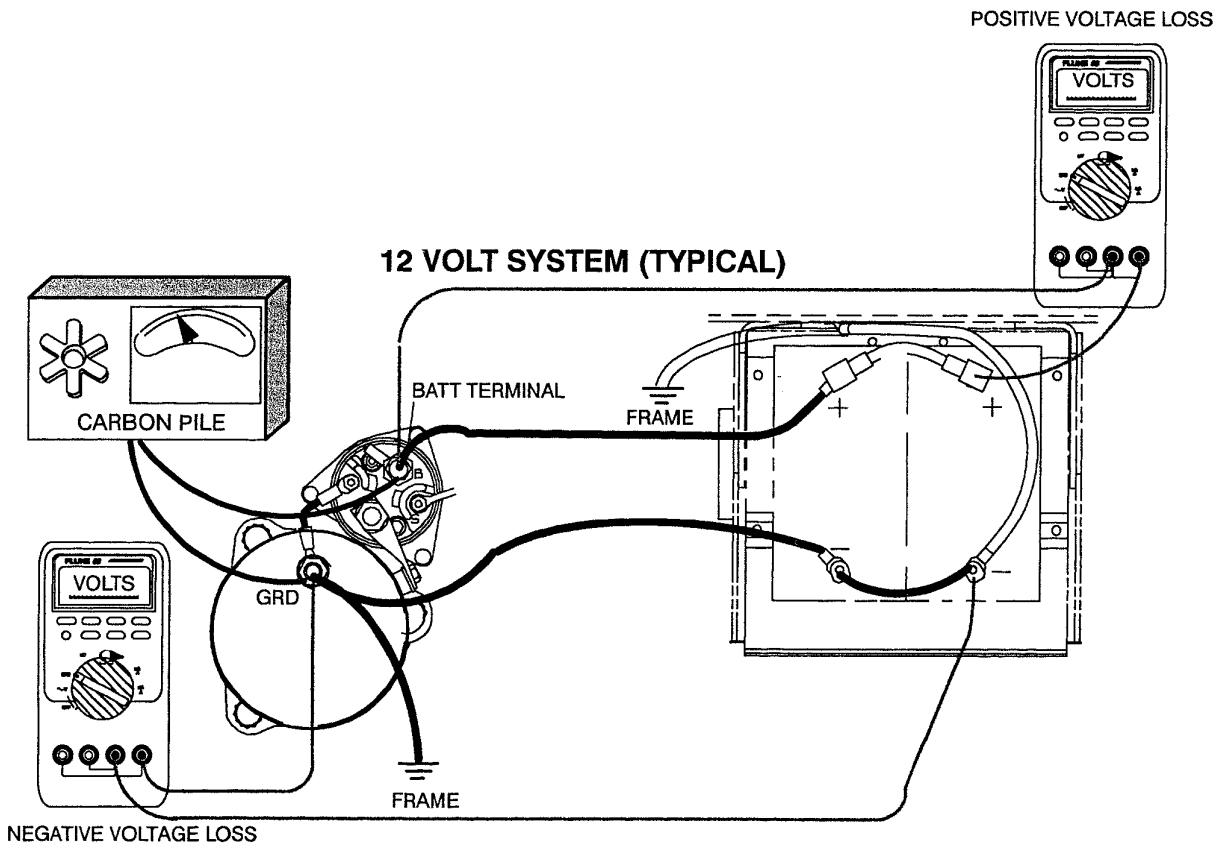


Figure 134 Battery Cable Voltage Loss Test

1.3. COMPONENT LOCATIONS

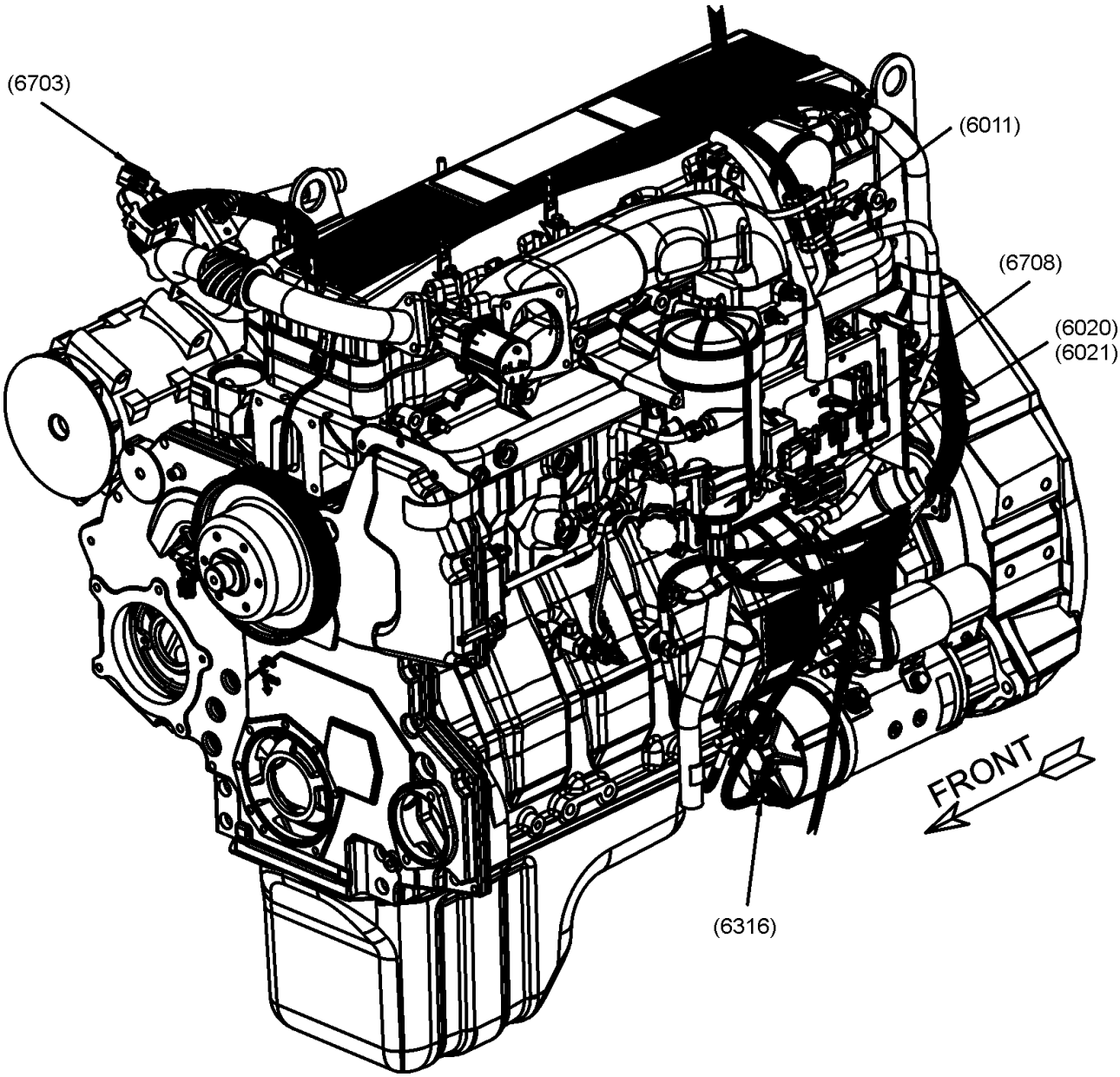


Figure 135 Cranking Motor Location (I6 Engine)

(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

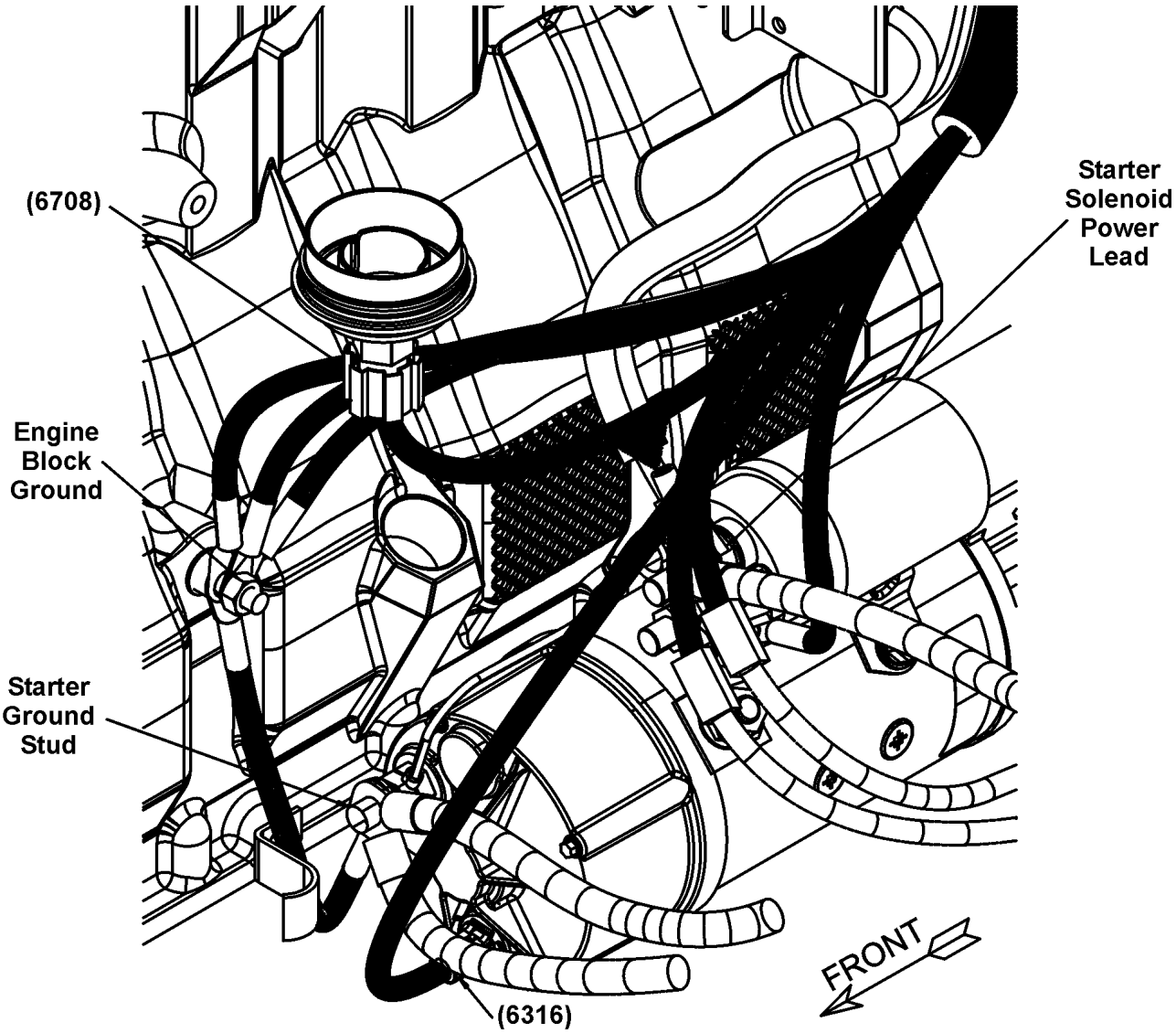


Figure 136 Cranking Motor (i6 Engine)

(6708) FUEL FILTER PREHEATER

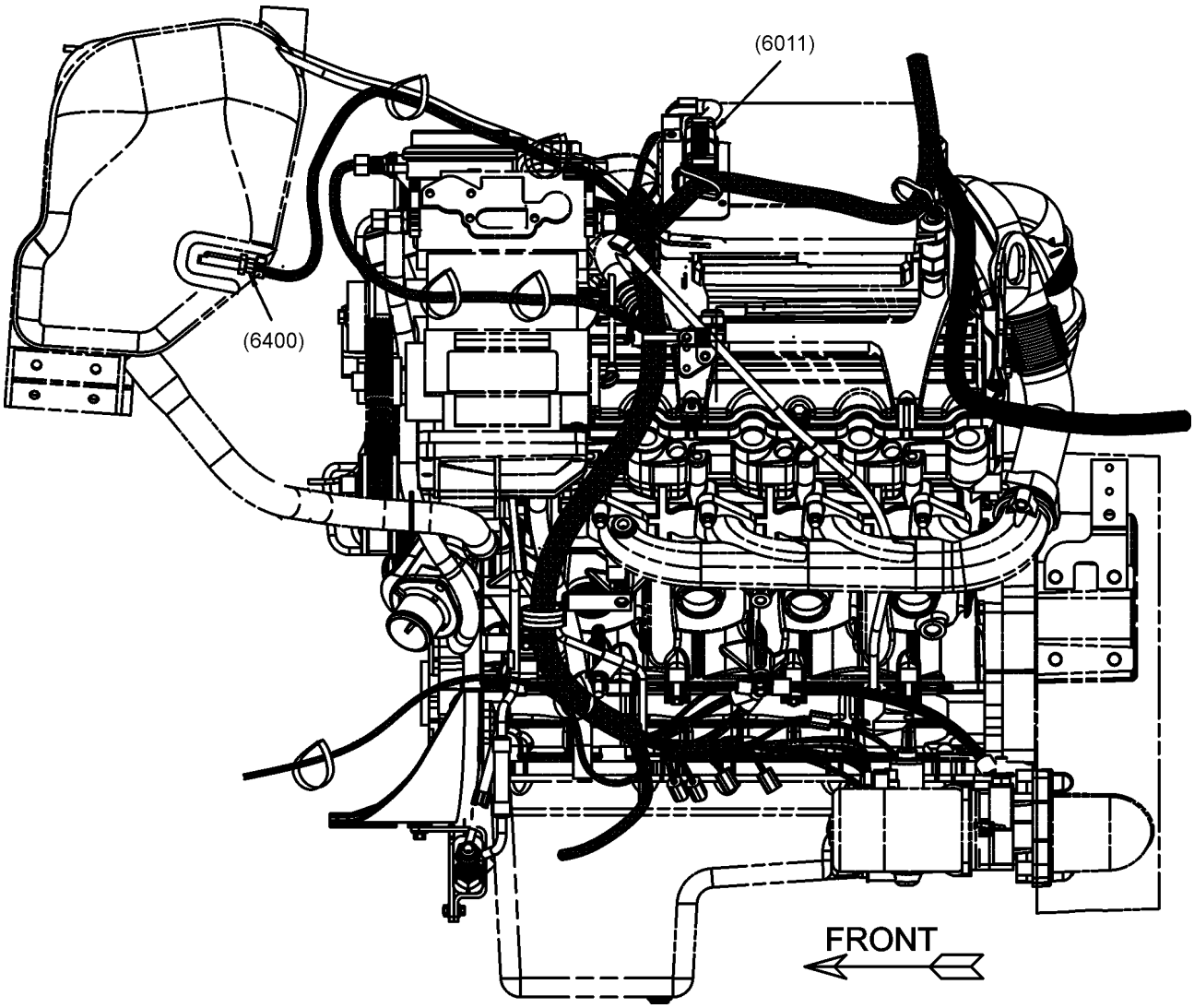


Figure 137 Cranking Motor Location (V8 Engine)

(6011) IDM2 CONNECTOR
(6400) LOW COOLANT SENSOR

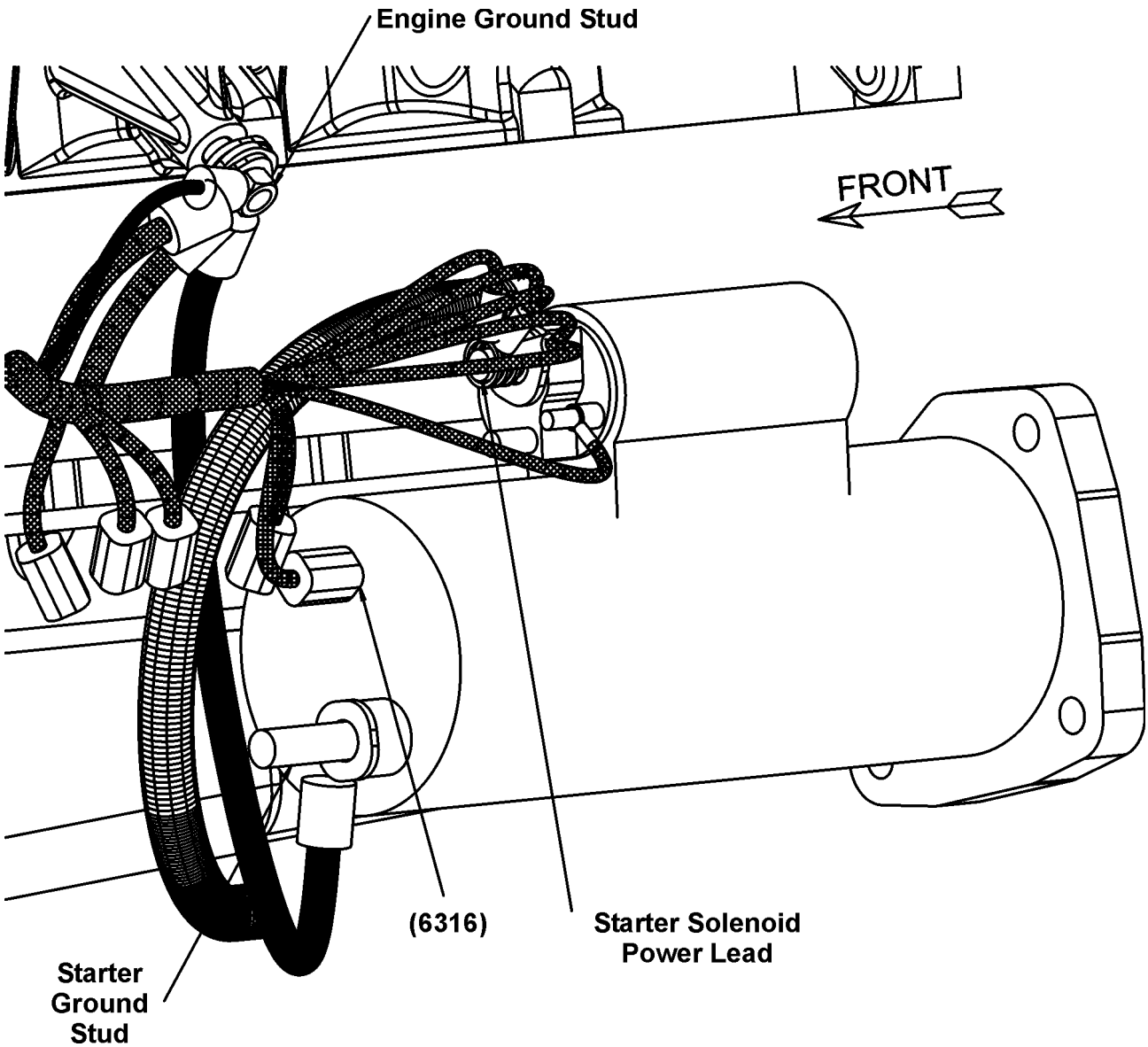


Figure 138 Cranking Motor (V8 Engine)

(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.

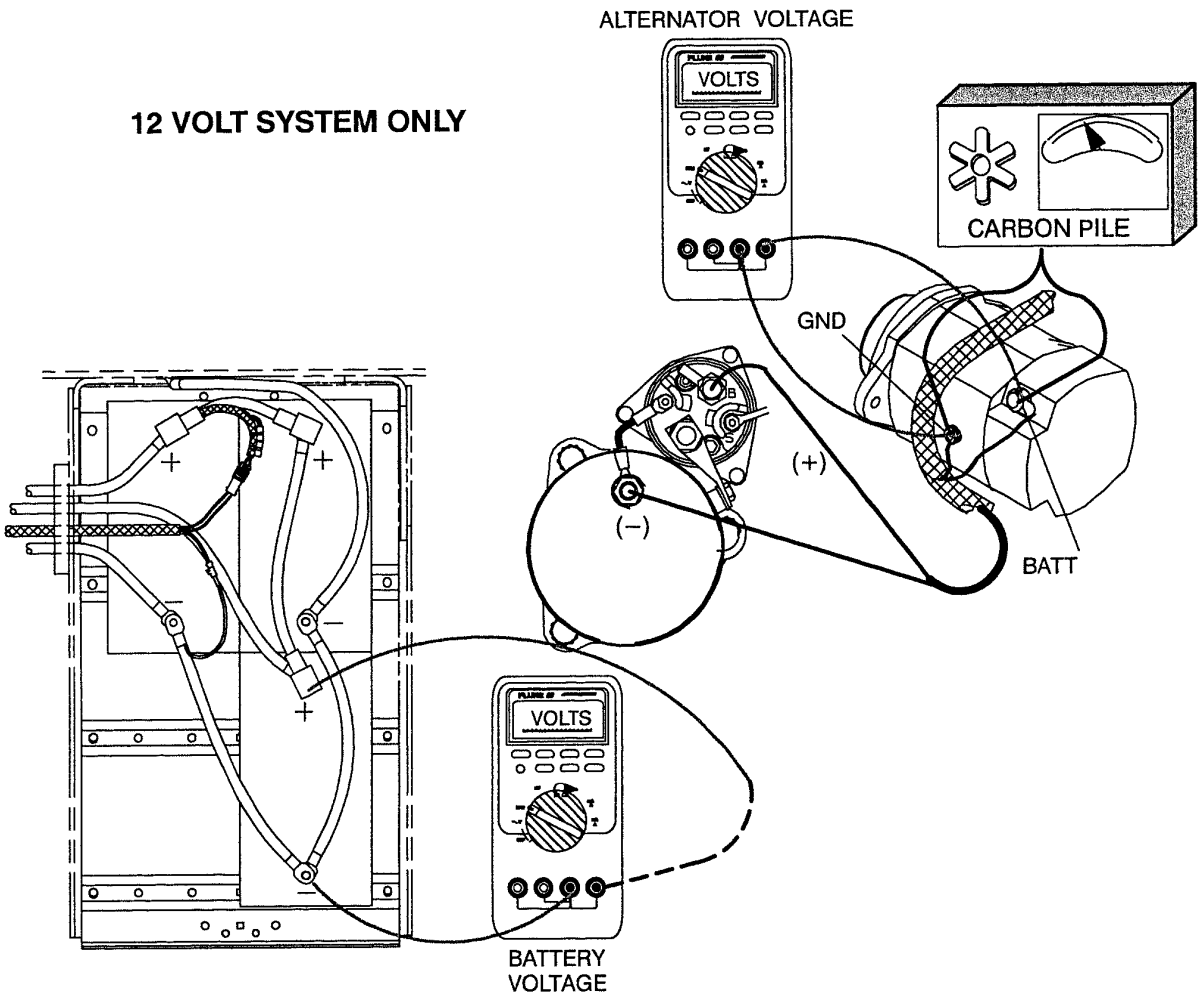


Figure 139 Alternator Wiring Test — Part 1

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.

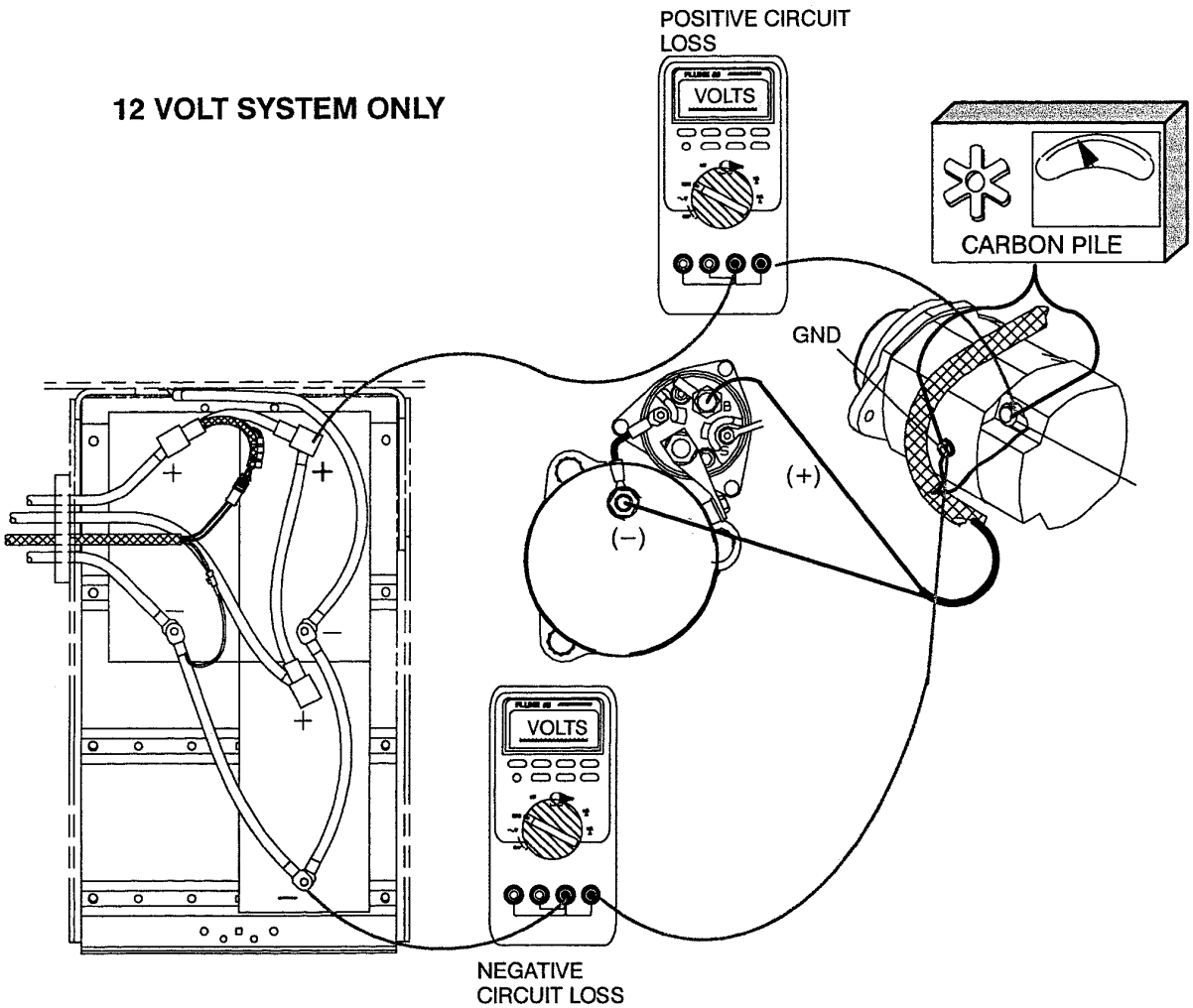


Figure 140 Alternator Wiring Test — Part 2 (12 volt System Only)

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.

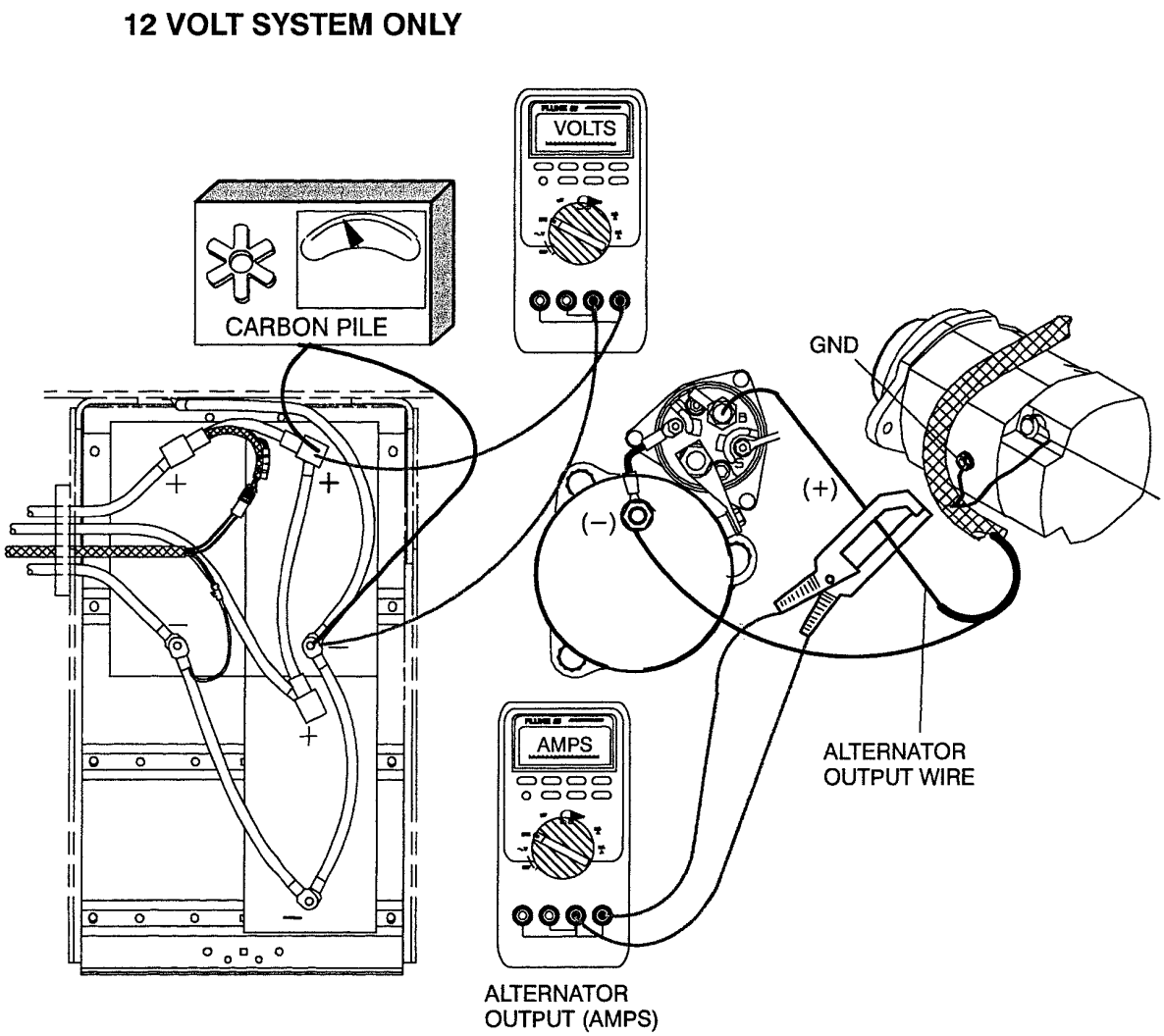
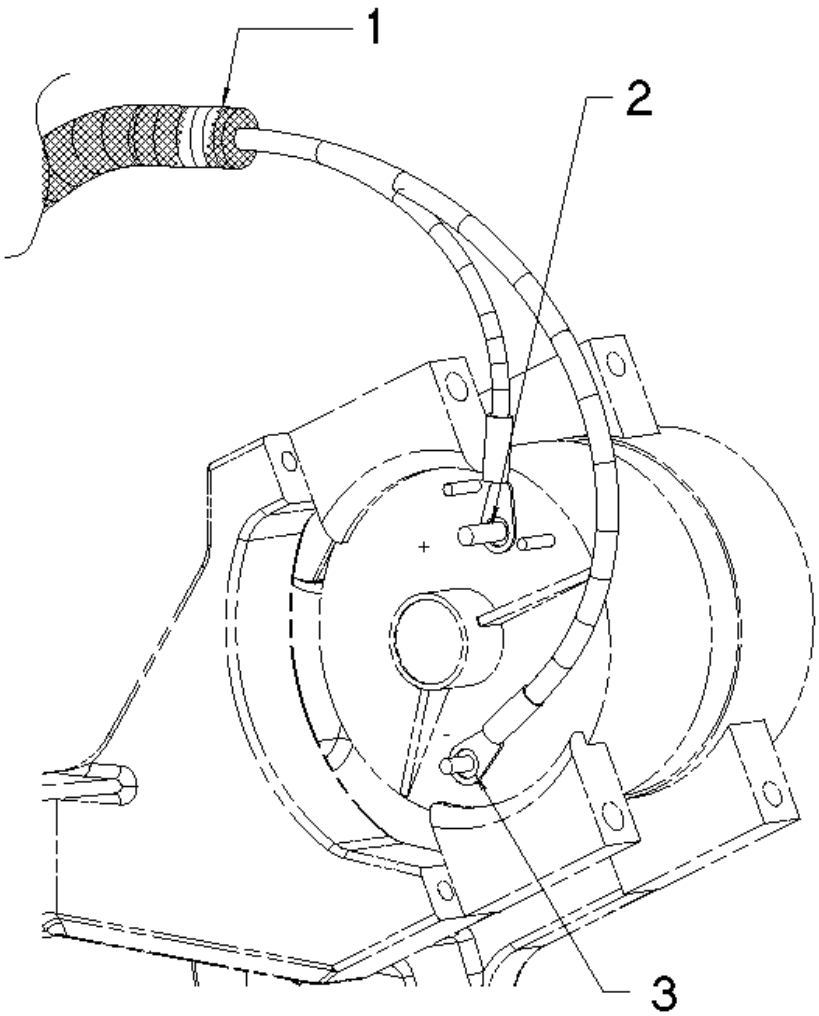


Figure 141 Alternator Replacement Test (12 Volt System Only)

2.3. COMPONENT LOCATIONS



DELCO

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

Figure 142 Delco Alternator Wiring With International Engines

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

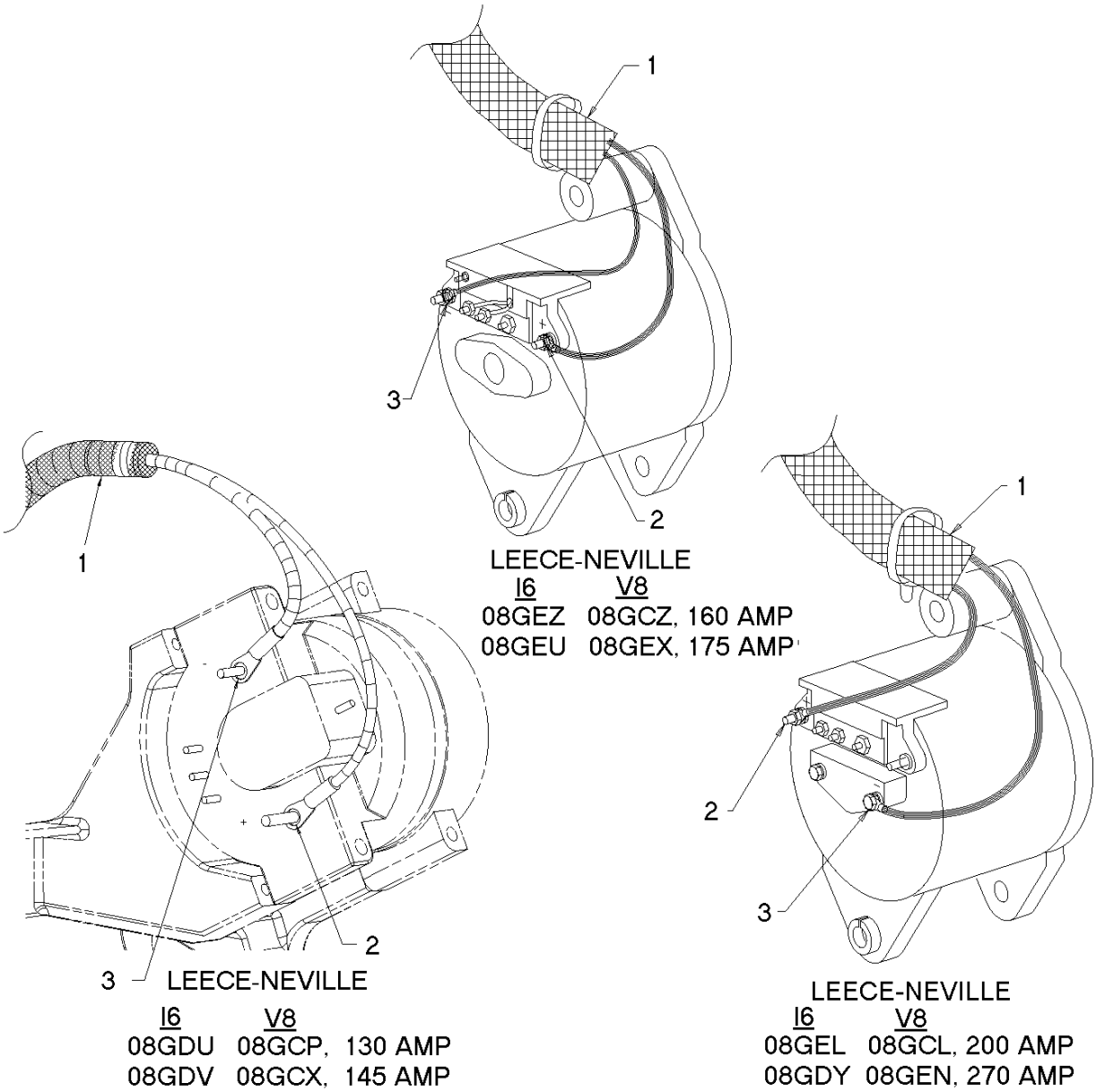


Figure 143 Leece–Neville Alternator Wiring

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 85 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.
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.	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.

