SERVICE MANUAL SECTION

ELECTRICAL SYSTEM TROUBLESHOOTING GUIDE — FE 300, RE 200, RE 300

Model: FE 300
Start Date: 03/01/2004

Model: RE 200
Start Date: 03/01/2004

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Start Date: 03/01/2004

S08296

02/08/2007

Table of Contents

DESCRIPTION

This Guide applies to FE 300 models built March 1, 2004 and after, RE 300 models built March 1, 2004 and after with DT 466E or I 530E engine.

This Guide applies to RE 200 models built March 1, 2004 and after with VT 365 engine.

USE WITH CIRCUIT DIAGRAM BOOK S08297.

Refer to S08313 for FE 300 Instruments.

Refer to S08314 for RE 200 and RE 300 Instruments.

Refer to S04023 for ABS Troubleshooting.

Refer to EGES-175 for DT 466E/I 530E Electronic Engine Control System Circuits Function and Diagnostics.

Refer to EGES-240 for VT 365 Electronic Engine Control System Circuits Function and Diagnostics.

1. FE 300 POWER DISTRIBUTION AND GROUNDS

1.1. DESCRIPTION

Power

The primary power distribution points in the electrical wiring are the batteries, key switch and the main fuse block. For power distribution charts and component system circuit diagrams, refer to Electrical Circuit Diagram Manual S08297.

Ground

The ground system provides a power return path to the vehicle batteries. In this system the major ground point junctions include the J1 platform ground, J3 cab ground, J6 alternator ground, and the J10 engine ground. This section includes a power distribution chart for grounds.

1.2. OPERATION

Twelve Volt Battery Power Distribution (Key Off)

Power is supplied from the vehicle batteries to the cranking motor solenoid terminal “B" over a 4/0 red cable. From the “B" terminal, power is supplied over circuits K90-FL and A90 to the hydraulic brake system pump control relay (85) and over circuits K90-FL, A90A and A90B to the hydraulic brake switch (209).

From the “B" terminal, power is also supplied on circuits K14A—FL, K14–FL, K14A and K14 to the (J2) battery feed stud. Splices along these circuits also supply power to the alternator on circuit K2, to the start relay switch (387) on circuit K17B, and to the ammeter over circuit K26A, and circuit K26 and A26.

From the (J2) feed stud, power is fed on circuit A14 to a splice, which directs the power to the power distribution center fuse panel on circuit A14A, which supplies the horn, stop lights and turn signals; circuit A14C, which supplies the headlights; circuit 19, which supplies the key switch and the heated fuel filter and water-in-fuel systems; and circuit A14B which supplies the ECM2 power relay and diagnostic connector.

Power is also supplied from the (J2) feed stud to the daytime running light system on circuit A66B and to the antilock brake system on circuit A94.

Twelve Volt Power Distribution (Key Switch — Accessory)

With the key switch in the accessory position, power is supplied over circuit A12 to the power distribution fuse panel to supply the daytime running lights, the air dryer, the drain valve and the body builder connector (170) circuits.

From the key switch, power is also supplied to the Delco 21-SI alternator “I" terminal or to the Leece-Neville 105 amp, slow speed alternator ignition terminal, over circuit 1.

Twelve Volt Power Distribution (Key Switch — Ignition or Start)

With the key switch in the ignition position, power is supplied over circuit A13E to the body builder connector (169); circuits 13 and A13A to the fuel heater relay; circuits 13 and 13F to the instrument panel cluster; circuits 13 and 13H to the backup light switch, warning alarm, auto transmission and ether start systems; and 13 and A13T to the radiator shutters. Power is also supplied to the same circuits as listed under the (Key Switch - Accessory) heading above.

With the key switch in the start position, power is supplied to the same circuits as in the ignition position, with the exception of circuits 1 and 12. Power is also supplied to the start interrupt (N/L), neutral position switch (N/L) and the start relay (387).

Grounds and Junction Points

Refer to Figure 1 and Figure 2.

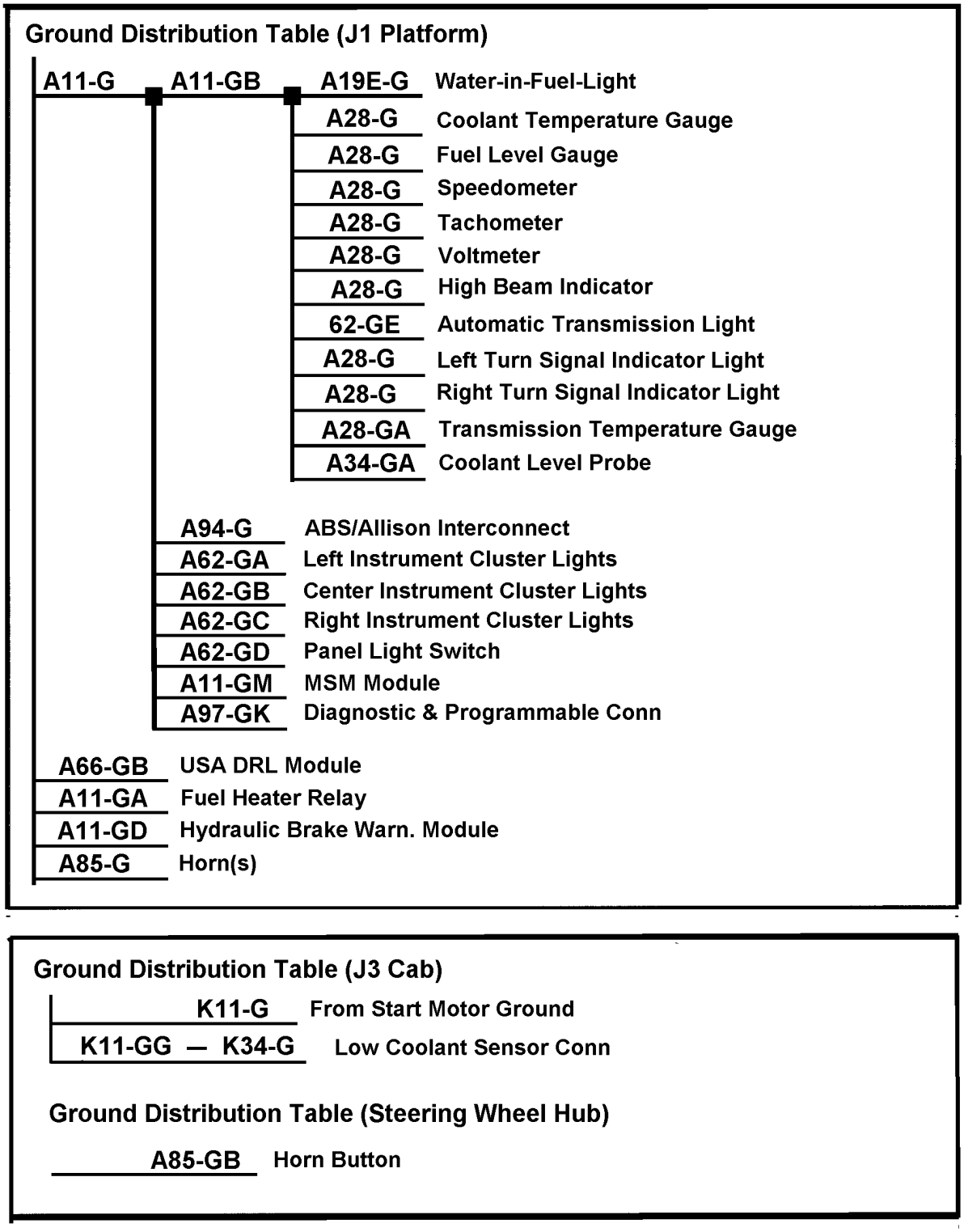
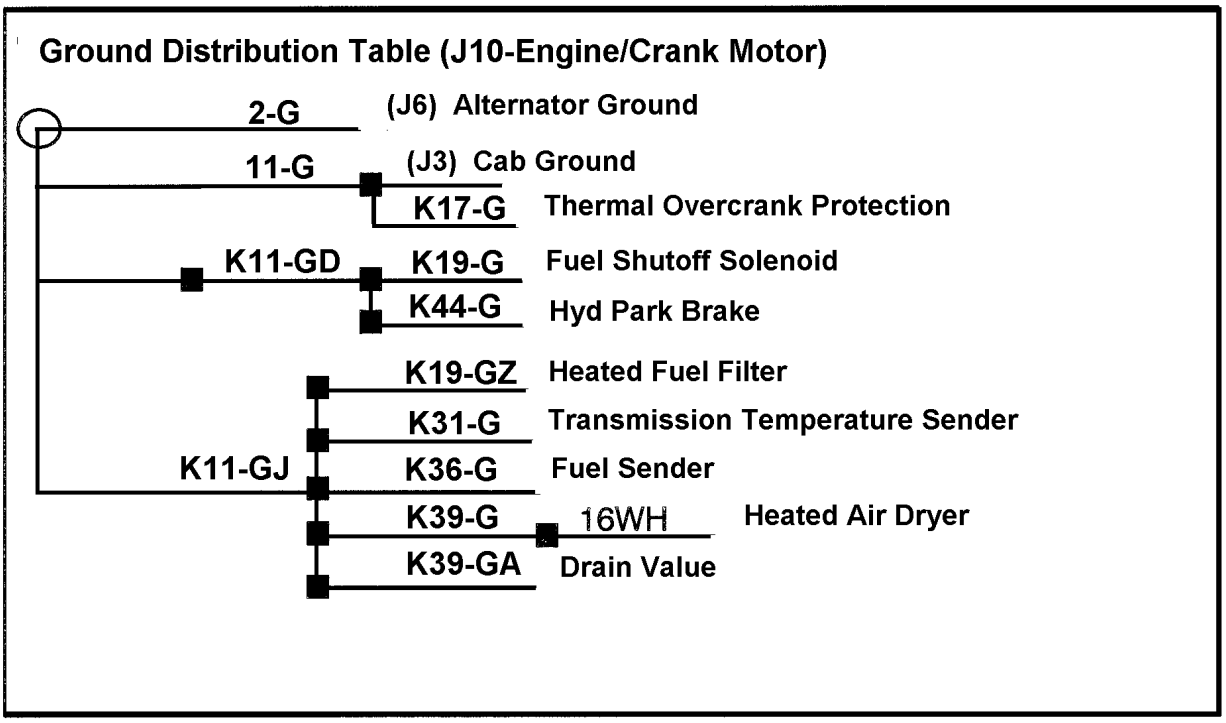
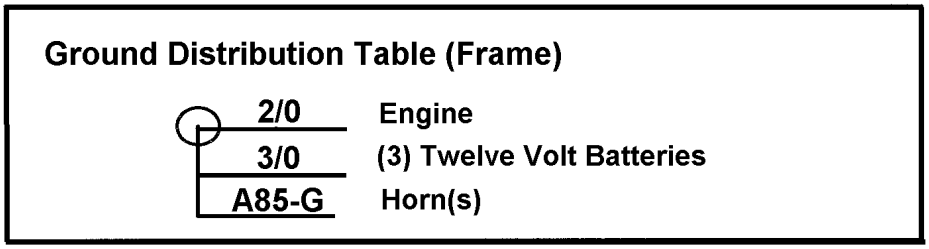


Figure 1 Ground Distribution Tables





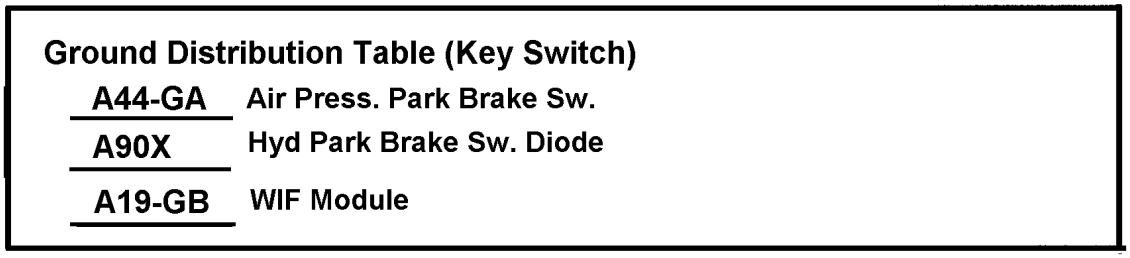


Figure 2 Ground Distribution Tables (Cont.)

1.3. TROUBLESHOOTING

Before beginning these test procedures, do the following:

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

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

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

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

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

12 Volt Power Distribution (Key Off)

Table 1 12 Volt Power Distribution (Key Off)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	At "B" stud of cranking motor solenoid, measure voltage to ground.	"B" stud to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in 4/0 red cable from battery, then repair.
2.	Off	At start relay (387), measure voltage from circuit K17B to ground.	(387), K17B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit K17B, then repair.
3.	Off	At alternator (J5), measure voltage from circuit K2 to ground.	(J5), K2 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit K2, then repair.
4.	Off	At (J2) battery feed stud and circuit A14, measure voltage to ground.	(J2), A14 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit K14–FL, K14A-FL, K14A, or A14, then repair.
5.	Off	At fuse F1 and circuit A90A, measure voltage to ground.	F1, A90A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A90A, then repair.

Table 1 12 Volt Power Distribution (Key Off) (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
6.	Off	At fuse F5 and circuit A66B, measure voltage to ground.	F5, A66B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A66B, then repair.
7.	Off	At fuse F12 and circuit A14A, measure voltage to ground.	F12, A14A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A14A, then repair.
8.	Off	At fuse F14 and circuit A14C, measure voltage to ground.	F14, A14C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A14C, then repair.
9.	Off	At fuse F17 and circuit A19, measure voltage to ground.	F17, A19 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A19, then repair.
10.	Off	At fuse F21 and circuit A62, measure voltage to ground with the headlight switch on.	F21, A62 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A62, then repair.
11.	Off	At fuse F34 and circuit A94, measure voltage to ground.	F34, A94 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A94, then repair.
12.	Off	Battery power distribution circuits check good.				

12 Volt Power Distribution (Key Accessory, Ignition, Start)

Table 2 12 Volt Power Distribution (Key Accessory, Ignition, Start)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Disconnect key switch connector (20) and measure voltage from circuit A15 to ground.	(20), A15 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A15, then repair.
2.	Acc	At key switch (20), measure resistance from Pin “Bat” to Pin “Acc.”	(20), Pin “Bat” to Pin “Acc.”	< 1 ohm.	Go to next step.	Replace defective key switch.
3.	On	At key switch (20), measure resistance from Pin “Bat” to Pin “Ign.”	(20), Pin “Bat” to Pin “Ign.”	< 1 ohm.	Go to next step.	Replace defective key switch.

Table 2 12 Volt Power Distribution (Key Accessory, Ignition, Start) (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
4.	Start	At key switch (20), measure resistance from Pin “Bat” to Pin “St.”	(20), Pin “Bat” to Pin “St.”	< 1 ohm.	Go to next step.	Replace defective key switch.
5.	Off/ On	Reconnect key switch (20) and turn key on. At alternator stud “I” (Delco 21–SI or Leece-Neville 105 amp slow speed), measure voltage to ground.	Alternator stud “I” to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 1, 1A, 1RW, or 16 TBL wire, then repair.
6.	On	At fuse F8 and circuit A12, measure voltage to ground.	F8, A12 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A12, then repair.
7.	On	At fuse F20 and circuit A13A, measure voltage to ground.	F20, A13A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A13A, then repair.
8.	On	At fuse F23 and circuit A13F, measure voltage to ground.	F23, A13F to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A13F, then repair.
9.	On	At fuse F25 and circuit A13H, measure voltage to ground.	F25, A13H to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A13H, then repair.
10.	On	At fuse F26 and circuit A13E, measure voltage to ground.	F26, A13E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A13E, then repair.
11.	On	At fuse F29 and circuit A13T, measure voltage to ground.	F29, A13T to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A13T, then repair.
12.	Off/ Start	Remove start interrupter connector (N/L), and with key held in start position, measure voltage from circuit K17S to ground.	(N/L), K17S/ K17A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit K17S, then repair.
13.	Off	Key switch power distribution circuits check good.				

1.4. COMPONENT LOCATIONS

(1) Fuse Block Panel	Left Side of Steering Column Support
(2) Platform Harness Dash Connector	Inside of Front Dash Panel
(2A) Engine Harness Cab Connector	Outside of Front Dash Panel
(20) Key Switch	Right Side of Instrument Cluster
(J1) Platform Ground	Inside Platform Below Oil Pressure Anchor Coupling
(J2) Battery Feed Stud	Inside Platform Left of Platform Harness Dash connector
(J3) Cab Ground	Front Side of Platform Below Oil Pressure Anchor Coupling
(J5) Alternator Feed	"BAT" (+) Stud on Alternator
(J6) Alternator Ground	"GND" (-) Stud on Alternator
(J8) Crank Motor Solenoid Battery Feed	"B" Stud on Crank Motor Solenoid
(J10) Engine Ground	Left Side, Flywheel Housing to Frame Rail (Pre-October 1996)
(J10) Crank Motor Ground Stud	Crank Motor (October 1996 and Later)

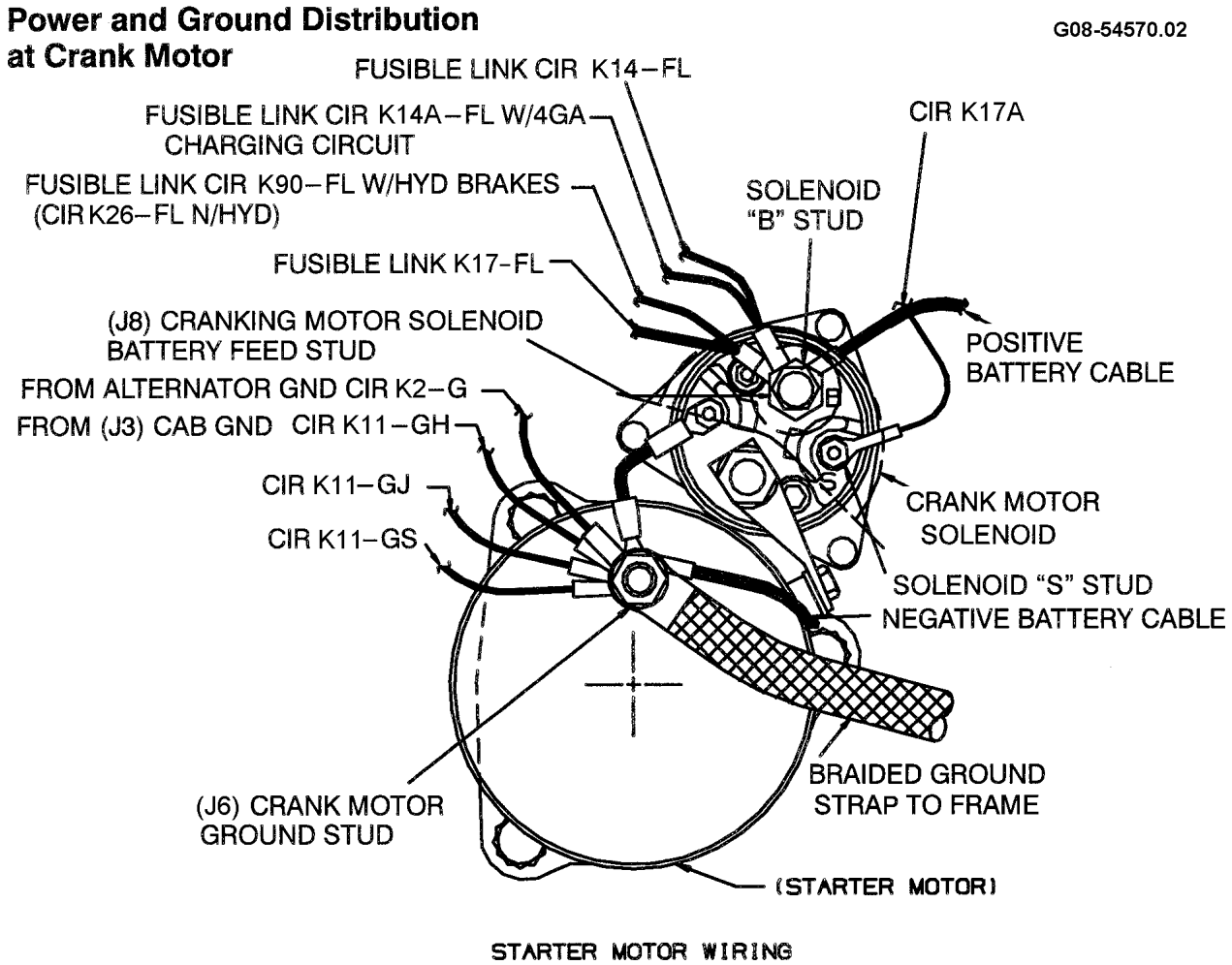


Figure 3 Power and Ground Distribution at Crank Motor

Power and Ground Distribution at Alternator G08-55085.12

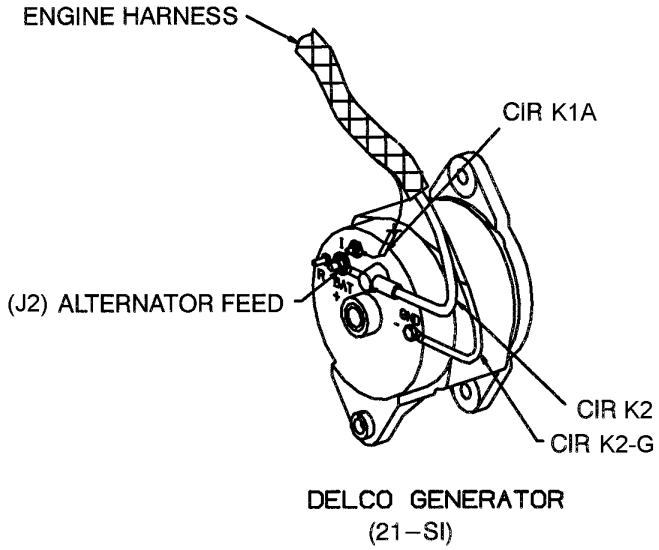


Figure 4 Power and Ground Distribution at Alternator

Power and Ground Distribution
Front Side of Platform

G08-55085.04

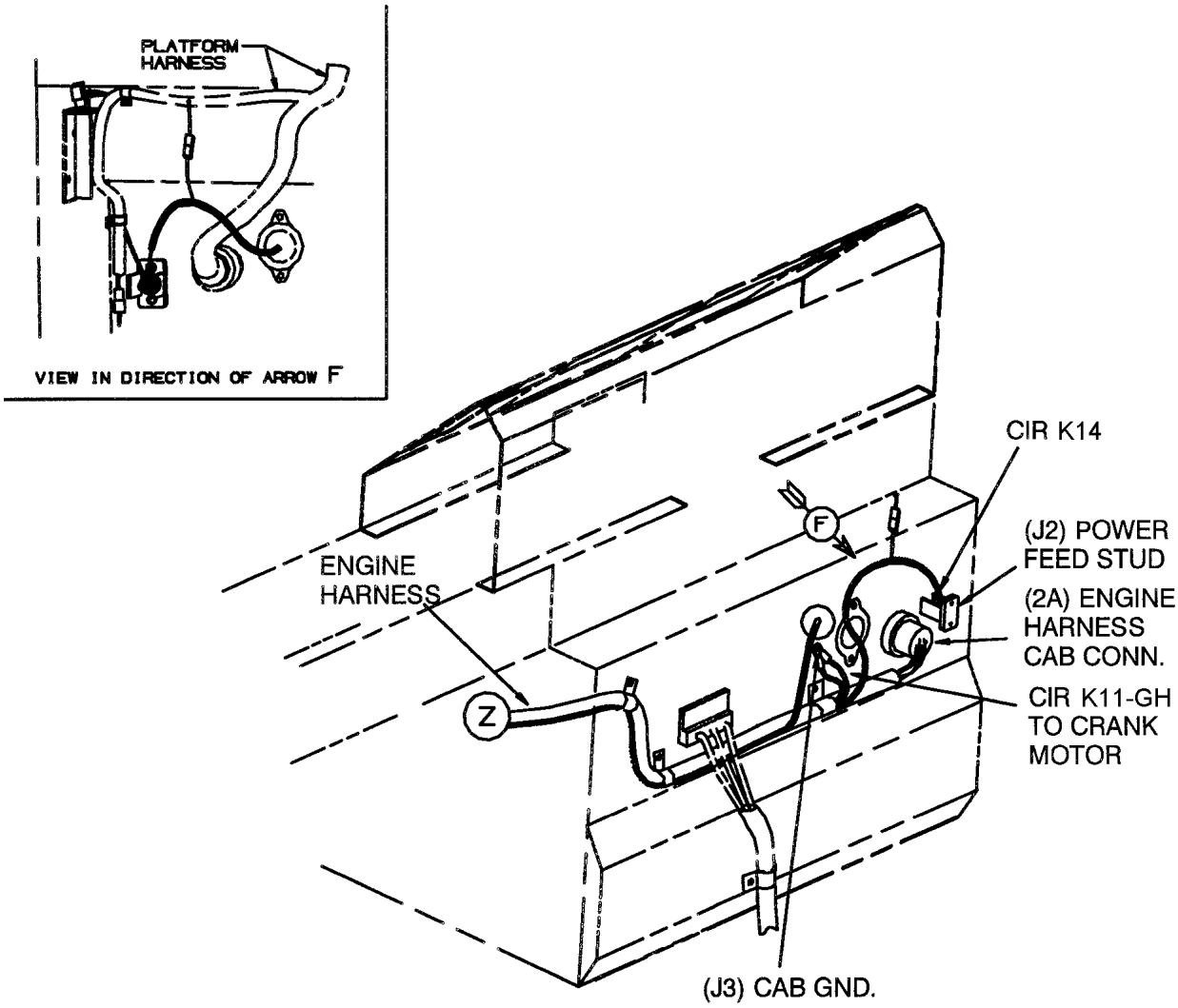


Figure 5 Power and Ground Distribution Front Side of Platform

Power and Ground Distribution Inside Platform

G08-55085.01.E

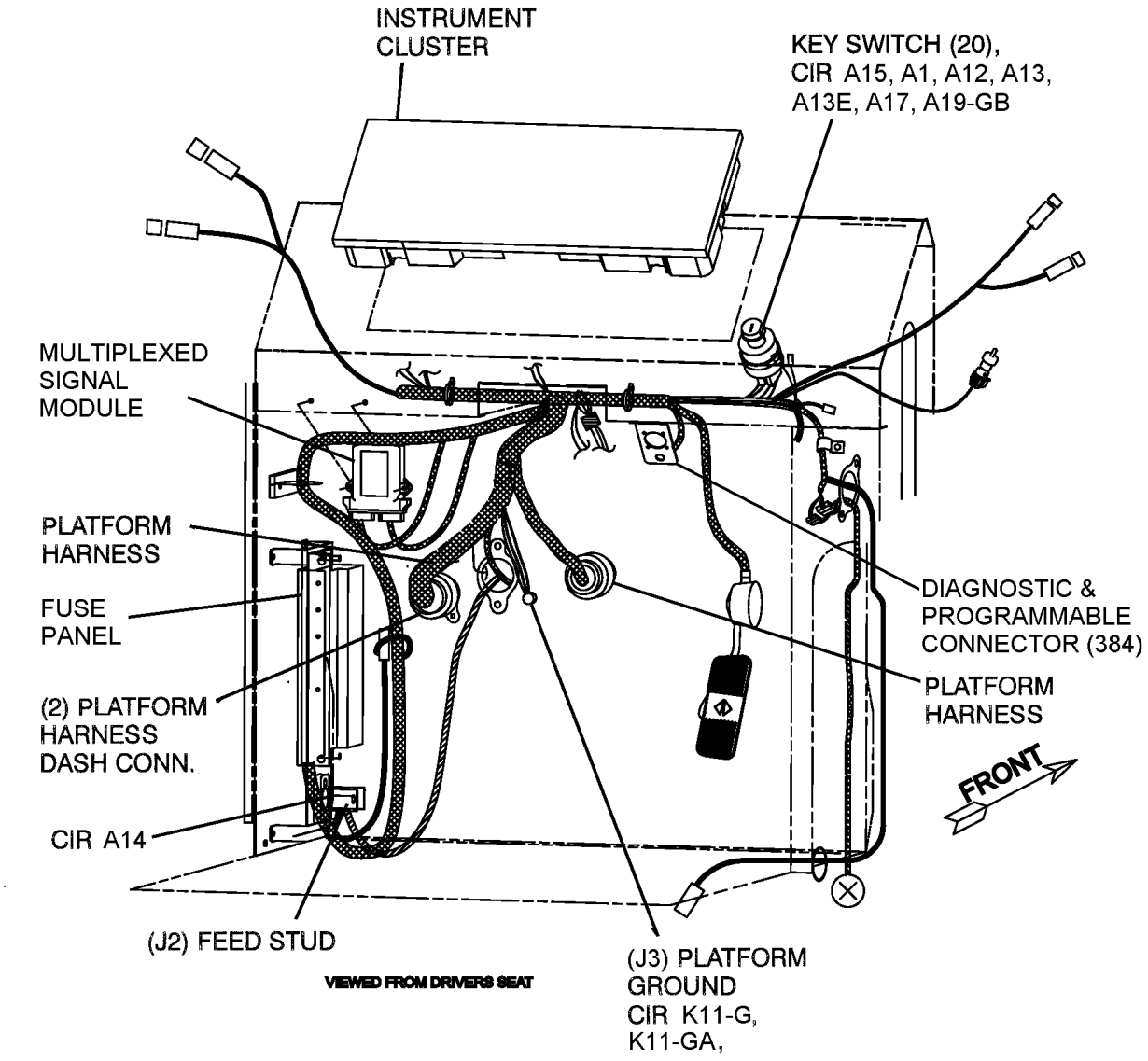
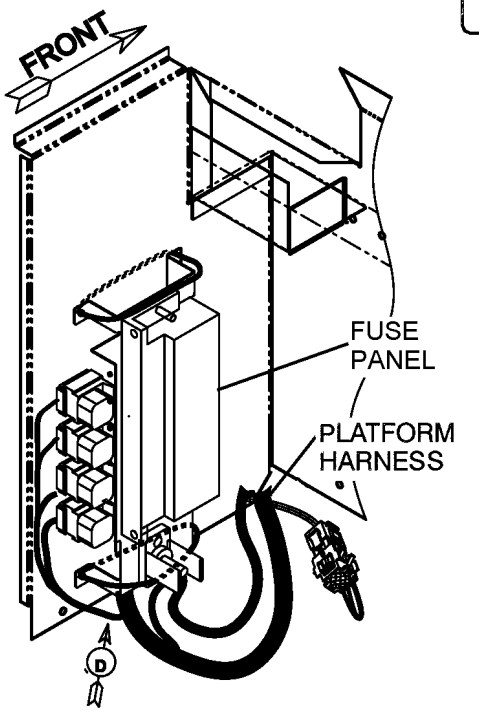
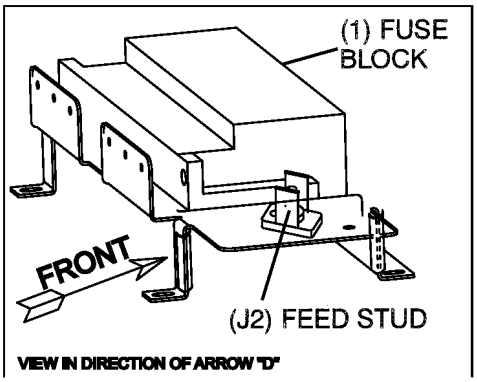


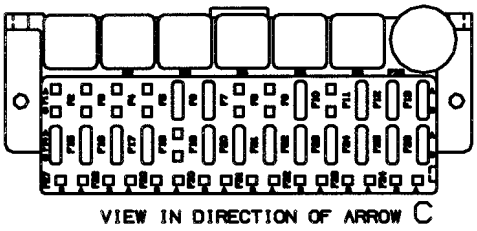
Figure 6 Power and Ground Distribution Inside Platform

Power Distribution at Fuse Panel

G08-55085.08.F







FUSE LOCATION	AMPERE RATING	DESCRIPTION
F1	10	HYD BRAKE SWITCH (A90A/A90B/A97DK)
F2	10	HYD BRAKE MONITOR MODULE (A90U/A90T)
F3	20	ECM2 PWR RELAY AND DIAGNOSTIC CONN (A14B/A97C/A97HA)
F4	----	NOT USED
F5	10	DAYTIME RUNNING LIGHTS (A66/A66A)
F6	10	DAYTIME RUNNING LIGHTS (A12B/A66B)
F7	10	AIR DRYER (A12/A12B/A39A)
F8	10	DRAIN VALVE RELAY (A12/A39A)
F9	10	BODY CONNECTIONS (A12/A12D)
F10	10	NIPS OR CPS (A13K/A97P/A99E)
F11	20	HORN (A14A/A85)
F12	10	STOP LIGHTS (A14A/A70B/A70/A97DK)
F13	20	TURN SIGNALS (A14A/A55A)
F14	10	PANEL AND PARKLIGHTS (A14C/50A)
F15	20	HEADLIGHTS (A14C/A50)
F16	30	KEY SWITCH (A19/A15)
F17	20	FUEL HEATER (A19/A19H/A66)
F18	----	NOT USED
F19	5	IGN FEED TO ECM2 (A13K/A13A)
F20	10	IGN FEED TO FUEL HEATER RELAY (A13A/A19D)
F21	5	PANEL LIGHTS (A62/A62A)
F22	5	INSTRUMENT CLUSTER (A13F/A28/A97B)
F23	10	(A13F/A39D)
F24	10	BACKUP LIGHT SWITCH WARNING ALARM (A13H/A71/A13B)
F25	----	NOT USED
F26	10	IGN FEED BODY BUILDER CONNECTOR (A13E/A13D)
F27	10	ANTILOCK BRAKE SYSTEM AIR/HYD (A13C/A13L/A13J/A94D)
F28	----	NOT USED
F29	5	ENGINE COOLING (A13T/A23Z)
F30	10	CRUISE CONTROL/ENGINE CONTROL (A13U/A97UA)
F31	10	MSM MODULE (A13P/A13MS)
F32	----	NOT USED
F33	----	NOT USED
F34	30	ABS POWER RELAY AIR/HYD (A94/A94A)

Figure 7 Power Distribution at Fuse Panel

2. FE 300 CAB ACCESSORIES

2.1. DESCRIPTION

Horn(s)

The single electric horn or optional dual electric horns, located at the base of the engine cowl, provide a means for the driver to signal a warning.

Turn Signal Switch

Turn signals provide a driver with the means to signal oncoming traffic or following vehicles of intended turns or lane changes.

2.2. OPERATION

Horn(s)

Power is applied from the battery feed stud (J2) to circuit A14D/A14A, fuse F11, and circuit A85 to the coil of the horn relay (R6). When the horn button is depressed, power flows through the horn relay coil, circuit A85A, an in-line connector (14), pin 1, circuit A85A, another in-line connector, and circuit A85A to the steering wheel slip ring. From the slip ring, power flows through circuit A85A, the horn button switch and circuit A85-GB to the steering column ground.

With the horn relay energized, power flows from circuit A85, through circuit A85B, the horn relay (R6), circuit A85C, to the high note horn and circuit A85D to the low note horn,. The horns are grounded through the mounting bolts, and through circuit A85-G to the platform ground (J1).

Turn Signals

Power for the turn signal circuitry is supplied by the feed stud (J2) through circuit A14/A14A, fuse F13, and circuit A55 to the flasher unit (1) (F35). Power is then supplied through circuit A55A/A60, turn signal jumper harness connector (13), pin C, and circuit A55A/A60 to the turn signal switch (62) [through circuit A55A/60, turn signal jumper harness connector (13), pin C, and circuit A55A/60 to the turn signal switch (95) with tilt steering column].

When the turn signal is moved to the left turn position, the switch contacts close and power is applied to the jumper harness circuit A56, jumper connector (13), pin D, and circuit A56 to a splice. From the splice, power is supplied to the body builder connector (169), pin F, on circuit A56C. From the splice, power is also applied through circuit A56B, the green dash cluster connector (11), pin 6, and a printed circuit board to the left turn indicator light. The light is grounded through the printed circuit, connector (11), pin 2, and circuit A28-G/A11-G to the platform ground (J0).

From the turn signal switch, power is also supplied to the body builder connector (170), pin E, through the jumper harness circuit A56A, jumper connector (13), pin E, and circuit A56A.

When the turn signal is moved to the right turn position, the switch contacts close and power is applied to the jumper harness circuit A57, jumper connector (13), pin F, and circuit A57 to a splice. From the splice, power is supplied to the body builder connector (169), pin G, on circuit A57C. From the splice, power is also applied through circuit A57B, the green dash cluster connector (11), pin 12, and a printed circuit board to the right turn indicator light. The light is grounded through the printed circuit, connector (11), pin 2, and circuit A28-G/A11-G to the platform ground (J0).

From the turn signal switch, power is also supplied to the body builder connector (170), pin B, through the jumper harness circuit A57A, jumper connector (13), pin A, and circuit A57A.

When the hazard button is pushed, switch contacts close and power is applied to all of the previously discussed feed circuits. This causes the indicator lights to flash and any lights connected to the turn signal circuitry in the body builder connectors (169) and (170).

2.3. TROUBLESHOOTING

Before beginning these test procedures, do the following:

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

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

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

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

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

Electric Horn(s)

Table 3 Electric Horn(s)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove fuse F11 and check for open condition.	F11	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	Off	Remove horn relay (R6) and re-install fuse F11. At relay connector, measure voltage from cavity 86 to ground.	(R6), cav. 86 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A85, then repair.
3.	Off	At (R6) cavity 86, measure voltage from circuit A85 to ground.	(R6) cav. 86, A85 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A85/A85B, then repair.
4.	Off	At (R6) cavity 30, measure voltage from circuit A85B to ground.	(R6) cav. 30, A85B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A85B/A85, then repair.

Table 3 Electric Horn(s) (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
5.	Off	Bench test horn relay by measuring resistance from cavity 30 to 87A.	(R6) cav. 30 to 87A.	<1 ohm.	Go to next step.	Replace horn relay.
6.	Off	Bench test horn relay by applying +12 volts to cavity 85, ground to cavity 86, and measuring resistance from cavity 30 to 87.	Energized relay, cav. 30 to 87.	<1 ohm.	Go to next step.	Replace horn relay.
7.	Off	With horn button depressed, at (R6) measure voltage between circuit A85 cavity 86, and circuit A85A cavity 85.	(R6), A85 cav. 86 to A85A cav. 85.	12 ± 1.5 volts.	Go to next step.	Locate cause of open or poor connection in circuit A85A, horn harness conn. (14), pin 1, the blue wire, slip ring, the horn button or the steering column ground, then repair.
8.	Off	At (R6) use a test lead to jumper circuit A85A cavity 30 to A85C cavity 87. Does horn sound?			Install relay. Horn circuits check good.	Leave test lead connected and go to next step.
9.	Off	Disconnect horn harness connector (2), pin C4 and measure voltage from circuit A85C to ground.	(2), pin C4, A85C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A85C dash conn. (2), pin C4, then repair.
10.	Off	At (2), pin C4, measure voltage from circuit A85–G.	(2), pin C4, A85–G.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A85–G, then repair.
11.	Off	Reconnect (2), pin C4, and disconnect high-note horn connector, measure voltage from circuit A85C (At circuit A85D w/dual horns) to ground.	Horn. A85C or A85D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A85C or A85D, then repair.

Table 3 Electric Horn(s) (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
12.	Off	At Horn, measure voltage from circuit A85C (circuit A85D w/dual horns) to circuit A85–G (A85–G w/dual horns).	Horn, A85C or A85D to A85–G or A85–G	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A85–G or A85–G w/ dual horns), then repair. Install horn relay and reconnect Horn.
13.	Off	Circuits check good. Reconnect Horn, and install horn relay.				

Turn Signal System

Table 4 Turn Signal System

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove fuse F13 and check for open condition.	F13	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	Off	At fuse F13, measure voltage from A14/A14A to ground.	F13, A14/A14A to gnd.	12 ± 1.5 volts.	Install fuse. Go to next step.	Locate cause of low or no voltage in circuit A14/A14A, then repair. Install fuse.
3.	Off	Remove flasher (F35) and at socket, measure voltage from cavity B, circuit A55 to ground.	(F35), cav. B, A55 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A55, then repair.
4.	Off	At socket (F35), install jumper from circuit A55 cavity B to A55A/A60 cavity A. Move turn lever to left and right turn positions. Then push hazard switch. Do lights illuminate at each position?		Turn signal/ hazard lights illuminate in each position.	Replace flasher.	Go to next step.

Table 4 Turn Signal System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
5.	Off	Disconnect turn signal harness connector (13). At platform connector, measure voltage from cavity C, circuit A55A/A60 to ground.	(13) , cav. C, A55A/A60 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A55A/A60 then repair.
6.	Off	Is vehicle equipped with a tilt steering column?			Go to Step 10.	Go to next step.
7.	Off	Move turn signal lever to left turn position. At turn signal connector (13), measure resistance from cavity C, circuit A55A/A60 to cavity D, circuit A56, and from cavity C, circuit A55A/A60 to cavity E, circuit A56A.	(13), cav. C, A55A/A60 to cav. D, A56 and cav. C A55A/A60 to cav. E, A56A.	< 1 ohm each circuit.	Go to next step.	Locate open in circuits A55A/A60 A56 or A56A, then repair. If none found, replace turn signal.
8.	Off	Move turn signal lever to right turn position. At turn signal connector (13), measure resistance from cavity C, circuit A55A/A60 to cavity A, circuit A57A and from cavity C, circuit A55A/A60 to cavity F, circuit A57.	(13), cav. C, A55A/A60 to cav. A, A57A and cav. C, A55A/A60 tocav. F, A57.	< 1 ohm each circuit.	Go to next step.	Locate open in circuit A57 or A57A, then repair. If none found, replace turn signal.
9.	Off	Push hazard switch and at (13), measure resistance from cavity C to all other cavities.	(13), cav. C to all other cavities.	< 1 ohm each circuit.	Go to next step.	Replace turn signal.
10.	Off	Reconnect (13) and disconnect body builder connector (170). With turn signal lever in the left turn position, measure voltage from circuit A56A to ground.	(170), A56A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A56A, then repair.
11.	Off	With turn signal lever in the right turn position, at (170), measure voltage from circuit A57A to ground.	(170), A57A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A57A, then repair.

Table 4 Turn Signal System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
12.	Off	Reconnect (170) and disconnect body builder connector (169). With turn signal lever in the left turn position, measure voltage from circuit A56C to ground.	(169), A56C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A56C/A56, then repair.
13.	Off	With turn signal lever in the right turn position, at (169), measure voltage from circuit A57C to ground.	(169), A57C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A57C/A57, then repair.
14.	Off	Reconnect connector (169). Does left turn signal indicator illuminate when lever is moved to the left turn position?			Go to Step 18.	Go to next step.
15.	Off	Disconnect green dash cluster connector (11). With lever in left turn position, measure voltage from circuit A56B to ground.	(11), A56B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A56B, then repair.
16.	Off	At (11), measure voltage across circuit A56B to circuit A28–G.	(11), A56B to A28–G.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A28–G/ A11–G, then repair.
17.	Off	Circuits to left turn indicator check good. Reconnect (11) and with lever in left turn position, does indicator light illuminate?			Go to next step.	Replace bulb and socket. If light still fails to illuminate, replace instrument cluster.
18.	Off	Does right turn signal indicator illuminate when lever is moved to the right turn position?			Install flasher. End test.	Go to next step.
19.	Off	Disconnect green dash cluster connector (11). With lever in right turn position, measure voltage from circuit A57B to ground.	(11), A57B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A57B, then repair.

Table 4 Turn Signal System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
20.	Off	At (11), measure voltage across circuit A57B to circuit A28–G.	(11), A57B to A28–G.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A28–G/A11–G, then repair.
21.	Off	Circuits to right turn indicator check good. Reconnect (11) and with lever in right turn position, does indicator light illuminate?			Install flasher. End test.	Replace bulb and socket. If the light still fails to illuminate, replace instrument cluster.

2.4. COMPONENT LOCATIONS

(F35) Turn Signal Flasher..... Inside Cab Relay Panel
(13) Front End Connector..... At Cowl Grommet, Front Side of Cowl
(11) Green Instrument Cluster Connector ..... Behind Instrument Cluster
(123) High-Note Horn Connector..... Lower Left Front Side of Cowl
(134) Engine/Horn Harness Connector..... Left Side of Brake Cylinder and Pump
(193) Turn Signal Switch Connector..... Above and Left of Pedal Support Bracket
(194) Body Builder Connector..... Left Side of Cab Fuse Panel
(222) Cab/Horn Harness Connector..... Above and Left of Pedal Support Bracket
(477) Low-Note Horn Connector..... Lower Left Front Side of Cowl
(590) Cowl Power Distribution Center..... Fuse/Relay Panel, Right Side of Cowl
(R6) Horn Relay..... Inside Power Distribution Panel

Horn Wiring

G08-55085.01

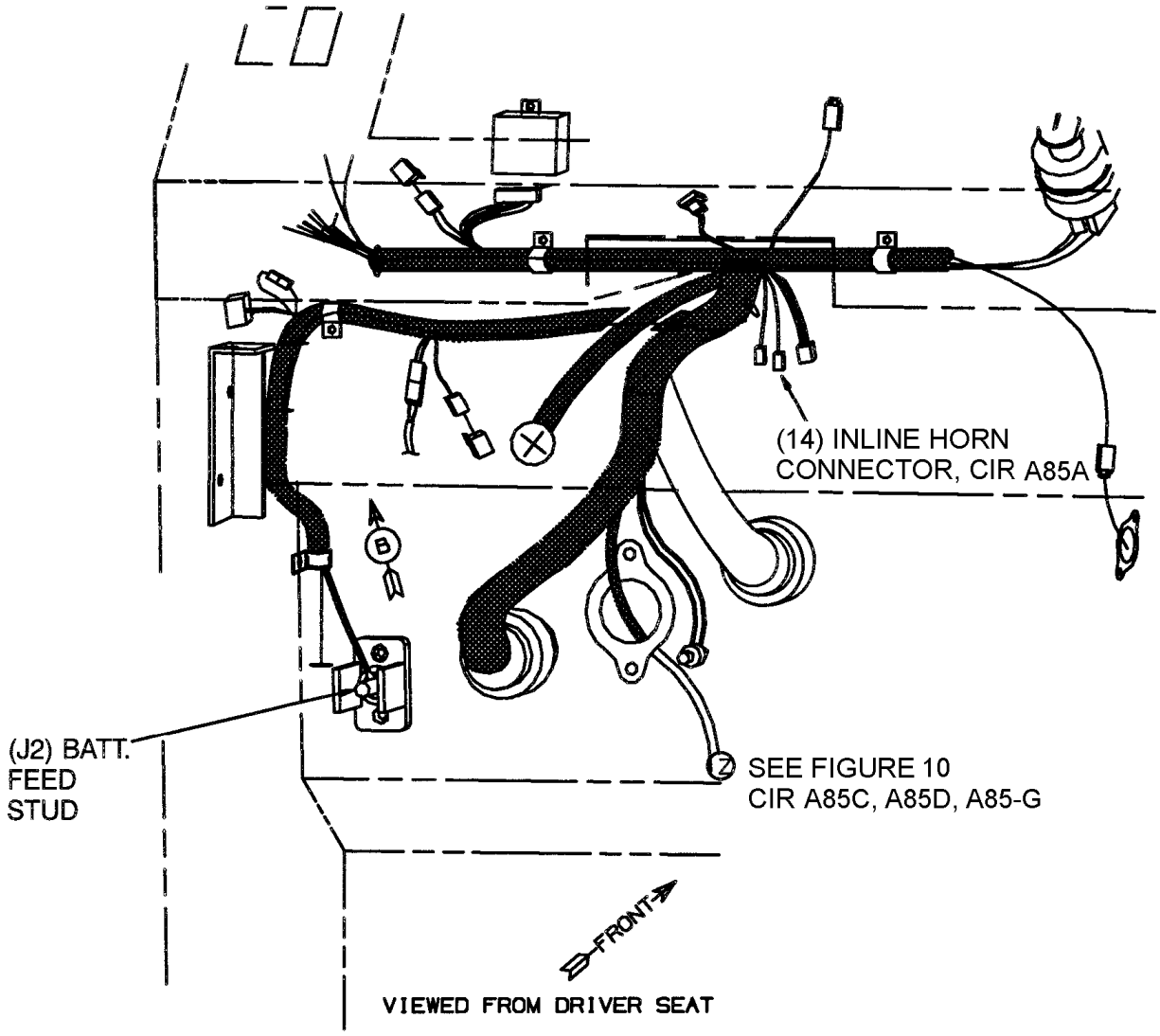


Figure 8 Horn Wiring

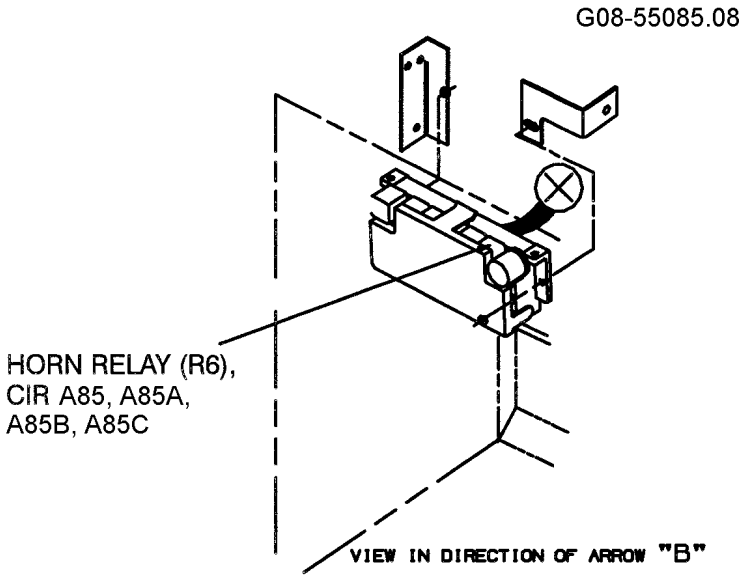


Figure 9 Horn Wiring

Horn Wiring

G08-55085.07

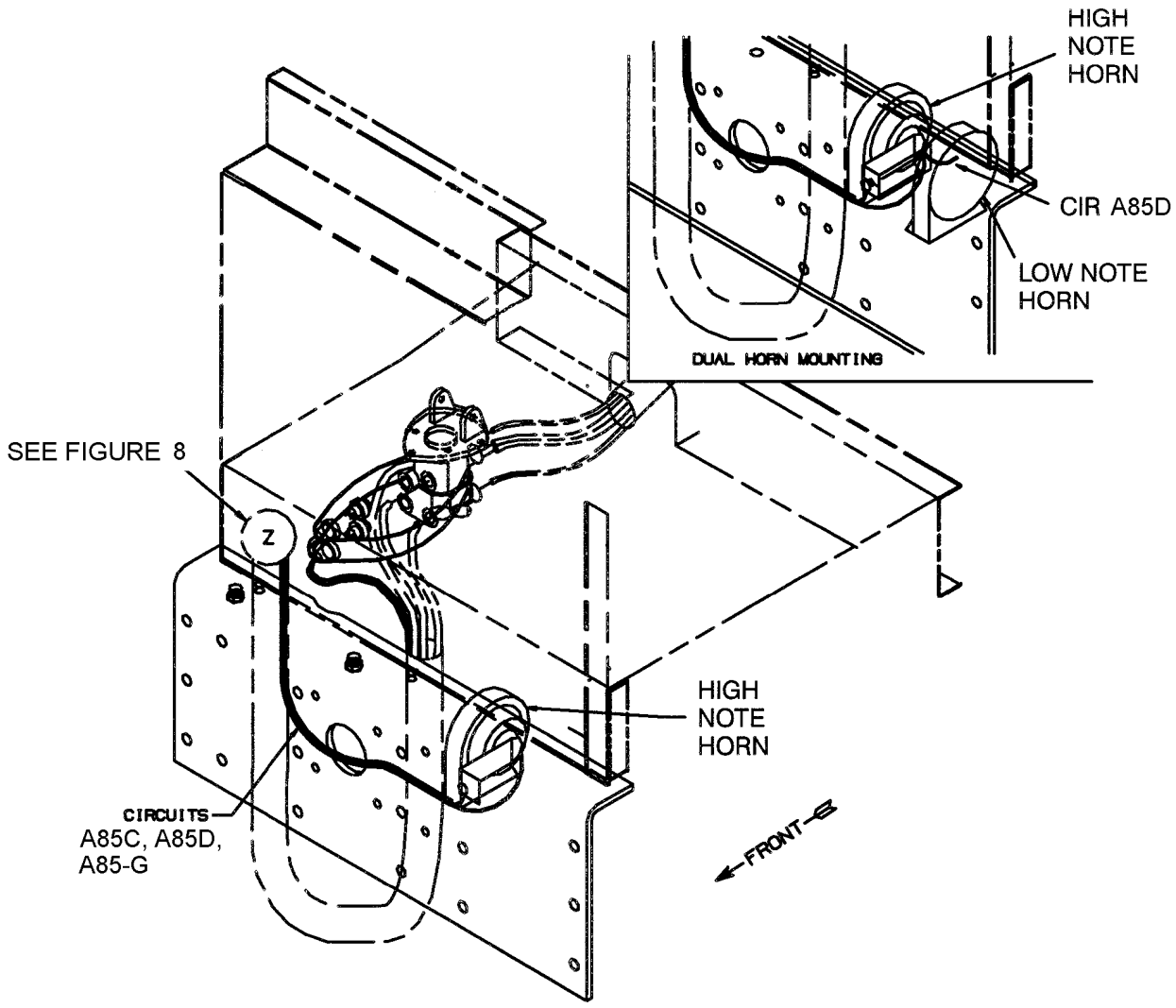


Figure 10 Horn Wiring

Horn Wiring

Y08−98157.01.

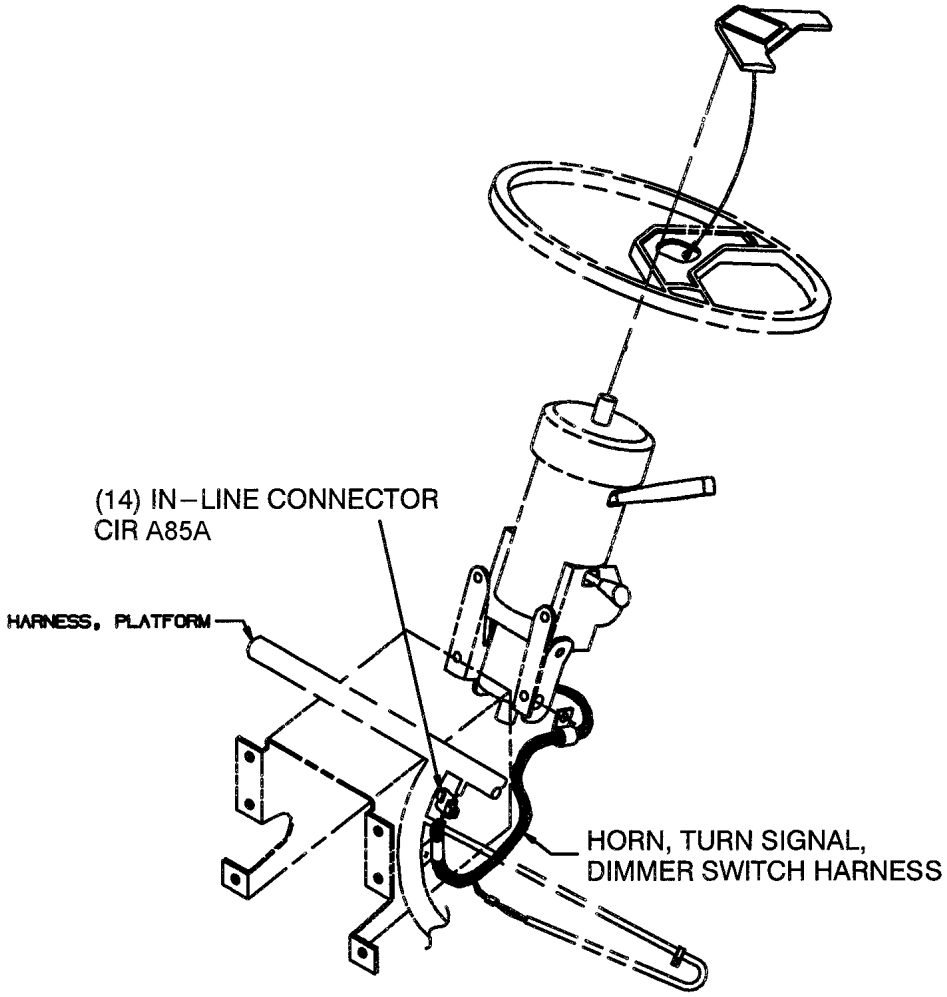


Figure 11 Horn Wiring

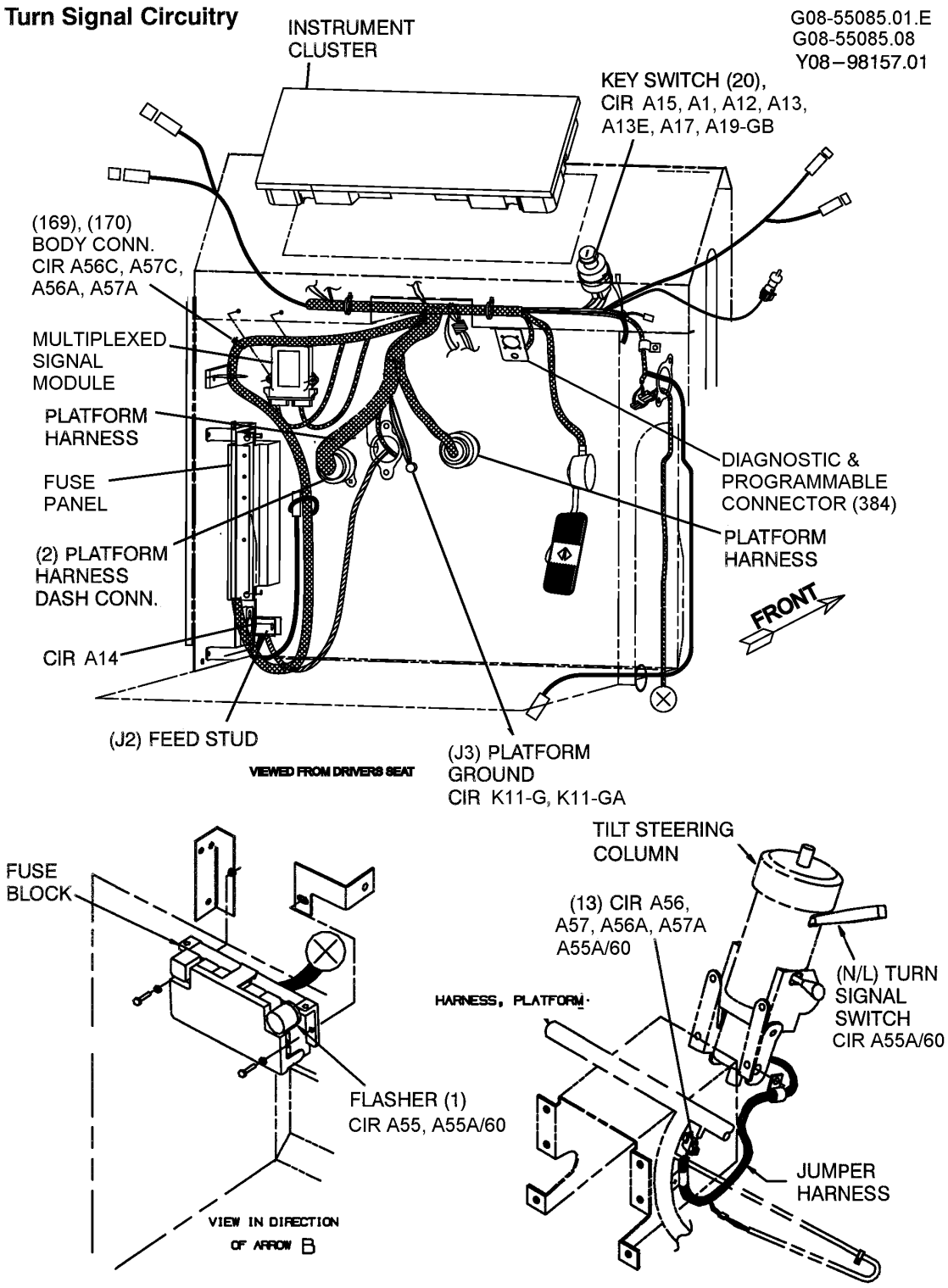


Figure 12 Turn Signal Circuitry

3. FE 300 BATTERY, CHARGING AND CRANKING SYSTEMS

3.1. DESCRIPTION

Battery Power

There are three main functions of the storage battery:

1. To supply power to the start and ignition system so the engine can be cranked and started.

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

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

Cranking Motor System

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 consist of the crank motor and solenoid, the key start switch, the start relay, a time delay crank relay, the Electronic Control Module (ECM2), and a neutral position switch.

Cranking Motor System — Cranking Motor Thermal Overcrank Protection

Excessive engine cranking will cause an overheat condition and damage the vehicle crank motor. On vehicles equipped with thermal overcrank protection, when the crank motor temperature exceeds a pre-set thermal overcrank limit, the thermal switch will open which causes the crank motor to disengage. When the crank motor cools, the switch closes and allows the motor to operate again.

Charging System

The Delco 21-SI, 12 volt, 100-ampere capacity, brush and slip ring type alternator is standard on the FE 300 model. It is a high-output, integral charging system alternator with a built-in diode rectifier and a solid state integrated circuit voltage regulator. The system produces DC current to operate the vehicle electrical systems and charge the batteries.

Charging System — Ammeter

An ammeter gauge is an optional part of the charging system and is used to measure amperage (continuous current) in the electrical system.

3.2. OPERATION

Battery Power

The vehicle batteries are connected in parallel and provide power, via the positive battery cable, to the cranking motor solenoid “B" stud.

The negative battery terminals are also connected in parallel and provide a ground path, via the negative battery cable, to the cranking motor ground stud. The frame, engine block, and the cab platform are also interconnected by ground cables to the battery ground.

For additional information on the operating principles for batteries, refer to GROUP 08 - ELECTRICAL, in the Master Service Manual.

Cranking System and Circuits

With the transmission in neutral (neutral position switch contacts closed) power flows from the key switch (20) through circuit A13/A13A/A13K, fuse F10, circuit A97P, engine cab connector (2) and circuit K97P to the neutral position switch. Power flows through the switch contacts, circuit K97AU, circuit K97L to the crank inhibit relay (R2) switch. With a manual transmission, a jumper bypasses the neutral position switch. A splice also provides the current from K97AU to ECM (6020) through circuit A97A, engine cab connector (2) and circuit A97A. This informs the ECM that the transmission is in neutral or the clutch pedal is depressed.

With the vehicle in neutral and the key switch (20) in the start position, current flows from the (J2) battery feed stud through circuit A14, a splice, circuit A19, fuse F16, circuit A15, and to the key switch (20). From the key switch, current flows through circuit A17F to the crank inhibit relay (R2) coil. If cranking is enabled the relay coil is grounded through circuit A97H and the engine cab connector (2) to ECM (6020).

The energized crank inhibit relay (R2) controls the start relay (387) by supply power to the relay coil through circuit K17A, cab connector (2) and circuit K17F. The coil is ground through circuit K17S to the crank motor ground stud.

For additional information on the operating principles for cranking motors, refer to GROUP 08 - ELECTRICAL in the CTS-5000 Master Service Manual.

Cranking System and Circuits — Starter Relay Switch

Battery power is always present at the crank motor solenoid (B) terminal through the 4/0 positive battery cable. The 3/0 negative battery cable is attached to the crank motor ground stud which is grounded to the frame rail. Power is also available at the start relay (387) through the solenoid (B) terminal and circuit K17-FL/K17B. With the starter relay energized, power flows through the closed contacts and circuit K17A to the (S) terminal of the crank motor solenoid which energizes the solenoid.

With the crank motor solenoid energized, the solenoid engages the crank motor’s shaft to rotate. When the engine starts and the key is released, power is removed from circuit K17S which de-energizes the start relay (387) and disengages the crank motor.

Cranking System and Circuits — Cranking Motor Thermal Overcrank Protection

On vehicles with optional crank motor thermal overcrank protection, the starter relay control coil ground K17D is connected to the normally closed thermal overcrank protection switch (N/L) located in the end of the cranking motor. The overcrank protection switch is grounded through circuits K17D, K17-G, and K11-G to the crank motor ground stud.

If excessive cranking causes the crank motor temperature to exceed a pre-set temperature limit, the thermal overcrank protection switch contacts open and causes the starter relay to de-energize and the crank motor to disengage. When the crank motor cools, the thermal switch contacts reset and the crank motor can be engaged.

Charging System

With the engine running, the function of the alternator is to produce direct current (DC) in order to supply power to the vehicle electrical system, and to charge the batteries.

The alternator supplies the vehicle electrical system through the alternator (+) terminal, circuits K2 and K14, to the (J2) battery feed stud.

Any current above the needs of the vehicle electrical system is used to supply the batteries. The alternator charges the batteries through the (+) terminal, circuits K2, K14A, K14-FL and K14A-FL to the “B" terminal of the crank motor solenoid and through the battery cable to the battery positive terminal.

The ground path for the alternator is the (-) terminal, and circuit K2-G to the crank motor ground stud.