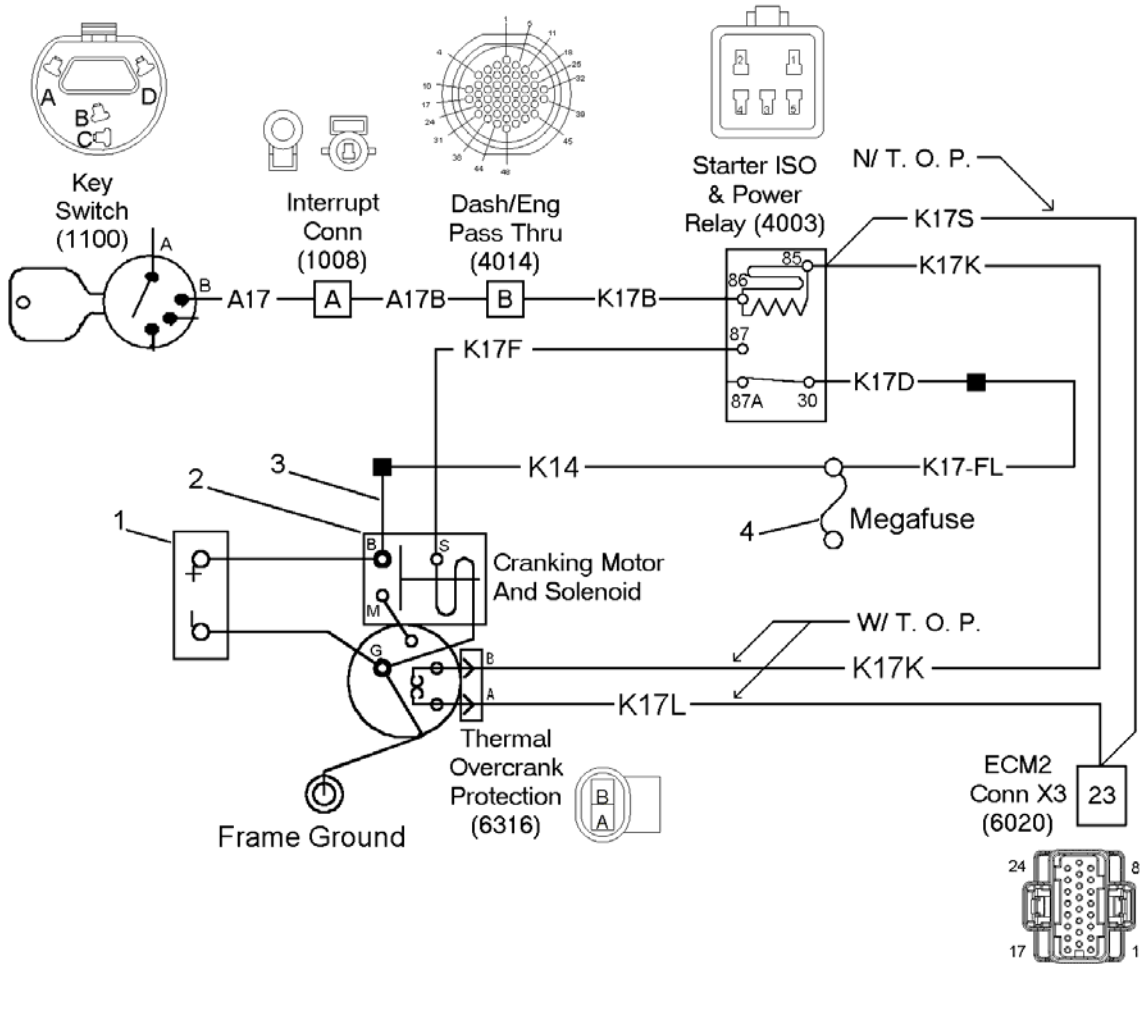


Figure 144 Starting Power Distribution Diagram

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 86 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 and replace if it has failed. (See BENCH TESTING RELAYS, page 29) **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.

Table 86 Starter ISO & Power Relay Circuit Tests (cont.)

(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: LCT transmissions, refer to Neutral and Back-Up Light Circuits. (See NEUTRAL AND BACK-UP LIGHT CIRCUITS , page 645) MD transmissions, refer to Neutral Signal Circuits. (See NEUTRAL SIGNAL CIRCUITS , page 628)		

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.

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.

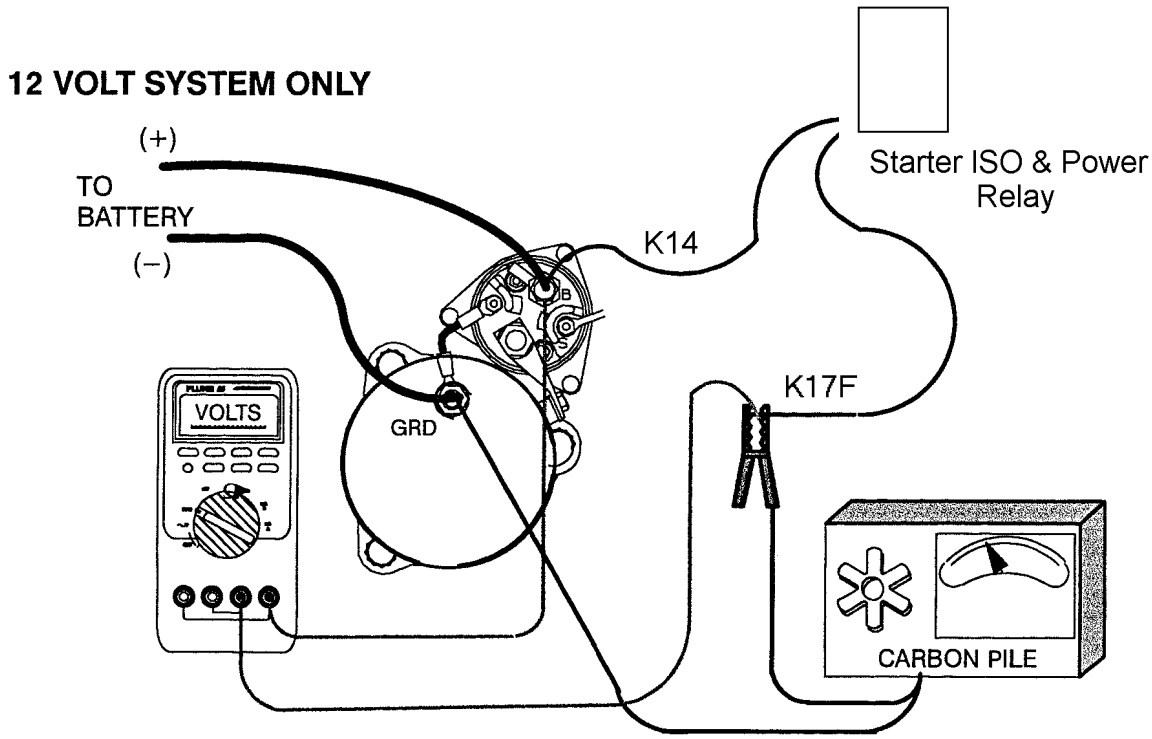


Figure 145 Cranking Motor Solenoid Circuit Test — Part 1 (With International Engine)

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.

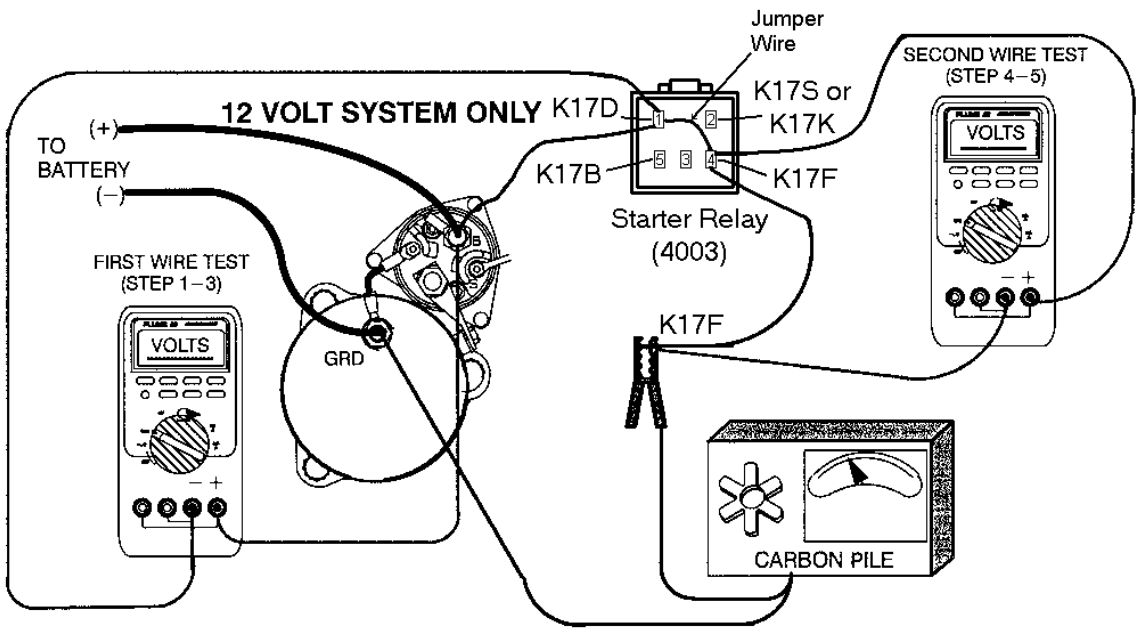


Figure 146 Cranking Motor Solenoid Circuit Test - Part 2 (Wire Voltage Loss)

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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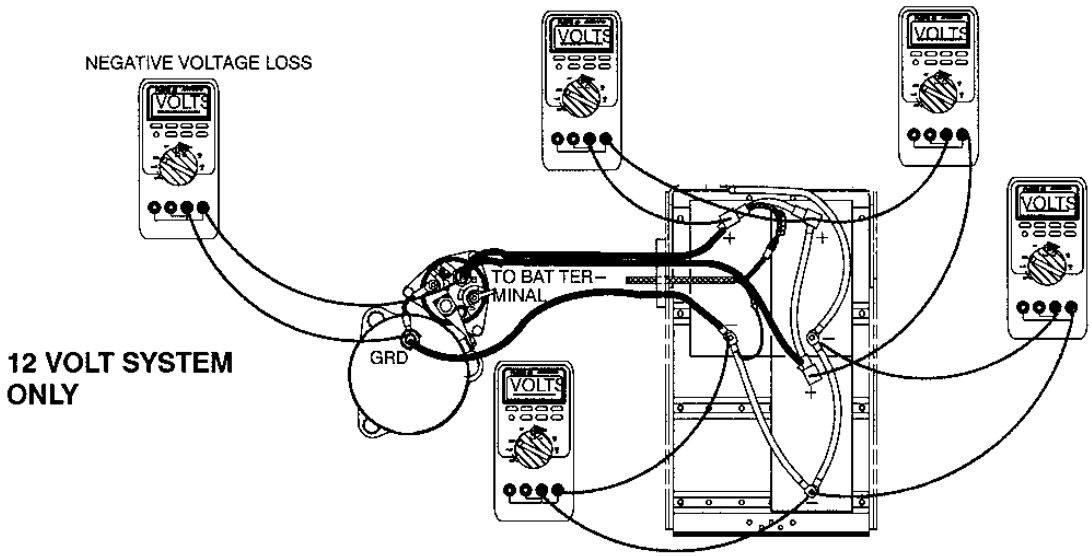

Figure 147 Cranking Motor Replacement Test

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 87 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.

Table 87 Thermal Overcrank Circuit Tests (cont.)

(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

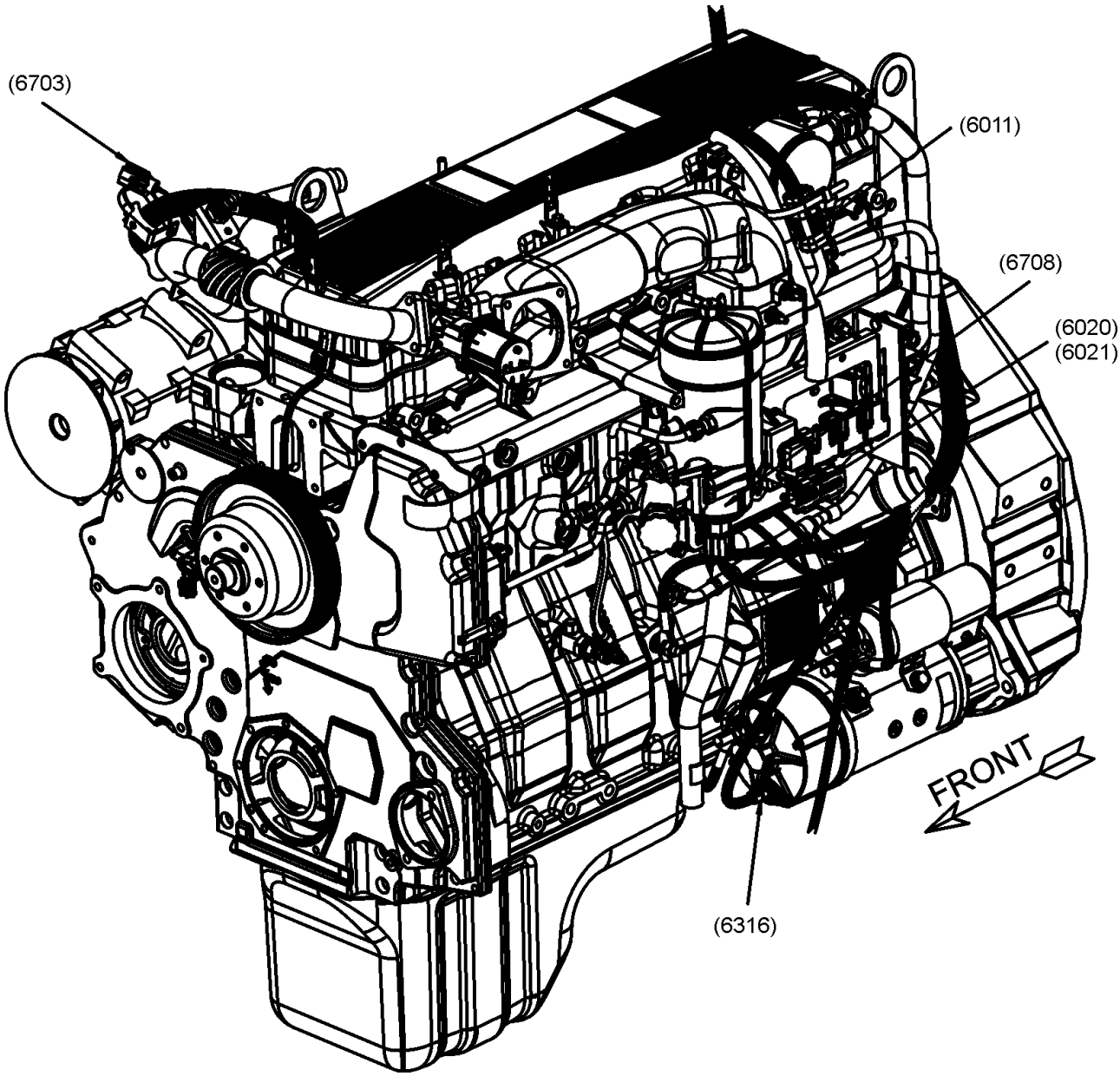

Figure 148 Cranking Motor Location (I6 Engine)

(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

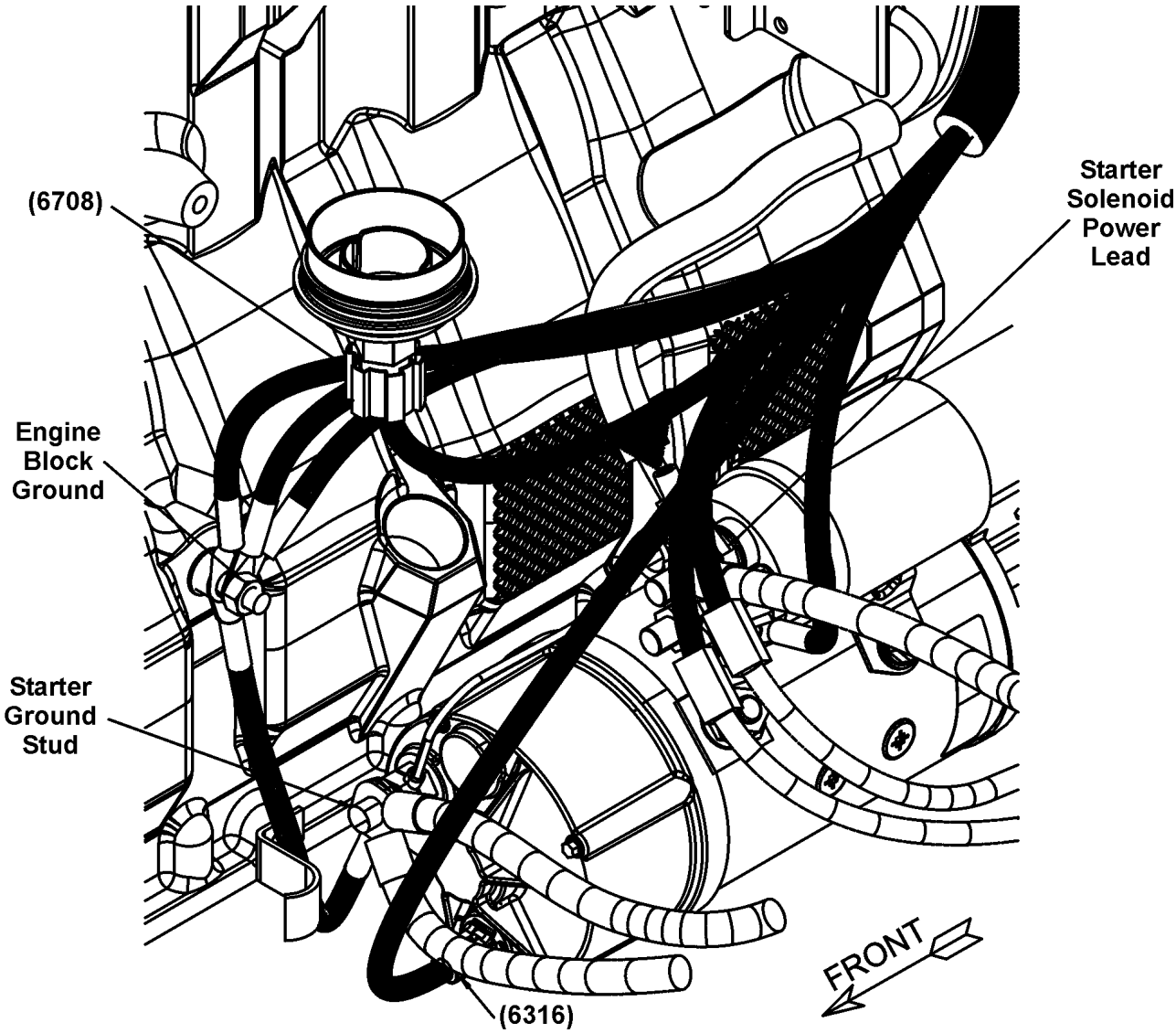

Figure 149 Cranking Motor (i6 Engine)

(6708) FUEL FILTER PREHEATER

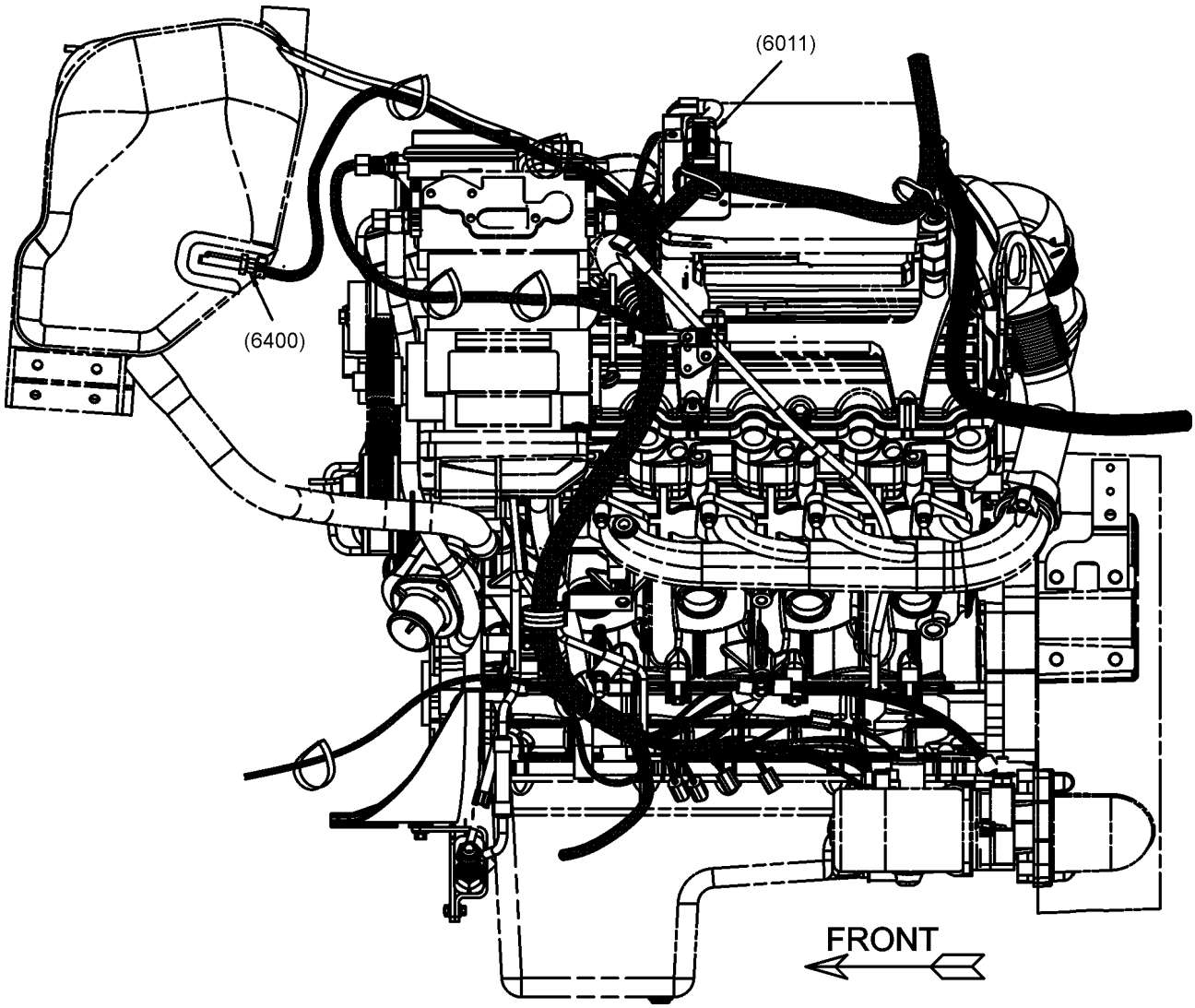

Figure 150 Cranking Motor Location (V8 Engine)

(6011) IDM2 CONNECTOR
(6400) LOW COOLANT SENSOR

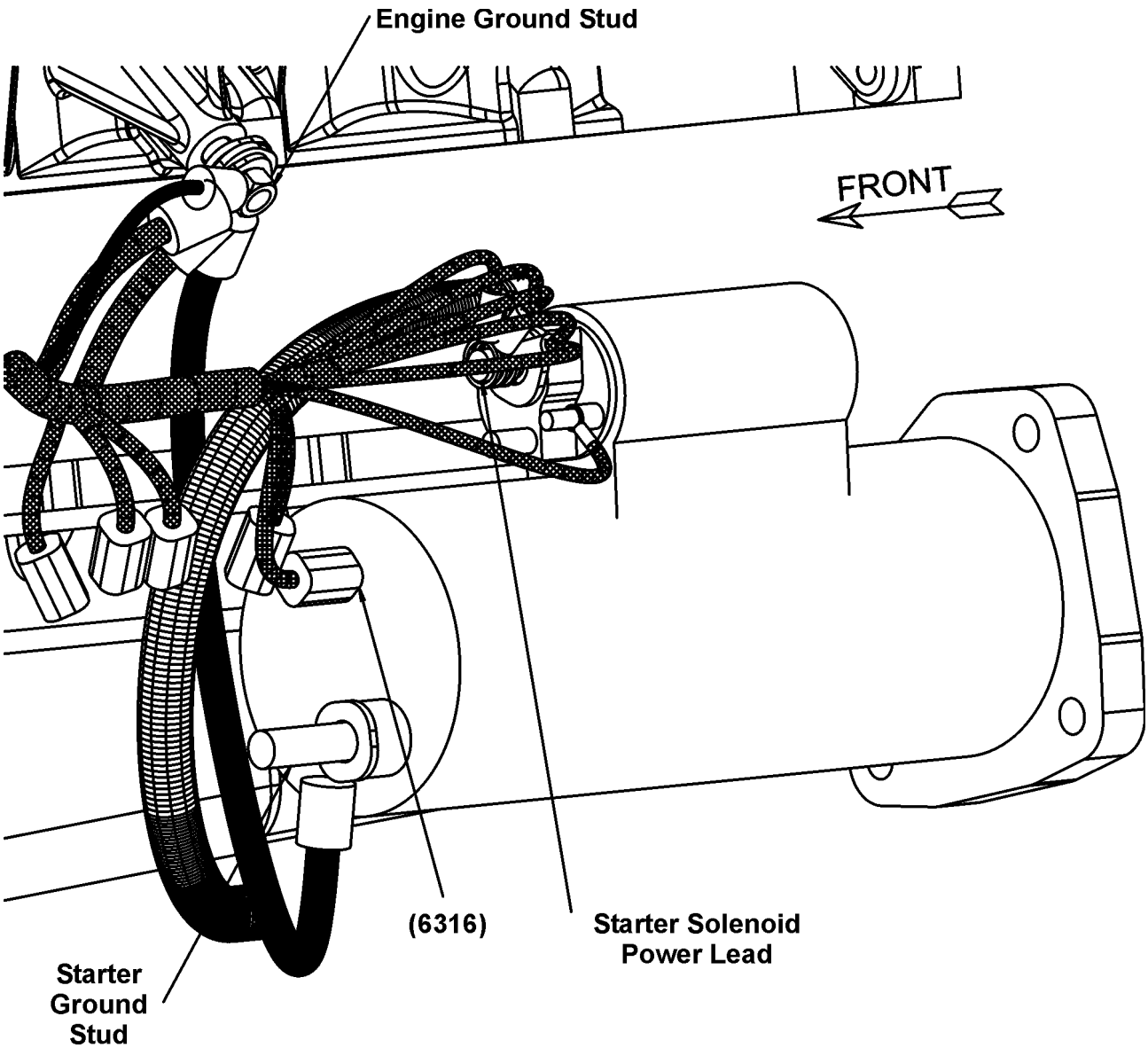

Figure 151 Cranking Motor (V8 Engine)

(6316) THERMAL OVERCRANK PROTECTION

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 International Truck 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 88 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	Engine cranks.	Go to Drivetrain 1939 Data Link. (See	Go to Fault Detection Management. (See Fault Detection Management, page 310)

Table 88 Engine Electronic Control Module Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
			attempt to start vehicle.		DRIVETRAIN 1939 DATA LINK, page 63)	

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.

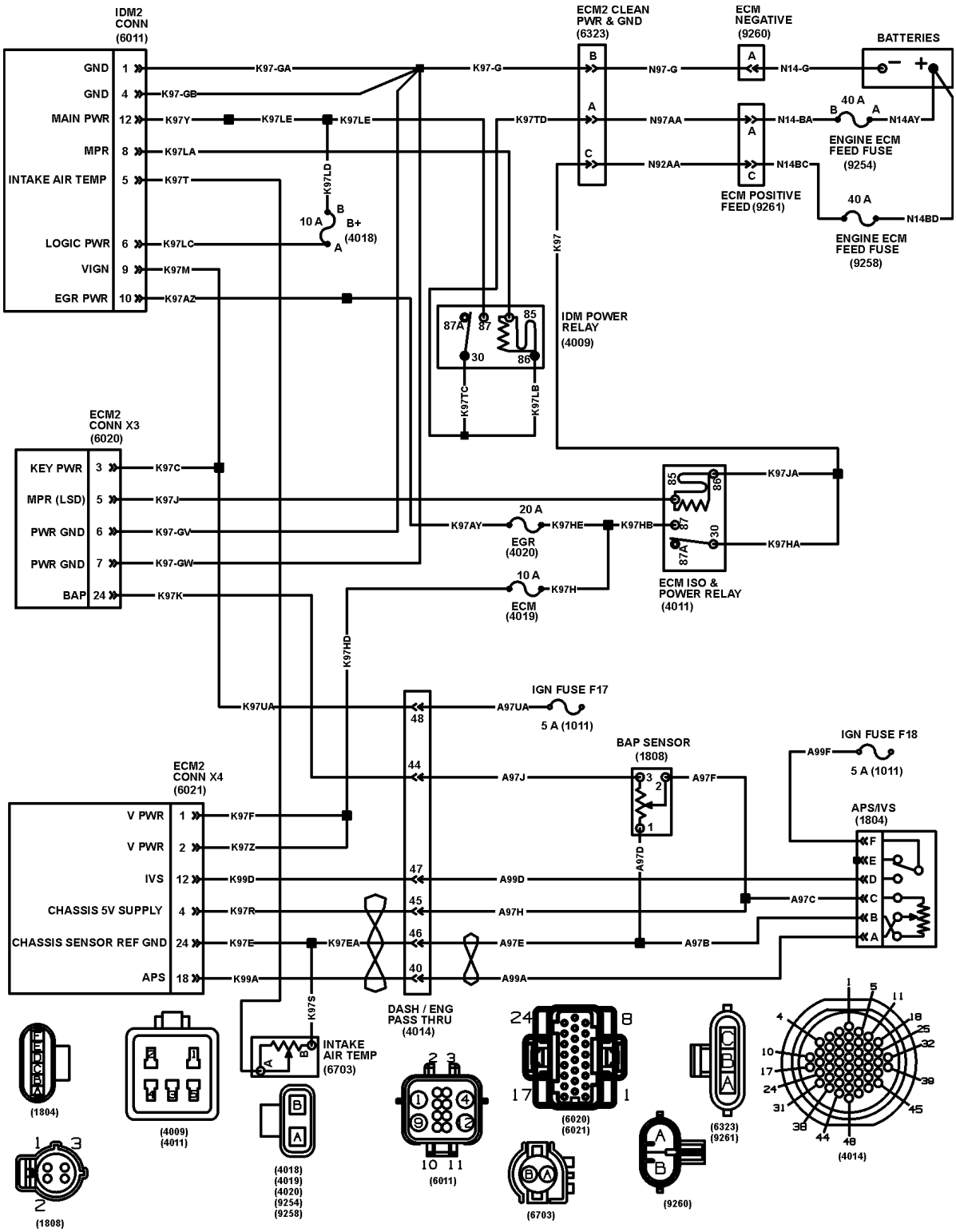

Figure 152 ECM Power Circuits

(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 89 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 89 ECM Power Circuit Tests (cont.)

ECM Power & Ground Connector (6323) Voltage Checks Check with (6323) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.**		
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 and replace if it has failed. **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 89 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 and replace if it has failed. **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 89 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 89 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

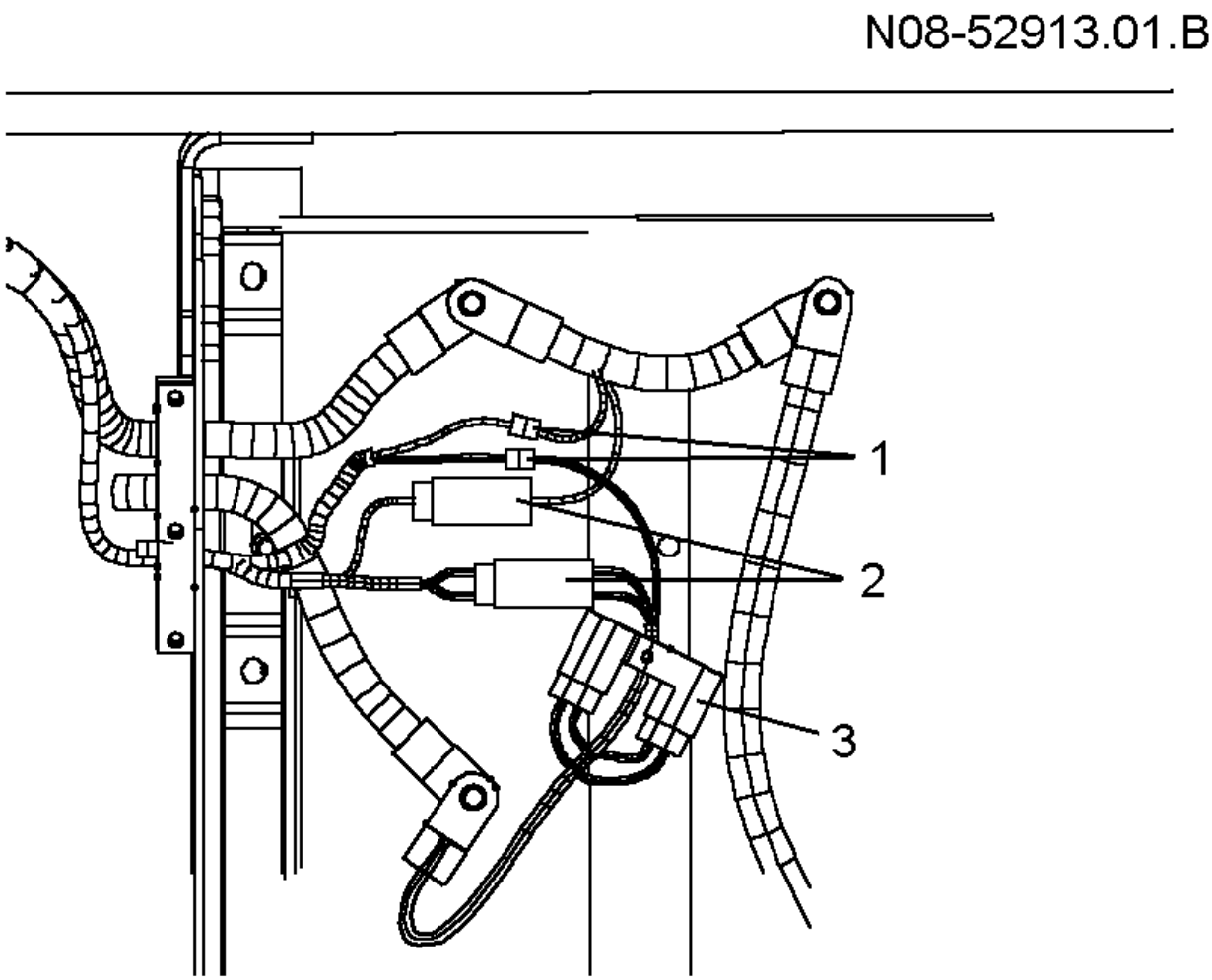

Figure 153 Engine ECM Power Battery Box Connectors (Typical)

1. 2–WAY RADIO CIRCUITS, N14HC TO POSITIVE AND N14–GD TO NEGATIVE TERMINALS ON THE BATTERY
2. ENGINE ECM CLEAN POWER FEED
3. 40 AMP FUSE FOR I6 OR 60 AMP FUSE FOR V8

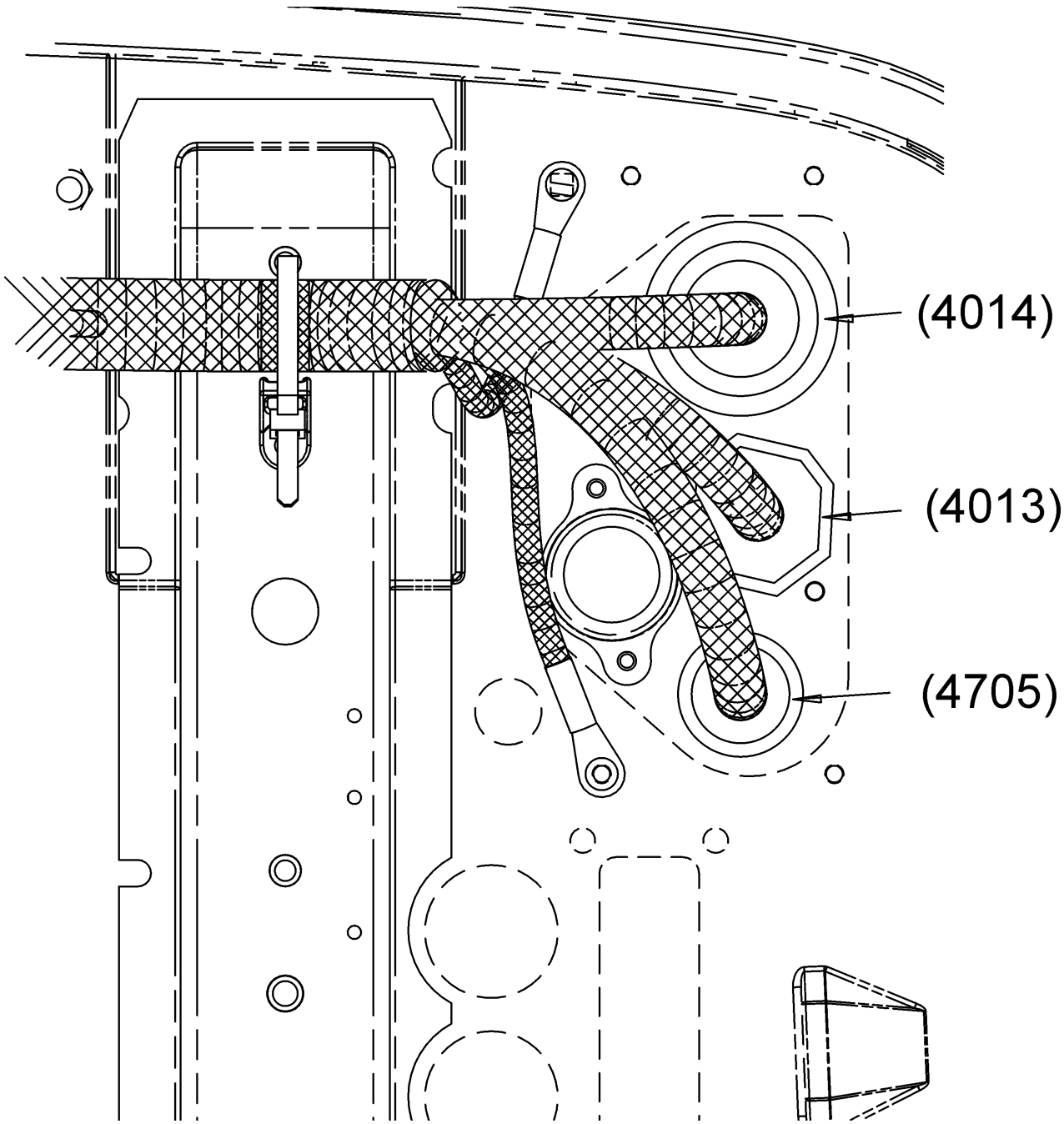

Figure 154 Pass Thru Connector Locations

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

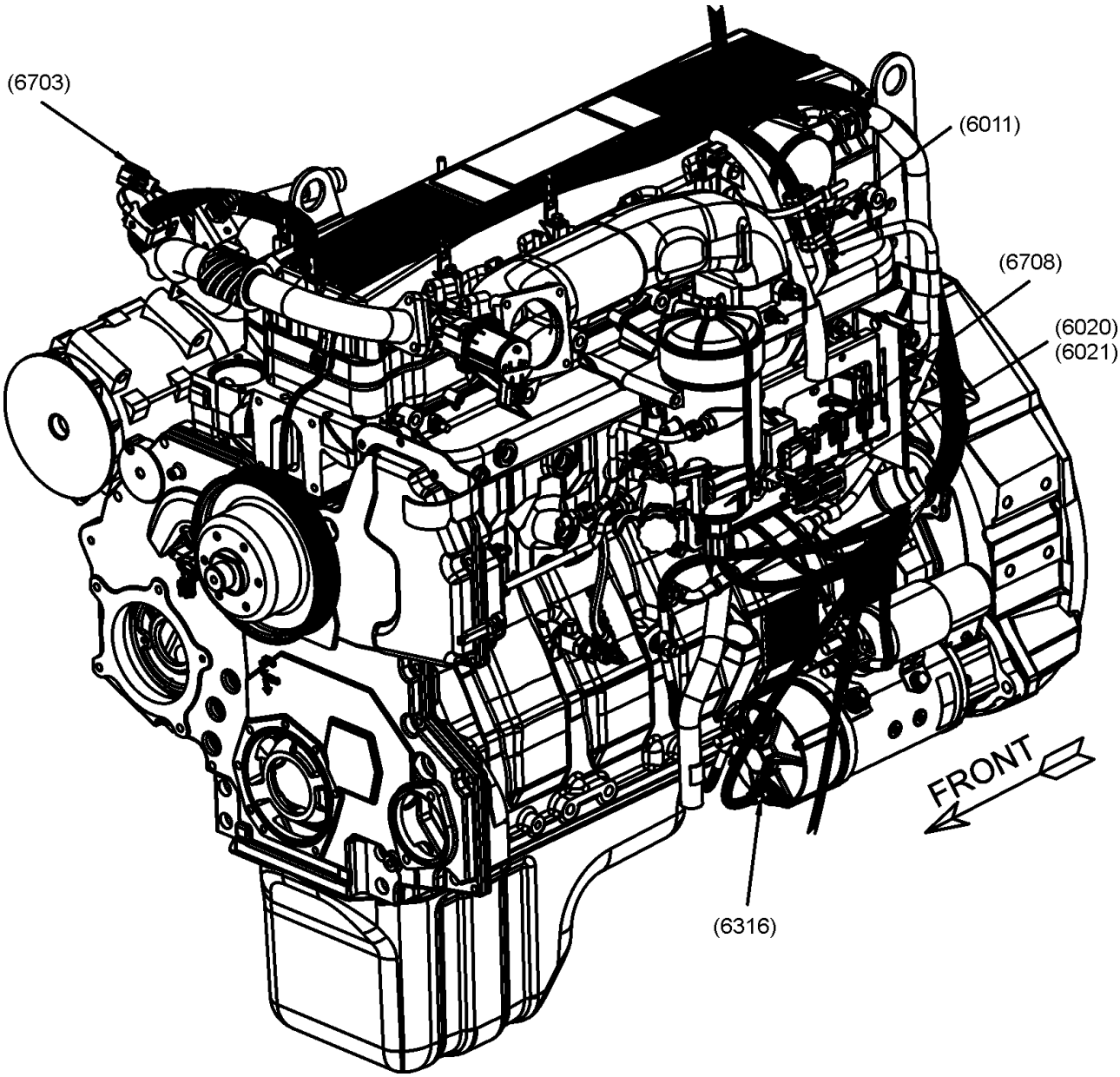

Figure 155 Engine ECM Location

(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

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 63)

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 74)

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 335)

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 International 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 90 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	Engine cranks.	Go to Drivetrain 1939 Data Link. (See	Go to Fault Detection Management. (See Fault Detection Management, page 321)

Table 90 Engine Electronic Control Module Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
			attempt to start vehicle.		DRIVETRAIN 1939 DATA LINK, page 63)	

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.

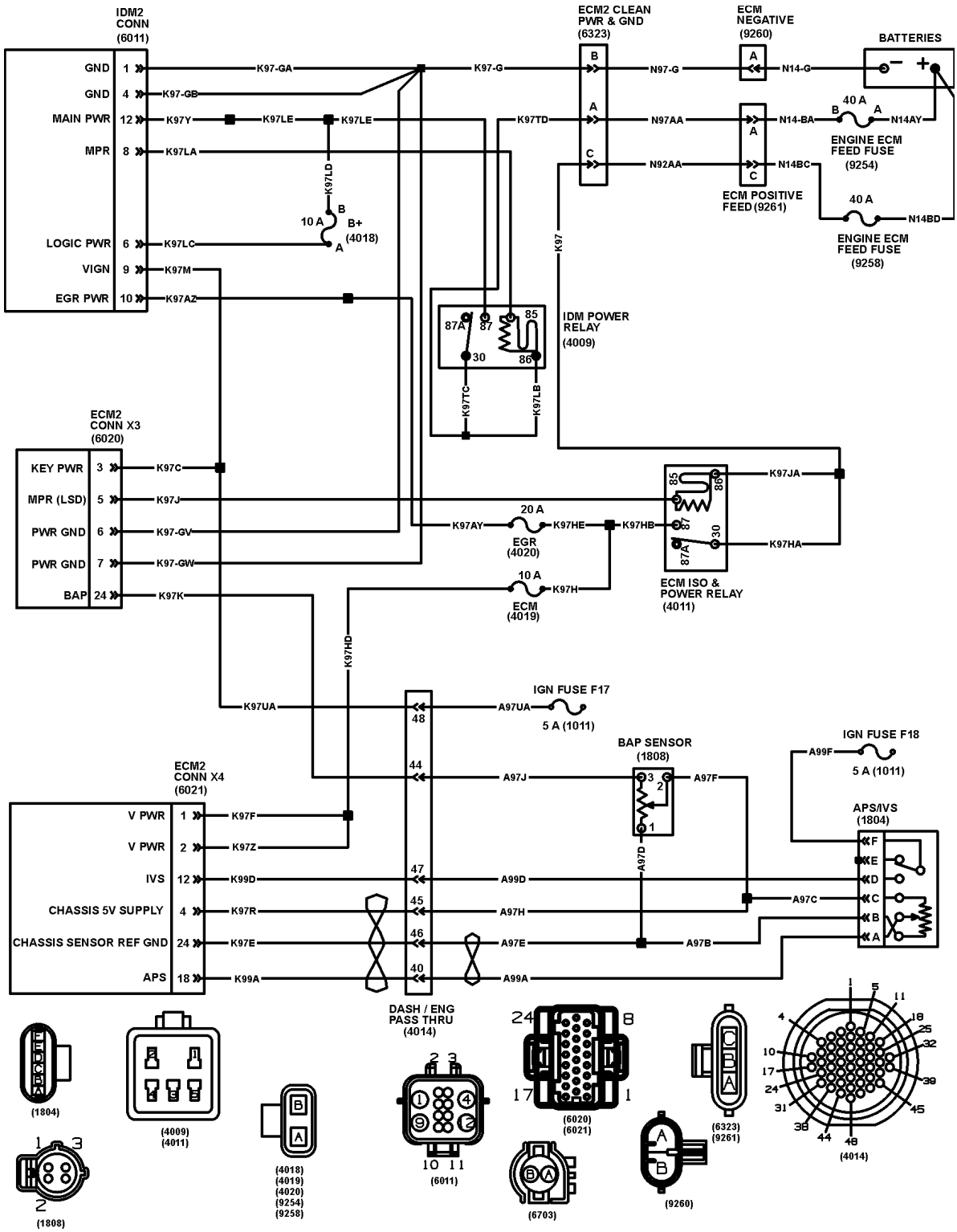

Figure 156 ECM Power Circuits for V8 Engine

(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 91 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 91 ECM Power Circuit Tests (cont.)

ECM Power & Ground Connector (6323) Voltage Checks Check with (6323) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.**		
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 and replace if it has failed. **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 91 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 and replace if it has failed. **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 91 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

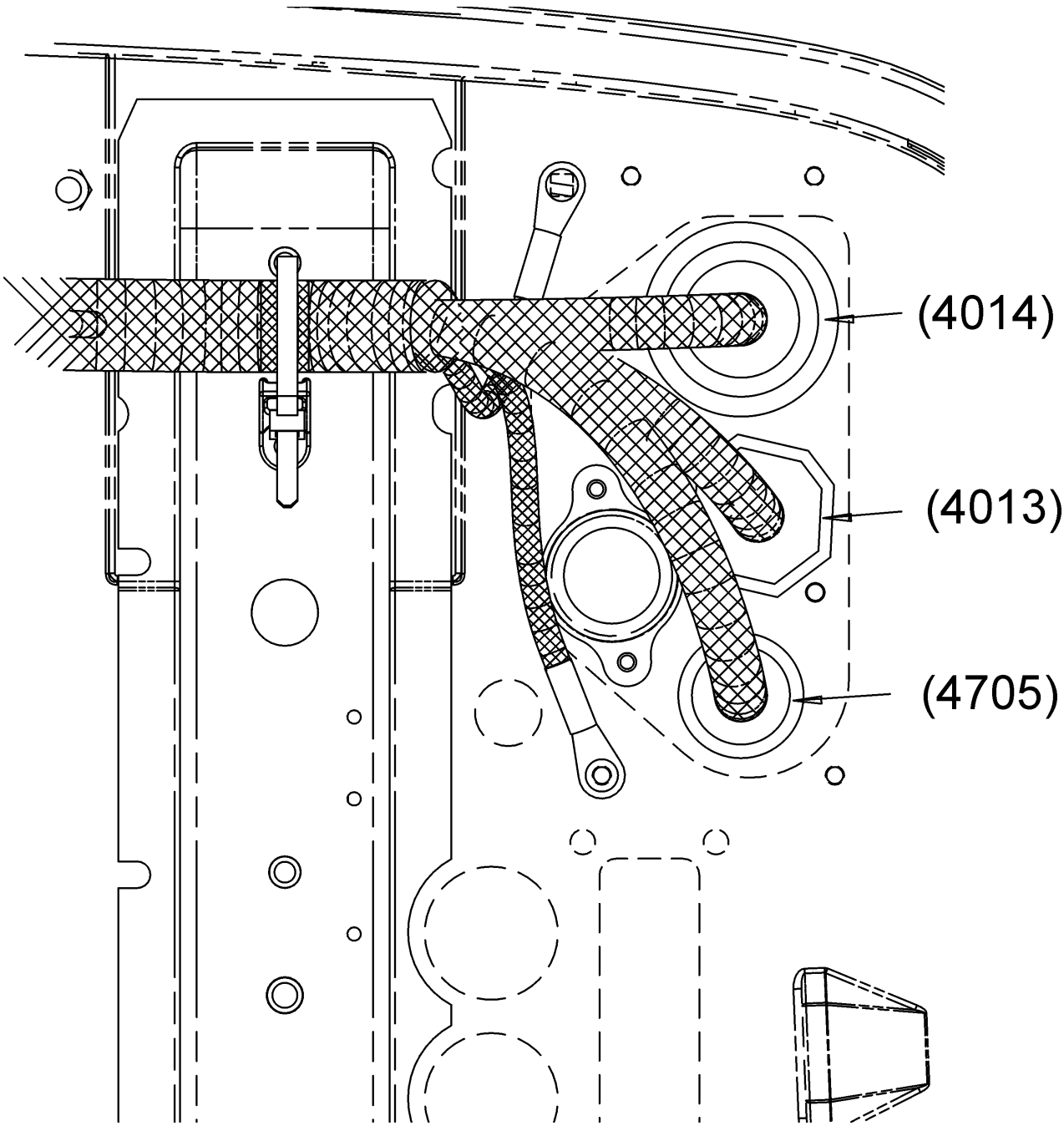

Figure 157 Pass Thru Connectors

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

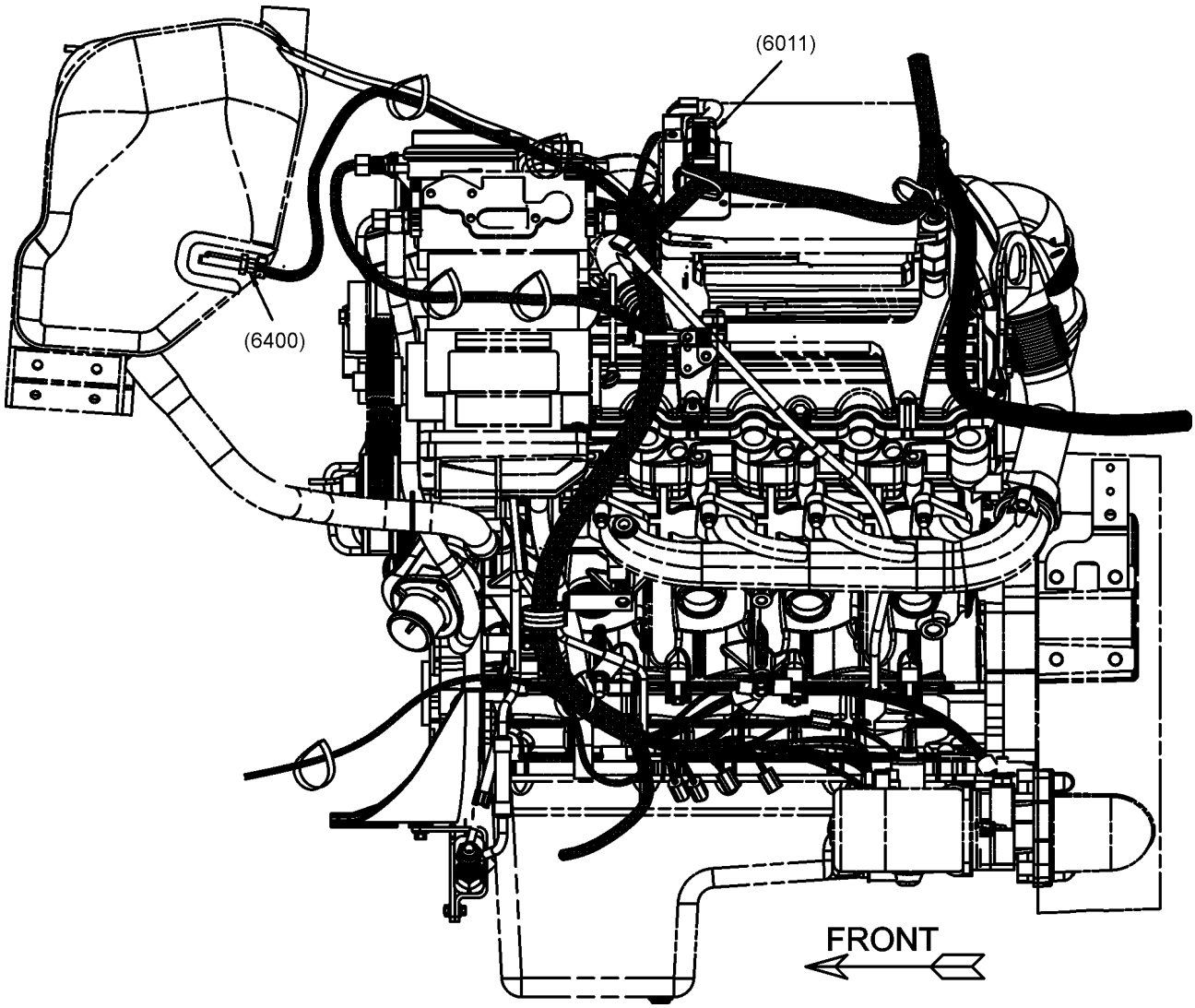

Figure 158 Engine Connector Location (V8)

(6011) IDM2 CONNECTOR
(6400) COOLANT SENSOR CONNECTOR

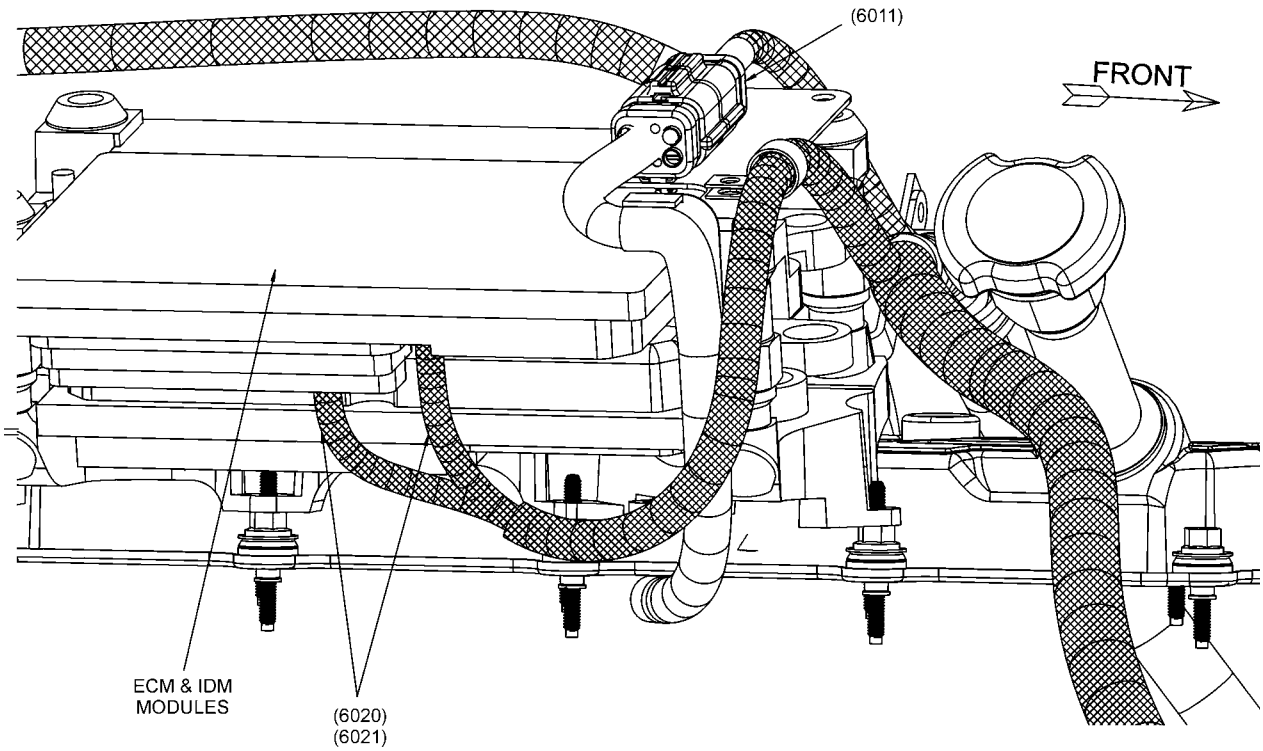

Figure 159 Engine ECM Location (V8)

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

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 63)

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 74)

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 335)

Table of Contents

1. CRUISE CONTROL

1.1. CIRCUIT FUNCTION

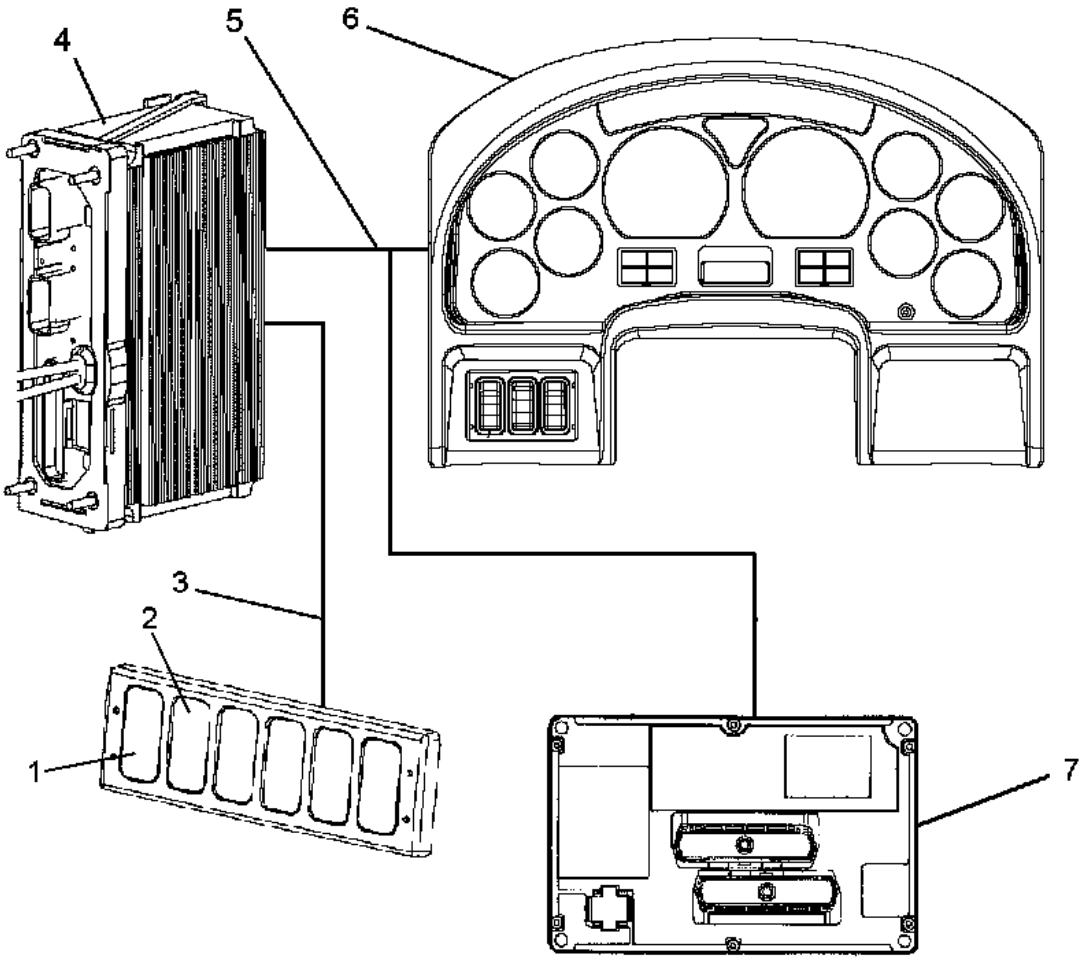

Figure 160 Cruise Control Function Diagram

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 engine controller activates the cruise control when it receives a message on the Drivetrain 1939 data link from the ESC. The ESC generates this message when it receives input from the cruise control switches on the steering wheel or from the switch pack.

The key must be in the accessory or run position for the cruise control to work.

The ESC will command the cruise to be deactivated when the brake or clutch is activated.

The ESC will also command the cruise to be deactivated when a brake or clutch switch DTC is set or an ABS or traction control event has occurred.

See the engine diagnostic manual for detailed information on troubleshooting cruise control problems not related to the truck circuits.

1.2. DIAGNOSTICS

NOTE – If cruise control switches are located in the switch pack, then refer to the switch pack troubleshooting section of this manual.

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.

The EGC cannot be put in diagnostic mode when there is a fault in these circuits. The Diamond Logic Builder™ software must be used to view this DTC.

Faults in the brake, clutch, ABS and drivetrain data link will set DTC's and will effect cruise control operation.

Table 92 Cruise Control Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On, with engine running	Verify cruise control is inoperative. Insure the brake and clutch are released, there are no active brake or clutch DTC's and no ABS/ATC events.	Test cruise control.	Cruise control is inoperative.	Go to next step.	Cruise control is operating. Problem does not exist or is intermittent.
2.	On, with engine off	Determine if any other features are malfunctioning that may have common circuits (Example: Missing power or ground common to several features).	Visually 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.

Table 92 Cruise Control Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
3.	On	Connect diagnostic tool (EZ-Tech) to the diagnostic connector. Turn key to ignition position. Start the "Diamond Logic Builder™" diagnostic software. Verify operation of the cruise control switch input to ESC.		Diamond Logic Builder™ software shows switches are operating.	Cruise switches are working. Go to next step.	Go to Cruise Switch Fault Detection/ Management. (See CRUISE SWITCH FAULT DETECTION/MANAGEMENT, page 337)
4.	On	Use the "Diamond Logic Builder™" diagnostic software to verify the brake or clutch switches are not active inputs to the ESC.		Diamond Logic Builder™ software shows switches are not active.	Brake and clutch switches are not disabling cruise control.	Go to Cruise Switch Fault Detection/ Management. (See CRUISE SWITCH FAULT DETECTION/MANAGEMENT, page 337)
5.	On	Use "Diamond Logic Builder™" diagnostic software to verify cruise commands from the ESC to the engine controller.		Cruise commands are being generated by the ESC.	Go to next step.	Message from ESC is not being transmitted. Consider replacing ESC. (See ESC REPLACEMENT, page 117)
6.	On	ESC is processing switch inputs and generating cruise commands to the engine controller. Refer to the engine troubleshooting manual for the engine installed in the vehicle.				

1.3. CRUISE SWITCH FAULT DETECTION/MANAGEMENT

Refer to Cruise Switch Circuits.

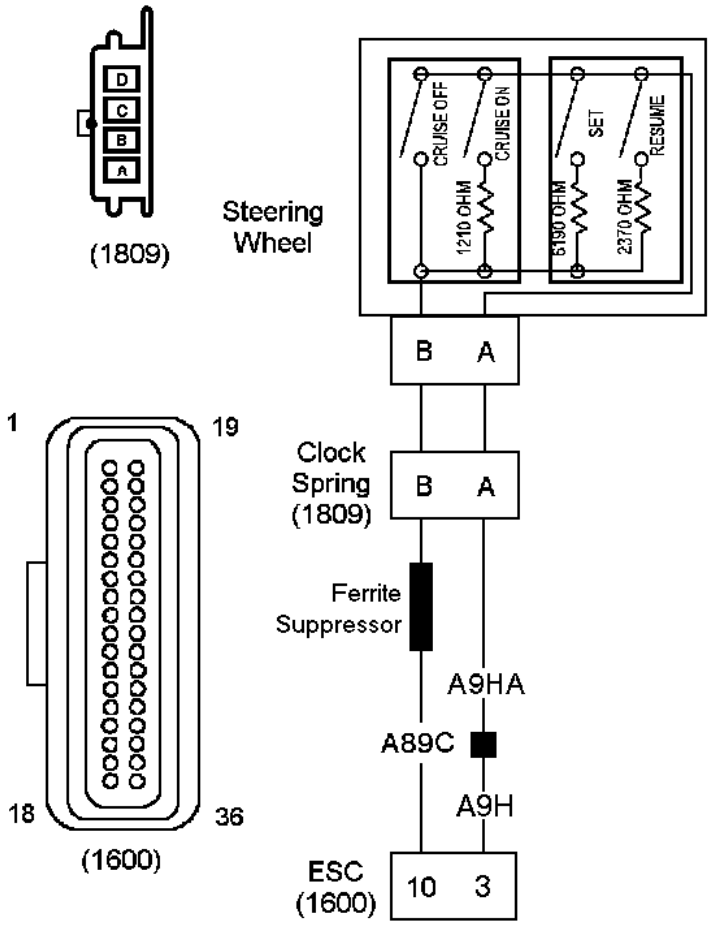

Figure 161 Cruise Switch Circuits (located in Steering Column) — Always refer to Circuit Diagram Book for Latest Circuit Information

(1600) SYSTEM CONTROLLER
LOCATED AT INSIDE RIGHT SIDE DASH PANEL
(1809) CLOCK SPRING
LOCATED IN STEERING COLUMN

Table 93 Cruise Control Switch (Located in Steering Column) Voltage Tests

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
612 14 5 1	Analog cruise switch out of range low Shorted to ground or open circuit
612 14 5 2	Analog cruise switch out of range high Shorted high

Table 93 Cruise Control Switch (Located in Steering Column) Voltage Tests (cont.)

Cruise Control Switch (Located in Steering Column) Voltage Checks Remove horn switch cover. Check with ignition key on and steering wheel switch connector removed. **NOTE – Voltage to the switch will be approximately 5 volts with the key off.** **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Steering wheel switch harness connector cavity A to B.	12 ± 1.5 volts.	If voltage is incorrect, check for open in clock spring or circuits to ESC connector (1600) pin 3. Resistance check of clock spring, disconnect connector (1809) from bottom of clock spring, check continuity between pin A to A. Repair or replace circuits.
If voltage is correct the circuits between the ESC and the cruise switches are functioning properly. Check switch resistances. If voltage is incorrect and there are no open or shorted circuits the ESC may need replaced.		
Cruise Control Switch (Located in Steering Column) Resistance Checks Check with ignition key off and steering wheel switch connector removed. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Steering wheel switch connector cavity A to B, no switches pushed.	>100K ohms	If resistance is incorrect there is a short in one of the switches.
Steering wheel switch connector cavity A to B, resume switch pushed.	2.4K ± 470 ohms	If resistance is incorrect replace the set/resume switch.
Steering wheel switch connector cavity A to B, set switch pushed.	6.2K ± 1200 ohms	If resistance is incorrect replace the set/resume switch.
Steering wheel switch connector cavity A to B, cruise on switch pushed.	1.2K ± 250 ohms	If resistance is incorrect replace the on/off switch.
Steering wheel switch connector cavity A to B, cruise off switch pushed.	<2 ohms	If resistance is incorrect replace the on/off switch. If all resistances check good the switches are functioning properly.

1.4. EXTENDED DESCRIPTION

The zero volt reference level from ESC connector (1600) pin 3 is supplied to steering wheel switch connector pin A.

Battery voltage from ESC connector (1600) pin 10 is supplied to steering wheel switch connector pin B.

Each cruise control switch is connected to a resistor with a different resistance. The switch and resistor are connected in parallel with the other switches and resistors. When a switch is pressed the ESC will sense the voltage drop across the switch and the resistor. This will signal the ESC to generate the appropriate cruise commands to the engine controller.

2. ELECTRIC HORNS

2.1. CIRCUIT FUNCTIONS

Refer to electric horn function diagram.

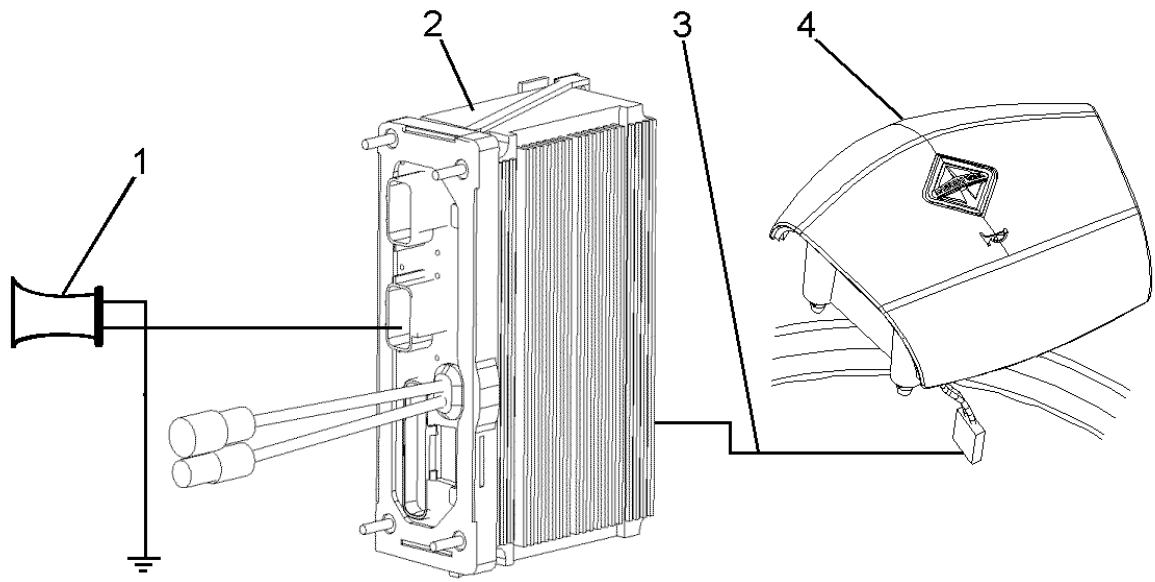

Figure 162 Electric Horn Function Diagram

1. ELECTRIC HORNS, RIGHT SIDE #2 (8312) & LEFT SIDE #1 (8311)
2. ELECTRICAL SYSTEM CONTROLLER
3. CIRCUITS TO ESC CONNECTOR (1600)
4. ELECTRIC HORN SWITCH IN STEERING WHEEL

The electric horns provide the driver audio warning to warn others.

The electric horn switch is a direct input (not multiplexed) to the ESC. When the horn button is pushed the ESC provides voltage to the horns. The circuits from the steering wheel travel through a clock spring assembly which is used instead of a slip ring assembly. Its winds and unwinds as the wheel is turned.

2.2. DIAGNOSTICS

Should the electric horns fail to operate, the problem could be attributed to a faulty switch in the steering wheel, open or shorted circuits between the horn switch and ESC or open or shorted output wiring between the ESC and the horns.

The ESC has an internal virtual fuse and software algorithm to protect output circuits in an over current situation.

A diagnostic trouble code will be logged if there is an over current (short to ground or excessive load) or an open in the circuits between the ESC and both electric horns.

An electronic service tool, running the "Diamond Logic Builder™" diagnostic software, can be used to check operation of the electric horns and monitor activation of the electric horns switch. See the diagnostic software manual for details on using the software.

Electric Horns Preliminary Check

Table 94 Electric Horns Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify electric horns are inoperative.	Attempt to operate electric horns.	Electric horns are inoperative.	Go to next step.	Electric horns are operating. Problem does not exist or is intermittent. (Check for previously active diagnostic trouble codes.)
2.	On	Determine if any other features are malfunctioning that may have common circuits. (Example: Missing power or ground common to several features.)	Visually 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	If more than one electric horn is connected to this circuit, are all horns inoperative?	Check if all electric horns are inoperative.	All electric horns are inoperative.	Go to next step.	Check specific circuits of the inoperative horn for open circuits.
4.	On	Check for diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 342)	Read display on odometer.	No electric horns diagnostic trouble codes are active.	Go to electric horns input circuits to the ESC. (See ELECTRIC HORN CIRCUIT INPUTS TO ESC, page 342)	Go to electric horns circuit outputs from ESC. (See ELECTRIC HORN CIRCUIT OUTPUTS FROM ESC, page 345)

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 95 Electric Horn Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
611 14 12 1	Electric horn open circuit
611 14 12 2	Electric horn over current
611 14 12 3	Electric horn, less than normal low current but more than open circuit
611 14 12 4	Electric horn, greater than normal high current and less than fusing current
611 14 12 6	Electric horn has current flow when output commanded off

2.3. ELECTRIC HORN CIRCUIT INPUTS TO ESC

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 input circuits will be apparent when the horns do not come on and no active diagnostic trouble codes are present. The ESC will not log any diagnostic trouble codes for electric horn input circuits to the ESC. Problems in the electric horn input circuits could be attributed to a short circuit between the horn switch and the ESC, an open circuit between the horn switch and the ESC, a faulty switch, or a problem in the ESC.

Refer to electric horn and ESC input circuits.

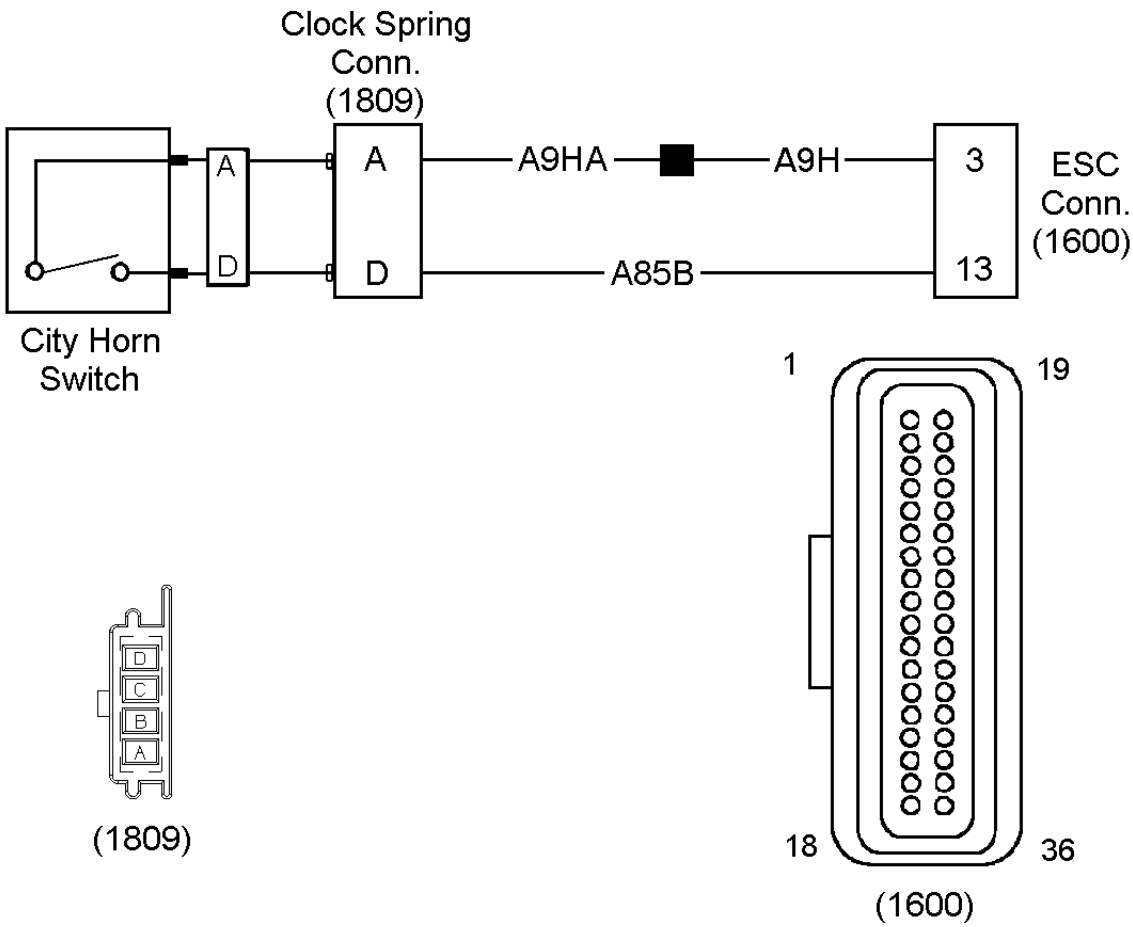

Figure 163 Electric Horn and ESC Input Circuits — Always Refer to Circuit Diagram Book for Latest Circuit Information

(1600) SYSTEM CONTROLLER
LOCATED AT INSIDE RIGHT SIDE DASH PANEL
(1809) CLOCK SPRING
LOCATED IN STEERING COLUMN

Table 96 Horn Switch Voltage Tests

Diagnostic Trouble Codes
There are no diagnostic trouble codes associated with the steering column horn switch.
A mechanically defective electric horn switch could also prevent the electric horn from operating. Remove the steering column horn switch and use jumper wire between the two harness connectors to the clock spring connector (1809) pins A and D. If the electric horns sound, the mechanical switch assembly should be replaced.