For additional information on the operating principles for alternators, refer to GROUP 08 - ELECTRICAL in the CTS-5000 Master Service Manual.

Charging System — Ammeter (Shunt)

The optional ammeter gauge indicates the rate of charge of electric current supplied by the alternator to the batteries, or the rate of discharge from the batteries.

When the alternator produces more current than the vehicle electrical circuits demand, the additional output charges the batteries, and the ammeter indicates the charge through circuits K26-FL, engine cab connector (15) and K26 to the ammeter.

When the electrical circuits demand more current than the alternator produces, current flows from the batteries to the vehicle electrical system, and the ammeter shows a discharge through circuits K26A-FL, engine cab connector (15) and K26A to the ammeter.

3.3. TROUBLESHOOTING

Before beginning these test procedures, do the following:

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

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

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

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

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

Batteries and Cables

The standard battery system for the FE 300 consists of two 12V maintenance-free batteries.

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

Batteries and Cables — Battery Test Procedure (Figure 13)

Test each battery separately.

1. Disconnect both battery terminals at each battery. Check each battery visually.
2. Examine the hydrometer eye (if no eye go to next step).
   a. Eye shows green — go to step 4.
   b. Eye shows dark — recharge, then go to step 3.
   c. Eye shows yellow — replace battery.
3. Apply a 300A load for 15 seconds. Turn off load and wait one minute.
   a. If 12.4V or more — go to step 4.
   b. If less than 12.4V — recharge, then repeat step 3.
4. Apply a test load equal to 50% of the battery CCA rating at 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 5

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.

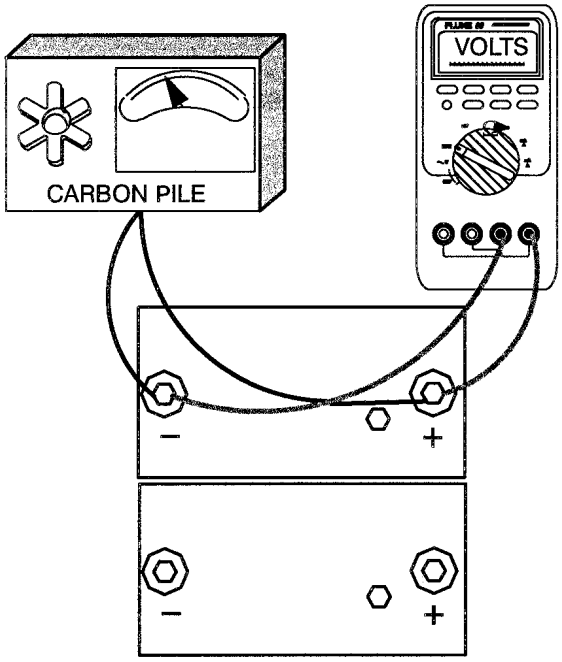


Figure 13 Battery Test Procedure

Batteries and Cables — Battery Cable Voltage Loss Test (Figure 14).

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 do this, 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 starter 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 (October 1996 and later) or to battery frame ground (before October 1996). Attach leads directly to ground studs and not the cables.

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

POSITIVE CABLE Voltage Loss (step 4) _____

plus

NEGATIVE CABLE Voltage Loss (step 6) _____

equals

TOTAL CABLE LOSS_____

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

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

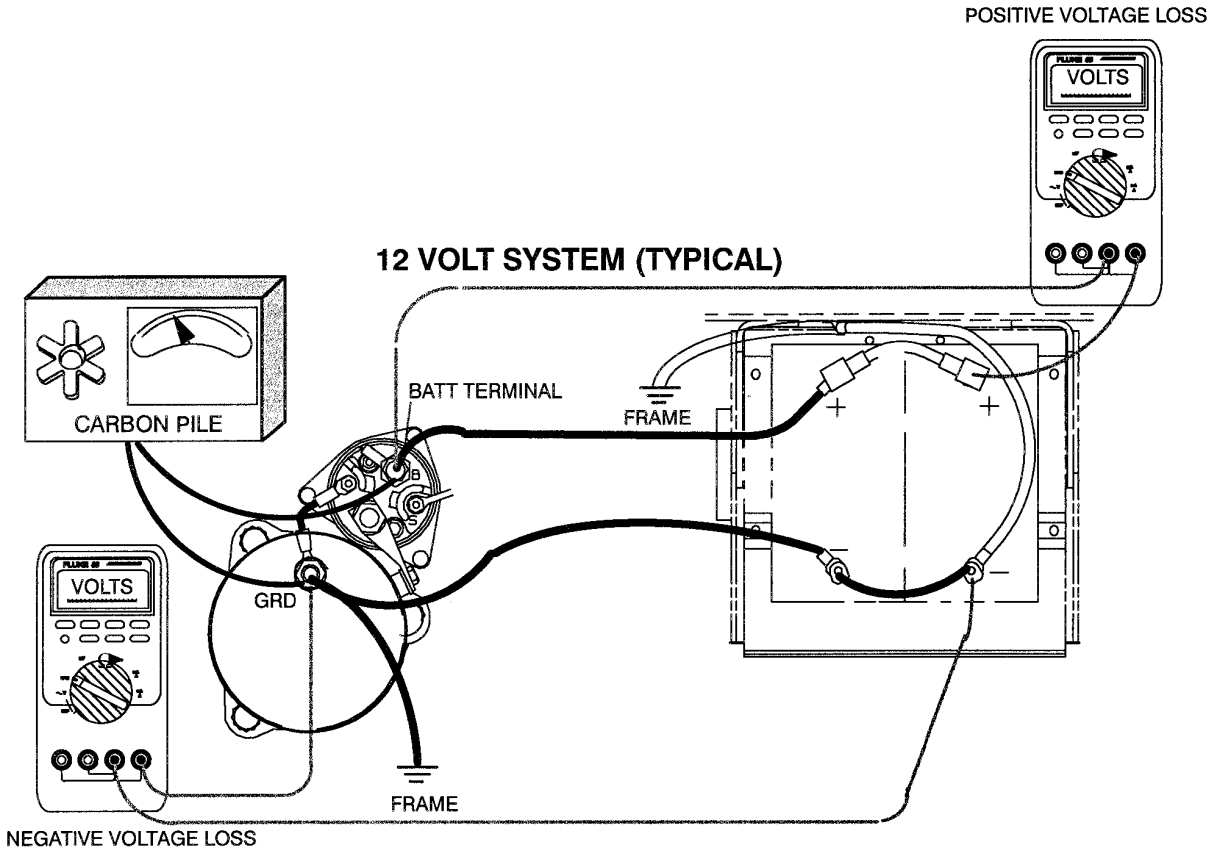


Figure 14 Battery Cable Voltage Loss Test

Starting Motor System Circuits and Components

This section consists of five parts: Starter Solenoid Circuit Test — Part 1, Starter Solenoid Circuit Test — Part 2, Starter Relay Switch Circuit Test, Starter Motor Replacement Test, and Testing Thermal Overcrank Protection System.

Starter Solenoid Circuit Test — Part 1 (Figure 15)

Starter shifting in and out, or not pulling in, is often caused by high resistance in the starter solenoid circuit. When the solenoid circuit has excessive voltage loss, the starter pinion sometimes 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 relay switch (located front side of platform) and leads connected to the starter solenoid.

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

1. Disconnect starter relay circuit K17A from the starter solenoid “S” terminal.

2. Connect the carbon pile positive lead to circuit K17A and the negative lead to the starter ground. Connect the positive lead of a DMM voltmeter to the solenoid “B” terminal. Connect negative lead of voltmeter to switch wire lead K17A (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 switch energize with a clicking sound. If the switch doesn’t “click,” either the starter relay switch is defective or there is no voltage from the key switch circuit (refer to diagnostic test, Starter Relay Switch Circuit Test).

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**, solenoid circuitry is OK. Go to Starter Relay Switch Circuit Test .

If circuit loss **is more than 0.5 volt**, go to Starter Solenoid Circuit Test — Part 2.

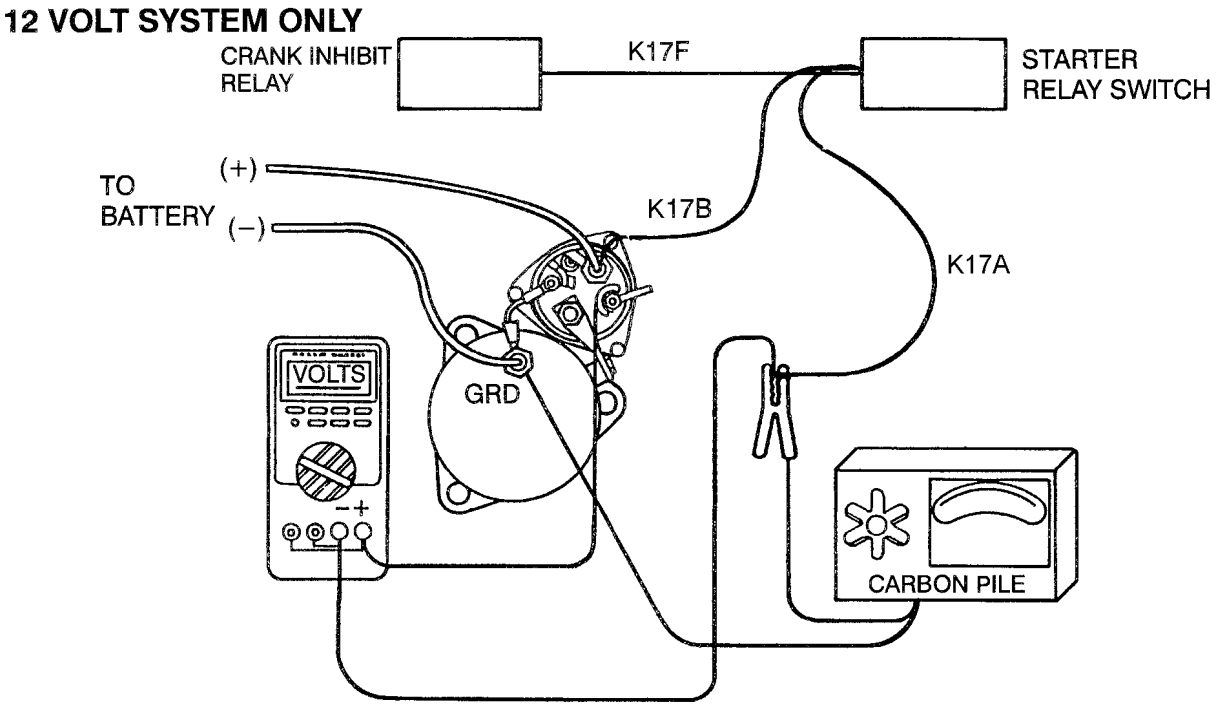


Figure 15 Starter Solenoid Circuit Test — Part 1

Starter Solenoid Circuit Test — Part 2 (Figure 16)

If voltage loss in Starter Solenoid Circuit Test — Part 1 was more than 0.5 volt, the loss is excessive. The loss may be from loose terminals, corrosion, or a worn out starter relay switch. To locate the problem:

1. Disconnect circuit K17A from “S” terminal at starter solenoid. Connect carbon pile to circuit K17A and to starter ground terminal. Turn the carbon pile on (will show 0 amps).

2. Disconnect starter relay and install a jumper lead from cavity 4, circuit K17A to cavity 1, circuit K17B.

   NOTE – Test lead will be at battery voltage.

   Connect DMM from solenoid BAT terminal to start relay connector cavity 1, circuit K17B (will show zero volts).

3. At relay connector, install other end of jumper lead to cavity 4, circuit K17A 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 4, K17A to circuit K17A 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,** replace starter relay and retest per Starter Solenoid Circuit Test — Part 1.

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

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

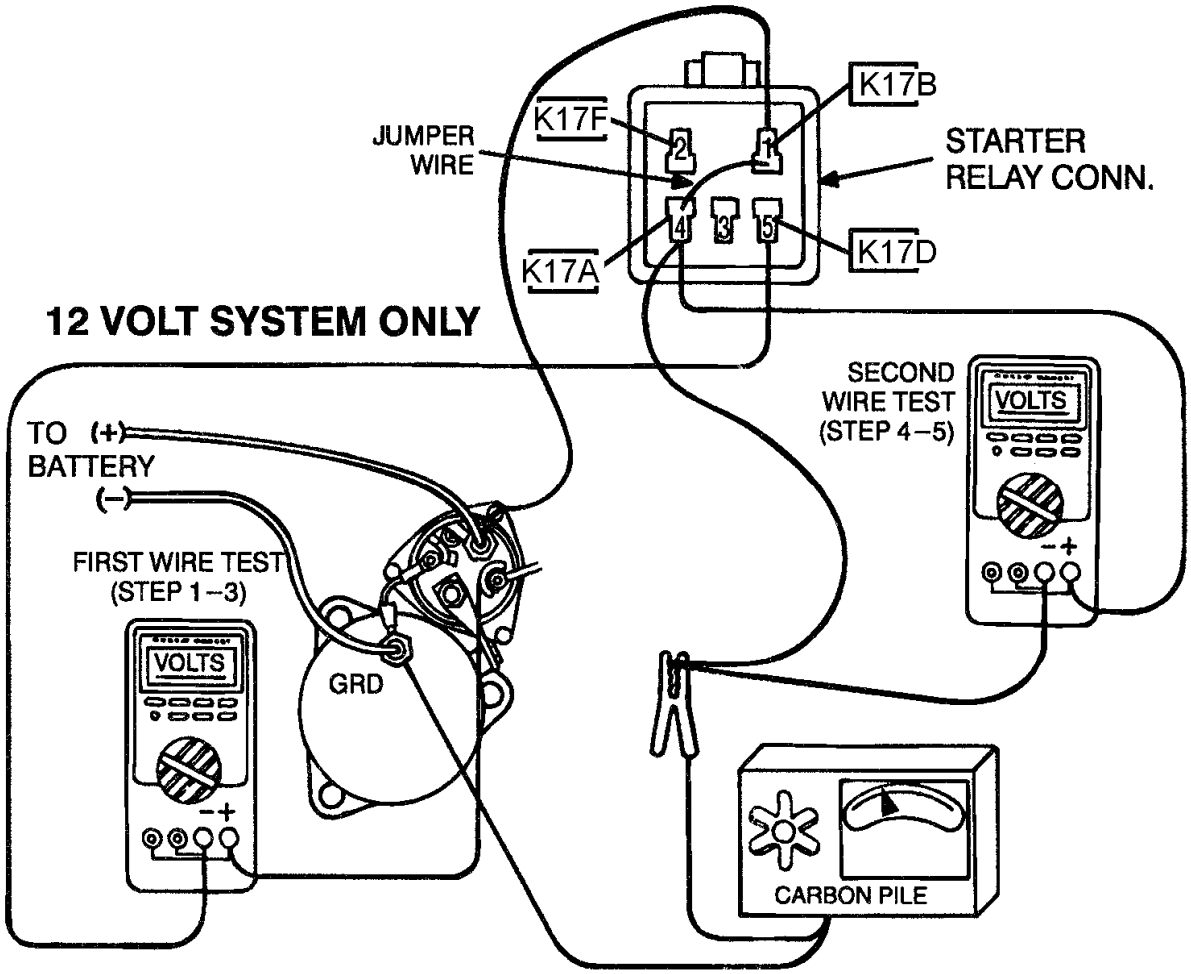


Figure 16 Starter Solenoid Circuit Test — Part 2

Starter Relay Switch Circuit Test (Figure 17)

A starter relay switch that does not close or drops out too soon can be caused by high resistance or an open in the control circuit.

1. Disconnect (insulate with tape) circuit K17A from starter solenoid “S" terminal. Connect voltmeter to the starter BAT and GND terminals. Turn key switch on. Read and record battery cable voltage.

2. With vehicle in neutral and key switch turned to start position, you should hear the starter relay “click." If not, proceed anyway. Read and record starter relay circuit voltage. Release starter switch.

Battery Cable Voltage (step 1) _____

minus Starter Relay Circuit Voltage (step 2) _____

equals Control Circuit Loss = _____

If circuit loss **is 0.5 volt or less** and the starter relay switch closes, end the test.

If circuit loss **is 0.5 volt or less** and the starter relay switch doesn't close, replace the switch and repeat the test.

If circuit loss **is more than 0.5 volt** and the starter relay switch doesn't close, replace switch and repeat test.

If circuit loss **is more than 0.5 volt** and the starter relay switch closes, refer to Engine Diagnostic Manual EGES-175 (DT 466E/530E) or EGES-190 (T444E) for engine cranking circuit diagnostic procedures.

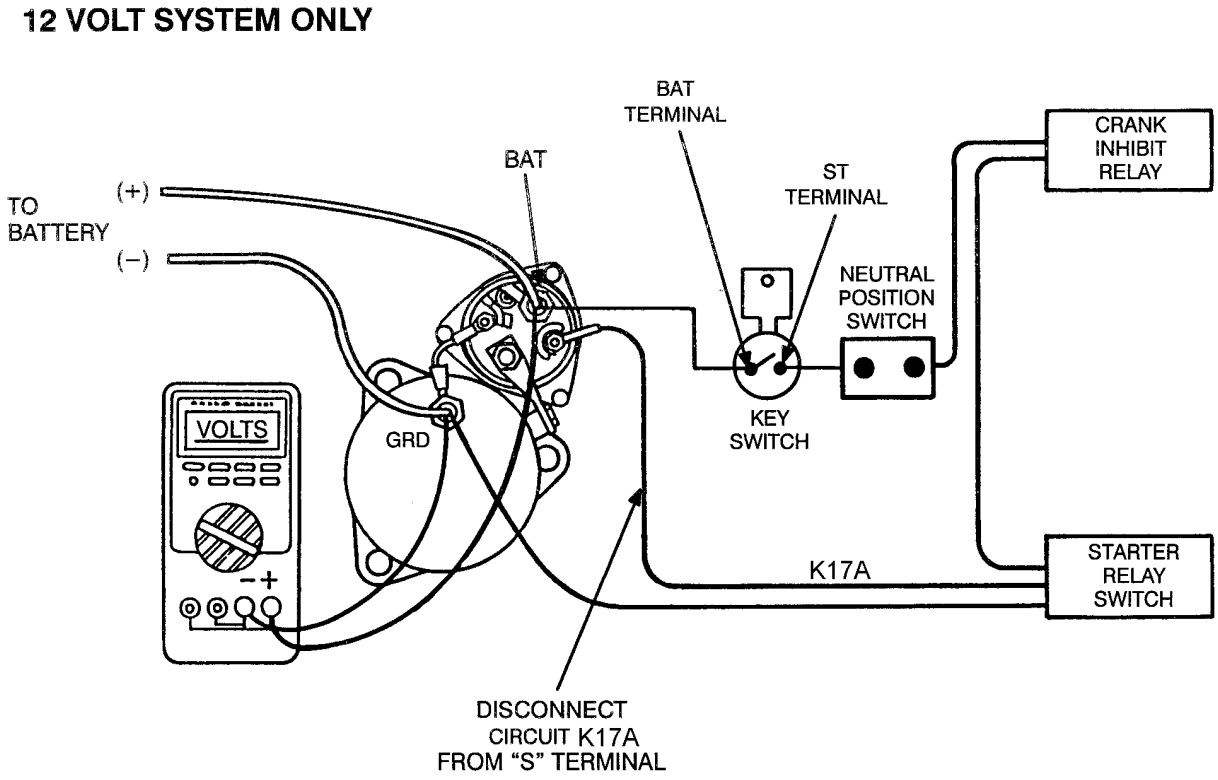


Figure 17 Starter Relay Switch Circuit Test

Starter Motor Replacement Test (Figure 18)

A. COLD WEATHER STARTER RELAY SWITCH PROBLEMS

If all tests from Battery Test Procedure through Starter Relay Switch Circuit Test have been performed, the vehicle batteries and starter wiring have been checked.

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

If this condition exists, remove starter relay switch. At the connector, using suitable jumper wire, attach one lead to circuit K17B and the other to circuit K17A **NOTE: Circuit K17B is at battery voltage and the engine should crank when the other end of the jumper is connected to circuit K17A. Remove jumper to stop cranking.** If engine cranks properly with jumper in place, replace starter relay switch and make sure starter mounting bolts are tight.

B. CHECKING AVAILABLE VOLTAGE AT STARTER

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

1. While cranking engine, measure voltage between the starter “BAT” terminal and starter ground.
   a. If voltage is 9.0 volts or more, the problem must be in the starter (or engine). Replace the starter.
   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 starter (or engine). Replace the starter.

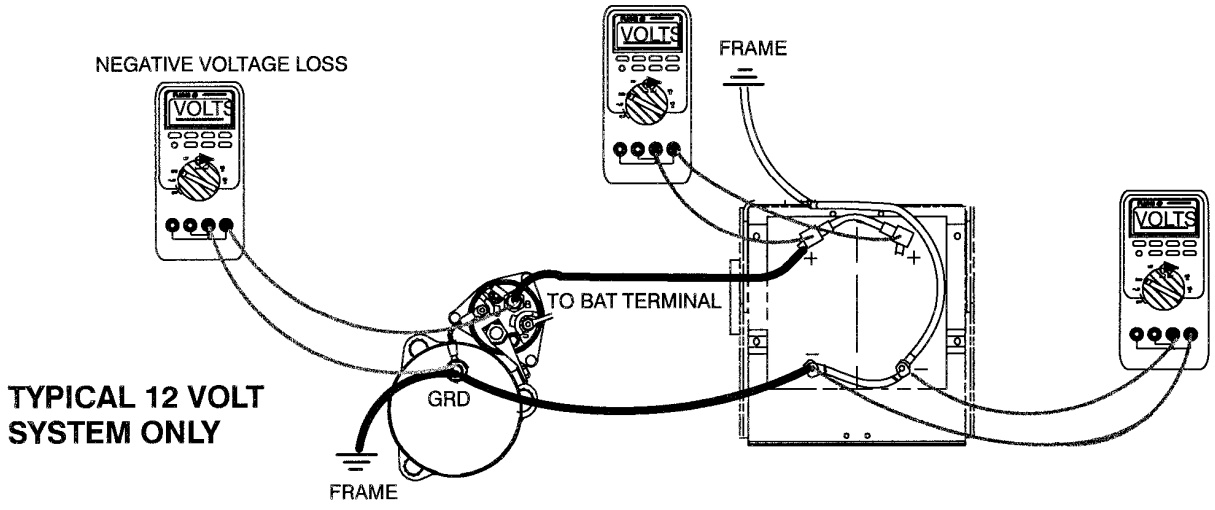


Figure 18 Starter Motor Replacement Test

Testing Thermal Overcrank Protection System

Table 6 Testing Thermal Overcrank Protection System

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove connector (N/L) from thermal switch and measure resistance across switch terminals (starter motor must not be hot).	Thermal sw. across term.	< 1 ohm.	Go to next step.	Replace crank motor.
2.	Start	With key in start position, at connector (N/L) measure voltage to ground at circuit K17D.	(N/L), K17D to gnd.	12 ± 1.5 volts.	Go to next step.	Go to Starter Solenoid Circuit Test — Part 1.

Table 6 Testing Thermal Overcrank Protection System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
3.	Start	With key in start position, at connector (N/L) measure voltage between circuits K17D and K17–G.	(N/L), K17D to K17–G.	12 ± 1.5 volts.	Go to next step.	Repair open in circuit K17G or K11–GJ to cranking motor ground stud.
4.	Off	Thermal overcrank circuits check good.				

Vehicle Charging System

This section consists of five parts: Batteries Undercharged, Alternator Tests, Alternator Wiring Test — Part 1, Alternator Replacement Test, and Ammeter Gauge.

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 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 defective batteries as described in GROUP 08 — ELECTRICAL, Battery Section in the Master Service Manual.

4. Wiring defects. 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 (+) terminal of the alternator. A zero reading indicates an open in circuits K2, K14A, K14–FL, or K14A-FL between the alternator and batteries.

6. A defective component or wiring defect 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 entire system for current drains, insert DMM leads in the COM and 10A fused jack on the meter. Set the meter to DC Amps. Connect meter in series with the alternator. If 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 CTS-5216V. 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.

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 (Figure 19)

Instead of using alternator current output this test 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. Connect the carbon pile to the alternator output terminal and to ground. Connect Fluke 88 DMM from alternator (+) terminal to positive battery terminal.

2. Turn on and adjust carbon pile to alternator rated output (amps). Read and record positive circuit voltage loss. Turn carbon pile off.

3. Connect the DMM from the alternator ground to the battery negative terminal.

4. Turn on and adjust carbon pile to alternator rated output (amps). Read and record negative circuit voltage loss. Turn carbon pile off.

Positive Circuit Loss (step 2) _____

plus

Negative Circuit Loss (step 4) _____

equals

TOTAL SYSTEM LOSS _____

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

If system loss **is greater than 0.7V**, repair circuit(s) with excessive voltage loss and retest. Then go to Alternator Replacement Test.

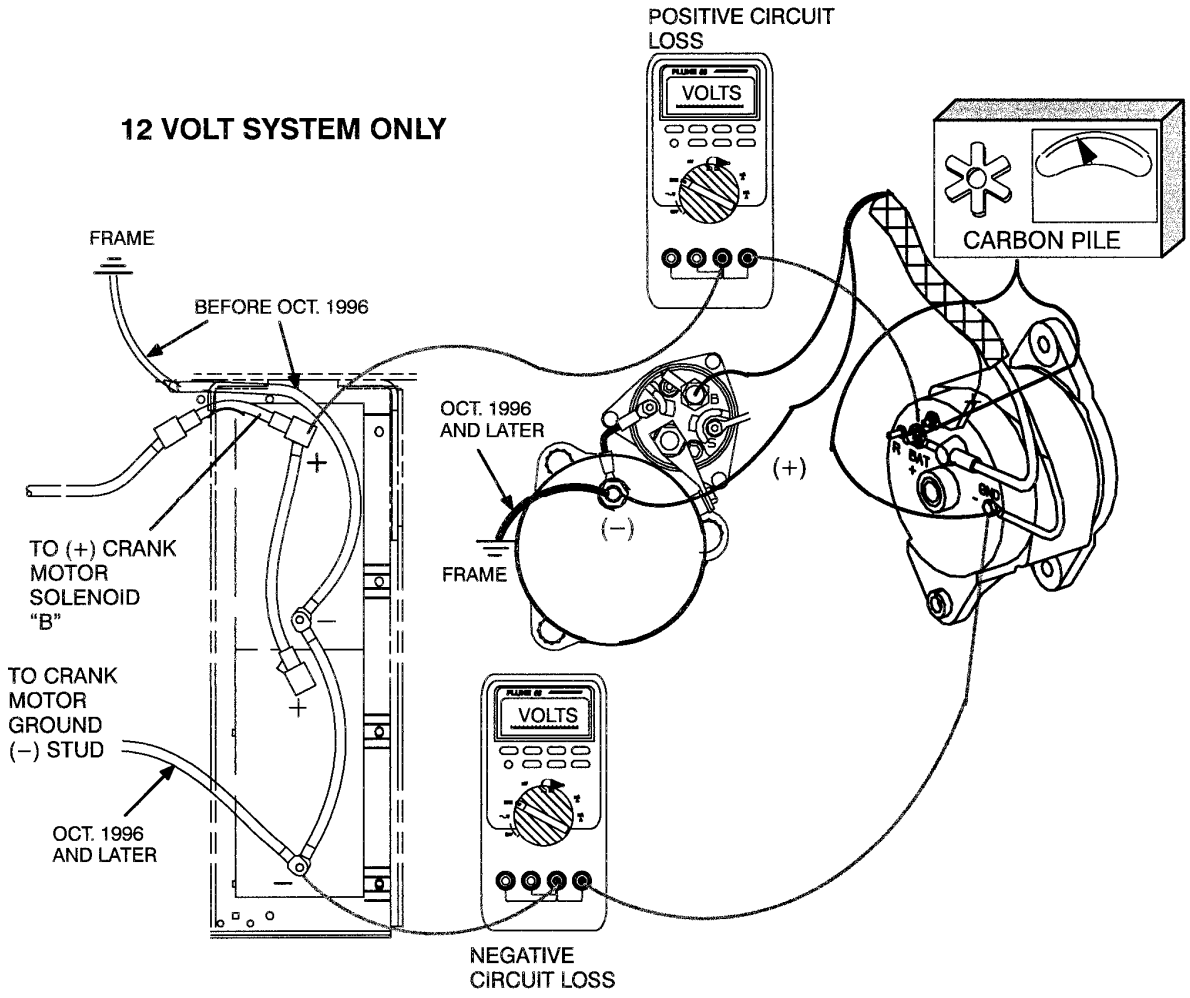


Figure 19 Alternator Wiring Test

Alternator Replacement Test (Figure 20)

If the wiring tests have been performed (circuits OK), adjust alternator belt and tighten mounting bolts and ground connections. Batteries must be near full charge with more than 12.4 volts no load voltage.

Voltage Output Test

— Refer to Figure 20

1. With vehicle at shop temperature, connect voltmeter between alternator BAT (+) and GND (-) terminals.
2. With NO electrical loads turned on, start the engine. Fast idle until voltage stabilizes (does not increase) for 2 minutes.
3. Check and record alternator output voltage _____ V (should not exceed 15.5 volts).
4. If voltage reading is above 15.5V, replace the alternator.

Amperage Output Test

— Refer to Figure 20

1. With vehicle at shop temperature, connect carbon pile and clamp-on ammeter as shown. Clamp around all wires connected to alternator B+ output terminal. (To use an ammeter without an induction clamp, disconnect circuits from alternator B+ terminal. Connect meter shunt between alternator B+ terminal and all circuits previously removed.) **CAUTION - Do not connect an ammeter without a high current shunt.**
2. With NO electrical loads turned on, start the engine, and speed up and retain a high RPM.
3. Turn on and adjust carbon pile until ammeter reads its highest value and record _____A.
4. Turn off carbon pile and engine.
5. If reading is zero (no output), the rotor should be magnetized with the alternator hooked up normally. To do this , momentarily connect a jumper lead from the alternator BAT (+) terminal to the indicator “I" terminal. This will restore normal residual magnetism.
6. Repeat steps 2, 3, and 4. If output is still zero, replace alternator.

Replacement

Replace alternator if either of the following exists:

A. Output voltage exceeded 15.5V.

B. Output current is not within 10% of the alternator rated output stamped on the alternator.

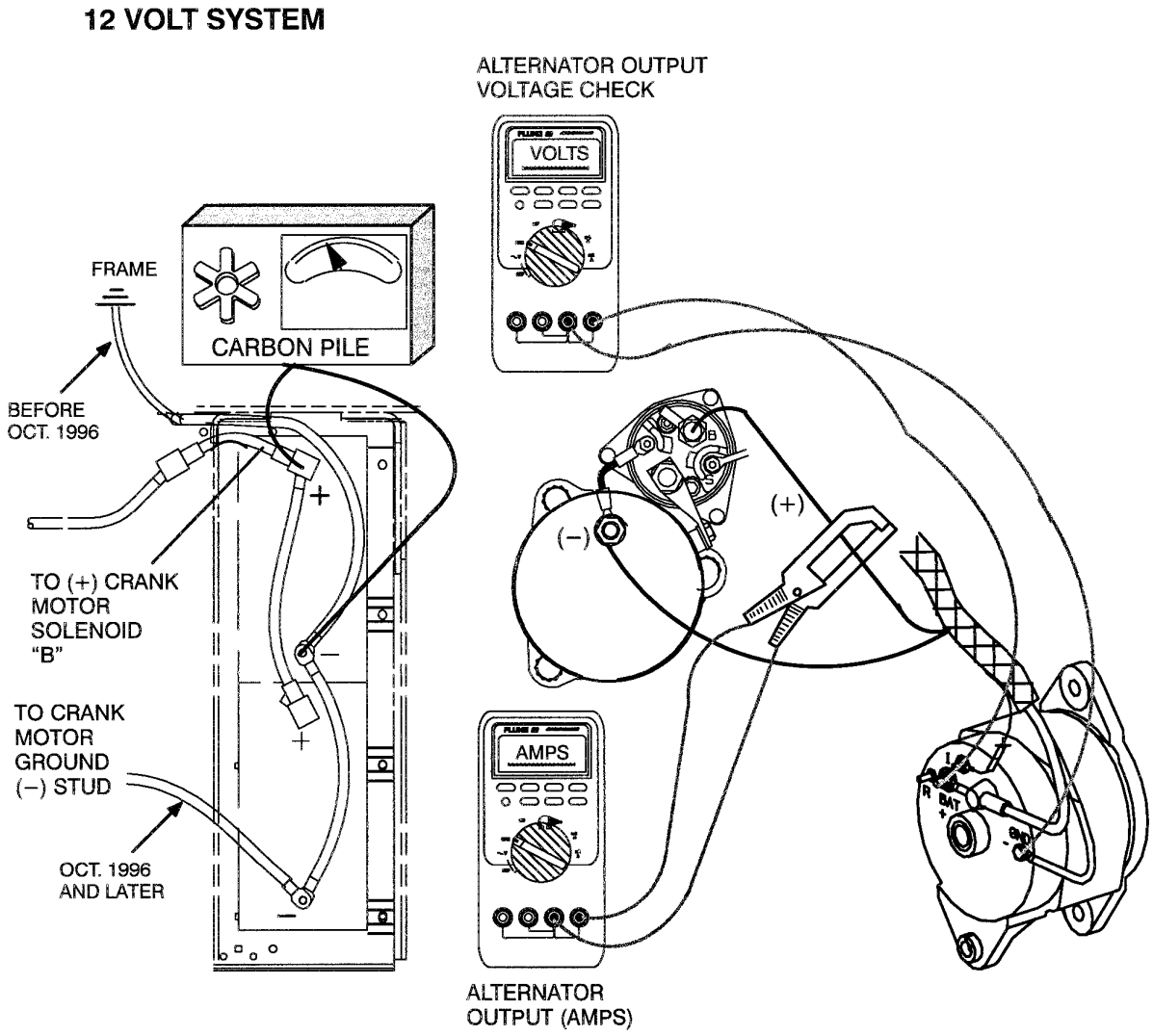


Figure 20 Alternator Replacement Test

Ammeter Gauge

NOTE – Ammeter circuitry contains fusible links and designated wire gauge and lengths, which must not be altered.

Table 7 Ammeter Gauge

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Disconnect engine cab connector (15). At engine connector (15A), measure voltage of circuit K26 to ground.	(15A), K26 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in engine harness circuit K26, then repair.

Table 7 Ammeter Gauge (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
2.	Off	At connector (15A) measure voltage of circuit K26A to ground.	(15A), K26A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in engine harness circuit K26A or K26A-FL, then repair.
3.	Off	Reconnect engine cab connector (15) and disconnect connector (10) from cluster panel. At (10) measure voltage of circuit A26 to ground.	(10), A26 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in platform harness circuit A26, then repair.
4.	Off	At (10) measure voltage of circuit A26A to ground.	(10), A26A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in platform harness circuit A26A, then repair.
5.	Off	Install test ammeter between (J2) feed stud and circuit K14. Turn headlights on and compare readings.	Visual between gauges.	Gauges read moderate discharge rate.	Go to next step.	Replace vehicle ammeter.
6.	On	Start engine and run at fast idle with no loads on.	Visual between gauges.	Gauges read moderate discharge rate.	Ammeter operation OK.	Replace vehicle ammeter.

3.4. COMPONENT LOCATIONS

(2) Dash Connector (Platform)..... Inside of Front Dash Panel
(2A) Cab Connector (Engine)..... Outside of Front Dash Panel
(15) Engine Cab Connector (Platform)..... Inside of Front Dash Panel
(15A) Engine Cab Connector (Engine)..... Outside of Front Dash Panel
(387) Start Relay..... Engine Compartment, Cowl Wall
(J2) Battery Feed Stud..... Inside Platform Left of Platform Harness Dash Connector
(J5) Alternator Feed..... “BAT” (+) Stud on Alternator
(J6) Alternator Ground..... “GND” (-) Stud on Alternator
(J8) Crank Motor Solenoid Battery Feed..... “B” Stud on Crank Motor Solenoid
(J10) Crank Motor Stud (October 1996 and Later)..... End of Cranking Motor
(R2) Crank Inhibit Relay..... Relay Panel Behind Right Dash Panel
(N/L) Thermo Overcrank Protection..... End of Cranking Motor
(N/L) Neutral Position Switch..... Left, Lower Side of Transmission

Battery Cable Wiring

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AND 02.B

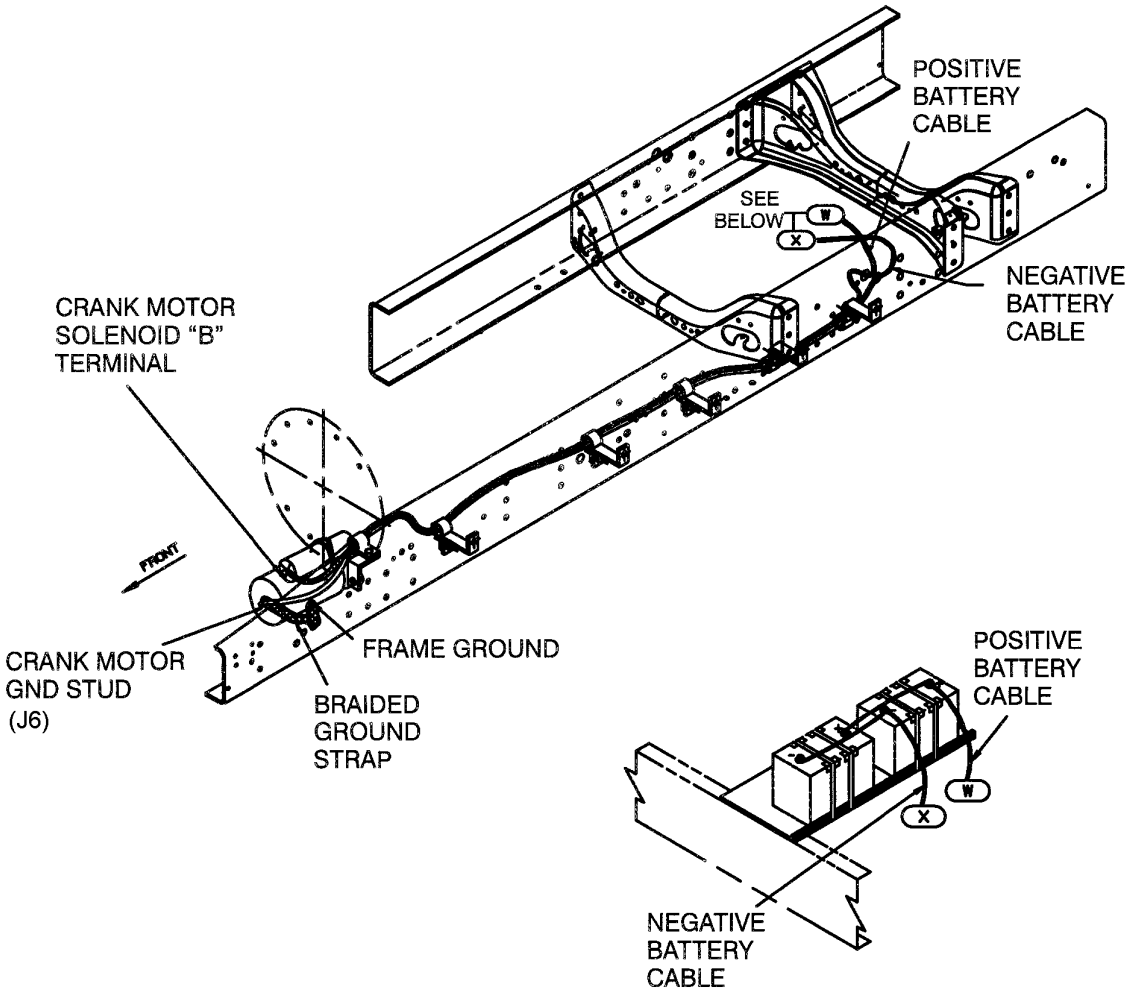

Figure 21 Battery Cable Wiring

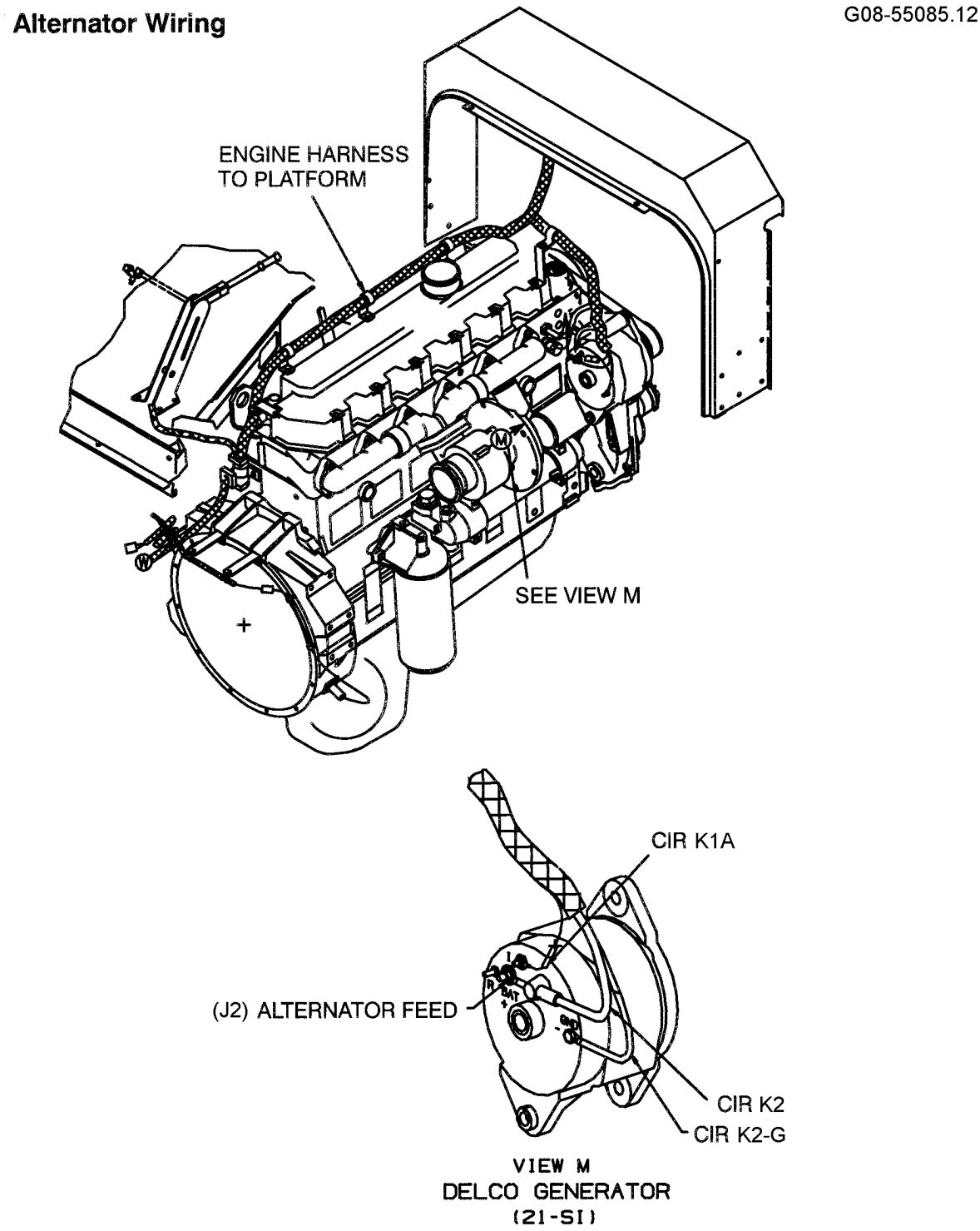

Figure 22 Alternator Wiring

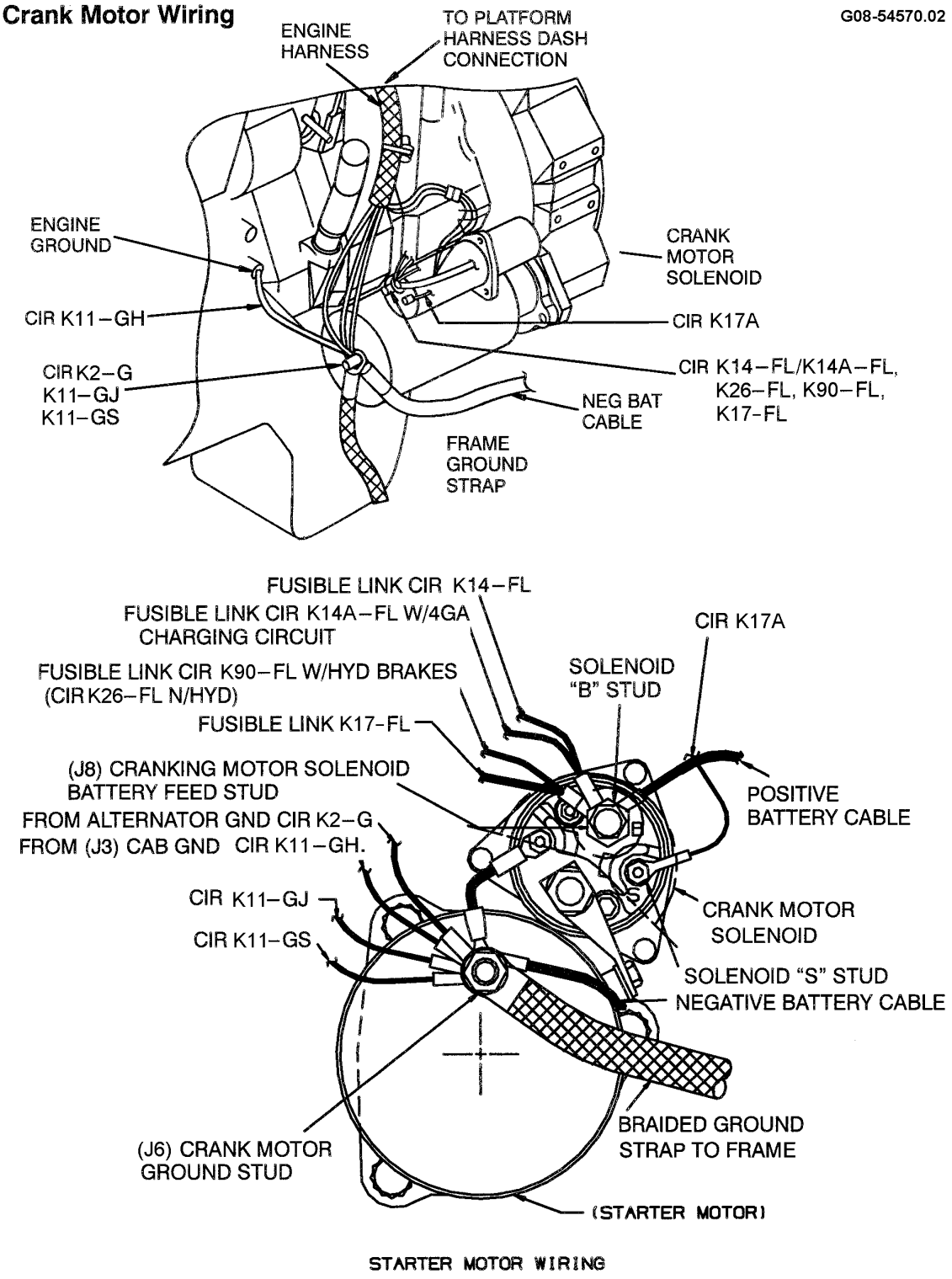

Figure 23 Crank Motor Wiring

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Crank Motor Wiring

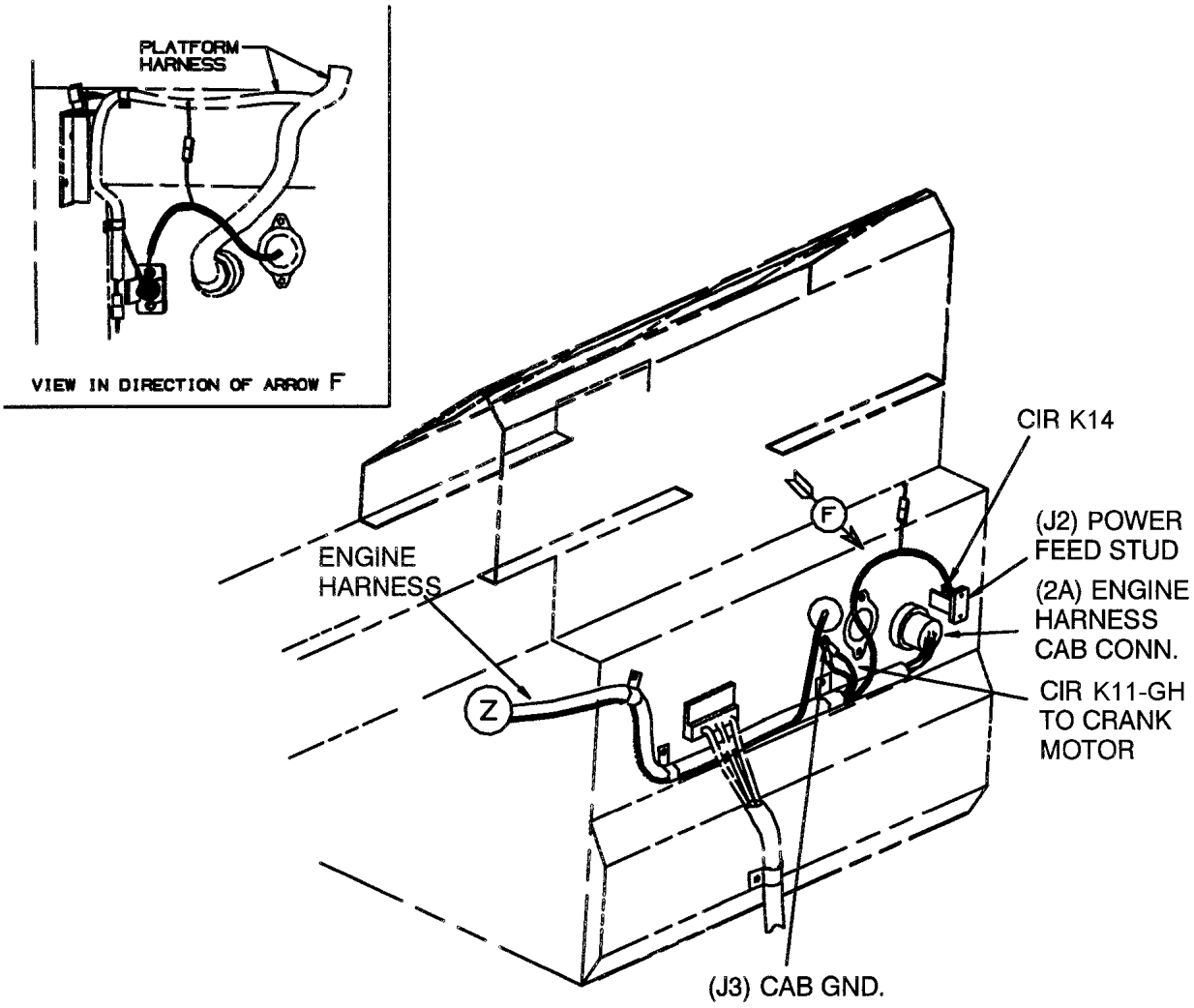

Figure 24 Crank Motor Wiring

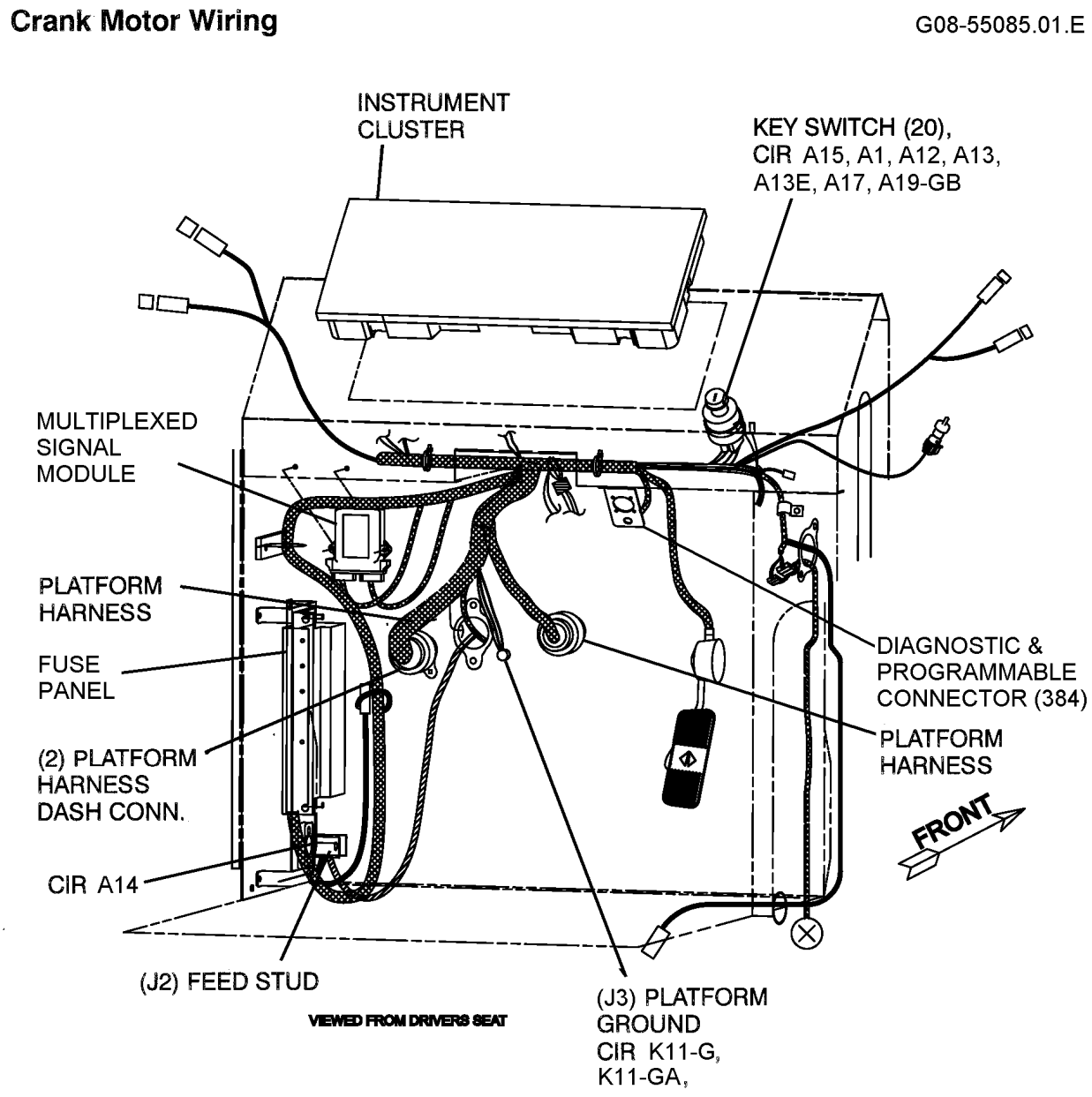

Figure 25 Crank Motor Wiring

4. FE 300 ENGINE SYSTEMS

Refer to EGES-175, the DT 466E/I 530E Engine/Vehicle Diagnostic Manual for ECM unit electronic engine control system circuit function and diagnostics.

5. FE 300 GAUGES AND WARNING LIGHTS

5.1. DESCRIPTION

ATA Data-Link Driven Cluster

With the Diamond Logic NAVPAK™ ECM2 the following gauges are driven by the ECM2:

- Speedometer
- Engine Oil Pressure
- Coolant Temperature
- Tachometer
- Voltmeter

Refer to Engine Diagnostic Manual EGES-175 (DT 466E/530E) for a description of the ATA data-link system.

Transmission Oil Temperature Gauges

The transmission oil temperature gauge is an electromagnetic air core design, which uses thermistor type, variable resistance sensors to control battery voltage through the gauge coils. Sensor circuits connect to the “S" (signal) terminal on the gauge.

Sensor resistance varies the current in the gauge circuit, causing the gauge needle to change position. Low sensor resistance will cause a high temperature reading while high sensor resistance will cause a low temperature reading.

Engine Oil Pressure Gauge

The engine oil pressure gauge indicates low engine oil pressure conditions. The system consists of the instrument panel gauge, a variable capacitance oil pressure sensor and the ECM2. Refer to the appropriate Engine Diagnostic Manual for a description of the engine oil pressure gauge system.

Fuel Level Gauge

The fuel level gauge system includes an electromagnetic air core design gauge, a float/resistive potentiometer type sender and the wiring circuitry. If the gauge or sender units are suspect, refer to S08313, INSTRUMENTS in the Master Service Manual for test procedures on these components.

Voltmeter Gauge

The voltmeter gauge does not have a sender to indicate voltage at the gauge. The ECM2 reads directly from the charging system. Any change in the charging system voltage shows a change on the gauge.

Tachometer Gauge and Speedometer Gauge

Refer to the appropriate Engine Diagnostic Manual for a description of the Tachometer and Speedometer system.

Engine Coolant Temperature

The engine coolant temperature gauge system consists of the instrument panel gauge, a thermistor-type sensor and the ECM2. Refer to the appropriate Engine Diagnostic Manual for a description of the engine coolant temperature gauge system.

Low Oil Pressure/High Water Temperature/Low Coolant Level Lights and Alarm

Refer to the appropriate Engine Diagnostic Manual for a description of the warning light and alarm system.

Hydraulic Brake Low Fluid and Parking Brake Warning Lights

The hydraulic brake low fluid warning system consists of a warning light, fluid level sensor, a blocking diode and the circuitry necessary to connect the components.

The parking brake warning system consists of the warning light, a parking brake switch and the necessary circuitry to connect the components.

Each of these systems receives power from the cluster warning lamp feed connector (10-1) and the circuitry is connected to the key switch ground. When the key switch is placed in the start position, the warning lights are momentarily grounded which causes the lights to come on and indicates that the bulbs are functioning.

Brake Pressure Warning Light and Alarm

The brake warning light and alarm system is designed to alert a driver of a potential problem within the vehicle braking system. With an air brake system, the brake pressure warning light and alarm will activate when air in the brake system is less than 60 PSI.

With a hydraulic brake system, the brake pressure warning light and alarm will activate when a brake fluid pressure differential is detected in the system. The hydraulic brake system also includes a low brake fluid level warning light which does not include an alarm.

Diagnostic/Programming Connector and Self-Test Switch and Warning Light System

Refer to the appropriate Engine Diagnostic Manual for a description of the Diagnostic/Programming Connector and Self-Test Switch and Warning Light System.

5.2. OPERATION

Engine Coolant Temperature Gauge

The engine water temperature gauge is driven by the ECM2 through the ATA data-link circuits.

Transmission Oil Temperature Gauge

The battery voltage is to circuit A13/A13F, fuse F22, circuit A28/A28A, the yellow instrument cluster connector (10), pin 1 to the transmission oil temperature gauge. The transmission temperature is sensed by the transmission temperature sending unit (38). The sending unit feeds an electrical voltage through pin A of connector (38), circuit K31, pin F of connector (2) and circuit A31, pin 17 of the yellow instrument cluster connector (10) to the transmission oil temperature gauge, which displays the transmission oil temperature. The transmission temperature sending unit (38) pin B is grounded through circuits K31–G/K11–GJ to the (J10) engine ground. The transmission oil temperature gauge is grounded through pin 6 of connector (10) circuits A28–GA/A11–GB/A11–G to the (J1) platform ground.

Fuel Level Gauge

The battery voltage is to circuit A13/A13F, fuse F22, circuit A28/A28B, the green instrument cluster (11), pin 10 to the fuel gauge. The level of fuel in the vehicle fuel tank is sensed by the fuel sending unit (37). The sending unit feeds an electrical voltage through circuit K36, pin A of connector (37), circuit K36, pin D of connector (2) and circuit A36, pin 3 of connector (11) to the fuel gauge, which displays the fuel level. The fuel sender (37) pin B is grounded through circuits K36–G/K11–GJ to the (J10) engine ground. The fuel gauge is grounded through pin 2 of connector (11) circuits A28–G/A11–GB/A11–G to the (J1) platform ground.

Voltmeter Gauge

The battery voltage is measured by the engine ECM2, converted to a data signal, and transferred over the data link to the instrument cluster's microprocessor. This signal is transferred over the data link on circuits A98E(+) and A98F(-) to pins 7 and 9 of connector (11), into the instrument cluster. The instrument cluster's processor then drives the voltmeter display gauge.

Tachometer Gauge and Speedometer Gauge

Refer to the appropriate Engine Diagnostic Manual for operation of the Tachometer and Speedometer system.

Low Oil Pressure/High Water Temperature/Low Coolant Level Lights and Alarm

Refer to the appropriate Engine Diagnostic Manual for operation of the warning light and alarm system.

Hydraulic Brake Low Fluid and Parking Brake Warning System

When the key switch (20) is turned to the on position, power is supplied to the low brake fluid warning system through circuit A28A, to a splice, circuit A90R, the low level fluid warning light (89), circuit A90V, to a splice, circuit A90P, connector (84), circuit A90P, connector (88), and circuit A90P to the normally open sensor switch (90). When a low brake fluid level is encountered, the sensor switch closes and the circuit is ground through the switch, circuits A11-GF and A11-GE to the platform ground.

When the key switch is turned to the start position, a momentary ground is applied through the key switch, circuit A90X, diode connector assembly (82) and circuit A90W to the previously mentioned splice. This causes the warning light to come on as a bulb check and go off when the key is released from the start position.

Power is fed by the battery voltage is through circuits A13/A13F, fuse F22 to circuits A28 and A28C and the "((P)) PARK BRAKE" warning light and connector (12)/pin 8. When the parking brake is applied, power will flow through the warning light and connector (12)/pin 17, circuits A44A and K44A, the park brake switch (218), and circuits K44-G and K11-GD to start motor ground. This will cause the park brake warning light to illuminate, indicating that the parking brake is applied. The lamp will also illuminate when the key switch (20) is moved to the start position, and a ground is applied through circuit A44, a brake diode (82), and circuit A90X, performing a bulb check.

When the key is turned to the start position, a ground is applied to the circuitry through the ignition switch, circuits A44B and A44, connector (2), and circuit A44 to circuit A44B at the park brake switch. This causes the warning light to come on as a bulb check and go off when the key is released from the start position.

Low Air Pressure Warning System

Power is fed by the battery voltage is through circuits A13/A13F, fuse F22 to circuits A28 and A28C and the "((P)) PARK BRAKE" warning light and connector (12)/pin 8. When the parking brake is applied, power will flow through the warning light and connector (12)/pin 17, circuits A44 to the park brake switch (218), and circuits A44GA to platform ground. This will cause the park brake warning light to illuminate, indicating that the parking brake is applied. The lamp will also illuminate when the key switch (20) is moved to the start position, and a ground is applied through circuit A44GB, a brake diode (64), and circuit A44, performing a bulb check.

When the key switch (20) is turned on, power is applied to circuit A13/A13F, fuse F22, circuit A28/A28A, connector (10), the instrument cluster printed circuit board, the brake warning light, the circuit board, connector (10), circuit A40A, and to the fast mode side of alarm (211).

When the vehicle is started and the air pressure is below 60 psi, the air pressure switch (717) is closed and provides a ground path for the alarm and warning light through circuit A40, connector (2), circuit K40, and through the closed air pressure switch (717) which is grounded through its mounting.

Diagnostic/Programming Connector and Self-Test Switch and Warning Light System

Refer to the appropriate Engine Diagnostic Manual for operation of the Diagnostic/Programming Connector and Self-Test Switch and Warning Light System.

Wait-to-Start Warning Light

Refer to the appropriate Engine Diagnostic Manual for a description of the warning light system.

5.3. TROUBLESHOOTING

Before beginning these test procedures, do the following:

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

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

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

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

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

Transmission Oil Temperature Gauge Circuitry

Table 8 Transmission Oil Temperature Gauge Circuitry

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove fuse F22 and check for open condition.	F22	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	On	At fuse F22, measure voltage from circuit A13F to ground.	F22, A13F to gnd.	12 ± 1.5 volts.	Install fuse. Go to next step.	Locate cause of low or no voltage in circuit A13/A13F, then repair. Install fuse.
3.	Off/ On	Disconnect green connector (10) from cluster. Turn key on and measure voltage from circuit A28A to ground.	(10), A28A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A28A, then repair.

Table 8 Transmission Oil Temperature Gauge Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
4.	On	At connector (10), measure voltage across circuit A28A to A28–GA.	(10), A28A to A28–GA.	12 ± 1.5 volts.	Go to next step.	Locate cause of open or poor connection in circuits A28–GA/ A11–GB/ A11–G, then repair.
5.	Off/ On	At connector (10), install jumper wire from circuit A28A to A31. Disconnect sender connector (38). Turn key on and measure voltage from circuit A31 to ground.	(38), A31 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A31 or conn. (A2 or A2A), then repair.
6.	On	At connector (38), measure voltage across circuit K31 to K31–G.	(38), K31 to K31–G.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuits K31–G/ A11–GD, then repair.
7.	Off	Remove jumper wire and reconnect cluster connector (10) and sender connector (38).			Go to next step.	
8.	Off	Transmission oil temperature gauge circuitry checks good. If condition still persists, refer to CTS-5228 to diagnose the gauge and sender.	Gauge and sender.	Pass test.	Replace cluster.	Replace defective component.