Table 96 Horn Switch Voltage Tests (cont.)

Steering Wheel Switch Harness Horn Switch Voltage Check Remove Horn Switch Cover. Check with ignition key on and horn switch disconnected. **NOTE – Voltage to the switch will be approximately 12 volts with the key off.** **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Steering wheel switch harness cavity D to ground.	12 ± 1.5 volts	If voltage is missing, check for open or shorts in circuit A85B, through the horn switch harness, the clock spring connector (1809) and ESC connector (1600). Resistance check of clock spring, disconnect connector (1809) from bottom of clock spring, check continuity between pin D to D. Repair or replace circuits.
Steering wheel switch cavity A to D.	12 ± 1.5 volts	If voltage is missing, check for open or shorts in circuits A9HA and A9H, through the horn switch harness, the clock spring connector (1809) and ESC connector (1600). Resistance check of clock spring, disconnect connector (1809) from bottom of clock spring, check continuity between pin A to A. Repair or replace circuits.
If voltage is correct the circuits between the ESC and the horn switch are functioning properly. Check switch resistances. If voltage is incorrect and there are no open or shorted circuits the ESC may need replaced.		
Horn Switch Resistance Check **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Steering wheel switch connector cavity A to D, horn switch not pushed.	>100K ohms	If resistance is incorrect there is a short in the horn switch.
Steering wheel switch connector cavity A to D, horn switch pushed.	<1 ohm	If there is no continuity, replaced the horn switch.

Extended Description

The electric horn switch is wired directly to the ESC. When the electric horn switch is turned on, 0 volt reference on pin 3 from the ESC will pass through the switch to pin 13 back to the ESC. This will cause the ESC to send 12 volts to the air solenoid pack to operate the horn.

2.4. ELECTRIC HORN CIRCUIT OUTPUTS FROM ESC

Fault Detection Management

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

NOTE – The virtual fuse in the ESC will trip during a short. To reset the fuse, the key switch must be cycled.

A fault in the electric horn output circuits from the ESC will be apparent when the horns do not come on and an active electric horn fault is active. The ESC will log a fault when there is a short in any of the circuits between the ESC and the electric horn or when there is an open in a circuit between the electric horn and ground. Problems in the electric horn circuits could be attributed to a short, an open, a faulty switch or a problem in the ESC.

Refer to electric horn outputs from ESC.

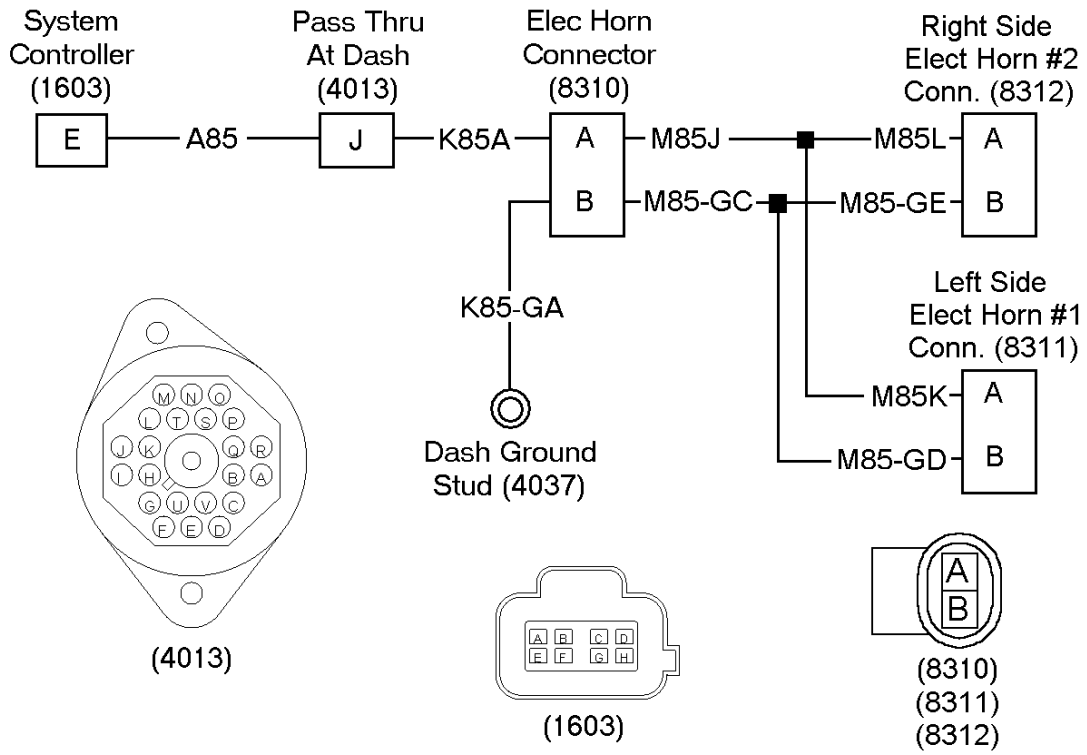

Figure 164 Electric Horn Outputs from ESC — Always Refer to Circuit Diagram Book for Latest Circuit Information

(1603) SYSTEM CONTROLLER
LOCATED INSIDE RIGHT SIDE DASH PANEL
(4013) PASS THRU AT DASH
LOCATED AT INSIDE LEFT SIDE DASH PANEL
(8310) ELECTRIC HORN
LOCATED AT ENGINE COMPARTMENT NEAR BUMPER
(8311) LEFT SIDE ELECTRIC HORN
LOCATED AT ENGINE COMPARTMENT NEAR BUMPER
(8312) RIGHT SIDE ELECTRIC HORN
LOCATED AT ENGINE COMPARTMENT NEAR BUMPER

Table 97 Electric Horn Tests

Diagnostic Trouble Codes	
611 14 12 3	Electric horn, less than normal low current but more than open circuit
611 14 12 4	Electric horn, greater than normal high current and less than fusing current
611 14 12 6	Electric horn has current flow when output commanded off
611 14 12 2	Electric horn over current

Table 97 Electric Horn Tests (cont.)

<table>
<tr><td colspan="3">This fault is logged when there is a short in the circuits between the electric horn and the ESC or an excessive load on the circuit attributed to too many accessories on the electric horn circuits.

NOTE – Disconnecting connectors will cause new open circuit diagnostic trouble codes to be logged. Clear all diagnostic trouble codes after connections have been restored.

Disconnect electric horns right side connector (8312) and left side connector (8311). Cycle key switch and clear DTC’s. Then turn on the electric horn switch and check for fault. If the fault does not reoccur, there is a short or an overload in the electric horn. If the fault reoccurs there is a short in the circuits between the ESC and horn switch or in the ESC.

Disconnect brown ESC connector (1603). Cycle key switch and clear DTC’s. Turn on electric horn switch and check for fault. If the fault does not reoccur, there is a short in the circuits between the ESC and electric horns. If the fault reoccurs there is a short inside the ESC.</td></tr>
<tr><td colspan="2">611 14 12 1</td><td>Electric horn open circuit</td></tr>
<tr><td colspan="3">This fault is due to an open in circuits between the electric horn output of the ESC or the horn and ground.

Check for open circuits.</td></tr>
<tr><td colspan="3">Electric Horn Harness Connectors (8311) and (8312) Voltage Checks

Check with ignition key off, electric horn on, and electric horn connectors (8311) and (8312) disconnected.

NOTE – Always check connectors for damage and pushed–out terminals.</td></tr>
<tr><td>Test Points</td><td>Spec.</td><td>Comments</td></tr>
<tr><td>Horn on. (8311) and (8312) Harness connectors, pin A to ground.</td><td>12 ± 1.5 volts</td><td>If voltage is missing, check for open in circuits A85, K85A, M85J, M85L or M85K.

If circuits check good and problem is still present, verify voltage out of ESC.

NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.</td></tr>
<tr><td>(8311) and (8312) Harness connectors, pin A to pin B.</td><td>12 ± 1.5 volts</td><td>If voltage is missing, check for open in ground circuits K85–GA, M85–GC, M85–GD or M85–GE.

If voltage is present and horn is inoperative, replace horn.</td></tr>
</table>

Extended Description

The ESC will supply 12 volts from system controller brown connector (1603) terminal E to electric horn connectors (8311) and (8312) terminals A.

Ground for the electric horn is supplied from ground stud to electric horn connector (8311) and (8312) terminals B.

2.5. COMPONENT LOCATIONS

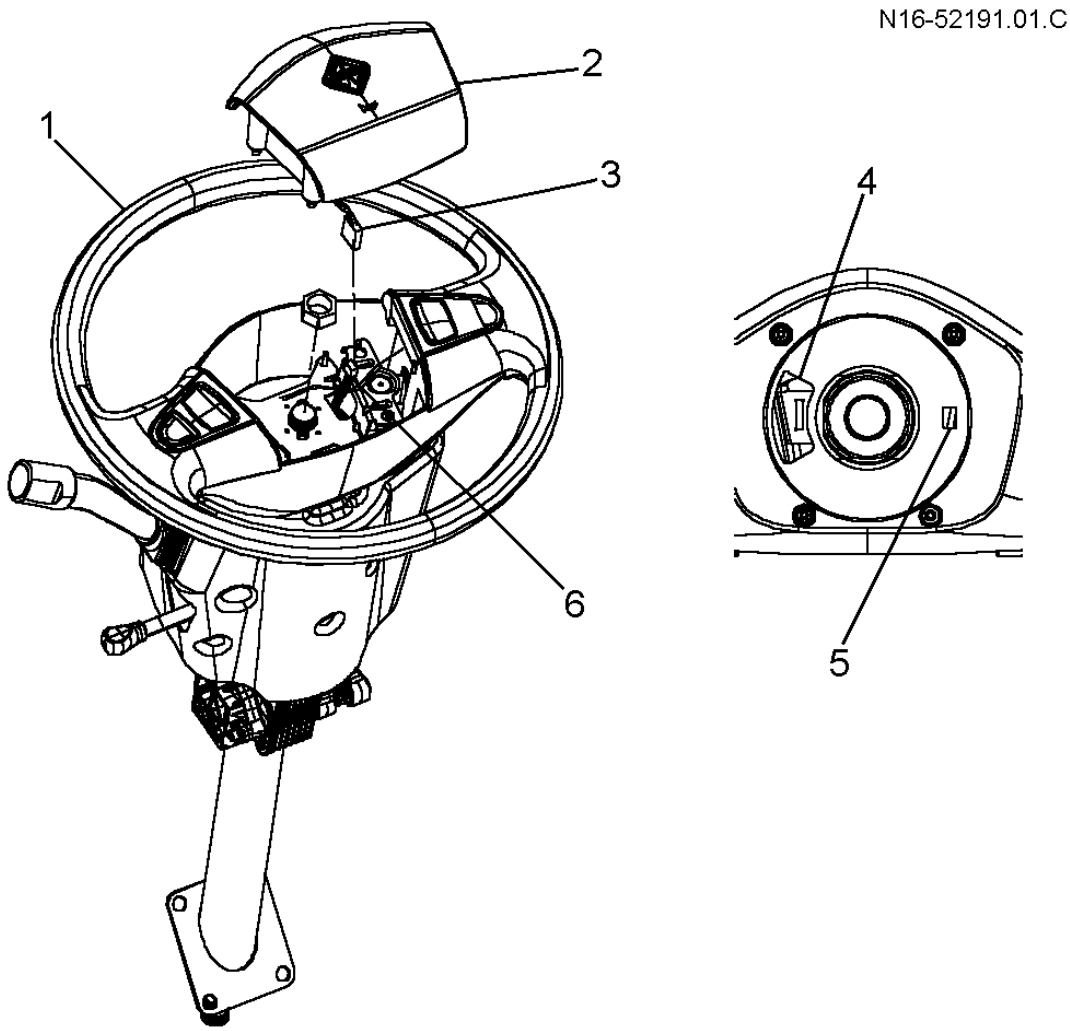

Figure 165 Electric Horn Wiring Steering Column

1. STEERING WHEEL
2. CITY HORN SWITCH
3. HARNESS TO HORN SWITCH
4. (1809) CLOCK SPRING CONNECTOR FOR CAB HARNESS
5. CLOCK SPRING TANG
6. CLOCK SPRING CONNECTOR TO HORN SWITCH AND CRUISE CONTROL SWITCHES

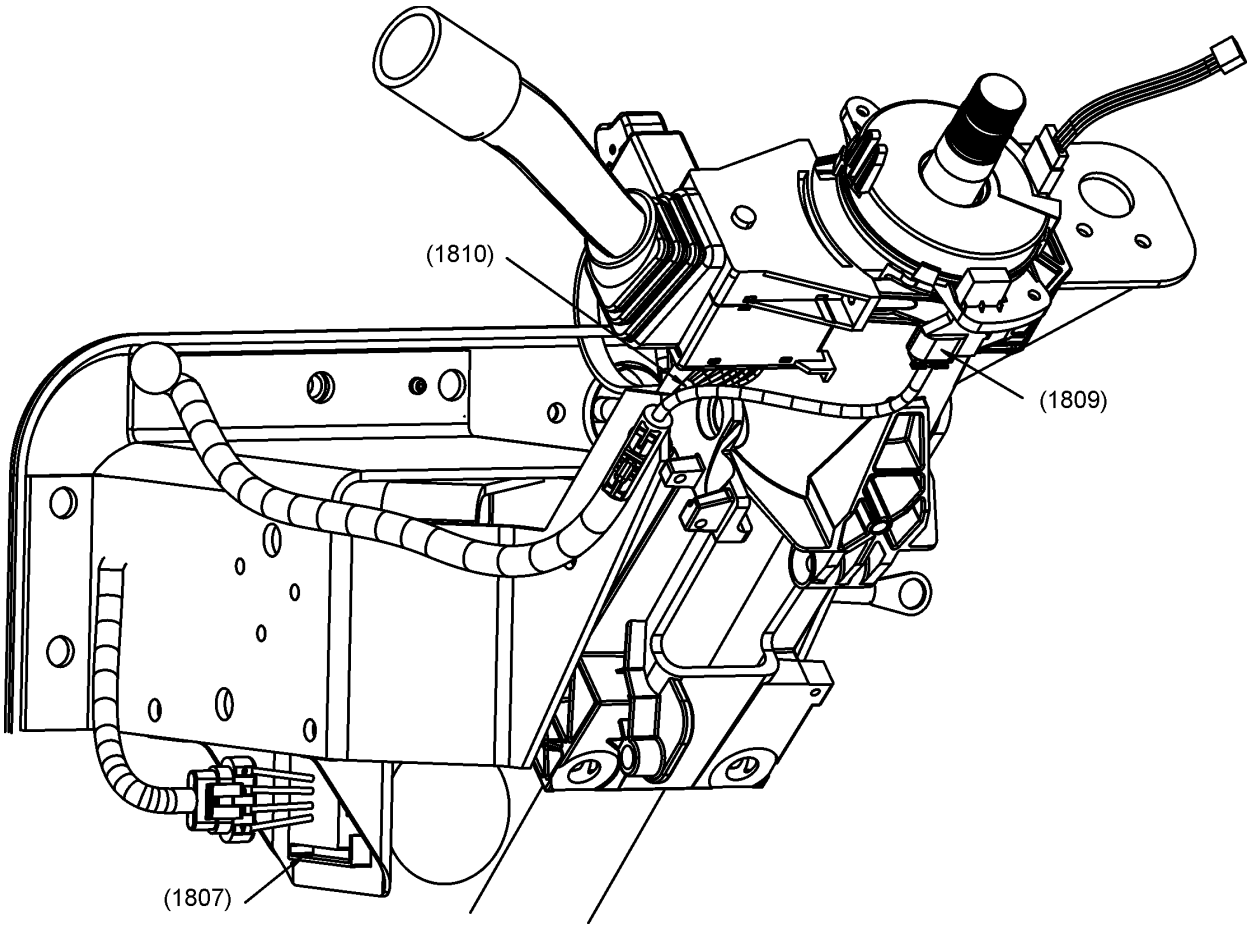

Figure 166 Steering Column Wiring

(1807) CLUTCH SWITCH
(1809) CLOCK SPRING CONNECTOR
(1810) TURN SIGNAL SWITCH

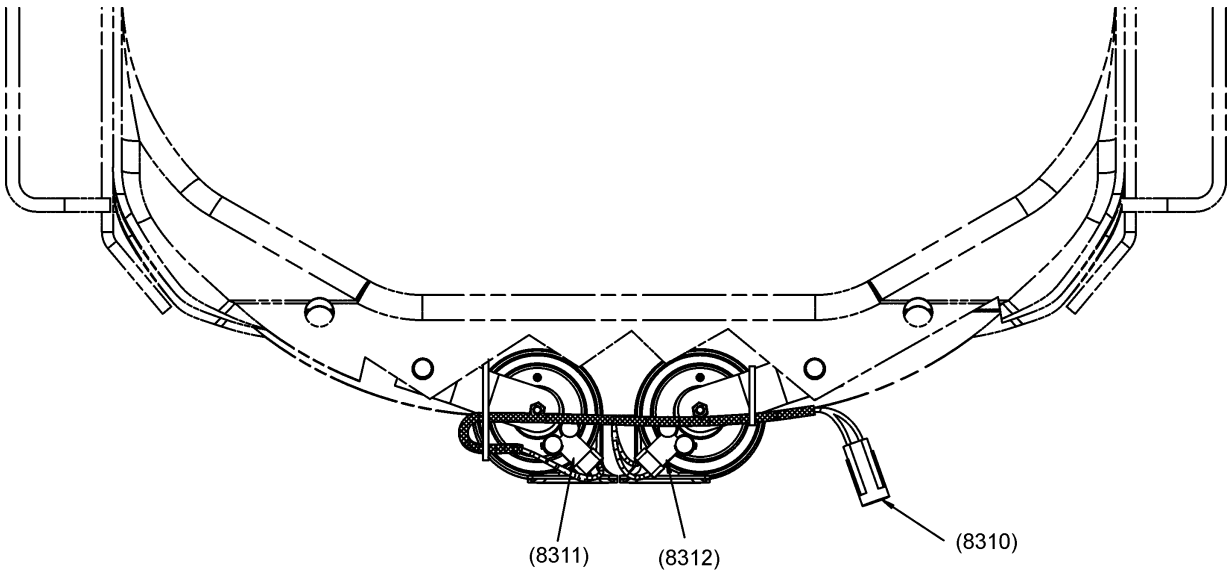

Figure 167 Electric Horn FWD Chassis Wiring Crossmember

(8310) ELECTRIC HORN
(8311) LEFT SIDE ELECTRIC HORN
(8312) LEFT SIDE ELECTRIC HORN

3. WINDSHIELD WIPERS

3.1. CIRCUIT FUNCTIONS

Circuit Functions

Refer to Wiper function diagram.

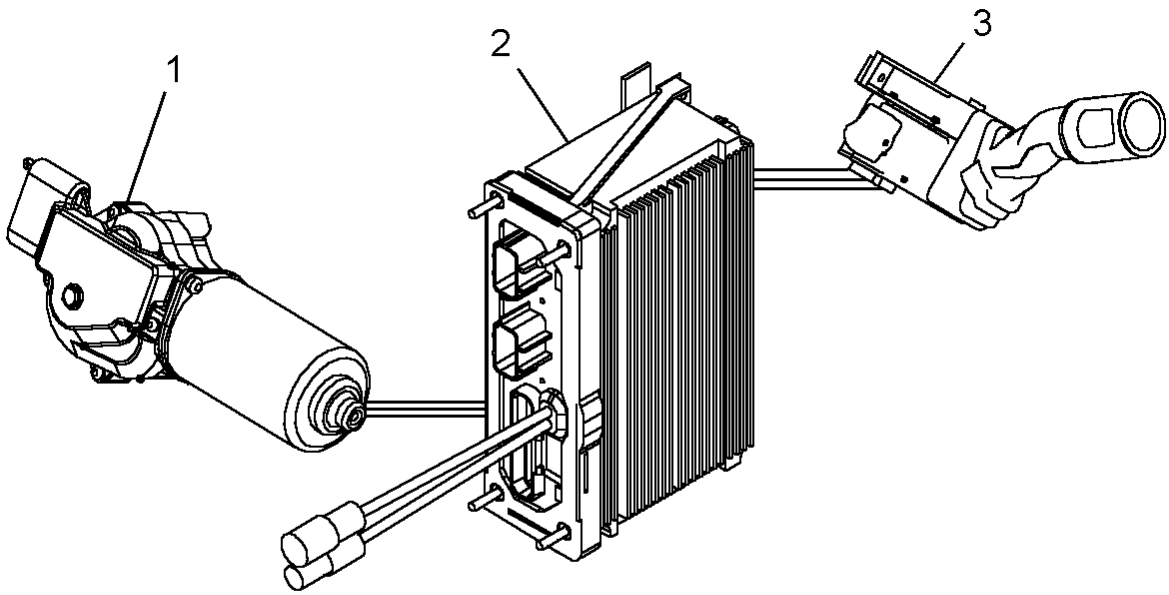

Figure 168 Wiper Function Diagram

1. WIPER MOTOR
2. ELECTRICAL SYSTEM CONTROLLER
3. TURN SIGNAL WIPER CONTROL

Windshield wiper functions Include, low wipers, high wipers, intermittent wipers and wiper park.

The wiper switches are direct inputs to the ESC (not multiplexed). The switches determine the speeds controlled by the ESC.

The ESC provides battery voltage on a 20 amp circuit to the wiper motor park circuits and two wiper control relays.

The wiper power relay switches control of the wiper motor from park circuit control to ESC circuit control.

The windshield wipers have eight speeds: off, high, low, and five different intermittent speeds. These are determined by the condition of the three wiper switches in the turn signal assembly.

When the wipers are turned off, while the ignition is on, the wipers will automatically park. The wiper park circuits also control the cycle of the intermittent wiper sweep.

3.2. DIAGNOSTICS

Faults with the wiper system are apparent when the wipers do not operate correctly. The ESC will also log diagnostic trouble codes for some types of failures.

There is no shortcut available to identify if a problem is caused by failures with inputs to the ESC or failures in circuits out of the ESC. The “Diamond Logic Builder™” software can identify if switch inputs are reaching

the ESC. It can also override switch inputs to test outputs from the ESC. Using the software will allow you to quickly identify if the problem is with an input to the ESC or an output from the ESC. If the software is not available check output circuits, then check switch input circuits to the ESC.

A problem with wiper operation could be attributed to an open or short in the wiper switch, missing power or ground to the wiper motor, open or shorted wires, a failed relay, a bad wiper motor or an internal problem in the ESC.

An electronic service tool, running the "Diamond Logic Builder™" diagnostic software, can be used to request operation of the wiper motor and monitor activation of the wiper switches. See the diagnostic software manual for details on using the software.

Wiper Preliminary Check

Table 98 Wiper Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify wipers are not operating incorrectly.	Attempt to operate wipers.	Wipers are **not** operating correctly.	Go to next step.	Wipers are operating correctly. Problem does not exist or is intermittent (Check for previously active diagnostic trouble codes).
2.	On	Determine if any other features are malfunctioning that may have common circuits (Example: Missing power or ground common to several features).	Visually 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	Are wipers working correctly except for wiper parking?	Visually check if wipers work correctly except for wiper parking.	Wipers work correctly except for wiper parking.	Go to wiper park circuits. (See WIPER PARK CIRCUITS, page 363)	Go to next step.

Table 98 Wiper Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
4.	On	Check for diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 353)	Read display on odometer.	No wiper diagnostic trouble codes are active.	Go to next step.	Go to Wiper Motor Circuits. (See WIPER MOTOR CIRCUITS, page 357)
6.	There is no shortcut available to identify if a problem is caused by failures with switch inputs to the ESC or failures in circuits out of the ESC. The “Diamond Logic Builder™” software can identify if switch inputs are reaching the ESC. It can also override switch inputs to test outputs from the ESC. Using the software will allow you to quickly identify if the problem is with an input to the ESC or an output from the ESC. If the software is not available check output circuits, then check switch input circuits to the ESC. Go to Wiper Motor Circuits. (See WIPER MOTOR CIRCUITS, page 357) Go to Wiper Input Circuits to the ESC. (See WIPER CIRCUIT INPUTS TO ESC, page 354)					

Diagnostic Trouble Codes (DTC)

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

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

Table 99 Wiper Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
611 14 6 1	Wiper power under current. 1604 pin F. Refer to Wiper Motor Circuits. (See WIPER MOTOR CIRCUITS, page 357)
611 14 6 2	**NOTE – The virtual fuse in the ESC will trip during a short. To reset the fuse, the key switch must be cycled.** Wiper power over current. 1604 pin F. Refer to Wiper Motor Circuits. (See WIPER MOTOR CIRCUITS, page 357)
611 14 6 3	Wiper power, less than normal low current but more than open circuit
611 14 6 4	Wiper power, greater than normal high current and less than fusing current
611 14 6 6	Wiper power has current flow when output commanded off

Table 99 Wiper Diagnostic Trouble Codes (cont.)

2033 14 8 1	Wiper high speed relay circuit overloaded. Connector 1602 pin 20 current overload. Refer to Wiper Motor Circuits. (See WIPER MOTOR CIRCUITS, page 357)
2033 14 8 2	Wiper high speed relay circuit open circuit. Connector 1602 Pin 20 open. Refer to Wiper Motor Circuits. (See WIPER MOTOR CIRCUITS, page 357)
2033 14 8 3	Wiper high speed relay circuit shorted to ground. Connector 1602 Pin 20 shorted to ground. Shorted to ground or defective relay. Refer to Wiper Motor Circuits. (See WIPER MOTOR CIRCUITS, page 357)
2033 14 14 1	Wiper on relay circuit overloaded. Connector 1602 pin 29 current overload. Refer to Wiper Motor Circuits. (See WIPER MOTOR CIRCUITS, page 357)
2033 14 14 2	Wiper on relay circuit open circuit. Connector 1602 Pin 29 open. Refer to Wiper Motor Circuits.
2033 14 14 3	Wiper on relay circuit shorted to ground. Connector 1602 Pin 29 shorted to ground. Shorted to ground or defective relay. Refer to Wiper Motor Circuits. (See WIPER MOTOR CIRCUITS, page 357)

3.3. WIPER CIRCUIT INPUTS TO ESC

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 wiper circuit inputs to the ESC will be apparent when the wipers do not operate correctly and there are no active wiper diagnostic trouble codes. Problems in the wiper input circuits could be attributed to short circuits, open circuits, a faulty switch or a problem in the ESC.

NOTE – Open circuits or failed switches may cause high speed wipers to operate when they haven't been selected.

Refer to wiper switch input circuits.

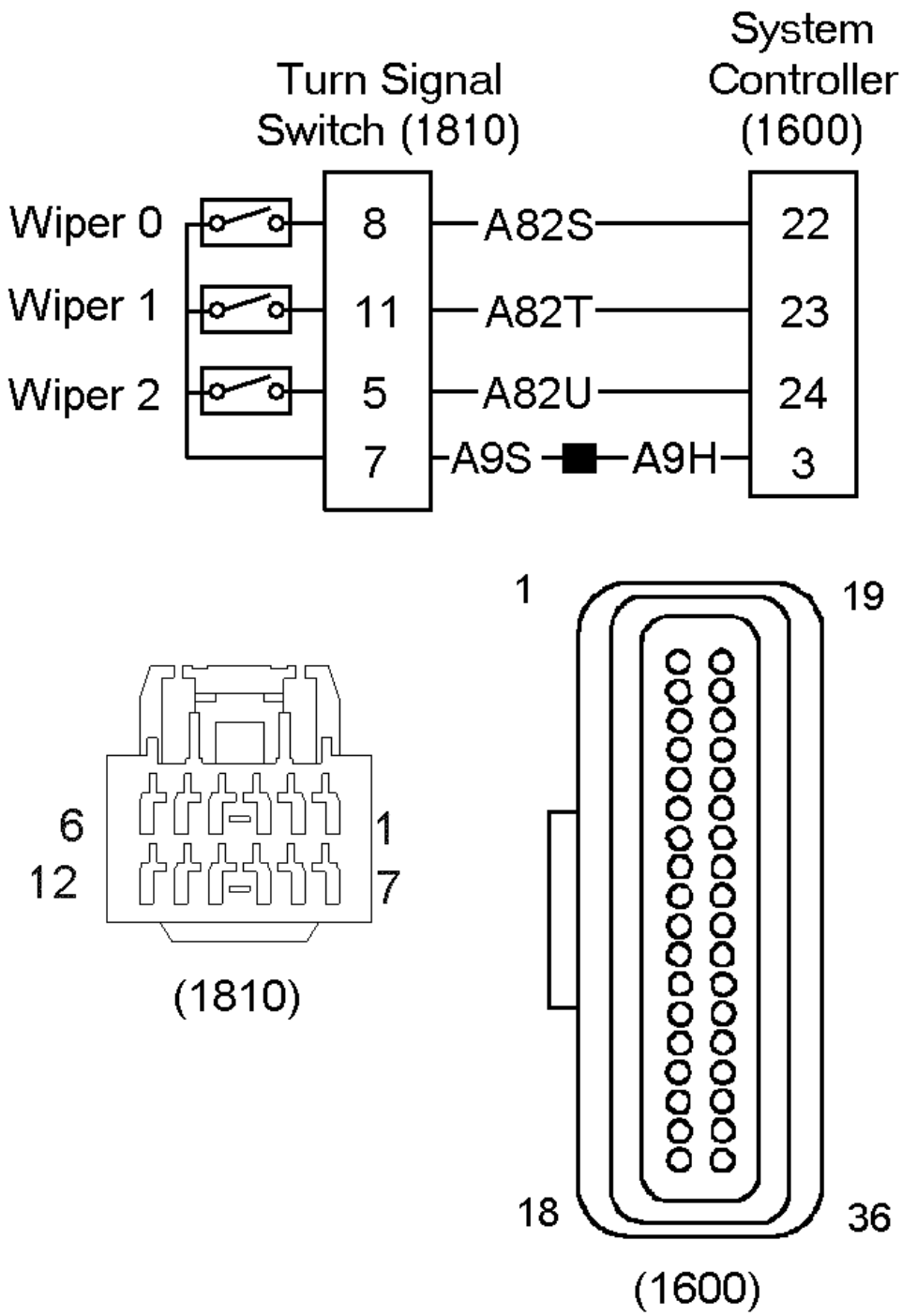

Figure 169 Wiper Switch Input Circuits — Always Refer to the Circuit Diagram Book for Latest Circuit Information

(1600) SYSTEM CONTROLLER
LOCATED AT RIGHT SIDE DASH PANEL
(1810) TURN SIGNAL SWITCH
LOCATED AT STEERING WHEEL

Table 100 Wiper Switch Input Tests

Turn signal switch Harness Connector (1810) Voltage Checks Check with ignition key on and connector (1810) removed. **NOTE – Voltage to the switch will be approximately 5 volts with the key off.** **NOTE – The high speed wipers and head lights should come on when connector (1810) is disconnected. Disconnect wiper motor connector (4046) to disable wiper during checks.** **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
(1810) harness connector, pin 8 to ground.	11 ± 1.5 volts	If voltage is missing, check for open in circuit A82S. If circuits check good and problem is still present, verify voltage out of ESC. **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**
(1810) harness connector, pin 11 to ground.	11 ± 1.5 volts	If voltage is missing, check for open in circuit A82T. If circuits check good and problem is still present, verify voltage out of ESC. **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**
(1810) harness connector, pin 5 to ground.	11 ± 1.5 volts	If voltage is missing, check for open in circuit A82U. If circuits check good and problem is still present, verify voltage out of ESC. **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**
(1810) harness connector, pin 7 to ground.	<2 Volts	Zero volt reference level. No voltage expected. If voltage is incorrect, check for shorts to voltage or incorrect output from ESC.
Reconnect wiper motor connector (4046). Reconnect turn signal switch harness connector (1810) and wiper stops operating. Ignition key off and on, ESC turns off headlights. Operate wiper speed control in the turn signal switch through all eight speeds, if wiper fails to operate and no diagnostic trouble codes are generated, replace switch.		

Table 100 Wiper Switch Input Tests (cont.)

Wiper Speed Control Switch in the Turn Signal Switch Connector (1810) Resistance Checks Check with ignition key off and turn signal connector (1810) removed. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Operate wiper speed control to the OFF position, check for continuity between pin 7 and pins 5, 8, and 11.	<1 ohm	If there is no continuity, replace turn signal switch.
Operate wiper speed control to the HI position, check for continuity between pin 7 and pins 5, 8, and 11.	>100K ohms	If there is continuity, replace turn signal switch.

Extended Description

The three wiper switches, in the turn signal assembly, are wired directly to the ESC. When the three wiper switches are turned on, 0 volt reference on pin 3 from the ESC will pass through the wiper switch 0 to pin 22 in the ESC, the wiper switch 1 to pin 23 in the ESC and the wiper switch 2 to pin 24 in the ESC. This will cause the ESC to send 12 volts to the windshield wipers and operate eight speeds (off, high, low, and five different intermittent speeds).

3.4. WIPER MOTOR CIRCUITS

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 wiper motor circuits will be apparent when the high or low speed wipers do not work. The ESC will log an active diagnostic trouble code when there is a short or open in the wiper power relay R1 circuits or the wiper high-low relay circuits. Problems in the wiper circuits could be attributed to a failed relay, a failed motor, a tripped wiper motor circuit breaker, a short, an open or a problem in the ESC.

Refer to wiper circuits.

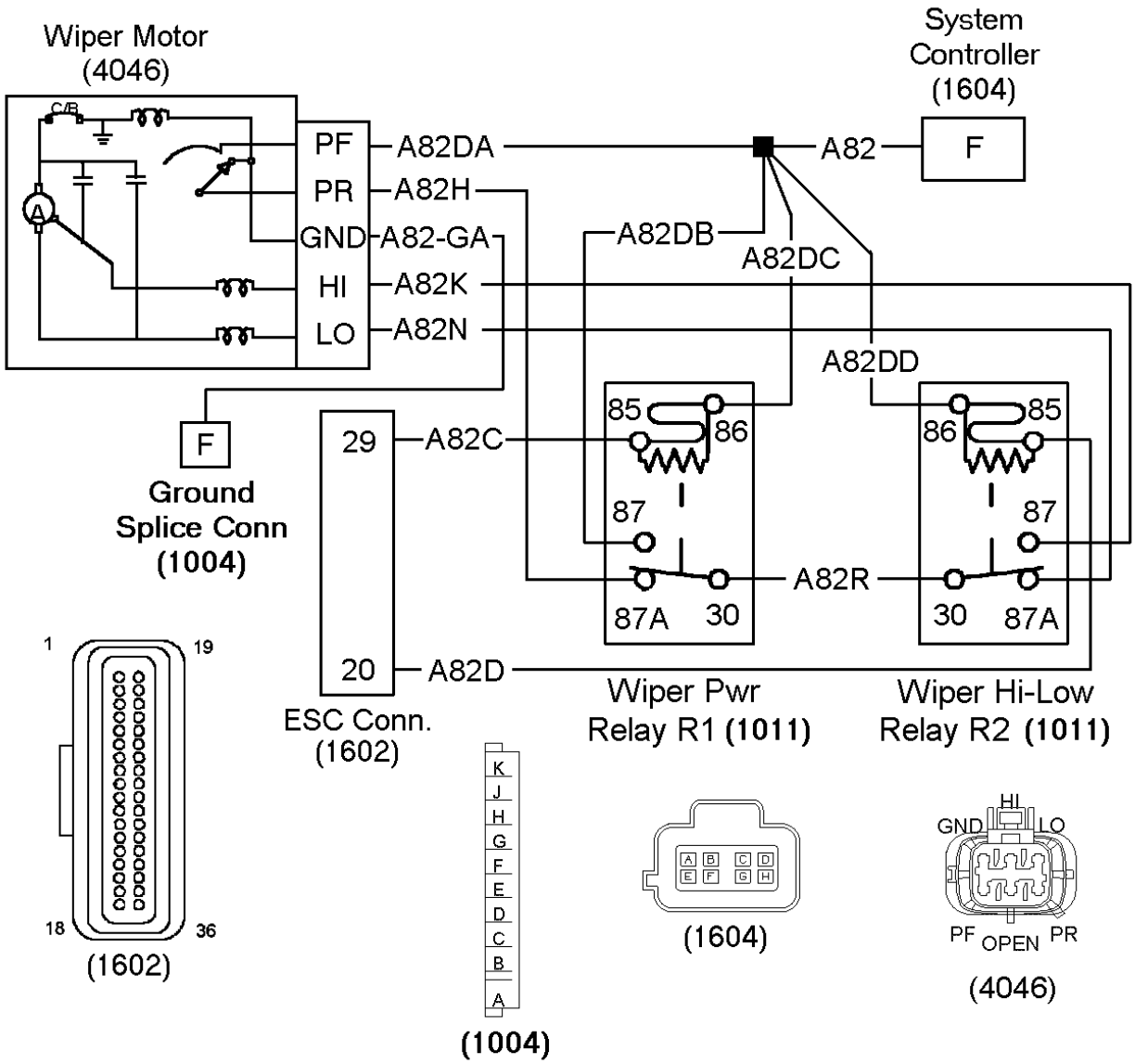

Figure 170 Wiper Circuits — Always Refer to the Circuit Diagram Book for Latest Circuit Information

(1004) GROUND SPLICE CONN
LOCATED RIGHT SIDE INSTRUMENT PANEL
(1011) FUSE BLOCK
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(1602) SYSTEM CONTROLLER
LOCATED AT INSIDE RIGHT SIDE DASH PANEL
(1604) SYSTEM CONTROLLER
LOCATED AT RIGHT SIDE DASH PANEL
(4046) WIPER MOTOR
LOCATED INSIDE RIGHT SIDE TOP SIDE COWL

Table 101 Wiper Motor Diagnostic Trouble Codes

Diagnostic Trouble Codes	
611 14 6 3	Wiper power, less than normal low current but more than open circuit
611 14 6 4	Wiper power, greater than normal high current and less than fusing current
611 14 6 6	Wiper power has current flow when output commanded off
611 14 6 2	Wiper power over current
This diagnostic trouble code is logged when there is a short to ground or an excessive load in a circuit connected to the wiper power output of ESC connector (1604) pin F. **NOTE – The virtual fuse in the ESC will trip during a short. To reset the fuse, the key switch must be cycled.** **NOTE – Disconnecting connectors will cause new open circuit diagnostic trouble codes to be logged. Clear all diagnostic trouble codes after connections have been restored.** Turn off wipers and disconnect wiper motor connector (4046). Cycle key switch and clear diagnostic trouble code codes. Turn on the high speed wipers. If the diagnostic trouble code does not reoccur, there is a short or an overload in the wiper motor. If the diagnostic trouble code reoccurs, there is a short in the circuits to the wiper relays or between the ESC and the wiper motor, or in the ESC. Disconnect blue ESC connector (1604). Cycle key switch and clear diagnostic trouble code codes. Turn on the high speed wiper and check for diagnostic trouble codes. If the diagnostic trouble code does not reoccur, there is a short in the circuits between the ESC and the wiper motor. If the diagnostic trouble code reoccurs, there is a short inside the ESC. Check high speed wiper voltage between harness connector (4046) pin HI and GND.	
611 14 6 1	Wiper power under current
This diagnostic trouble code is logged when the wipers are turned on and there is an open in circuits between the high speed wiper motor output of the ESC, through the motor, and ground. Check for open circuits or tripped wiper motor circuit breaker. Check high speed wiper voltage between harness connector (4046) pin HI and GND with high speed wiper switch on.	
2033 14 14 1	Wiper on relay driver overloaded. Connector 1602 pin 29 current overload. To much load attached or defective relay.

Table 101 Wiper Motor Diagnostic Trouble Codes (cont.)

<table>
<tr><td colspan="2">This diagnostic trouble code is logged when there is an overload in the circuits between wiper power relay R1 and the ESC, an excessive load on the circuit or a high resistance in the relay coil.

NOTE – Disconnecting connectors will cause new open circuit diagnostic trouble codes to be logged. Clear all diagnostic trouble codes after connections have been restored.

Remove wiper power relay R1. Clear diagnostic trouble codes and turn on the high speed wipers. If the diagnostic trouble code does not reoccur, there is a short or an overload in the relay. If the diagnostic trouble code reoccurs, there is a short in the circuits between the relay socket and the ESC, or in the ESC.

Disconnect ESC connector (1602), and clear diagnostic trouble codes. Turn on the high speed wiper and check for diagnostic trouble codes. If the diagnostic trouble code does not reoccur, there is an overload in the circuits between the ESC and the relay. If the diagnostic trouble code reoccurs, there is an overload inside the ESC.</td></tr>
<tr><td>2033 14 14 2</td><td>Wiper on relay driver circuit open circuit.</td></tr>
<tr><td colspan="2">Connector 1602 Pin 29 open. Open circuit or defective relay.

This diagnostic trouble code is logged when wipers are turned on and there is an open in circuits between ESC connector (1602) pin 29, through the wiper power relay, and ground.

Check for open circuits or open relay coil.</td></tr>
<tr><td>2033 14 14 3</td><td>Wiper on relay driver circuit shorted. Connector 1602 pin 29 shorted to ground. short circuit or defective relay.</td></tr>
<tr><td colspan="2">This diagnostic trouble code is logged when there is a short in the circuits between wiper power relay R1 and the ESC, an excessive load on the circuit or a short in the relay coil.

NOTE – Disconnecting connectors will cause new open circuit diagnostic trouble codes to be logged. Clear all diagnostic trouble codes after connections have been restored.

Remove wiper power Relay R1. Clear diagnostic trouble codes and turn on the high speed wipers. If the diagnostic trouble code does not reoccur, there is a short or an overload in the relay. If the diagnostic trouble code reoccurs, there is a short in the circuits between the relay socket and the ESC, or in the ESC.

Disconnect ESC connector (1602), and clear diagnostic trouble codes. Turn on the high speed wiper and check for diagnostic trouble codes. If the diagnostic trouble code does not reoccur, there is a short in the circuits between the ESC and the relay. If the diagnostic trouble code reoccurs, there is a short inside the ESC.</td></tr>
<tr><td>2033 14 8 1</td><td>Wiper high–low relay driver overloaded. Connector 1602 pin 20 current overload. To much load attached or defective relay.</td></tr>
</table>

Table 101 Wiper Motor Diagnostic Trouble Codes (cont.)

<table>
<tr><td colspan="2">This diagnostic trouble code is logged when there is an overload in the circuits between wiper hi-low relay R2 and the ESC, an excessive load on the circuit or a high resistance in the relay coil.

NOTE – Disconnecting connectors will cause new open circuit diagnostic trouble codes to be logged. Clear all diagnostic trouble codes after connections have been restored.

Remove high–low relay R2. Clear diagnostic trouble codes and turn on the high speed wipers. If the diagnostic trouble code does not reoccur, there is a short or an overload in the relay. If the diagnostic trouble code reoccurs, there is a short in the circuits between the relay socket and the ESC, or in the ESC.

Disconnect ESC connector (1602), and clear diagnostic trouble codes. Turn on the high speed wiper and check for diagnostic trouble codes. If the diagnostic trouble code does not reoccur, there is an overload in the circuits between the ESC and the relay. If the diagnostic trouble code reoccurs, there is an overload inside the ESC.</td></tr>
<tr><td>2033 14 8 2</td><td>Wiper high–low relay driver circuit open circuit.</td></tr>
<tr><td colspan="2">Connector 1602 Pin 20 open. Open circuit or defective relay.

This diagnostic trouble code is logged when high wipers are turned on and there is an open in circuits between ESC connector (1602) pin 20, through the wiper power relay, and ground.

Check for open circuits or open relay coil.</td></tr>
<tr><td>2033 14 8 3</td><td>Wiper high–low relay driver circuit shorted. Connector 1602 pin 20 shorted to ground, short circuit or defective relay.</td></tr>
<tr><td colspan="2">This diagnostic trouble code is logged when there is a short in the circuits between wiper high–low relay R2 and the ESC, an excessive load on the circuit or a short in the relay coil.

NOTE – Disconnecting connectors will cause new open circuit diagnostic trouble codes to be logged. Clear all diagnostic trouble codes after connections have been restored.

Remove wiper high–low relay R2. Clear diagnostic trouble codes and turn on the high speed wipers. If the diagnostic trouble code does not reoccur, there is a short or an overload in the relay. If the diagnostic trouble code reoccurs, there is a short in the circuits between the relay socket and the ESC, or in the ESC.

Disconnect ESC connector (1602), and clear diagnostic trouble codes. Turn on the high speed wiper and check for diagnostic trouble codes. If the diagnostic trouble code does not reoccur, there is a short in the circuits between the ESC and the relay. If the diagnostic trouble code reoccurs, there is a short inside the ESC.</td></tr>
</table>

Table 102 Wiper Motor Voltage Checks

Wiper Motor Harness Connector (4046) Voltage Checks Check with ignition on and (4046) disconnected. **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**		
Test Points	Spec.	Comments
(4046) Harness connector, pin PF to ground.	**NOTE – A load device, such as a test light, must be used in parallel with voltmeter probes to read an accurate voltage.** 12 ± 1.5 volts	If voltage is missing, check for short or open in circuit A82DA or A82. If circuits check good check for voltage from ESC connector (1604) pin F. **NOTE – A load device, such as a test light, must be used in parallel with voltmeter probes to read an accurate voltage from pin F.** If voltage is missing consider replacing ESC. Refer to ESC Replacement in this manual. (See ESC REPLACEMENT, page 117)
(4046) Harness connector, pin PF to pin GND.	12 ± 1.5 volts	If voltage is missing, check for open in circuit A82–GA to ground.
With wiper switch in low selection (4046) Harness connector, pin LO to ground.	With low speed wiper switch on, 12 ± 1.5 volts With low speed wiper switch off and wipers parked, 0 volts	If voltage is incorrect, check for open or short in circuit A82N and perform wiper relay R1 and R2 circuit checks. If circuit and relays check good, verify voltage out of ESC.
(4046) Harness connector, pin HI to ground.	With high speed wiper switch on, 12 ± 1.5 volts With low speed wiper switch off, 0 volts	If voltage is incorrect, check for open or short in circuit A82K and perform wiper relay R1 and R2 circuit checks. If circuit and relays check good, verify voltage out of ESC.

Extended Description

When the key is on the ESC will supply battery voltage to blue connector (1604) pin F. This voltage is applied to wiper motor connector (4046) cavity PF, wiper power relay R1 pins 4 and 5, and wiper high–low relay R2.

When high or low wipers are selected the ESC will supply a ground from system controller connector (1602) terminal 29 to wiper power relay R1 terminal 2. This will energize the wiper power relay and apply 12 volts to the common contact of wiper high–low relay R2.

When low speed wipers are selected the wiper high-low relay will remain de-energized and the voltage at the common contact will pass through the normally closed contact to the low speed wiper motor windings.

When high speed wipers are selected the wiper high-low relay will energize and the voltage at the common contact will pass through the normally open contact to the high speed wiper motor windings.

Ground for the wiper motor is supplied from ground splice (1004) to wiper motor connector (4046) terminal GND.

3.5. WIPER PARK CIRCUITS

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.

When the high and low speed wipers are turned off and the ignition is on, the wipers should return to the parked position.

A fault in the wiper park circuits will be apparent when the wipers do not park, after they are turned turn off and the intermittent wipers are inoperative (low wipers should still operate when selected). There are no diagnostic trouble codes associated with the wiper parking circuits. Problems in the wiper parking circuits could be attributed to, a short to ground, an open, faulty circuits in the motor or a problem in the ESC.

Refer to Wiper Park Circuits.

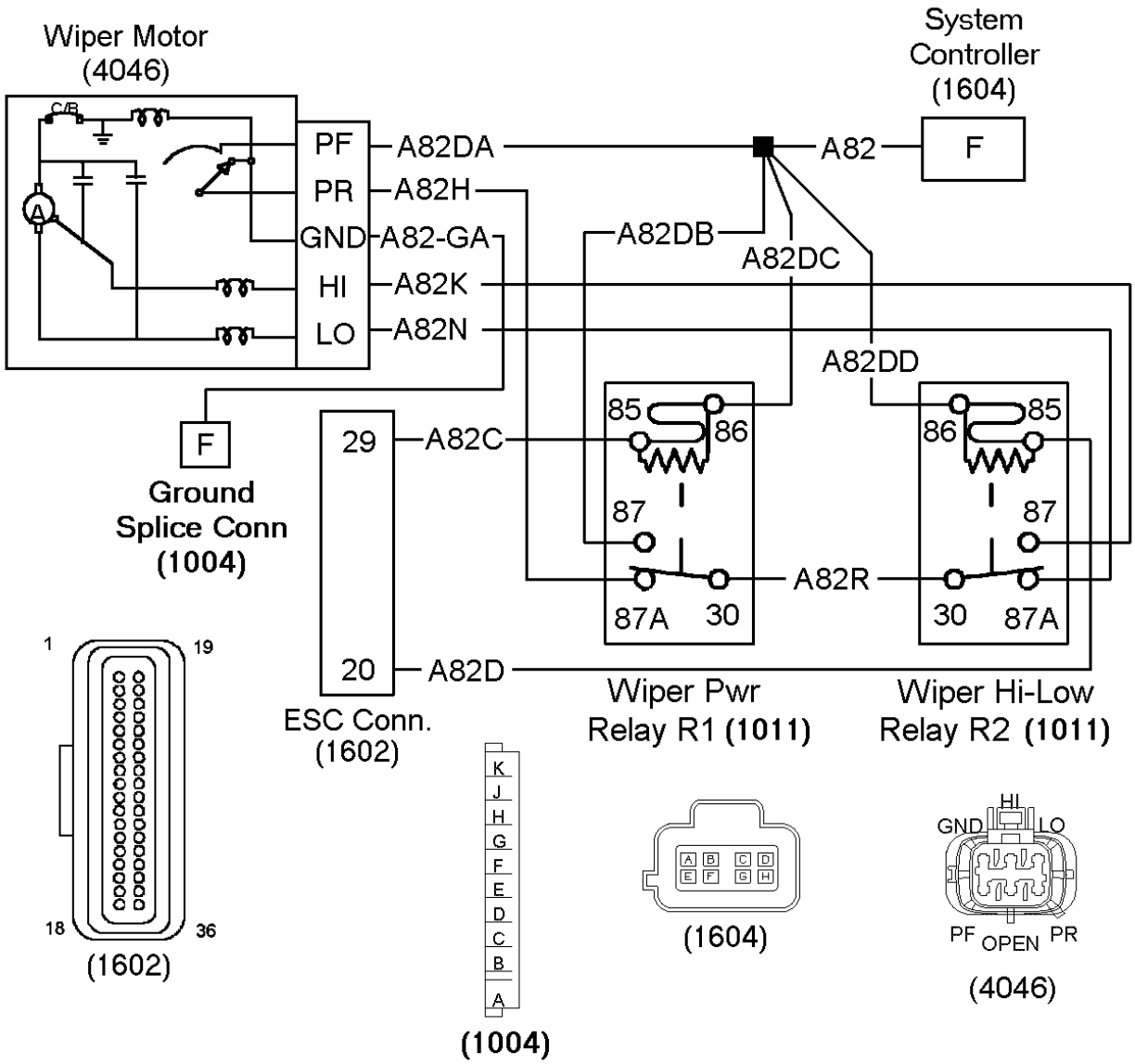

Figure 171 Wiper Park Circuits — Always Refer to the Circuit Diagram Book for Latest Circuit Information

(1004) GROUND SPLICE CONN
LOCATED RIGHT SIDE INSTRUMENT PANEL
(1011) FUSE BLOCK
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(1602) SYSTEM CONTROLLER
LOCATED AT INSIDE RIGHT SIDE DASH PANEL
(1604) SYSTEM CONTROLLER
LOCATED AT RIGHT SIDE DASH PANEL
(4046) WIPER MOTOR
LOCATED INSIDE RIGHT SIDE TOP SIDE COWL

Table 103 Park Circuits Tests

Diagnostic Trouble Codes		
There are no specific diagnostic trouble codes associated with the wiper park circuits.		
Wiper Motor Harness Connector (4046) Park Circuit Voltage Checks Check with ignition on and (4046) disconnected. **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.** **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
(4046) Harness connector, pin PF to ground.	**NOTE – A load device, such as a test light, must be used in parallel with voltmeter probes to read an accurate voltage.** 12 ± 1.5 volts	If voltage is missing, check for short or open in circuit A82DA or A82. If circuits check good check for voltage from ESC.
Wiper Motor Harness Connector (4046) Park Circuit Resistance Checks Check with ignition off and (4046) disconnected. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
(4046) Harness connector, pin PR to pin LO.	< 1 ohm	If resistance is high check for open in circuits A82H, A82R and A82N. Also check for failed normally closed contacts of wiper power relay R1 and wiper high low relay R2.
If voltages and resistances check good, consider replacing wiper motor.		

Extended Description

When the high and low speed wipers are turned off and the ignition is on, the wipers should return to the parked position.

When the key is on the ESC will supply battery voltage to blue connector (1604) pin F. This voltage is applied to wiper motor connector (4046) cavity PF, wiper power relay R1 pins 4 and 5, and wiper high–low relay R2.

When the wipers are off and the wipers are not parked, the voltage at (4046) pin PF will pass through the wiper motor park contact to (4046) pin PR and the normally closed contact of wiper power relay. This voltage will also be applied to the wiper power relay common contact, wiper high–low relay normally closed contact, and the wiper motor low speed winding.

When the wipers reach the park position a ground will replace the voltage causing the wipers to stop at the parked position.

3.6. COMPONENT LOCATIONS

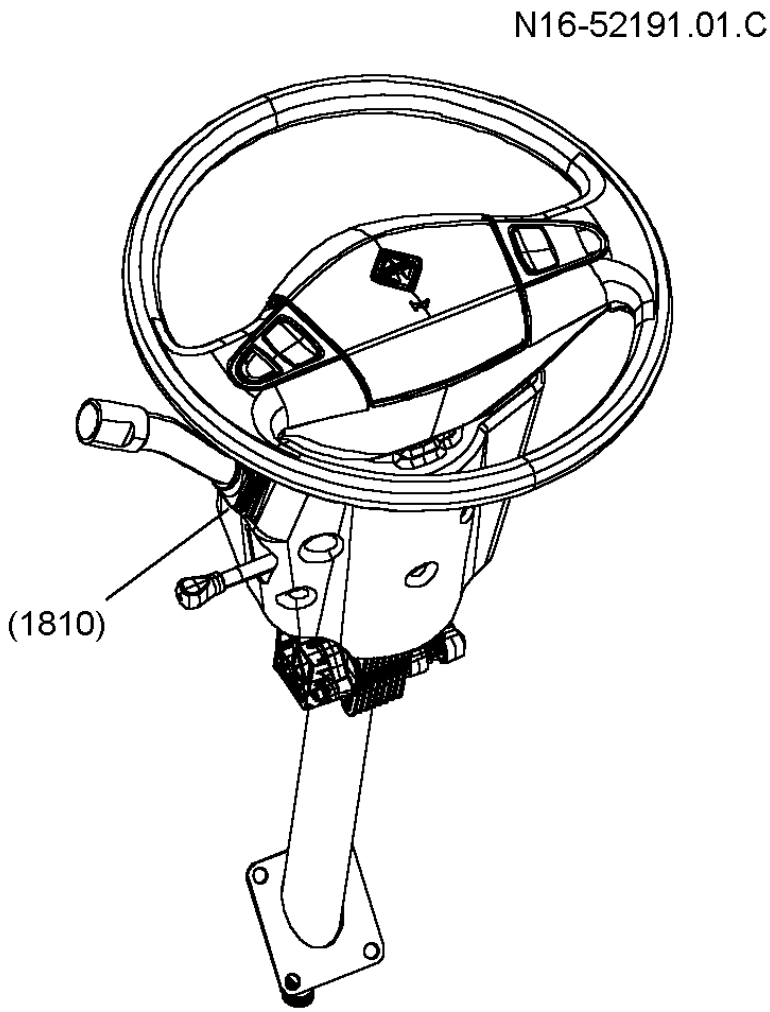

Figure 172 Turn Signal Assembly (Wiper Switch)

(1810) TURN SIGNAL ASSEMBLY CONNECTOR (BEHIND STEERING COLUMN SHROUD)

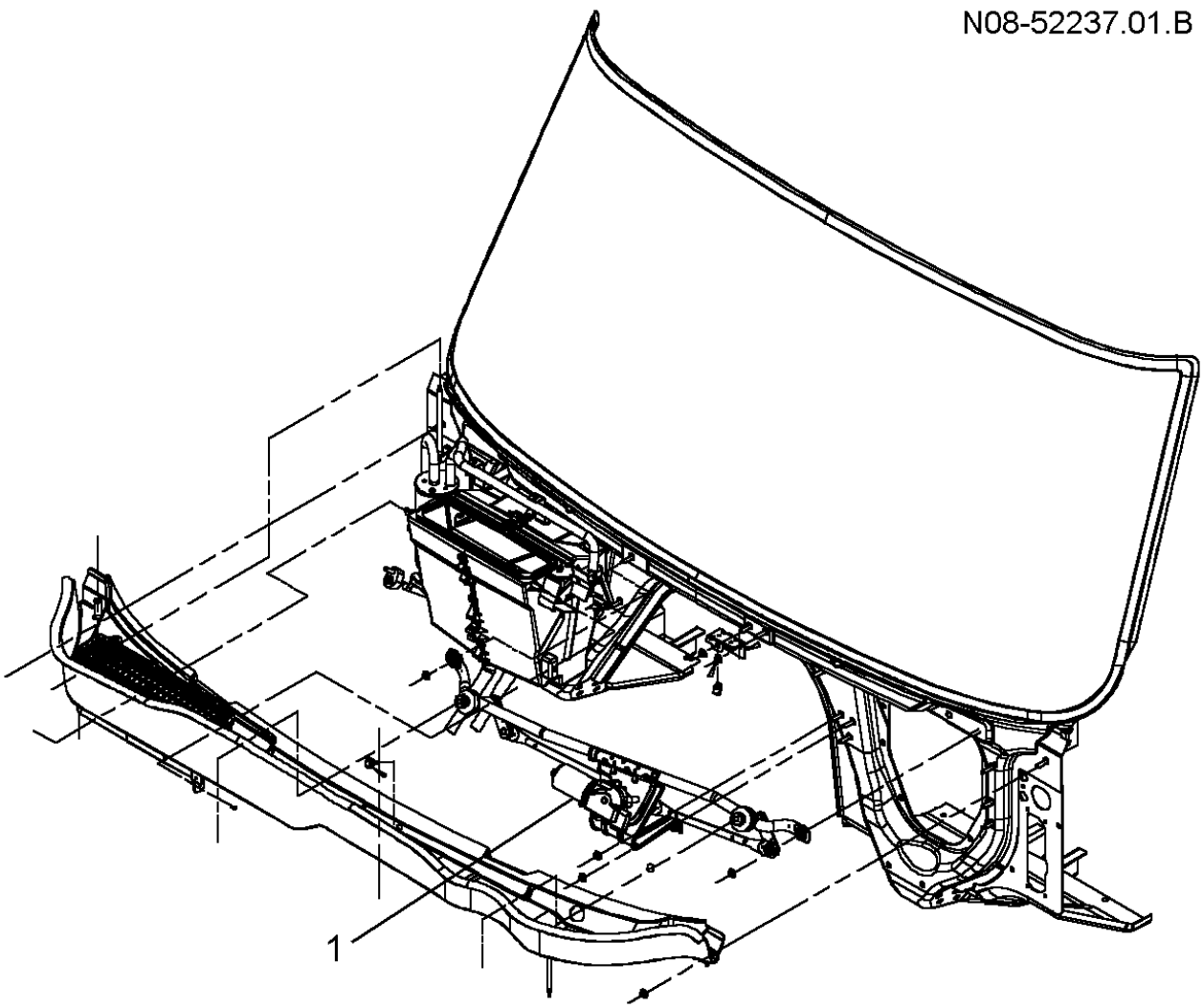

Figure 173 Wiper Motor Location

1. WIPER MOTOR

4. CLUTCH SWITCH

4.1. CIRCUIT FUNCTIONS

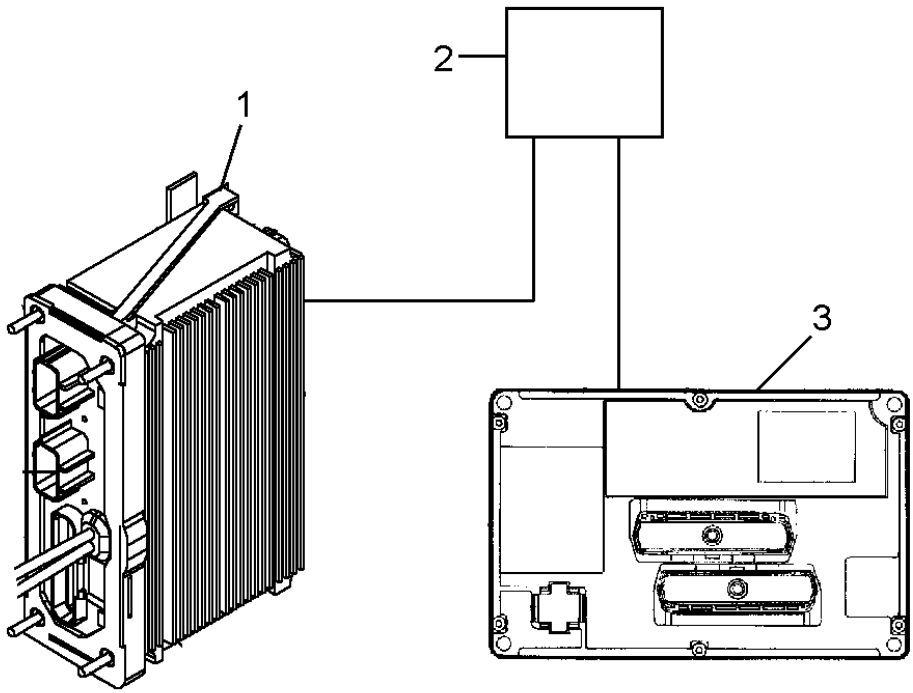

Figure 174 Clutch Switch Function Diagram

1. ELECTRICAL SYSTEM CONTROLLER
2. CLUTCH SWITCH MODULE
3. ENGINE CONTROL MODULE

Refer to Clutch Switch Function Diagram.

The clutch switch module contains two clutch switches. One switch is an input to the ESC and senses clutch pedal position to disengage the cruise control. The other clutch switch is an input to the engine controller and senses clutch pedal position to enable engine cranking.

Both switches are magnetic and require no adjustment.

4.2. DIAGNOSTICS

A failure of the clutch switch to the ESC should be suspected if the cruise control does not engage or disengage when the clutch pedal is pushed. A diagnostic trouble code (DTC) for this switch will be logged if there is an open or short in circuits to the switch. A (DTC) will also be logged if the switch is stuck in the open or closed position.

An electronic service tool, running the "Diamond Logic Builder™" diagnostic software, can be used to check operation of the clutch switch to the ESC. See the diagnostic software manual for details on using the software.

A failure of the clutch switch to the engine controller should be suspected if the engine does not crank when the key is in the start position.

An electronic service tool, running the "Master Diagnostics" diagnostic software, can be used to check operation of the clutch switch to the engine controller. See the diagnostic software manual for details on using the software.

Clutch Switch Preliminary Check

Table 104 Clutch Switch Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Attempt to crank engine with clutch pedal depressed.		Engine cranks.	Go to next step.	Refer to the Engine Cranking section of this manual. (See ENGINE CRANKING, page 291)
2.	On	Start engine and operate cruise control. Attempt to disengage cruise control by depressing clutch pedal.		Cruise control does not engage or does not disengage when clutch pedal is depressed.	Go to next step.	Clutch Switches are operating correctly. Problem does not exist or is intermittent (Check for previously active diagnostic trouble codes).
3.	On	Determine if any other features are malfunctioning that may have common circuits (Example: Missing power or ground common to several features).	Visually 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.
4.	On	Check for diagnostic trouble codes.	Read display on odometer.	**No** clutch switch diagnostic trouble codes are active.	Go to next step.	Go to Fault Detection Management. (See FAULT DETECTION MANAGEMENT, page 370)
5.	On	Clutch switch is operating correctly.				

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 105 Clutch Switch Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
598 14 1 0	Upper Clutch Switch stuck in the open or closed position Occurs if the vehicle speed increases from 0 kph to 72 kph without a change in state of the clutch switch. Defective upper clutch switch. Refer to Fault Detection Management. (See FAULT DETECTION MANAGEMENT, page 370).
612 14 2 1	Upper Clutch Switch out of range low Shorted to ground. Refer to Fault Detection Management. (See FAULT DETECTION MANAGEMENT, page 370).
612 14 2 2	Upper Clutch Switch out of range high. Shorted high or open circuit. Refer to Fault Detection Management. (See FAULT DETECTION MANAGEMENT, page 370).

4.3. 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.

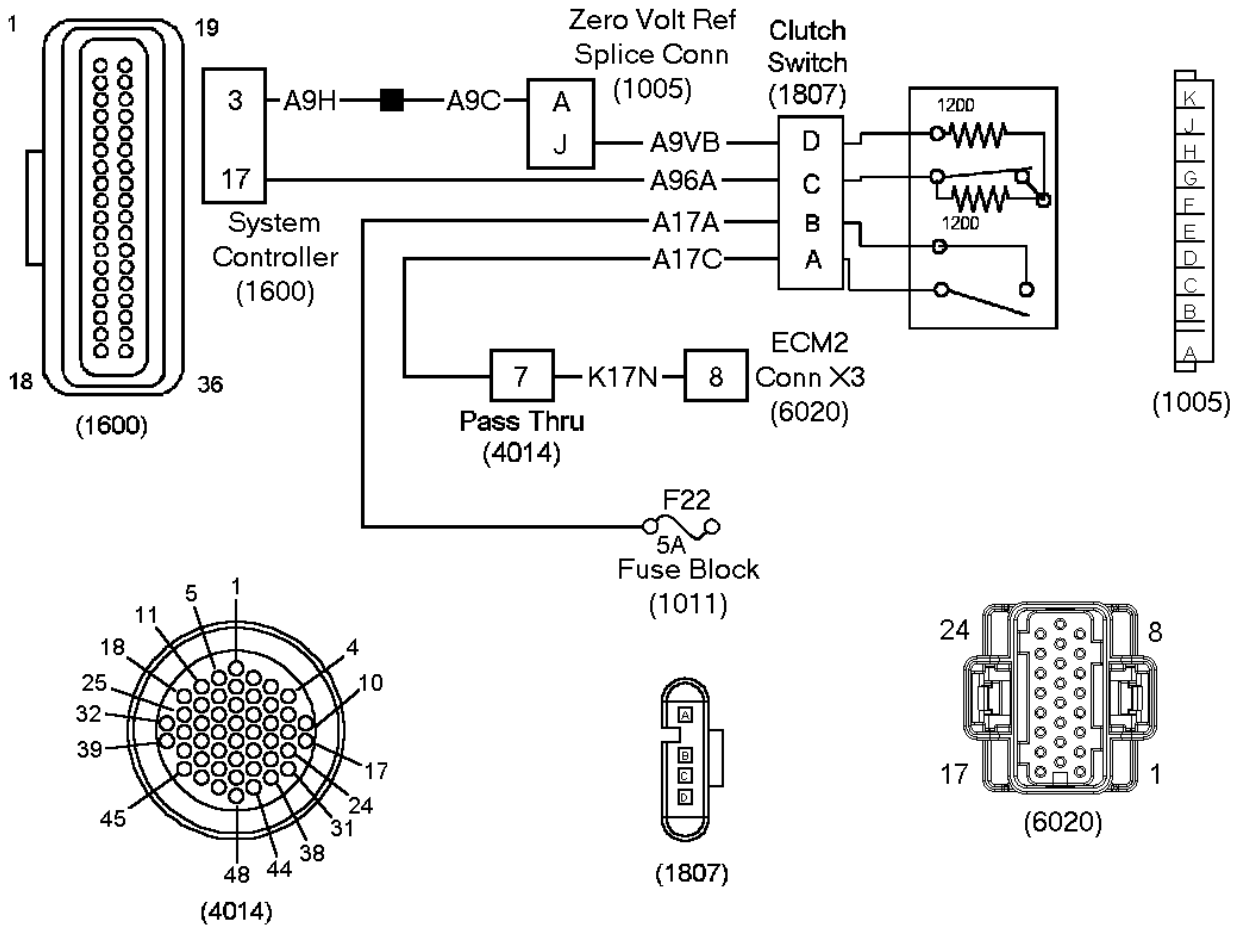

Figure 175 Clutch Switch Circuits — Always Refer to the Circuit Diagram Book for Latest Circuit Information

(1005) ZERO VOLT REF SPLICE CONN
LOCATED RIGHT SIDE INSTRUMENT PANEL
(1011) FUSE BLOCK
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(1600) SYSTEM CONTROLLER
LOCATED INSIDE RIGHT SIDE DASH PANEL
(1807) CLUTCH SWITCH
LOCATED ABOVE ACCELERATOR PEDAL
(4014) PASS THRU AT DASH
LOCATED AT INSIDE LEFT SIDE DASH PANEL
(6020) ECM2 CONN — X3
LOCATED AT ENGINE COMPARTMENT AT ECM

Refer to Clutch Switch Circuits.

Table 106 Clutch Switch Circuit Tests

Clutch Switch Harness Connector (1807) Voltage Checks Check with ignition key on and connector (1807) removed. **NOTE – Voltage to the switch will be approximately 5 volts with the key off.** **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
(1807) harness connector, pin B to ground.	12 ± 1.5 volts	If voltage is missing, check for open or shorts in circuit A17A. Also check for blown fuse F22.
(1807) harness connector, pin B to A.	12 ± 1.5 volts	If voltage is good. Bench check clutch switch. Replace if defective. If voltage is missing, check for open in circuits between clutch switch and engine controller. If circuits check good and voltage is still missing, verify signal (low) out of engine controller. Refer to the applicable engine manual.
(1807) harness connector, pin C to ground.	12 ± 1.5 volts	If voltage is missing, check for open or shorts in circuit A96A.
(1807) harness connector, pin C to pin D.	12 ± 1.5 volts	If voltage is correct, bench check clutch switch. Replace if defective. If voltage is missing, check for open in circuit A9VB or circuits to ESC (1600) cavity 3. If circuits check good and voltage is not present, verify zero volt reference level from ESC. **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.**
Clutch Switch Module Resistance Checks Check with clutch switched removed. **NOTE – Always check connectors for damage and pushed–out terminals.** This is a magnetic switch. To activate the switch put a piece of steel (such as a wrench) against the switch face.		
Test Points	Spec.	Comments

Table 106 Clutch Switch Circuit Tests (cont.)

Clutch switch connector (1807) cavity A to B.	<1 ohm with switch activated >10K ohms with switch not activated	If there is no continuity with switch activated or continuity with switch activated, replace clutch switch module.
Clutch switch connector (1807) cavity C to D.	Approximately 1200 ohms with switch activated Approximately 2400 ohms with switch not activated	If switch module resistances are not correct, replace clutch switch module.

4.4. EXTENDED DESCRIPTION

Clutch Switch to ESC

The ESC supplies approximately 6 volts to Pin C of the clutch switch module and the zero volt reference signal to pin D.

When nothing is in front of the switch module face, the switch will be closed and the ESC will sense the voltage drop across one 1200 ohm resistor.

When steel is passed in front of the switch module face, the switch will open and the ESC sense the voltage drop across two 1200 ohm resistors.

The ESC will use this information to enable or disable the cruise control.

These resistors, one in series with the switch and one in parallel with the switch, allow the ESC to monitor the switch and its circuits for opens or shorts to ground.

An open circuit or short to ground will cause the voltage drop to be out of rang and the ESC will log the appropriate DTC.

Clutch Switch to Engine Controller

Battery voltage is supplied to pin B of the clutch switch. When steel is passed in front of the switch module face, the switch will close and the voltage will connect to pin A and will be applied to the engine controller.