Fuel Level Gauge Circuitry

Table 9 Fuel Level Gauge Circuitry

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove fuse F22 and check for open condition.	F22	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	On	At fuse F22, measure voltage from circuit A13F to ground.	F22, A13F to gnd.	12 ± 1.5 volts.	Install fuse. Go to next step.	Locate cause of low or no voltage in circuit A13/A13F, then repair. Install fuse.

Table 9 Fuel Level Gauge Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
3.	Off/ On	Disconnect green connector (11) from cluster. Turn key on and measure voltage from circuit A28B to ground.	(11), A28B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A28/A28B, then repair.
4.	On	At connector (11), measure voltage across circuit A28B to A28–G.	(11), A28B to A28–G.	12 ± 1.5 volts.	Go to next step.	Locate cause of open or poor connection in circuits A28–G/ A11–GB/ A11–G, then repair.
5.	Off/ On	At connector (11), install jumper wire from circuit A28B to A36. Disconnect sender connector (37). Turn key on and measure voltage from circuit A36 to ground.	(37), A36 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A36 or conn. (2 or A2A), then repair.
6.	On	At connector (37), measure voltage across circuit K36 to K36–G.	(37), K36 to K36–G.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuits K36–G/ K11–GD, then repair.
7.	Off	Remove jumper wire and reconnect cluster connector (11) and sender connector (37).			Go to next step.	
8.	Off	Fuel level gauge circuitry checks good. If condition still persists, refer to S08313 to diagnose the gauge and sender.	Gauge and sender.	Pass test.	Replace cluster.	Replace defective component.

Hydraulic Brake Low Fluid and Parking Brake Warning Light System and Bulb Check

Table 10 Hydraulic Brake Low Fluid and Parking Brake Warning Light System and Bulb Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Start	Do both bulbs operate when key switch is in the start position?			Go to next step.	Go to Step 14.
2.	On	Does the low brake fluid warning light operate properly?			Go to next step.	Go to Step 9.

Table 10 Hydraulic Brake Low Fluid and Parking Brake Warning Light System and Bulb Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
3.	On	With parking brake applied, does the parking brake warning light operate properly?			End test.	Go to next step.
4.	Off	Disconnect parking brake switch connector (N/L). At circuit K44–G, measure resistance to ground.	Park brake sw. (N/L), K44–G to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit K44–G/ K11–GD or start motor ground, then repair.
5.	Off/ On	At park brake switch connector, install jumper wire from circuit K44B to ground and turn key on. Does light work?			Replace park brake switch.	Go to next step.
6.	Off/ On	Disconnect natural dash connector (12). Turn key on and measure voltage from circuit A28C to ground.	(12), A28C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit A28C/A28A, then repair.
7.	On	At connector (12), measure voltage across circuit A28C and A44A.	(12), across A28C to A44A.	12 ± 1.5 volts.	Replace cluster. Go to next step.	Locate open or poor connection in circuit A44A, or conn. (2), then repair. Go to next step.
8.	Off	Remove jumper wire and reconnect connectors. Park brake circuitry checks OK.				
9.	Off	Remove low brake fluid level sensor connector (90). At connector, measure resistance from circuit A11–GF to ground.	(90), A11–GF to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuits A11–GE, A11–GE, conn. (88), (84), or ground connections, then repair.
10.	On	At connector, install jumper wire from circuit A90P to ground. Does light operate?			Replace sensor (90).	Go to next step.

Table 10 Hydraulic Brake Low Fluid and Parking Brake Warning Light System and Bulb Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
11.	Off/ On	Remove low brake fluid light connector (89). Turn key on and measure voltage from circuit A90R to ground.	(89), A90R to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90R/A28A, then repair.
12.	On	At connector (89), measure voltage across circuit A90R and A90V.	(89), across A90R to A90V.	12 ± 1.5 volts.	Replace bulb/ socket assy. (89). Go to next step.	Locate open or poor connection in circuits A90V, A90P, or conn. (84), (88), then repair. Go to next step.
13.	Off	Remove jumper wire and reconnect connectors. Low brake fluid light circuitry checks good.				
14.	Off/ Start	Disconnect key switch (20). Hold switch in start position and measure resistance from ground terminal of switch to its case.	(20), gnd. term. to case gnd.	< 1 ohm.	Go to next step.	Replace defective key switch (20).
15.	Off/ Start	Reconnect connector (20) and disconnect park brake switch connector (N/L). With key in start position, measure resistance from circuit A44 to ground.	(N/L),A44 to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A44, conn. (2), or platform ground, then repair.
16.	Off/ Start	Reconnect park brake switch connector and disconnect low brake fluid diode (82). With key in start position, measure resistance of circuit A90X to ground.	(82), A90X to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A90X, then repair.
17.	Off	With multimeter in diode test mode, check blocking diode (82). Is diode good?	(82)	0.6V to 0.8V.	Go to next step.	Replace defective diode.

Table 10 Hydraulic Brake Low Fluid and Parking Brake Warning Light System and Bulb Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
18.	Off/ Start	Reconnect blocking diode and disconnect brake fluid light connector (89). With key in start position, measure resistance of circuit A90V to ground.	(89), A90V to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A90V/A90W, then repair.
19.	Off	Bulb check ground circuitry checks good. If bulbs still do not operate properly, go to Step 2 and 3.				

Low Air Pressure Warning Light and Alarm System

Table 11 Low Air Pressure Warning Light and Alarm System

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	On	With air pressure below 60 psi, do BOTH the warning light and alarm fail to operate?			Go to Step 4.	Go to next step.
2.	On	With air pressure below 60 psi, does the alarm operate but the warning light does not?			Perform Steps 7 — 12.	Go to next step.
3.	On	With air pressure below 60 psi, does the warning light operate properly but the alarm does not?			Perform Steps 13 — 16.	End test.
4.	Off/ On	At low air pressure switch (717), remove connector and jumper circuit K40 to ground. Turn key ON. Does the warning system work?			Replace air pressure switch.	Go to next step.
5.	Off	Disconnect alarm (211) and measure resistance from cavity A to ground.	(211), cav. A to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A40 or conn. (2), then repair.

Table 11 Low Air Pressure Warning Light and Alarm System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
6.	Off	Remove jumper and reconnect switch (717) and alarm (211). Warning system ground circuitry checks good.				
7.	Off	Remove fuse F22 and check for open condition.	F22	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
8.	On	At fuse F22, measure voltage from circuit A13F to ground.	F22, A13F to gnd.	12 ± 1.5 volts.	Install fuse. Go to next step.	Locate cause of low or no voltage in circuit A13/A13F, then repair. Install fuse.
9.	Off/ On	Disconnect yellow connector (10) from IP cluster. Turn key on and measure voltage from circuit A28A to ground.	(10), A28A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A28/A28A, then repair.
10.	On	Remove alarm (211) and install jumper from cavity A to ground. At connector (10), measure voltage across circuit A28A to A40A.	(10), A28A to A40A.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit A40A, then repair.
11.	Off	Remove bulb and check for open condition. Is bulb OK?			Replace IP cluster. Go to next step.	Replace bulb. Go to next step.
12.	Off	Remove jumpers and reconnect connectors. Warning light power circuits check good.				
13.	Off	Remove fuse F24 and check for open condition.	F24	< 1 ohm.	Go to next step. Install fuse.	Locate cause of overload condition and repair. Replace fuse.
14.	On	At fuse F24, measure voltage from circuit A13H to ground.	F24, A13H to gnd.	12 ± 1.5 volts.	Install fuse. Go to next step.	Locate cause of low or no voltage condition in circuits A13/A13H, then repair. Install fuse.

Table 11 Low Air Pressure Warning Light and Alarm System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
15.	On	Remove alarm (211) and at cavity B, measure voltage to ground.	(211), cav. B to gnd.	12 ± 1.5 volts.	Replace alarm.	Locate cause of low or no voltage in circuit A13B, then repair.
16.	Off	Reconnect alarm. Alarm power circuits check good.				

5.4. COMPONENT LOCATIONS

(1) Fuse Block Panel..... Left Side of Steering Column Support
(2) Platform Harness Dash Connector..... Inside of Front Dash Panel
(2A) Engine Harness Dash Connector..... Front Side of Front Dash Panel
(10) Lt. Instrument Cluster Connector..... Rear of Instrument Cluster Panel (Yellow)
(11) Ctr. Instrument Cluster Connector..... Rear of Instrument Cluster Panel (Green)
(12) Rt. Instrument Cluster Connector..... Rear of Instrument Cluster Panel (Natural)
(20) Key Switch..... Right Side of Instrument Cluster
(37) Fuel Sender Connector..... Top Side of Transmission Bell Housing
(38) Transmission Oil Temperature Sender..... Right Side of Transmission
(82) Low Brake Fluid Diode Assembly..... Front of Dash, Above Fuse Block
(84) Hyd. Brake Booster Inline Connector..... Right Side of Brake Pump Motor
(88) Brake Booster Inline Connector..... At Right Platform Grommet Retainer
(89) Low Brake Fluid Level Warning Light..... Below Voltmeter Gauge
(90) Low Brake Fluid Level Sensor..... Bottom of Brake Fluid Reservoir
(211) Alarm..... Left Side Dash in Fuse Panel
(717) Low Air Pressure Switch Connector..... At Compressor
(J1) Platform Ground..... Inside Platform Below Oil Pressure Anchor Coupling
(J10) Engine Ground..... Left Side of Flywheel Housing (Pre-Oct. 96)
(J10) Starter Ground..... Ground Stud in Front of Starter (Oct. 96 and Later)

Transmission Oil Temperature Gauge Wiring

G08-55085.01.E

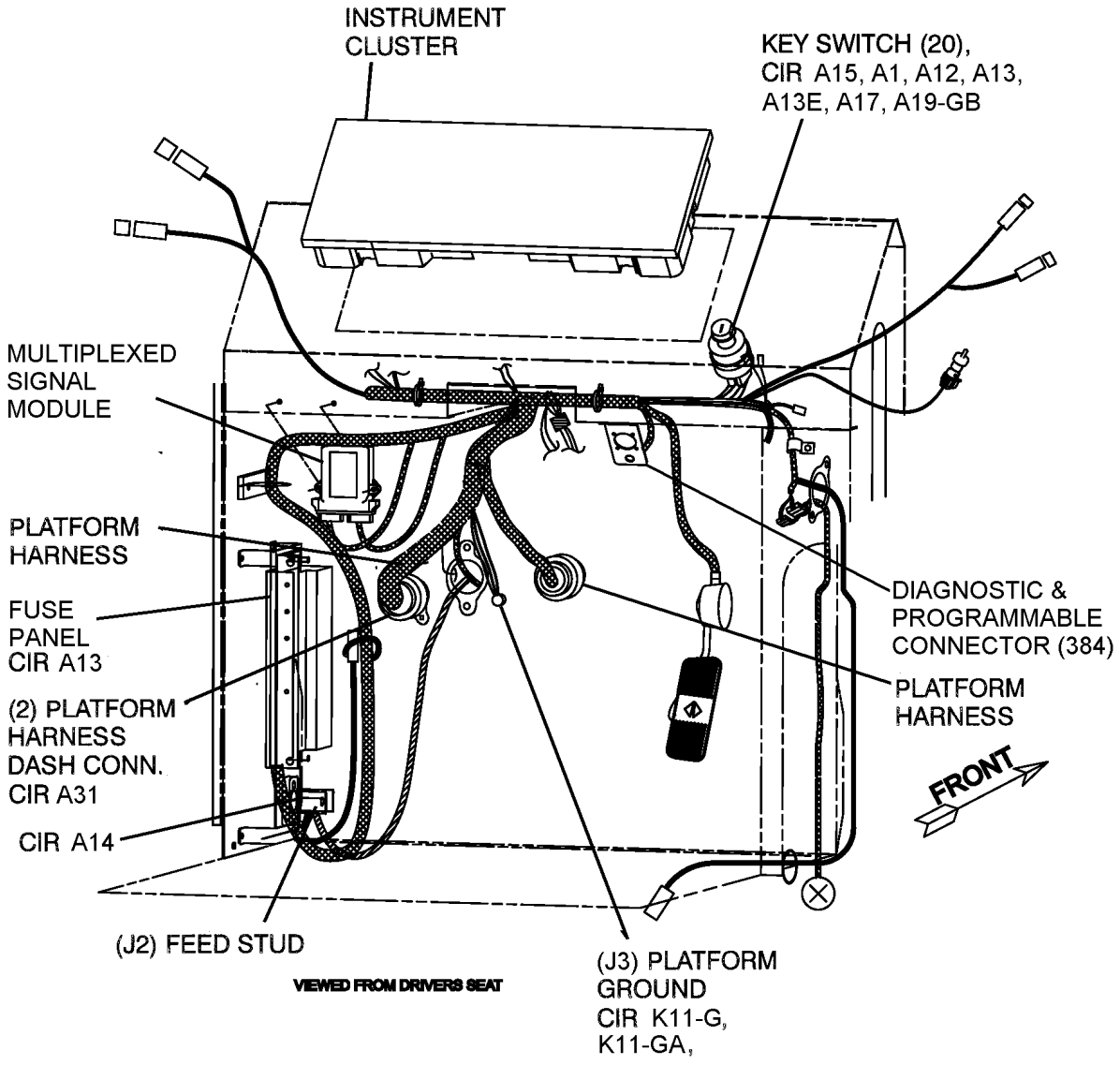

Figure 26 Transmission Oil Temperature Gauge Wiring

G08-54592.05.B

Transmission Oil Temperature Gauge Wiring

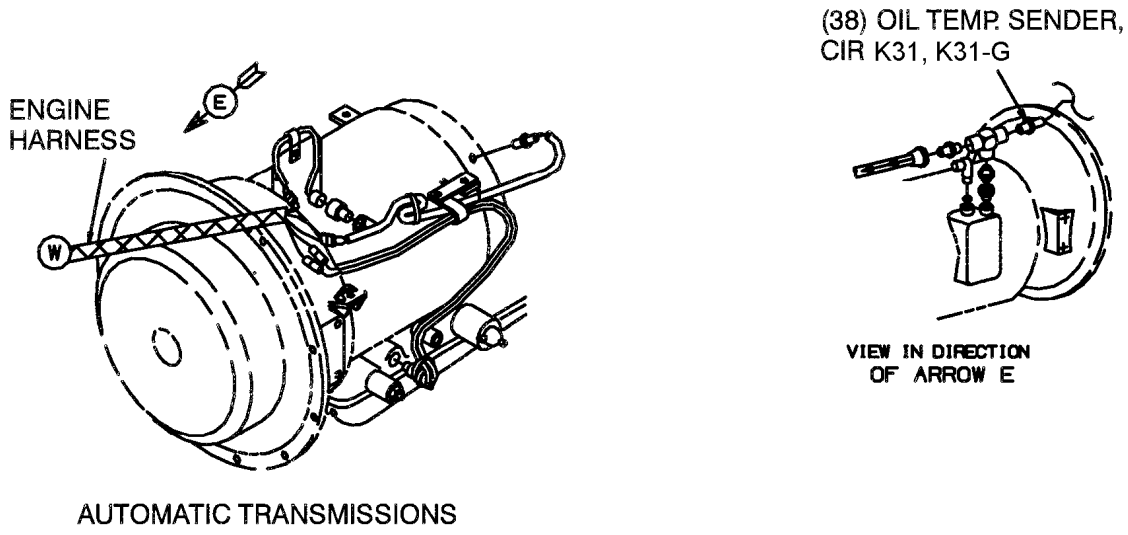

Figure 27 Transmission Oil Temperature Gauge Wiring

Crank Motor Wiring G08-54570.02

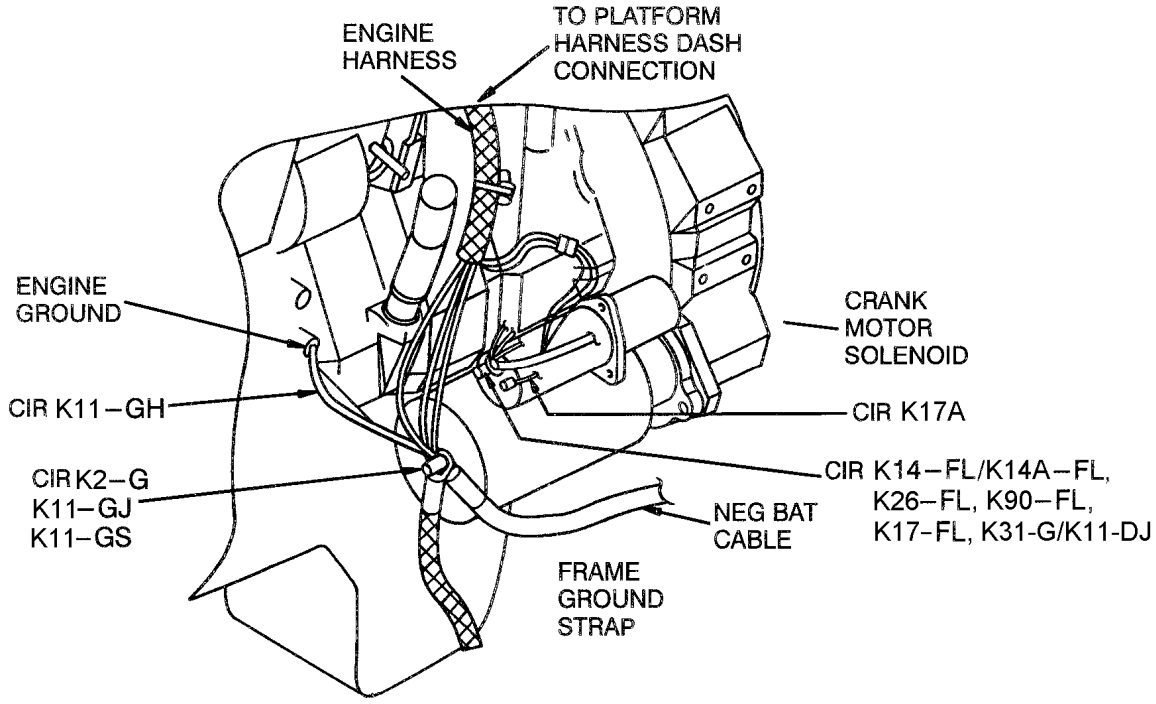

Figure 28 Cranking Motor and Connections

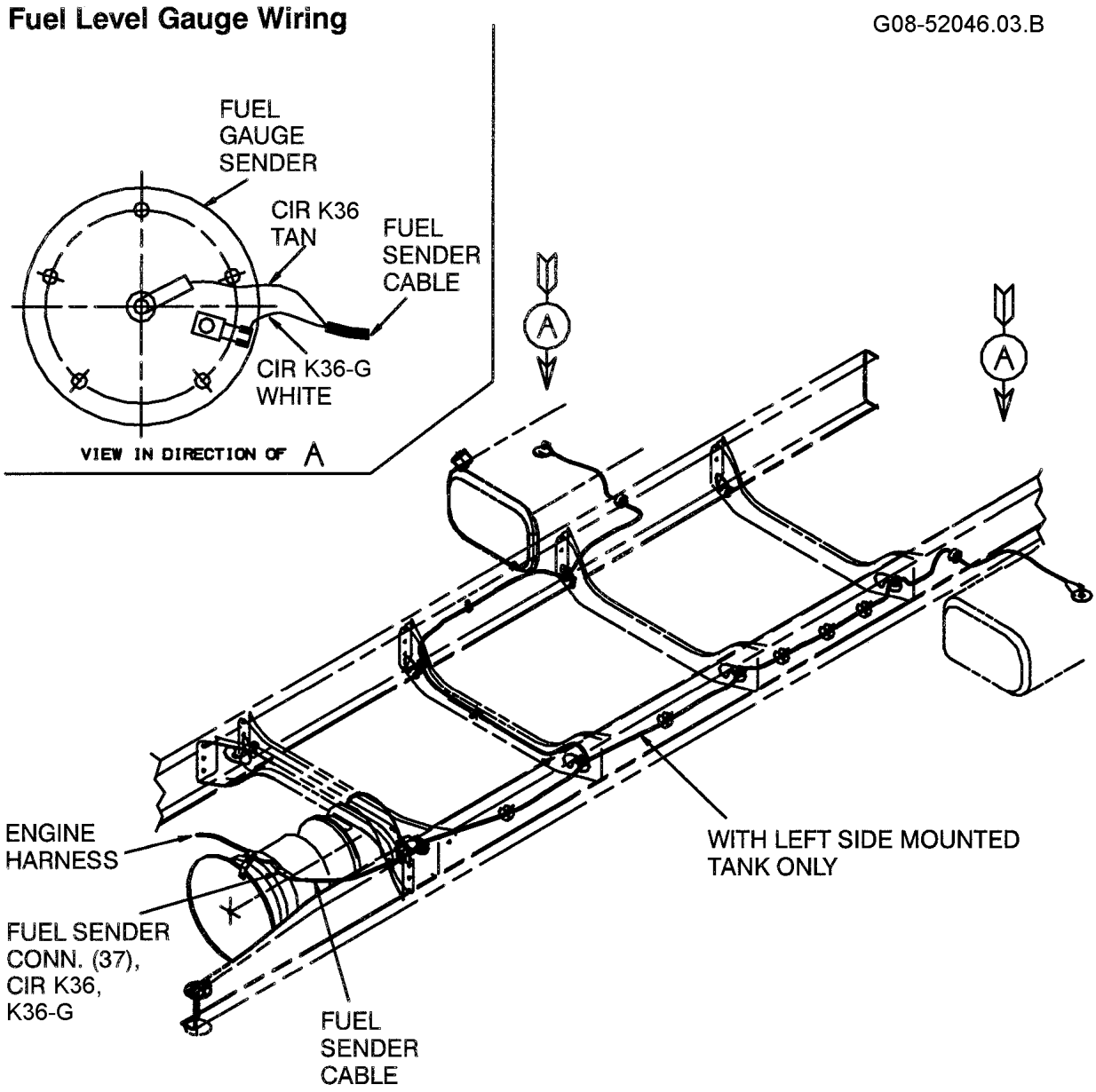

Figure 29 Fuel Level Gauge Wiring

Fuel Level Gauge Wiring

G08-55085.01.E

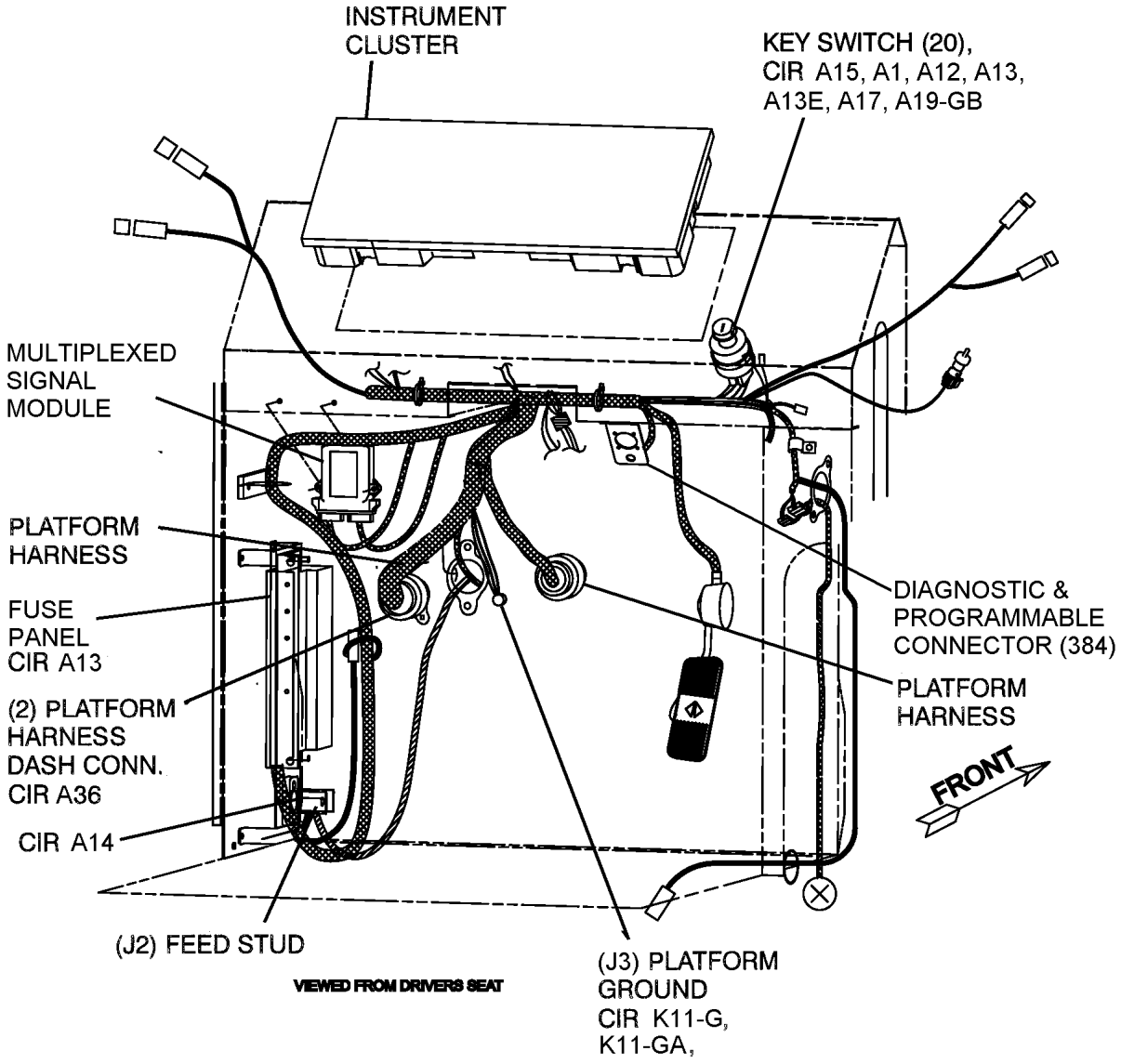

Figure 30 Fuel Level Gauge Wiring

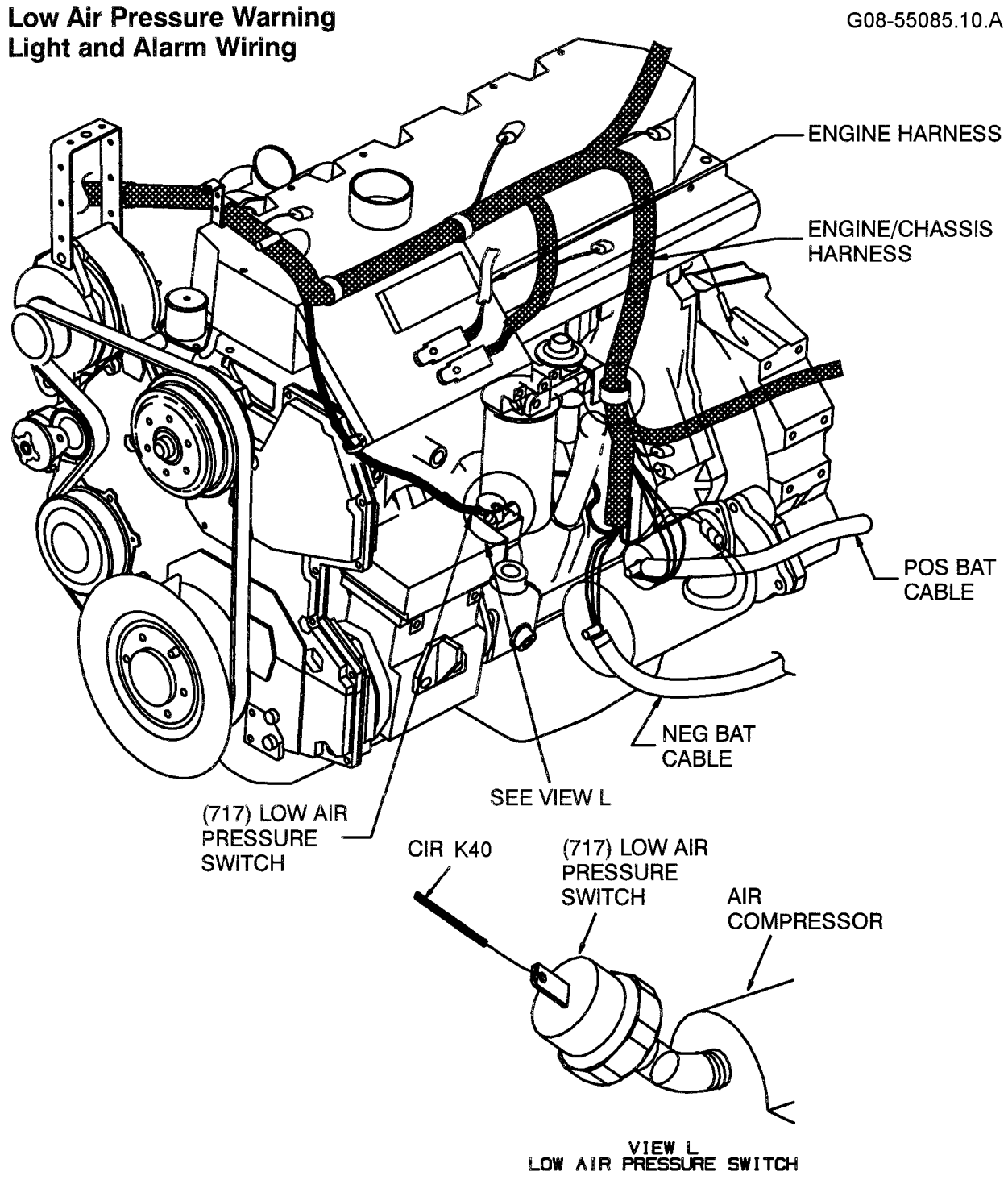

Figure 31 Low Air Pressure Warning Light and Alarm Wiring

Low Air Pressure Warning Light and Alarm Wiring

G08-55085.01.E

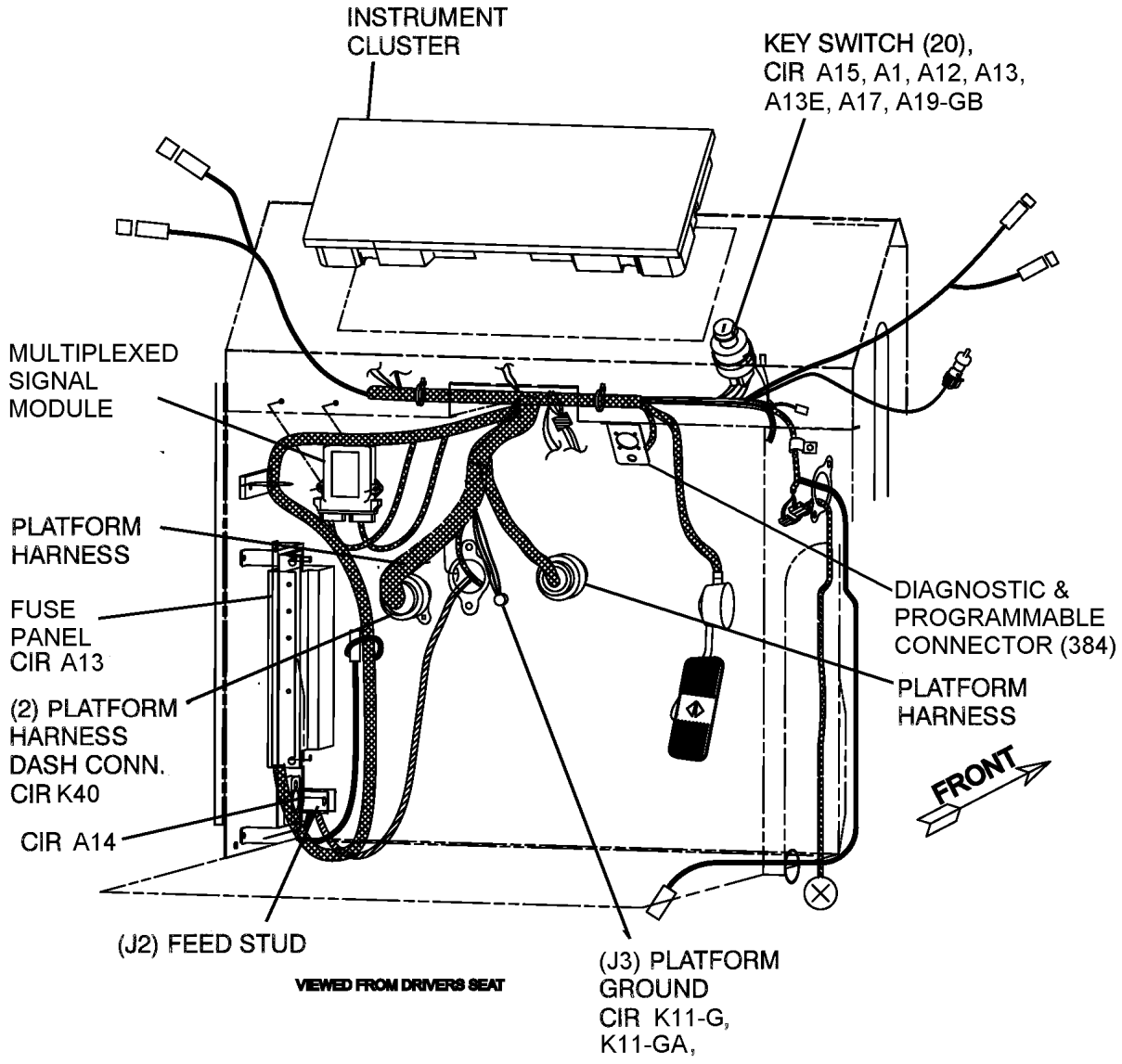

Figure 32 Low Air Pressure Warning Light and Alarm Wiring

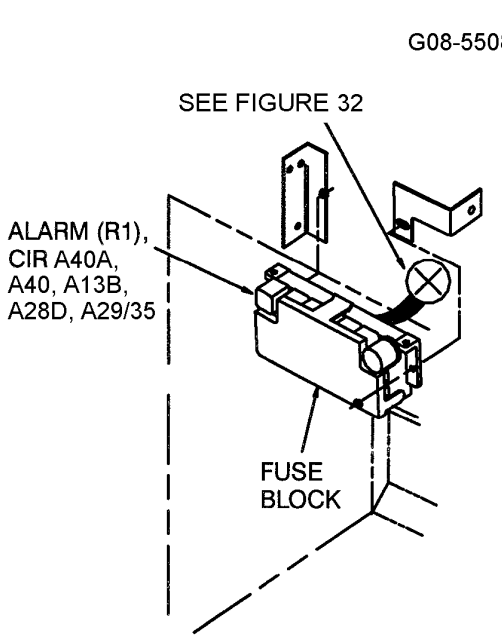

Figure 33 Low Air Pressure Warning Light and Alarm Wiring

6. FE 300 CHASSIS ACCESSORIES

6.1. DESCRIPTION

Air Dryer with Heater

The function of the air dryer is to collect moisture and contaminants in the air system before it reaches the first reservoir. This will provide for moisture-free air for the air brake system. The heater in the air dryer prevents freeze-up in the purge drain valve during cold weather.

Antilock Brake System

Refer to S04023 ANTILOCK AIR BRAKE SYSTEM.

Body Connections

The purpose of the body connectors is to provide connections of the body lighting circuits and the chassis circuitry.

Automatic Drain Valve with Heater

The function of the automatic drain valve is to automatically expel accumulated moisture from the air tank. The heater in the drain valve prevents freeze-up during cold weather operation.

Heated Fuel Filter/Water-In-Fuel

The fuel filter heater is mounted in the fuel filter and when operating, it helps prevent fuel from gelling up in the unfiltered side of the filter. The system consists of a fuel heater relay, the filter heating element, and a normally open thermal switch. The switch contacts close at approximately 50°F (10°C).

The water-in-fuel system consists of a control module, a water probe, and a warning light in the dash cluster. When water is present in the fuel filter, increased current will flow from the probe to ground. The module senses this increase and turns on the warning light. The system also conducts a bulb check when the key switch is in the start position to verify the light operates.

Hydraulic Brakes

The Bendix Hydro-Max II hydraulic brake booster is offered on all hydraulic brake models. It powers a split system which protects against brake failure by using separate fluid lines to feed the front and rear axle brakes. The master cylinder provides fluid pressurized by the power steering pump and the Hydro-Max II booster to activate the brake pads against the disc brakes. It is a dual mode system which will automatically provide back-up brake power, from an electric/hydraulic pump, should there be a loss of power steering pump pressure.

A warning light and alarm, which can indicate various hydraulic and electrical malfunctions, are standard.

Stop Light Switch (Air Brakes)

The stop light switch circuit controls voltage to the body builder connector (169) and is used by the body builder stop light circuits.

Allison WTEC Transmission

Refer to Troubleshooting Guide S08246 for a description of the Allison WTEC III transmission.

Allison LCT Transmission

Refer to Troubleshooting Guide S08247 for a description of the Allison 2000 LCT transmission.

6.2. OPERATION

Air Dryer with Heater

When the key switch (20) is in the on or accessory position, power is applied to circuit A12, fuse F7, circuit A39A, dash connector (2), A39A, connector (40), a black wire, connector (51)/(76), and a black wire to the heated air dryer (94). If the air dryer thermostat senses air temperature below 50°F (10°C), its contacts close and allow current to flow through the heating element. This assures that the accumulated moisture does not freeze during cold weather.

Ground is through a white wire, connector (51)/(76), a white wire, connector (40), and circuit K39-G/K11-GJ to (J10) engine ground.

Antilock Brake System

Refer to S04023 ANTILOCK BRAKE SYSTEM.

Body Builder Connections

Refer to Description, Operation and Troubleshooting sections for circuitry of any system which may supply power to the body builder connectors (169) or (170).

Automatic Drain Valve with Heater

When the key switch (20) is in the on position, power is fed to circuit A12, fuse F8, circuit A39, dash connector (2), circuit K39, in-line connector (40), and a black wire to the heated drain valve. The drain valve is grounded through a white wire, in-line connector (40), circuit K39-GA/K11-GJ to the (J10) engine or starter ground.

When the temperature drops below 50°F (10°C), its contacts close and allow current to flow through the heating element. This assures that the accumulated moisture does not freeze in the drain valve during cold weather.

Heated Fuel Filter/Water-In-Fuel

Power is applied from the (J2) battery feed stud to the fuel heater relay (R5) through circuit A14/A19, fuse F17 and circuit A19H. When the key switch is turned to the ON or START position, power flows from the key switch (20), through circuit A13A, fuse F20, circuit A19D and the relay coil. Ground for the relay is through circuit A11-GA to the (J1) platform ground. This energizes the relay.

With the relay energized, power is applied to the heated fuel filter (N/L) through circuit A19A, connector (2), circuit K19A, connector (6706) and a green wire. When the temperature drops below approximately 50°F (10°C), the thermal switch contacts close and a ground path is applied through a blue wire, connector (6706), circuit A19-GD/A11-GJ to the (J10) engine ground. This causes the heater element to come on.

With key switch on, power is also applied from the fuel heater relay connector through circuit AA19E to the water-in-fuel module (16). From the module, power is applied to the fuel filter water probe through circuit A19A, connector (2), circuit K19A, connector (6706), and a yellow wire. Whenever water builds up to an unacceptable level, it causes a completed circuit path from the probe to the filter housing, which is grounded to the frame through its mounting bracket. This causes the module to energize.

When the water-in-fuel module becomes energized, power is supplied to circuit A19F and the water-in-fuel light (9). This energizes the lamp as power flows through circuit A19-G/A11-G to the (J1) platform ground.

When the key switch is in the start position, the water-in-fuel module is grounded through circuit A19-GB to the key switch ground. This serves as a bulb check to assure the bulb is operational.

Hydraulic Brake System

The Hydro-Max II hydraulic brake system uses hydraulic pressure from the power steering pump. If the flow is inadequate or interrupted, the monitor module (86) is fed a signal from the flow switch (N/L), causing the monitor to turn on a brake warning light and alarm system and to start the hydraulic reserve pump to provide additional braking power. The reserve pump and warning system is also activated when the differential pressure switch (91) is tripped due to a pressure loss in one half of the brake system.

When the key switch (20) is in ignition or start position, power is supplied to circuits A13A, A90U, fuse F2, circuit A90T, and blocking diode assembly (80). From the blocking diode, power is supplied through circuit A90J, to the hydraulic pump control relay (85) coil, and also through circuit A90H to the brake monitor module (86). The brake monitor module is grounded through circuit A11-GD to the platform ground.

Battery power is applied to fusible link A90-FL, circuit A90, and pump control relay (85). Power is also applied from circuit A90-FL to circuit A90, circuit A90A, fuse F1, circuit A90B, connectors (83), (87), and (92), and hydraulic brake switch (209).

When the key switch is moved to the start or ignition position, the flow switch contacts will be closed (engine not running) and a ground path is provided from the switch through circuits A90L, A90K, connector (84), circuit A90K, connector (88) and A90K, to a splice. From the splice, a ground path is provided over circuit A90L to the brake monitor module alarm input (86-A). This causes the module to switch the alarm output (86-C) to ground, which activates the alarm and warning light. From the splice, a ground circuit is also provided by way of circuit A90E to the pump control relay (85), causing it to energize. With the relay energized, power flows through its N.C. contacts, circuit A90S and connectors (84) and (88) to the reserve pump motor. This causes the reserve pump motor, which is grounded through its case, to run and provide additional brake power (fluid flow).

A signal path, on circuit A90Q, connectors (84) and (88) to brake monitor module connector (86-F), provides information to the module. It continuously monitors the continuity of the reserve pump and power supplied to it. The warning system activates if the pump motor winding opens up or if the hydraulic brake relay (85) remains closed (provides power to circuit A90S and the reserve pump motor), after the engine is running. The warning system is also activated if no power is supplied to the pump motor when the flow switch or differential switch contacts are closed.

When the brake monitor module switches its alarm output (86-C) to ground, the brake warning light illuminates by power flowing to the lamp feed connector (10), through the light, connector (10), and circuits A90N, A90M, to the module at connector (86-C).

At the same time, the alarm also sounds by power flowing to the B+ terminal of the alarm, through the alarm, and circuit A90M to the module at connector (86-C).

If the ignition key is in the off position and the truck brakes are applied, the contacts of the hydraulic brake switch (209) close. With the contacts closed, power flows through circuits A70C, A90F, A90G and blocking diode assembly (81), circuit A70D, connector and diode assembly (80), and circuit A90H, to feed the brake monitor module at connector (86-E).

At the same time, power signals are fed from the diode connector (81) to circuit A90D and the brake monitor module connector (86-G) and on circuit A90C to brake monitor module connector (86-H). The module compares these signals and if there is a voltage on just one of the two circuits, A90D or A90C, for more than 14±5 seconds, the warning light and alarm will be turned on.

Battery voltage is also applied to the stop light relay (R4) through fuse F12 and circuit A70B. When the brakes are applied, power flows from diode connector (80), through circuit A70E, to the relay coil, which energizes the relay. The relay is grounded through circuit A70-G/A11-GA to (J1) platform ground. With the relay energized, the contacts close and allow power to flow through the relay, circuit A70A, to the body builder connector (169).

Stop Light Switch (Hydraulic Brakes)

From the cranking motor solenoid, power is applied to circuit A90-FL/A90, a connector (N/L), circuit A90A, fuse F1, circuit A90B, connectors (83), (87) and (92) to the brake switch (209). When the brake pedal is depressed, the contacts of switch (209) close and power is supplied to circuit A70C, connectors (93), (87) and (83), and circuit A90C to the brake monitor module (86).

At the same time, power is also applied to a blocking diode (81), circuit A70D, connector (80), and circuit A70E to the stop light relay (R4). This energizes the relay and allows power to be applied through fuse F12, circuit A70B, relay (R4), and circuit A70A to the body builder connector (169). From this point, power is applied to the tail lights through the body builder circuitry.

Stop Light Switch (Air Brakes)

From the battery feed stud (J2), power is applied to circuit A14/A14A, fuse F12, circuit A70, stop light switch jumper harness connector (26), a red wire, first stop light switch (26), and a red wire to the second stop light switch (26).

When the brake pedal is depressed, the stop light switch contacts close and power is supplied to the common brown wire and to jumper harness connector (26). From connector (26), power is applied to circuits A70B/A70A and the body builder connector (169).

6.3. TROUBLESHOOTING

Before beginning these test procedures, do the following:

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

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

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

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

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

Air Dryer with Heater

Table 12 Air Dryer with Heater

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Check fuse F7 for open condition.	F7	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	On	At fuse F7 and circuit A12, measure voltage to ground.	F7, A12 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A12, then repair. Install fuse.
3.	Off/ On	Disconnect air dryer/ drain valve connector (40). Turn key on and measure voltage from circuit A39A to ground.	(40), A39A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A39A or dash conn. (2), then repair.
4.	On	At (40) measure voltage across circuit A39A to K39–GA.	(40), A39A to K39–GA.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit K39–GA/ K11–GJ, then repair.
5.	Off/ On	Reconnect connector (40) and disconnect air dryer connector (94). Turn key on and measure voltage from black wire to ground.	(94), black wire to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in black wire or conn. (51) or (76), then repair.

Table 12 Air Dryer with Heater (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
6.	On	At connector (94), measure voltage across black wire to white wire.	(94), black wire to white wire.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in white wire or conn. (51) or (76), then repair.
7.	Off/ On	At (94), install jumper from black wire to heater element feed. With key on and unit cooled to below 50°F (10°C), measure voltage from element ground terminal to white wire.	(94), gnd. stud to white wire.	12 ± 1.5 volts.	Go to next step.	Replace air dryer.
8.	Off	Remove jumper wire and reconnect connector (94). Air dryer circuitry checks good.				

Automatic Drain Valve with Heater

Table 13 Automatic Drain Valve with Heater

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Check fuse F8 for open condition.	F8	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	On	At fuse F8 and circuit A12, measure voltage to ground.	F8, A12 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A12, then repair. Install fuse.
3.	Off/ On	Disconnect air dryer/ drain valve connector (40). Turn key on and measure voltage from circuit A39 to ground.	(40), A39 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A39 or dash conn. (2), then repair.
4.	On	At (40) measure voltage across circuit A39 to K39–GA.	(40), A39 to K39–GA.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit K39–GA/ K11–GJ, then repair.

Table 13 Automatic Drain Valve with Heater (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
5.	Off/ On	Reconnect connector (40) and disconnect drain valve pigtail. Turn key on and measure voltage from black wire to ground.	Drain valve conn., black wire to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in black wire, then repair.
6.	On	Disconnect white wire. At connector, measure voltage across black wire to white wire.	Drain valve conn., black wire to white wire.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in white wire, then repair.
7.	Off/ On	Reconnect white ground wire to drain valve. With key on and unit cooled to below 50°F (10°C), measure voltage from black wire to valve pigtail.	Drain valve pigtail to black wire.	12 ± 1.5 volts.	Go to next step.	Replace drain valve.
8.	Off	Reconnect pigtail connector. Drain valve circuitry checks good.				

Heated Fuel Filter/ Water-In-Fuel

Table 14 Heated Fuel Filter/ Water-In-Fuel

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Does the water-in-fuel system operate properly?			Go to next step.	Go to Step 11.
2.	Off	Does the heated fuel filter work properly?			End test.	Go to next step.
3.	Off	Remove fuel heater relay (R5). At relay connector, measure voltage from cavity E to ground.	(R5), cav. E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit A19H, or open fuse F17, then repair.
4.	On	At relay connector, measure voltage from cavity B to ground.	(R5), socket, cav. B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit A19D, or open fuse F20, then repair.

Table 14 Heated Fuel Filter/ Water-In-Fuel (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
5.	On	At relay socket (R5), measure voltage from cavity B to cavity A.	(R5) socket, cav. B to A.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A11–GA, then repair.
6.	Off	Bench test fuel filter relay (R5) by measuring resistance from pin 30 to 87A.	(R5), pin 30 to 87A.	< 1 ohm.	Go to next step.	Replace defective relay.
7.	Off	Apply +12V to relay pin 86 and ground to pin 85. Measure resistance from pin 30 to 87.	Energized (R5), pin 30 to 87.	< 1 ohm.	Go to next step.	Replace defective relay.
8.	Off/ On	Reconnect relay (R5) and disconnect green wire from fuel filter. Turn key on and measure voltage from green wire to ground.	Fuel filter, green wire to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit A19A, dash conn. (2), circuit K19A, conn. (6706) or green wire, then repair.
9.	On	At fuel filter, remove brown wire and measure voltage across green wire to brown wire.	Fuel filter, from green to brown wire.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in brown wire or circuit A19–GD/ A11–GJ, then repair.
10.	On	Reconnect brown wire. With the fuel heater cooled to below 50°F (10°C), measure voltage from the green wire to the heater power stud.	Fuel filter, green wire to heater power stud.	12 ± 1.5 volts.	Reconnect green wire. Heated fuel filter system checks good.	Repair or replace heated fuel filter.
11.	Off/ On	Disconnect water-in-fuel module (16). Turn key on and at connector, measure voltage from circuit A19E to ground.	(16), A19E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit A19E, then repair.
12.	Start	At socket (16), measure voltage across circuit A19E to A19–GB.	(16), across A19E to A19–GB.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A19–GB, or key switch, then repair.

Table 14 Heated Fuel Filter/ Water-In-Fuel (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
13.	On	At socket (16), install jumper from circuit A19E to A19F. Does warning light operate?			Go to Step 16.	Go to next step.
14.	On	Disconnect WIF warning light conn. (9) and at circuit A19F, measure voltage to ground	(9), A19F to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit A19F, then repair.
15.	On	At WIF connector (9), measure voltage across circuit A19F to A19–G.	(9), across A19F to A19–G.	12 ± 1.5 volts.	Replace lamp or socket assy.	Locate open or poor connection in circuit A19–G/ A11–G, then repair.
16.	Off/ On	At WIF connector (16) move jumper across circuit A19E to A19A. At the filter, disconnect yellow wire from the water probe. Turn key on and measure voltage from yellow wire to ground.	Water probe conn., yellow wire to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit A19A, dash conn. (2), circuit A19A, conn. (6706), or yellow wire, then repair.
17.	On	Remove jumper and reconnect WIF module (16). At water probe connector, jumper yellow wire to ground. Does light work?	Water probe conn., jumper yellow wire to gnd.	Light works.	Go to next step.	Replace WIF module.
18.	Off	Remove water probe and install jumper from the probe to ground. Measure voltage from yellow wire to water probe feed stud.	Water probe, yellow wire to probe feed stud.	12 ± 1.5 volts.	Install probe and connections. WIF system checks good.	Replace water probe.

Hydraulic Brake System Circuitry

Table 15 Hydraulic Brake System Circuitry

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove pump control relay (85) and measure voltage from circuit A90 to ground.	(85), A90 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in fusible link A90–FL or circuit A90, then repair.

Table 15 Hydraulic Brake System Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
2.	Off	Disconnect reserve pump motor connector. Install a jumper wire at relay socket (85) from circuit A90 to A90S. At pump motor connector, measure voltage from circuit 90S to ground.	Pump motor conn., A90S to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90S or conn. (84) or (88), then repair.
3.	Off	Reconnect circuit A90S to pump motor terminal. Does motor run?			Remove jumper. Go to next step.	Replace pump motor.
4.	Off	Bench test relay (85) by measuring resistance from pin 30 to 87A.	Relay (85), pin 30 to 87A.	< 1 ohm.	Go to next step.	Replace relay.
5.	Off	Bench test relay by applying +12 volts to pin 85, ground to pin 86, and measure resistance from pin 30 to 87.	Energized relay, pin 30 to 87.	< 1 ohm.	Go to next step.	Replace relay.
6.	Off	Remove fuse F1 and check for open condition.	F1	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
7.	Off	At fuse F1 and circuit A90A, measure voltage to ground.	F1, A90A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90A, then repair. Re-install fuse.
8.	Off	Disconnect connectors (92) and (93) from brake switch (209). At (92) measure voltage from circuit A90B to ground.	(92), A90B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90B, or conn. (83), (87) or (92), then repair.
9.	Off	Measure resistance across switch (209) from BK3 to BK2 and BK3 to BK1 while brake pedal is depressed.	(209), across BK3 to BK2, and BK3 to BK1.	< 1 ohm each test.	Go to next step.	Replace brake switch.

Table 15 Hydraulic Brake System Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
10.	Off	Reconnect (92) and (93) to brake switch (209). Remove blocking diode from connector (81). With pedal depressed, measure voltage from circuit A90G to ground.	(81), A90G to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90G or conn. (92), (87) or (83), then repair.
11.	Off	At (81), and with brake pedal depressed, measure voltage from A70C to ground.	(81), A70C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A70C or conn. (93), (87) or (83), then repair.
12.	Off	With multimeter in diode test mode, test diode (81). Does diode test good?	Diode (81).	0.6V to 0.8V.	Go to next step.	Replace diode.
13.	Off	Re-install diode (81). Remove fuse F2 and check for open condition.	F2	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
14.	On	At fuse F2, measure voltage from circuit A90U to ground.	F2, A90U to gnd.	12 ± 1.5 volts.	Go to next step	Locate cause of low or no voltage in circuit A90U or A13A, then repair. Install fuse.
15.	Off/ On	Remove diode from connector (80). Turn key on and at (80), measure voltage from circuit A90T to ground.	(80), A90T to gnd.	12 ± 1.5 volts.	Go to next step	Locate cause of low or no voltage in circuit A90T, then repair.
16.	Off	With brake pedal depressed and at (80), measure voltage from circuit A70D to ground.	(80), A70D to gnd.	12 ± 1.5 volts.	Go to next step	Locate cause of low or no voltage in circuit A70D, then repair.
17.	Off	With multimeter in diode test mode, test diode (80). Does diode test good?	Diode (80).	0.6V to 0.8V.	Install diode. Go to next step.	Replace diode.
18.	Off	Disconnect monitor module connector (86). With brake pedal depressed, measure voltage from circuit A90C to ground and A90D to ground.	(86), A90C to gnd., A90D to gnd.	12 ± 1.5 volts each test.	Go to next step.	Locate cause of low or no voltage in circuit A90C and/or A90D, then repair.

Table 15 Hydraulic Brake System Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
19.	On	At 86, measure voltage from circuit A90H to ground.	(86), A90H to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90H, then repair.
20.	Off	At (86), measure resistance from circuit A11–GD to ground.	(86), A11–GD to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A11–GD/ A11–GA, then repair.
21.	On	At pump control relay socket (85), measure voltage from circuit A90J to ground.	(85), A90J to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90J, then repair.
22.	Off/ On	At (85), install jumper wire between circuit A90J and A90E. Turn key on and at connector (86), measure voltage from circuit A90L to ground.	(86), A90L to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90E or A90L, then repair.
23.	Off/ On	Remove jumper and re-install relay (85). Turn key on and at (86), measure voltage from circuit A90Q to ground.	(86), A90Q to gnd.	Momen-tarily 12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90Q or conn. (84) or (88), then repair.
24.	On	At (86), measure voltage from circuit A90M to ground. Did alarm and warning light operate?	(86), A90M to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90M, alarm (R1), circuit A90N, or the circuit board, then repair.
25.	Off	Disconnect flow switch connector and measure resistance from switch terminal to ground.	Flow switch conn. to gnd.	< 1 ohm.	Go to next step.	Replace flow switch.
26.	Off/ On	Reconnect flow switch connector and disconnect differential pressure switch connector (91). Turn key on and measure voltage from circuit A90K to ground.	(91), A90K to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90K, or conn. (84) or (88), then repair.

Table 15 Hydraulic Brake System Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
27.	On	At (91), measure voltage across circuit A90K to circuit A90L.	(91), A90K to A90L.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A90L, then repair.
28.	Off	Hydraulic brake pump motor circuitry checks good. Re-install monitor module (86) and apply brakes. Does motor operate?			Go to next step.	Replace monitor module.
29.	On	With brake pedal released, turn key to on position. Does pump motor operate?			End of test.	Replace monitor module.

Stop Light Switch Circuitry (Hydraulic Brakes)

This procedure checks for proper operation of the circuitry to the body builder connector.

Table 16 Stop Light Switch Circuitry (Hydraulic Brakes)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	With brake pedal depressed, does hydraulic reserve pump motor operate?			Go to next step.	First perform previous test: Hydraulic Brake System Circuitry.
2.	Off	Remove brake monitor module (86) and with brakes applied, measure voltage from circuit A90C to ground.	(86), A90C to gnd.	12 ± 1.5 volts.	Reconnect (86). Go to Step 5.	Go to next step.
3.	Off	Remove connector (93) from brake switch (209). With brakes applied, measure voltage from switch circuit BK1 to ground.	(209), BK1 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit BK1, then repair.
4.	Off	Reconnect (93) and remove blocking diode connector (81). With brakes applied, measure voltage from circuit A70C to ground.	(81), A70C to gnd.	12 ± 1.5 volts.	Repair open in circuit 90C and connect (86) and (81).	Locate cause of low or no voltage in circuit A70C or conn. (93), (87), or (83), then repair. Reconnect conn. (86) and block diode (81).

Table 16 Stop Light Switch Circuitry (Hydraulic Brakes) (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
5.	Off	Check fuse F12 for open condition.	F12	< 1 ohm.	Go to next step.	Locate cause of overload condition and repair. Replace fuse.
6.	Off	At fuse F12, measure voltage from circuit A14A to ground.	F12, A14A to gnd.	12 ± 1.5 volts.	Install fuse. Go to next step.	Locate cause of low or no voltage in circuit A14A, then repair. Install fuse.
7.	Off	Remove stop light relay (R4) from fuse panel socket. At socket, measure voltage from cavity D to ground.	(R4), cav. D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A70B, then repair.
8.	Off	With brakes applied and at socket (R4), measure voltage from cavity B to ground.	(R4), cav. B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuits A70E, A70D or diode (81), then repair.
9.	Off	At socket (R4), measure resistance from cavity A to ground.	(R4), cav. A to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A70–G/ A11–GA, then repair.
10.	Off	Bench test relay (R4) by measuring resistance from pin 30 to 87A.	Relay (R4), pin 30 to 87A.	< 1 ohm.	Go to next step.	Replace relay.
11.	Off	Bench test relay by applying +12 volts to pin 85 and ground to pin 86. Measure resistance from pin 30 to 87.	Energized relay, pin 30 to 87.	< 1 ohm.	Go to next step.	Replace relay.
12.	Off	Install relay (R4) and disconnect body builder connector (169). With brake applied and at cavity A, measure voltage from circuit A70A to ground.	(169), cav. A to gnd.	12 ± 1.5 volts.	Circuitry checks good. Reconnect (169).	Locate cause of low or no voltage in circuit A70A, then repair. Reconnect (169).

Stop Light Switch Circuitry (Air Brakes)

This procedure checks for proper operation of the circuitry to the body builder connector.

Table 17 Stop Light Switch Circuitry (Air Brakes)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Check fuse F12 for open condition.	F12	< 1 ohm.	Go to next step.	Locate cause of overload condition and repair. Replace fuse.
2.	Off	At fuse F12, measure voltage from circuit A14A/A14 to ground.	F12, A14A/A14 to gnd.	12 ± 1.5 volts.	Install fuse. Go to next step.	Locate cause of low or no voltage in circuit A14A/A14, then repair. Install fuse.
3.	Off	At stop light switch, remove jumper harness connector coming from platform harness. At connector, measure voltage from red wire to ground.	1st stop light sw. conn., red wire to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in red wire, conn. (26), or circuit A70, then repair.
4.	Off	Remove harness connector from other switch. At connector, measure voltage from red wire to ground.	2nd stop light sw. conn., red wire to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in red wire, then repair.
5.	Off	Measure resistance of brown wire between switch connectors.	Switch conn., brown wire.	< 1 ohm.	Go to next step.	Locate open or poor connection in brown wire, then repair.
6.	Off	With brakes applied, measure resistance across terminal leads of each switch (N/L).	Switch (N/L), across term. leads.	< 1 ohm each switch.	Go to next step.	Replace stop light switch(es).
7.	Off	Reconnect stop light switch connectors and disconnect body builder connector (169). With brakes applied and at (169), measure voltage from circuit A70A to ground.	(169), A70A to gnd.	12 ± 1.5 volts.	Stop light switch circuitry to (169) checks good.	Locate cause of low or no voltage in circuit A70A, circuit A70B, conn. (26) or the brown wire, then repair.