4.5. COMPONENT LOCATIONS

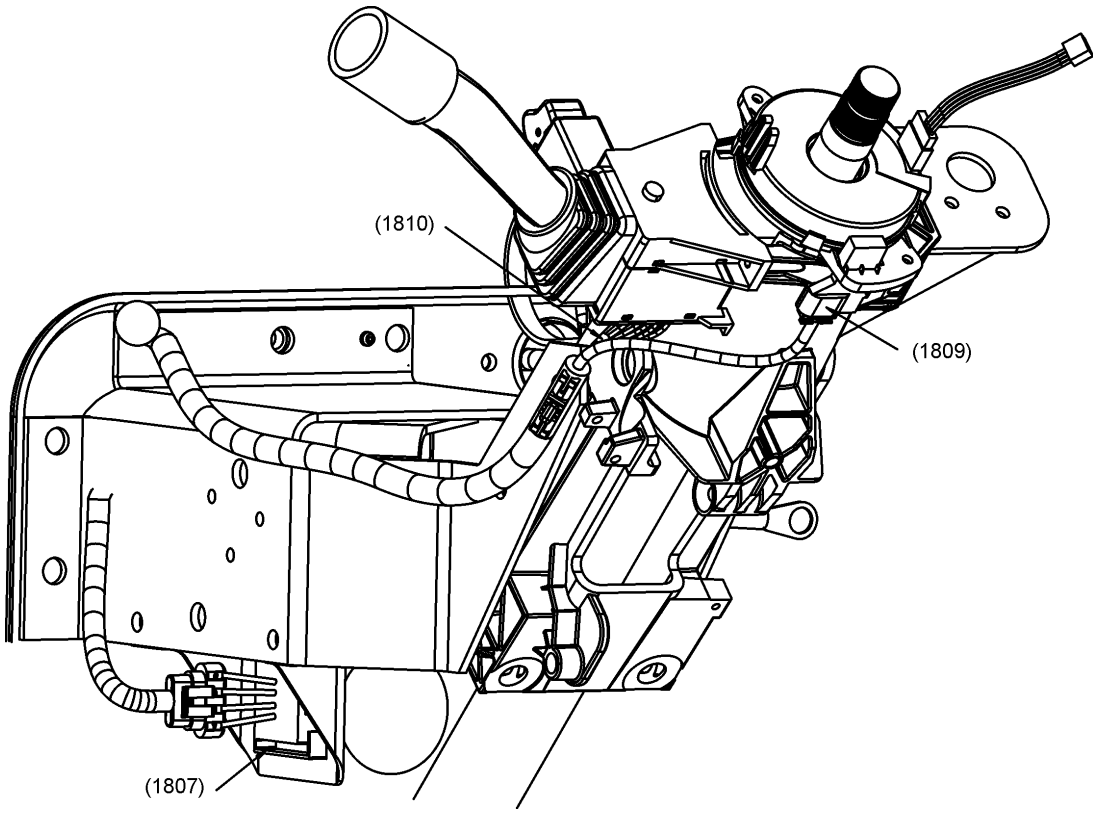

Figure 176 Clutch Switch Location

(1807) CLUTCH SWITCH
(1809) CLOCK SPRING
(1810) TURN SIGNAL SWITCH

5. PARK BRAKE SWITCH

5.1. CIRCUIT FUNCTIONS

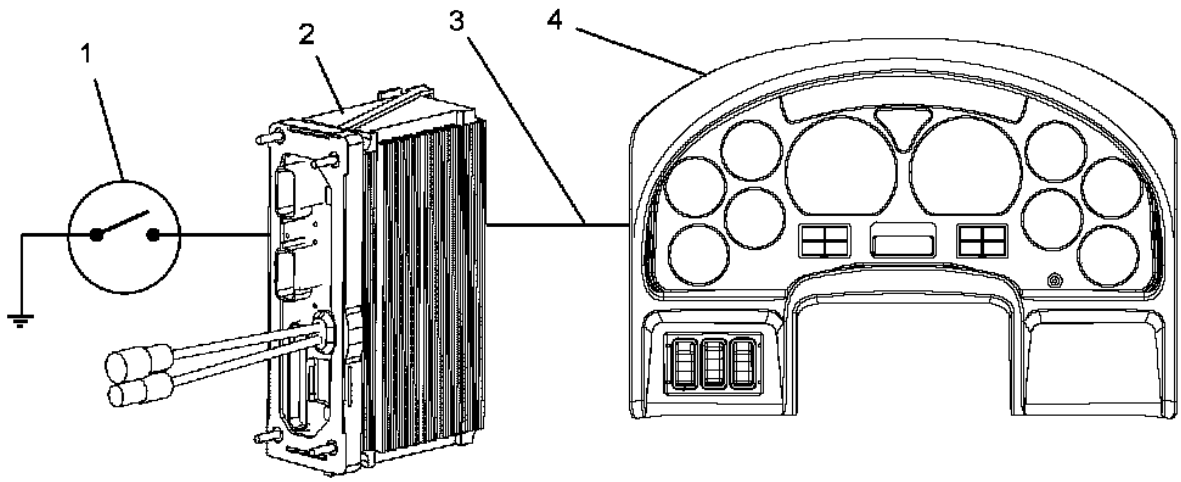

Figure 177 Park Brake Switch Function Diagram

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

NOTE – There is no park brake switch if the vehicle is equipped with the full power brake system option.

The ESC uses the park brake switch input for the following functions:

- To determine when to turn on the park lamp on the EGC.
- 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.
- To enable the diagnostic trouble code retrieval procedure.
- Used as an input to generate the command to the transmission controller to shift to neutral (used with auto neutral feature only).

5.2. DIAGNOSTICS

A failure of the park brake switch inputs to the ESC should be suspected if the park indicator lamp in the EGC does not illuminate when the park brake is set and the EGC cannot be put in diagnostic mode.

An electronic service tool, running the "Diamond Logic Builder™" diagnostic software, can be used to check operation of the park brake switch. See the diagnostic software manual for details on using the software.

Park Brake Switch Preliminary Check

Table 107 Park Brake Switch Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify park brake switch operation.	Set and release park brake	Park indicator on EGC Illuminates with brake set and goes out with brake off.	Park brake switch is functioning.	Go to next step.
2.	On	Attempt to put EGC in diagnostic mode.	Set park brake and press cruise “ON” and RESUME” simultaneously.	EGC displays fault messages.	Go to next step.	Go to Fault Detection Management. (See FAULT DETECTION MANAGEMENT, page 376)
3.	On	Determine if any other features are malfunctioning that may have common circuits (Example: Missing power or ground common to several features).	Visually check for other malfunctioning features.	No other features are malfunctioning.	Go to next step.	Identify and repair condition causing several features to be inoperative.
4.	On	Go to Park Brake Warning Lamp. (See PARK BRAKE WARNING LAMP, page 177)				

5.3. 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 monitor park brake switch operation. See the diagnostic software manual for details on using the software.

If the park indicator on the EGC 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.

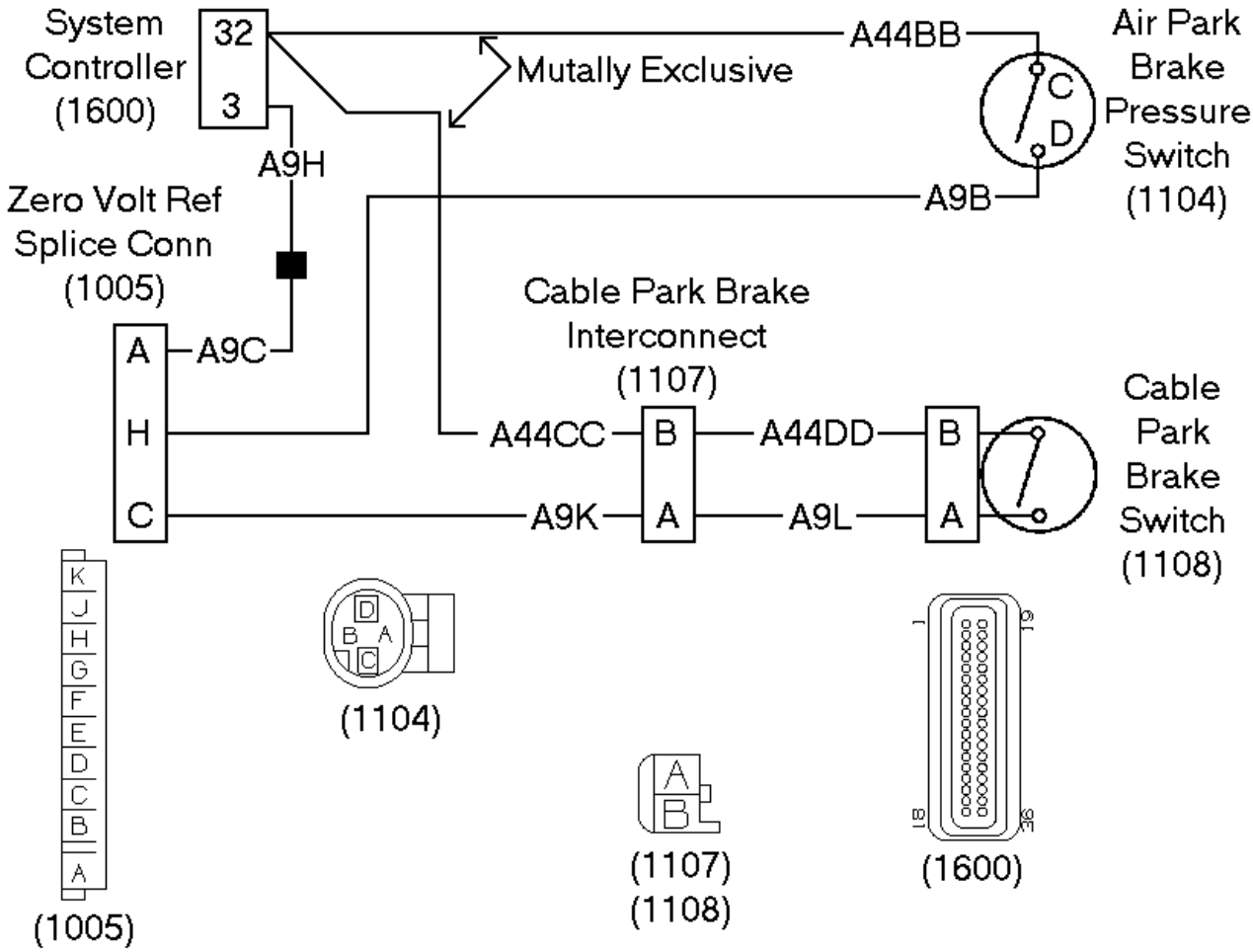

Figure 178 Park Brake Circuits — Always Refer to Circuit Diagram Book for Latest Circuit Information

(1011) FUSE BLOCK
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(4013) PASS THRU AT DASH
LOCATED AT INSIDE LEFT SIDE DASH PANEL
(4014) DASH/ENGINE PASS THRU
LOCATED AT INSIDE LEFT SIDE DASH PANEL
(4036) HYDRAULIC BRAKE SWITCH
LOCATED AT HYDRAULIC MASTER CYLINDER
(4905) AIR BRAKE SOLENOID
LOCATED AT OUTSIDE LEFT SIDE DASH PANEL
(6350) GROUND SPLICE PACK
LOCATED AT ENGINE COMPARTMENT NEAR STARTER
(9511) HYDRAULIC BRAKE CONTROL UNIT — HCU
LOCATED AT INSIDE LEFT FRAME RAIL AT HCU
(9523) ENGINE/CHASSIS INTERCONNECT
LOCATED AT INSIDE LEFT FRAME RAIL BEHIND ENGINE

Table 108 Park Brake Switch Circuits Voltage Check Chart

Diagnostic Trouble Codes		
70 14 1 0	Air Powered Park Brake is stuck.	
70 14 1 1	The auto apply portion with the Air Powered Park Brake is not operating.	
639 14 241 254	Full Power Brake information not communicating to the ESC.	
Park Brake Switch Connector (1813) or (1815) Voltage Checks Check with Brake Switch Disconnected and the Ignition Key “On”. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
(1104) harness connector, cavity C or (1107) cavity B to ground.	12 ± 1.5 volts	If voltage is incorrect, check circuits A44BB or A44CC for open or short circuits. If circuits check good voltage is missing from ESC connector (1600) pin 32.
(1104) harness connector, cavity C or (1107) cavity B to (1104) cavity D or (1107) cavity A.	12 ± 1.5 volts	If voltage is correct and condition still exists, the brake switch has failed. Replace brake switch. If voltage is incorrect, check circuit A9B, A9K, A9C or A9H for an open circuit or good connection to ground. If no open circuits are found, check system controller connector (1600) pin 3 for zero volt reference signal.
There are no diagnostic trouble codes associated with the park brake switch.		

5.4. EXTENDED DESCRIPTION

On vehicles with hydraulic brakes, the zero volt reference level is supplied from ESC connector (1600) terminal 3 to park brake switch connector (1107) terminal A.

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

5.5. COMPONENT LOCATIONS

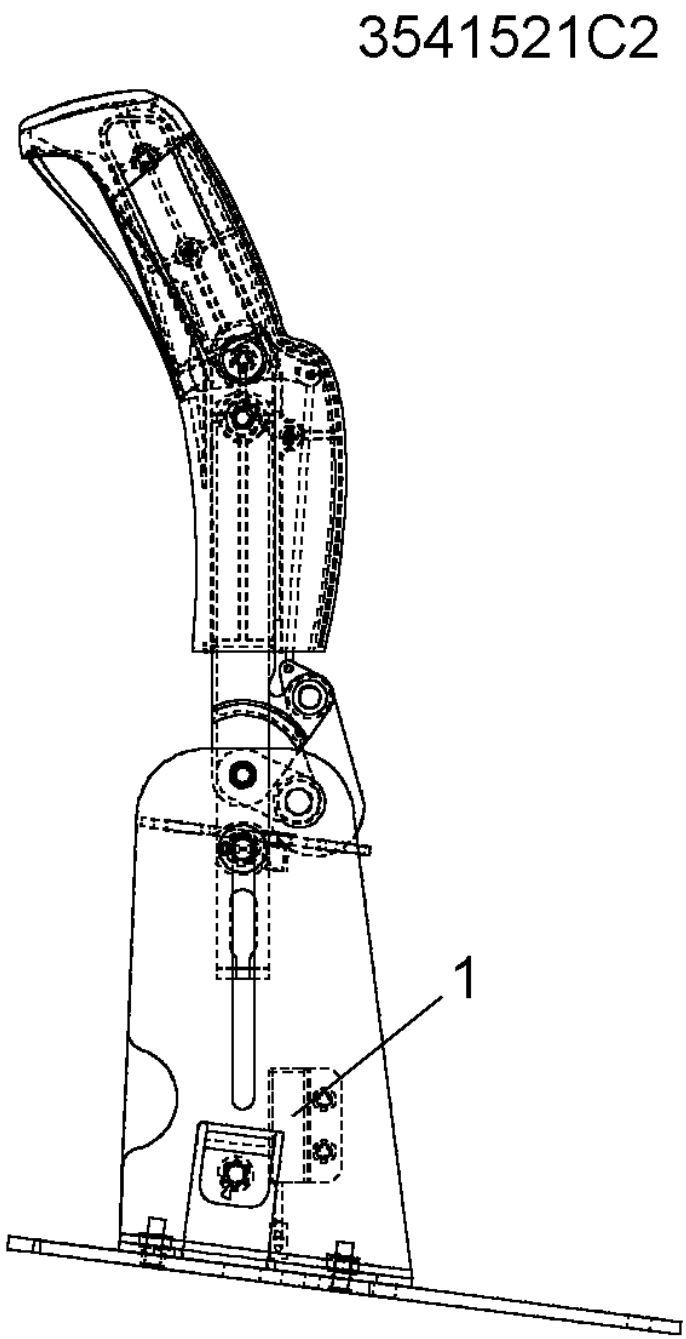

Figure 179 Park Brake Switch Location (With Cable Park Brake)

1. PARK BRAKE SWITCH

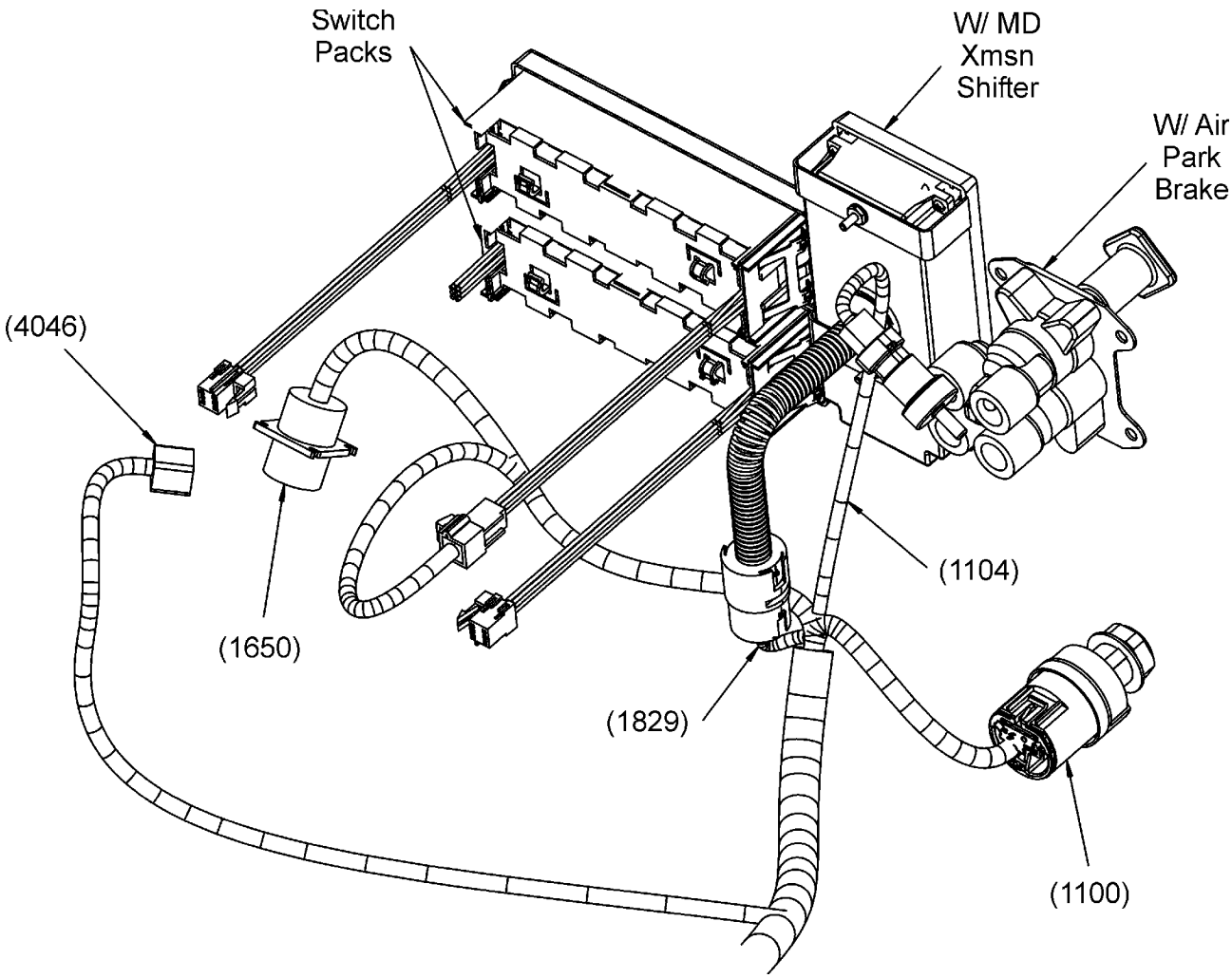

Figure 180 Air Park Brake Switch Location (Steering Column Support View)

(1100) KEY SWITCH
(1104) AIR PARK BRAKE PRESS SWITCH
(1650) DIAGNOSTICS CONNECTOR
(1829) MD TRANSMISSION PRIMARY SHIFT SELECTOR

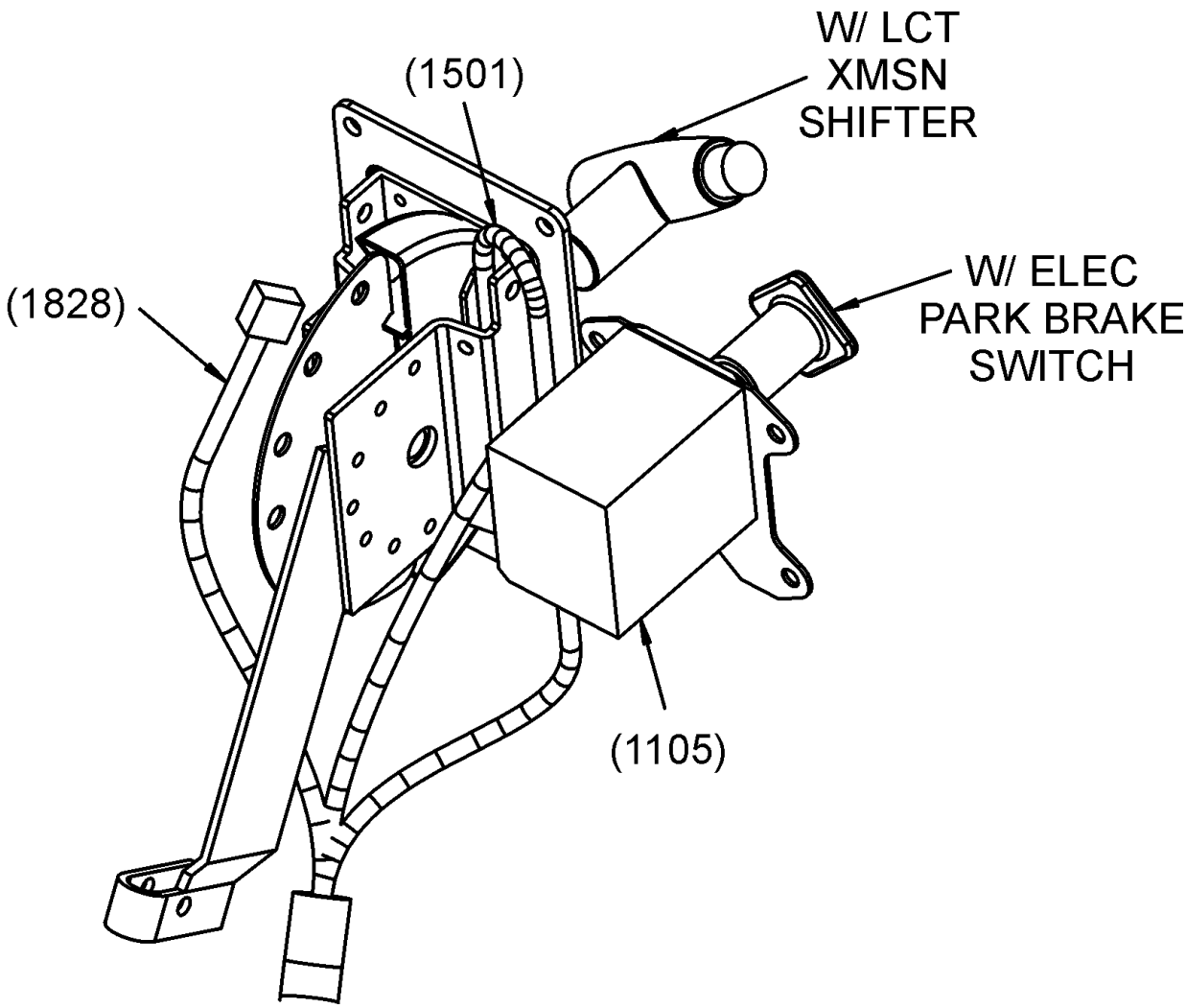

Figure 181 Hydraulic Park Brake Switch Location

(1105) HYDRAULIC PARK BRAKE SWITCH
(1501) SHIFT CONTROL CONNECTOR
(1828) LCT TRANSMISSION SHIFT CONTROL

6. DIAGNOSTIC CONNECTOR

6.1. CIRCUIT FUNCTIONS

Refer to diagnostic connector function diagram.

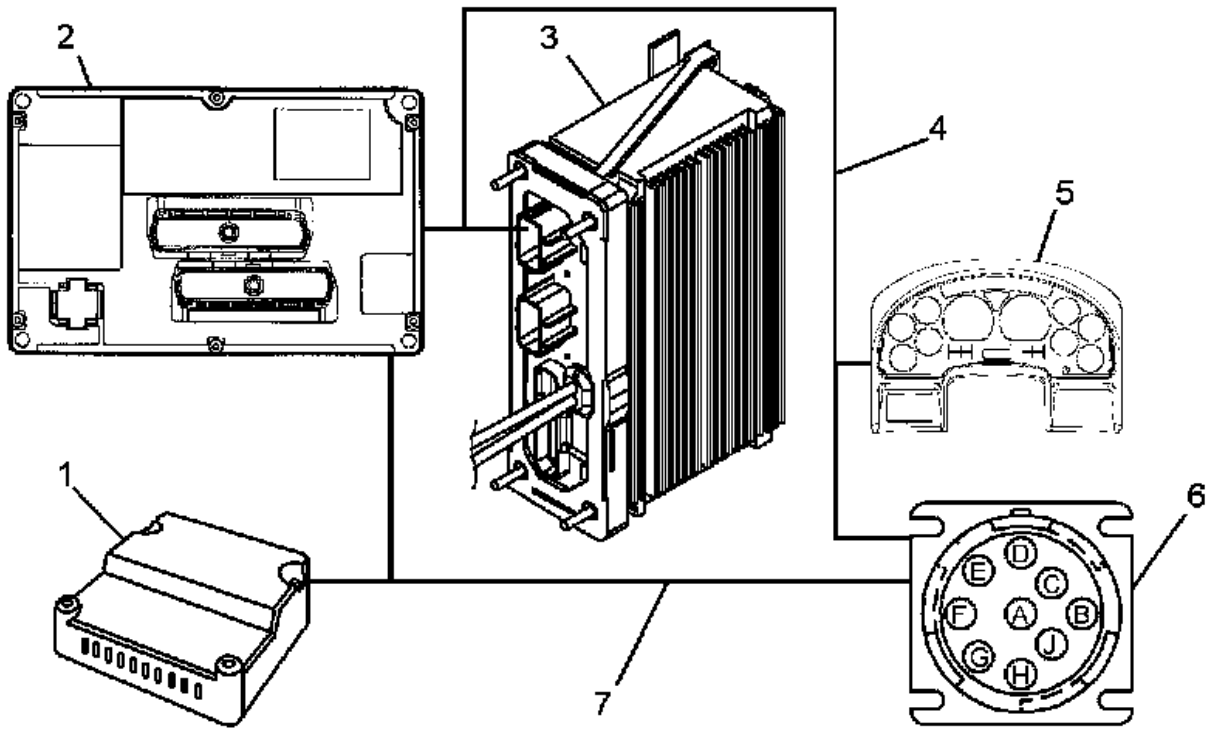

Figure 182 Diagnostic Connector Function Diagram

1. ABS CONTROLLER (OTHER CONTROLLERS ALSO CONNECTED)
2. ENGINE ECM
3. ESC
4. DRIVETRAIN 1939 DATA LINK
5. EGC
6. (1650) DIAGNOSTIC CONNECTOR
7. 1708 DATA LINK

The diagnostic connector provides an connection to the vehicle drivetrain 1939 data link, the 1708 data link, battery voltage and ground.

The diagnostic connector provides an interface between the vehicle and an electronic service tool (EST) such as the EZ-Tech®.

6.2. DIAGNOSTIC CONNECTOR CIRCUITS

Fault Detection Management

A fault in the diagnostic connector circuits will be apparent when the EST (EZ-Tech®) is not able to communicate with any devices communicating on the data links.

Should the diagnostic connector fail to provide an interface with the vehicle electronic controllers, the problem could be attributed to open or shorted wiring in power or ground circuits to the diagnostic connector or a failure in data link circuits.

Refer to diagnostic connector circuits.

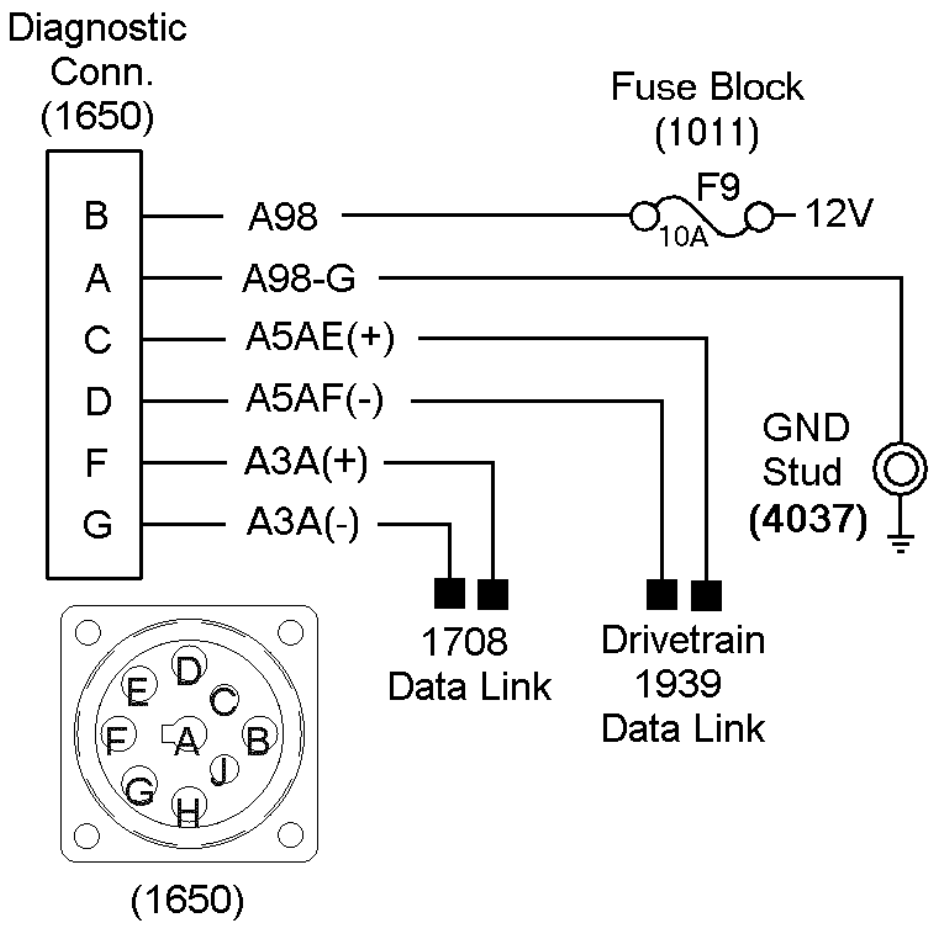

Figure 183 Diagnostic Connector Circuits — Always Refer to Circuit Diagram Book for Latest Circuit Information

(1011) FUSE BLOCK
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(1650) DIAGNOSTICS CONNECTOR
LOCATED AT INSTRUMENT WING PANEL

Table 109 Diagnostic Connector Tests

Diagnostic Trouble Codes		
There are no diagnostic trouble codes associated with the diagnostic connector circuits.		
Diagnostic Connector Voltage Checks **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Diagnostic connector cavity B to ground.	12 ± 1.5 volts	If voltage is missing, check for open or shorts in circuits between diagnostic connector and F9. Also check for blown fuse F9.
Diagnostic connector cavity B to cavity A.	12 ± 1.5 volts	If voltage is missing, check for open in ground circuits between diagnostic connector and ground stud. If voltage is correct diagnostic connector is inoperative, the diagnostic connector should be replaced.
Diagnostic connector cavity C to cavity A.	2.5 ± .5 volts	If voltage is missing, check for open in circuits between diagnostic connector and 1939 data link circuits.
Diagnostic connector cavity D to cavity A.	2.5 ± .5 volts	If voltage is missing, check for open in circuits between diagnostic connector and 1939 data link circuits.
(1650) Pin F to ground.	Approximately 4 volts	(+) data link circuit. If voltage is low check for open in positive data link circuits.
(1650) Pin G to ground.	Approximately 1 volt	(-) data link circuit. If voltage is low check for open in negative data link circuits. If voltage is high check for crossed data link circuits.

Extended Description

Battery voltage, required to operate the diagnostic circuits, is supplied from fuse F9 on circuit A98 to diagnostic connector (1650) pin B. Ground is supplied from ground stud connector to diagnostic connector (1650) pin A.

6.3. COMPONENT LOCATIONS

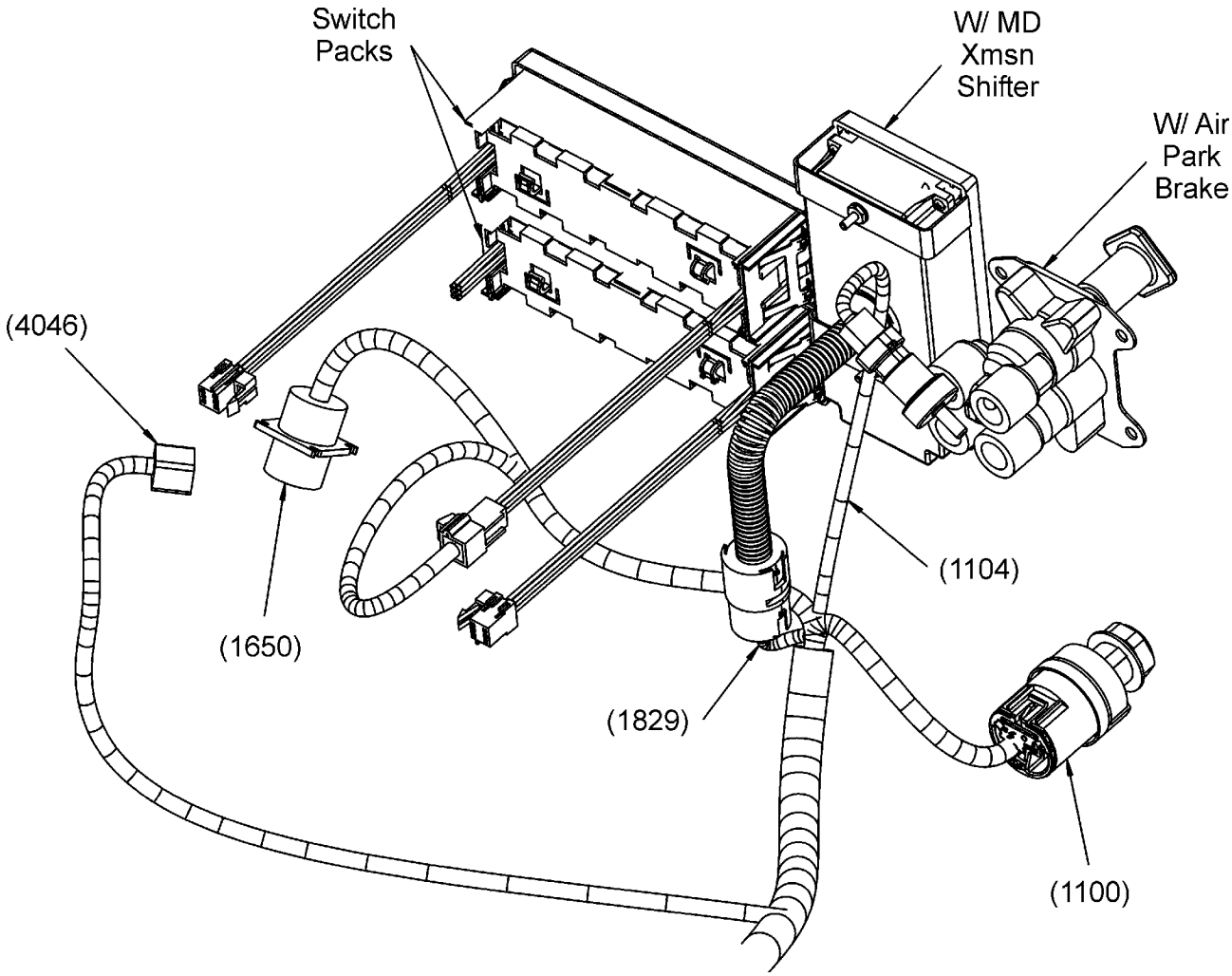

Figure 184 Diagnostic Connector Location

(1100) KEY SWITCH
(1104) AIR PARK BRAKE PRESS SWITCH
(1650) DIAGNOSTICS CONNECTOR
(1829) MD TRANSMISSION PRIMARY SHIFT SELECTOR

7. BRAKE SWITCH / STOP LIGHT SWITCH

7.1. CIRCUIT FUNCTION

The brake switch(es) sense when the driver is pressing the brake pedal to apply the brakes and thus signal the ESC to turn on the stop lights and turn off the cruise control.

On vehicles with hydraulic brakes the stop light signal to the ESC comes from a switch activated by the brake pedal. The switch also signals the ESC to activate the brake booster pump when the engine is off and/or a failure in the brake system has occurred.

On vehicles with air brakes the stop light signal to the ESC comes from switches, connected to the air brake lines, activated by brake air pressure. The switches are located near the steering column.

Refer to Hydraulic Brake Switch(See HYDRAULIC BRAKE SWITCH INPUTS TO ESC, page 585) or Air Brake Switch(See AIR BRAKE SWITCH INPUTS TO ESC, page 587) for more details.

8. ALLISON MD TRANSMISSION SHIFTER

8.1. CIRCUIT FUNCTIONS

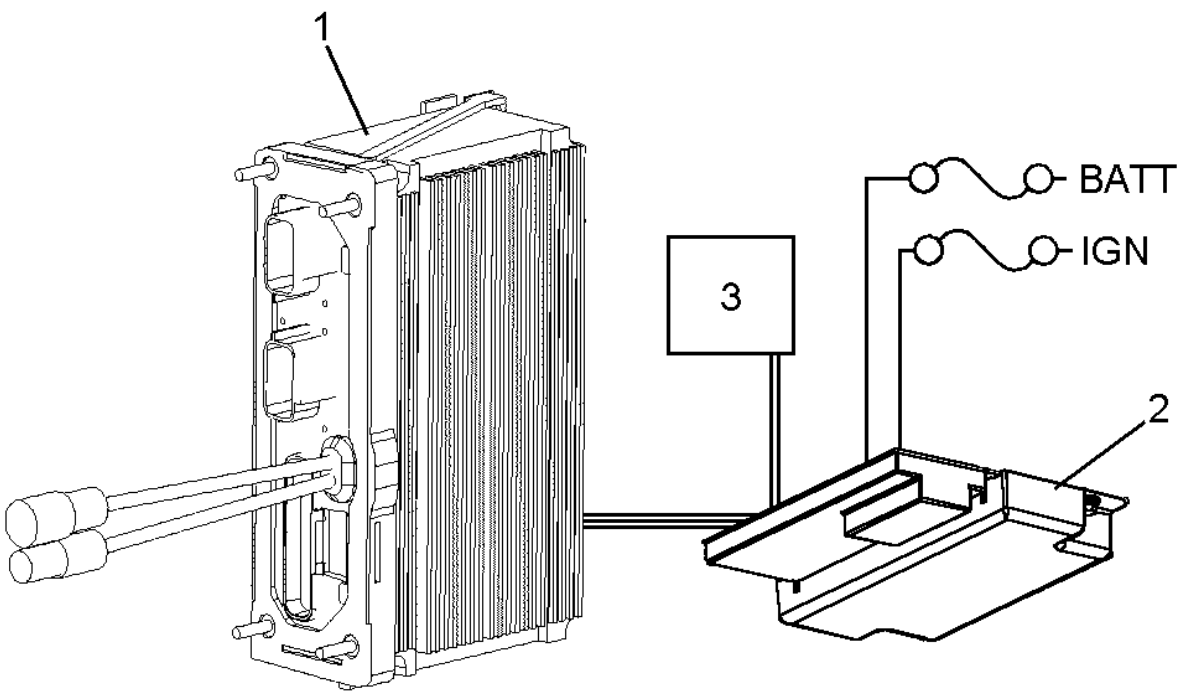

Figure 185 Allison MD Transmission Shifter Function Diagram

1. ELECTRICAL SYSTEM CONTROLLER (ESC)
2. MD TRANSMISSION CONTROL MODULE
3. MD TRANSMISSION PUSH BUTTON SHIFTER

8.2. DIAGNOSTICS

A failure in the Allison MD Transmission Shifter circuits should be suspected. A diagnostic trouble code (DTC) for this switch will be logged if there is an open or short in circuits to the switch.

An electronic service tool, running the "Diamond Logic Builder™" diagnostic software, can be used to check operation of the micro relay to the ESC. See the diagnostic software manual for details on using the software.

Allison MD Transmission Shifter Preliminary Check

Table 110 Allison MD Transmission Shifter Preliminary Check Table

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify operation of Allison MD Transmission Push Button Shifter.	Visually check Allison MD Transmission Push Button Shifter.	Allison MD Transmission Push Button Shifter does not operate.	Go to next step.	Allison MD Transmission Push Button Shifter is operating correctly.
2.	On	Determine if any other features are malfunctioning that may have common circuits (Example: Missing power or ground common to several features).	Visually 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	Check for diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 388)	Read display on odometer.	**No** Allison MD Transmission Push Button Shifter diagnostic trouble codes are active.	Go to next step.	Go to Fault Detection Management. (See FAULT DETECTION MANAGEMENT, page 388)
4.	On	Go to Fault Detection Management. (See FAULT DETECTION MANAGEMENT, page 388)				

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 111 Allison MD Transmission Shifter Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
2033 14 13 0	Park Position Unlock solenoid. There is a load on this pin that has been configured as unused.
2033 14 13 1	Park Position Unlock solenoid. Output overloaded.
2033 14 13 2	Park Position Unlock solenoid. Output open circuit.
2033 14 13 3	Park Position Unlock solenoid. Output shorted to ground.

8.3. 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.

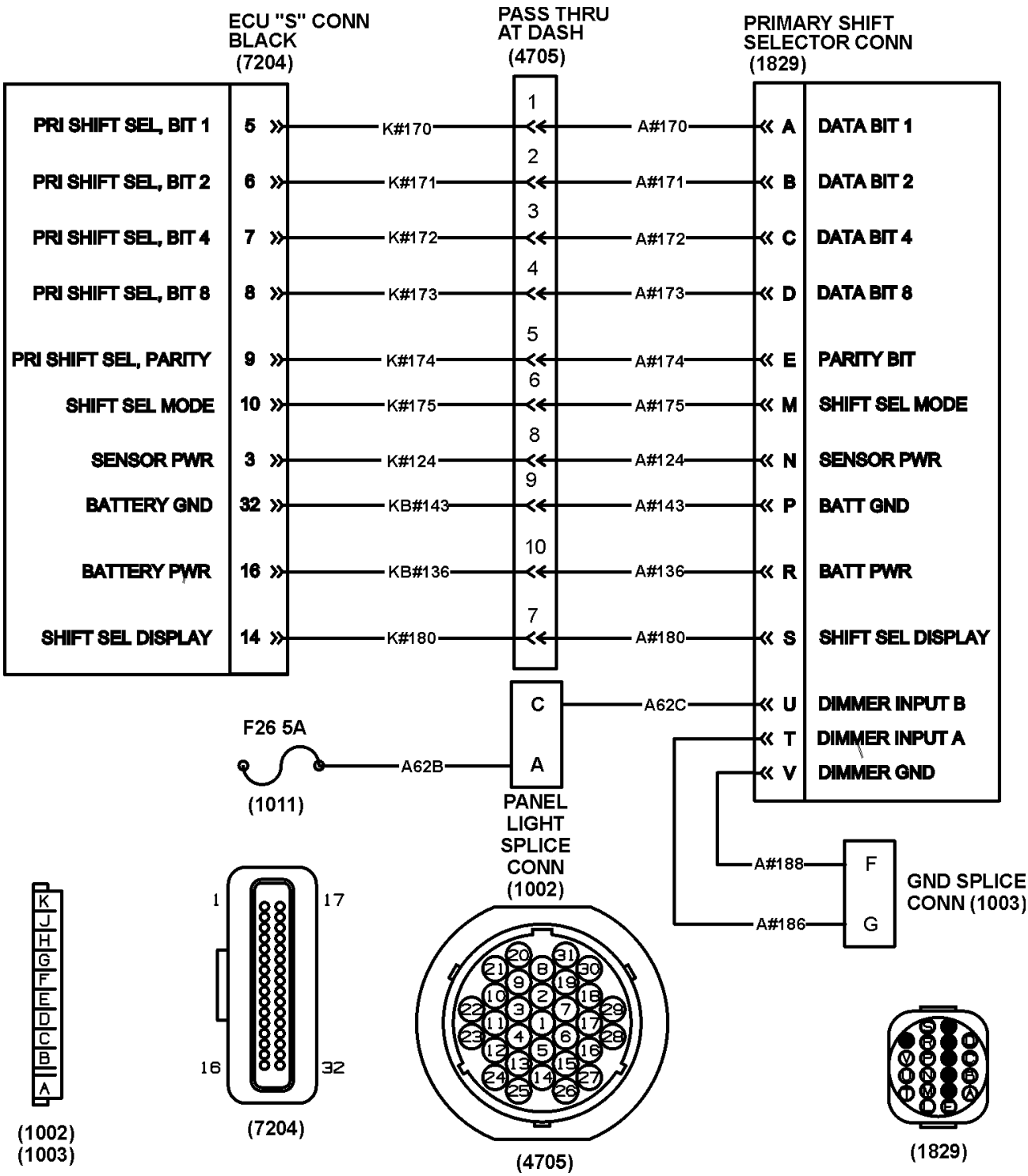

Figure 186 Allison MD Transmission Shifter Circuits — Always Refer to the Circuit Diagram Book for Latest Circuit Information

(1002) PANEL LIGHT SPLICE CONNECTOR
LOCATED AT LEFT SIDE INSTRUMENT PANEL
(1003) GROUND SPLICE CONNECTOR
LOCATED LEFT SIDE INSTRUMENT PANEL
(1011) FUSE BLOCK
LOCATED AT LEFT SIDE VEHICLE AT FLASHER PLATE
(1829) MD XMSN PRIMARY SHIFT SELECTOR CONNECTOR
LOCATED AT INSTRUMENT WING PANEL
(4705) PASS THRU AT DASH
LOCATED AT INSIDE DASH PANEL LEFT SIDE
(7204) MD ECU “S” CONNECTOR BLACK
LOCATED AT ENGINE COMPARTMENT TRANSMISSION

Refer to Allison MD Transmission Shifter Circuits.

Table 112 Allison MD Transmission Shifter Circuit Tests

Allison MD Transmission Shifter Checks Check with key in ignition position switch on. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Allison MD Transmission Shifter connector (1829) cavity R to ground.	12 ± 1.5 volts	If voltage is missing check for open or short on circuits A#136 and KB#136.
Allison MD Transmission Shifter connector (1829) cavity R to P.	12 ± 1.5 volts	If voltage is missing, check for open or short to high on circuits A#143 and KB#143. Also check power supply to ECU. Also check all other connections from ECU to Allison MD Transmission Shifter for open or short. If all voltages and connections are good, but shift control still fails, replace shift control.

8.4. COMPONENT LOCATIONS

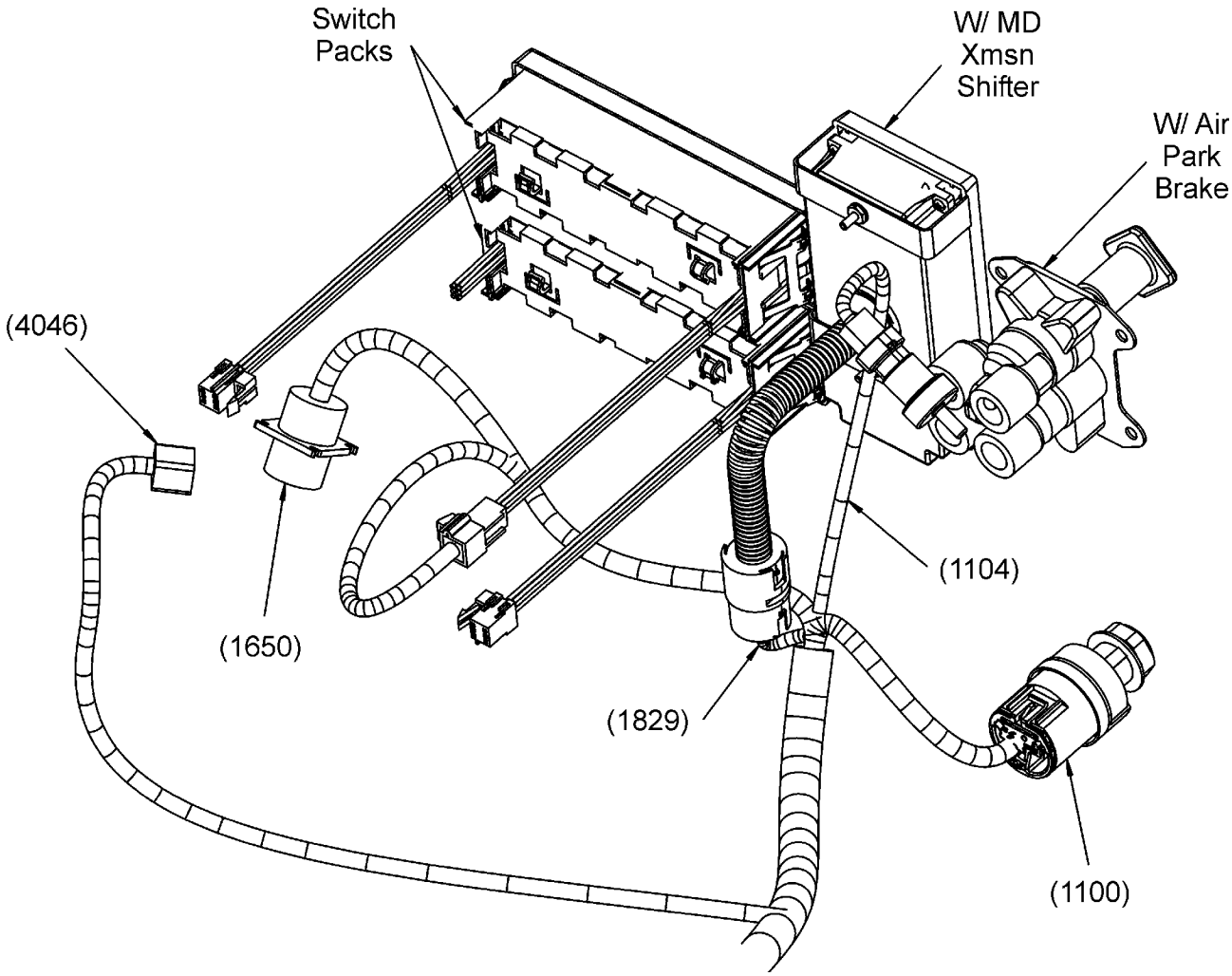

Figure 187 Allison MD Transmission Shifter Cab Wiring

(1104) AIR PARK BRAKE PRESS SWITCH
(1650) DIAGNOSTICS CONNECTOR
(1829) MD TRANSMISSION PRIMARY SHIFT SELECTOR CONNECTOR

9. SERVICE DOOR CONTROLS

9.1. CIRCUIT FUNCTIONS

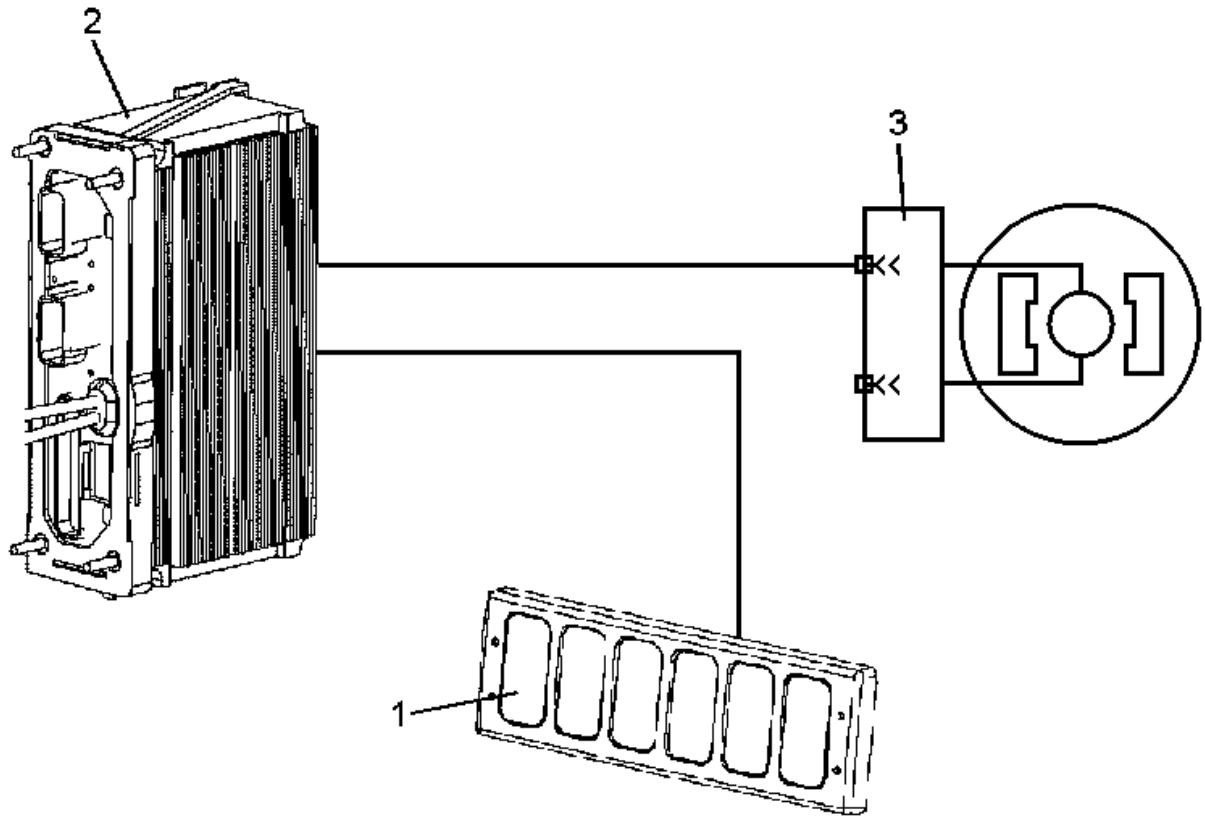

Figure 188 Door Controls Function Diagram

1. SERVICE DOOR CONTROL SWITCHES (LOCATION VARIES)
2. ELECTRONIC SYSTEM CONTROLLER
3. SERVICE DOOR MOTOR (ELECTRIC) OR SOLENOID (AIR)

9.2. DIAGNOSTICS

NOTE – If Service Door Control Switches are located in dash board switch pack, please refer to the Switch Pack diagnostics section of this manual for troubleshooting the service door inputs to the ESC.

A failure in the service door will be apparent when the door fails to operate. Refer to Door Controls Function Diagram.

Service Door Controls Preliminary Check

Table 113 Service Door Controls Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify operation of service door.	Visually check service door.	Service door does not operate.	Go to next step.	Service door is operating correctly.
2.	On	Determine if any other features are malfunctioning that may have common circuits (Example: Missing power or ground common to several features).	Visually 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	Check for diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 393)	Read display on odometer.	**No** service door control diagnostic trouble codes are active.	Go to next step.	Go to Fault Detection Management. (See FAULT DETECTION MANAGEMENT, page 394)
4.	On	Go to Fault Detection Management. (See FAULT DETECTION MANAGEMENT, page 394)				

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 114 Service Door Control Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
612 14 5 1	Diags/flashers/Entrance Door Input out of range low.
612 14 5 2	Diags/flashers/Entrance Door Input out of range high.
2033 14 3 1	Electric Door Open Output overloaded.
2033 14 3 2	Electric Door Output open circuit.
2033 14 3 3	Electric Door Open Output shorted to ground.
2033 14 6 1	Electric Door Control is Output overloaded.
2033 14 6 2	Electric Door Control, Output open circuit.
2033 14 6 3	Electric Door Control, Output shorted to ground.

9.3. 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.

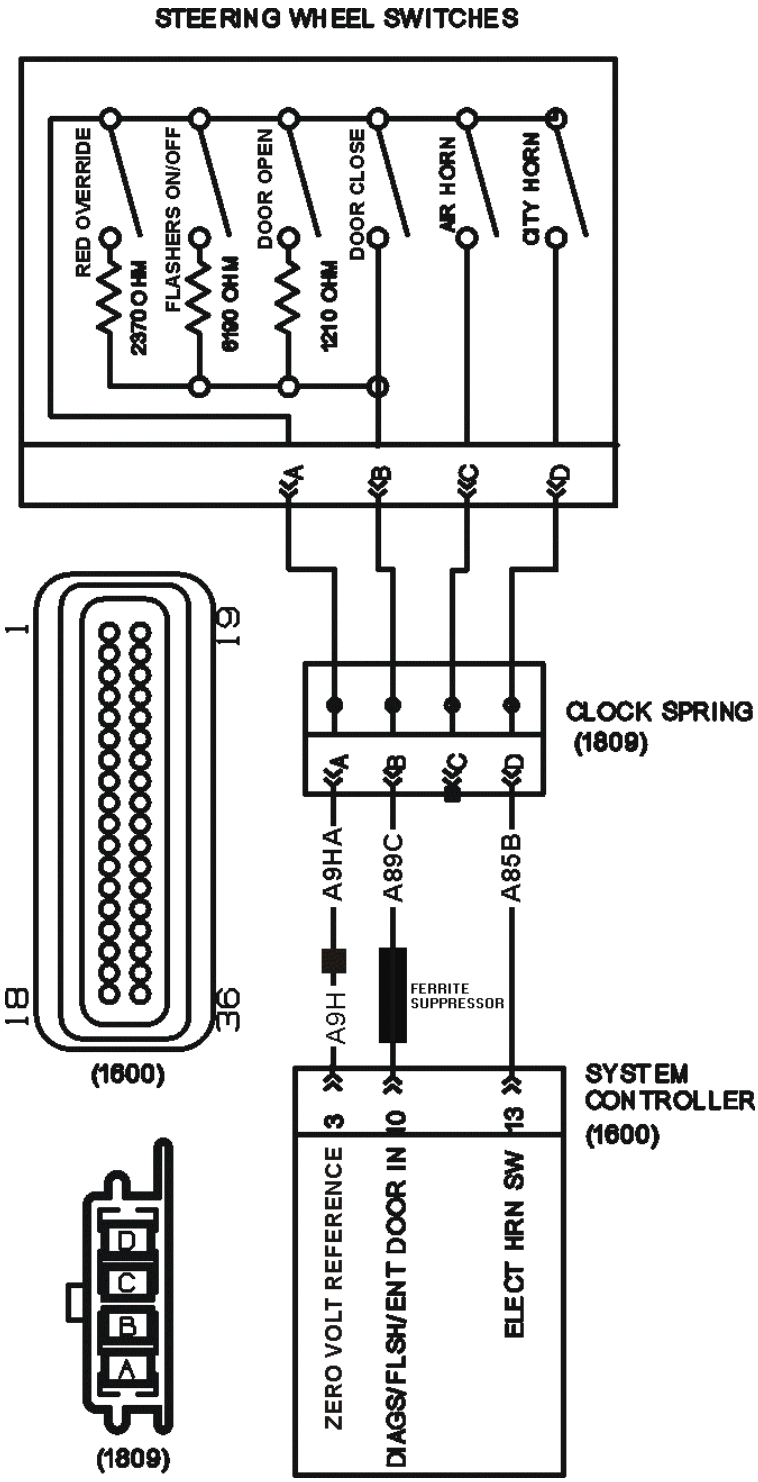

Figure 189 Service Door Control Circuits (Steering Wheel Switches) — Always Refer to the Circuit Diagram Book for Latest Circuit Information

(1600) SYSTEM CONTROLLER
LOCATED AT INSIDE RIGHT SIDE DASH PANEL
(1809) CLOCK SPRING
LOCATED IN STEERING COLUMN

Table 115 Service Door Control Circuit Tests

Door Control Switch Resistance Checks Check with clock spring connector (1809) 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
Clock spring connector cavity A to D.	>200 Kohms	If resistance value is less, then there is a short in the steering wheel switches. Replace steering wheel switches.
Clock spring connector cavity A to D (while pushing city horn button).	<0.5 ohms	If resistance is greater significantly greater than 0.5 ohms, then there is an open in the steering wheel switches. Replace steering wheel switches.
Clock spring connector cavity A to B.	>200 Kohms	If resistance value is less, then there is a short in the steering wheel switches. Replace steering wheel switches.
Clock spring connector cavity A to B (while pushing Red Override switch).	Approximately 2.4 Kohms	If resistance value is incorrect, then there is a fault in the steering wheel switches. Replace steering wheel switches.
Clock spring connector cavity A to B (while pushing Flashers On/Off switch).	Approximately 6.2 Kohms	If resistance value is incorrect, then there is a fault in the steering wheel switches. Replace steering wheel switches.
Clock spring connector cavity A to B (while pushing Door Open switch).	Approximately 1.2 Kohms	If resistance value is incorrect, then there is a fault in the steering wheel switches. Replace steering wheel switches.
Clock spring connector cavity A to B (while pushing Door Close switch).	<0.5 ohms	If resistance value is incorrect, then there is a fault in the steering wheel switches. Replace steering wheel switches.

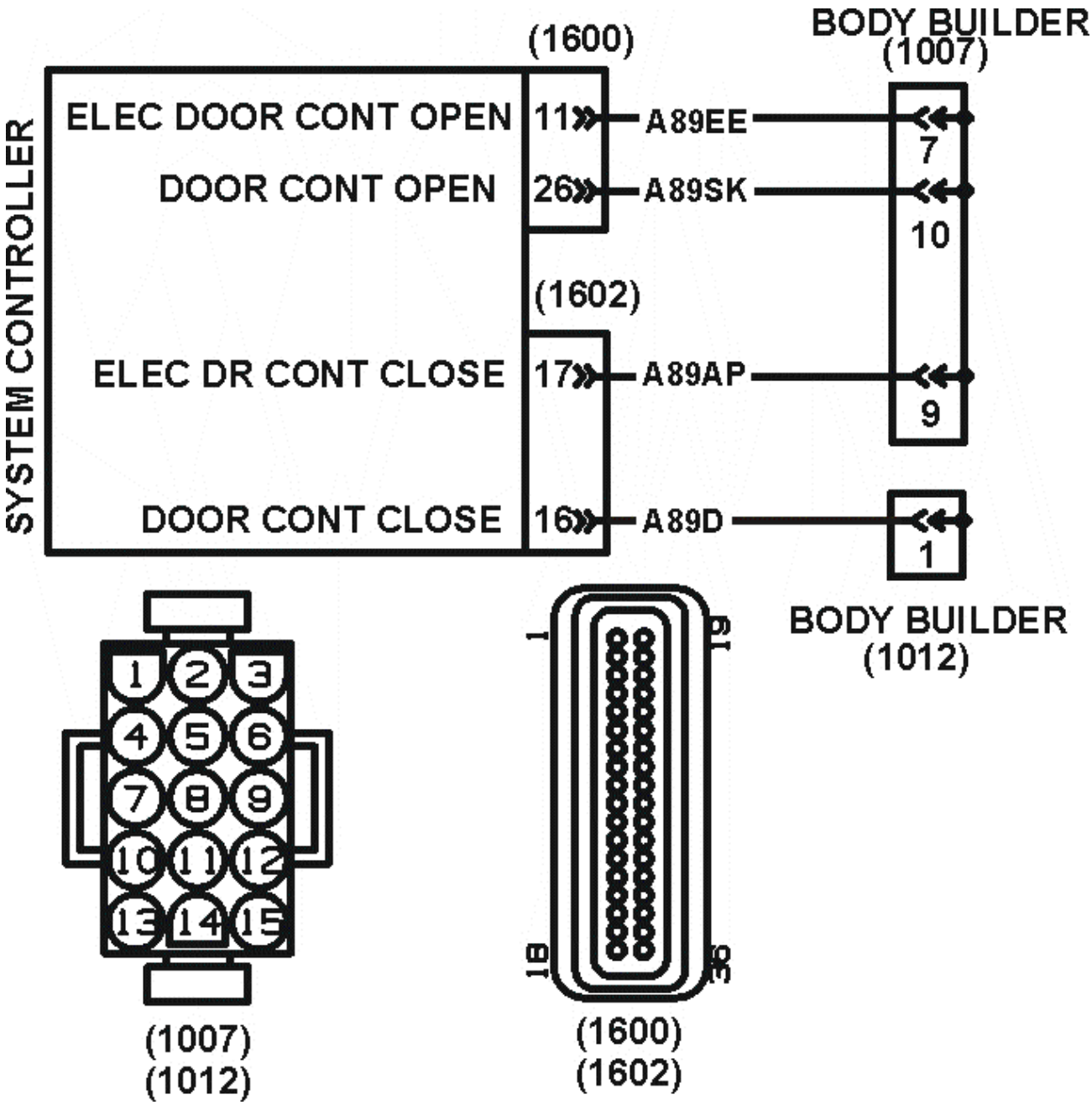

Figure 190 Service Door Output Circuits — Always Refer to the Circuit Diagram Book for Latest Circuit Information

(1007) (1012) BODY BUILDER CONN
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(1600) (1602) SYSTEM CONTROLLER
LOCATED AT INSIDE RIGHT SIDE DASH PANEL

9.4. EXTENDED DESCRIPTION

Refer to Service Door Control Circuits and Service Door Output Circuits.

When the door open switch is closed the electronic system controller will supply a ground signal on connector (1600) pin 11.

When the door close switch is closed the electronic system controller will supply a ground signal on connector (1602) pin 17.

9.5. COMPONENT LOCATIONS

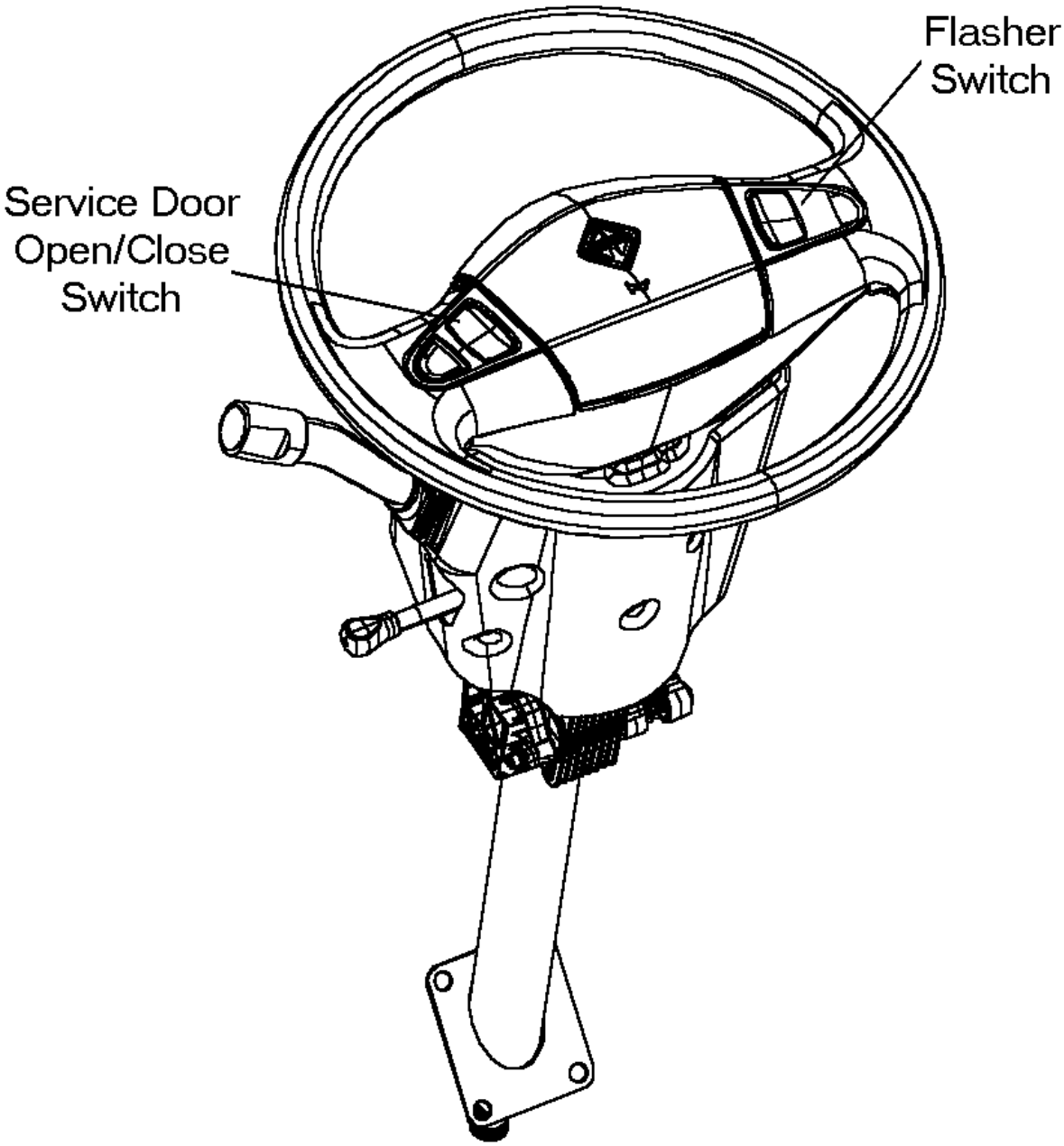

Figure 191 Service Door Control Switches Located In Steering Column

10. EMERGENCY EXIT CONTROLS

10.1. CIRCUIT FUNCTIONS

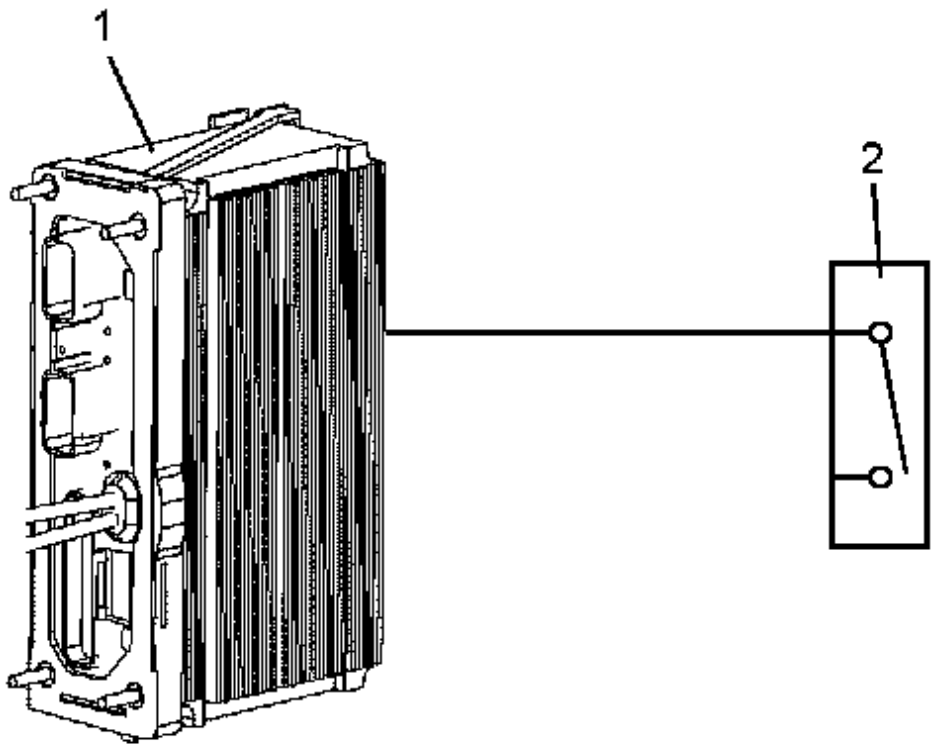

Figure 192 Emergency Exit Controls Function Diagram

1. ELECTRONIC SYSTEM CONTROLLER
2. EMERGENCY EXIT SWITCH

10.2. DIAGNOSTICS

Diagnostic Trouble Codes (DTC)

There are no Diagnostic Trouble Codes associated with the Emergency Exits.

Emergency Exit Controls Preliminary Check

Table 116 Emergency Exit Controls Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify operation of emergency exits.	Visually check emergency exits.	Emergency exits do not operate.	Go to next step.	Emergency exits are operating correctly.
2.	On	Determine if any other features are malfunctioning that may have common circuits (Example: Missing power or ground common to several features).	Visually 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	Check for diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 400)	Read display on odometer.	**No** Emergency exit diagnostic trouble codes are active.	Go to next step.	Go to Fault Detection Management. (See emergency exit(s) FAULT DETECTION MANAGEMENT, page 400)
4.	On	Go to Fault Detection Management. (See emergency exit(s) FAULT DETECTION MANAGEMENT, page 400)				

10.3. EMERGENCY EXIT(S) 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.

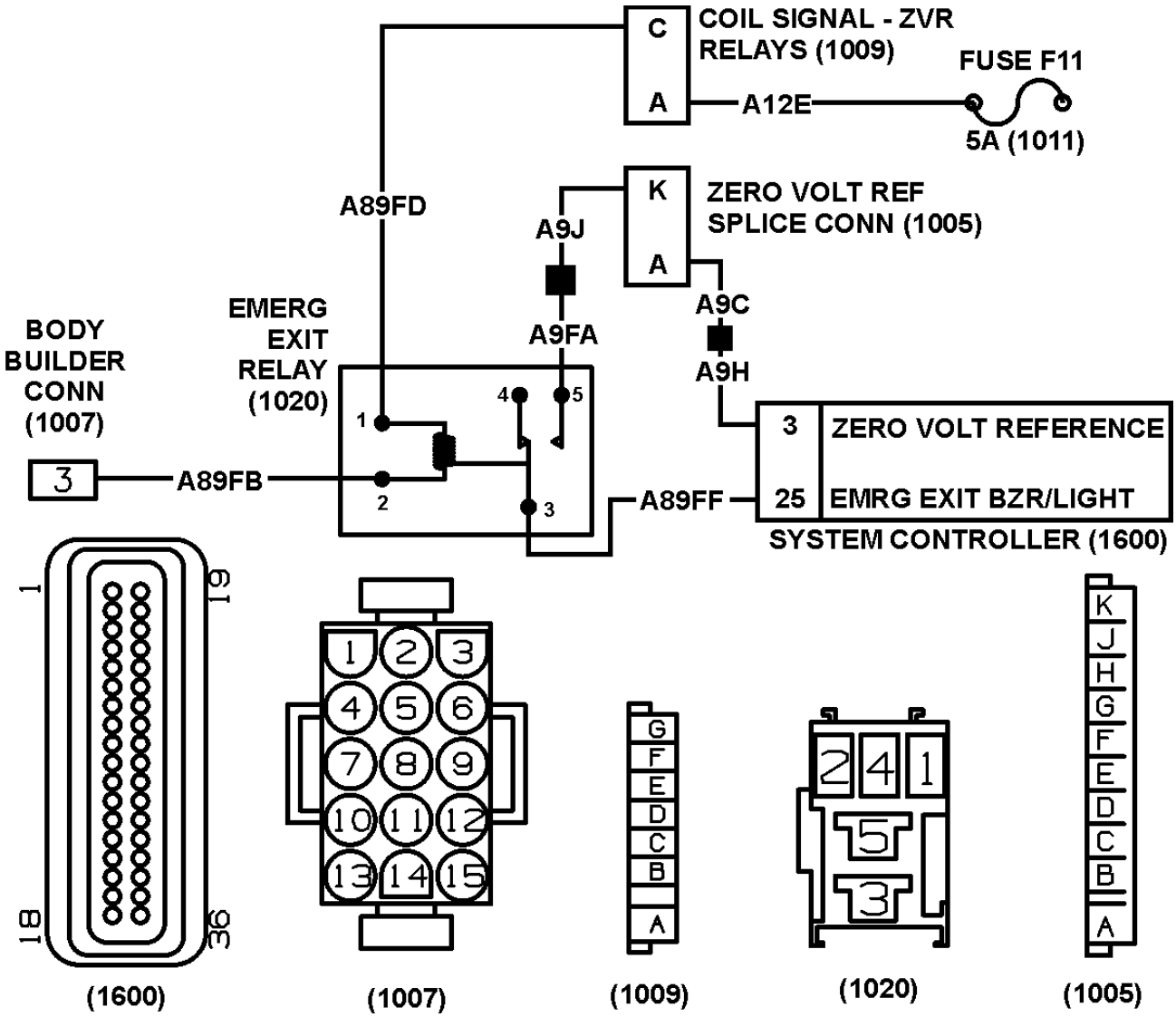

Figure 193 Emergency Exit Circuits — Always Refer to the Circuit Diagram Book for Latest Circuit Information

(1005) ZERO VOLT REFERENCE SPLICE CONNECTOR
LOCATED RIGHT SIDE INSTRUMENT PANEL
(1007) BODY BUILDER CONNECTOR
LOCATED AT LEFT SIDE VEHICLE AT FLASHER PLATE
(1009) COIL SIGNAL ZERO VOLT REFERENCE (ZVR) CONNECTOR
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(1011) FUSE BLOCK
LOCATED AT LEFT SIDE VEHICLE AT FLASHER PLATE
(1020) EMERGENCY EXIT RELAY
LOCATED AT LEFT SIDE VEHICLE AT FLASHER PLATE
(1600) SYSTEM CONTROLLER CONNECTOR
LOCATED AT INSIDE RIGHT SIDE DASH PANEL

Table 117 Emergency Exit Circuit Tests

Emergency Exit Relay (1020) Voltage Checks Check with emergency exit relay (1020) removed and key in ignition position switch on. **NOTE – Always check connectors for damage and pushed–out terminals.** **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.** Bench test relay. If relay fails, replace relay and see if fault continues.		
Test Points	Spec.	Comments
Emergency exit relay (1020) cavity 1 to ground.	12 ± 1.5 volts	If voltage is missing check for blown fuse F11 and for open or short on circuits A89FD and A12E.
Emergency exit relay (1020) cavity 1 to 2.	0 ± 1.5 volts	If voltage is present check for short to ground in circuit A89FB.
While voltmeter is still connected to emergency exit relay (1020) from cavity 1 to cavity 2, open emergency exit.		
Emergency exit relay (1020) cavity 1 to 2.	12 ± 1.5 volts	If voltage is missing check for open or short to high in circuits A89FB.
Leave emergency exit open.		
Emergency exit relay (1020) cavity 5 to cavity 3. **NOTE – Emergency exit should sound at this test.**	0 ± 1.5 volts	If voltage is present or emergency exit buzzer and lights fail to operate, check for open or short on circuits A89FF, A9FA and A9J. Also ensure proper zero volt signal from zero volt reference splice connector (1005) and from ESC (1600) pin 3 on circuits A9H and A9C. If circuits are good, retest with different emergency exit open. If emergency exit sounds, replace emergency exit switch.