6.4. COMPONENT LOCATIONS

(J1) Platform Ground	Inside Platform Below Oil Pressure Anchor Coupling
(J2) Battery Feed Stud	Inside Platform Left of Platform Harness Dash Connector
(J10) Engine Ground	Left Side of Flywheel Housing (Pre-Oct. 96)
(J10) Crank Motor Stud	Cranking Motor (Oct. 96 and Later)
(R4) Hydraulic Brake Light Switch Relay	Left Side Dash in Fuse Panel
(R5) Heated Fuel Filter Relay	Left Side Dash in Fuse Panel
(R6) Horn Relay	Left Side Dash in Fuse Panel
(2) Platform Harness Dash Connector	Inside of Front Dash Panel
(9) Water-In-Fuel Light	Below Voltmeter Gauge
(10) Dash Cluster Connector	Yellow Connector, Left Rear of Dash Cluster
(14) Horn Relay Inline Connector	Between Fuse Panel and Steering Column
(16) Water-In-Fuel Module	Left, Center of Dash Panel
(20) Key Switch	Right Side of Instrument Cluster
(26) Stop Light Switch Jumper Harness Connector	Above Steering Column Support
(6706) Fuel Filter Heater/ Water-In-Fuel Inline Connector	Upper, Left Flywheel Housing
(40) Air Dryer/ Drain Valve Inline Connector	Upper, Left Flywheel Housing
(51) Air Dryer Inline Connector	Inside Left Frame Rail Near Air Dryer
(76) Air Dryer Inline Connector	Inside Left Frame Rail Near Air Dryer
(80) Hydraulic Brake Blocking Diode	Front of Dash, Above Fuse Block
(81) Hydraulic Brake Blocking Diode	Front of Dash, Above Fuse Block
(83) Hydraulic Brake Motor/ Stop Light Switch Inline Connector	At Right Platform Grommet Retainer
(84) Hydraulic Brake Booster Inline Connector	Right Side of Brake Pump Motor
(85) Hydraulic Brake Pump Control Relay	Left of Platform Harness Dash Connector (2)
(86) Hydraulic Brake Monitor Module	Left Side of Dash, Above Fuse Block Support
(87) Hydraulic Brake Motor/ Stop Light Switch Inline Connector	Right Side of Brake Pump Motor
(88) Brake Booster Inline Connector	At Right Platform Grommet Retainer
(91) Hydraulic Brake Differential Press. Switch	Below Brake Fluid Reservoir
(92) Hydraulic Brake Switch Inline Connector	Right Side of Brake Booster Pump
(93) Hydraulic Brake Stop Light Switch Connector	Right Side of Brake Booster Pump
(94) Air Dryer (Bendix AD-9)	Inside Left Frame Rail, Behind Transmission
(169) Body Connector	Left Side Dash Above Fuse Panel
(170) Body Connector	Left Side Dash Above Fuse Panel
(209) Brake Switch	Under Platform, Front of Brake Pedal Linkage

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Heated Air Dryer Wiring
Automatic Drain Valve With Heater Wiring
(Dash and Ground Effects)

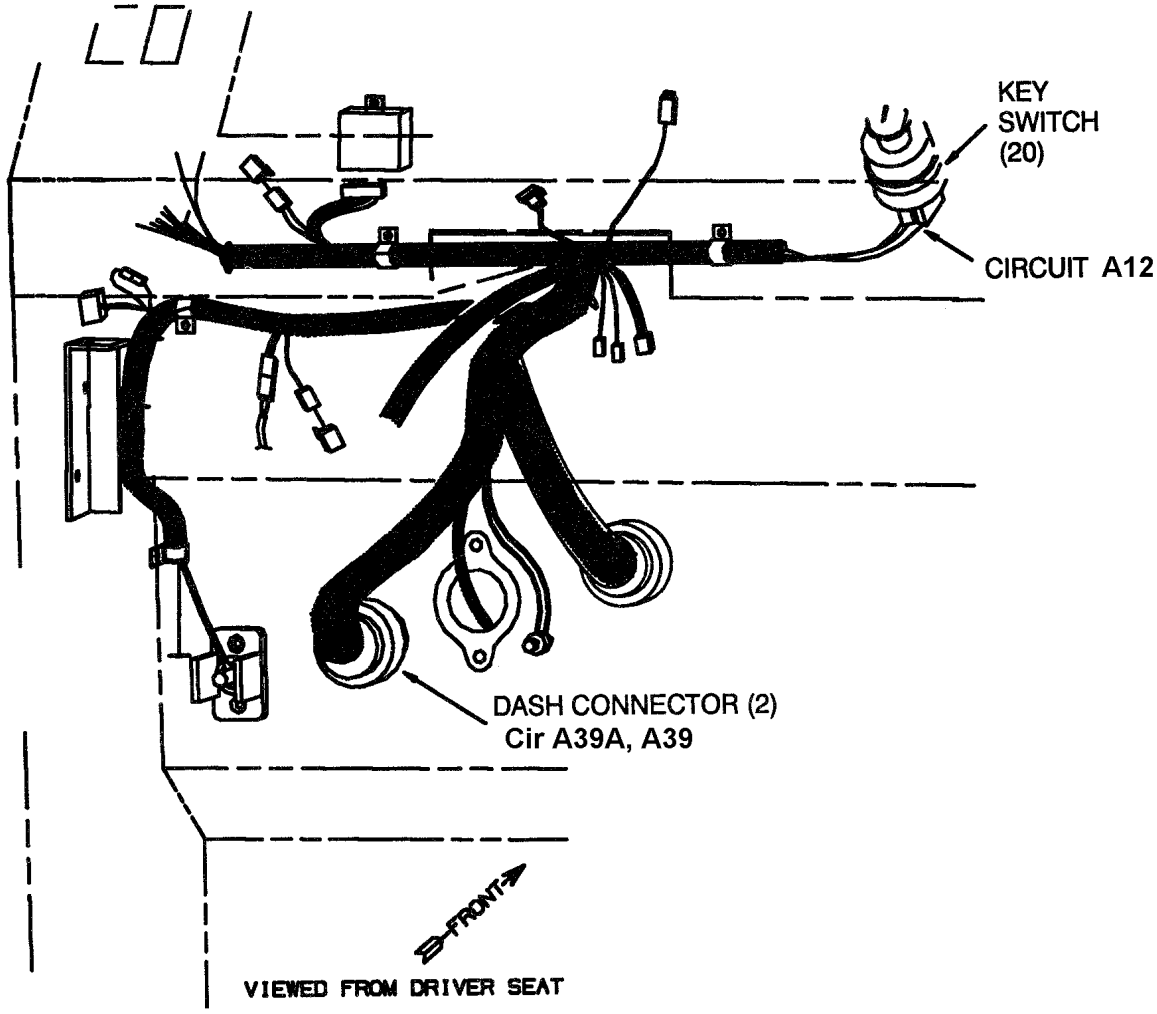

Figure 34 Heated Air Dryer Wiring — Automatic Drain Valve With Heater Wiring (Dash and Ground Effects)

G08-55085.10

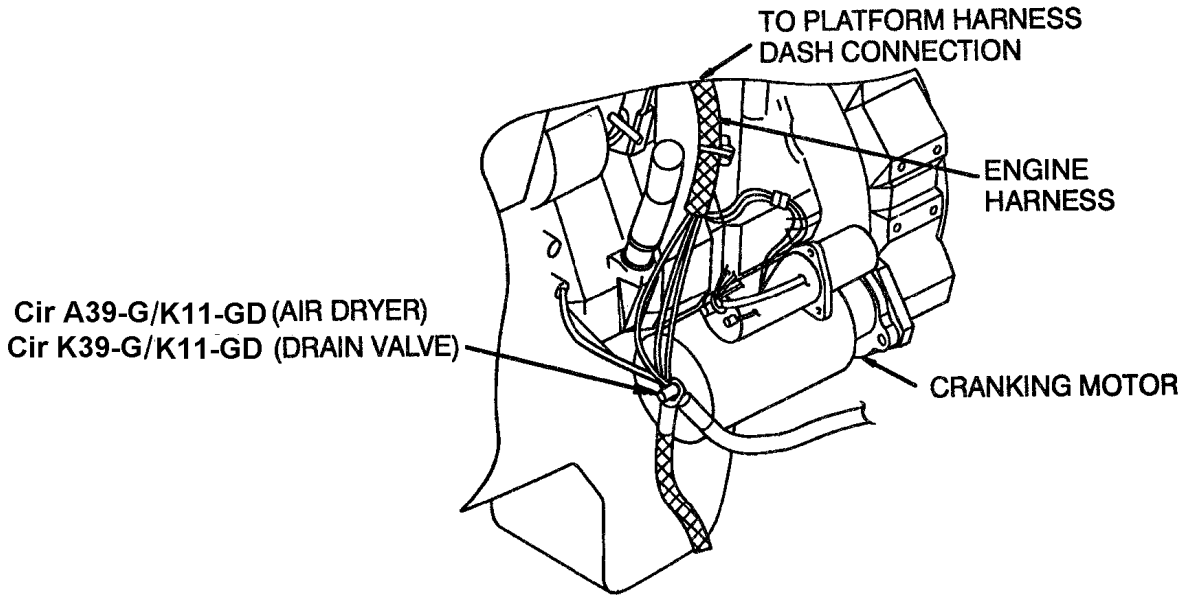

Figure 35 Heated Air Dryer Wiring — Automatic Drain Valve With Heater Wiring (Dash and Ground Effects)

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Air Dryer Wiring

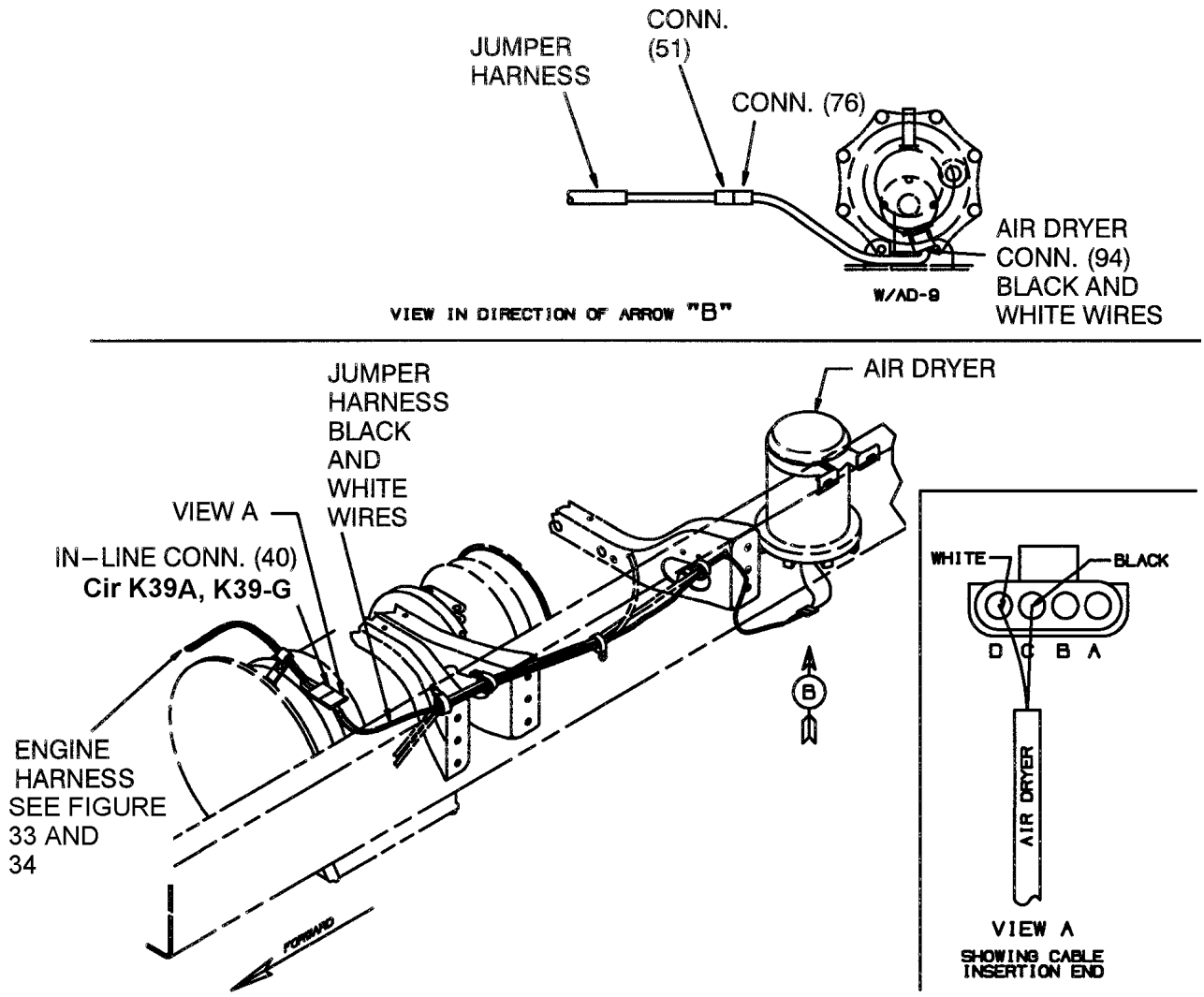

Figure 36 Air Dryer Wiring

Drain Valve Wiring

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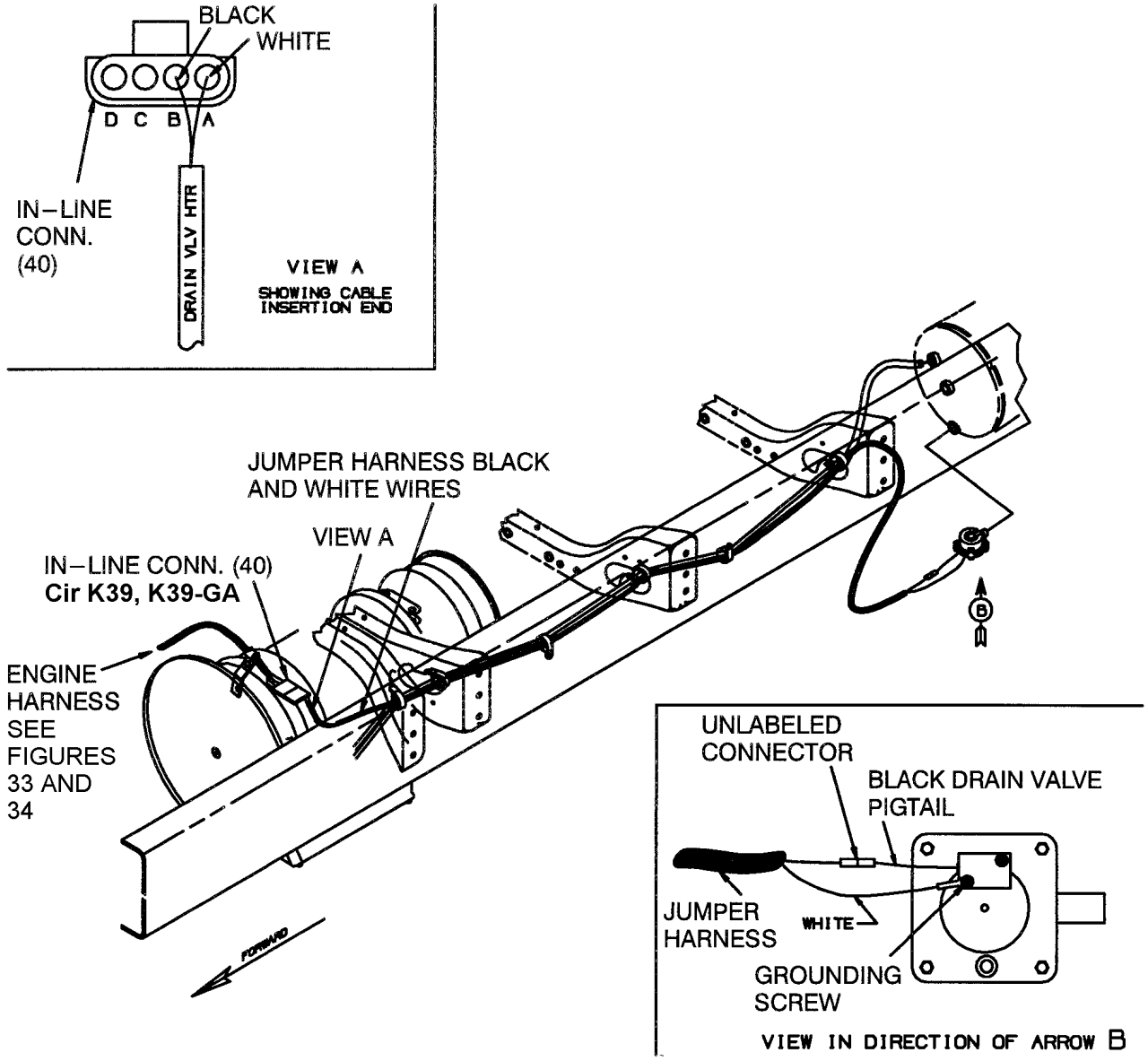

Figure 37 Drain Valve Wiring

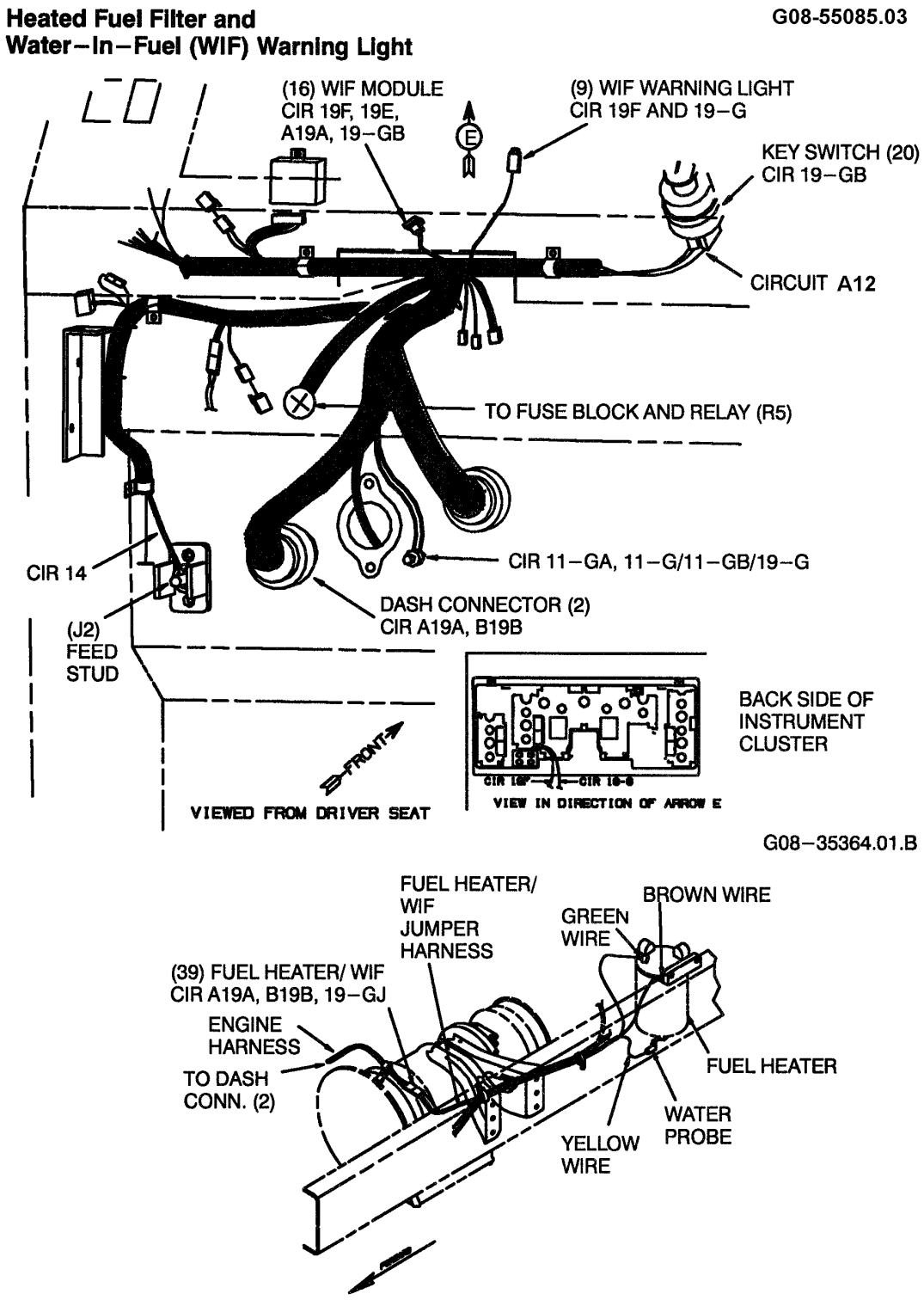

Figure 38 Heated Fuel Filter and Water-In-Fuel (WIF) Warning Light

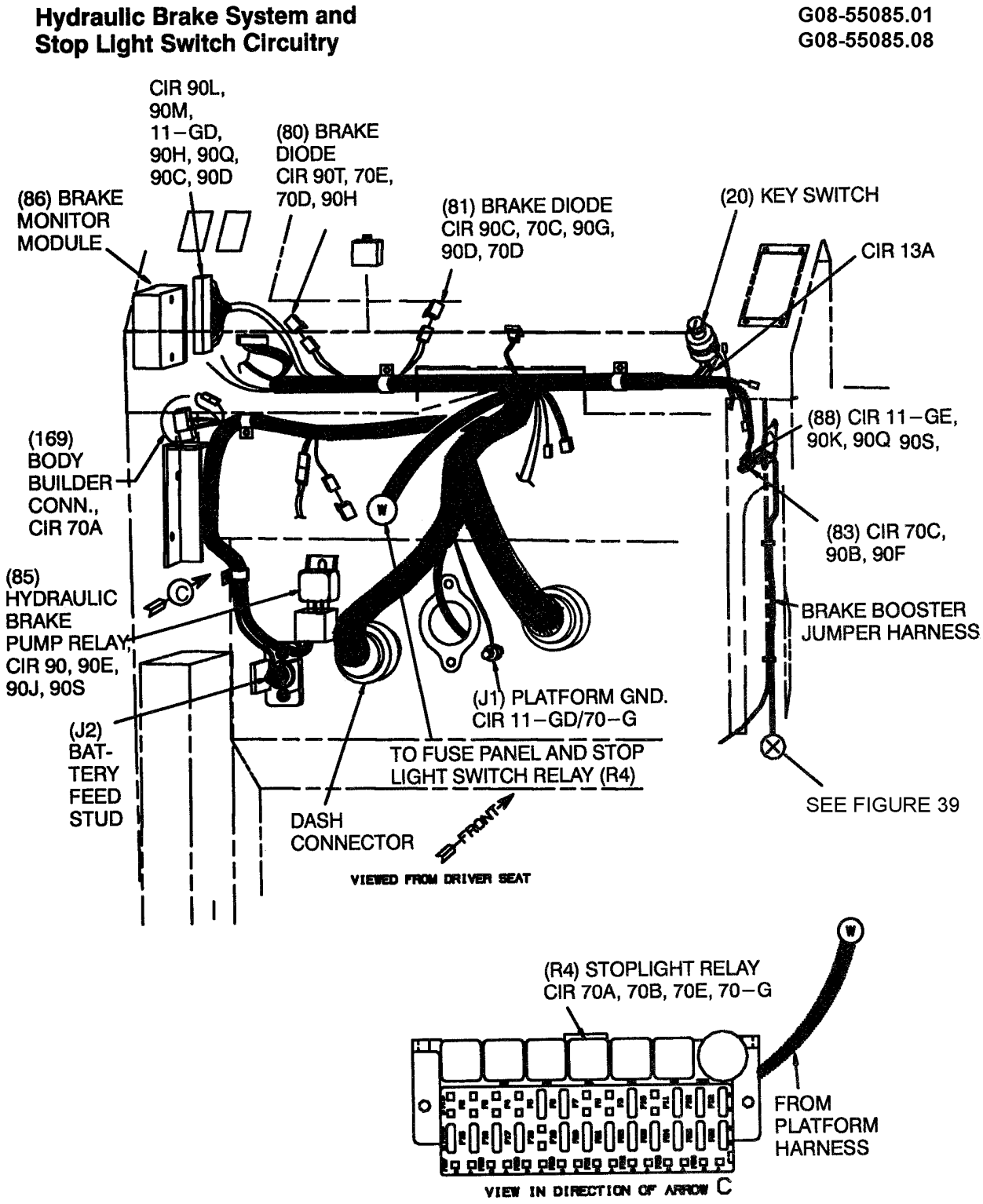

Figure 39 Hydraulic Brake System and Stop Light Switch Circuitry

Hydraulic Brake System and Stop Light Switch Circuitry

G08-55085.06

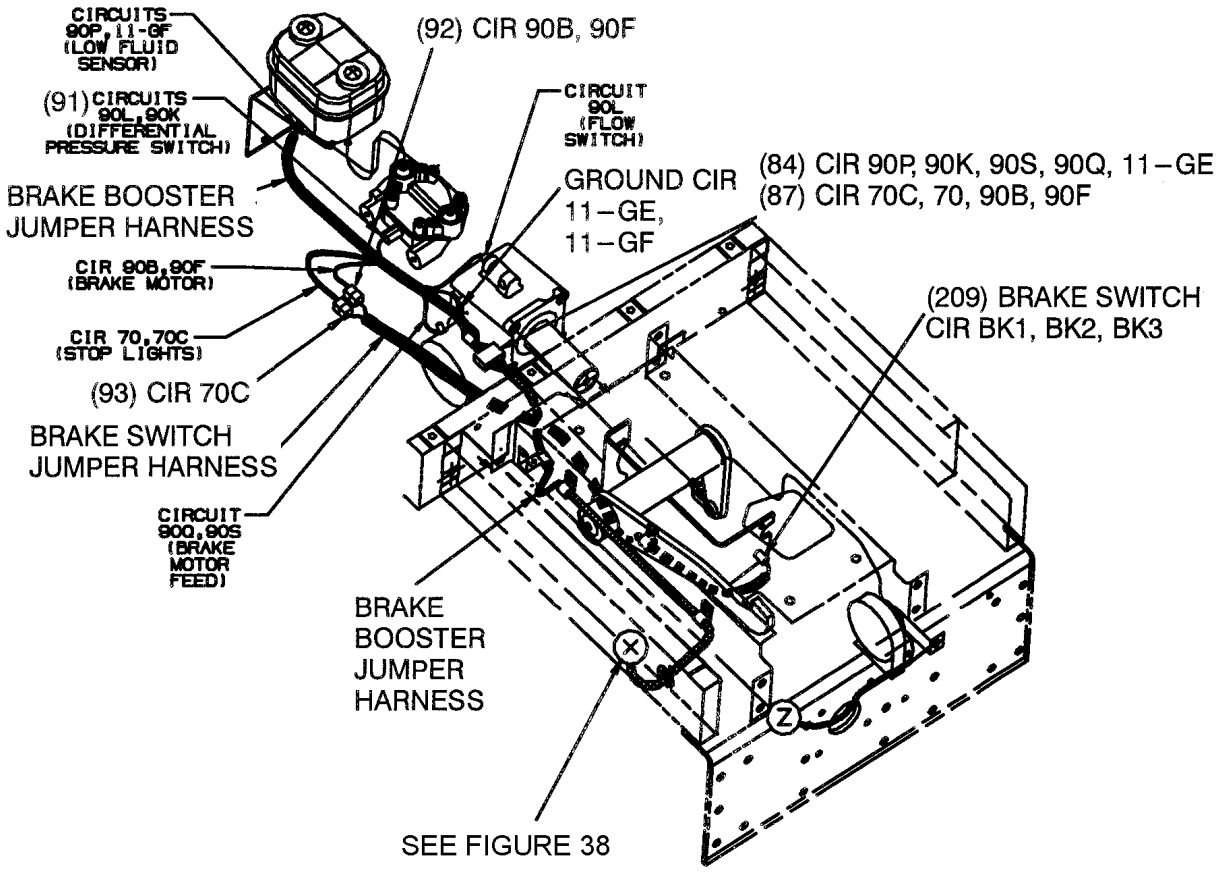

Figure 40 Hydraulic Brake System and Stop Light Switch Circuitry

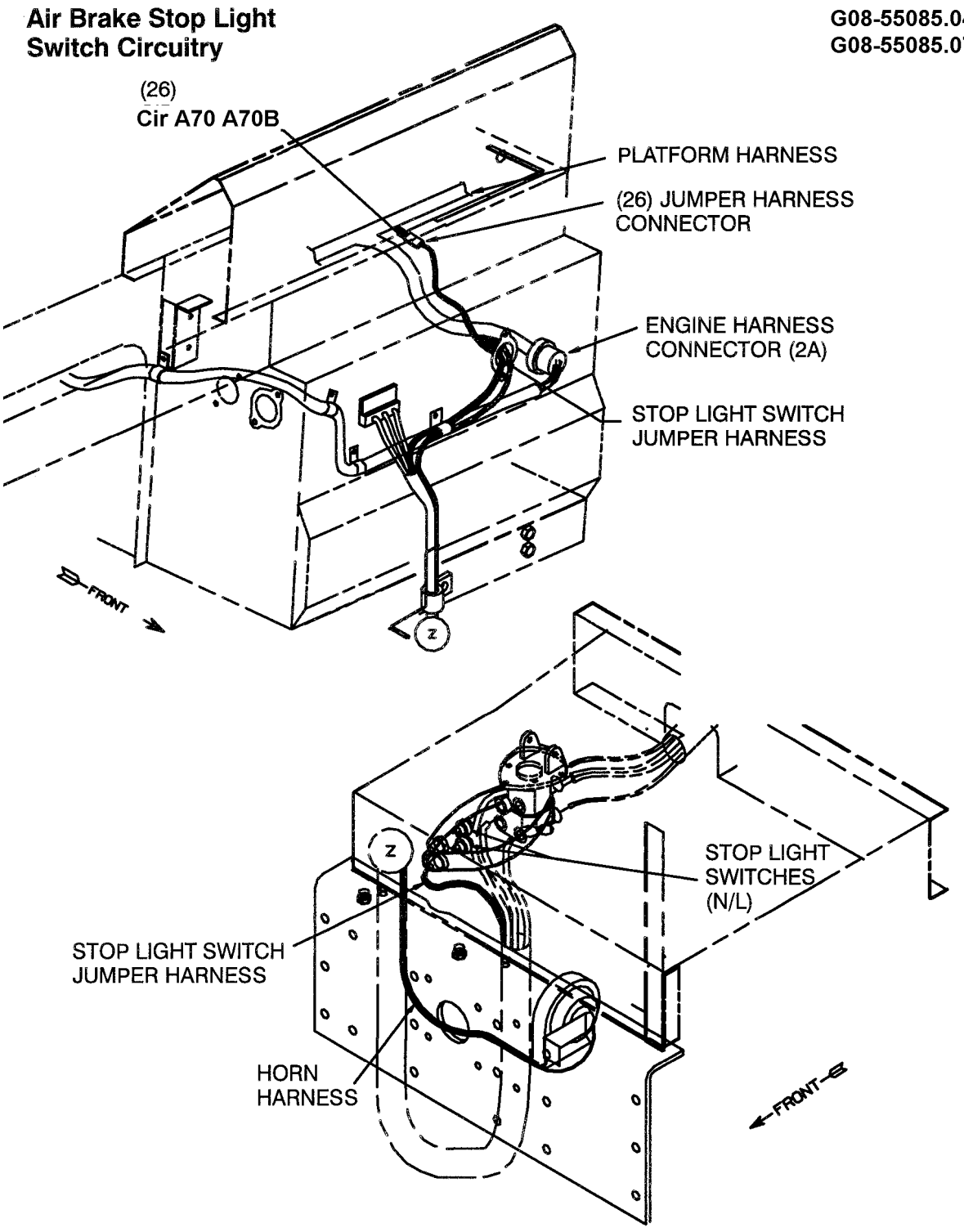

Figure 41 Air Brake Stop Light Switch Circuitry

7. FE 300 LIGHT SYSTEMS

7.1. DESCRIPTION

Back-Up Lights

The vehicle back-up lights are a set of lamps that come on when the vehicle transmission is shifted into reverse. This allows the driver to see while backing when dark.

Headlight System

A headlight system along with a turn signal lever controlled dimmer switch is provided for illumination while driving.

Panel Lights

The instrument panel lights and the automatic transmission shift light are low wattage bulbs and the brightness of these lights are controlled by the panel light switch.

Daytime Running Lights

The Daytime Running light feature allows the vehicle to operate in a “Lights On" condition at all times without driver input. This system operates the headlights at partial illumination but still helps to increase visibility even in bright sunshine.

7.2. OPERATION

Back-Up Light System

When the key switch (20) is moved to the on or start position, power is applied to circuit A13/A13H, fuse F24, circuit A71, dash connector (2), circuit A71, back-up light switch connector (41) and a black wire to the back-up light switch. When the back-up light switch contacts close, power flows through a white wire, connector (41), circuit A71A, connector (2), and circuit A71A to the body builder connector (169).

Headlight System

Power flows from the (J2) battery feed stud through circuit A14/A14C to fuses F14 and F15. When the headlight switch is in the park or on position, power flows through fuse F14, circuit A50A, to the headlight switch (23). This supplies power for the parking lights through circuit A58, and body builder connector (169), cavity H. Power is also applied to the panel lights through circuit A62.

When the headlight switch is in the on position, power flows through fuse F15, circuit A50, headlight switch (23), circuit A51, connector (27), a green wire, and to the dimmer switch.

With the headlight switch on and the dimmer switch in the low beam position, power flows through the low beam switch contacts, a blue wire, connector (27), and circuit A53/A53A to the body builder connector (170), cavity C.

With the headlight switch on and the dimmer switch in the high beam position, power flows through the high beam switch contacts, a brown wire, connector (27), and circuit A52/A52B to the body builder connector (170), cavity D. At the same time, power is also applied to the high beam dash indicator light through circuit A52A and the green cluster connector (11). Ground for the light is through circuit A28-G/A11-GB /A11-G to the (J1) platform ground.

Panel Lights

With the headlight switch on, power is supplied to the panel light switch (22) through circuit A62, fuse F21 and circuit A62A. The switch is grounded through circuit A62-GD/A11-G to the platform ground (J1).

The panel light switch applies variable voltage through circuit A62H to the bussed connector (8), and to the body builder connector (169) on circuit A62J. Power also flows through the bussed connector (8) to the yellow instrument panel connector (10) on circuit A62B, to the green connector (11) on circuit A62C, and to the natural colored connector (12) on circuit A62D. Power is also supplied to the automatic transmission shift selector light (7) through circuit A62E.

The ground for the transmission shift selector light is through A62-GE/A11-GB/ A11-G to the (J1) platform ground. Ground for the instrument panel lights is through the printed circuit board and circuit A62-GA/A11-G for connector (10), circuit A62-GB/A11-G for connector (11), and circuit A62-GC/A11-G for connector (12). Circuit A11-G is connected to the (J1) platform ground.

Daytime Running Lights (DRL)

Power is supplied to USA DRL module (165) from (J2) junction block, through circuit A66, fuse F5 and circuit A66A. The module is provided a ground path through circuit A66-GA to platform ground (J1).

When high beam/bright headlights are turned ON, a signal is sent to the USA DRL module (165) through circuit A66E, connector (224) and circuit A66E. Thus the module which supplies power to the fog light circuit A64A can switch OFF the fog lights when the high beam/bright headlights are selected.

The USA DRL module (165) is enabled via circuit A66 when the key switch (20) is moved to the ignition or accessories position. The module will then apply power to circuit A66C, connector (224), circuits A66C and A53A to body builder connector (170), cavity C. The module will power the lights at about 60% of full power. When the headlight switch is moved to the headlight ON position, the power from the headlight switch will override the module and power the lamps at 100%.

7.3. TROUBLESHOOTING

Before beginning these test procedures, do the following:

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

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

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

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

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

Back-Up Light System

Table 18 Back-Up Light System

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Check fuse F24 for open condition.	F24	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	On	At F24 and circuit A13H, measure voltage to ground.	F24, A13H to gnd.	12 ± 1.5 volts.	Install fuse. Go to next step.	Locate cause of low or no voltage in circuit A13H/A13, then repair.
3.	On	At body builder connector (169) and with transmission in reverse, measure voltage from cavity D, circuit A71A to ground.	(169), A71A to gnd.	12 ± 1.5 volts.	Problem exists in body circuitry. Refer to body builders manual.	Go to next step.
4.	Off	At body builder connector (169), install jumper from cavity D, circuit A71A to ground. Disconnect back-up light switch connector (41). At connector, measure resistance from circuit A71A to ground.	(41), A71A to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A71A, or platform harness connector (2)/(2A), then repair.
5.	On	At connector (41), measure voltage from circuit A71 to ground.	(41), A71 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A71, or platform harness connector (2)/(2A), then repair.
6.	Off	At switch (41) and with transmission in reverse, measure resistance from black wire to white wire.	(41), black wire to white wire.	< 1 ohm.	Go to next step.	Replace switch (41).
7.	Off	Remove jumper and reconnect (41). Back-up light switch circuitry checks good.				

Headlight System

Table 19 Headlight System

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove fuses F14 and F15. Check for open condition.	F14, F15.	< 1 ohm	Go to next step.	Locate cause of overload condition, then repair. Replace fuse(s).
2.	Off	At fuse F14, measure voltage from A14C/A14 to ground.	F14, A14C/A14 to gnd.	12 ± 1.5 volts.	Install fuses. Go to next step.	Locate cause of low or no voltage in circuit A14C/A14, then repair. Install fuses.
3.	Off	Remove headlight switch connector (23). Measure voltage from circuit A50A to ground.	(23), A50A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A50A, then repair.
4.	Off	At connector (23), measure voltage from circuit A50 to ground.	(23), A50 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A50, then repair.
5.	Off	With headlight switch (23) in park position, measure resistance across terminals that were connected to circuits A50A and A62, and A50A and A58.	(23), across A50A to A62 and A50A to A58.	< 1 ohm.	Go to next step.	Replace headlight switch.
6.	Off	With headlight switch (23) in on position, measure resistance across terminals that were connected to circuits A50 and A51.	(23), across A50 to A51.	< 1 ohm.	Go to next step.	Replace headlight switch.
7.	Off	Reconnect connector (23) and disconnect body builder connector (169). With headlight switch in park or on position, measure voltage from cavity H, circuit A58 to ground.	(169), cav. H, A58 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A58, then repair.

Table 19 Headlight System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
8.	Off	Reconnect connector (169) and disconnect dimmer switch connector (27). With headlight switch on, measure voltage from circuit A51 to ground.	(27), A51 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A51, then repair.
9.	Off	With dimmer switch (27) in the low beam position, measure resistance from green wire to blue wire.	(27), green wire to blue wire.	< 1 ohm.	Go to next step.	Replace dimmer switch.
10.	Off	With dimmer switch (27) in the high beam position, measure resistance from green wire to brown wire.	(27), green wire to brown wire.	< 1 ohm.	Go to next step.	Replace dimmer switch.
11.	Off	Reconnect (27) and disconnect body builder connector (170). With dimmer switch in low beam position and headlight switch on, measure voltage from circuit A53A to ground.	(170), A53A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A53/A53A, then repair.
12.	Off	With dimmer switch in high beam position and headlight switch on, measure voltage from circuit A52B to ground.	(170), A52B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A52/A52B, then repair.
13.	Off	Reconnect (170) and disconnect dash connector (11). With headlight switch on and dimmer switch in high beam position, measure voltage from circuit A52A (cavity 4) to ground.	(11), A52A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A52A, then repair.

Table 19 Headlight System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
14.	Off	With switches still set, measure voltage from circuit A52A to A28–G (cavity 2).	(11), A52A to A28–G.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A28–G/ A11–GB/ A11–G or platform ground (J1), then repair.
15.	Off	Circuits to high beam indicator check good. Reconnect (11) and with switches still set, does indicator light work?			End test.	Replace bulb and socket. If the light still fails to work, replace instrument cluster.

Panel Lights

Table 20 Panel Lights

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove fuse F21 and check for open condition.	F21	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	Off	The following steps must be performed with the headlight switch on. At fuse F21, measure voltage from A62 to ground.	F21, A62 to gnd.	12 ± 1.5 volts.	Re-install fuse. Go to next step.	Locate cause of low or no voltage in circuit A62, then repair. Re-install fuse.
3.	Off	Disconnect panel light switch connector (22). At harness connector, measure voltage from circuit A62 to ground.	(22), A62A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A62A, then repair.
4.	Off	At connector (22), measure voltage across circuit A62A to A62–GD.	(22), A62A to A62–GD.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A62–GD/ A11–G, then repair.
5.	Off	Adjust switch (22) to bright position and measure resistance across pigtail blue wire to yellow wire.	(22), pigtail blue to yellow wire.	< 1 ohm.	Go to next step.	Replace switch.

Table 20 Panel Lights (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
6.	Off	Reconnect switch connector (22) and disconnect bussed connector (8). At circuit A62H, measure voltage to ground.	(8), A62H to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A62H, then repair.
7.	Off	Reconnect connector (8) and disconnect body builder connector (169). At (169), measure voltage from circuit A62J to ground.	(169), A62J to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A62J, then repair.
8.	Off	Reconnect connector (169) and disconnect yellow dash connector (10). At harness connector (10), cavity 8, measure voltage from circuit A62B to ground.	(10), cav. 8, A62B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A62B, then repair.
9.	Off	At (10), measure voltage across cavity 8, circuit A62B to cavity 15, circuit A62–GA.	(10), across A62B to A62–GA.	12 ± 1.5 volts.	Go to next step	Locate open or poor connection in circuit A62–GA/ A11–G, then repair.
10.	Off	Circuits to left cluster check good. Reconnect (10) and replace any lamps that fail to work. Do all lamps work?			Go to next step.	Replace dash cluster assembly.
11.	Off	Disconnect green dash connector (11). At harness connector (11), cavity 1, measure voltage from circuit A62C to ground.	(11), cav. 1, A62C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A62C, then repair.
12.	Off	At (11), measure voltage across cavity 1, circuit A62C to cavity 11, circuit A62–GB.	(11), across A62C to A62–GB.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A62–GB/ A11–G, then repair.
13.	Off	Circuits to center cluster check good. Reconnect (11) and replace any lamps that fail to work. Do all lamps work?			Go to next step.	Replace dash cluster assembly.

Table 20 Panel Lights (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
14.	Off	Disconnect natural colored dash connector (12). At (12), cavity 1, measure voltage from circuit A62D to ground.	(12), cav. 1, A62D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A62D, then repair.
15.	Off	At (12), measure voltage across cavity 1, circuit A62D to cavity 10, circuit A62–GC.	(12), across A62D to A62–GC.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A62–GC/ A11–G, then repair.
16.	Off	Circuits to center cluster check good. Reconnect (12) and replace any lamps that fail to work. Do all lamps work?			Go to next step.	Replace dash cluster assembly.
17.	Off	Disconnect automatic transmission light connector (7) and measure voltage from circuit A62E to ground.	(7), A62E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A62E, then repair.
18.	Off	At (7), measure voltage across circuit A62E to circuit A62–GE.	(7), across A62E to A62–GE.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A62–GE/ A11–GB/ A11–G, then repair.
19.	Off	Automatic transmission light circuits check good. Reconnect connector (7). Does light operate?				Replace lamp or socket assembly.

Daytime Running Lights (DRL)

Table 21 Daytime Running Lights (DRL)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove fuse F5 and check for open condition.	F5	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	Off	Re-install fuse F5, and at circuit A66F, measure voltage to ground.	F5, A66F to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A66F, then repair.

Table 21 Daytime Running Lights (DRL) (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
3.	Off	Remove fuse F6 and check for open condition.	F6	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
4.	Off	Re-install fuse F6, and at circuit A12B/A12, measure voltage to ground.	F6, A12B/A12 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A12B/A12, then repair.
5.	Off	Disconnect connector (224) and with headlight switch in headlight position and dimmer switch in dim position, at (224) circuit A66C, measure voltage to ground.	(224), A66C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A66C, then repair.
6.	Off	Move dimmer switch to high beam position and at connector (224) circuit A66E, measure voltage to ground.	(224), A66E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage circuit A66E, then repair.
7.	Off	Disconnect connector (165) and reconnect (224). With switches still set, at (165) measure voltage from circuit A66E to ground.	(165), A66E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage circuit A66E, then repair.
8.	Off	Move dimmer switch to dim position and at connector (165) circuit A66C, measure voltage to ground.	(165), A66C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage circuit A66C, then repair.
9.	Off	At connector (165) and circuit A66–GA, measure resistance to ground.	(165), A66–GA to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A66–GA, then repair.
10.	Off	Move key switch to accessories position and at connector (165) circuit A66, measure voltage to ground.	(165), A66 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A66, then repair.
11.	Off	Reconnect connector (165). DRL circuits check good.				

7.4. COMPONENT LOCATIONS

(J1) Platform Ground	Inside Platform Below Oil Pressure Anchor Coupling
(J2) Battery Feed Stud	Inside Platform Left of Platform Harness Dash Connector
(N/L) Turn Signal Switch	Part of Turn Signal Lever Assembly
(1) Turn Signal/Hazard Flasher	In Fuse Block Panel
(2) Platform Harness Dash Connector	Inside of Front Dash Panel
(7) Auto. Trans. Shift Light	Behind Shift Lever Assembly
(8) Panel Lights	Back Side of Instrument Cluster
(10) Lt. Instrument Cluster Connector	Rear of Instrument Cluster Panel (Yellow)
(11) Ctr. Instrument Cluster Connector	Rear of Instrument Cluster Panel (Green)
(12) Rt. Instrument Cluster Connector	Rear of Instrument Cluster Panel (Natural)
(13) Turn Signal Switch Connector	Lower Dash at Steering Column
(20) Key Switch	Right Side of Instrument Cluster
(23) Headlight Switch	Left Side of Dash
(27) Dimmer Switch	Left Side of Dash
(41) Back-up Light Switch and Jumper	Right Side Trans. and Upper Right Bell Housing
(165) USA DRL Module	Platform, Center
(224) USA DRL Connector	Platform Harness

Back–Up Light Circuitry

G08-55085.01.E
G08-55085.08

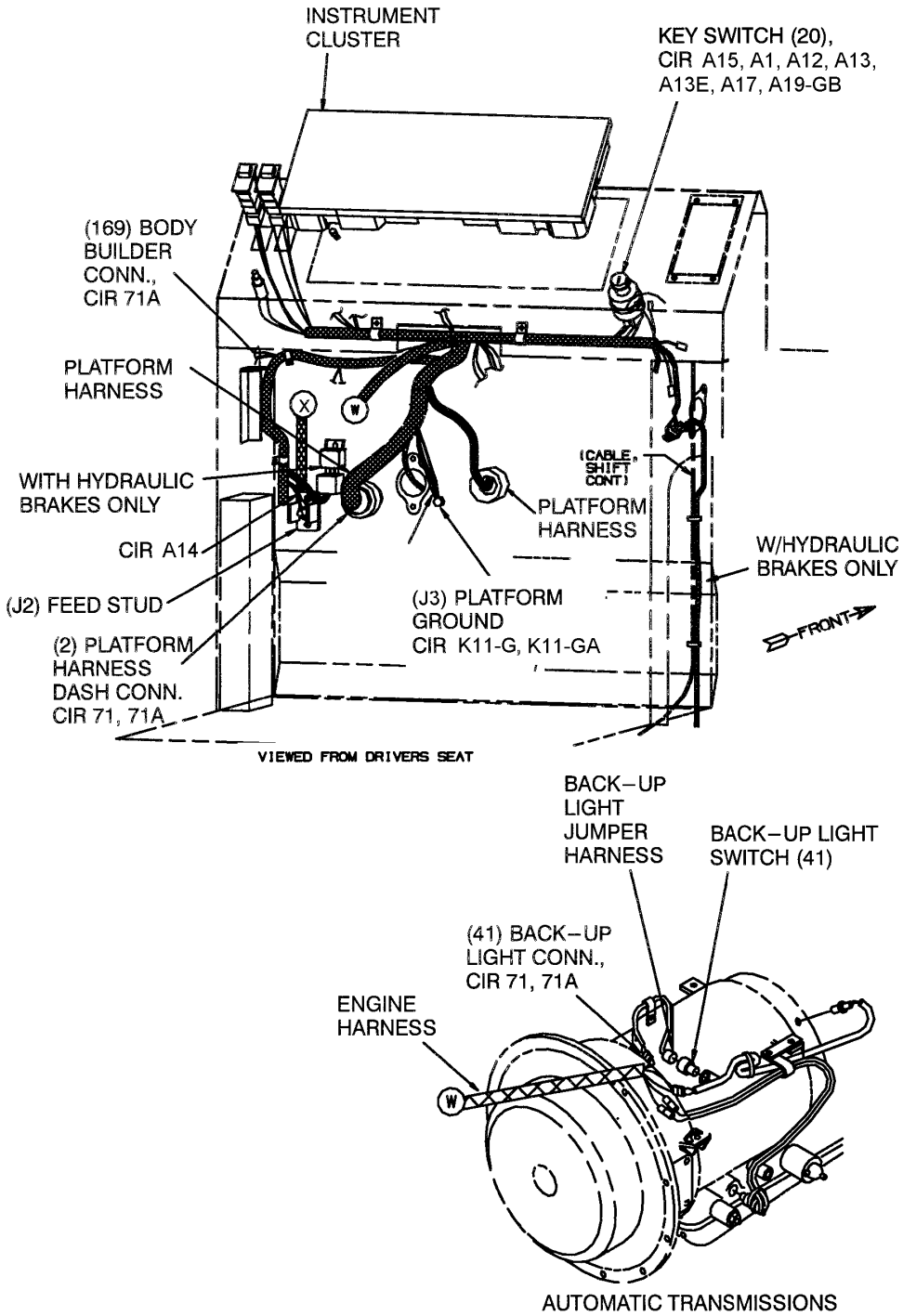

Figure 42 Back-Up Light Circuitry

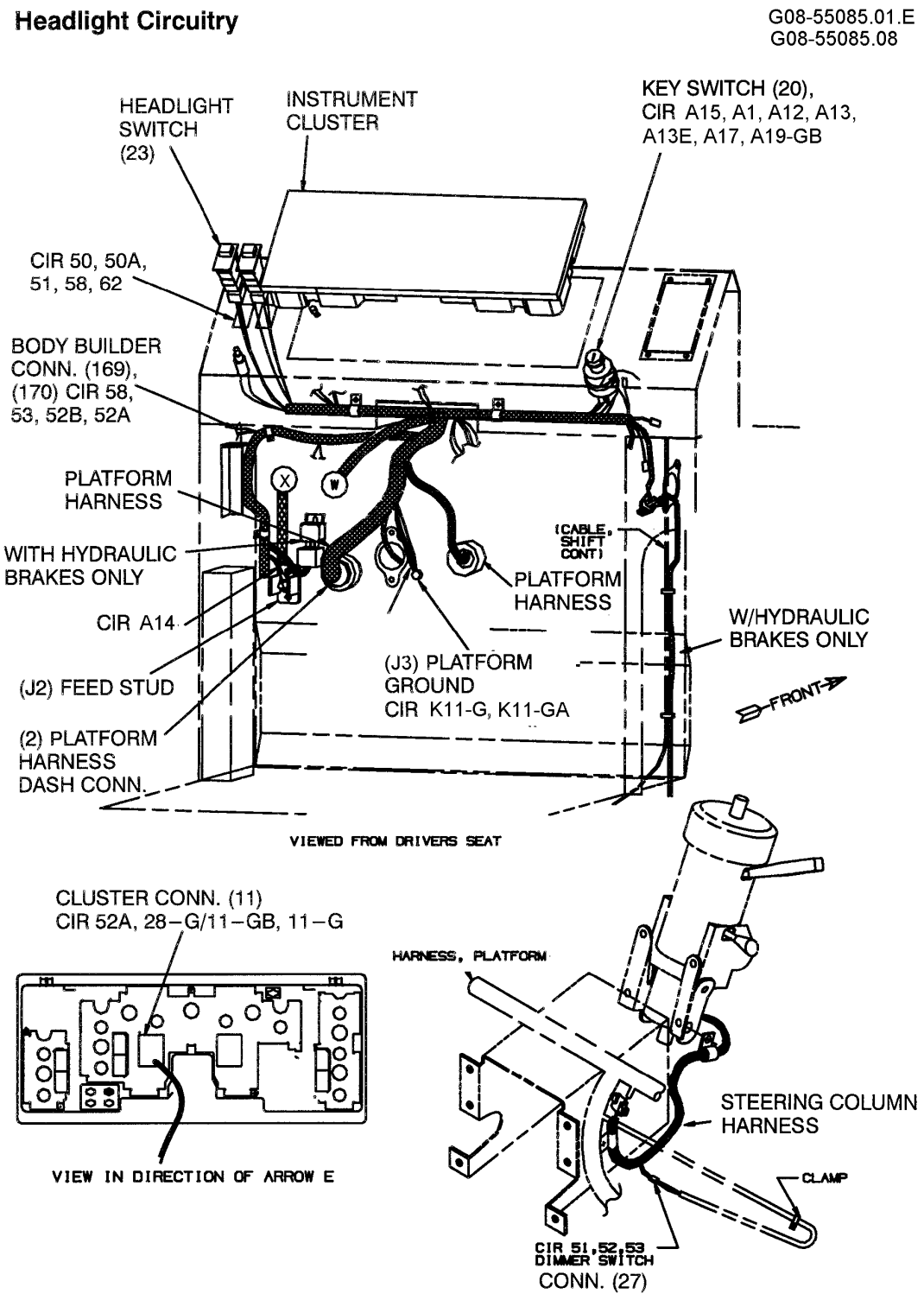

Figure 43 Headlight Circuitry

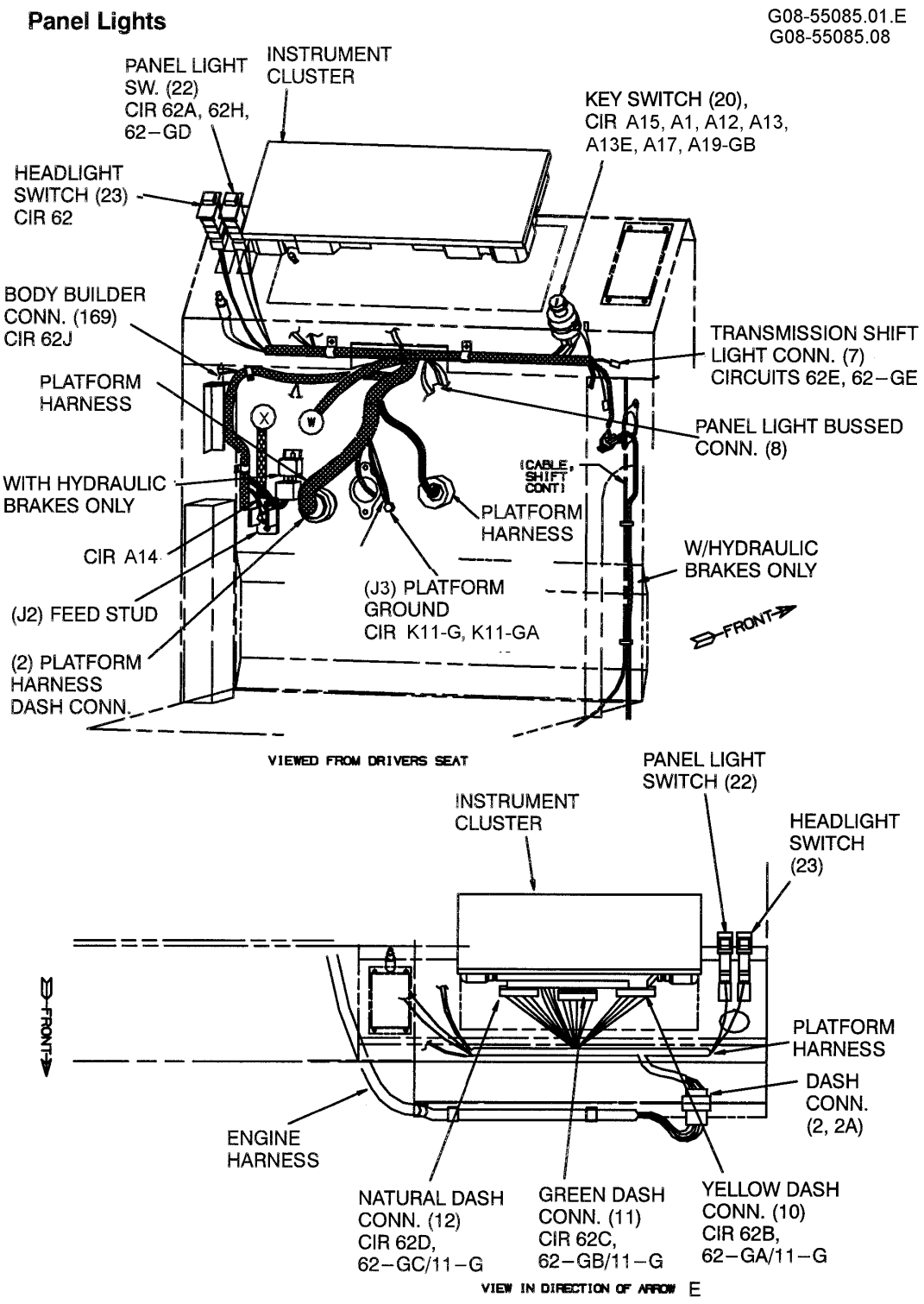

Figure 44 Panel Lights

Daytime Running Lights (DRL)

G08-55085.01.E
G08-55085.08

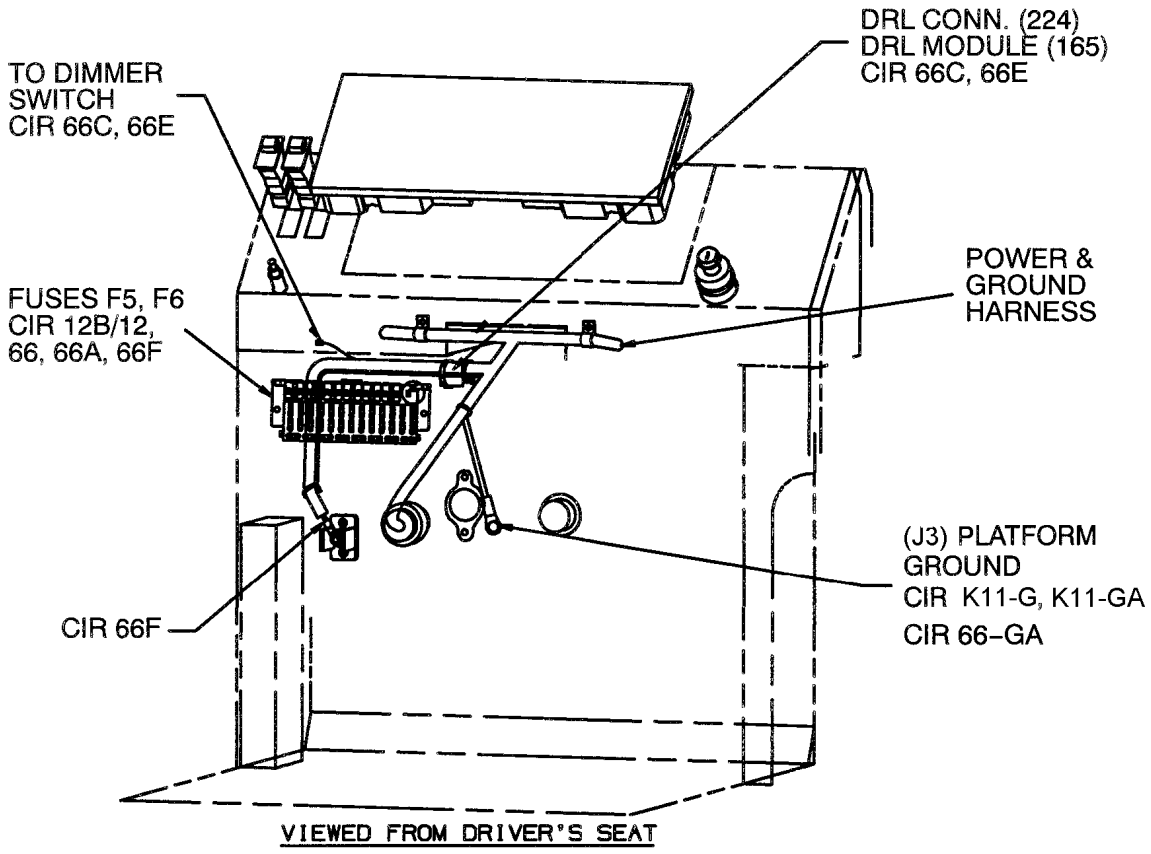

Figure 45 Daytime Running Lights (DRL)

8. FE 300 ELECTRONIC CONTROLS

8.1. DESCRIPTION

ATA Data Link and Diagnostic/ Programming Connector

A diagnostic/programming ATA data link connector allows an Electronic Service Tool (EST) to communicate with the engine Electronic Control Module (ECM2), the Injector Driver Module (IDM2) and the Multiplexed Signal Module (MSM). The data communication link carries serial data transmissions between the ECM2 and the electronic service tool and is used to transmit calibration, programming and diagnostic information. The data link provides communication capabilities for:

- Engine parameter data transmission
- Diagnostics and troubleshooting
- Customer programming of vehicle parameters
- Production line programming of vehicle features
- Field programming.

ECM2 Power and Ground

The engine Electronic Control Module 2 (ECM2) monitors and controls engine performance to ensure maximum performance and adherence to emission standards. The ECM2 also monitors and controls vehicle features such as cruise control and starter engagement. The module is provided with 12 volt operating power through a relay when the key switch is in the ignition position. The circuitry is protected by a 50 amp fuse that is part of the battery cable assembly. Control module ground is to the negative post of the batteries.

APS/IVS

The Accelerator Pedal Position Sensor (APS) is a potentiometer type sensor which, when supplied with a 5 volt reference signal from the Electronic Control Module 2 (ECM2), provides a linear analog voltage signal that indicates the driver's demand for power. The APS signal is used in calculating desired fuel quantity and injector timing.

The Idle Validation Switch (IVS) is a 0/12 volt switch that provides the ECM2 with a redundant signal to verify when the pedal is in the idle position.

These two functions are integrated into one component mounted on the accelerator pedal. The pedal assembly is serviceable to the extent that the APS/IVS can be replaced without replacing the complete pedal.

BAP

The Barometric Air Pressure sensor (BAP) is a variable capacitance sensor, that when supplied with a 5 volt reference signal from the ECM2, produces a linear analog voltage signal that varies with altitude. The BAP signal is used by the ECM2 to adjust timing and fuel quantity, to optimize engine operation and control smoke throughout all altitude conditions.

ATS

The ambient Air Temperature Sensor (ATS) is a thermistor type sensor that has a variable resistance which changes when exposed to different temperatures. The ECM2 and IDM2 measures the signal from the sensor and uses the data to adjust timing and fuel rate to limit smoke emissions in cold weather starting.

Cruise Control/Remote Engine Controls

The cruise control system controls engine and vehicle speed using automotive style on/off and set/resume switches. Speed control is disabled when the off switch is depressed, the brake is applied, the clutch pedal is depressed or an automatic transmission is placed in neutral.

The clutch pedal switch supplies the Driveline Disengaged Signal (DDS) to the ECM2 and the brake switches also supply input signals to the ECM2. These signals indicate pedal positions and are used by the ECM2 in operating the cruise control system.

The Vehicle Speed Sensor (VSS) and the Camshaft Position sensor (CMP) provide vehicle speed and engine RPM signals to the ECM2. This information is also used by the ECM2 to control the system.

Circuity for remote engine speed controls are provided for use by a body builder. For information on remote engine controls for body builder applications, refer to Miscellaneous Information in CT-471 Body Builder Book.

8.2. OPERATION

ATA Data Link and Diagnostic/ Programming Connector

The 9-pin ATA data link connector (384) supplies power for an Electronic Service Tool (EST) through fuse F3 and circuit A97C. Ground for the EST is through A97-GK to cab ground (2G).

The EST is able to communicate with the engine control system through a twisted pair of wire circuits. The connector serial data transmission lines are through circuit A98E(+) and circuit A98F(-) to the instrument cluster (11). Communication with the ECM2 or IDM2 is through circuit A3A(+) and circuit A3A(-) to the 48-pin dash connector (2). From the dash connector (2), the communication circuits are K3AA(+) to ECM2 connector (6021) pin 20 and K3AA(-) to pin 21, and circuits are K3AB(+) to IDM2 connector (6011) pin 2 and K3AB(-) to pin 3.

The communication system also includes an ATA interface connector (374) for use with aftermarket requirements. The communication link for the interface is through circuits A3A(+) and A3A(-).

ECM Power and Ground

Power is supplied by the batteries to circuit 14B, a 40A maxifuse (F3), circuit 14C, engine harness to positive battery cable connector (496), circuit K97JA to the ECM power relay (396) coil and circuit K97HB, fuse (F3), circuit K97HA to contacts. Also, power is supplied through circuit K97LB to the IDM power relay (392M) coil and circuit K97TC to contacts.

From the ECM power relay (396) coil, power is applied to circuit K97J and pin 5 of the ECM2 (6020). Also, from the IDM2 power relay (392M) coil, power is applied to circuit K97LA and pin 8 of the IDM2 (6011).

When key switch (20) is moved to the ignition position, power is supplied through fuse F30, circuit K97UA, the 48-pin dash connector (2), and circuit K97UA, and a splice. From the splice power is applied to pin 3 of the ECM2 (6020) on circuit K97UA . This signals the ECM2 that the ignition switch is on and causes the ECM2 to internally switch pin 5 to ground. This completes the circuit for the ECM power relay (396) which energizes the relay. With the relay (396) energized, power is applied through the closed contacts to circuit K97TD and a splice. From the splice power is applied to the ECM2 (6021) pins 1 and 2 on circuits K97F and K97ZA respectively, and to the IDM2 (6011) pin 10 on circuit K97AZ.

Also, when key switch (20) is moved to the ignition position, power is supplied through fuse F30, circuit K97UA, the 48-pin dash connector (2), and circuit K97UA and a splice. From the splice power is applied to pin 9 of the IDM2 (6011) on circuit K97UB . This signals the IDM2 that the ignition switch is on and causes the IDM2 to internally switch pin 9 to ground. This completes the circuit for the IDM power relay (392M) which energizes

the relay. With the relay (392M) energized, power is applied through the closed contacts to circuit K97TD and a splice. From the splice power is applied to the IDM2 (6011) pin 12 on circuit K97Y, and the IDM2 (6011) pin 6 on circuit K97LC, fuse (F39) and circuit K97LD.

Grounds for the ECM2 (6020) pins 6 and 7 are through circuits K97-GW and K97-GV respectively, to a splice. From the splice, ground is through circuit 11-G, the engine harness to negative battery cable harness connector (426) and circuit 11-GA to the negative battery terminal. Also, grounds for the IDM2 (6011) pin 1 is through circuit K97-GA to a splice. From the splice, ground is through circuit 11-G, the engine harness to negative battery cable harness connector (426) and circuit 11-GA to the negative battery terminal.

Accelerator Position Sensor (APS) and Idle Validation Switch (IVS)

The engine Electronic Control Module (ECM2) determines the position of the accelerator pedal by processing the input signals from the Accelerator Position Sensor (APS) and Idle Validation Switch (IVS).

The ECM2 sends a regulated 5 volt signal through the ECM2 connector (6021), circuit A99C, dash connector (15), circuit A99C to a splice, and circuit A99J to the APS/IVS (382). The APS then returns a variable voltage signal (depending on pedal position) through connector (382), circuit A99B, connector (15), and circuit A99B to the ECM2. The APS is grounded through circuit A99A/A97W, connector (15), and circuit K97W/K97WB to the ECM2 signal ground.

The ECM2 learns the lowest and highest pedal positions by reading and storing the minimum and the maximum voltage levels from the APS. In this manner the ECM2 “auto-calibrates" the system to allow maximum pedal sensitivity.

The ECM2 auto-calibrates as the key is on, but when the key is turned off, these values are lost. When the key is turned on again, this process starts over. When the pedal is disconnected (or a new one is installed), the pedal does not need to be calibrated, as the calibration happens when the key is turned on.

When the key switch (20) is in the on or start position, the Idle Validation Switch (IVS) (382) receives 12 volt ignition voltage through circuit breaker F10, and circuit A99E. When the pedal is not in the idle position (throttle applied), the IVS sends this 12 volt signal to the ECM over circuit A99D, connector (15), and circuit A99D to the ECM2 (6021).

The ECM2 compares the inputs it receives on circuit A99B and circuit A99D from the APS/IVS to verify when the pedal is in the idle position. If the APS signal from circuit A99B indicates throttle is being applied, then the ECM2 expects to see 12 volts at IVS circuit A99D. If the APS signal, circuit A99B, indicates throttle is not applied, then the ECM2 expects to see 0 volts at the IVS circuit A99D. The timing process is critical between the APS and the IVS sensors. For this reason, it is very difficult to determine if the APS/IVS assembly is working properly using a volt-ohmmeter.

Barometric Air Pressure (BAP) Sensor

The ECM2 (6021) sends a regulated 5 volt signal from ECM2 (6021) through circuit A99C, dash connector (15), circuit A99C to a splice, and circuit A97BL to BAP sensor (406). The BAP sensor returns a variable voltage signal (represents atmospheric pressure) on circuitA97CD, connector (15) and circuit A97CD to the ECM2 (6020). The BAP sensor is grounded by circuit K97ZK97W, connector (15), circuit K97W/K97WB to the ECM2 (6021) signal ground.

Air Temperature Sensor (ATS)

The IDM2 (6011) sends a regulated 5 volt reference signal through circuit K97AX to the Air Temperature Sensor (6703). As the temperature changes, the sensor changes resistance and provides the IDM2 (6011)

with an air temperature signal voltage. The sensor is grounded through circuit K97BU/K97WB to the ECM2 (6021) signal ground.

Cruise Control/Remote Engine Controls

When key switch (20) is in the ignition or start position, power is supplied through circuit A13 and circuit A13F to circuit breaker F22. From the circuit breaker, power is supplied through circuit A97B to the brake/cruise interface relay (1133). The brake/cruise interface relay (1133) is grounded through circuits A97-GM/A11-GA to cab ground.

Battery power is applied to fusible link circuit through circuits N14–FL/N14A-FL, circuit breaker F12 and circuit A97DK to the brake/cruise interface relay (1133) contacts. Power is supplied to the cruise control On/Off switch (391) through the closed relay contacts and circuit A97DJ. When the switch is in the On position, power flows through the closed switch contacts and circuit A97CF to the MSM (3111). The MSM (3111) received the On position of the cruise control On/Off switch and is communicated to the ECM2.

The cruise control Set/Resume switch (392) to be operational, with the cruise control On/Off switch (391) in the On position and power is applied from the switch to the cruise Set/Resume switch (392) through circuit A97DH. Momentarily depressing the Set portion of this switch supplies a 12 volt signal to the MSM (3111M) through circuits A97CA and is communicated to the ECM2. This engages the cruise control and causes the ECM2 to maintain the current engine RPM. If the cruise control speed is already set, depressing the switch in the Set position causes the engine RPM to decrease until the switch is released.

With the cruise control On/Off switch (391) in the On position, depressing the Resume portion of the Set/Resume switch (392) supplies a 0 volt ground signal to the MSM (3111M) through circuits A97–GE/A97–GL to cab ground and is communicated to the ECM2. If the cruise control speed has not been engaged, momentarily depressing the switch causes the ECM2 to resume the last engine RPM setting.

If the cruise control is already engaged, momentarily depressing the resume portion of the switch will cause the engine RPM and speed to increase in small incremental amounts until the desired speed is reached.

For information on remote engine controls for body builder applications, refer to Miscellaneous Information in CT-471 Body Builder Book.

8.3. TROUBLESHOOTING

Before beginning these test procedures, do the following:

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

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

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

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

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

ATA Data Link and Diagnostic/Programming Connector

Table 22 ATA Data Link and Diagnostic/Programming Connector

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	At ATA connector (384), measure voltage from cavity B circuit A97C to ground.	(384), cav. B, A97C to gnd.	12 ± 1.5 volts.	Go to next step.	Check fuse F3 for open condition. If okay, locate cause of low or no voltage in circuit A97C, then repair.
2.	Off	Disconnect ECM2 connector (6021) and install jumper wires from cavity 20 circuit K3AA(+) and cavity 21 circuit K3AA(-) to ground.			Go to next step.	
3.	Off	At (384) measure resistance of circuits A3A(+) and A3A(+) to ground.	(384), A3A(+) to gnd.	< 2 ohms.	Go to next step.	Locate open or poor connection in circuits A3A(+) and 98A(+) or dash conn. (2), then repair.
4.	Off	At (384) measure resistance of circuits A3(-) and A3(-) to ground.	(384), A3(-) to gnd.	< 2 ohms.	Go to next step.	Locate open or poor connection in circuits A3(-) and A3(-) or dash conn. (2), then repair.
5.	Off	Remove jumpers and reconnect (6021). Disconnect IDM2 connector (6011) and install jumper wires from cavity 2 circuit K3AA(+) and cavity 3 circuitK3AA(-) to ground.			Go to next step.	
6.	Off	At (384) measure resistance of circuits A3A(+) and A3A(+) to ground.	(384), A3A(+) to gnd.	< 2 ohms.	Go to next step.	Locate open or poor connection in circuits A3A(+) and A3A(+) or dash conn. (2), then repair.

Table 22 ATA Data Link and Diagnostic/Programming Connector (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
7.	Off	At (384) measure resistance of circuits A3A(-) and A3A(-) to ground.	(384), A3A(-) to gnd.	< 2 ohms.	Go to next step.	Locate open or poor connection in circuits A3A(-) and A3A(-) or dash conn. (3), then repair.
8.	Off	Remove jumpers and reconnect (6011). Disconnect cluster connector (11) and install jumper wires from cavity 7 circuit A98E(+) and cavity 9 circuit A98F(-) to ground.			Go to next step.	
9.	Off	At (384) measure resistance of circuit A3AA(+) to ground.	(384), A3AA(+) to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A3AA(+)/ A3AA(+), then repair.
10.	Off	At (384) measure resistance of circuits A3AA(-) to ground.	(384), A3AA(-) to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A3AA(-)/ A3AA(-), then repair.
11.	Off	Reconnect (11). At ATA interface connector (374), measure resistance from circuit A3A(+) to (384) circuit A3A(+).	(374), A3A(+) to (384) A3AA(+).	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A3A(+)/ A3A(+), then repair.
12.	Off	At ATA interface connector (374), measure resistance from circuit A3A(-) to (384) circuit A3A(-).	(374), A3A(-) to (384) A3A(-).	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A3A(-)/ A3A(-), then repair.
13.	Off	Data communication link circuitry checks good. If condition persists, refer to Engine Diagnostic Manual.				

ECM Power and Ground System Circuitry

Table 23 ECM Power and Ground System Circuitry

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove 40A power module maxifuse (F3) and check for open condition.	Maxifuse (F3).	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	Off	At fuse holder, measure voltage from circuit 14B to ground. Re-install fuse.	Fuse holder, 14B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 14B, then repair or replace cable assembly.
3.	Off	Check fuse F31 for open condition.	F31	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
4.	Off	At F31 fuse cavity A, measure voltage from circuit K97HB to ground.	F31, cav. A, K97HB to gnd.	12 ± 1.5 volts.	Go to next step.	Refer to 12 Volt Power Distribution (Battery) in Section 1.
5.	Off	Check fuse F396A for open condition.	F396A	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
6.	Off	At F396A fuse cavity A, measure voltage from circuit K97LD to ground.	F396A cav. A, K97LD to gnd.	12 ± 1.5 volts.	Go to next step.	Refer to 12 Volt Power Distribution (Battery) in Section 1.
7.	Off	Check fuse F12 for open condition.	F12	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
8.	On	At F12 fuse cavity A, measure voltage from circuit A13 to ground.	F12, cav. A, A13 to gnd.	12 ± 1.5 volts.	Go to next step.	Refer to 12 Volt Power Distribution (Key Switch) in Section 1.
9.	Off	Disconnect ECM2 connector (6020) and measure resistance of circuits at harness cavities 6 and 7 to ground.	(6020), cav. 6 and 7 to gnd.	< 5 ohms.	Go to next step.	Go to next step.

Table 23 ECM Power and Ground System Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
10.	Off	Disconnect IDM2 connector (6011) and measure resistance of circuits at harness cavity 1 to ground.	(6011), cav. 1 to gnd.	< 5 ohms.	Go to Step 13.	Go to next step.
11.	Off	Disconnect engine harness/ negative battery cable connector (426). At cable cavity A, measure resistance of circuit 11–G to ground.	(426), cav. A, 11–G to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 11–G, then repair or replace cable assembly.
12.	Off	Locate open or poor connection in circuits 11–G/K97–GV, 11–G/K97–GW, or 11–G/K97–GA, then repair.				
13.	On	At (6020) harness cavity 3, measure voltage from circuit K97UA to ground.	(6020), cav. 3, K97UA to gnd.	12 ± 1.5 volts.	Go to next step.	Go to next step.
14.	On	At (6011) harness cavity 9, measure voltage from circuit K97UB to ground.	(6011), cav. 9, K97UB to gnd.	12 ± 1.5 volts.	Go to Step 16.	Go to next step.
15.	Off/ On	Disconnect dash connector (2). Turn key on and at cavity 15, measure voltage from circuit K97CR to ground.	(2), cav. 15, K97CR to gnd.	12 ± 1.5 volts.	Repair K97C/97UA or K97C/97UB between (2) and (6020) or (6011).	Locate cause of low or no voltage in circuit K97CR, then repair.
16.	Off	At (6020), measure voltage from harness cavity 5 circuit K97J to ground.	(6020), cav. 5, K97J to gnd.	12 ± 1.5 volts.	Go to Step 20.	Go to next step.
17.	Off	Remove ECM power relay (396). At socket cavity 8B, measure voltage from circuit K97JA to ground.	(396) cav. 8B, 97JA to gnd.	12 ± 1.5 volts.	Go to Step 19.	Go to next step.

Table 23 ECM Power and Ground System Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
18.	Off	Disconnect dash connector (426). At cavity A, measure voltage from circuit 14B/K97JA to ground.	(426), cav. A, 14B/K97JA to gnd.	12 ± 1.5 volts.	Repair 14B/K97JA between (426) and (396).	Locate cause of low or no voltage in circuit 14B, then repair.
19.	Off	Measure resistance of circuit K97J between relay (396), socket cavity 6C, and ECM2 connector (6020), cavity 5.	(396), cav. 6C to (6020), cav. 5.	< 1 ohm.	Replace relay.	Locate open or poor connection in circuit K97JA, then repair.
20.	On	At (6021) measure voltage from harness cavities 1, 2, and at (6011) cavity 10 to ground.	(6021), cav. 1, 2 and (6011), cav. 10 to gnd.	12 ± 1.5 volts.	Go to Step 24.	Go to next step.
21.	Off	Remove ECM power relay (396). At socket cavity 6B, measure voltage from circuit 14B/K97HB, fuse F31, and K97HA to ground.	(396), cav. 6B, 14B/97HB, F31, and K97HA to gnd.	12 ± 1.5 volts.	Go to Step 23.	Go to next step.
22.	Off	Disconnect positive battery/ engine harness connector (426) and at circuit 14B, measure voltage to ground.	(426), 14B to gnd.	12 ± 1.5 volts.	Repair 14B between (411) and (396).	Locate cause of low or no voltage in circuit 14B, then repair.
23.	Off	Measure resistance of circuits between relay (396), socket cavity 8C, and ECM2 connector (6021), cavities 1, 2, and IDM2 connector (6011), cavity 10.	(396), cav. 8C to (6021), cav. 1, 2, and (6011), cav. 10.	<1 ohm each check.	Replace relay.	Locate open or poor connection in circuits K97TA/97CL, K97TA/97CK, or K97TA/97AL, then repair.
24.	Off	At (6011), measure voltage from harness cavity 8 circuit K97LA to ground.	(6011), cav. 8, K97LA to gnd.	12 ± 1.5 volts.	Go to Step 28.	Go to next step.
25.	Off	Remove IDM power relay (392). At socket cavity 8B, measure voltage from circuit K97LB to ground.	(392), cav. 8B, K97LB to gnd.	12 ± 1.5 volts.	Go to Step 27.	Go to next step.

Table 23 ECM Power and Ground System Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
26.	Off	Disconnect dash connector (411). At cavity A, measure voltage from circuit 14B/K97LB to ground.	(411), cav. A, 14B/K97LB to gnd.	12 ± 1.5 volts.	Repair 14B/K97LB between (411) and (392).	Locate cause of low or no voltage in circuit 14B, then repair.
27.	Off	Measure resistance of circuit K97LA between relay (392), socket cavity 6C, and IDM2 connector (6011), cavity 8.	(392), cav. 6C to (6011), cav. 8.	< 1 ohm.	Replace relay.	Locate open or poor connection in circuit K97LB, then repair.
28.	On	At (6011) measure voltage from harness cavities 6 and 12 to ground.	(6011), cav. 6 and 12 to gnd.	12 ± 1.5 volts.	Go to Step 32.	Go to next step.
29.	Off	Remove IDM power relay (392). At socket cavity 6B, measure voltage from circuit 14B/K97TC to ground.	(392), cav. 6B, 14B/K97TC to gnd.	12 ± 1.5 volts.	Go to Step 31.	Go to next step.
30.	Off	Disconnect positive battery/ engine harness connector (426) and at circuit 14B, measure voltage to ground.	(426), 14B to gnd.	12 ± 1.5 volts.	Repair 14B between (426) and (392).	Locate cause of low or no voltage in circuit 14B, then repair.
31.	Off	Measure resistance of circuits between relay (392), socket cavity 8C, and IDM2 connector (6011), cavities 6 and 12.	(392), cav. 8C to (6011), cav. 6 and 12.	<1 ohm each check.	Replace relay.	Locate open or poor connection in circuitsK97TA/97Y, K97TA/97LD, or K97TA, F40 and K97LC, then repair.
32.	Off	Reconnect connectors. Power module and ground system circuits check good. Should condition persist, refer to Engine Diagnostics Manual for ECM2 diagnostics.				

Accelerator (APS/IVS), Barometric Air Pressure (BAP), and Ambient Air Temperature Sensor (ATS) Systems

Table 24 Accelerator (APS/IVS), Barometric Air Pressure (BAP), and Ambient Air Temperature Sensor (ATS) Systems

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Is a fault code present for APS/IVS sensor/switch?			Go to next step.	Go to Step 9.
2.	Off	Check circuit breaker F10 for open condition.	F10	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace circuit breaker.
3.	On	Disconnect APS/IVS conn. (382) and at cavity F, measure voltage from circuit A99E to ground.	(382), cav. F, A99E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A99E, then repair.
4.	Off	At (382), install jumper from cavity A, circuit A99B to ground. Disconnect ECM2 connector (6021). At cavity 18, measure resistance from circuit A99B to ground.	(6021), cav. 18, A99B to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A99B or dash conn. (2), then repair.
5.	Off	At (382), move jumper to cavity B, circuit A99A and ground. At (6021) cavity 24, measure resistance of circuit A97W to ground.	(6021), cav. 24, A97WB to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A97W, dash conn. (3), or circuit A97W/99A, then repair.
6.	Off	At (382), move jumper to cavity C, circuit A99J and ground. At (6021) cavity 4, measure resistance of circuit A99C to ground.	(6021), cav. 4, A99C to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A99C, dash conn. (3), or circuit A99C/A99J, then repair.
7.	Off	At (382), move jumper to cavity D, circuit A99D and ground. At (6021) cavity 12, measure resistance of circuit A99D to ground.	(6021), cav. 12, A99D to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A99D, or dash conn. (3), then repair.

Table 24 Accelerator (APS/IVS), Barometric Air Pressure (BAP), and Ambient Air Temperature Sensor (ATS) Systems (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
8.	Off	Remove jumper and reconnect connectors. APS/IVS circuits check good. Is problem corrected?			End test.	Replace APS/IVS. If problem persists, refer to Engine Diagnostic Manual for ECM2 diagnostics.
9.	Off	Is a fault code present for BAP sensor?			Go to next step.	Go to Step 14.
10.	Off	Disconnect BAP sensor connector (406). Install jumper wire from cavity 1, circuit A97Z to ground. Disconnect ECM2 connector. (6021). At cavity 24, measure resistance of circuit A97W to ground.	(6021), cav. 24, A97W to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A97W, dash conn. (3), or circuit A97W, then repair.
11.	Off	At (437), move jumper wire to cavity 2, circuit A97BL and ground. At (6021) cavity 4, measure resistance of circuit A99C to ground.	(6021), cav. 4, A99C to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A99C, dash conn. (3), or circuit A99C/A97BL, then repair.
12.	Off	At (437), move jumper wire to cavity 3, circuit A97CD and ground. At (6020) cavity 24, measure resistance of circuit A97CD to ground.	(6020), cav. 24, A97CD to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A97CD or dash conn. (3), then repair.
13.	Off	Remove jumper and reconnect connectors. BAP system circuits check good. Is problem corrected?			End test.	Replace BAP sensor. If problem persists, refer to Engine Diagnostic Manual for ECM2 diagnostics.
14.	Off	Is a fault code present for the ATS system?			Go to next step.	End test.

Table 24 Accelerator (APS/IVS), Barometric Air Pressure (BAP), and Ambient Air Temperature Sensor (ATS) Systems (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
15.	Off	Disconnect ATS connector (463). Install jumper wire from cavity B, circuit K97AX to ground. Disconnect IDM2 connector (6011). At cavity 5, measure resistance from circuit K97AX to ground.	(6011), cav. 5, K97AX to gnd.	< 1 ohm	Go to next step.	Locate open or poor connection in circuit K97AX, then repair.
16.	Off	At (463), move jumper to cavity A, circuit K97BU and ground. At (6021) cavity 24, measure resistance of circuit K97W to ground.	(6021), cav. 24, K97W to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit K97W/ K97BU, then repair.
17.	Off	Remove jumper and reconnect connectors. ATS system circuits check good. Is problem corrected?			End test.	Replace ATS. If problem persists, refer to Engine Diagnostic Manual for ECM2 diagnostics.

Cruise Control/Remote Engine Controls

Table 25 Cruise Control/Remote Engine Controls

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	1. Turn key to RUN 2. Connect J1939 sniffer		Are both the engine (0x00) and the MSM (aka ESC) on the Datalink?	Go to step 2.	Go to step 9.
2.	Off	1. Disconnect J1939 sniffer. 2. Connect Master Diagnostics 3. Monitor the Cruise ON/OFF input 4. Exercise the Cruise ON/OFF switch		Does the input in MD change with the switch changes?	Go to step 3.	Go to step 4.

Table 25 Cruise Control/Remote Engine Controls (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
3.	Off	1. Monitor the Cruise Set/Resume input 2. Exercise the Cruise Set/Resume switch		Does the input in MD change with the switch changes?	MSM is functioning properly. Check that cruise control is enabled in the engine controller	Go to step 6.
4.	Off	1. Verify Cruise ON/OFF switch and wiring, OFF state 2. Disconnect MSM connector J2		Is pin 8 open to ignition when switch is OFF?	Go to step 5.	Repair wiring or switch, and retest
5.	Off	1. Verify Cruise ON/OFF switch and wiring, ON state		Is pin 8 shorted to ignition when switch is ON?	Replace MSM and retest	Repair wiring or switch, and retest
6.	Off	1. Verify Cruise SET/RES switch and wiring, normal state		Is pin 9 open to ground and ignition when switch is not pressed?	Go to step 7.	Repair wiring or switch, and retest
7.	Off	1. Verify Cruise SET/RES switch and wiring, RESUME state		Is pin 9 shorted to ground when switch is moved to RESUME?	Go to step 8.	Repair wiring or switch, and retest
8.	Off	1. Verify Cruise SET/RES switch and wiring, SET state 2. Turn Cruise ON/OFF switch to ON		Is pin 9 shorted to ignition when switch is moved to SET?	Replace MSM and retest	Repair wiring or switch, and retest

Table 25 Cruise Control/Remote Engine Controls (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
9.	Off	1. Leave J1939 sniffer connected		Is the engine (0x00) on the Datalink?	Go to step 10.	Go to step 13.
10.	Off	1. Turn the key to OFF. 2. Disconnect MSM connector J1. 3. Measure resistance across datalink pins in wiring harness		Is the resistance approx. 60 ohms?	Go to step 11.	Fix datalink wiring and retest
11.	Off	1. Turn the key to Ignition. 2. Measure the voltage at the MSM's harness ignition pin		Is the voltage 12-16 volts?	Go to step 12.	Fix wiring or fuse
12.	Off	1. Measure the resistance between the MSM's harness ground pin and ground		Is the resistance less than 10 ohms?	Replace MSM and retest	Fix ground wiring
13.	Off	1. Leave J1939 sniffer connected		Is the MSM (aka ESC) on the Datalink?	Check the engine's power connections and data link wiring.	Verify sniffer is working properly
1.	Off	Remove circuit breaker F31. and check for open condition.	F31.	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	Off	At fuse holder, measure voltage from circuit A90B to ground. Re-install fuse.	Fuse holder, A90B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuits A90–FL/90/90B, dash conn. (2), or circuit A90B, then repair or replace cable assembly.

Table 25 Cruise Control/Remote Engine Controls (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
3.	Off/ On	Disconnect MSM connector (3111). Turn key and cruise switch (391) on. At (3111), measure voltage from circuit A97CF cavity 8 to ground.	(3111), A97CF cav. 8 to gnd.	12 ± 1.5 volts.	Go to Step 6.	Go to next step.
4.	Off	Disconnect cruise on/off switch (391) and with switch in on position, measure resistance across terminals.	(391), across sw. terminals.	< 1 ohm.	Go to next step.	Replace cruise switch.
5.	On	At Brake/Cruise Interface Relay connector (1133), measure voltage from circuit A97B to ground. Reconnect connectors.	(1133), A97B to gnd.	12 ± 1.5 volts.	Repair open or poor con- nection in circuit A97B.	Check open circuit breaker F22. If okay, locate cause of low or no voltage in circuit A97B, then repair.
6.	On	With on/off switch on and set/resume switch held in set position, measure voltage at MSM connector (3111M) from circuit A97CA cavity 9 to ground.	(3111M), A97DJ cav. 9 to gnd.	12 ± 1.5 volts.	Go to Step 9.	Go to next step.
7.	Off	Disconnect cruise set/resume switch (392). With switch held in set position, measure resistance across terminals 1 to 2.	(392), across switch term. 1 to 2.	< 1 ohm.	Go to next step.	Replace set/resume switch.
8.	On	With on/off switch on and at connector (392), measure voltage from circuit A97DH to ground. Reconnect connectors.	(392), A97DH to gnd.	12 ± 1.5 volts.	Repair open in cir. A97DH or A97CA .	Locate cause of low or no voltage in circuit A97CA, then repair.
9.	On	With on/off switch on and set/resume switch held in resume position, measure voltage at MSM connector (3111) from circuit A97DK cavity 9 to ground.	(3111), A97DK cav. 9 to gnd.	0 volts.	Go to Step 11.	Go to next step.

Table 25 Cruise Control/Remote Engine Controls (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
10.	Off	Disconnect cruise set/resume switch (392). With switch held in resume position, measure resistance across terminals 2 to 3. Reconnect connectors.	(392), across switch term. 2 to 3.	< 1 ohm.	Repair open in cir. A97–GE, A97–GJ A97DK, or poor connection to Cab ground.	Replace set/resume switch.
11.	Off	Is the vehicle equipped with remote engine controls?			Refer to Body Builder Book.	Go to Step 12.
12.	Off	Reconnect connectors. Cruise control circuitry checks good. If condition persists, refer to Engine Diagnostic Manuals for ECM2 diagnostics.				

8.4. COMPONENT LOCATIONS

(1DVA) Electronic Device Power Stud..... Inside Cab Fuse/Relay Panel
(2DVA) Electronic Device Ground Stud..... Inside Cab Fuse/Relay Panel
(2) 22–Way Dash Connector..... At Left Front Cowl, Below Conn. (3)
(3) 48-Way Elect. Engine Dash Connector..... At Left Front Cowl, Above Conn. (2)
(63) Key Switch Connector..... Behind Key Switch
(374) ATA Interface Connector..... Left of Dash Connectors (2) and (3)
(384) ATA Data Link Connector..... Right of Key Switch
(391) Cruise On/Off Switch Connector..... Behind Cruise On/Off Switch
(392) Cruise Set/Resume Switch Connector..... Behind Cruise Set/Resume Switch
(408) 50A Sealed Maxifuse..... Top of Batteries
(409) Negative Battery to Engine Harness Connector..... Part of Battery Cable at Battery Box
(411) Positive Battery to Engine Harness Connector..... Part of Battery Cable at Battery Box
(413) 20A Sealed Maxi-Fuse..... Top of Batteries
(437) BAP Sensor Connector..... Inside Dash Fuse/Relay Panel
(463) Air Temp. Sensor Connector..... In Air Inlet Pipe
(590A) IDM Power Relay..... Cowl Fuse/Relay Panel
(590B) ECM Power Relay..... Cowl Fuse/Relay Panel
(590B) Power Distribution Center..... Cowl Fuse/Relay Panel
(6011) Engine Control Module IDM2..... Mounted to Right Valve Cover
(6020) Engine Control Module ECM2..... Mounted to Right Valve Cover
(6021) Engine Control Module ECM2..... Mounted to Right Valve Cover
(N/L) Remote Engine Control Connector..... Cowl Fuse/Relay Panel

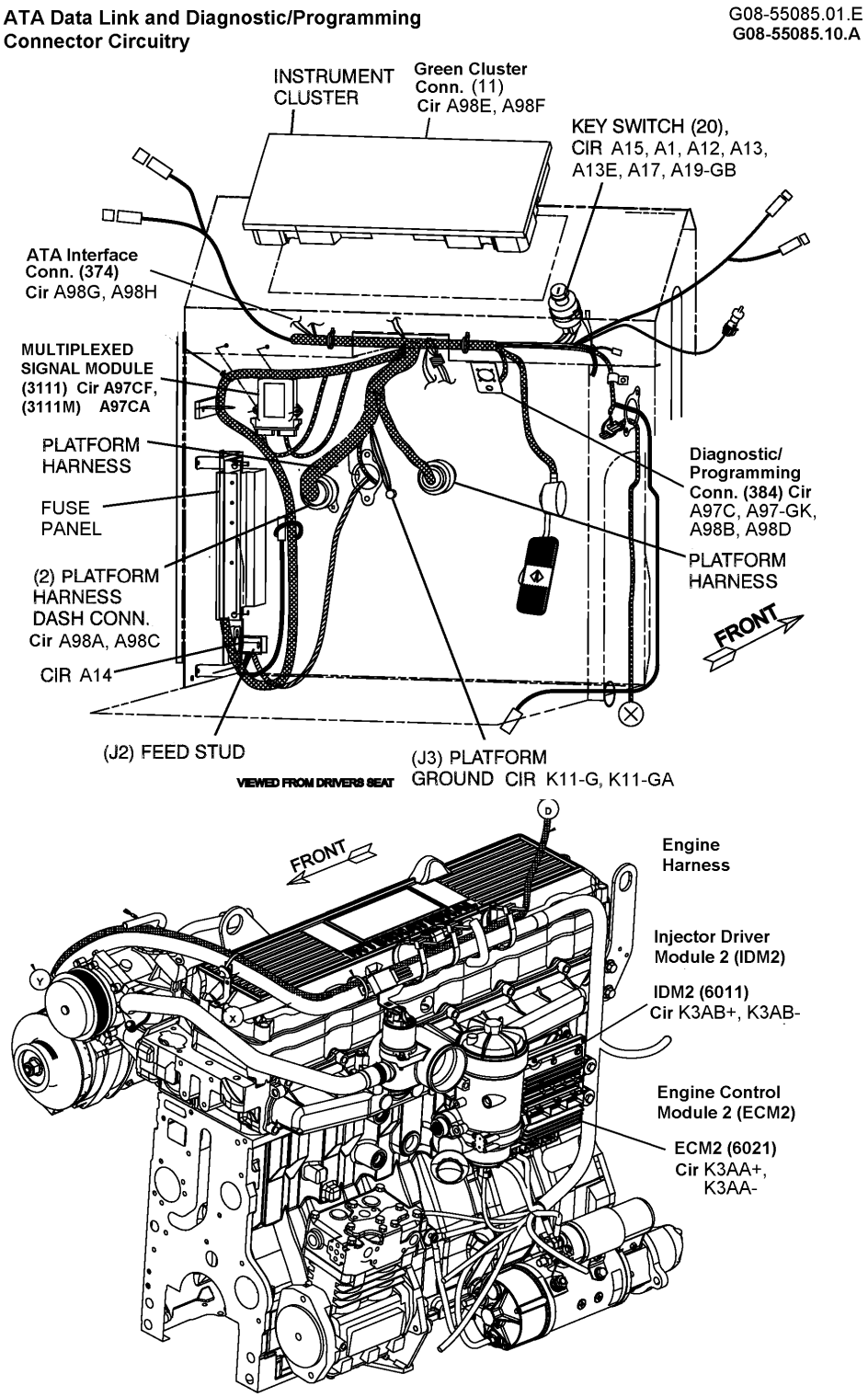

Figure 46 ATA Data Link and Diagnostic/Programming Connector Circuitry

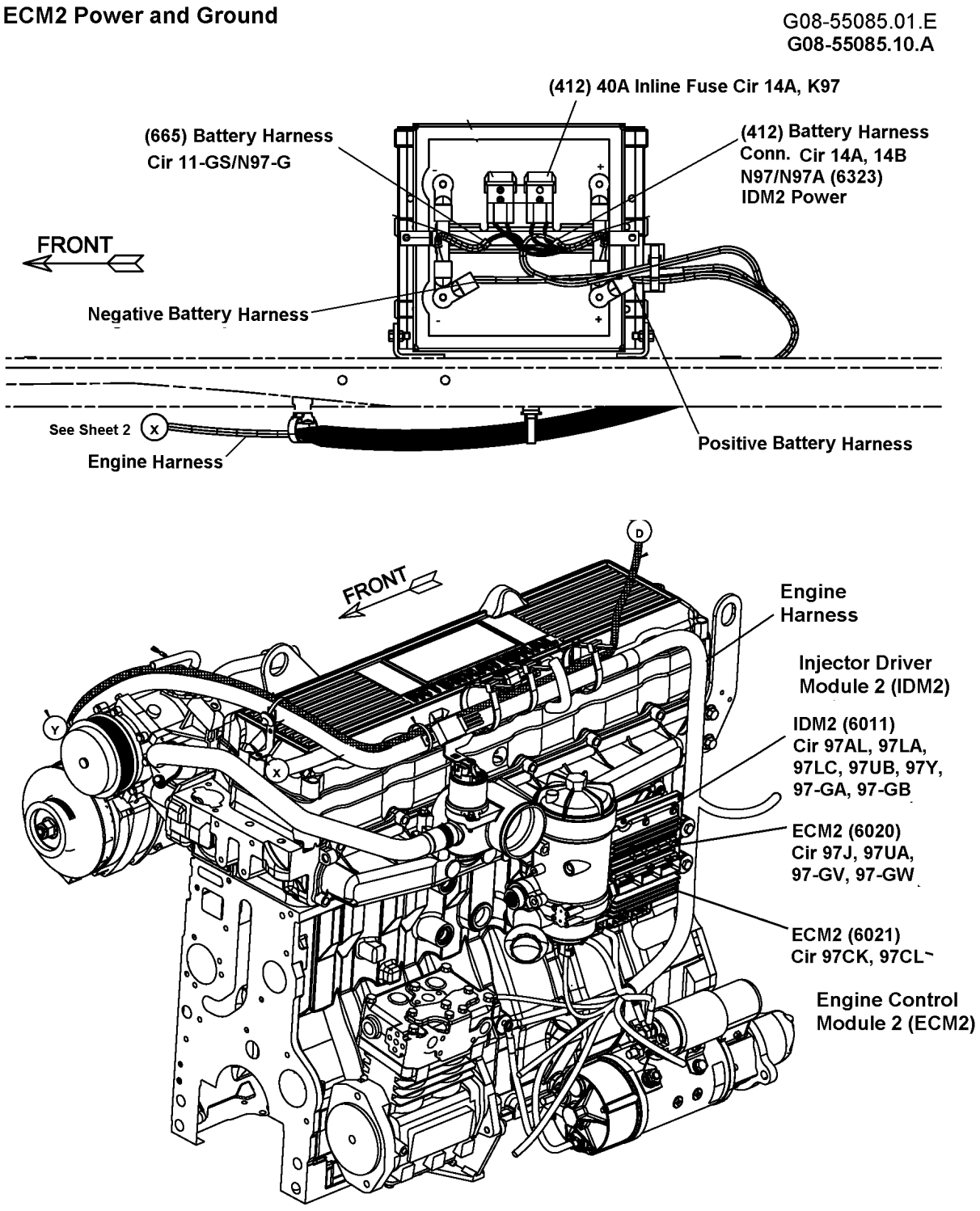

Figure 47 ECM2 Power And Ground Wiring At Battery Harness

ECM2 Power and Ground
- Front Cowl

G08-55085.01.E
G08-55085.10.A

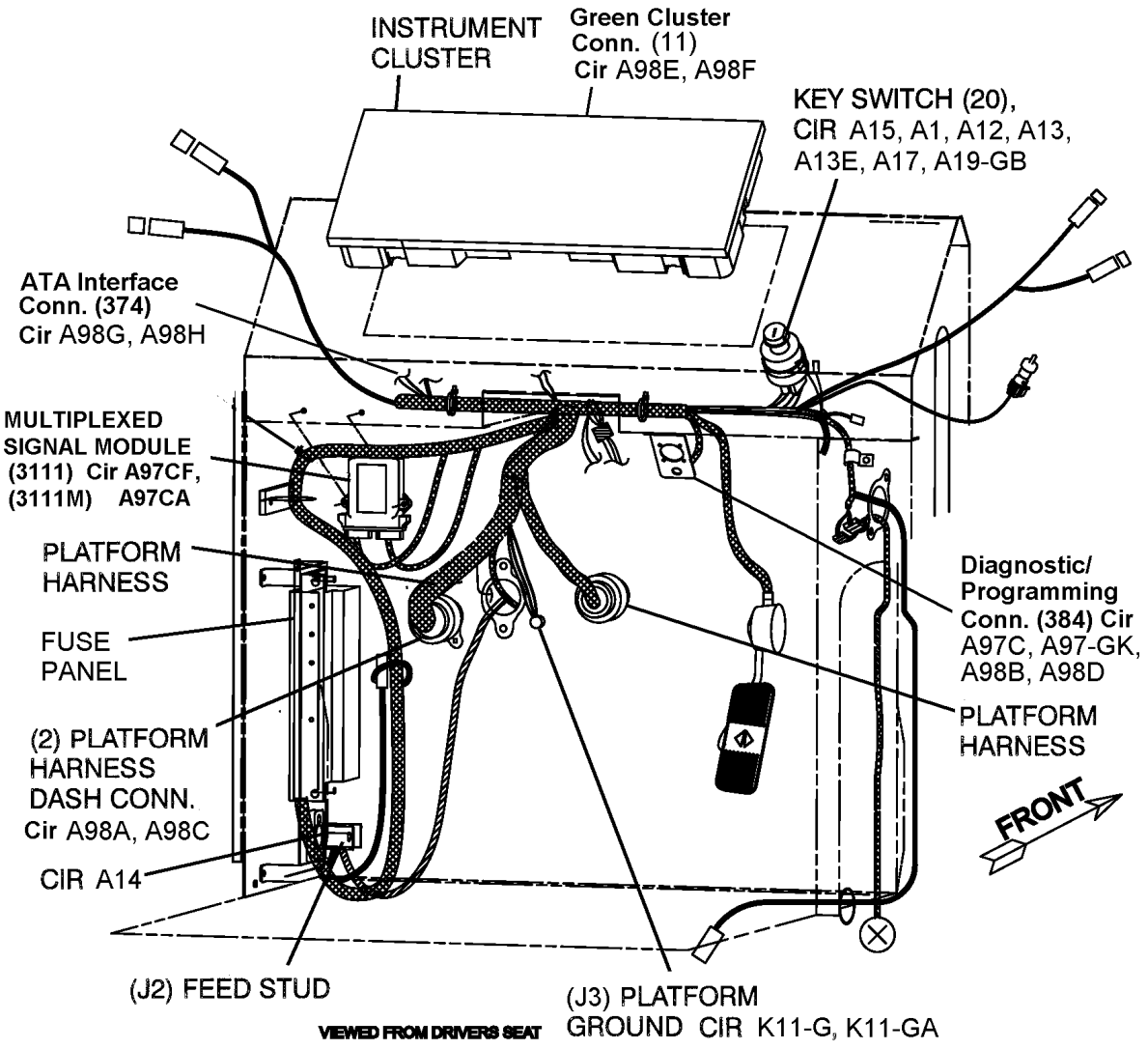

Figure 48 ECM2 Power and Ground — Front Cowl

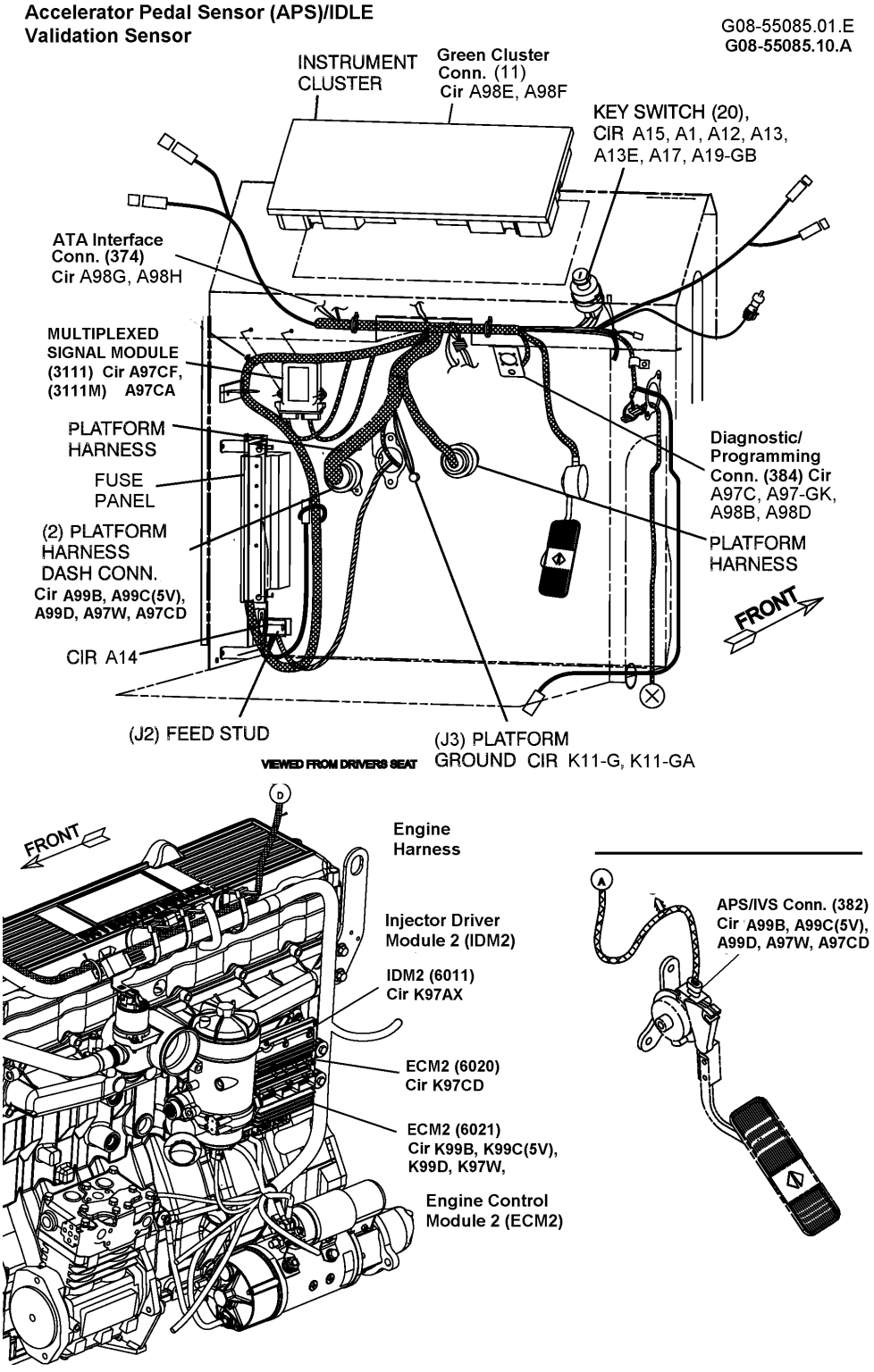

Figure 49 Accelerator Pedal Sensor (APS)/Idle

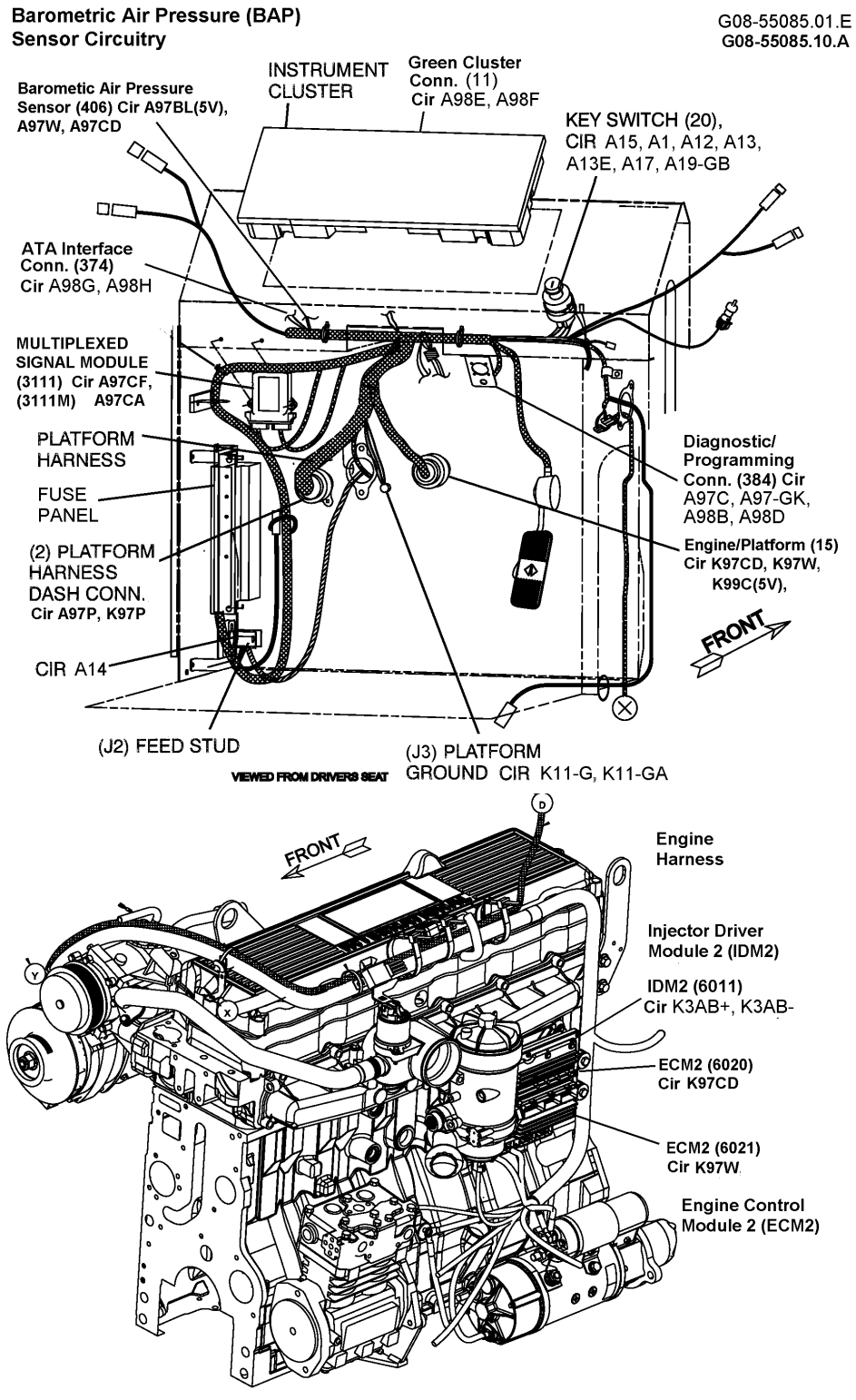

Figure 50 Barometric Air Pressure (BAP) Sensor Circuitry

Ambient Air Temperature Sensor (ATS)

G08-55085.01.E
G08-55085.10.A

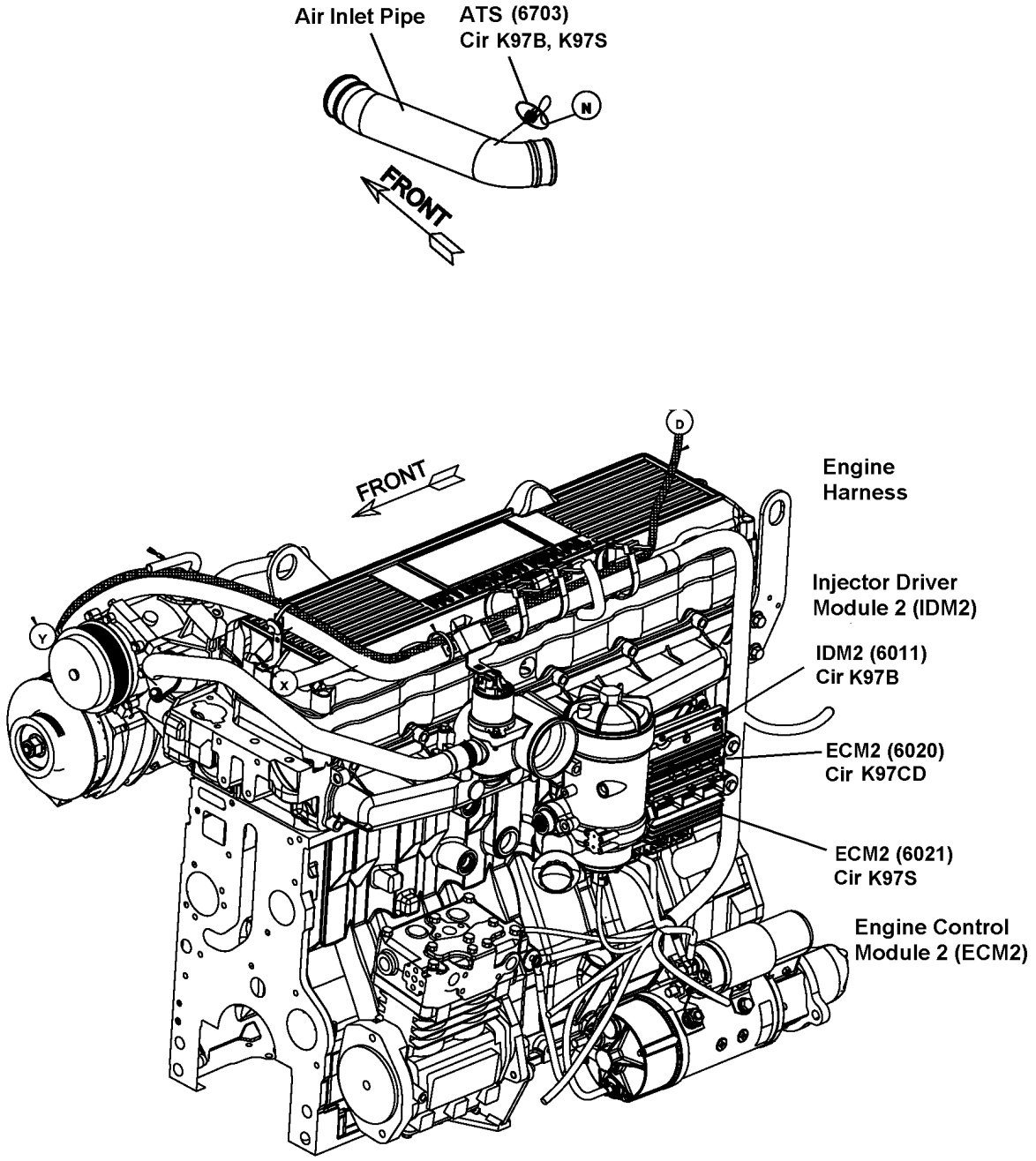

Figure 51 Ambient Air Temperature Sensor (ATS)

Cruise Control

G08-55085.01.E
G08-55085.10.A

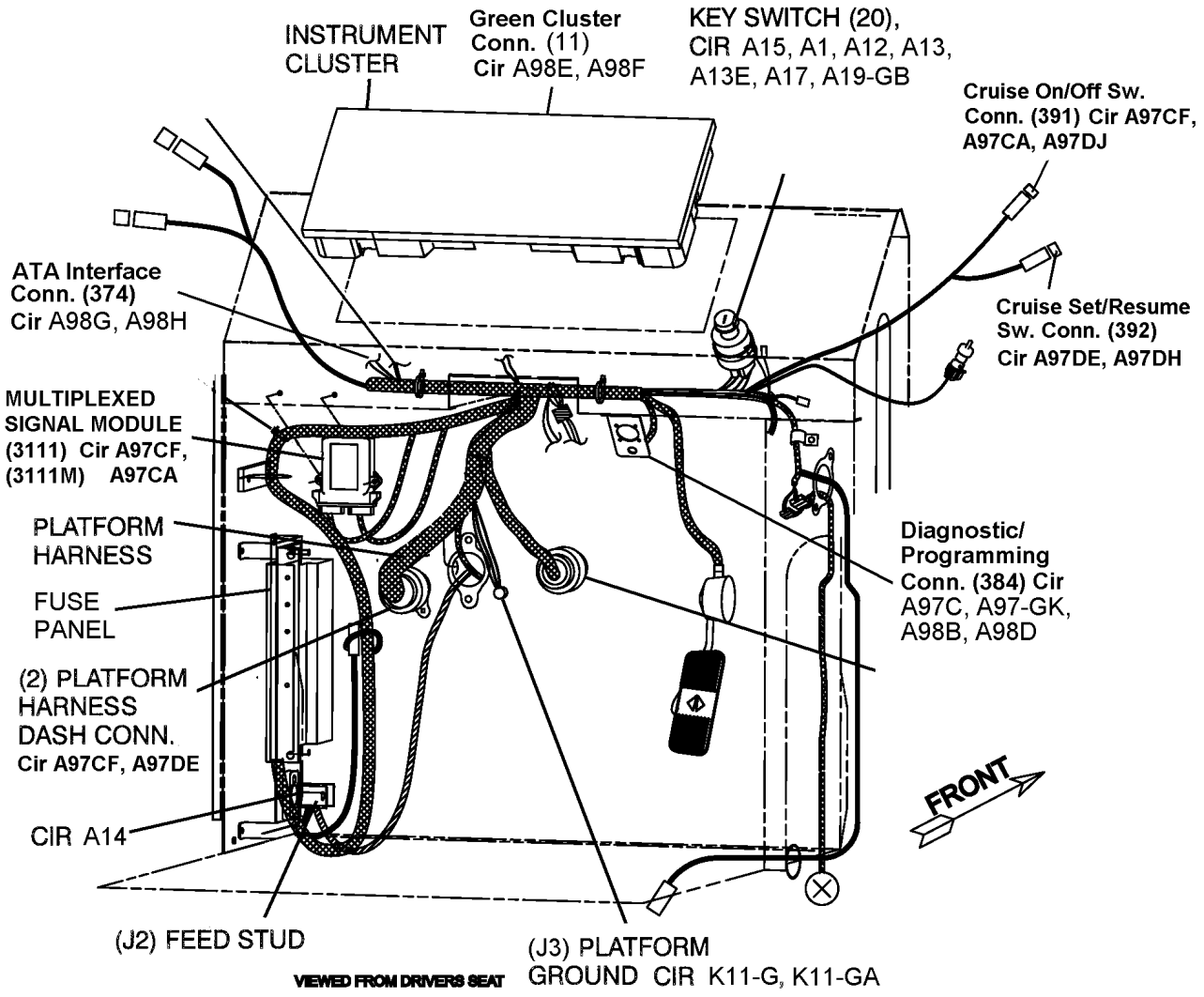

Figure 52 Cruise Control

9. RE 200/RE 300 POWER DISTRIBUTION AND GROUNDS

9.1. DESCRIPTION

Power

The primary power distribution points in the electrical wiring are the batteries, the body builder feed stud, the key switch and the main fuse block. For power distribution charts and component system circuit diagrams, refer to Electrical Circuit Diagram Manual S08297.

Ground

The ground system provides a power return path to the vehicle batteries. In this system are three major ground point junctions which include the platform ground, control box ground, and the engine ground. This section includes a power distribution chart for grounds.

9.2. OPERATION

Twelve Volt Power Distribution Battery/Alternator W/VT365

Power is supplied by the vehicle batteries to the engine ECM power in-line fuse (N/L) over circuits 14A and 14A. Power is also supplied by the vehicle batteries to the cranking motor solenoid battery stud (B) through a 4/0 wire and also by the alternator over circuit K2/K2-FL/K2A-FL. From the cranking motor solenoid stud (B), power is supplied to circuit K18-FL/K18 going to the glow plug relay (6010), circuit K17D-FL/K17D to the start relay (6310–1), and circuit K14B-FL/K14B to the control box.

From the “B" terminal, power is also supplied on circuits N14A-FL, N14-FL and N14 to the 1F feed stud. The feed stud (1F) supplies power to the power distribution center on circuits A14D/A14A for the horn, brake/cruise interface relay, air stop light, and the turn signal/hazard light systems. Also on circuit A14D/A14E for the diagnostic and programmable connector, and circuit A14D/A94 for the ABS control system. The power distribution center is also supplied power on circuit A14D/A14C for the headlight system, and on circuit A14D/A19 for the key switch (20) and the fuel heater relay.

Twelve Volt Power Distribution Battery/Alternator W/I6

Power is supplied by the vehicle batteries to the engine ECM power in-line fuse (N/L) over circuits 14A and 14B. Power is also supplied by the vehicle batteries to the cranking motor solenoid battery stud (B) through a 4/0 wire and also by the alternator over circuit K2A/K2C-FL/K2D-FL/K2E-FL. From the cranking motor solenoid stud (B), power is supplied to circuit K17-FL/K17D to the start relay (6310–1), and circuit K14B-FL/K14B to the control box.

From the “B" terminal, power is also supplied on circuits N14A-FL, N14-FL and N14 to the 1F feed stud. The feed stud (1F) supplies power to the power distribution center on circuits A14D/A14A for the horn, brake/cruise interface relay, air stop light, and the turn signal/hazard light systems. Also on circuit A14D/A14E for the diagnostic and programmable connector, and circuit A14D/A94 for the ABS control system. The power distribution center is also supplied power on circuit A14D/A14C for the headlight/panel system, and on circuit A14D/A19 for the key switch (20) and the fuel heater relay.

Twelve Volt Power Distribution (Key Switch)

Power is supplied to the key switch through fuse F16, circuit A15A/A15B and the ignition switch relay (1711), circuit A15. When the key switch (20) is moved to the start position, power is supplied to the inline starter interrupt connector (195) w/hyd or (6348) w/air, circuit A17A, and to the rear engine key switch (6305) and the starter & ISO power relay (6310) through circuit V17.

When the key switch is in the ignition position, power is supplied to the ignition switch relay coil (1711), circuit A13L, energized through circuits A11-GX/A11–GB, to the platform ground (4PG). Power is supplied to the power distribution center, circuits A15/A13, through the closed contacts of the ignition switch relay (1711). Power is supplied through circuit A13/A13A for the MSM module, the fuel heater relay, the rear ignition feed, the clutch switch, and the hyd brake pump control. Power is supplied through circuit A13/A13C for the air ABS power relay. Power is supplied through circuit A13/A13F for the ABS warning light, the instrument cluster, the ABS warning light relay, the hyd ABS/Allison interconnect, and the brake/cruise interface relay. Power is supplied through circuit A13/A13H for the audible alarm, the back-up light switch, the accelerator pedal switch, and the fuel filter light. Power is supplied from the key switch (20) to the power distribution center through circuit A13E, fuse F26, circuit A13D to supply power for the body builder connector (169).

When the key switch is moved to the accessories position, power is supplied to the power distribution center through circuit A12, fuse F9, circuit A12D to supply power for the body builder connector (169).

Grounds and Junction Points

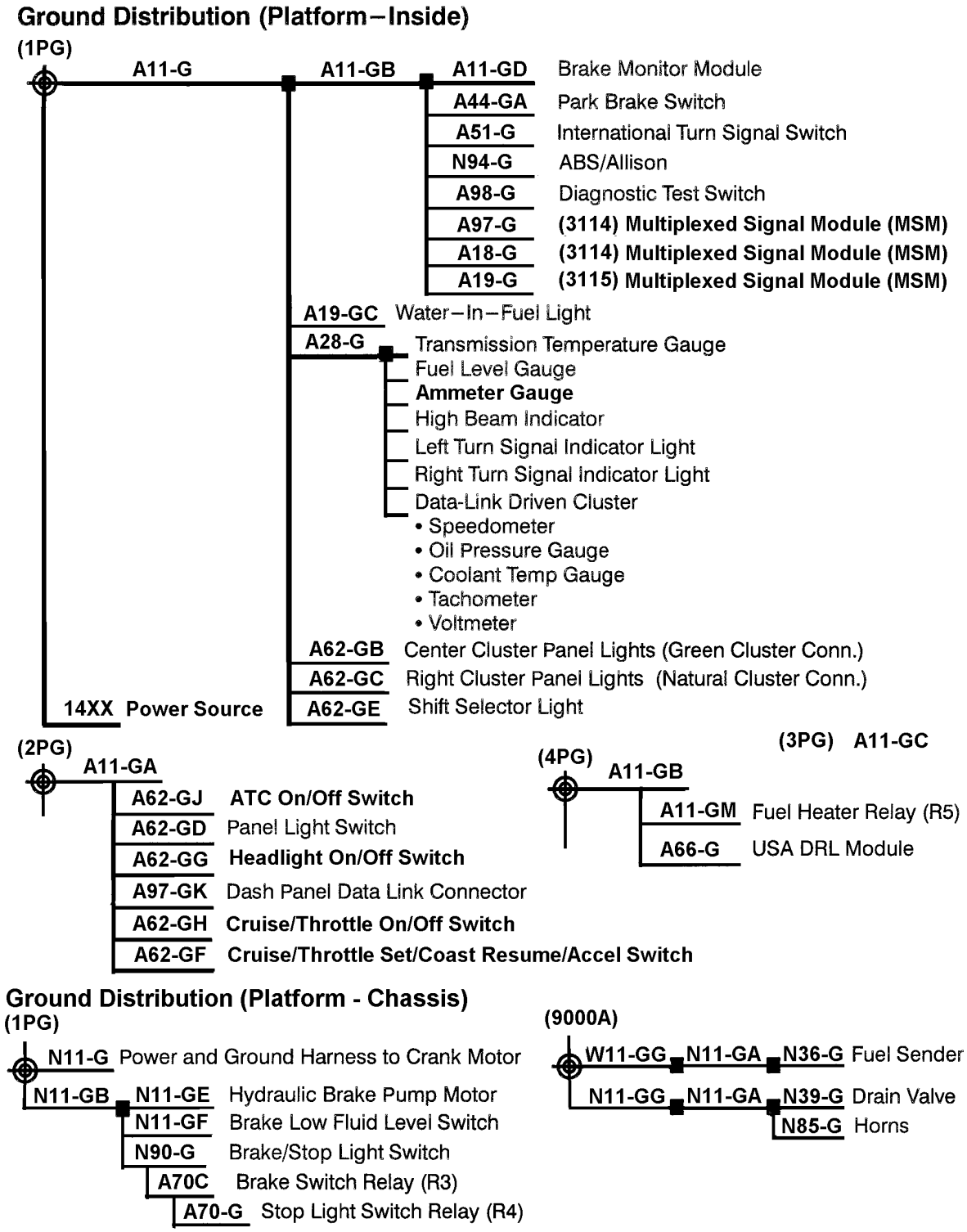

Figure 53 Ground Distribution Tables

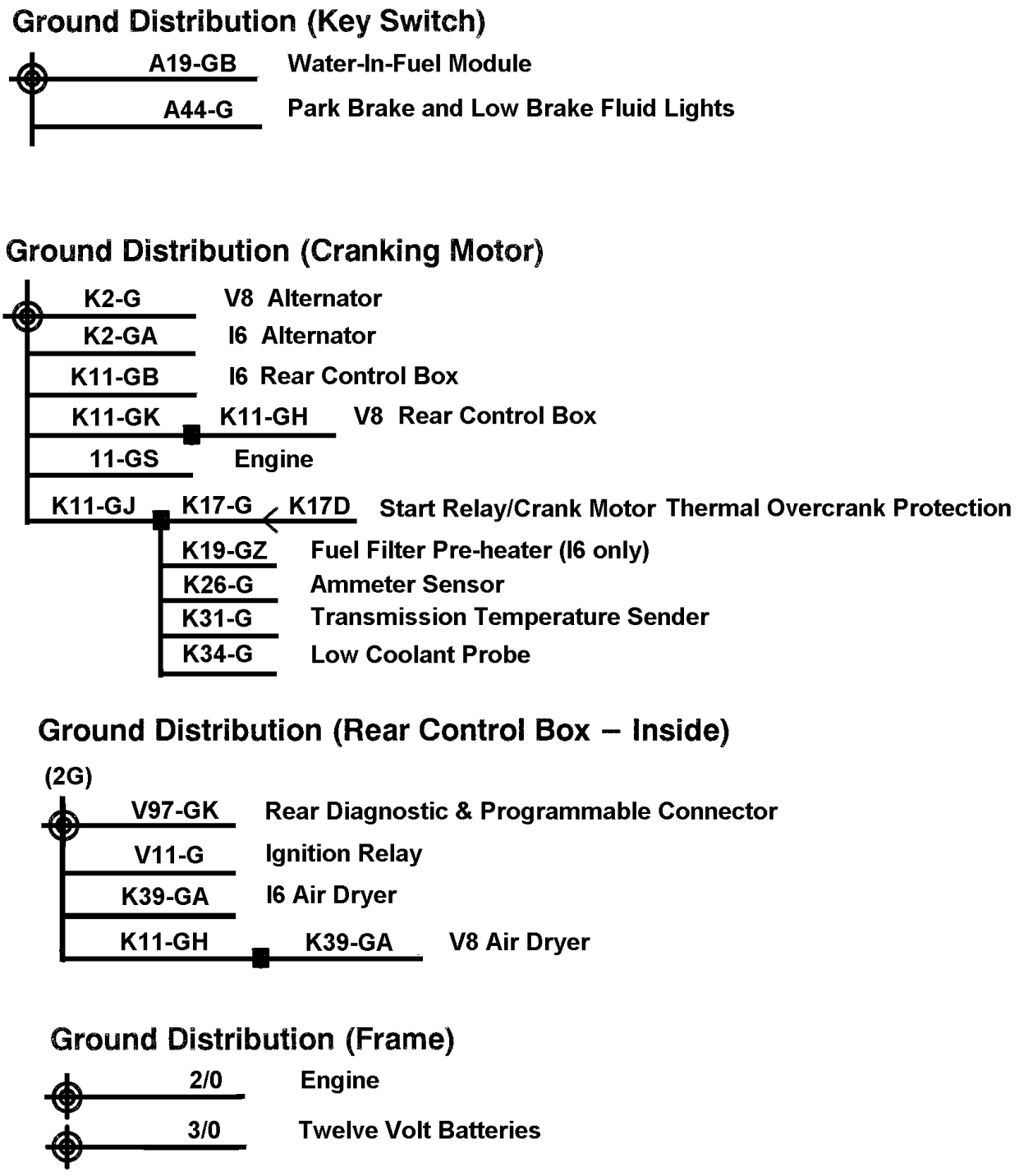

Figure 54 Ground Distribution Tables

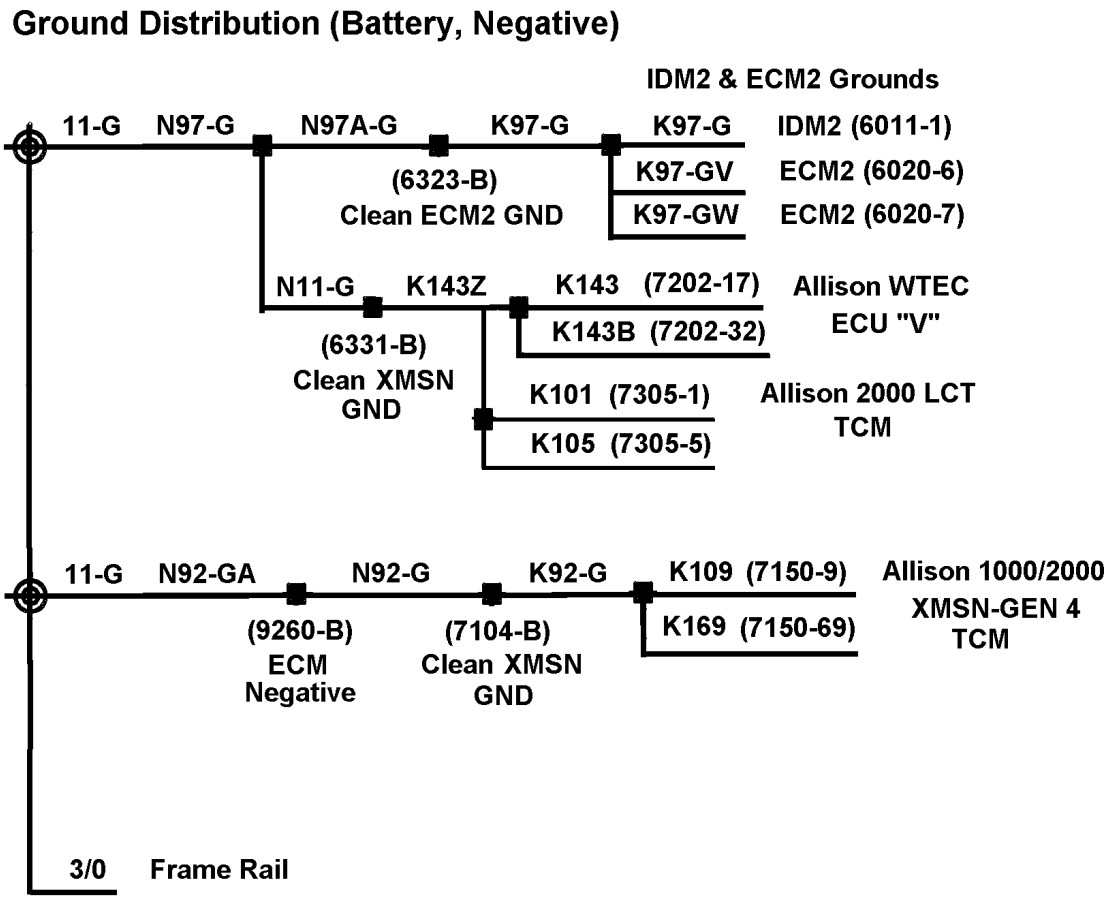

Figure 55 Ground Distribution Tables

9.3. TROUBLESHOOTING

Before beginning these test procedures, do the following:

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

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

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

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

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

12 Volt Power Distribution Battery/Alternator W/VT365

Table 26 12 Volt Power Distribution Battery/Alternator W/VT365

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	At "B" stud of cranking motor solenoid, measure voltage to ground.	"B" stud to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in 4/0 red cable from battery or 3/0 cable from battery to frame ground, then repair.
2.	Off	At alternator stud “B,” measure voltage to ground.	“B” stud to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in fusible links K2A-FL, K2–FL or circuit K2, then repair.
3.	Off	Disconnect start relay connector (6310) and measure voltage from circuit V17D to ground.	(6310), V17D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in fusible link K17D–FL, circuits K17D or V17D, then repair.
4.	Off	Remove fuse A4 from fuse holder (1A) in rear engine control box (3). Measure voltage from circuit V14E to ground.	A4, V14E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in fusible link K14B-FL, K14B, V14B or K14E, then repair. Install fuse A4.
5.	Off	Disconnect glow plug relay (N/L) connector and measure voltage from circuit K18 to ground.	Glow plug relay (N/L), K18 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in fusible link K18–FL or circuit K18, then repair.