10.4. EXTENDED DESCRIPTION

Refer to Emergency Exit Circuits.

When an emergency exit is opened a circuit will close applying a ground signal to body builder connector (1007) pin 3. This will charge the emergency exit relay (1020). This will close a circuit between the zero volt reference signal and the system controller (1600) pin 25. When the ESC sees the zero volt signal, it will activate the emergency lights and buzzer.

10.5. COMPONENT LOCATIONS

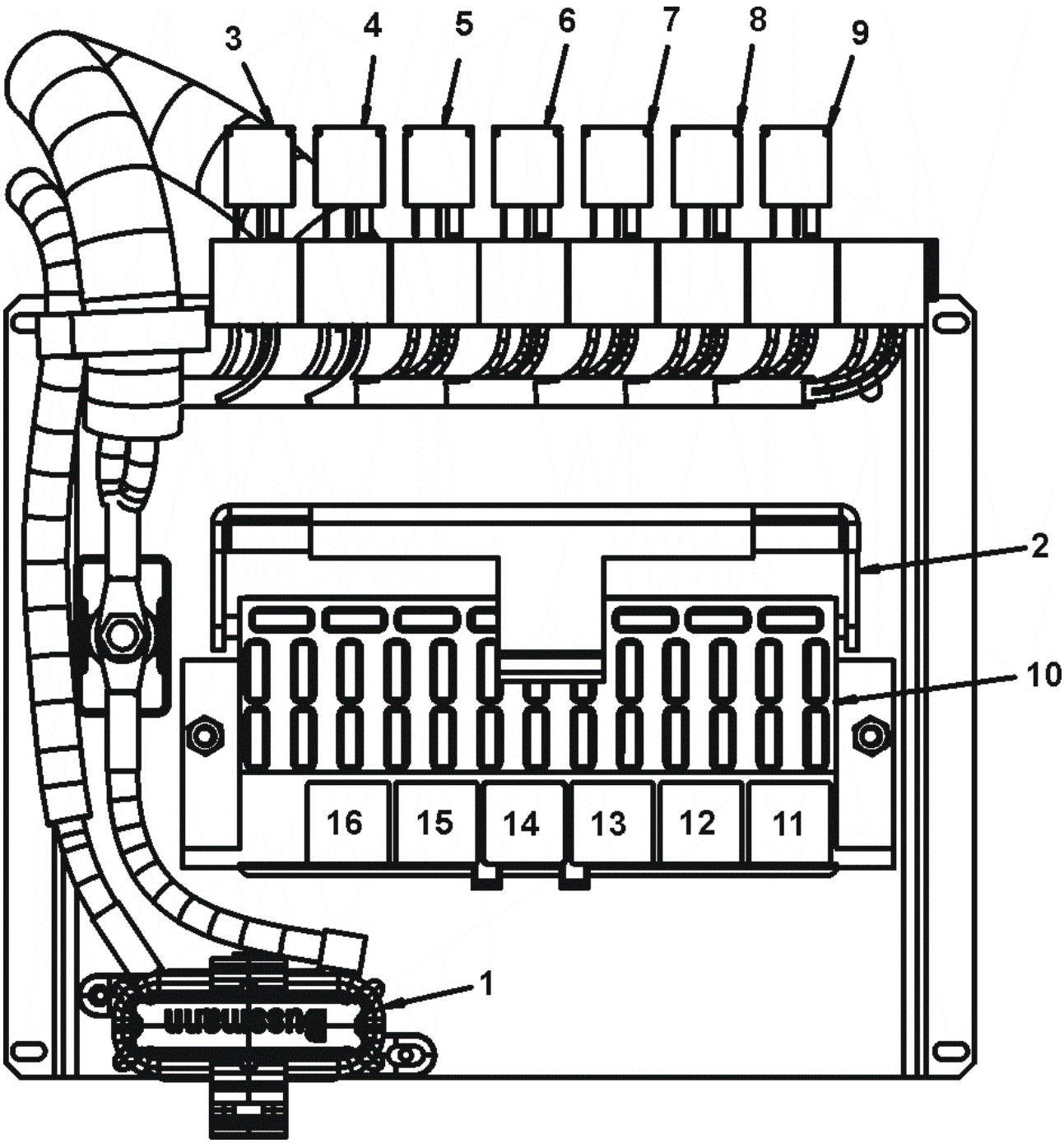

Figure 194 Relay Location Diagram

1. 125 A MAXIFUSE
2. FUSE BLOCK COVER
3. (1015) BACK UP LIGHT RELAY
4. (1017) FOG LIGHT RELAY
5. (1018) AUTO DRAIN VALVE RELAY
6. (1016) BACK UP LIGHT CHECK RELAY
7. (1020) EMERGENCY EXIT RELAY
8. (1021) POST TRIP INSPECTION RELAY
9. (1019) WHEELCHAIR LIFT RELAY
10. (1011) FUSE BLOCK
11. R1 — WIPER POWER RELAY
12. R2 — WIPER HI-LOW RELAY
13. R3 — BODY BUILDER STOP LIGHT RELAY
14. R4 — AIR SOLENOID POWER RELAY
15. R5 — IGNITION RELAY
16. R6 — IGNITION RELAY

11. POST TRIP INSPECTION CIRCUITS

11.1. CIRCUIT FUNCTIONS

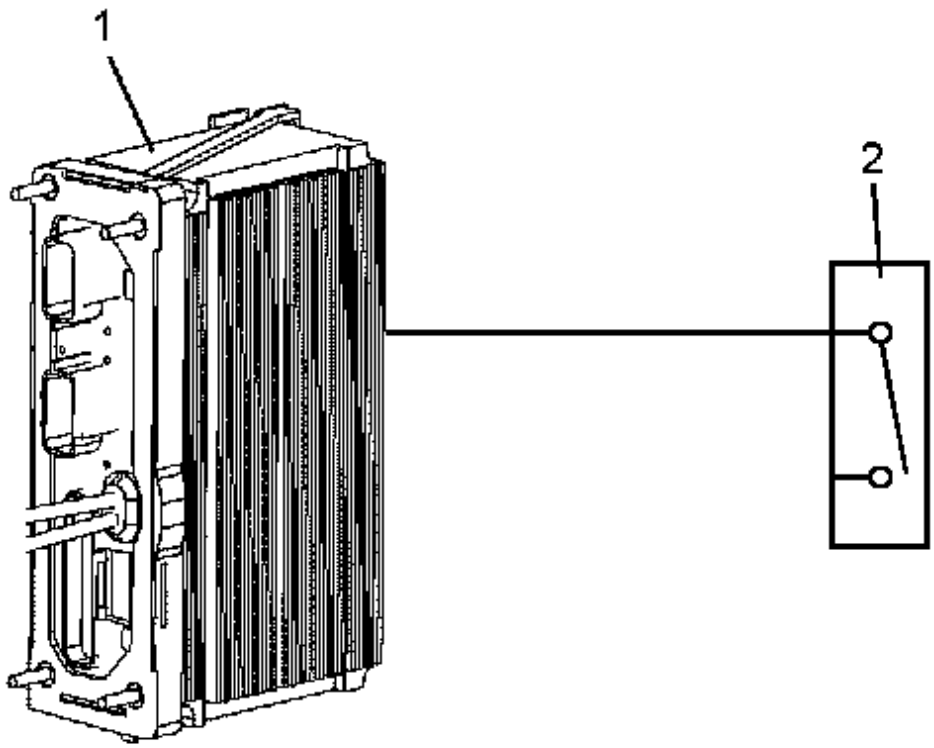

Figure 195 Post Trip Inspection Function Diagram

1. ELECTRONIC SYSTEM CONTROLLER
2. EMERGENCY EXIT DOOR SWITCH

The post trip inspection relay governs a safety system to ensure that the driver inspects the vehicle when the route has been completed. This feature was added to ensure no passengers are left on the bus when it is secured at the end of its route.

The Post Trip Inspection System system is armed when the service door is opened while the red pupil warning lights (PWL) are energized. While the engine is running the post trip inspection system will have no effect on any other system or vehicle operation.

The post trip inspection system is activated when the key switch is turned off. At this point the operator will have sixty (60) seconds to do the following to disarm the system:

A. Set park brake

B. Place key switch in the accessory position

C. Lift the **rear emergency exit handle** and return to the locked position

NOTE – Opening and closing one of the emergency window exits and/or roof hatches will NOT disarm the post trip inspection alarm. Only opening and closing the rear emergency exit can disarm the post trip inspection alarm.

If the post trip inspection system is not disarmed in the allotted time then the electric horn will pulse and the headlights will flash for twenty minutes or until the alarm is disarmed as stated in the steps above.

11.2. DIAGNOSTICS

Diagnostic Trouble Codes (DTC)

There are no Diagnostic Trouble Codes associated with the Post Trip Inspection Circuits.

Emergency Exit Controls Preliminary Check

Table 118 Emergency Exit Controls Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify operation of emergency exits.	Visually check emergency exits.	Emergency exits do not operate.	Go to next step.	Emergency exits are operating correctly.
2.	On	Determine if any other features are malfunctioning that may have common circuits (Example: Missing power or ground common to several features).	Visually 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	Check for diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 406)	Read display on odometer.	**No** Emergency exit diagnostic trouble codes are active.	Go to next step.	Go to Fault Detection Management. (See FAULT DETECTION MANAGEMENT, page 406)
4.	On	Go to Fault Detection Management. (See FAULT DETECTION MANAGEMENT, page 406)				

11.3. 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.

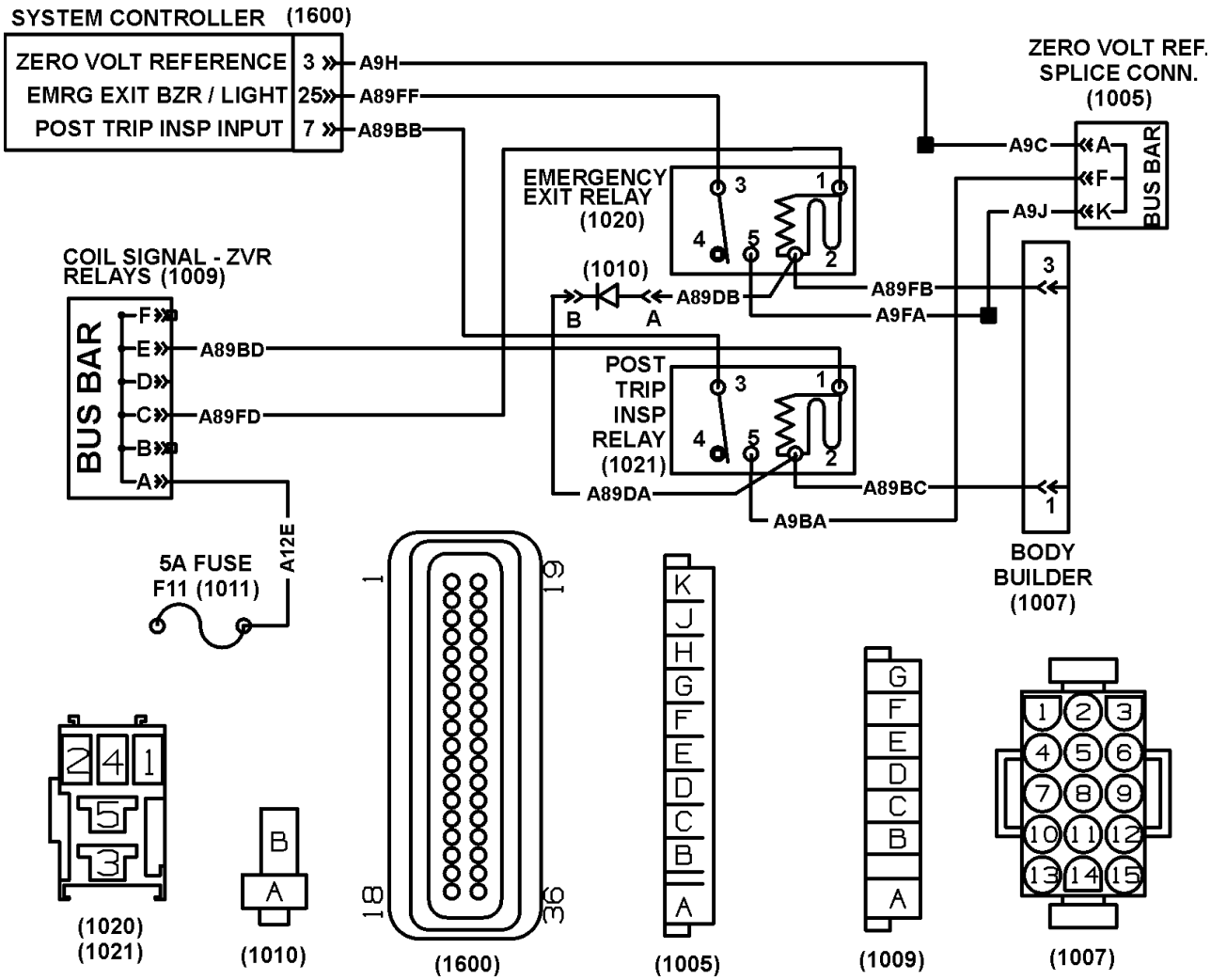

Figure 196 Post Trip Inspection Circuits — Always Refer to the Circuit Diagram Book for Latest Circuit Information

(1005) ZERO VOLT REF SPLICE CONN
LOCATED RIGHT SIDE INSTRUMENT PANEL
(1007) BODY BUILDER CONNECTOR
LOCATED AT LEFT SIDE VEHICLE AT FLASHER PLATE
(1009) COIL SIGNAL ZERO VOLT REFERENCE (ZVR) CONNECTOR
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(1010) POST TRIP INSPECTION DIODE ASSEMBLY
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(1011) FUSE BLOCK
LOCATED AT LEFT SIDE VEHICLE AT FLASHER PLATE
(1020) EMERGENCY EXIT RELAY
LOCATED AT LEFT SIDE VEHICLE AT FLASHER PLATE
(1021) POST TRIP INSPECTION RELAY
LOCATED AT LEFT SIDE VEHICLE AT FLASHER PLATE
(1600) SYSTEM CONTROLLER CONNECTOR
LOCATED AT INSIDE RIGHT SIDE DASH PANEL

Table 119 Post Trip Inspection Circuit Tests

Emergency Exit Relay Voltage Checks Check with emergency exit relay (1020) removed and key in ignition position switch on. **NOTE – Always check connectors for damage and pushed–out terminals.** **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.** Bench test relay. If relay fails, replace relay and see if fault continues.		
Test Points	Spec.	Comments
Emergency exit relay (1020) cavity 1 to ground.	12 ± 1.5 volts	If voltage is missing check for blown fuse F11 and for open or short on circuits A89FD and A12E.
Emergency exit relay (1020) cavity 1 to 2.	0 ± 1.5 volts	If voltage is present check for short to ground in circuits A89FB, A89DB, A89DA, and A89BC.
While voltmeter is still connected to emergency exit relay (1020) from cavity 1 to cavity 2, open emergency exit.		
Emergency exit relay (1020) cavity 1 to 2.	12 ± 1.5 volts	If voltage is missing check for open or short to high in circuits A89FB, A89DB, A89DA, and A89BC.
Leave emergency exit open.		
Emergency exit relay (1020) cavity 5 to cavity 3. **NOTE – Emergency exit should sound at this test.**	0 ± 1.5 volts	If voltage is present or emergency exit buzzer and lights fail to operate, check for open or short on circuits A89FF, A9FA and A9J. Also ensure proper zero volt signal from zero volt reference splice connector (1005) and from ESC (1600) pin 3 on circuits A9H and A9C. If circuits are good, ESC could be malfunctioning and may require reprogramming.
Post Trip Inspection Relay Voltage Checks Check with post trip inspection relay (1021) removed and key in ignition position switch on. **NOTE – Always check connectors for damage and pushed–out terminals.** **NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.** Bench test relay. If relay fails, replace relay and see if fault continues.		
Test Points	Spec.	Comments

Table 119 Post Trip Inspection Circuit Tests (cont.)

Post trip inspection relay (1021) cavity 1 to ground.	12 ± 1.5 volts	If voltage is missing check for blown fuse F11 and for open or short on circuits A89BD and A12E.
Post trip inspection relay (1021) cavity 1 to 2.	0 ± 1.5 volts	If voltage is present check for short to ground in circuits A89BC and A89DA.
While voltmeter is still connected to post trip inspection relay (1021) from cavity 1 to cavity 2, open rear emergency exit.		
Post trip inspection relay (1021) cavity 1 to 2.	12 ± 1.5 volts	If voltage is missing check for open in circuit A89DA.
Post trip inspection relay (1021) cavity 5 to cavity 3.	0 ± 1.5 volts	If voltage is present check for open or short on circuits A89BB and A9BA. Also ensure proper zero volt signal from zero volt reference splice connector (1005) and from ESC (1600) pin 3 on circuits A9H and A9C. If circuits are good, ESC could be malfunctioning and may require reprogramming.

11.4. EXTENDED DESCRIPTION

Refer to Post Trip Inspection Circuits.

The Post Trip Inspection system is armed when the following conditions are met:

- Engine is running
- Red pupil warning lights are activated
- Service door is opened

To disarm the Post Trip Inspection system the following conditions must be met:

- Put transmission in park
- Apply parking brake
- Turn key to accessory position
- Open and close rear emergency exit

The operator will have 60 seconds to disarm the Post Trip Inspection system. If the system is not disarmed in time, then the electric horn will pulse and the headlights will flash for twenty minutes. The Post Trip Inspection system can be disarmed at any time by following the steps above.

If the Post Trip Inspection system was not armed during operation of the CE Bus, then the system will not need to be disarmed.

11.5. COMPONENT LOCATIONS

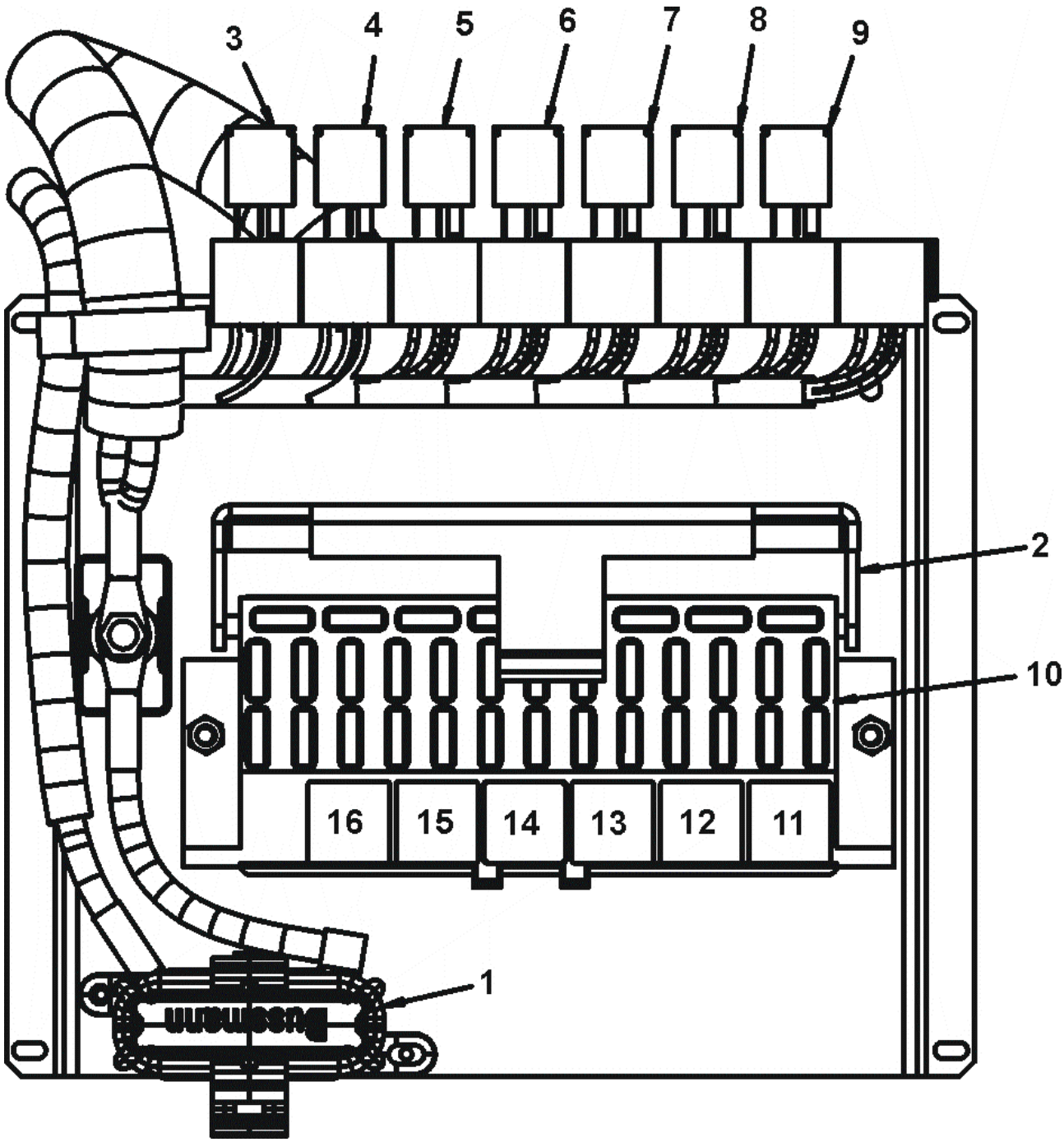

Figure 197 Relay Location Diagram

1. 125 A MAXIFUSE
2. FUSE BLOCK COVER
3. (1015) BACK UP LIGHT RELAY
4. (1017) FOG LIGHT RELAY
5. (1018) AUTO DRAIN VALVE RELAY
6. (1016) BACK UP LIGHT CHECK RELAY
7. (1020) EMERGENCY EXIT RELAY
8. (1021) POST TRIP INSPECTION RELAY
9. (1019) WHEELCHAIR LIFT RELAY
10. (1011) FUSE BLOCK
11. R1 — WIPER POWER RELAY
12. R2 — WIPER HI-LOW RELAY
13. R3 — BODY BUILDER STOP LIGHT RELAY
14. R4 — AIR SOLENOID POWER RELAY
15. R5 — IGNITION RELAY
16. R6 — IGNITION RELAY

12. WHEELCHAIR LIFT CONTROLS

12.1. CIRCUIT FUNCTIONS

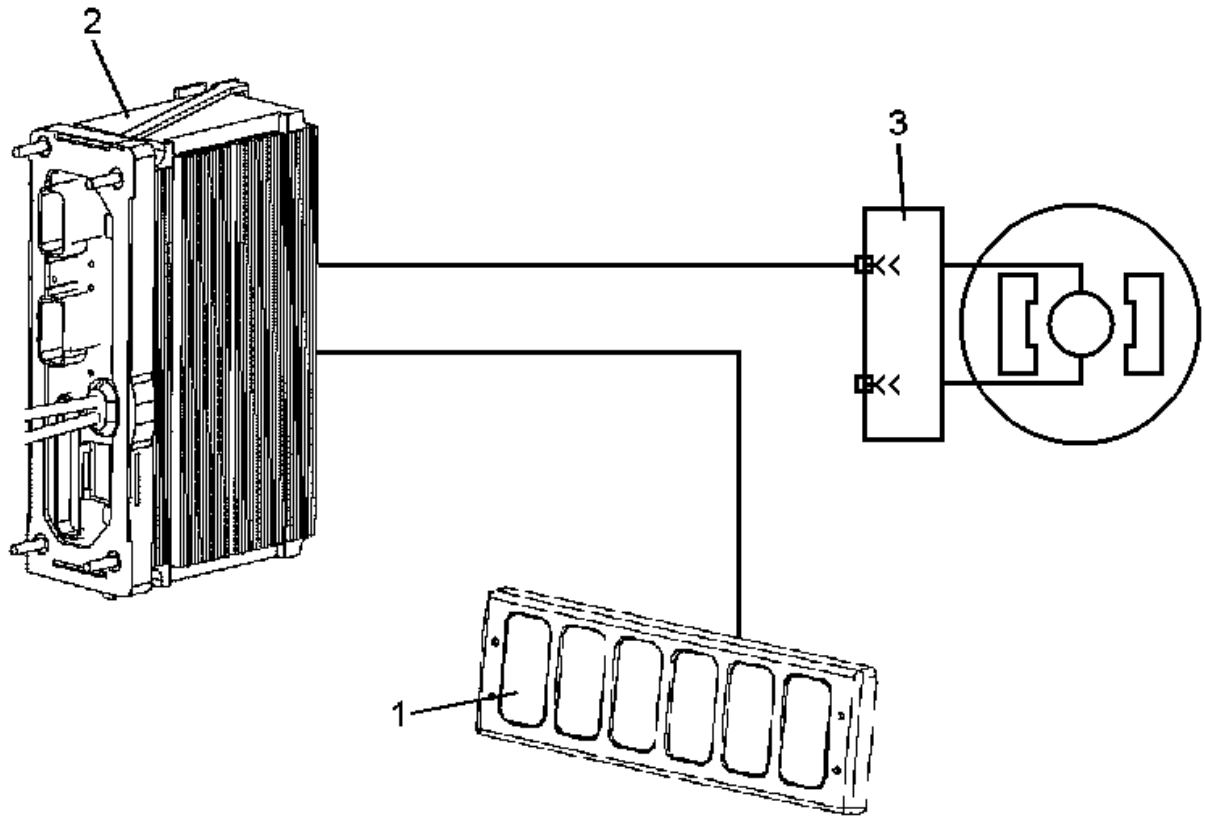

Figure 198 Wheelchair Lift Controls Function Diagram

1. WHEELCHAIR LIFT SWITCH
2. ELECTRONIC SYSTEM CONTROLLER
3. WHEELCHAIR LIFT MOTOR

NOTE – The wheelchair lift will NOT operate unless the park brake is applied, transmission is in neutral and lift door is open.

12.2. DIAGNOSTICS

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 120 Wheelchair Lift Control Diagnostic Trouble Codes

DIAGNOSTIC TROUBLE CODE	FAULT DESCRIPTION
2033 14 11 1	Wheelchair lift solenoid current overload.
2033 14 11 2	Wheelchair lift solenoid open circuit.
2033 14 11 3	Wheelchair lift solenoid shorted to ground.

Wheelchair Lift Controls Preliminary Check

Table 121 Wheelchair Lift Controls Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify operation of wheelchair lift.	Visually check wheelchair lift.	Wheelchair lift does not operate.	Go to next step.	Wheelchair lift is operating correctly.
2.	On	Determine if any other features are malfunctioning that may have common circuits (Example: Missing power or ground common to several features).	Visually 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	Check for diagnostic trouble codes. (See Diagnostic Trouble Codes (DTC), page 412)	Read display on odometer.	**No** Wheelchair lift diagnostic trouble codes are active.	Go to next step.	Go to Fault Detection Management. (See FAULT DETECTION MANAGEMENT, page 413)
4.	On	Go to Fault Detection Management. (See FAULT DETECTION MANAGEMENT, page 413)				

12.3. 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.

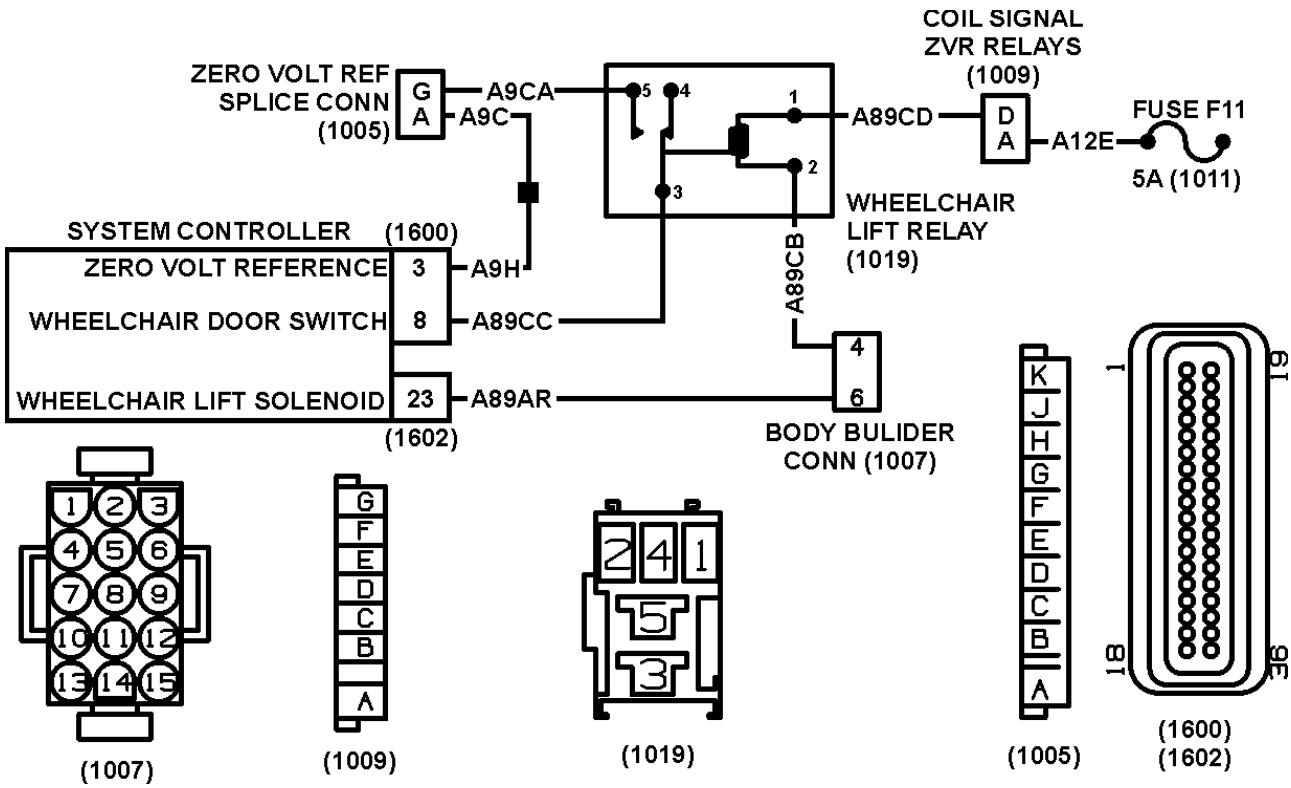

Figure 199 Wheelchair Lift Circuits — Always Refer to the Circuit Diagram Book for Latest Circuit Information

(1005) ZERO VOLT REFERENCE SPLICE CONNECTOR
LOCATED RIGHT SIDE INSTRUMENT PANEL
(1007) BODY BUILDER CONNECTOR
LOCATED AT LEFT SIDE VEHICLE AT FLASHER PLATE
(1009) COIL SIGNAL ZERO VOLT REFERENCE (ZVR) CONNECTOR
LOCATED LEFT SIDE VEHICLE AT FLASHER PLATE
(1011) FUSE BLOCK
LOCATED AT LEFT SIDE VEHICLE AT FLASHER PLATE
(1019) WHEELCHAIR LIFT RELAY
LOCATED AT LEFT SIDE VEHICLE AT FLASHER PLATE
(1600) (1602) SYSTEM CONTROLLER CONNECTOR
LOCATED AT INSIDE RIGHT SIDE DASH PANEL

Table 122 Wheelchair Lift Circuit Tests

Wheelchair Lift Relay (1019) Voltage Checks
Check with wheelchair lift relay (1019) removed, key in ignition position switch on, park brake applied, transmission in neutral, lift door open, and all other relays installed.
NOTE – Always check connectors for damage and pushed–out terminals.
NOTE – Always use breakout box ZTSE 4477 to take measurements on ESC connectors.

Table 122 Wheelchair Lift Circuit Tests (cont.)

Bench test relay. If relay fails, replace relay and see if fault continues.		
Test Points	Spec.	Comments
Wheelchair lift relay (1019) cavity 1 to ground.	12 ± 1.5 volts	If voltage is missing check for blown fuse F11 and for open or short on circuits A89CD and A12E.
Wheelchair lift relay (1019) cavity 1 to cavity 2.	12 ± 1.5 volts	If voltage is missing check for open on circuits A89CD, A12E and circuits connected to lift door switch.
Wheelchair lift relay cavity 5 to cavity 3. **NOTE – Emergency exit should sound at this test.**	0 ± 1.5 volts	If emergency exit buzzer and lights do not sound, check for open or short on circuits A89CC and A9CA. Also ensure proper zero volt signal from zero volt reference splice connector (1005). If circuits are good, ESC could be malfunctioning and require reprogramming.

12.4. EXTENDED DESCRIPTION

Refer to the Wheelchair Lift Circuits.

When the lift door is opened, a circuits will close providing a ground signal at body builder connector (1007) pin 4. This will charge the wheelchair lift relay (1019). The zero volt reference signal from system controller (1600) pin 3 will then be applied to system controller (1600) pin 8. This will signal the system controller that the lift door is open and the lift can be used. A ground signal will then be applied at system controller (1602) pin 23 which will be the ground for the power supply to the lift motor.

The wheelchair lift cannot be activated unless the follow conditions are met:

- Park brake is activated.
- Transmission is placed in neutral (or PB).
- Lift door is open.

If all conditions are met, then power is now supplied to the lift door power relay and wheelchair lift can operate.

12.5. COMPONENT LOCATIONS

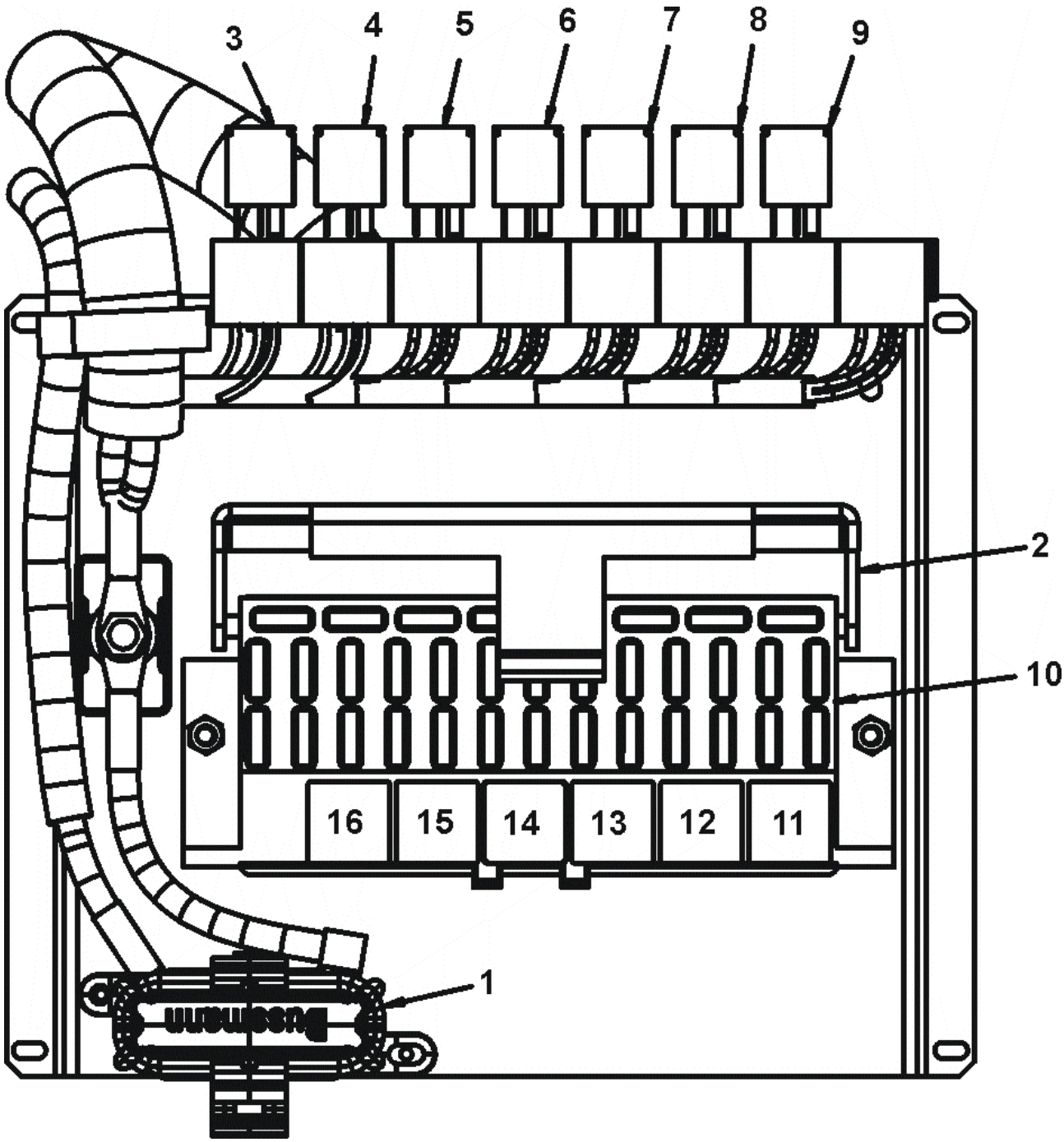

Figure 200 Relay Location Diagram

1. 125 A MAXIFUSE
2. FUSE BLOCK COVER
3. (1015) BACK UP LIGHT RELAY
4. (1017) FOG LIGHT RELAY
5. (1018) AUTO DRAIN VALVE RELAY
6. (1016) BACK UP LIGHT CHECK RELAY
7. (1020) EMERGENCY EXIT RELAY
8. (1021) POST TRIP INSPECTION RELAY
9. (1019) WHEELCHAIR LIFT RELAY
10. (1011) FUSE BLOCK
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16. R6 — IGNITION RELAY