Table 26 12 Volt Power Distribution Battery/Alternator W/VT365 (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
6.	Off	Reconnect glow plug relay connector and disconnect ECM2 power in-fuse connector (1C-A) and measure voltage from circuits 14A and 14B to ground.	Power In-line fuse (1C-A), 14A and 14B to gnd.	12 ± 1.5 volts each check.	Go to next step.	Locate cause of no or low voltage in circuit 14A or 14B, then repair.
7.	Off	Reconnect power relay fuse and disconnect chassis connector (2). Measure hydraulic brake system voltage from cavity B1, circuit A90 to ground.	(2), cav. B1, A90 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in fusible link N90–FL/ N90FA/A90, then repair.
8.	Off	At (2), measure hydraulic brake system voltage from cavity B2, circuit A90A to ground.	(2), cav. B2, A90A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in fusible link N90–FL/ N90FA/A90A, then repair.
9.	Off	Reconnect connector (2) and at body builder feed stud (1F), measure voltage from circuit N14 to ground.	(1F), N14 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in fusible links N14A-FL, N14–FL, or circuit N14, then repair.
10.	Off	Remove fuse F12. At cavity B, measure voltage from circuit A14A to ground.	F12, cav. B, A14A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A14A/A14D, then repair.
11.	Off	Replace fuse F12 and remove fuse F28. At cavity B, measure voltage from circuit A14E to ground.	F28, cav. B, A14E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A14E/A14D, then repair.
12.	Off	Replace fuse F28 and remove fuse F34. At cavity B, measure voltage from circuit A94 to ground.	F34, cav. B, A94 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A94/A14D, then repair.

Table 26 12 Volt Power Distribution Battery/Alternator W/VT365 (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
13.	Off	Replace fuse F34 and remove fuse F14. At cavity B, measure voltage from circuit A14C to ground.	F14, cav. B, A14C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A14C/A14D, then repair.
14.	Off	Replace fuse F14 and remove fuse F16. At cavity B, measure voltage from circuit A19 to ground.	F16, cav. B, A19 to gnd.	12 ± 1.5 volts.	Replace fuse.	Locate cause of low or no voltage in circuit A19/A14D, then repair. Replace fuse.

12 Volt Power Distribution Battery/Alternator W/I6

Table 27 12 Volt Power Distribution Battery/Alternator W/I6

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	At "B" stud of cranking motor solenoid, measure voltage to ground.	"B" stud to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in 4/0 red cable from battery or 3/0 cable from battery to frame ground, then repair.
2.	Off	At alternator stud “B,” measure voltage to ground.	“B” stud to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in fusible links K2C-FL, K2D-FL, K2E–FL or circuit K2A, then repair.
3.	Off	Disconnect start relay connector (6310) and measure voltage from circuit K17B to ground.	(6310), K17B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in fusible link K17–FL or circuit K17B, then repair.
4.	Off	Remove fuse A4 from fuse holder (1A) in rear engine control box (3). Measure voltage from circuit V14E to ground.	A4, V14E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in fusible link K14B-FL/ K14B/K14E , then repair. Install fuse A4.

Table 27 12 Volt Power Distribution Battery/Alternator W/I6 (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
5.	Off	Disconnect ECM2 power In-line fuse (1C-A), and measure voltage from circuits 14A and 14B to ground.	Power In-line fuse (1C-A), 14A and 14B to gnd.	12 ± 1.5 volts each check.	Go to next step.	Locate cause of no or low voltage in circuit 14A or 14B, then repair.
6.	Off	Reconnect power relay fuse and disconnect chassis connector (2). Measure hydraulic brake system voltage from cavity B1, circuit A90 to ground.	(2), cav. B1, A90 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in fusible link N90–FL/ N90FA/A90, then repair.
7.	Off	At (2), measure hydraulic brake system voltage from cavity B2, circuit A90A to ground.	(2), cav. B2, A90A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in fusible link N90–FL/ N90FA/A90A, then repair.
8.	Off	Reconnect connector (2) and at body builder feed stud (1F), measure voltage from circuit N14 to ground.	(1F), N14 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in fusible links N14A-FL, N14–FL, or circuit N14, then repair.
9.	Off	Remove fuse F12. At cavity B, measure voltage from circuit A14A to ground.	F12, cav. B, A14A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A14A/A14D, then repair.
10.	Off	Replace fuse F12 and remove fuse F28. At cavity B, measure voltage from circuit A14E to ground.	F28, cav. B, A14E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A14E/A14D, then repair.
11.	Off	Replace fuse F28 and remove fuse F34. At cavity B, measure voltage from circuit A94 to ground.	F34, cav. B, A94 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A94/A14D, then repair.

Table 27 12 Volt Power Distribution Battery/Alternator W/I6 (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
12.	Off	Replace fuse F34 and remove fuse F14. At cavity B, measure voltage from circuit A14C to ground.	F14, cav. B, A14C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A14C/A14D, then repair.
13.	Off	Replace fuse F14 and remove fuse F16. At cavity B, measure voltage from circuit A19 to ground.	F16, cav. B, A19 to gnd.	12 ± 1.5 volts.	Replace fuse.	Locate cause of low or no voltage in circuit A19/A14D, then repair. Replace fuse.

12 Volt Power Distribution Key Switch

Table 28 12 Volt Power Distribution Key Switch

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove fuse F16 and check for open condition.	F16	< 1 ohm.	Replace fuse. Go to next step.	Locate cause of overload condition and repair. Replace fuse.
2.	Off	At fuse cavity B, measure voltage from circuit A19 to ground.	Fuse cav. B, A19 to gnd.	12 ± 1.5 volts.	Replace fuse. Go to next step.	Locate cause of low or no voltage in circuit A19/A14D, then repair.
3.	Off	Disconnect key switch connector (20) and measure voltage from circuit A15B to ground.	(20), A15B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A15A/A15B, then repair.
4.	Acc	At key switch (20), measure resistance from pin B to pin A with switch in accessory position.	(20), pin B to pin A.	< 1 ohm.	Go to next step.	Replace key switch.
5.	On	At key switch (20), measure resistance from pin B to pin I with key switch in ignition position.	(20), pin B to pin I.	< 1 ohm.	Go to next step.	Replace key switch.
6.	Start	At key switch (20), measure resistance from pin B to pin S with switch in start position.	(20), pin B to pin S.	< 1 ohm.	Go to next step.	Replace key switch.

Table 28 12 Volt Power Distribution Key Switch (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
7.	Off/ On	Reconnect key switch (20) and disconnect dash connector (2). Turn key to start position. Start interrupt at cavity G6, measure voltage from circuit A17A to ground.	(2), cav. G6, A17A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A17A, then repair.
8.	Off/ On	Reconnect dash connector (2) and remove fuse F8. Turn key on and at cavity A, measure voltage from circuit A12 to ground.	F8, cav. A, A12 to gnd.	12 ± 1.5 volts.	Replace fuse. Go to next step.	Locate cause of no or low voltage in circuit A12, then repair. Replace fuse.
9.	Off/ On	Remove fuse F26. Turn key on and at cavity A, measure voltage from circuit A13E to ground.	F26, cav. A, A13E to gnd.	12 ± 1.5 volts.	Replace fuse. Go to next step.	Locate cause of no or low voltage in circuit A13E, then repair. Replace fuse.
10.	Off/On	Remove IGN switch relay (1711). At relay connector, measure voltage from cavity 85 to ground.	(1711) cav. 85 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A13L, then repair.
11.	Off	At (1711) cavity 30, measure voltage from circuit A15 to ground.	(1711) cav. 30, A15 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A15/A15B/A15A, then repair.
12.	Off	At (1711) cavity 86, measure voltage from circuit A11–GX to ground.	(1711) cav. 86, A11–GX to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A11–GX/A11–GB then repair.
13.	Off	Bench test IGN switch relay by measuring resistance from cavity 30 to 87A.	(1711) cav. 30 to 87A.	<1 ohm.	Go to next step.	Replace IGN switch relay.
14.	Off	Bench test IGN switch relay by applying +12 volts to cavity 85, ground to cavity 86, and measuring resistance from cavity 30 to 87.	Energized relay, cav. 30 to 87.	<1 ohm.	Go to next step.	Replace IGN switch relay .

Table 28 12 Volt Power Distribution Key Switch (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
15.	Off/On	Reconnect IGN switch relay (1711), move key switch to ignition position, at (1711) measure voltage between circuit A11–GX cavity 86, and circuit A13L cavity 85.	(1711), A11–GX cav. 86 to A13L cav. 85.	12 ± 1.5 volts.	Go to next step.	Locate cause of open or poor connection in circuit A13L or A11–GX/A11–GB, to ground, then repair.
16.	Off	At (1711) use a test lead to jumper circuit A15 cavity 30 to A13 cavity 87. Does IGN switch relay energized?			Install relay. IGN switch circuits check good.	Leave test lead connected and go to next step.
17.	Off/ On	Remove fuse F20. Turn key on and at cavity A, measure voltage from circuit A13A to ground.	F20, cav. A, A13A to gnd.	12 ± 1.5 volts.	Replace fuse. Go to next step.	Locate cause of no or low voltage in circuit A13A/A13, then repair. Replace fuse.
18.	Off/ On	Remove fuse F25. Turn key on and at cavity A, measure voltage from circuit A13H to ground.	F25, cav. A, A13H to gnd.	12 ± 1.5 volts.	Replace fuse. Go to next step.	Locate cause of no or low voltage in circuit A13H/A13, then repair. Replace fuse.
19.	Off/ On	Remove fuse F23. Turn key on and at cavity A, measure voltage from circuit A13F to ground.	F23, cav. A, A13F to gnd.	12 ± 1.5 volts.	Replace fuse. Go to next step.	Locate cause of no or low voltage in circuit A13F/A13, then repair. Replace fuse.
20.	Off/ On	Remove fuse F27. Turn key on and at cavity A, measure voltage from circuit A13C to ground.	F27, cav. A, A13C to gnd.	12 ± 1.5 volts.	Replace fuse.	Locate cause of no or low voltage in circuit A13C/A13, then repair. Replace fuse.
21.	Off	Key switch power distribution circuits check good.				

9.4. COMPONENT LOCATIONS

NOTE – Engine, chassis and platform connector locations (Left Side or Right Side) are described as viewed from the driver's seat position. The engine compartment connector locations (Front or Rear) are described as viewed from the front of the engine.

(1B) Fuse Holder	In Rear Engine Control Box
(1F) Body Builder Feed Stud	Lower Left Platform Kick Panel
(2) Dash Connector	Right Side of Platform, Inside
(2F) Chassis Connector	Right Side of Platform, Outside
(3) Control Box Engine W/H Conn.	Rear Control Box at Outside Right Rear Frame Rail
(20) Front Key Switch	Right Side of Instrument Cluster
(387) Start Relay	Strapped to Engine Harness at Rear Control Box
(195) Starter Interrupt	Left Platform Kick Panel
(196) Chassis to Engine W/H Conn.	Upper Right Side at Transmission Bell Housing
(412) Positive Battery Connector	At Battery
(426) Engine/Neg. Battery Harness Connector	Top of Transmission Bell Housing
(445) Negative Battery Connector	At Battery
("B") Starter Motor Solenoid Stud	On Starter Motor Solenoid
("B") Alternator Power Stud	On Alternator
("I") Alternator Ignition Stud	On Alternator
(N/L) ECM Power Relay Fuse Connector	Strapped to Positive Battery Near Battery
(N/L) Glow Plug Relay	Top, Right Side on ECM Mounting Bracket

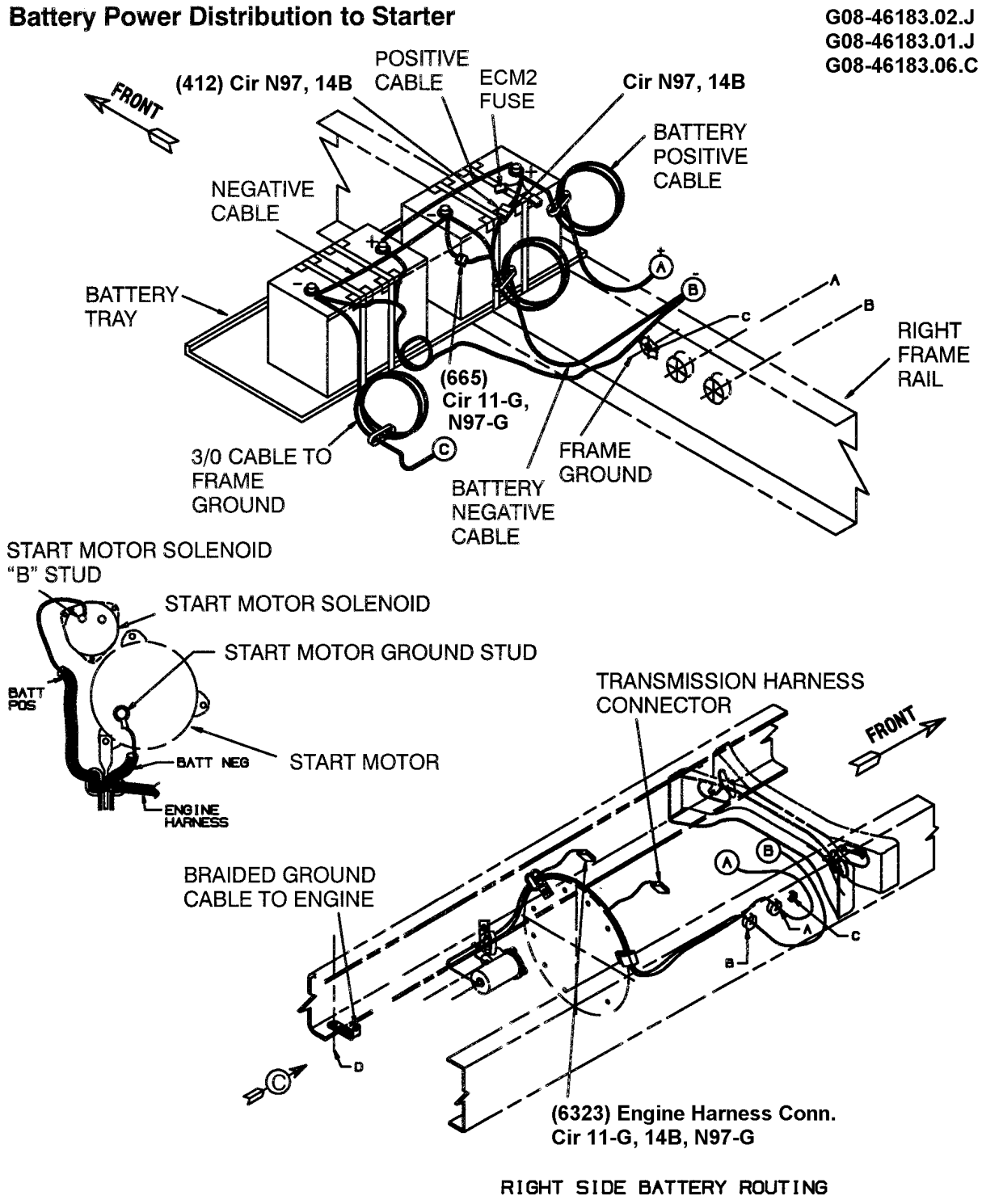

Figure 56 Battery Power Distribution to Starter

Battery/ Alternator Power Distribution at Starter

G08-51061.04
G08-51061.07.B

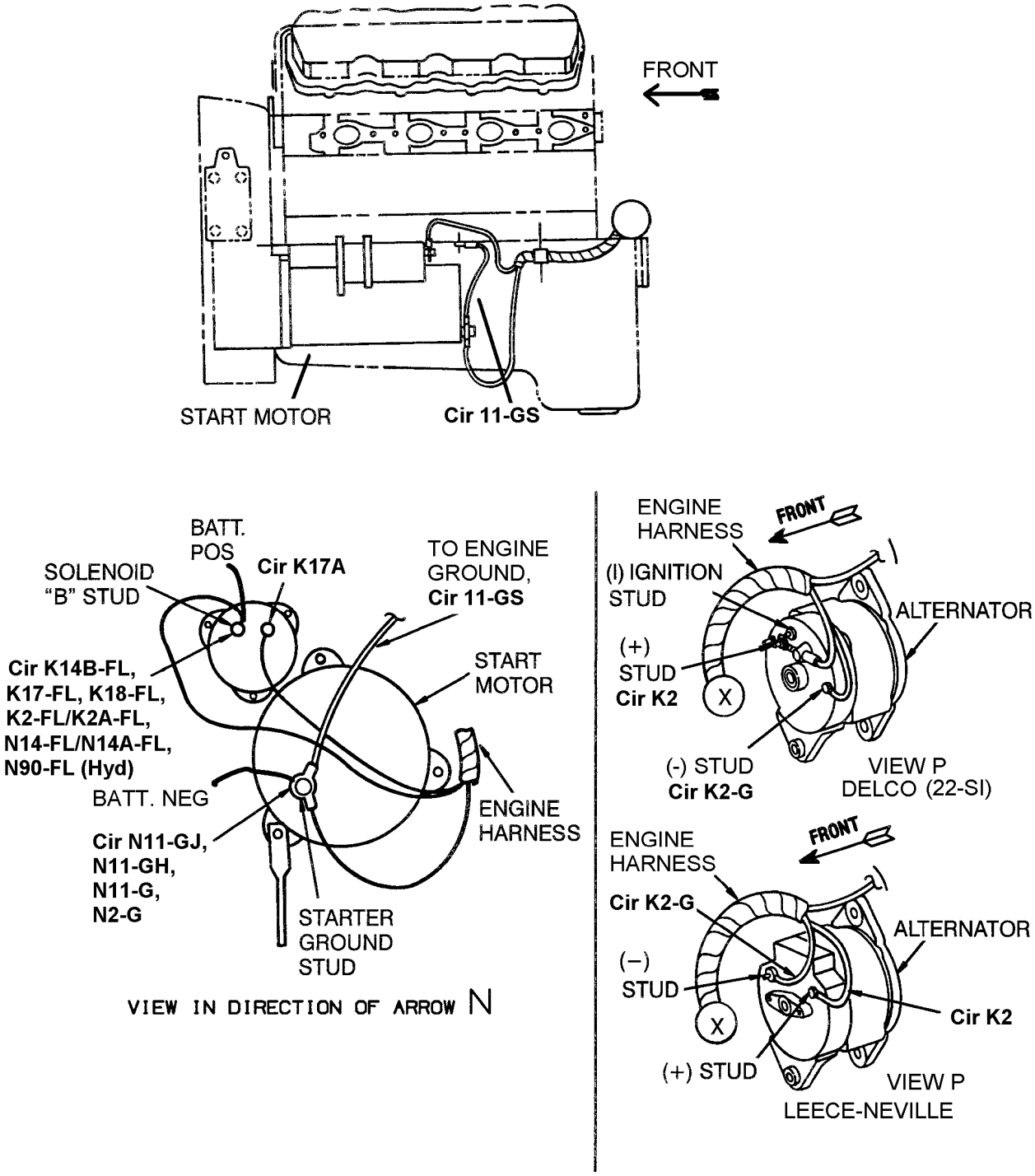

Figure 57 Battery/Alternator Power Distribution at Starter

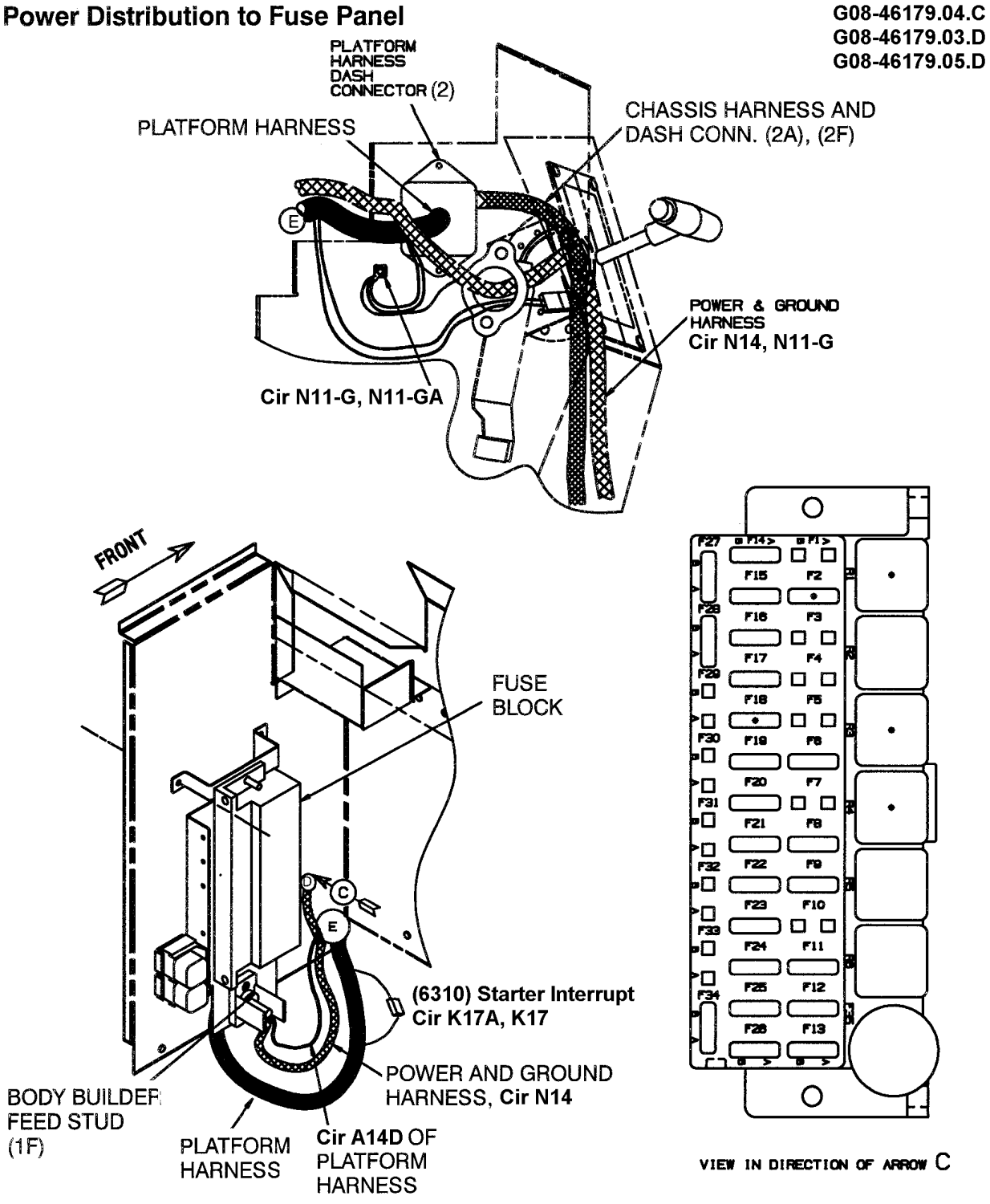

Figure 58 Power Distribution to Fuse Panel

Power Distribution (Key Switch)

G08-46179.02.D

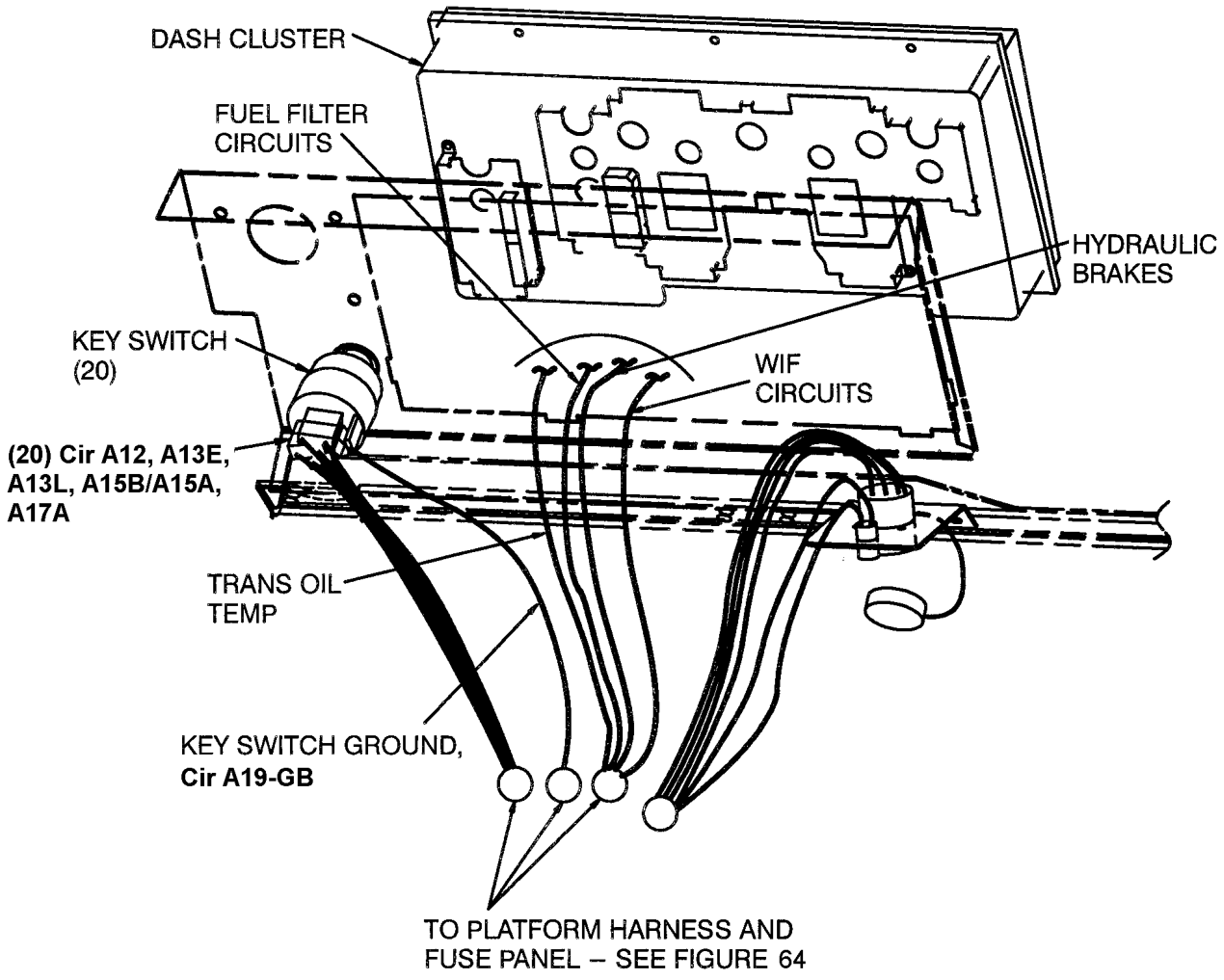

Figure 59 Power Distribution (Key Switch)

10. RE 200/RE 300 CAB ACCESSORIES

10.1. DESCRIPTION

Ammeter Gauge

Refer to S08314 RE 200/RE 300 Instruments.

Horn(s)

The dual electric horns (high and low note), located on the front side of the left platform support, provide a means for the driver to signal or provide warning.

Turn Signals

The turn signal system provides a driver with the means to signal oncoming or following traffic of intended lane changes.

Power Source

The 12 volt power source outlet is provided for the driver to connect accessories.

10.2. OPERATION

Horn(s)

Power is applied from the battery feed stud (1F) to circuit A14D/A14A, fuse F11, and circuit A85 to the coil of the horn relay (R6). When the horn button is depressed, power flows through the horn relay coil, circuit A85A, an in-line connector (14), pin 1, circuit 85A, another in-line connector, and circuit 85A to the steering wheel slip ring. From the slip ring, power flows through circuit 85A, the horn button switch and circuit 85-GB to the steering column ground.

With the horn relay energized, power flows from circuit A85, through circuit A85B, the horn relay (R6), circuit A85C, dash connector (2), pin C4, and circuit N85C to the high note horn (9151A), and circuit N85D to the low note horn (9151),. The horns are grounded through the mounting bolts (9150), and through circuit N85-G/N11-GG to the platform ground (9000A).

Turn Signals

Power for the turn signal circuitry is supplied by the feed stud (1F) through circuit A14D/A14A, fuse F13, and circuit A55 to the flasher unit (1) (F35). Power is then supplied through circuit A55A/A60A, turn signal jumper harness connector (13), pin C, and circuit A55A/A60A to the turn signal switch (62) [through circuit A55A/60A, turn signal jumper harness connector (13), pin C, and circuit A55A/60A to the turn signal switch (95) with tilt steering column].

When the turn signal is moved to the left turn position, the switch contacts close and power is applied to the jumper harness circuit A56, jumper connector (13), pin D, and circuit A56 to a splice. From the splice, power is supplied to the body builder connector (169), pin F, on circuit A56C. From the splice, power is also applied through circuit A56B, the green dash cluster connector (11), pin 6, and a printed circuit board to the left turn indicator light. The light is grounded through the printed circuit, connector (11), pin 2, and circuit A28-G/A11-G to the platform ground (1PG).

From the turn signal switch, power is also supplied to the body builder connector (170), pin E, through the jumper harness circuit A56A, jumper connector (13), pin E, and circuit A56A.

When the turn signal is moved to the right turn position, the switch contacts close and power is applied to the jumper harness circuit A57, jumper connector (13), pin F, and circuit A57 to a splice. From the splice, power is supplied to the body builder connector (169), pin G, on circuit A57C. From the splice, power is also applied through circuit A57B, the green dash cluster connector (11), pin 12, and a printed circuit board to the right turn indicator light. The light is grounded through the printed circuit, connector (11), pin 2, and circuit A28-G/A11-G to the platform ground (1PG).

From the turn signal switch, power is also supplied to the body builder connector (170), pin B, through the jumper harness circuit A57A, jumper connector (13), pin A, and circuit A57A.

When the hazard button is pushed, switch contacts close and power is applied to all of the previously discussed feed circuits. This causes the indicator lights to flash and any lights connected to the turn signal circuitry in the body builder connectors (169) and (170).

Power Source

Power for the power source outlet is supplied by the feed stud (1F) through circuit 14XZ, fuse F30, and circuit 14XY to the power source connector (208). The ground path for the power source connector (208) is circuit 14XX to the platform ground (1PG).

10.3. TROUBLESHOOTING

Before beginning these test procedures, do the following:

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

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

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

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

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

Electric Horn(s)

Table 29 Electric Horn(s)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove fuse F11 and check for open condition.	F11	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.

Table 29 Electric Horn(s) (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
2.	Off	Remove horn relay (R6) and re-install fuse F11. At relay connector, measure voltage from cavity 86 to ground.	(R6), cav. 86 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A85, then repair.
3.	Off	At (R6) cavity 86, measure voltage from circuit A85 to ground.	(R6) cav. 86, A85 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A85/A85B, then repair.
4.	Off	At (R6) cavity 30, measure voltage from circuit A85B to ground.	(R6) cav. 30, A85B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A85B/A85, then repair.
5.	Off	Bench test horn relay by measuring resistance from cavity 30 to 87A.	(R6) cav. 30 to 87A.	<1 ohm.	Go to next step.	Replace horn relay.
6.	Off	Bench test horn relay by applying +12 volts to cavity 85, ground to cavity 86, and measuring resistance from cavity 30 to 87.	Energized relay, cav. 30 to 87.	<1 ohm.	Go to next step.	Replace horn relay.
7.	Off	With horn button depressed, at (R6) measure voltage between circuit A85 cavity 86, and circuit A85A cavity 85.	(R6), A85 cav. 86 to A85A cav. 85.	12 ± 1.5 volts.	Go to next step.	Locate cause of open or poor connection in circuit A85A, horn harness conn. (14), pin 1, the blue wire, slip ring, the horn button or the steering column ground, then repair.
8.	Off	At (R6) use a test lead to jumper circuit A85A cavity 30 to A85C cavity 87. Does horn sound?			Install relay. Horn circuits check good.	Leave test lead connected and go to next step.
9.	Off	Disconnect horn harness connector (2), pin C4 and measure voltage from circuit A85C to ground.	(2), pin C4, A85C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit A85C dash conn. (2), pin C4, then repair.

Table 29 Electric Horn(s) (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
10.	Off	At (2), pin C4, measure voltage from circuit N85C to N85–G.	(2), pin C4, N85C to N85–G.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit N85–G/ N11–GG, then repair.
11.	Off	Reconnect (2), pin C4, and disconnect high-note horn connector (9151A). At (9151A)., measure voltage from circuit N85C (At (9151) circuit N85D w/dual horns) to ground.	(9151A). N85C or (9151) N85D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit N85C or N85D, then repair.
12.	Off	At (9151A), measure voltage from circuit N85C (circuit N85D w/dual horns) to circuit N85–G (N85–G w/dual horns).	(9151A), N85C or N85D to N85–G or N85–G	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit N85–G or N85–G w/ dual horns), then repair. Install horn relay and reconnect (9151A).
13.	Off	Reconnect (9151A) and disconnect low-note horn connector (9151). At (9151), measure voltage from circuit N85D to ground.	(9151), N85D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit N85D, then repair.
14.	Off	At (9151), measure voltage from circuit N85D to circuit N85–G.	(9151), N85D to N85–G.	12 ± 1.5 volts.	Replace horn. Go to next step.	Locate open or poor connection in circuit N85D to N85–G, then repair.
15.	Off	Circuits check good. Reconnect (9151), and install horn relay.				

Turn Signal System

Table 30 Turn Signal System

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove fuse F13 and check for open condition.	F13	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.

Table 30 Turn Signal System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
2.	Off	At fuse F13, measure voltage from A14A/A14D to ground.	F13, A14A/A14D to gnd.	12 ± 1.5 volts.	Install fuse. Go to next step.	Locate cause of low or no voltage in circuit A14A/A14D, then repair. Install fuse.
3.	Off	Remove flasher (F35) and at socket, measure voltage from cavity B, circuit A55 to ground.	(F35), cav. B, A55 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A55, then repair.
4.	Off	At socket (F35), install jumper from circuit A55 cavity B to A55A/A60A cavity A. Move turn lever to left and right turn positions. Then push hazard switch. Do lights illuminate at each position?		Turn signal/ hazard lights illuminate in each position.	Replace flasher.	Go to next step.
5.	Off	Disconnect turn signal harness connector (13). At platform connector, measure voltage from cavity C, circuit A55A/A60A to ground.	(13) , cav. C, A55A/A60A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A55A/A60A then repair.
6.	Off	Is vehicle equipped with a tilt steering column?			Go to Step 10.	Go to next step.
7.	Off	Move turn signal lever to left turn position. At turn signal connector (13), measure resistance from cavity C, circuit A55A/A60A to cavity D, circuit A56, and from cavity C, circuit A55A/A60A to cavity E, circuit A56A.	(13), cav. C, A55A/A60A to cav. D, A56 and cav. C A55A/A60A to cav. E, A56A.	< 1 ohm each circuit.	Go to next step.	Locate open in circuits A55A/A60A A56 or A56A, then repair. If none found, replace turn signal.

Table 30 Turn Signal System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
8.	Off	Move turn signal lever to right turn position. At turn signal connector (13), measure resistance from cavity C, circuit A55A/A60A to cavity A, circuit A57A and from cavity C, circuit A55A/A60A to cavity F, circuit A57.	(13), cav. C, A55A/A60A to cav. A, A57A and cav. C, A55A/A60A tocav. F, A57.	< 1 ohm each circuit.	Go to next step.	Locate open in circuit A57 or A57A, then repair. If none found, replace turn signal.
9.	Off	Push hazard switch and at (13), measure resistance from cavity C to all other cavities.	(13), cav. C to all other cavities.	< 1 ohm each circuit.	Go to next step.	Replace turn signal.
10.	Off	Reconnect (13) and disconnect body builder connector (170). With turn signal lever in the left turn position, measure voltage from circuit A56A to ground.	(170), A56A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A56A, then repair.
11.	Off	With turn signal lever in the right turn position, at (170), measure voltage from circuit A57A to ground.	(170), A57A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A57A, then repair.
12.	Off	Reconnect (170) and disconnect body builder connector (169). With turn signal lever in the left turn position, measure voltage from circuit A56C to ground.	(169), A56C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A56C/A56, then repair.
13.	Off	With turn signal lever in the right turn position, at (169), measure voltage from circuit A57C to ground.	(169), A57C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A57C/A57, then repair.
14.	Off	Reconnect connector (169). Does left turn signal indicator illuminate when lever is moved to the left turn position?			Go to Step 18.	Go to next step.

Table 30 Turn Signal System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
15.	Off	Disconnect green dash cluster connector (11). With lever in left turn position, measure voltage from circuit A56B to ground.	(11), A56B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A56B, then repair.
16.	Off	At (11), measure voltage across circuit A56B to circuit A28–G.	(11), A56B to A28–G.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A28–G/ A11–G, then repair.
17.	Off	Circuits to left turn indicator check good. Reconnect (11) and with lever in left turn position, does indicator light illuminate?			Go to next step.	Replace bulb and socket. If light still fails to illuminate, replace instrument cluster.
18.	Off	Does right turn signal indicator illuminate when lever is moved to the right turn position?			Install flasher. End test.	Go to next step.
19.	Off	Disconnect green dash cluster connector (11). With lever in right turn position, measure voltage from circuit A57B to ground.	(11), A57B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A57B, then repair.
20.	Off	At (11), measure voltage across circuit A57B to circuit A28–G.	(11), A57B to A28–G.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A28–G/A11–G, then repair.
21.	Off	Circuits to right turn indicator check good. Reconnect (11) and with lever in right turn position, does indicator light illuminate?			Install flasher. End test.	Replace bulb and socket. If the light still fails to illuminate, replace instrument cluster.

Power Source

Table 31 Power Source

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove fuse F30 and check for open condition.	F30	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	Off	At fuse F30, measure voltage from 14XZ to ground.	F30, 14XZ to gnd.	12 ± 1.5 volts.	Install fuse. Go to next step.	Locate cause of low or no voltage in circuit 14XZ, then repair. Install fuse.
3.	Off	At the power source socket conn. (208), measure voltage from circuit 14XY to ground.	(208), 14XY to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 14XY, then repair.
4.	Off	At the power source socket conn. (208), measure voltage from circuit 14XX to ground.	(208), 14XX to gnd.	12 ± 1.5 volts.	Replace power source socket conn. (208)	Locate cause of low or no voltage in circuit 14XX to platform ground, then repair.

10.4. COMPONENT LOCATIONS

(1) Body Electrical Panel..... Fuse/Relay Panel, Right Side of Cowl
(2) Cab/Horn Harness Connector..... Above and Left of Pedal Support Bracket
(11) Green Instrument Cluster Connector ..... Behind Instrument Cluster
(13) Turn Signal Switch Connector..... Above and Left of Pedal Support Bracket
(14) Front End Connector..... At Cowl Grommet, Front Side of Cowl
(62) Turn Signal Switch (Stationary Column)..... Above and Left of Pedal Support Bracket
(95) Turn Signal Switch (Tilt Column)..... Above and Left of Pedal Support Bracket
(169) Body Builder Connector..... Left Side of Cab Fuse Panel
(170) Body Builder Connector..... Left Side of Cab Fuse Panel
(208)) Power Source Socket Connector..... Above and Left of Pedal Support Bracket
(9150) Engine/Horn Harness Connector..... Left Side of Brake Cylinder and Pump
(9151) Low-Note Horn Connector..... Lower Left Front Side of Cowl
(9151A) High-Note Horn Connector..... Lower Left Front Side of Cowl
(F35) Turn Signal Flasher..... Inside Cab Relay Panel
(R6) Horn Relay..... Inside Power Distribution Panel

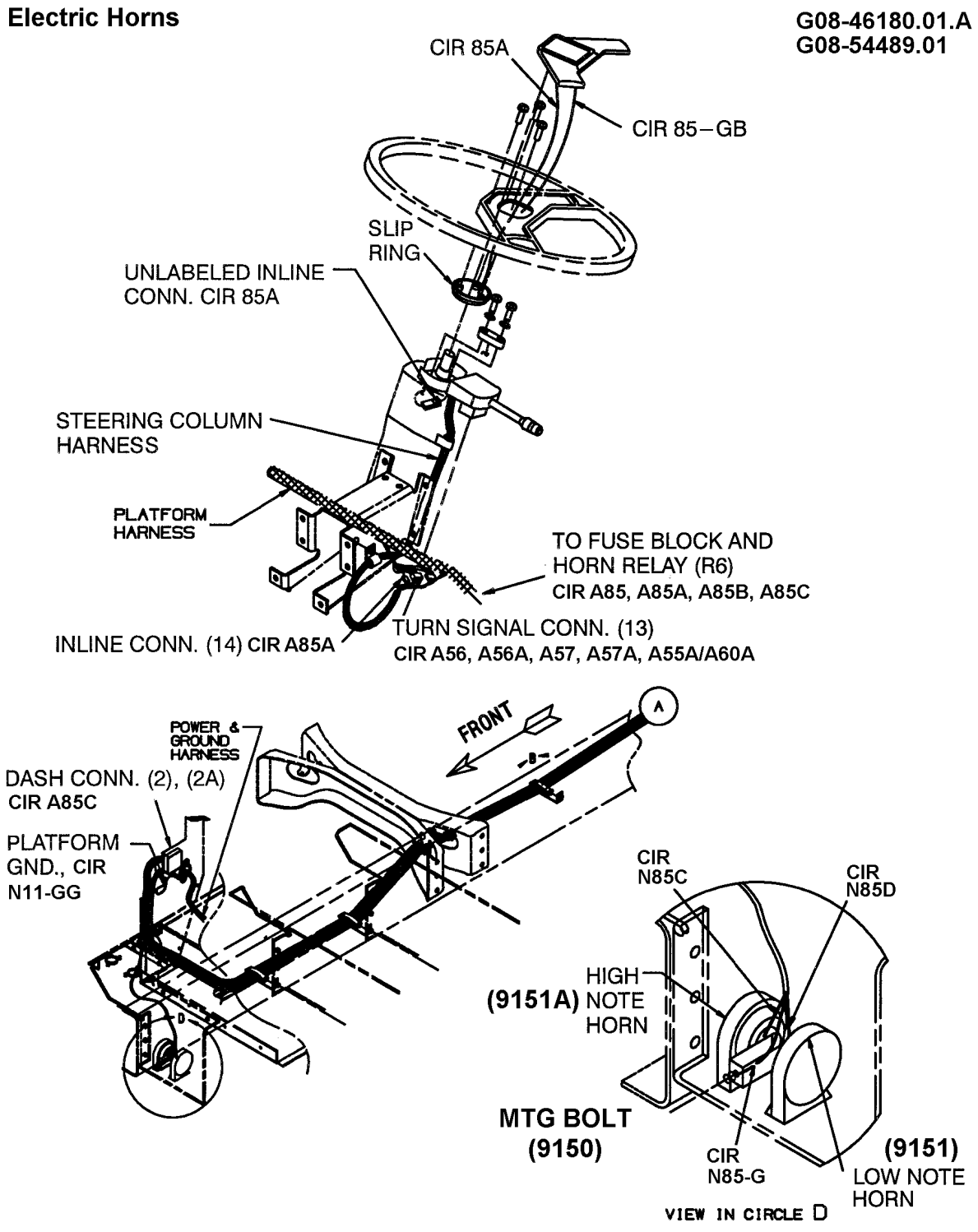

Figure 60 Electric Horns

Turn Signal Circuit

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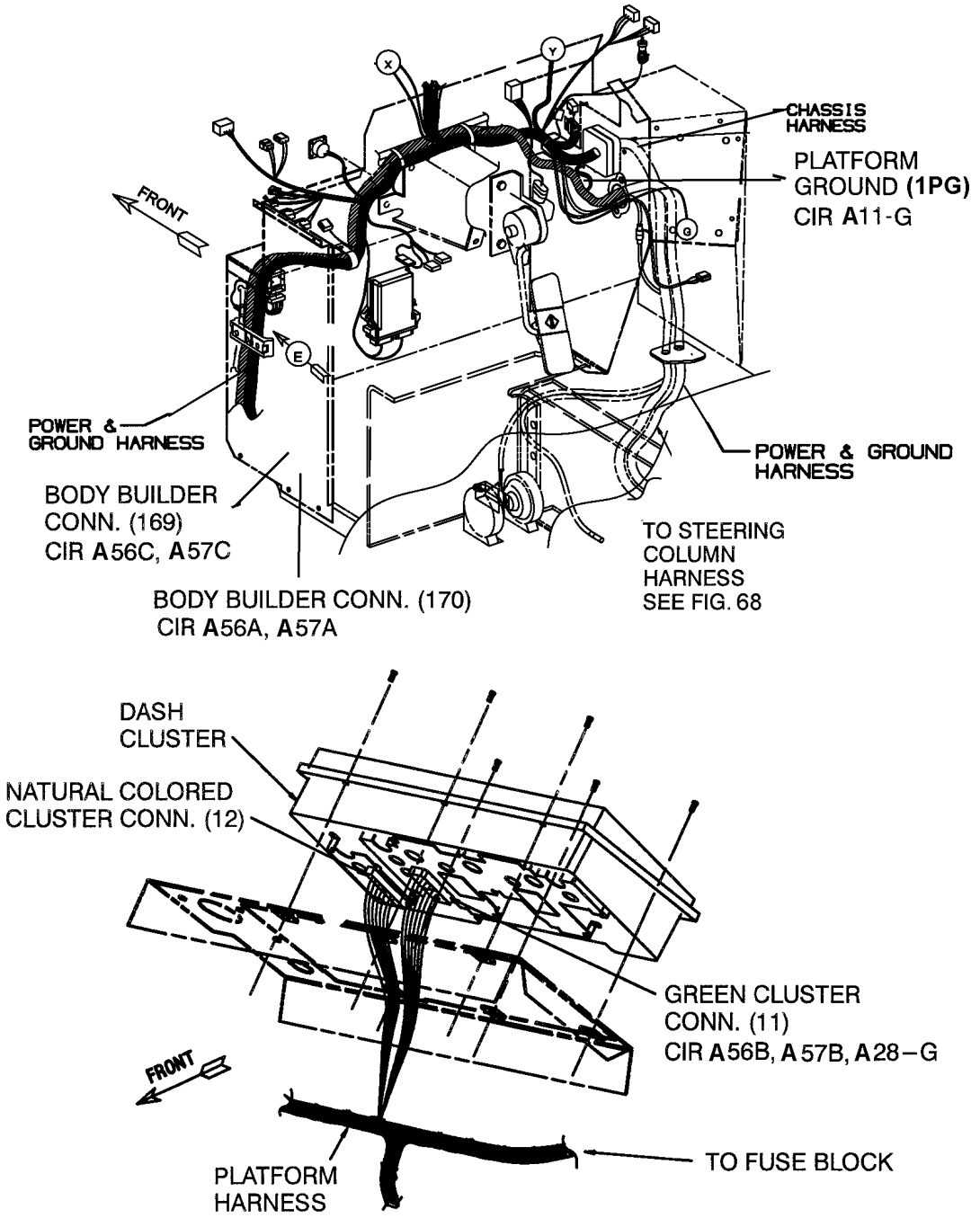

Figure 61 Turn Signal Circuit

Turn Signal Circuit

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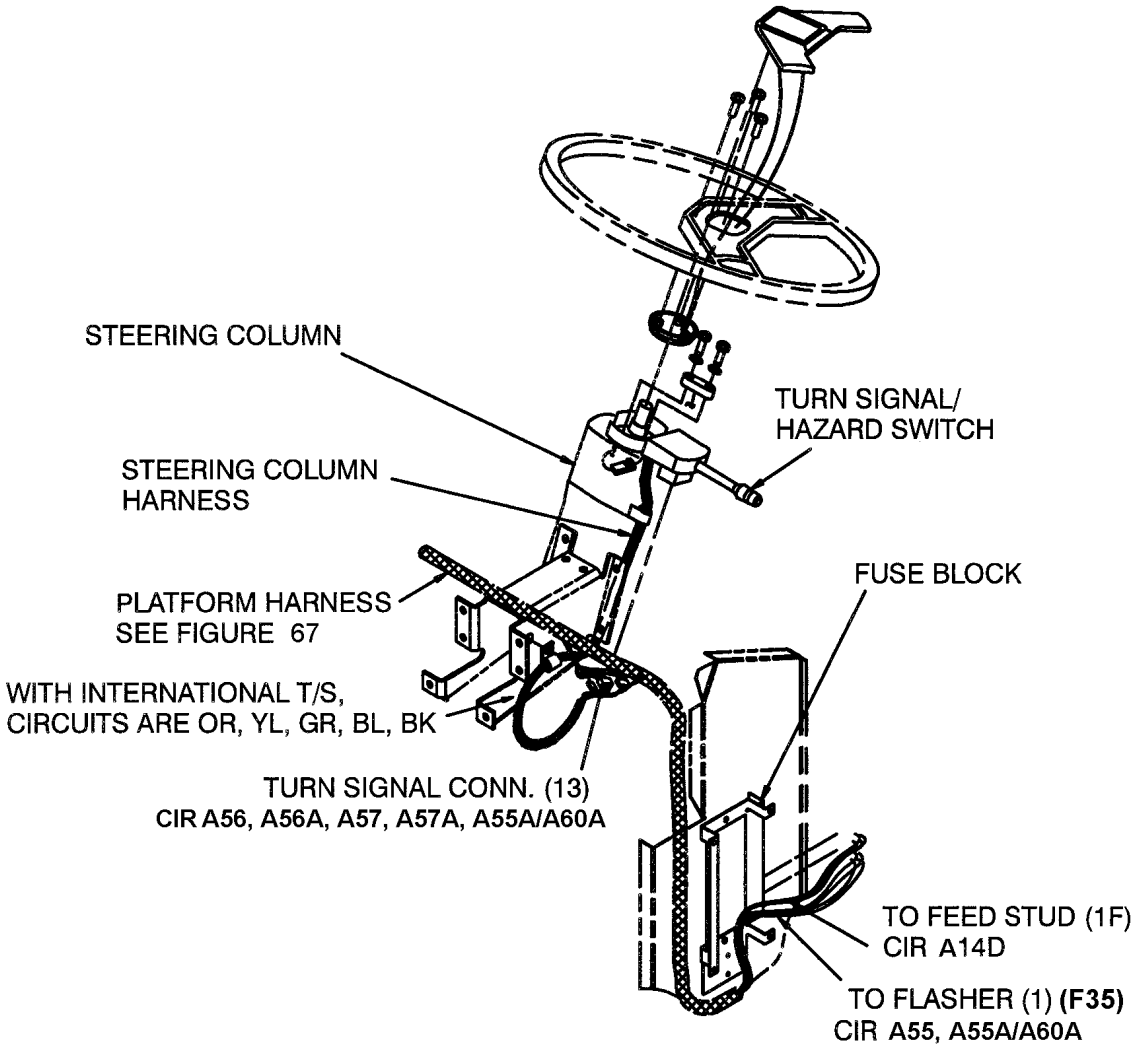


Figure 62 Turn Signal Circuit

11. RE 200/RE 300 BATTERY, CHARGING AND CRANKING SYSTEMS

11.1. DESCRIPTION

Battery Power

There are three main functions of the storage battery:

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

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

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

Cranking Motor System

A Delco MT-37 is the standard cranking motor and 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 consist of the crank motor and solenoid, the key start switch, the start relay, a time delay crank relay, the Electronic Control Module (ECM2), and a neutral position switch.

Cranking Motor System — Cranking Motor Thermal Overcrank Protection

The Delco MT-37 is equipped with a thermal overcrank protection system. Excessive engine cranking will cause an overheat condition and damage the vehicle crank motor. When the crank motor temperature exceeds a pre-set thermal overcrank limit, the thermal switch will open, which causes the crank motor to disengage. When the crank motor cools, the switch closes and allows the motor to operate again.

Charging System

The Leece—Neville, 12 volt, 105–ampere capacity alternator is standard on the RE200/RE300 models. The system produces DC current to operate the vehicle electrical systems and charge the batteries.

11.2. OPERATION

Battery Power

The vehicle batteries are connected in parallel and provide power through the 4/0 positive battery cable to the cranking motor solenoid (B) stud.

The negative battery terminals are also connected in parallel and provide a ground path through the 3/0 negative battery cable to the cranking motor ground stud. The frame, engine block, and cab platform are also interconnected by ground cables to the battery ground.

For additional information on the operating principles for batteries, refer to GROUP 08 - ELECTRICAL, in the Master Service Manual.

Cranking System and Circuits — Front Key Start

With the vehicle in neutral and the instrument panel key switch (20) in the start position, power flows from the battery feed stud (1F) through circuit A14D, circuit A19, fuse F16, circuit A15A, and to the key switch (20). From the key switch, power flows through circuit A17A, the start interrupt connector (195), circuit K17 and dash connector (2). Power is then applied through the chassis harness on circuit N17, the chassis harness to engine harness connector (9850), and circuit K17 to the rear control box connector (6000). From the control box connector (6000), power flows through circuit V17S to the logic side of the crank relay (6309). The relay is grounded through circuit K17S to the control box.

Power is also available at the switch contact end of the time delay crank relay (6309) through the start relay (6310) circuitry. With the engine stop switch (6308) contacts closed, power is supplied to the ignition relay through circuit K14B-FL/K14B, control box connector (6000), circuit V14B/V14A, engine stop switch (6308), and circuit V14D.

With the ignition in the on or start position, power flows through circuit A13/A13A, fuse F19, circuit A13K to the rear control box connector (6000). From connector (6000), power flows through circuit V13K to the blocking diode assembly (6311), and through circuit V13R to the coil of the ignition relay. The relay is grounded through circuit V11-G/11–GH to the (2G) control box ground. This causes the ignition relay to energize.

With the transmission in neutral (neutral position switch contacts closed) and the ignition relay (6309) energized, power flows through circuit V13S to the rear fuse holder (1C), fuse C1, circuit V97P, control box connector (6000) and circuit K97P to the neutral position switch (3120). Power then flows through the switch contacts, circuit K17E, connector (6000) and circuit V17E to the time delay crank relay (6309).

Voltage is provided from the front key switch (circuit A17A) through circuit K17D to the crank relay (6309) coil. If cranking is enabled, a ground path is provided through circuit K17S, control box connector (6000), and circuit K17S to the (ECM2) Engine Control Module (6020).

The energized crank relay controls the start relay (6310) by providing power through circuit K17A. This energizes the start relay which is grounded through circuit K17D, and circuit K17-G/11-GS to the crank motor ground stud (G).

Battery power is always present at the crank motor solenoid (B) terminal through the 4/0 positive battery cable. The 3/0 negative battery cable is attached to the crank motor ground stud which is grounded to the frame rail. Power is also available at the start relay (6310) through the solenoid (B) terminal and circuit K17-FL/K17B. With the starter relay energized, power flows through the closed contacts and circuit K17A to the (S) terminal of the crank motor solenoid which energizes the solenoid.

With the crank motor solenoid energized, the solenoid engages the crank motor’s shaft to rotate. When the engine starts and the key is released, power is removed from circuit K17A which de-energizes the start relay (6310) and disengages the crank motor.

If the engine does not start initially, the engine will crank until the key switch is released, the crank motor thermal overcrank protection system is activated, or the ECM2 supply voltage drops below 6 volts. This causes the ECM2 to remove power from the time delay crank relay which allows the starter to crank for only an additional 2 second time delay period.

Cranking System and Circuits — Rear Key Start

In order to start the engine from the rear, the rear control box is equipped with an additional key switch (6305). Battery power is available from the battery feed stud (1F), through circuit K14B-FL/K14B, control box connector (6000), and circuit V14B/V14 to the key switch (6305). When the key switch is turned to the on or start position, power flows through the key switch and through circuit V17E to the crank relay (6309) and

through circuit V13N to the blocking diode assembly (6311). From there, the system circuitry is the same as described for the front key start.

For additional information on the operating principles for cranking motors, refer to GROUP 08 - ELECTRICAL in the CTS-5000 Master Service Manual.

Cranking System and Circuits — Cranking Motor Thermal Overcrank Protection

With crank motor thermal overcrank protection, the start relay (6310) control coil ground K17D is connected to the normally closed thermal overcrank protection switch (N/L) located in the end of the cranking motor. The overcrank protection switch is grounded through circuits K17-G/11-GS to the crank motor ground stud.

If excessive cranking causes the crank motor temperature to exceed a pre-set temperature limit, the thermal overcrank protection switch contacts open and causes the start relay to de-energize and the crank motor to disengage. When the crank motor cools, the thermal switch contacts reset and the crank motor can be engaged.

Charging System

With the engine running, the function of the alternator is to produce direct current (DC) in order to supply power to the vehicle electrical system, and to charge the batteries.

When the vehicle is running, the alternator supplies power through the alternator (+) terminal, circuit K2, and K2-FL/K2A-FL to the crank motor solenoid (B) stud. From this stud, power is supplied to the body builder feed stud (1F) through circuit N14-FL/N14A-FL/N14.

Any current above the needs of the vehicle electrical system is used to supply the batteries. From the crank motor solenoid (B) stud, the alternator also charges the batteries through the 4/0 battery cable to the battery positive terminal.

The ground path for the alternator is the (-) terminal and circuit K2-G to the crank motor ground stud.

For additional information on the operating principles for alternators, refer to GROUP 08 - ELECTRICAL in the CTS-5000 Master Service Manual.

11.3. TROUBLESHOOTING

Before beginning these test procedures, do the following:

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

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

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

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

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

Batteries and Cables

The standard battery system for the RE 200/RE 300 consists of two 12V maintenance-free batteries.

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

Batteries and Cables — Battery Test Procedure (Figure 63)

Test each battery separately.

1. Disconnect both battery terminals at each battery. Check each battery visually.
2. Examine the hydrometer eye (if no eye go to next step).
   a. Eye shows green — go to step 4.
   b. Eye shows dark — recharge, then go to step 3.
   c. Eye shows yellow — replace battery.
3. Apply a 300A load for 15 seconds. Turn off load and wait one minute.
   a. If 12.4V or more — go to step 4.
   b. If less than 12.4V — recharge, then repeat step 3.
4. Apply a test load equal to 50% of the battery CCA rating at 0°F. After 15 seconds, **with the load still applied,** read 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 32

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.

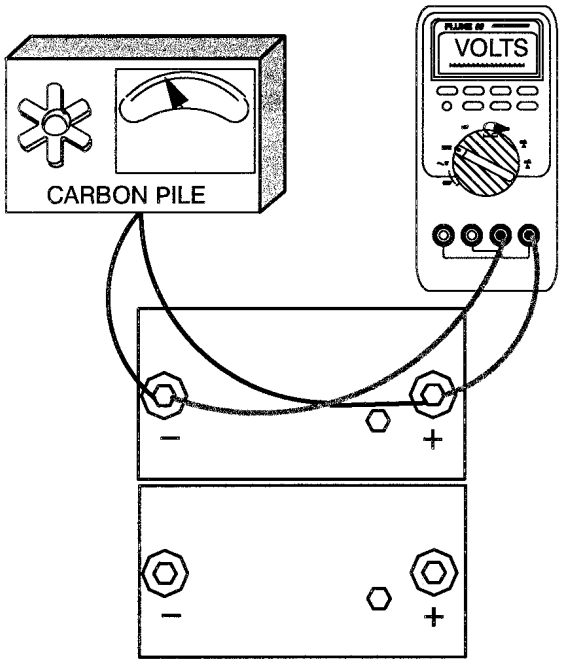


Figure 63 Battery Test Procedure

Batteries and Cables — Battery Cable Voltage Loss Test (Figure 64).

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 do this, 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 starter solenoid BAT terminal and negative lead to starter ground terminal.

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

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

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

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

POSITIVE CABLE Voltage Loss (step 4) _____

plus

NEGATIVE CABLE Voltage Loss (step 6) _____

equals

TOTAL CABLE LOSS_____

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

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

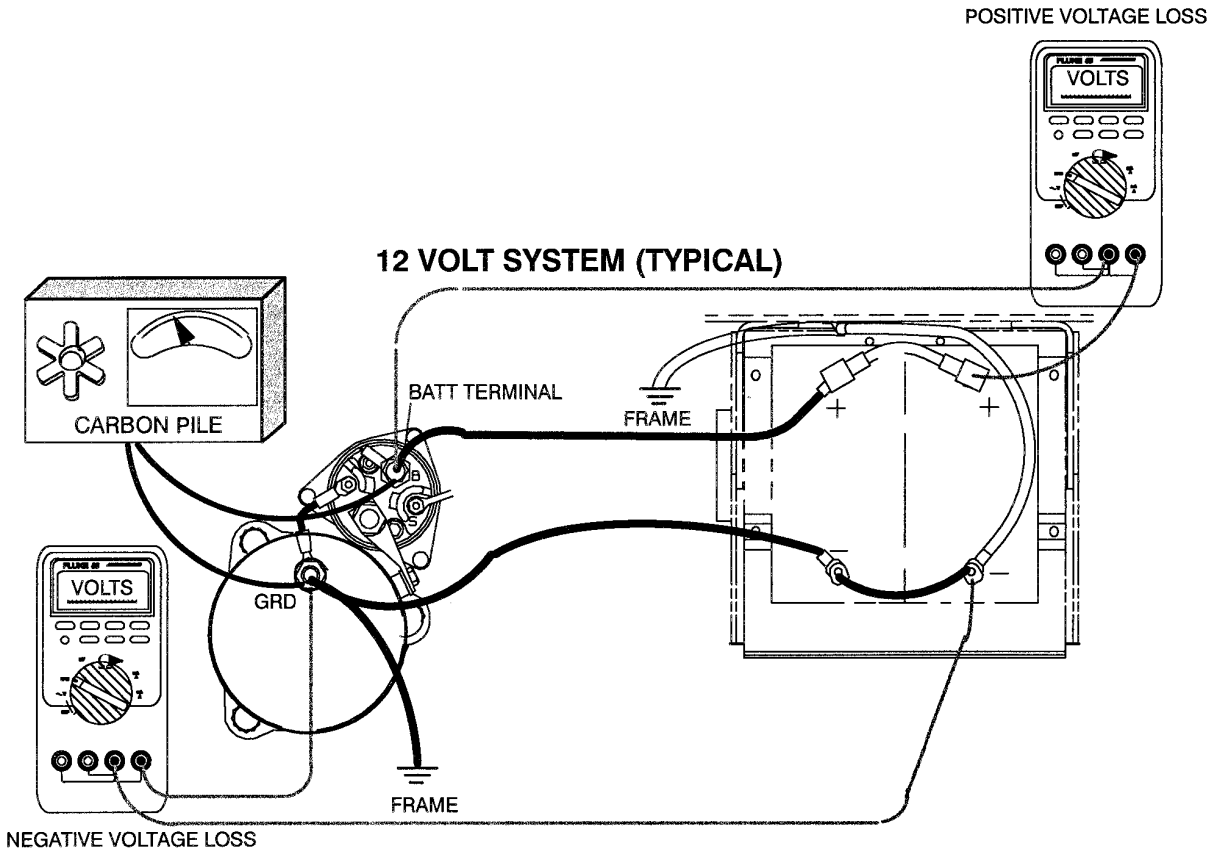


Figure 64 Battery Cable Voltage Loss Test

Starting Motor System Circuits and Components

This section consists of five parts: Starter Solenoid Circuit Test — Part 1, Starter Solenoid Circuit Test — Part 2, Engine Cranking System Circuit Test, Testing Thermal Overcrank Protection System, and Starter Motor Replacement Test.

Starter Solenoid Circuit Test — Part 1 (Figure 65)

Starter shifting in and out, or not pulling in, is often caused by high resistance in the starter solenoid circuit. When the solenoid circuit has excessive voltage loss, the starter pinion sometimes 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 relay switch (located front side of platform) and leads connected to the starter solenoid.

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

1. Disconnect starter relay circuit K17A from the starter solenoid “S” terminal.

2. Connect the carbon pile positive lead to circuit K17A and the negative lead to the starter ground. Connect the positive lead of a DMM voltmeter to the solenoid “B” terminal. Connect negative lead of voltmeter to switch wire lead K17A (not to carbon pile clamp). Meter will show battery voltage.

3. Have an assistant turn the key switch to the start position. Voltmeter reading should be zero. You should hear the starter relay switch energize with a clicking sound. If the switch doesn’t “click,” either the starter relay switch is defective or there is no voltage from the key switch circuit (refer to diagnostic test, Engine Cranking System Circuit Test).

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 the key start switch. Turn off and disconnect carbon pile and voltmeter.

If circuit loss **is 0.5 volt or less**, solenoid circuitry is OK. Go to Engine Cranking System Circuit Test.

If circuit loss **is more than 0.5 volt**, go to Starter Solenoid Circuit Test — Part 2.

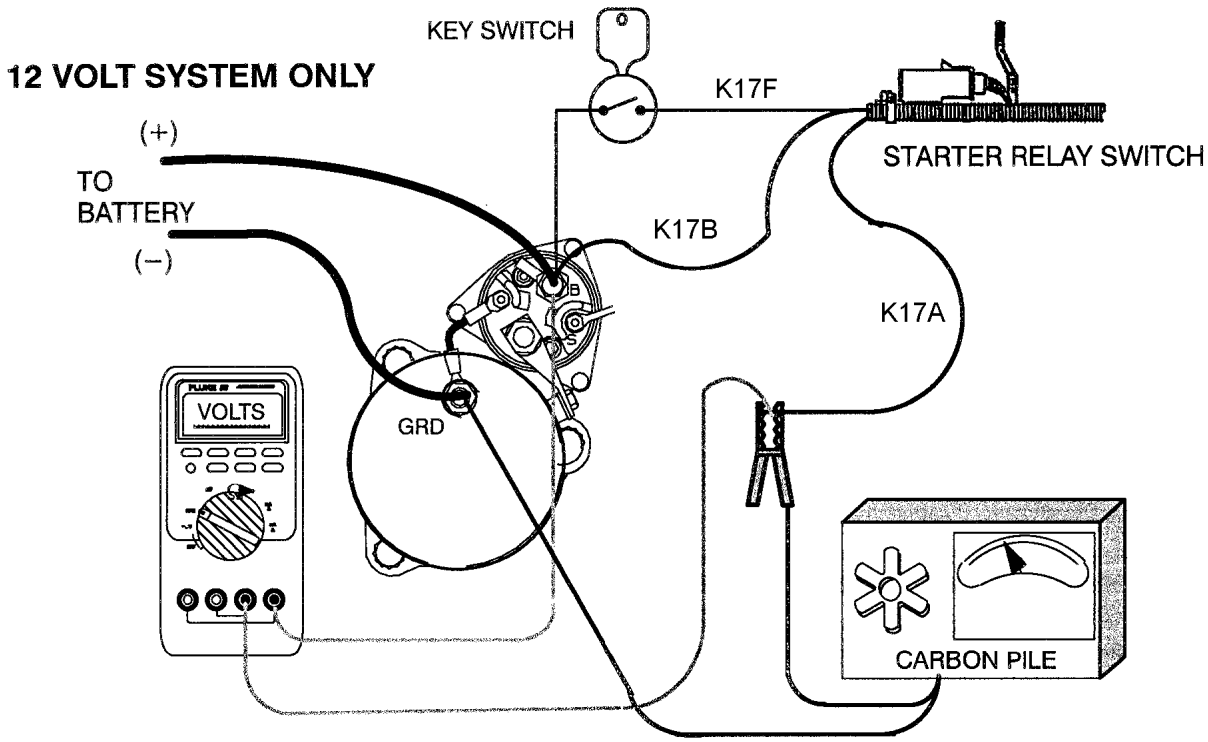


Figure 65 Starter Solenoid Circuit Test — Part 1

Starter Solenoid Circuit Test — Part 2 (Figure 66)

If voltage loss in Starter Solenoid Circuit Test — Part 1 was more than 0.5 volt, the loss is excessive. The loss may be from loose terminals, corrosion, or a worn out starter relay switch. To locate the problem:

1. Disconnect circuit K17A from “S” terminal at starter solenoid. Connect carbon pile to circuit K17A and to starter ground terminal. Turn the carbon pile on (will show 0 amps).

2. Disconnect starter relay and install a jumper lead from cavity 4, circuit K17A to cavity 1, circuit K17B.

   NOTE – Test lead will be at battery voltage.

   Connect DMM from solenoid BAT terminal to start relay connector cavity 1, circuit K17B (will show zero volts).

3. At relay connector, install other end of jumper lead to cavity 4, circuit K17A 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 4, K17A to circuit K17A 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,** replace starter relay and retest per Starter Solenoid Circuit Test — Part 1.

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

If retest results are still above 0.5 volt loss, replace starter relay and retest per Starter Solenoid Circuit Test — Part 1.

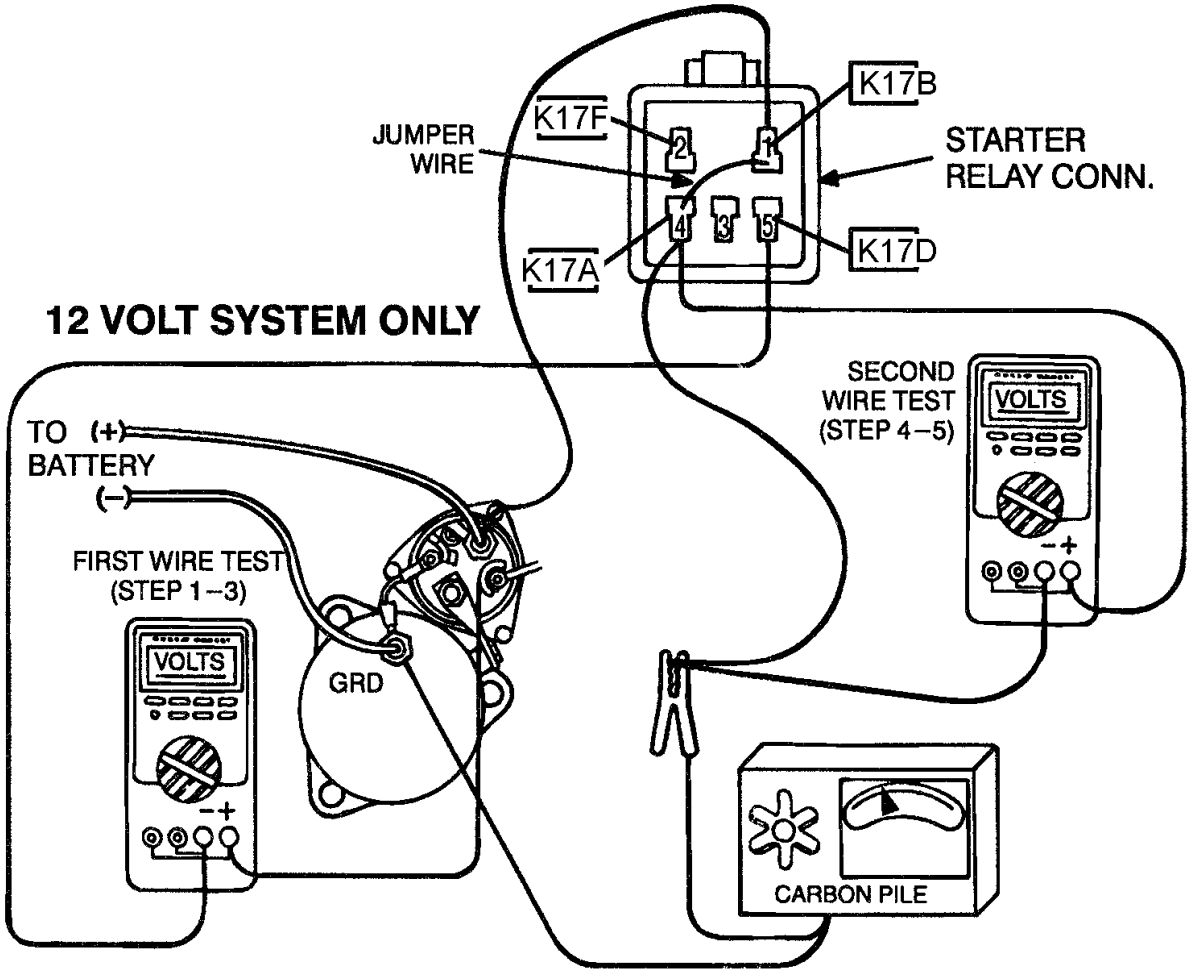


Figure 66 Starter Solenoid Circuit Test — Part 2

Engine Cranking System Circuit Test

NOTE – Perform Starter Solenoid Circuit Test — Part 1 and Part 2 before conducting the following test.

Table 33 Engine Cranking System Circuit Test

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Using suitable jumper wire, jump crank motor solenoid “B” terminal to “S” terminal. Does crank motor operate?	Crank motor “B” to “S” term.		Go to next step.	Go to Starter Motor Replace- ment Test.
2.	On	Remove crank relay (6309). With transmission in neutral, measure voltage from circuit K17E to ground.	(6309), K17E to gnd.	12 ± 1.5 volts.	Install relay (6309). Go to next step.	Go to Step 17 for diagnostics of the ignition relay and neutral position switch circuitry.
3.	Start	Remove start relay (6310). At connector, measure voltage from circuit V17A to ground.	(6310), V17A to gnd.	12 ± 1.5 volts.	Go to next step.	Go to Step 7.
4.	Off	At connector (6310), measure voltage from circuit V17D to ground.	(6310), V17D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit K17–FL/ V17D, then repair.
5.	Off	At connector (6310), measure voltage across circuit V17D to circuit K17A.	(6310), V17D to K17A.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit K17A then repair.
6.	Off	At connector (6310), measure voltage across circuit V17B to circuit K17D.	(6310), V17B to K17D.	12 ± 1.5 volts.	Replace relay.	Locate cause of low or no voltage in circuit K17D or K17–G/ 11–GJ, then repair. Also test Thermal Overcrank Protection Switch.
7.	Start	Reconnect start relay (6310). Disconnect dash connector (2). Measure voltage from circuit A17 to ground.	(2), A17 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in front key switch (20), circuit A17A, start interrupt conn. (195) or circuit A17, then repair.

Table 33 Engine Cranking System Circuit Test (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
8.	Start	Reconnect connector (2) and disconnect engine harness from control box connector (6000). At harness, measure voltage from circuit K17 to ground.	(6000), K17 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A17, chassis/ engine harness conn. (9850), or circuit N17, then repair.
9.	Off	At harness connector (6000), measure voltage from circuit V14B to ground.	(6000), V14B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit K14B/ K14B-FL, then repair.
10.	Off/ Start	Reconnect connector (6000) and disconnect start relay (6310). With **front** key switch in start position, measure voltage from circuit V17/V17E to ground.	(6310), V17/V17E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit V17/V17E , then repair.
11.	Start	With **rear** key switch in start position, measure voltage from circuit V17/V17E to ground.	(6310), V17/ V17E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit V17/V17E, rear key switch (6305), circuit V14/V14B, then repair.
12.	On	At connector (6310), measure voltage from circuit V17A to circuit K17D.	(6310), V17A to K17D.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit V17A control box conn. (6000) or circuit K17D to start relay, then repair.
13.	On	Disconnect ECM2 connector (6020) and measure voltage from circuit K17S to ground.	(6020), K17S to gnd.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit K17S, control box conn. (6000) or circuit V17S then repair.
14.	On	At connector (6020), connect jumper wire from circuit V17S to circuit K17D At start relay (6310), measure voltage from circuit A17A to ground.	(6310), K17D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit V17S control box conn. (6000) or circuit K17D then repair.

Table 33 Engine Cranking System Circuit Test (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
15.	On	Remove jumper and reconnect ECM (6020). At start relay (6310), measure voltage from circuit K17D to ground.	(6310), K17D to gnd.	0.1 to 0.6 volt.	Go to next step.	Refer to Electronic Control System Diagnostics in the Engine Diagnostics Manual.
16.	Start	Reconnect start relay (6310). Does crank motor operate?			Engine starting system circuits check good.	Replace time delay crank relay.
17.	On	At rear fuse holder (1C), check fuse C1 for open condition.	(1C), fuse C1.	< 1 ohm.	Go to next step.	Locate cause of overload condition and repair. Replace fuse.
18.	Off	At rear fuse holder (1B), measure voltage from circuit V13S to ground.	(1C), V13S to gnd.	12 ± 1.5 volts.	Go to Step 33.	Go to next step.
19.	On	Disconnect dash connector (2) and measure voltage from circuit A13K to ground.	(2), A13K to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in front key switch (20), circuit A13/1A3A, fuse F19, or circuit A13K, then repair.
20.	On	Reconnect connector (2) and disconnect engine harness from control box connector (6000). At harness, measure voltage from circuit A13K to ground.	(6000), A13K to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A13K, chassis/ engine harness connector (9850), or circuit A13K, then repair.
21.	Off	At harness connector (6000), measure voltage from circuit N14B to ground.	(6000), N14B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit N14B/ N14B–FL, then repair.
22.	On	Reconnect engine harness to connector (6000). Inside control box, remove blocking diode assembly (6311). With multimeter in diode test mode, test diode.	(6311), diode assy.	0.6 to 0.8 volt.	Go to next step.	Replace diode.

Table 33 Engine Cranking System Circuit Test (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
23.	On or Start	With **front** key switch in the on or start position, and at diode connector (6311), measure voltage from circuit V13K to ground.	(6311), V13K to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit V13K, then repair.
24.	On or Start	With **rear** key switch in the on or start position, and at diode connector (6311), measure voltage from circuit V13N to ground.	(6311), V13N to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit V14/14B, key switch (6305), or circuit V13N, then repair.
25.	On	Install diode assembly (6311) and disconnect ignition relay connector (6309). At connector, measure voltage from circuit V13R to ground.	(6309), V13R to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit V13R, then repair.
26.	On	At connector (6309), measure voltage from circuit V13R to circuit V11–G.	(6309), V13R to V11–G.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit V11–G, then repair.
27.	Off	Disconnect engine stop switch connector (6308). Measure voltage from circuit V14A to ground.	(6308), V14A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit V14A, then repair.
28.	Off	At engine stop switch (6308), measure resistance across terminals.	(6308), across term.	< 1 ohm.	Go to next step.	Replace engine stop switch.
29.	Off	Reconnect (6308) and at ignition relay connector (6309), measure voltage from circuit V14D to ground.	(6309), V14D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit V14D, then repair.
30.	Off	Bench test relay (6309) by applying +12V to pin 85 and ground to pin 86. Measure resistance across pin 30 to 87.	Energized relay (6309), pin 30 to 87.	< 1 ohm.	Install relay (6309). Go to next step.	Replace ignition relay.
31.	On	At rear fuse holder (1C) fuse C1, measure voltage from circuit V13S to ground.	(1C), V13S to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit V13S, then repair.

Table 33 Engine Cranking System Circuit Test (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
32.	On	Disconnect neutral position switch connectors (3120). Measure voltage from circuit K97P to ground.	(3120), K97P to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit K97P, control box conn. (6000), or K17E, then repair.
33.	Off	At neutral position switch (3120) and with transmission in neutral, measure resistance across terminals.	(3120), across term.	< 1 ohm.	Go to next step.	Replace switch.
34.	On	Reconnect neutral position switch connectors and remove crank relay (6309). Measure voltage from circuit V97B to ground.	(6309), V97B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit V97B then repair.
35.	Off	Reconnect crank relay (6309). Engine start system circuitry checks good.				

Testing Thermal Overcrank Protection System

Table 34 Testing Thermal Overcrank Protection System

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove connector (N/L) from thermal switch and measure resistance across switch terminals (starter motor must not be hot).	Thermal sw. across term.	< 1 ohm.	Go to next step.	Replace crank motor.
2.	Start	With key in start position, at connector (N/L) measure voltage to ground at circuit K17D.	(N/L), K17D to gnd.	12 ± 1.5 volts.	Go to next step.	Go to Starter Solenoid Circuit Test — Part 1.
3.	Start	With key in start position, at connector (N/L) measure voltage between circuits K17D and K17–G.	(N/L), K17D to K17–G.	12 ± 1.5 volts.	Go to next step.	Repair open in circuit K17G or 11–GS to cranking motor ground stud.
4.	Off	Thermal overcrank circuits check good.				

Starter Motor Replacement Test (Figure 67)

A. COLD WEATHER STARTER RELAY SWITCH PROBLEMS

If all tests from Battery Test Procedure through Testing Thermal Overcrank Protection System have been performed, the vehicle batteries and starter wiring have been checked.

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

If this condition exists, remove starter relay switch. At the connector, using suitable jumper wire, attach one lead to circuit K17B and the other to circuit K17C. **NOTE: Circuit K17B is at battery voltage and the engine should crank when the other end of the jumper is connected to circuit K17C. Remove jumper to stop cranking.** If engine cranks properly with jumper in place, replace starter relay switch and make sure starter mounting bolts are tight.

B. CHECKING AVAILABLE VOLTAGE AT STARTER

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

1. While cranking engine, measure voltage between the starter “BAT” terminal and starter ground.
   a. If voltage is 9.0 volts or more, the problem must be in the starter (or engine). Replace the starter.
   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 starter (or engine). Replace the starter.

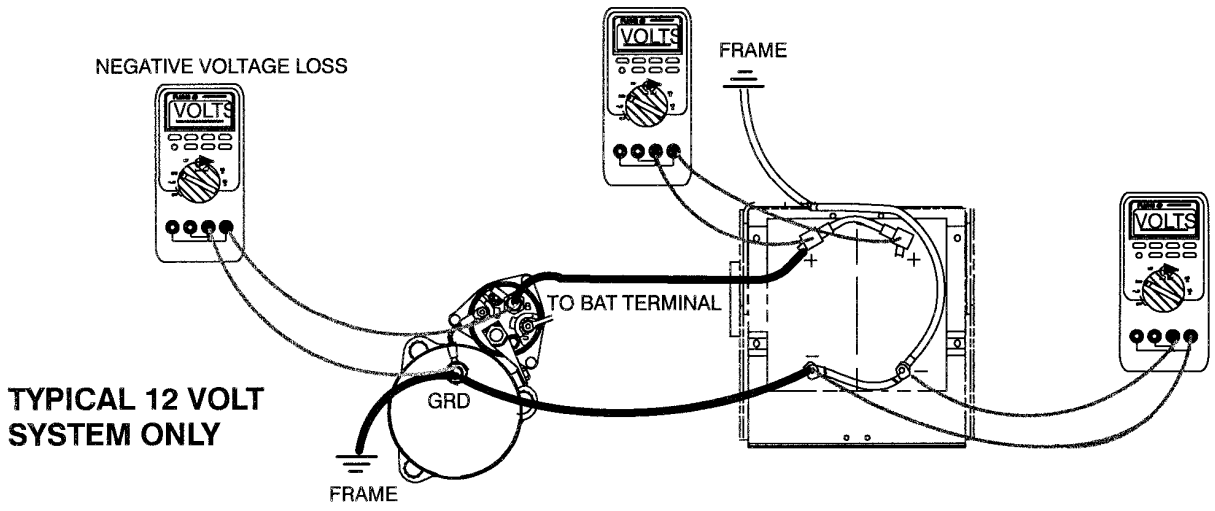


Figure 67 Starter Motor Replacement Test

Vehicle Charging System

This section consists of four parts: Batteries Undercharged, Alternator Tests, Alternator Wiring Test, and Alternator Replacement Test.

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 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 defective batteries as described in GROUP 08 — ELECTRICAL, Battery Section in the Master Service Manual.

4. Wiring defects. 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 (+) terminal of the alternator. A zero reading indicates an open in circuits k2, k2–FL, or k2A-FL between the alternator and batteries.

6. A defective component or wiring defect 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 k2 from the alternator B terminal.

   b. To check entire system for current drains, insert DMM leads in the COM and 10A fused jack on the meter. Set the meter to DC Amps. Connect meter in series with the alternator. If 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 CTS-5216V. 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.

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.

Alternator Wiring Test (Figure 68)

Instead of using alternator current output this test 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. Connect the carbon pile to the alternator output terminal and to ground. Connect Fluke 88 DMM from alternator (+) terminal to positive battery terminal.

2. Turn on and adjust carbon pile to alternator rated output (amps). Read and record positive circuit voltage loss. Turn carbon pile off.

3. Connect the DMM from the alternator ground to the battery negative terminal.

4. Turn on and adjust carbon pile to alternator rated output (amps). Read and record negative circuit voltage loss. Turn carbon pile off.

Positive Circuit Loss (step 2) _____

plus

Negative Circuit Loss (step 4) _____

equals

TOTAL SYSTEM LOSS _____

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

If system loss **is greater than 0.7V**, repair circuit(s) with excessive voltage loss and retest. Then go to Alternator Replacement Test.

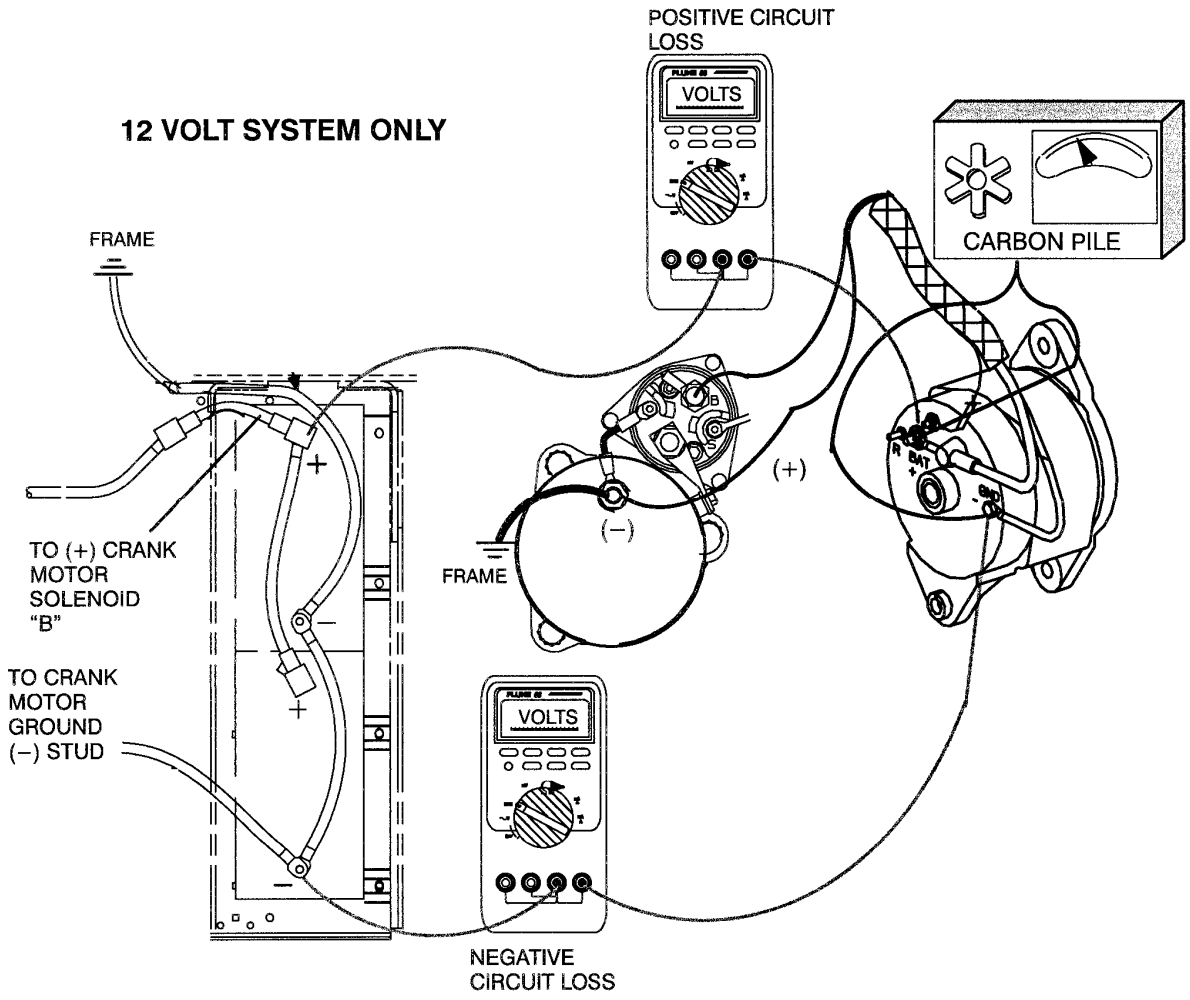


Figure 68 Alternator Wiring Test

Alternator Replacement Test (Figure 69)

If the wiring tests have been performed (circuits OK), adjust alternator belt and tighten mounting bolts and ground connections. Batteries must be near full charge with more than 12.4 volts no load voltage.

Voltage Output Test

— Refer to Figure 69

1. With vehicle at shop temperature, connect voltmeter between alternator BAT (+) and GND (-) terminals.
2. With NO electrical loads turned on, start the engine. Fast idle until voltage stabilizes (does not increase) for 2 minutes.
3. Check and record alternator output voltage _____ V (should not exceed 15.5 volts).
4. If voltage reading is above 15.5V, replace the alternator.

Amperage Output Test

— Refer to Figure 69

1. With vehicle at shop temperature, connect carbon pile and clamp-on ammeter as shown. Clamp around all wires connected to alternator B+ output terminal. (To use an ammeter without an induction clamp, disconnect circuits from alternator B+ terminal. Connect meter shunt between alternator B+ terminal and all circuits previously removed.) **CAUTION - Do not connect an ammeter without a high current shunt.**
2. With NO electrical loads turned on, start the engine, and speed up and retain a high RPM.
3. Turn on and adjust carbon pile until ammeter reads its highest value and record _____A.
4. Turn off carbon pile and engine.
5. If reading is zero (no output), the rotor should be magnetized with the alternator hooked up normally. To do this, **momentarily** connect a jumper lead from the alternator BAT (+) terminal to the indicator “I" terminal. This will restore normal residual magnetism.
6. Repeat steps 2, 3, and 4. If output is still zero, replace alternator.

Replacement

Replace alternator if either of the following exists:

A. Output voltage exceeded 15.5V.

B. Output current is not within 10% of the alternator rated output stamped on the alternator.

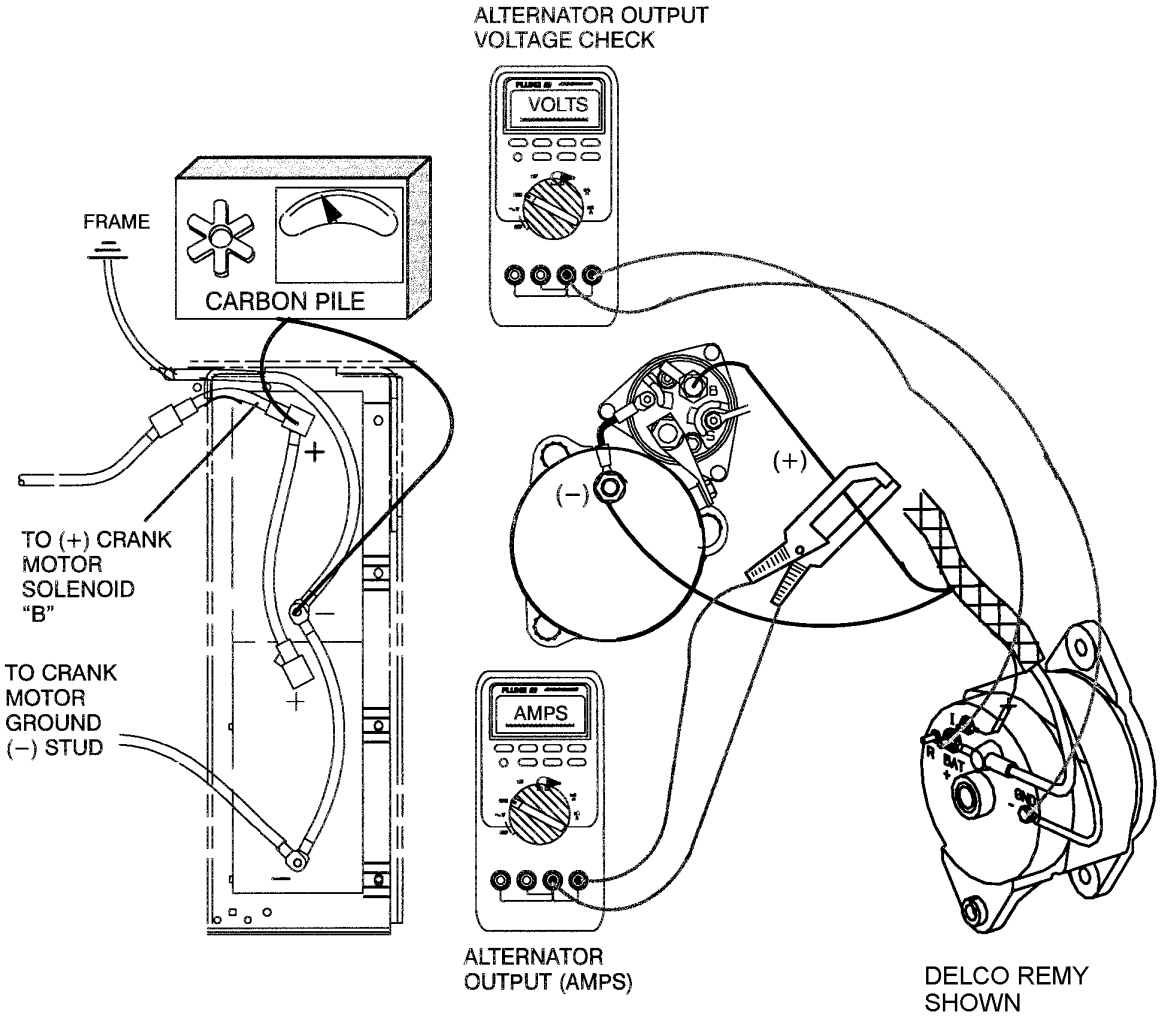


Figure 69 Alternator Replacement Test

11.4. COMPONENT LOCATIONS

(1B) Fuse Holder	In Rear Engine Control Box
(1F) Body Builder Feed Stud	Lower Left Platform Kick Panel
(2) Dash Connector	Right Side of Platform, Inside
(2F) Chassis Connector	Right Side of Platform, Outside
(2G) Control Box Ground	Inside Control Box
(6000) Control Box Engine Connector	Rear Control Box at Outside Right Rear Frame Rail
(20) Front Key Switch	Right Side of Instrument Cluster
(6305) Rear Key Switch	On Control Box
(6311) Diode Assembly	In Control Box
(6308) Engine Stop Switch	Inside Control Box
(195) Start Interrupt Connector	Lower, Left Kick Panel
(9850) Chassis to Engine Connector	Upper Right Side at Transmission Bell Housing
(6020) Engine Control Module (ECM2)	On ECM
(6021) Engine Control Module (ECM2)	On ECM
(385) Crank Relay	Inside Control Box
(6310) Start Relay	Part of Engine Harness, Above Control Box
(6309) Ignition Relay	Inside Control Box

Charging and Cranking System Wiring

G08-51061.04
G08-51061.07.B

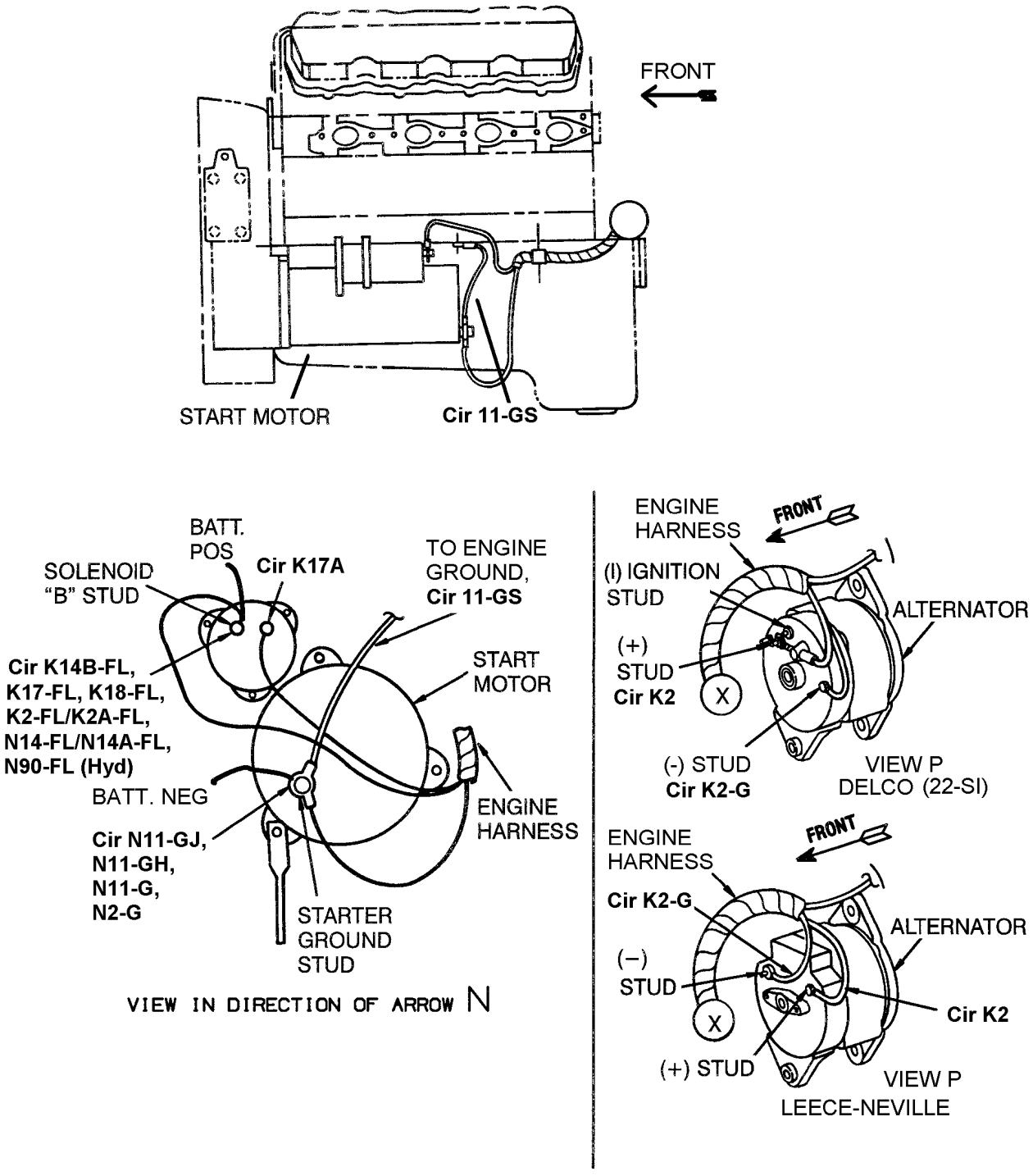


Figure 70 Charging and Cranking System Wiring

Power Distribution (Key Switch) **G08-46179.02.D**

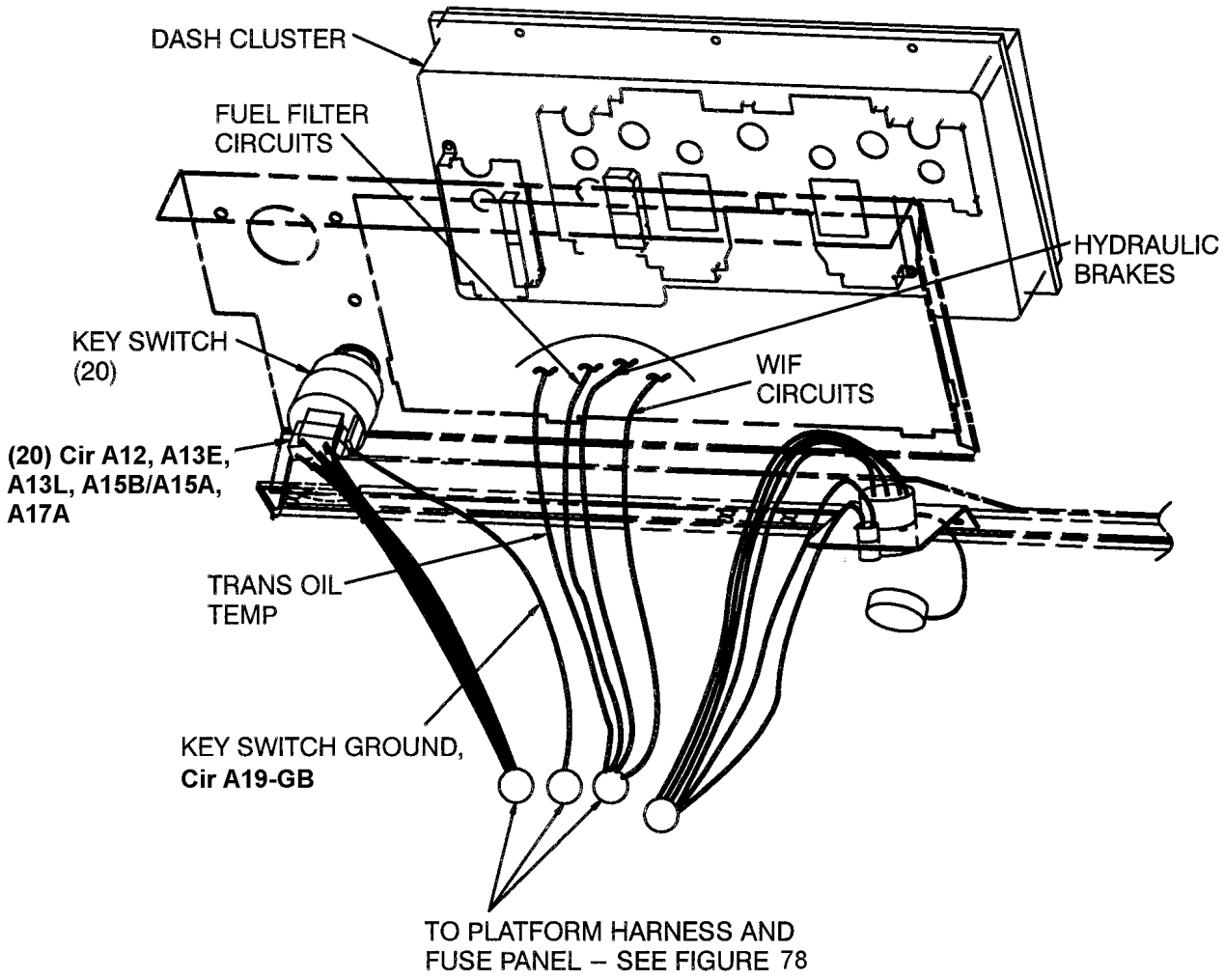


Figure 71 Charging and Cranking System Wiring

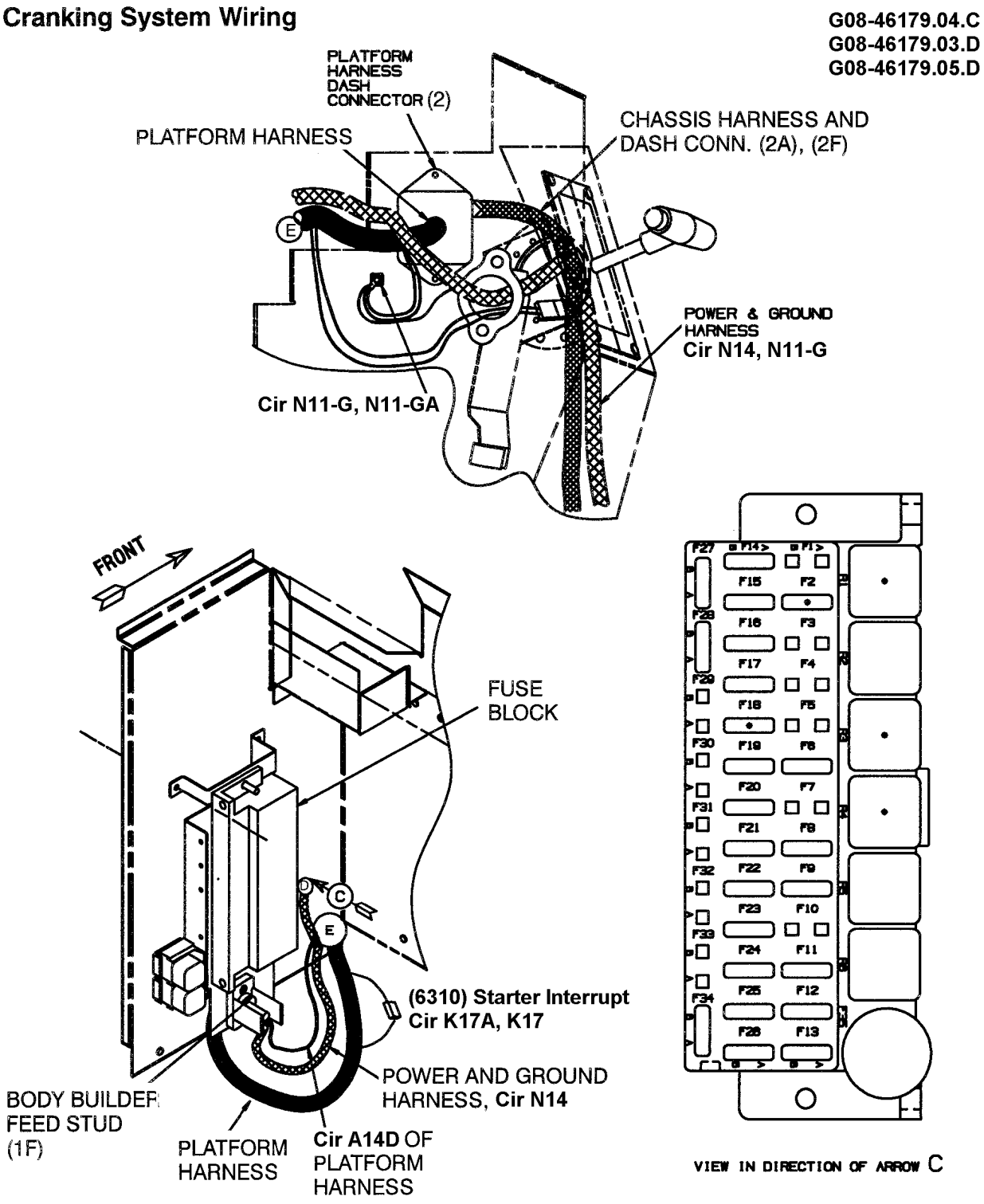
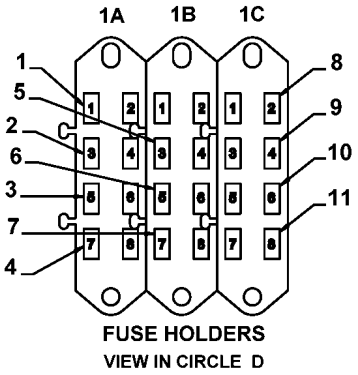


Figure 72 Cranking System Wiring

Cranking System Wiring In The Rear Control Box

3594297C93.01.B

1. 10 AMP FUSE, RED, TO ECM2 (6020), Cir V97UA.
2. 5 AMP FUSE, TAN, TO FAN SOLENOID RELAY (6405), Cir V23Z.
3. 15 AMP FUSE, LIGHT BLUE, TO DRAIN VALVE (42), Cir V39A.
4. 10 AMP FUSE, RED, TO REAR CONN (6010), Cir V97C.
5. 15 AMP FUSE, LIGHT BLUE, TO AIR DRYER (74) OR AMMETER SENSOR (226), Cir V39.
6. 10 AMP FUSE, RED, TO IDM2 (6011), Cir V97LC.
7. 20 AMP FUSE, YELLOW, TO ECM2 POWER RELAY (6005), Cir V97HA.
8. 10 AMP FUSE, RED, TO RETARDER WARNNG LIGHT RELAY (7807), Cir V146A/V146D.
   TO NEUTRAL SAFETY & CLUTCH RELAYS (3121) & (3122), Cir V97B.
   TO CONTROL BOX XMSN CONN (7101), Cir V13T.
   TO BACKUP RELAY (7505), Cir V146E.
9. 10 AMP FUSE, RED, TO XMSN CONN (7100), Cir V14H OR Cir V136Y.
10. 10 AMP FUSE, RED, TO RETARDER SERVICE BRAKE RELAY (7806), Cir V70.
11. 5 AMP FUSE, TAN, TO XMSN NSBU SWITCH (640), Cir V97P.



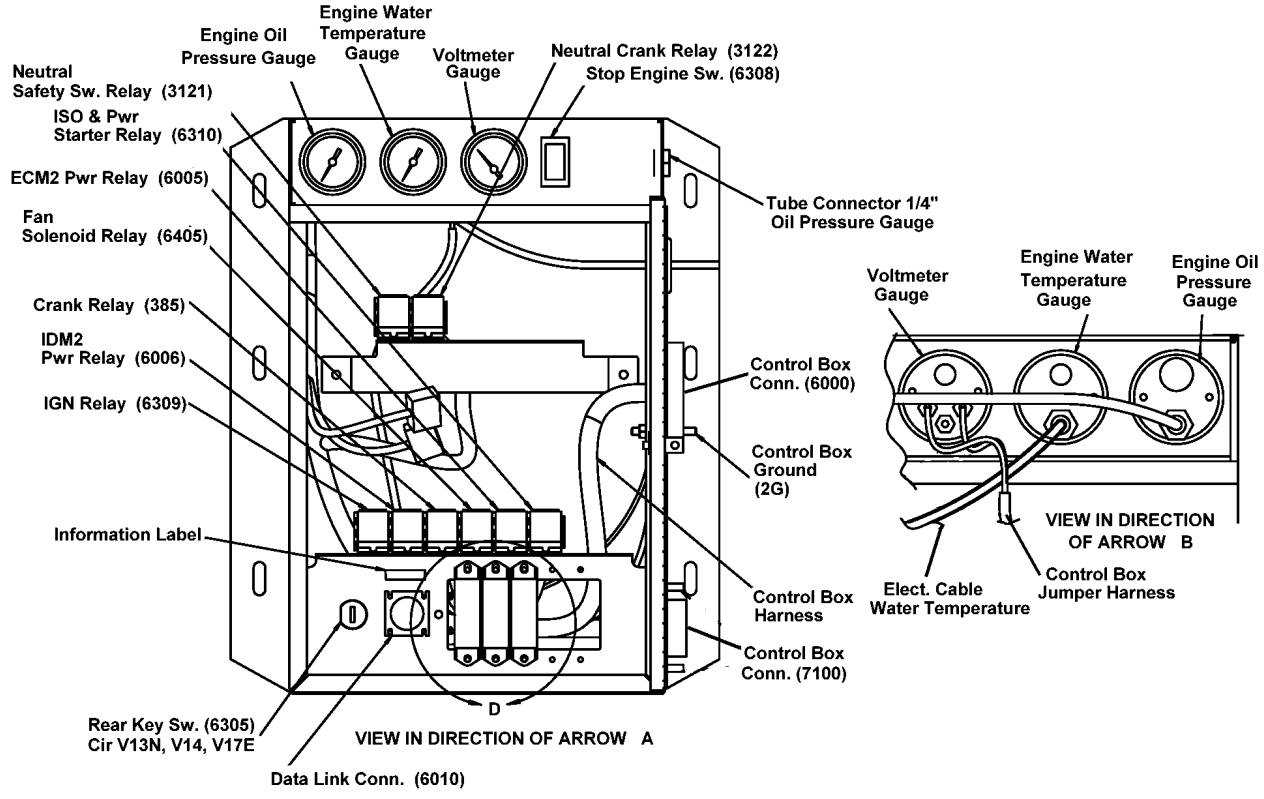


Figure 73 Cranking System Wiring (Control Box)

Cranking System Wiring In The Rear Control Box

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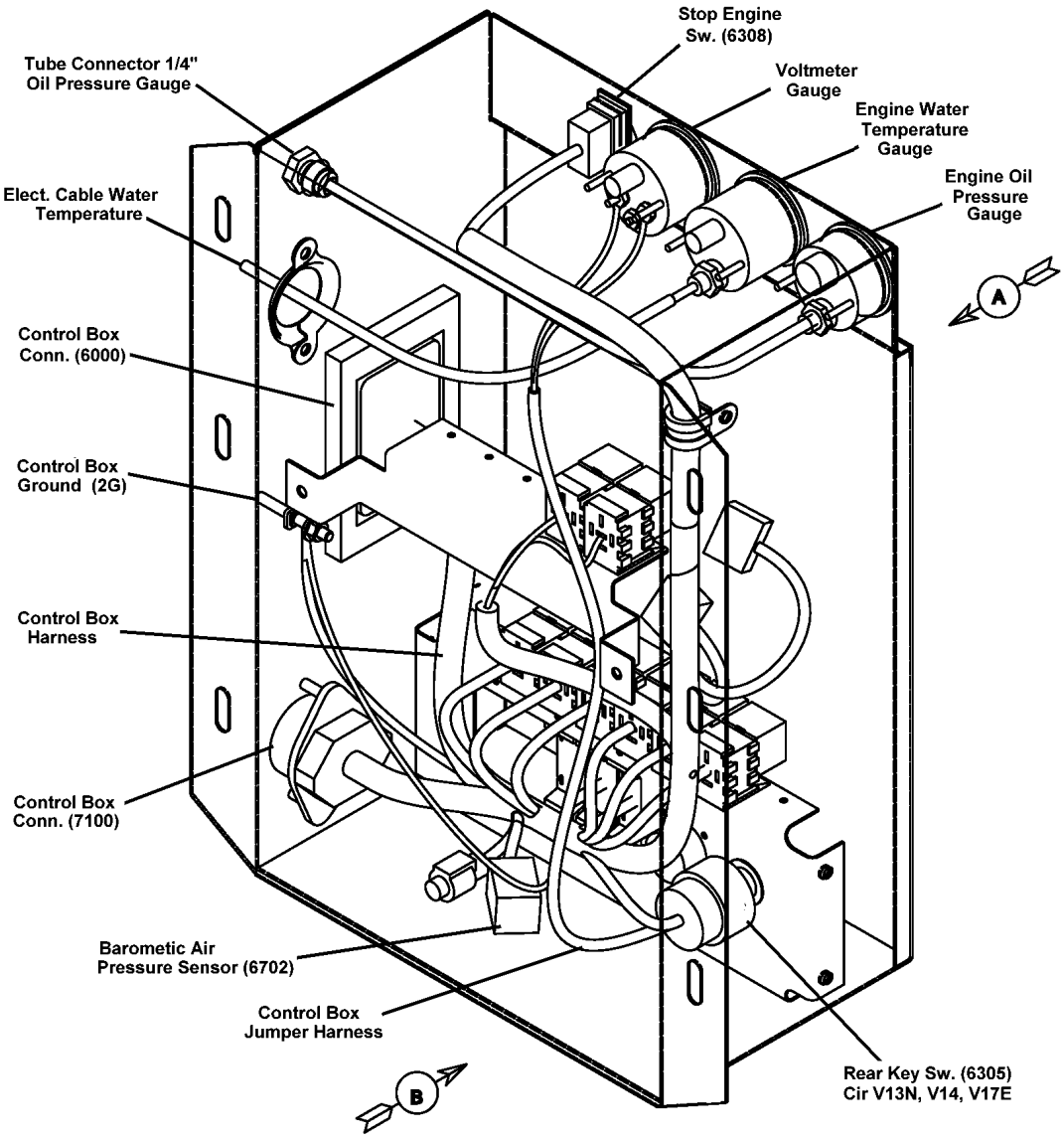

Figure 74 Cranking System Wiring (Control Box)

12. RE 200/RE 300 ENGINE SYSTEMS

Refer to EGES-175, the DT 466E/I 530E Engine/Vehicle Diagnostic Manual for ECM unit electronic engine control system circuit function and diagnostics.

Refer to EGES-240, the VT 365 Engine/Vehicle Diagnostic Manual for ECM unit electronic engine control system circuit function and diagnostics.

13. RE 200/RE 300 GAUGES AND WARNING LIGHTS

13.1. DESCRIPTION

ATA Data-Link Driven Cluster

With the Diamond Logic NAVPAK™ ECM2 the following gauges are driven by the ECM2:

- Speedometer
- Engine Oil Pressure
- Coolant Temperature
- Tachometer
- Voltmeter

Refer to Engine Diagnostic Manual EGES-175 (DT 466E/530E) or EGES-240 (VT 365) for a description of the ATA datalink system.

Engine Oil Pressure Gauge

The engine oil pressure gauge indicates low engine oil pressure conditions. The system consists of the instrument panel gauge, a variable capacitance oil pressure sensor and the ECM2. Refer to the appropriate Engine Diagnostic Manual for a description of the engine oil pressure gauge system.

Fuel Level Gauge

The fuel level gauge system includes an electromagnetic air core design gauge, a float/resistive potentiometer type sender and the wiring circuitry. If the gauge or sender units are suspect, refer to S08314 INSTRUMENTS in the Master Service Manual for test procedures on these components.

Voltmeter Gauge

The voltmeter gauge does not have a sender to indicate voltage at the gauge. The ECM2 reads directly from the charging system. Any change in the charging system voltage shows a change on the gauge.

Tachometer Gauge and Speedometer Gauge

Refer to the appropriate Engine Diagnostic Manual for a description of the Tachometer and Speedometer system.

Engine Coolant Temperature

The engine coolant temperature gauge system consists of the instrument panel gauge, a thermistor-type sensor and the ECM2. Refer to the appropriate Engine Diagnostic Manual for a description of the engine coolant temperature gauge system.

Low Oil Pressure/High Water Temperature/Low Coolant Level Lights and Alarm

Refer to the appropriate Engine Diagnostic Manual for a description of the warning light and alarm system.

Brake Pressure Warning Light and Alarm

The brake warning light and alarm system is designed to alert a driver of a potential problem within the vehicle braking system. With an air brake system, the brake pressure warning light and alarm will activate when air in the brake system is less than 60 PSI.

With a hydraulic brake system, the brake pressure warning light and alarm will activate when a brake fluid pressure differential is detected in the system. The hydraulic brake system also includes a low brake fluid level warning light which does not include an alarm.

Hydraulic Brake Low Fluid and Parking Brake Warning Lights

The hydraulic brake low fluid warning system consists of a warning light and a fluid level sensor.

The parking brake warning system consists of the warning light and a parking brake switch.

When the key switch is placed in the start position, the warning lights are momentarily grounded which causes the lights to come on and indicates that the bulbs are functioning.

Diagnostic/Programming Connector and Self-Test Switch and Warning Light System

Refer to the appropriate Engine Diagnostic Manual for a description of the Diagnostic/Programming Connector and Self-Test Switch and Warning Light System.

Wait-To-Start Warning Light

Refer to the appropriate Engine Diagnostic Manual for a description of the warning light system.

Transmission Oil Temperature Warning Light

The transmission warning light notifies a driver of an overheated transmission fluid condition. Should the fluid reach a temperature of 305°F (151.7°C) or more, the warning light will come on.

Change Transmission Filter Warning Light

The transmission oil filter warning light indicates a need for servicing the oil filter. The system consists of the warning light and a transmission filter pressure differential switch.

13.2. OPERATION

Engine Oil Pressure Gauge

When the engine is running, the ECM2 supplies a 5 volt signal to the engine oil pressure sensor through circuit K97CY. The sensor then provides a variable voltage signal to the ECM2.

Fuel Level Gauge

The battery voltage is through the ignition switch relay (1711), circuit A13/A13F, fuse F22, circuit A28/A28B, the green instrument cluster (11), pin 10 to the fuel gauge. The level of fuel in the vehicle fuel tank is sensed by the fuel sending unit (37). The sending unit feeds an electrical voltage through circuit 36, pin A of connector (37), circuit N36, pin C6 of connector (2) and circuit A36, pin 3 of connector (11) to the fuel gauge, which displays the fuel level. The fuel sender (37) pin B is grounded through circuits N36–G/N11–GA/W11–GG to the (9000A) platform ground. The fuel gauge is grounded through pin 2 of connector (11) circuits A28–G/A11–GA to the (IPG) platform ground.

Voltmeter Gauge

The voltmeter gauge is powered whenever the key switch is on, through the ECM2 and the ATA data-link circuits.

Tachometer Gauge and Speedometer Gauge

Refer to the appropriate Engine Diagnostic Manual for operation of the Tachometer and Speedometer system.

Engine Coolant Temperature Gauge

The engine water temperature gauge is driven by the ECM2 through the ATA data-link circuits.

Low Oil Pressure/High Water Temperature/Low Coolant Level Lights and Alarm

Refer to the appropriate Engine Diagnostic Manual for operation of the warning light and alarm system.

Brake Pressure Warning Light and Alarm — With Air Brake System

The brake press warning light, the battery voltage is through the ignition switch relay (1711), circuits A13/A13F, fuse F22, circuits A28 and A28D, and natural instrument cluster connector (12), pin 4. When the air pressure drops below 60 psi, the pressure switch will close, and power will flow through the warning light, natural instrument cluster connector (12), pin 9, circuits A40A and A40, connector (2), pin A4, circuit N40, connector (9850), pin 9, circuit K40 and the low air pressure switch (6740) to ground (1LA). This will cause the brake press warning light to illuminate, and the warning alarm (211) to sound at a fast rate. The warning alarm receives power from fuse F24 over circuit A13B.

Brake Pressure Warning Light and Alarm — With Hydraulic Brake System

Refer to Hydraulic Brake System in the Chassis Accessories Section of this manual.

Hydraulic Brake Low Fluid and Parking Brake Warning Lights

When the key switch (20) is turned to the on position, power is supplied to the low brake fluid warning system through circuit A28, to a splice, circuit A90R, the low level fluid warning light (89), circuit A90V, to a splice, platform/ chassis connector (2) and (90A), and circuit N90P to the normally open sensor switch (90). When a low brake fluid level is encountered, the sensor switch closes and the circuit ground is through the switch and circuit N11-GF/N11-GB to the platform ground.

When the key switch is turned to the start position, a momentary ground is applied through the key switch, circuit A31-GD, circuit A44-G, brake diode assembly (82), circuit A90W to the previously mentioned splice, and circuit A90V to the fluid level warning bulb. This causes the warning light to come on as a bulb check and goes off when the key is released from the start position.

Power is fed by the battery voltage is through the ignition switch relay (1711), circuits A13/A13F, fuse F22 to circuits A28 and A28C and the “((P)) PARK BRAKE” warning light and connector (12)/pin 8. When the parking brake is applied, power will flow through the warning light and connector (12)/pin 17, circuits A44 and A44A, the park brake switch (218), and circuits A44-GA, A11-GB, and A11-G to platform ground. This will cause the park brake warning light to illuminate, indicating that the parking brake is applied. The lamp will also illuminate when the key switch (20) is moved to the start position, and a ground is applied through circuit A44, a brake diode (82), and circuit A44-G, performing a bulb check.

When the key is turned to the start position, a ground is applied to the circuitry through the ignition switch, circuit A31-GD, circuit A44-G, brake diode assembly (82) and circuit A44 to the park brake bulb. This causes the warning light to come on as a bulb check and goes off when the key is released from the start position.

Diagnostic/Programming Connector and Self-Test Switch and Warning Light System

Refer to the appropriate Engine Diagnostic Manual for operation of the Diagnostic/Programming Connector and Self-Test Switch and Warning Light System.

Wait-to-Start Warning Light

Refer to the appropriate Engine Diagnostic Manual for a description of the warning light system.

Transmission Oil Temperature Warning Light

The battery voltage is through the ignition switch relay (1711), circuit A13/A13F, fuse F22, circuit A28/A28B, the green instrument cluster connector (11), pin 10 to the transmission oil temperature gauge. The transmission temperature is sensed by the transmission temperature sending unit (6741). The sending unit feeds an electrical voltage through pin A of connector (6741), circuit K31A, pin 6 of connector (9850), circuit N31A, pin F4 of connector (2) and circuit A31A, pin 2 of the natural instrument cluster connector (12) to the transmission oil temperature gauge, which displays the transmission oil temperature. The transmission temperature sending unit (6741) pin B is grounded through circuits N31–G/11–GJ to the (7104) control box ground. The transmission oil temperature gauge is grounded through pin 2 of connector (11) circuits A28–G/A11–G to the (IPG) platform ground.

When the transmission oil temperature reaches 305°F (151.7°C) or more, the switch contacts close and completes the ground path. This causes the warning light to come on.

Change Transmission Filter Warning Light

For vehicles equipped with the automatic transmission filter warning light, power is supplied to fuse F10, circuit A31D, and the filter warning light (94). When the key switch (20) is held in the start position, power will flow through the filter warning light (94), circuit A31-GA, connector (344), a blue wire, and the pigtail of the filter pressure differential switch. This power will flow through the normally closed contacts of the pressure switch and its connector, a green wire, connector (344), circuit A31-GB, blocking diode (64), circuits A31-GC and A31-GD, and the key switch ground, thus causing the warning light to illuminate for a bulb check. When the transmission filter becomes restricted, the pressure differential switch's normally open contacts will close and power will flow through the warning light to the switch as above, but the power will flow through the normally open contacts of the switch and its connector, a brown wire, connector (344) and circuit A11-GE to platform ground, thus illuminating the change trans filter warning light.

13.3. TROUBLESHOOTING

For the following, refer to Engine Diagnostic Manual EGES-175 (DT 466E/530E) or EGES-190 (T444E):

- Tachometer and Speedometer System
- Low Oil Pressure/High Water Temperature/Brake Warning (Air) and Low Coolant Level Lights and Alarm
- Low Oil Pressure/High Water Temperature/Brake Warning (Hyd.) and Low Coolant Level Lights and Alarm
- Diagnostic/Programming Connector and Self-Test Switch and Warning Light System
- Wait-To-Start Warning Light
- Engine Oil Pressure Gauge
- Voltmeter Gauge
- Engine Coolant Temperature Gauge

Before beginning these test procedures, do the following:

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

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

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

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

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

Fuel Level Gauge Circuitry

Table 35 Fuel Level Gauge Circuitry

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove fuse F22 and check for open condition.	F22	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	On	At fuse F22, measure voltage from circuit A13F to ground.	F22, A13F to gnd.	12 ± 1.5 volts.	Install fuse. Go to next step.	Locate cause of low or no voltage in circuit A13/A13F, then repair. Install fuse.
3.	Off/ On	Disconnect green connector (11) from cluster. Turn key on and measure voltage from circuit A28B to ground.	(11), A28B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A28/A28B, then repair.
4.	On	At connector (11), measure voltage across circuit A28B to A28–G.	(11), A28B to A28–G.	12 ± 1.5 volts.	Go to next step.	Locate cause of open or poor connection in circuits A28–G/ A11–GB/ A11–G, then repair.
5.	Off/ On	At connector (11), install jumper wire from circuit A28B to A36. Disconnect sender connector (37). Turn key on and measure voltage from circuit A36 to ground.	(37), A36 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A36 or conn. (2 or 2A), then repair.
6.	On	At connector (37), measure voltage across circuit N36 to N36–G.	(37), N36 to N36–G.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit N36–G/ N11–G, then repair.

Table 35 Fuel Level Gauge Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
7.	Off	Remove jumper wire and reconnect cluster connector (11) and sender connector (37).			Go to next step.	
8.	Off	Fuel level gauge circuitry checks good. If condition still persists, refer to S08314 to diagnose the gauge and sender.	Gauge and sender.	Pass test.	Replace cluster.	Replace defective component.

Low Air Pressure Warning Light and Alarm System

Table 36 Low Air Pressure Warning Light and Alarm System

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	On	With air pressure below 60 psi, do BOTH the warning light and alarm fail to operate?			Go to Step 4.	Go to next step.
2.	On	With air pressure below 60 psi, does the alarm operate but the warning light does not?			Perform Steps 7 — 12.	Go to next step.
3.	On	With air pressure below 60 psi, does the warning light operate properly but the alarm does not?			Perform Steps 13 — 16.	End test.
4.	Off/ On	At low air pressure switch (1LA), remove connector and jumper circuit K40 to ground. Turn key ON. Does the warning system work?		Warning system works.	Replace air pressure switch.	Go to next step.
5.	Off	Disconnect alarm (211) and measure resistance from cavity 2 to ground.	(211), cav. 2 to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 40 or conn. (2) or (9850), then repair.
6.	Off	Remove jumper and reconnect switch (1LA). Warning system ground circuitry checks good.			Go to next step.	

Table 36 Low Air Pressure Warning Light and Alarm System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
7.	Off	Remove fuse F22 and check for open condition.	F22	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
8.	On	At fuse F22, measure voltage from circuit A13F to ground.	F22, A13F to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A13/A13F, then repair.
9.	Off/ On	Disconnect natural connector (12) from IP cluster. Turn key on and measure voltage from circuit A28D to ground.	(12), A28D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A28/A28D, then repair.
10.	On	Remove alarm (R1) and install jumper from cavity A to ground. At connector (12), measure voltage across circuit A28D to A40A.	(12), A28D to A40A.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit A40A, then repair.
11.	Off	Remove bulb and check for open condition.		Bulb OK.	Replace IP cluster. Go to next step.	Replace bulb. Go to next step.
12.	Off	Remove jumpers and reconnect connectors. Warning light power circuits check good.			Go to next step.	
13.	Off	Remove fuse F24 and check for open condition.	F24	< 1 ohm.	Go to next step.	Locate cause of overload condition and repair. Replace fuse.
14.	On	At fuse F24, measure voltage from circuit A13H to ground.	F24, A13H to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit A13/A13H, then repair.
15.	On	Remove alarm (211) and at cavity 5, measure voltage to ground.	(211), cav. 5 to gnd.	12 ± 1.5 volts.	Replace alarm.	Locate cause of low or no voltage in circuit A13B, then repair.
16.	Off	Reconnect alarm. Alarm power circuits check good.				

Hydraulic Brake Low Fluid and Parking Brake Warning Lights

Table 37 Hydraulic Brake Low Fluid and Parking Brake Warning Lights

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Start	Do both bulbs operate when key switch is in the start position?			Go to next step.	Go to Step 14.
2.	On	Does the low brake fluid warning light operate properly?			Go to next step.	Go to Step 9.
3.	On	With parking brake applied, does the parking brake warning light operate properly?			End test.	Go to next step.
4.	Off	Disconnect parking brake switch connector (218). At circuit A44–GA, measure resistance to ground.	(218), A44–GA to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A44–GA/ A11–GB, then repair.
5.	Off/ On	At park brake switch connector, install jumper wire from circuit A44A to ground and turn key on. Does light work?			Replace park brake switch.	Go to next step.
6.	Off/ On	Disconnect natural dash connector (12). Turn key on and measure voltage from circuit A28C to ground.	(12), A28C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit A28C/A28, then repair.
7.	On	At connector (12), measure voltage across circuit A28C to A44.	(12), across A28C to A44.	12 ± 1.5 volts.	Check bulb. If OK, replace cluster.	Locate open or poor connection in circuit A44, conn. (82), or circuit A44A, then repair.
8.	Off	Remove jumper wire and reconnect connectors. Park brake circuitry checks OK.				
9.	Off	Remove low brake fluid level sensor connector (90). At connector, measure resistance from circuit N11–GF to ground.	(90), N11–GF to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuits N11–GF/ N11–GB, then repair.

Table 37 Hydraulic Brake Low Fluid and Parking Brake Warning Lights (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
10.	On	At connector, install jumper wire from circuit N90P to ground. Does light operate?			Replace sensor (90).	Go to next step.
11.	Off/ On	Remove low brake fluid light connector (89). Turn key on and measure voltage from circuit A90R to ground.	(89), A90R to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90R/A28A, then repair.
12.	On	At connector (89), measure voltage across circuit A90R to A90V.	(89), across A90R to A90V.	12 ± 1.5 volts.	Replace bulb/ socket assy. (89).	Locate open or poor connection in circuit A90V, conn. (2), or circuit A90P, then repair.
13.	Off	Remove jumper wire and reconnect connectors. Low brake fluid light circuitry checks good.				
14.	Off/ Start	Disconnect key switch (20). Hold switch in start position and measure resistance from ground terminal of switch to its case.	(20), gnd. term. to case gnd.	< 1 ohm.	Go to next step.	Replace defective key switch (20).
15.	Off/ Start	Reconnect connector (20) and disconnect brake diode assembly (82). With key in start position, measure resistance from circuit A44–G to ground.	(82), A44–G to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A44–G (and/or A31–GD with trans. filter, then repair.
16.	Off	With multimeter in diode test mode, check blocking diode (82). Is diode good?	(82)	0.6V to 0.7V.	Go to next step.	Replace defective diode.
17.	On	At connector (82), measure voltage from circuit A90W to ground.	(82), A90W to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90W/A90V, warning light conn. (89), or circuit A90R, then repair.

Table 37 Hydraulic Brake Low Fluid and Parking Brake Warning Lights (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
18.	On	At connector (82), measure voltage from circuit A44/A44A to ground.	(82), A44/A44A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A44, warning light, or circuit A28C, then repair.
19.	Off	Bulb check ground circuitry checks good. If bulbs still do not operate properly, go to Step 2 and 3.				

Transmission Oil Temperature Warning Light

Table 38 Transmission Oil Temperature Warning Light

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove fuse F22 and check for open condition.	F22	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	On	At fuse F22, measure voltage from circuit A13F to ground. Replace fuse.	F22, A13F to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A13/A13F, then repair.
3.	On	Disconnect engine/ chassis harness connector (9850). Install jumper from circuit K31A to ground. Does warning light illuminate?			Go to next step.	Go to Step 5.
4.	On	Reconnect (9850) and disconnect warning light switch connector (N/L). Measure voltage from circuit K31A to ground.	(N/L) switch, K31A to gnd.	12 ± 1.5 volts.	Replace switch.	Locate cause of open or poor connection in circuit K31A, then repair.
5.	Off	Disconnect dash connector (2). At (2), measure resistance of circuit A31A to ground.	(2), A31A to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A31A, then repair.
6.	On	Disconnect warning light connector (11) and measure voltage from circuit A28B to ground.	(11), A28B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A28B/A28, then repair.

Table 38 Transmission Oil Temperature Warning Light (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
7.	On	At (11) install jumper from circuit A28B to circuit A31A. At dash connector (2), measure voltage from circuit A31A to ground.	(2), A31A to gnd.	12 ± 1.5 volts.	Replace cluster. Go to next step.	Locate cause of low or no voltage in circuit A31A, then repair. Go to next step.
8.	Off	Remove jumpers and reconnect connectors (9850), (2), and (11).			Warning light circuits check good.	

Change Transmission Filter Warning Light

Table 39 Change Transmission Filter Warning Light

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Start	Does the warning light work when the key switch is in the start position?			Go to next step.	Go to Step 8.
2.	Off	Remove fuse F10 and check for open condition.	F10	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
3.	On	At fuse F10, measure voltage from circuit A12A to ground.	F10, A12A to gnd.	12 ± 1.5 volts.	Install fuse. Go to next step.	Locate cause of low or no voltage in circuit A12A, then repair. Install fuse.
4.	Off	Disconnect jumper harness from filter pigtail connector (N/L). Measure resistance from brown wire to ground.	(N/L) pigtail, brown wire to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in brown wire, conn. (344), or circuit A11–GE, then repair.
5.	On	At jumper harness, install jumper from brown wire to blue wire. Disconnect warning light connector (94) and measure voltage from circuit A31D to ground.	(94), A31D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A31D, then repair.

Table 39 Change Transmission Filter Warning Light (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
6.	On	At (94), measure voltage across circuit A31D to A31–GA.	(94), across A31D to A31–GA.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A31–GA, conn. (344), or blue wire, then repair.
7.	Off	Remove jumper, reconnect (94), and filter pigtail to jumper harness connector.			Warning light circuitry checks good.	
8.	On	Disconnect circuit A31–GD conn. from key switch (20) and install jumper to ground. Does light operate?			Replace key switch.	Go to next step.
9.	Off	Disconnect rectifier assembly (64) and measure resistance from circuit A31–GC to ground.	(64), A31–GC to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A31–GC or A31–GD, then repair.
10.	Off	With multimeter in diode test mode, check rectifier assembly (64). Test good?	(64)	0.6 to 0.7 volt.	Go to next step.	Replace rectifier assembly.
11.	Off	Reconnect (64) and disconnect jumper harness from filter switch pigtail. At jumper, measure resistance from green wire to ground.	Jumper harness, green wire to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in green wire, conn. (344) or circuit A31–GB, then repair.
12.	Off	At filter switch pigtail, measure resistance from white wire to black wire.	(N/L) switch pigtail, white to black wire.	< 1 ohm.	Go to next step.	Replace filter switch.
13.	Off	At filter switch pigtail, measure resistance from red wire to black wire.	(N/L) switch pigtail, red to black wire.	> 100K ohms.	Go to next step.	Replace filter switch.

Table 39 Change Transmission Filter Warning Light (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
14.	On	Install jumper lead from jumper harness blue wire to ground. Disconnect warning light connector (94). Measure voltage from circuit A31D to ground.	(94), A31D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A31D, then repair.
15.	On	At (94), measure voltage across circuit A31D to A31–GA.	(94), across A31D to A31–GA.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A31–GA, conn. (344), or the blue wire, then repair.
16.	Off	Remove jumpers and reconnect key switch ground connector, filter switch pigtail and warning light connector (94).			Warning light bulb check circuits check good.	

13.4. COMPONENT LOCATIONS

(1LA) Low Air Pressure Switch..... On Compressor
(2) Dash Connector..... Right Side of Platform, Inside
(2A) Chassis Connector..... Right Side of Platform, Outside
(11) Instrument Cluster Connector..... Rear of Instrument Cluster Panel (Green)
(12) Instrument Cluster Connector..... Rear of Instrument Cluster Panel (Natural)
(20) Key Switch..... Right Side of Instrument Cluster
(64) Rectifier Assembly Connector..... Above Accelerator Pedal
(82)Hydraulic Brake Diode Assembly..... Above Accelerator Pedal
(89) Low Brake Fluid Level Warning Light..... Below Voltmeter Gauge
(90) Low Brake Fluid Level Sensor..... Bottom of Brake Fluid Reservoir
(94) Hydraulic Brake Warning Light..... In Cluster Panel
(9850) Chassis to Engine W/H Connector..... Right Side, Rear of Engine
(211) Low Air Press./ High Water Temp. Alarm..... Under Instrument Panel
(218) Park Brake Switch..... Left Side of Platform
(344) Auto Transmission Oil Filter Switch Connector..... Right Frame Rail

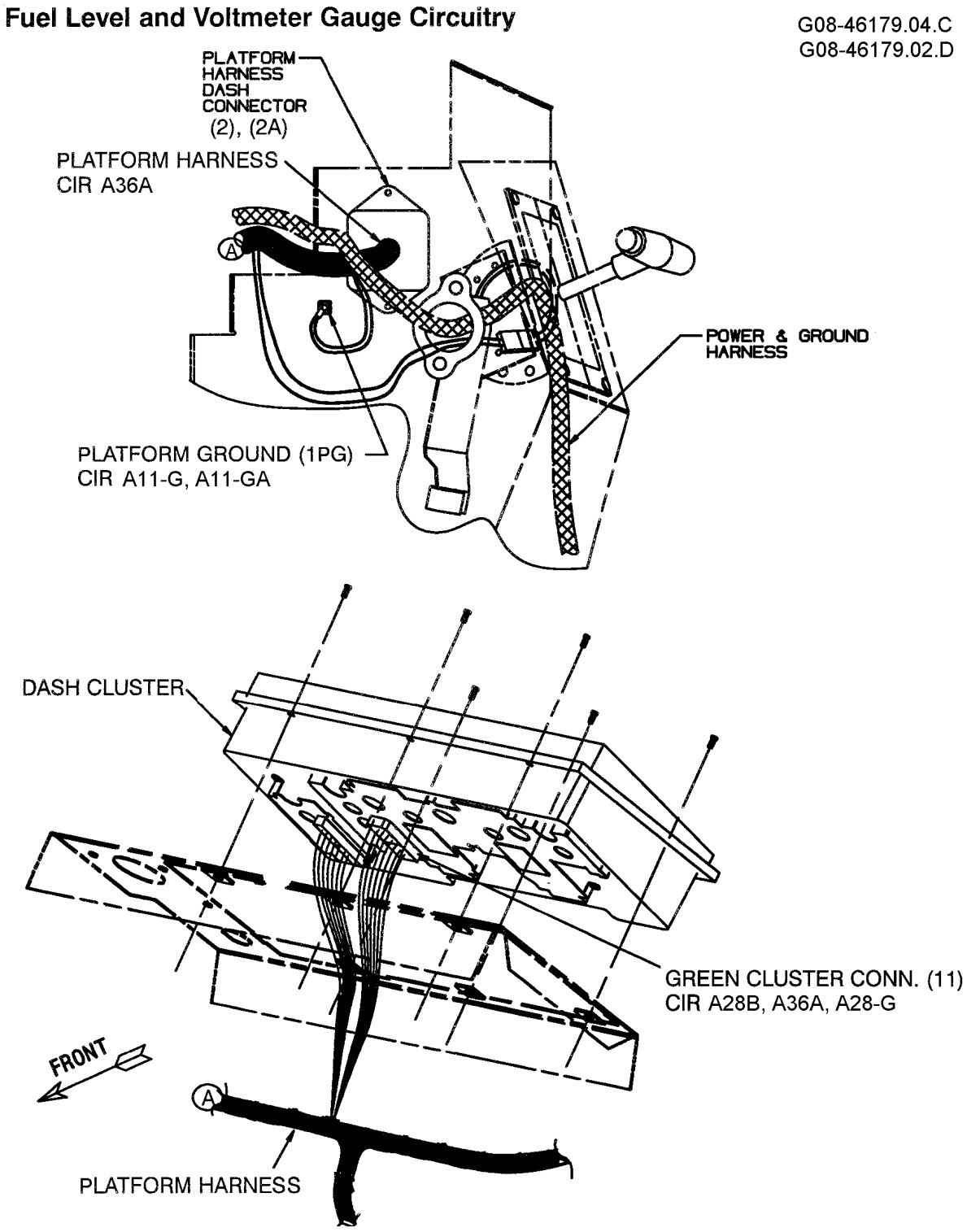

Figure 75 Fuel Level and Voltmeter Gauge Circuitry

Fuel Level Gauge Circuitry

G08-52046.03.B

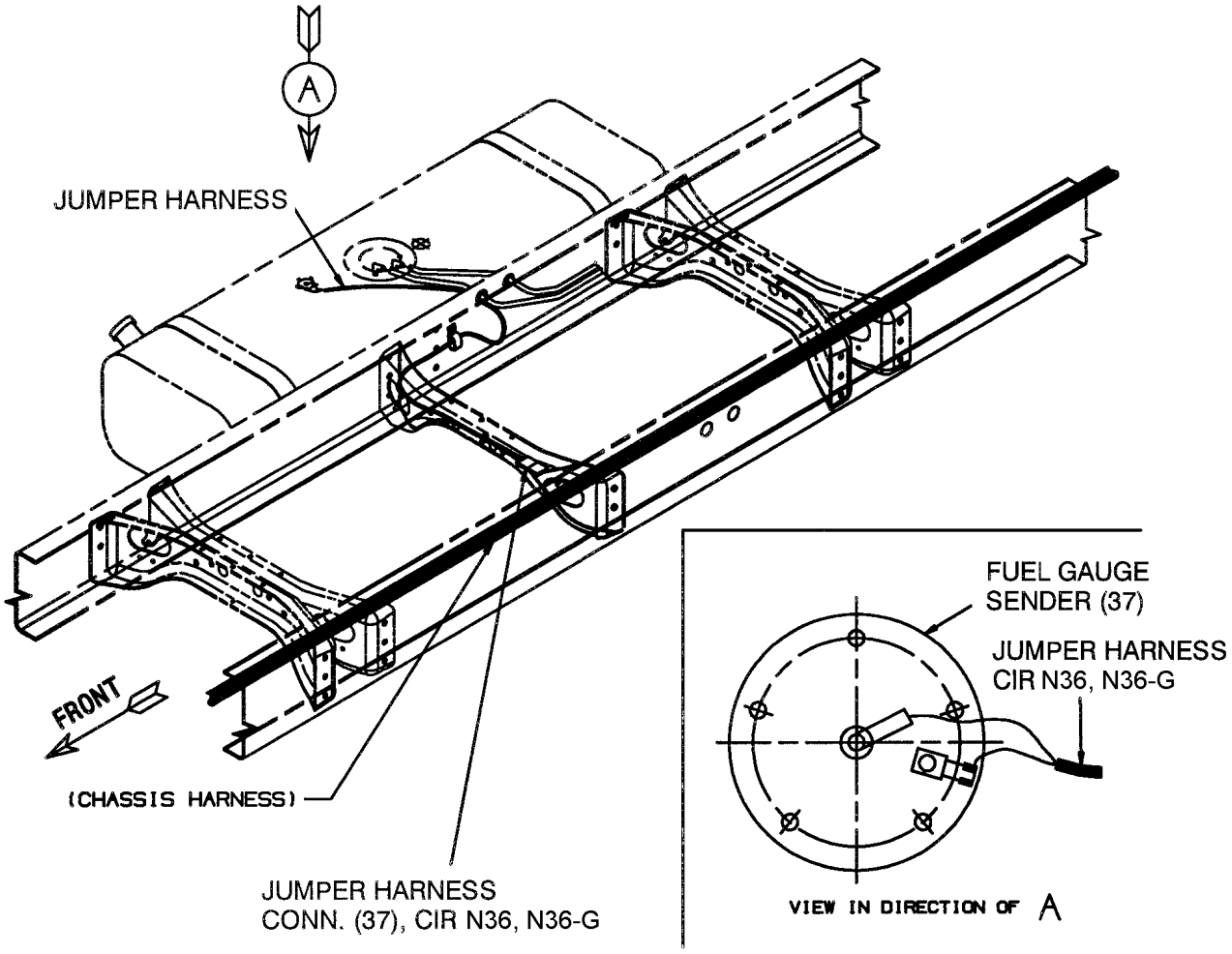

Figure 76 Fuel Level Gauge Circuitry

Air Brake Pressure Warning Light and Alarm

G08−46179.01.C
G08−46178.06.C

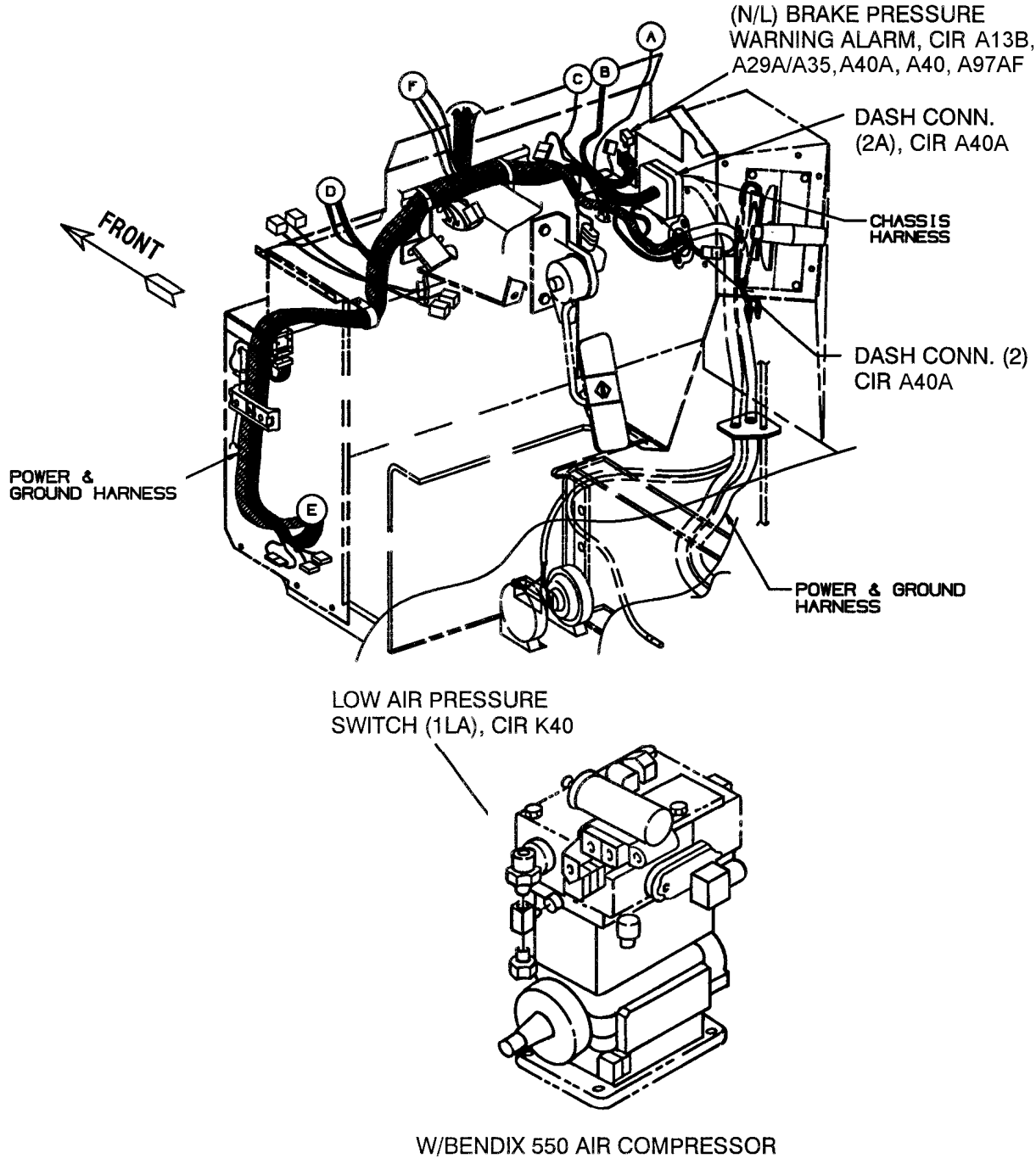

Figure 77 Air Brake Pressure Warning Light and Alarm

Air Brake Pressure Warning Light and Alarm

G08−51047.01.A

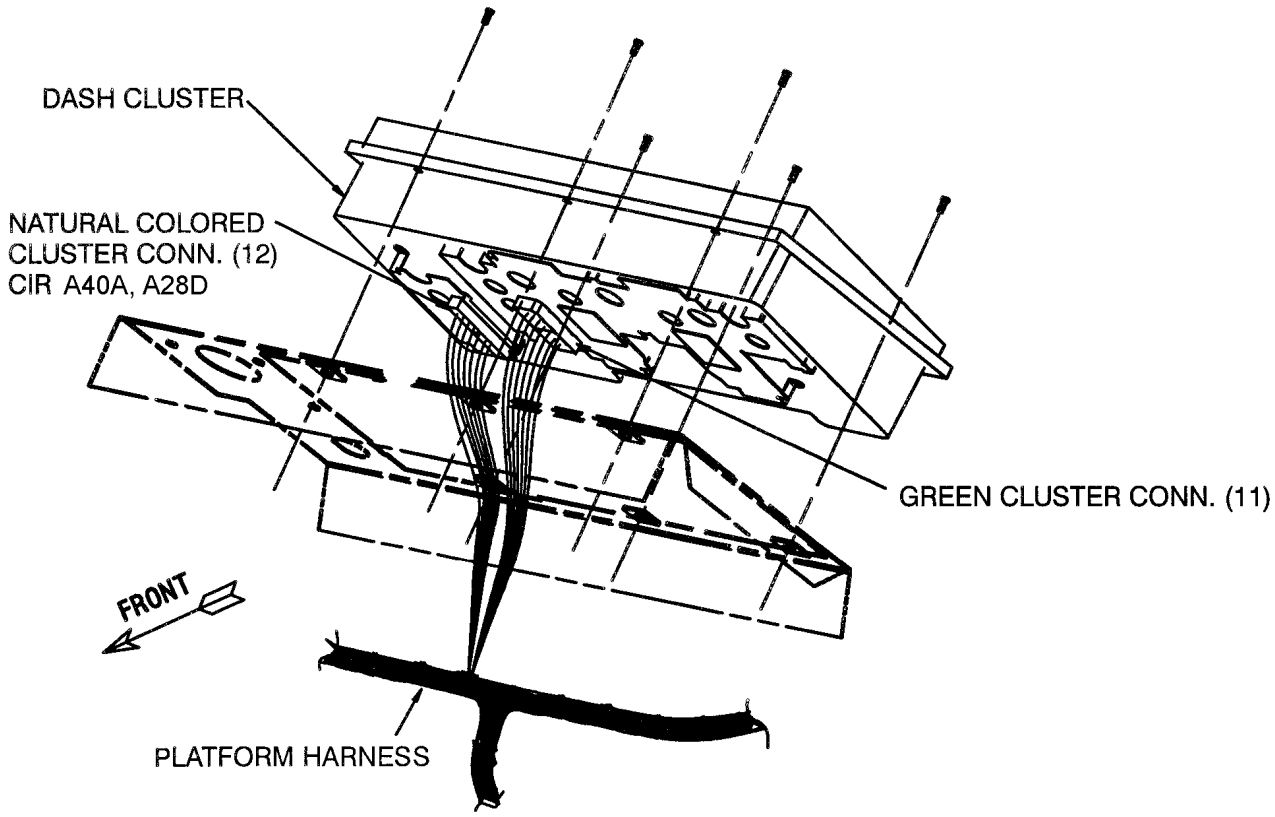

Figure 78 Air Brake Pressure Warning Light and Alarm

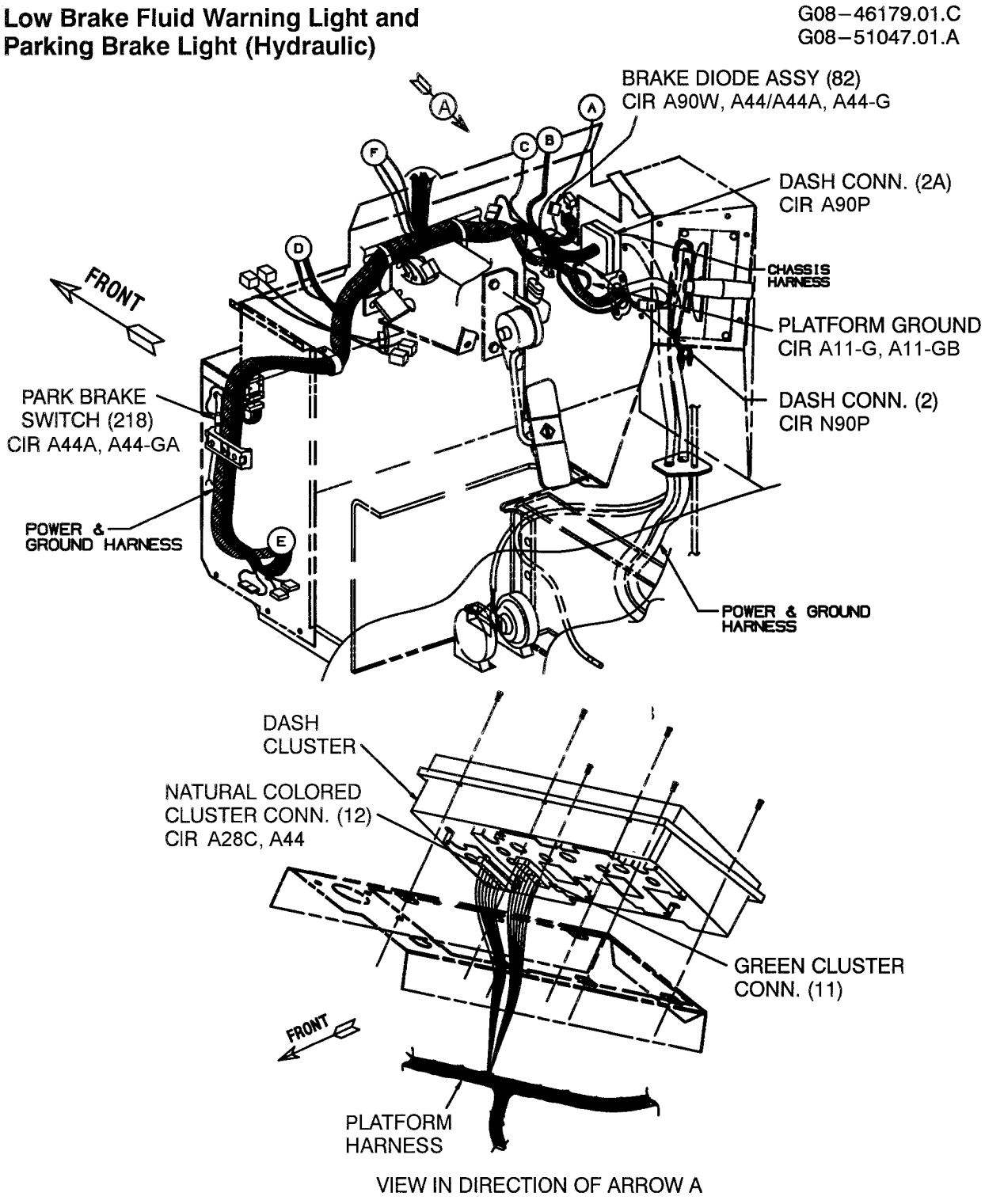

Figure 79 Low Brake Fluid Warning Light and Parking Brake Light (Hydraulic)

Low Brake Fluid Warning Light

G08−46179.02.D
G08−46179.04.C

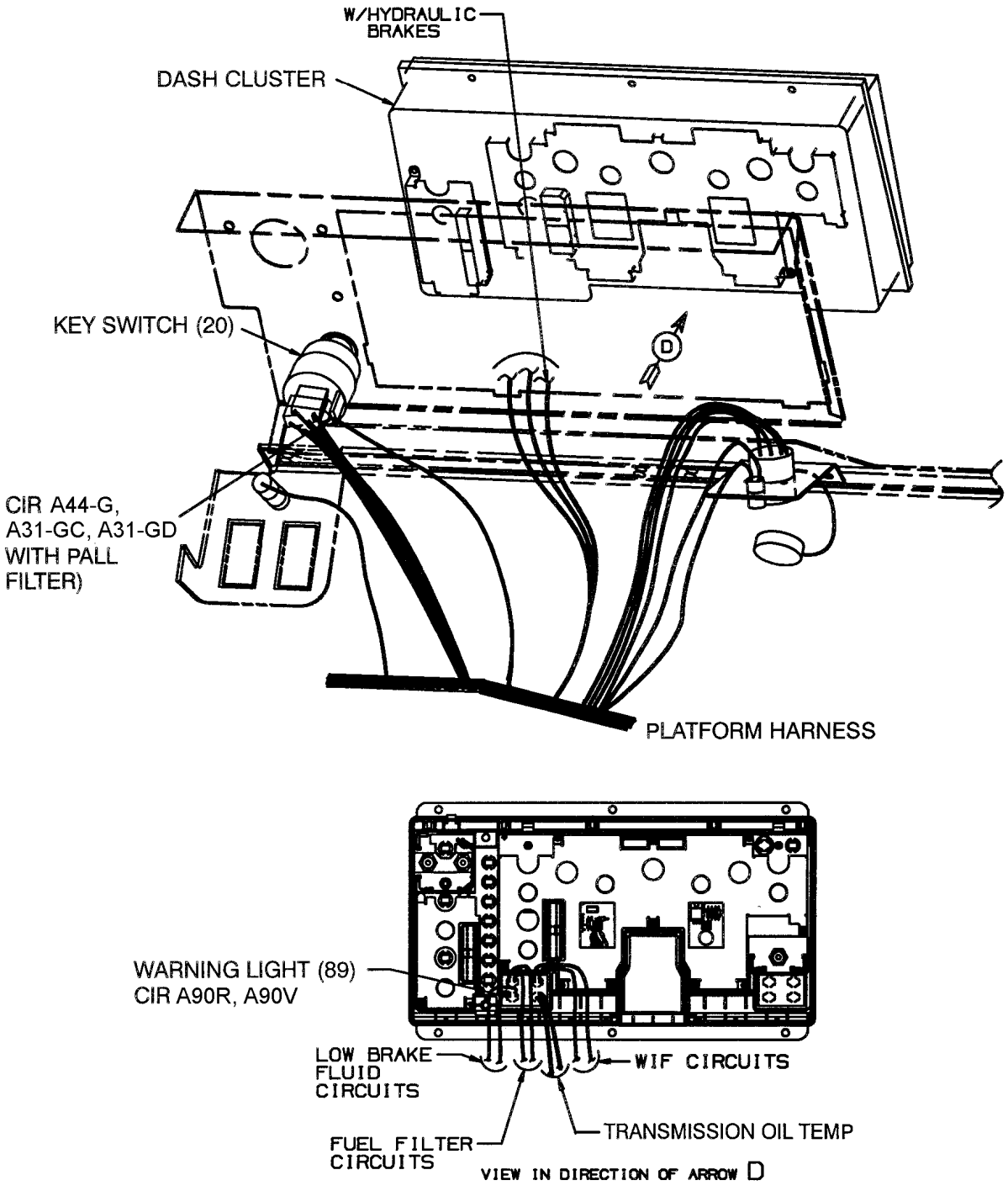

Figure 80 Low Brake Fluid Warning Light

Low Brake Fluid Warning Light Switch

G08−46658.07.

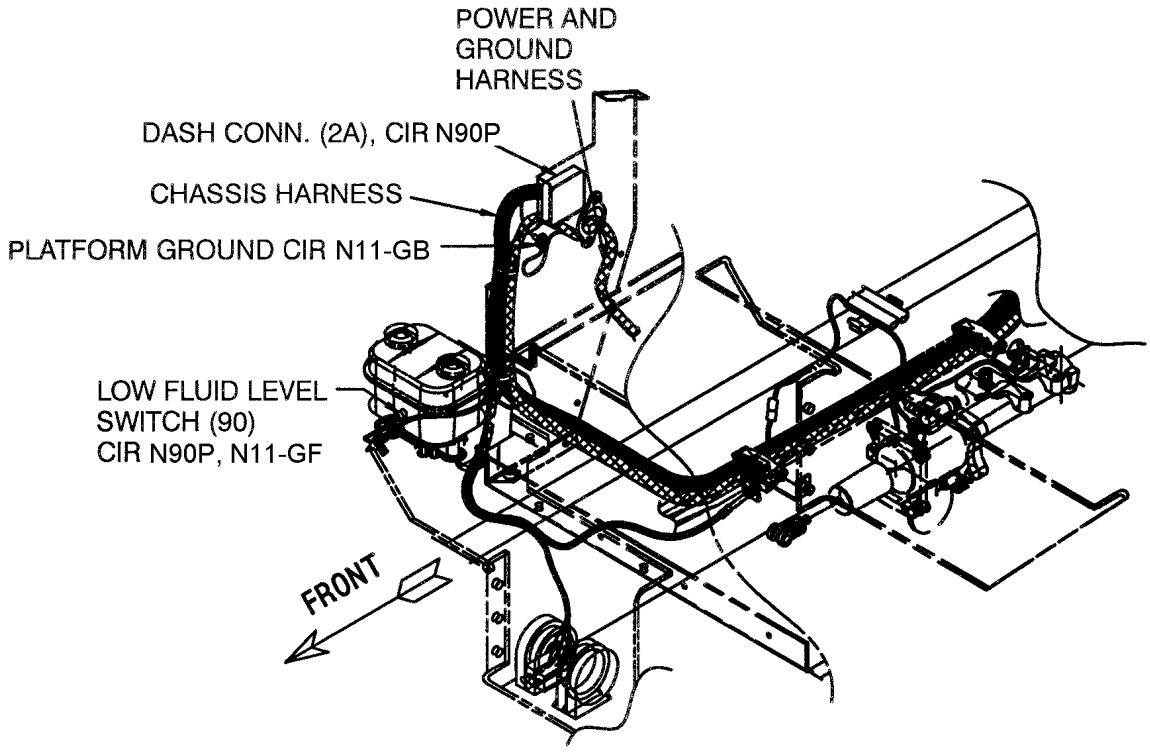

Figure 81 Low Brake Fluid Warning Light Switch

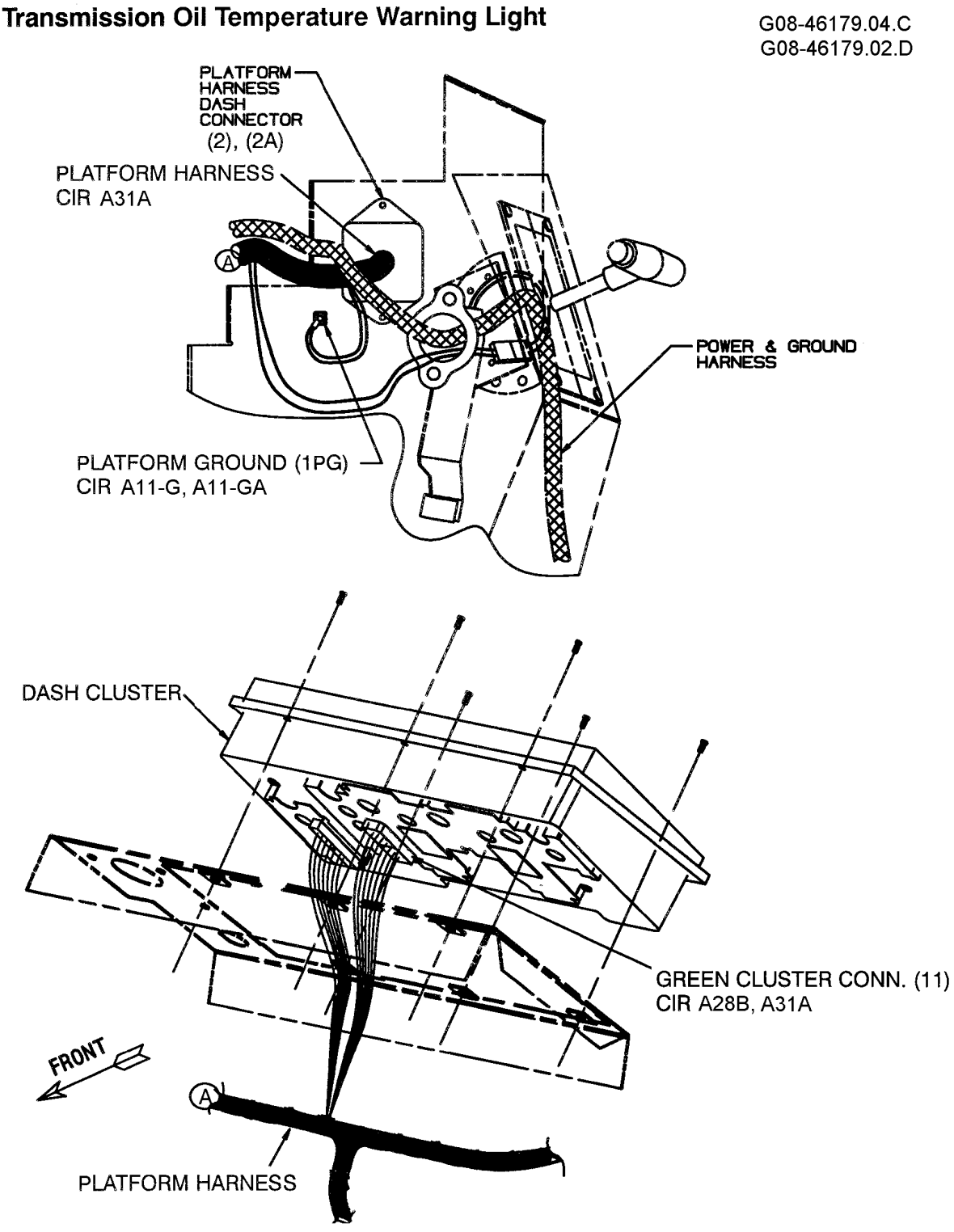

Figure 82 Transmission Oil Temperature Warning Light

Transmission Oil Temperature Warning Light

G08−51061.03

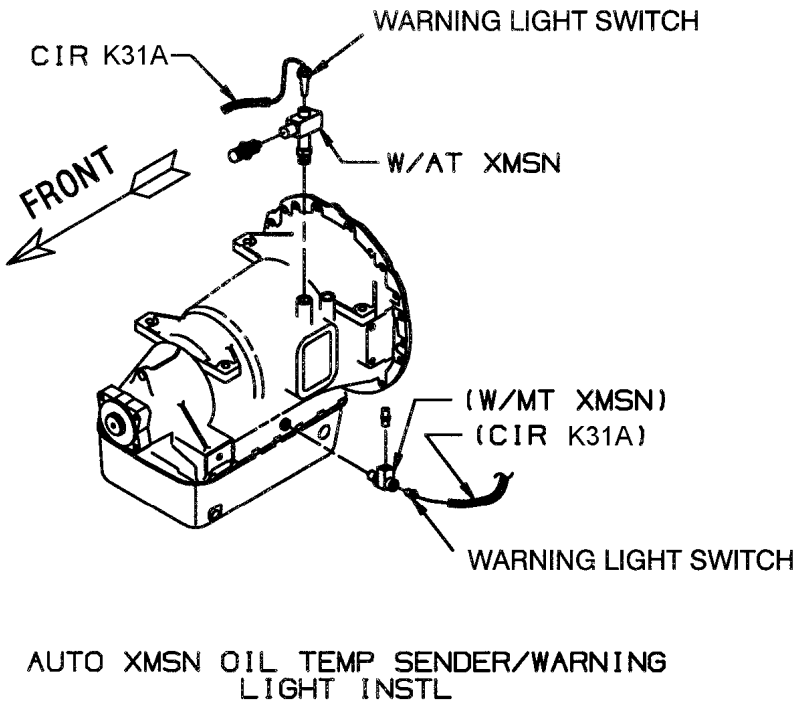

Figure 83 Transmission Oil Temperature Warning Light

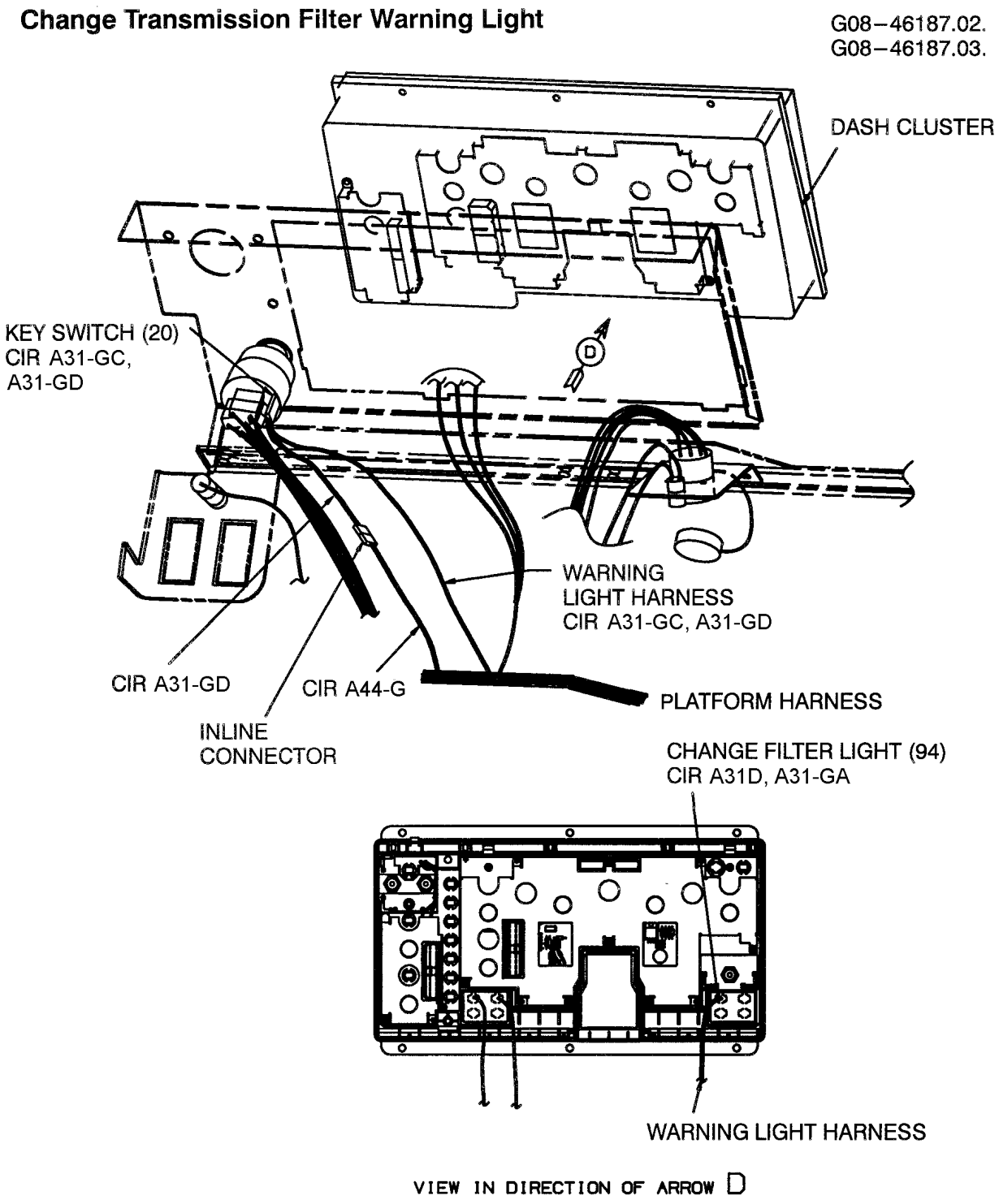

Figure 84 Change Transmission Filter Warning Light

Change Transmission Filter Warning Light

G08−46187.03.
G08−46187.07.

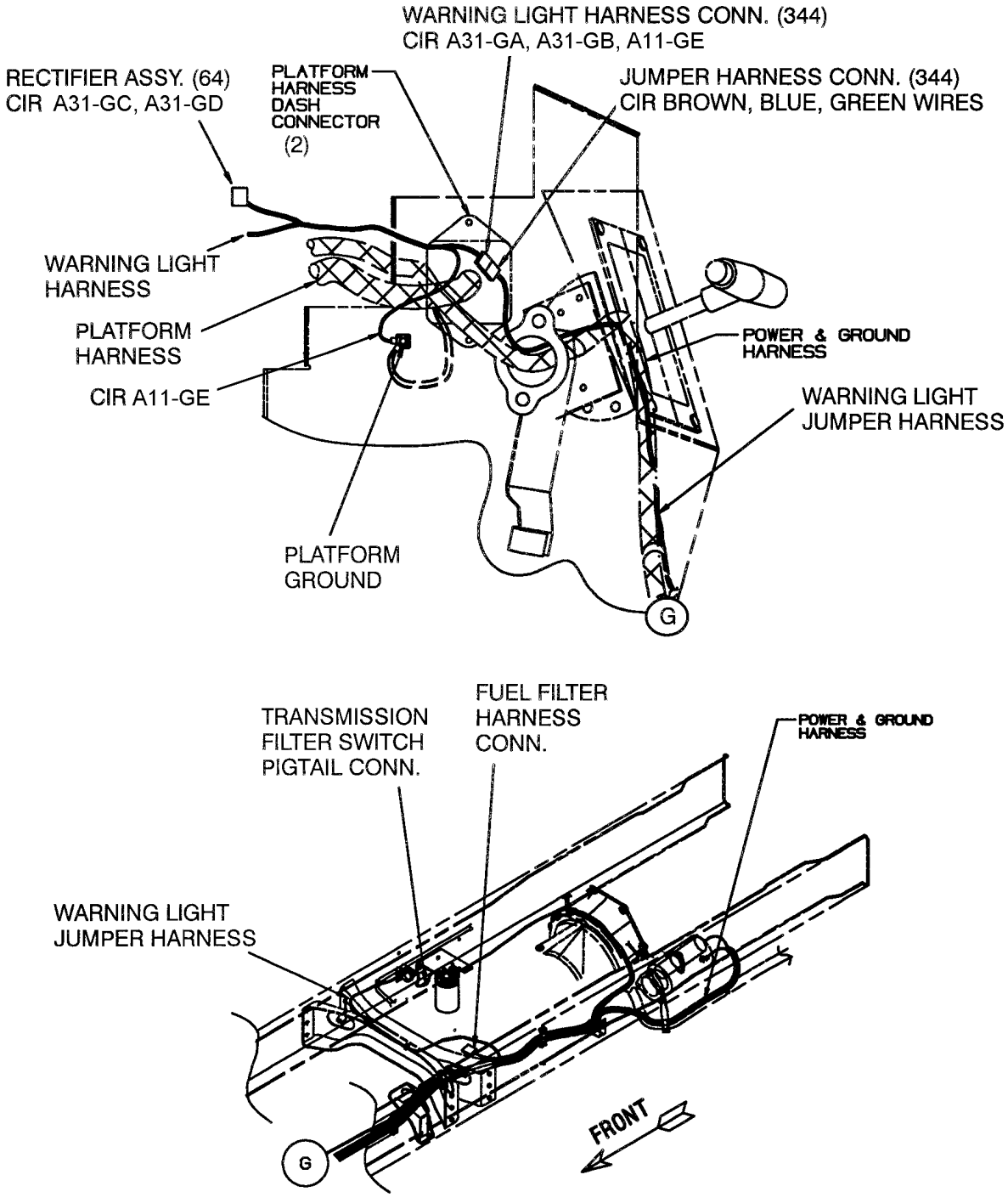

Figure 85 Change Transmission Filter Warning Light

14. RE 200/RE 300 CHASSIS ACCESSORIES

14.1. DESCRIPTION

Air Dryer with Air Brakes

The function of the air dryer is to collect moisture and contaminants in the air system before it reaches the first reservoir. This will provide for moisture-free air for the air brake system. The heater in the air dryer prevents freeze-up in the purge drain valve during cold weather.

Allison WTEC Transmission

Refer to Troubleshooting Guide S08246 for a description of the Allison WTEC III transmission.

Allison LCT Transmission

Refer to Troubleshooting Guide S08247 for a description of the Allison 2000 LCT transmission.

Drain Valve

The function of the automatic drain valve is to automatically expel accumulated moisture from the air tank. The heater in the drain valve prevents freeze-up during cold weather operation.

Heated Fuel Filter With Water-In-Fuel Light, Fuel Filter Restriction Light

The fuel filter heater is mounted in the fuel filter and when operating, it helps prevent fuel from gelling up in the unfiltered side of the filter. The system consists of a fuel heater relay, filter heating element, and a normally open thermal switch. The switch contacts close at approximately 50°F (10°C).

WATER-IN-FUEL: RE 200 (V8 ENGINE). The water-in-fuel system consists of a control module, a water probe, and a warning light in the dash cluster. When water is present in the fuel filter, increased current will flow from the probe to ground. The module senses this increase and turns on the warning light. The system also conducts a bulb check when the key switch is in the start position to verify that the light operates.

WATER-IN-FUEL: RE 300 (I6 ENGINE). The I6 engine ECM2 will turn on the “WATER-IN-FUEL” warning light. The battery voltage is through the ignition switch relay (1711), fuse F20, to the MSM1 connector (3114) pin 7 and to the WIF connector (3116), pin G, to the WIF connector (3116), pin C, to the “WATER-IN-FUEL” warning light (9), pin B. The “WATER-IN-FUEL” indicator is controlled by the ECM2 (6020). The control from ECM2 connector (6020), pins 12 and 13, is transferred over the data link on circuits K5AA(+) and K5AA(-) through pins 14 and 15 of connector (9850), to the MSM1 connector (3114) pins 5 and 6. A ground is sent from the MSM2 connector (3115) through pin 3, to the WIF connector (3116), pin H, to the WIF connector (3116), pin B, to the “WATER-IN-FUEL” warning light (9), pin A, thus causing the “WATER-IN-FUEL” warning light to illuminate.

The fuel filter restriction light is activated when the fuel filter becomes restricted. This causes the fuel filter vacuum switch contacts to close and activates the light.

Brake System

The Bendix Hydro-Max II hydraulic brake booster is offered on all hydraulic brake models. It powers a split system which protects against brake failure by using separate fluid lines to feed the front and rear axle brakes. The master cylinder provides fluid pressurized by the power steering pump and the Hydro-Max II booster to activate the brake pads against the disc brakes. It is a dual mode system which will automatically provide back-up brake power, from an electric/hydraulic pump, should there be a loss of power steering pump pressure.

A warning light and alarm, which can indicate various hydraulic and electrical malfunctions, are standard.

Antilock Brakes (4 Channel)

Refer to Troubleshooting Guide S04023 for a description of the Antilock Brakes System.

14.2. OPERATION

AIR DRYER WITH AIR BRAKES: RE 200 (V8 ENGINE)

When the key switch (20) is in the on or accessory position, power is applied from the ignition relay (6309), through circuit V13P, rear control box fuse B3, circuit V39, control box connector (6000), pin F2, and engine harness circuit K39/K39B to the heated air dryer (6705), pin A. If the air dryer thermostat senses air temperature below 50°F (10°C), its contacts close and allow current to flow through the heating element. This assures that the accumulated moisture does not freeze during cold weather.

Ground is through circuit K39-GA, an inline connector (6705), pin B and circuits K39-G/K11-GH to the starter motor ground (7104).

AIR DRYER WITH AIR BRAKES: RE 300 (I6 ENGINE)

When the key switch (20) is in the on or accessory position, power is applied from the ignition relay (6309), through circuit V13P, rear control box fuse B3, circuit V39, control box connector (6000), pin F2, and engine harness circuit K39/K39B to the heated air dryer (6705), pin A. If the air dryer thermostat senses air temperature below 50°F (10°C), its contacts close and allow current to flow through the heating element. This assures that the accumulated moisture does not freeze during cold weather.

Ground is through circuit K39-GA, an inline connector (6705), pin B and circuits K39-GA to the starter motor ground (7104).

Drain Valve

When the key switch (6305) is in the ignition position, power is fed from the ignition relay (6309) through circuit V13L, rear control box fuse A3, circuit K39A, control box connector (6000), circuit K39A, and the electronic engine/chassis harness connector (9850). Power continues through the chassis harness circuit N39A to the heated drain valve jumper harness connector (43), and to the drain valve pigtail connector (42).

The drain valve is grounded through pigtail connector (42), conn. (43), and circuit N39-G/N11-GA/N11-GB to platform ground.

When the temperature drops below 50°F (10°C), its contacts close and allow current to flow through the heating element. This assures that the accumulated moisture does not freeze in the drain valve during cold weather.

Heated Fuel Filter

Power is applied by the body builder feed stud (1F), to circuit A14D/A19, fuse F17, and circuit A19H to the fuel heater relay (R5). When the key switch (20) is placed in the ignition or start position, power is also applied to circuits A13 and A13A, fuse F20, and circuit A19D to the fuel heater relay (R5) coil. The relay is energized through ground circuit A11-GM/A11–GB to the platform ground.

With the relay (R5) energized, power flows through its contacts, circuit A19A, dash connector (2), circuit A19A, connector (6704 or 6708), and circuit K19A to the fuel filter heater and thermo switch (N/L). The ground path is through the filter housing and its mounting bracket. When the temperature is 50°F (10°C) or less, the thermo switch contacts close and cause the heater element to activate.

WATER-IN-FUEL: RE 200 (V8 ENGINE)

The battery voltage is through the ignition switch relay (1711), circuits A13/A13A, fuse F20, circuits A19D, to the fuel heater relay (R5). With the key switch (20) in the on or start position, the water-in-fuel module (16) receives power at WIF connector (3116), pin A, from fuel heater relay (R5) and circuit A19E. When the key switch is moved to the start position, the key switch (20) ground is applied to circuit A19-GB going to the water-in-fuel module (16), pin C, to the WIF connector (3116), pin E. This initiates a bulb check by causing the module to apply power to connector (16), pin B, circuit A19F, to the WIF connector (3116), pin B, and the water-in-fuel module warning light (9). This causes the warning light, grounded through connector (9), circuit A19-G, to the WIF connector (3116), pin C, circuit A19-G, to the WIF connector (3116), pin D, circuits A19-GC/A11–G, to platform ground (1PG), to illuminate. When water is detected in the fuel filter by the water probe, a ground path is completed to the water-in-fuel module (16), pin D, circuit A19C, to the WIF connector (3116), pin F, circuit A19C, to connector (2), pin H6, circuit N19C, connector (9851), pin F, circuit K19C, fuel filter connector (6704), pin 2, and water probe (1WP), thus causing the “WATER-IN-FUEL” warning light to illuminate.

WATER-IN-FUEL: RE 300 (I6 ENGINE)

The I6 engine ECM2 will turn on the “WATER-IN-FUEL” warning light. The battery voltage is through the ignition switch relay (1711), circuits A13/A13A, fuse F20, circuits A97AC/A97AB, to the MSM1 connector (3114) pin 7 and to the WIF connector (3116), pin G, circuit A19K, to the WIF connector (3116), pin C, circuit A19–G, to the “WATER-IN-FUEL” warning light (9), pin B. The “WATER-IN-FUEL” indicator is controlled by the ECM2 (6020). The control from ECM2 connector (6020), pins 12 and 13, is transferred over the data link on circuits K5AA(+) and K5AA(-) through pins 14 and 15 of connector (9850), to the MSM1 connector (3114) pins 5 and 6. A ground is sent from the MSM2 connector (3115) through pin 3, circuit A19–GD, to the WIF connector (3116), pin H, circuit A19F, to the WIF connector (3116), pin B, to the “WATER-IN-FUEL” warning light (9), pin A, thus causing the “WATER-IN-FUEL” warning light to illuminate.

Fuel Filter Restriction Light

With the key switch (20) in the ignition position, power is applied through circuit A13H, fuse F25, and circuit A19J to the fuel filter light (69). From the light, power is applied through circuit A19B, dash connector (2), circuit A19B, fuel filter connector (6704 or 6708), and to the fuel filter vacuum switch (N/L). When the fuel filter becomes restricted, the fuel filter vacuum switch contacts close and complete a ground path for the fuel filter light.

Hydraulic Brake System

The Hydro-Max II hydraulic brake system uses hydraulic pressure from the power steering pump. If the flow is inadequate or interrupted, the monitor module (86) is fed a signal from the flow switch (N/L), causing the monitor to turn on a brake warning light and alarm system and to start the hydraulic reserve pump to provide additional braking power. The reserve pump and warning system is also activated when the differential pressure switch (91) is tripped due to a pressure loss in one half of the brake system.

When the key switch (20) is in ignition or start position, power is supplied to circuit A13A, fuse F18, circuit A90T, and blocking diode assembly (80). From the blocking diode, power is supplied through circuit A90J, to the pump control relay (R1), and also through circuit A90H to the brake monitor module (86-E). The brake monitor module is grounded through circuit 11-GD/11-GB/ 11-G to the platform ground.

Battery power is applied to fusible link N90-FL/N90FA/A90, dash connector (2), and circuit A90, to the pump control relay (R1). When the key switch is moved to the start or ignition position, the flow switch contacts will be closed (engine not running) and a ground path is provided from the switch through circuit A90L, pressure differential switch (91), circuit A90K, connector (88), dash connector (2) and circuit A90K, to a splice. From the splice, a ground path is provided over circuit A90L, to the brake monitor module (86-A). This causes the module to switch the alarm output (86-C) to ground which activates the alarm and warning light. From the splice, a ground circuit is also provided by way of circuit A90E to the brake pump control relay (R1), causing it

to energize. With the relay energized, power flows through its N.C. contacts, circuit A90S, dash connector (2) and connector (88) to the reserve pump motor (1F). This causes the reserve pump motor, which is grounded through its case and to the platform ground, to run and provide additional brake power (fluid flow).

From the pump motor, a signal path on circuit N90Q, connector (88) and dash connector (2), to the brake monitor module connector (86-F), provides information to the module. It continuously monitors the continuity of the reserve pump and power supplied to it. The warning system activates if the pump motor winding opens up or if the pump control relay (R1) remains closed (provides power to circuit N90S and the reserve pump motor), after the engine is running. The warning system is also activated if no power is supplied to the pump motor when the flow switch or differential switch contacts are closed.

When the brake monitor module switches its alarm output (86-C) to ground, the brake warning light illuminates by power flowing to the dash connector (12), through the printed circuit board and the light, dash connector (12), and circuits A90N and A90M, to the monitor module at connector (86-C). At the same time, the alarm also sounds by power flowing to the B+ terminal of the alarm, through the alarm, circuit A90NA, blocking diode (25), and circuit A90M to the module at connector (86-C).

When the hydraulic brake pressure system monitor module (86) detects a problem with the brake system, it applies a ground to circuit A90M, connector and blocking diode (25), and circuit A90NA to the alarm (211). Power will then flow from fuse F24 through circuit A13B and alarm connector (211), causing the alarm to sound at a fast rate. When a problem is detected, a ground is also applied by circuit A90M, connector (25), circuit A90N, and natural instrument cluster connector (12), pin 9 to the brake warning light, causing it to illuminate. The brake warning light, the battery voltage is through the ignition switch relay (1711), circuits A13/A13F, fuse F22, circuits A28 and A28C, and natural instrument cluster connector (12), pin 8.

Battery voltage is applied from circuit N90-FL/N90FA to circuit A90A, dash connector (2), circuit A90A, fuse F2, circuit A90B, dash connector (2) and circuit N90B to the hydraulic brake stop light switch (209). The stop light switch ground is through circuit N90-G/N11-GB to the platform ground.

Battery voltage is also applied through fuse F2 and circuit A90U to the brake relay (R3) coil, and circuit A90X to the relay contacts. The relay ground is through circuit A70C, dash connector (2) and circuit N70C to the stop light switch (209). When the brakes are applied, the contacts of the hydraulic brake switch (209) close. This energizes the brake relay (R3) and power is applied through circuit A90F to a blocking diode (80) and circuit A90H to the brake monitor module connector (86-E). Power is also applied from the blocking diode connector (80), through circuit A90D, to the monitor module connector (86-G). If the key switch is in the off position, power is also applied to the pump control relay (R1).

Battery power is also applied through fuse F12 and circuit A70B, to the stop light relay (R4) coil, and circuit A70D to the relay contacts. The relay ground is through circuits A70-G, the brake relay (R3) and A70C to the stop light switch (209). When the brake is applied, the relay is energized and applies power through circuit A90C to the brake monitor module connector (86-H). The module compares the signals received at (86-G) and (86-H) and if there is a voltage on just one of the two circuits, A90D or A90C, for more than 14±5 seconds, the warning light and alarm will be turned on.

When the brakes are applied, power also flows from the energized stop light relay (R4) through circuit A70A and to the body builder connector (169).

14.3. TROUBLESHOOTING

Before beginning these test procedures, do the following:

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

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

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

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

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

Air Dryer with Heater

Table 40 Air Dryer with Heater

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Check rear control box fuse B3 for open condition.	B3	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	On	At fuse B3, measure voltage from circuit V13P to ground.	B3, V13P to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit V13P, then repair. Install fuse.
3.	Off/ On	Disconnect air dryer connector (6705). Turn key on and measure voltage from circuit K39B to ground.	(6705), K39B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit K39B, conn. (6705), circuit K39B/K39, conn. (6000) or circuit 39, then repair.
4.	On	At (6705) measure voltage across circuit K39 to K39–GA.	(6705), K39 to K39–GA.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit K39–GA, conn. (6705), circuit K39–G/ K11–GJ, then repair.

Table 40 Air Dryer with Heater (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
5.	Off/ On	At (6705) install jumper from circuit K39B to heater element feed. With key on and unit cooled to below 50°F (10°C), measure voltage from element ground terminal to ground.	(6705), element gnd. term. to gnd.	12 ± 1.5 volts.	Go to next step.	Repair or replace heated air dryer.
6.	Off	Remove jumper wire and reconnect connector (6705). Air dryer circuitry checks good.				

Drain Valve

Table 41 Drain Valve

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Check rear control box fuse A3 for open condition.	A3	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	On	At fuse A3, measure voltage from circuit V13L to ground.	A3, V13L to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit V13L, then repair. Install fuse.
3.	Off/ On	Disconnect air dryer/ drain valve connector (42). Turn key on and measure voltage from circuit K39A (red) to ground.	(42), K39A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit K39A or drain valve to chassis harness conn. (43), chassis to electronic engine harness conn. (9850), or control box conn. (6000), then repair.
4.	On	At (42) measure voltage across circuit K39A (red) to N39–GA (brown).	(42), K39A to N39–G.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit N39–G, conn. (43), or circuit N39–G/ N11–GA/ N11–GB, then repair.

Table 41 Drain Valve (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
5.	Off/ On	At (42) install jumper from circuit K39A to heater element feed. With key on and unit cooled to below 50°F (10°C), measure voltage from element ground terminal to ground.	(42), element gnd. term. to gnd.	12 ± 1.5 volts.	Go to next step.	Replace air dryer.
6.	Off	Remove jumper and reconnect pigtail connector. Drain valve circuitry checks good.				

Heated Fuel Filter With Water-In-Fuel Light, Fuel Filter Restriction Light

Table 42 Heated Fuel Filter With Water-In-Fuel Light, Fuel Filter Restriction Light

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Does the fuel filter restriction light work properly?			Go to next step.	Go to Step 19.
2.	Off	Does the water-in-fuel system operate properly?			Go to next step.	Go to Step 11.
3.	Off	Does the heated fuel filter work properly?			End test.	Go to next step.
4.	Off	Remove fuel heater relay (R5). At relay connector, measure voltage from cavity E, circuit A19H to ground.	(R5), cav. E, A19H to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit A19H, or open fuse F17, then repair.
5.	On	At relay connector, measure voltage from cavity B, circuit A19D to ground.	(R5) socket, cav. B, A19D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A19D, or open fuse F20, then repair.
6.	On	At relay socket (R5), measure voltage from cavity B to cavity A, circuit A11–GM/A11–GB.	(R5) socket, cav. B to A, A11–GM/A11–GB.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A11–GM/A11–GB. then repair.

Table 42 Heated Fuel Filter With Water-In-Fuel Light, Fuel Filter Restriction Light (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
7.	Off	Bench test fuel filter relay (R5) by measuring resistance from pin 30 to 87A.	(R5), pin 30 to 87A.	< 1 ohm.	Go to next step.	Replace defective relay.
8.	Off	Apply +12V to relay pin 86 and ground to pin 85. Measure resistance from pin 30 to 87.	Energized (R5), pin 30 to 87.	< 1 ohm.	Go to next step.	Replace defective relay.
9.	Off/ On	Reconnect relay (R5) and disconnect circuit A19A from fuel filter. Turn key on and measure voltage from circuit A19A to ground.	Fuel filter, A19A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A19A, dash conn. (2), or fuel filter conn. (6704 or 6708), then repair.
10.	On	With the fuel heater cooled to below 50°F (10°C), measure voltage from circuit N19A to the heater power stud.	Fuel filter, N19A to heater power stud.	12 ± 1.5 volts.	Heated fuel filter system checks good.	Repair or replace heated fuel filter.
11.	Off/ On	Disconnect water-in-fuel module (16). Turn key on and at connector, measure voltage from circuit A19E to ground.	(16), A19E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit A19E, then repair.
12.	Start	At WIF socket (3116), measure voltage across circuit A19E to A19–GB.	(3116), across A19E to A19–GB.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A19–GB, or key switch, then repair.
13.	On	At WIF socket (3116), install jumper from circuit A19E to A19F. Does warning light operate?			Go to Step 16.	Go to next step.
14.	On	Disconnect WIF warning light conn. (9) and at circuit A19F, measure voltage to ground.	(9), A19F to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit A19F, then repair.
15.	On	At WIF connector (9), measure voltage across circuit A19F to A19–G.	(9), across A19F to A19–G.	12 ± 1.5 volts.	Replace lamp or socket assy.	Locate open or poor connection in circuit A19–G/ A11–GB/ A11–G, then repair.

Table 42 Heated Fuel Filter With Water-In-Fuel Light, Fuel Filter Restriction Light (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
16.	Off/ On	At WIF connector (3116) move jumper across circuit A19E to A19C. At the fuel filter, disconnect circuit A19C from the water probe. Turn key on and measure voltage from circuit A19C to ground.	Water probe conn., A19C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit A19C, dash conn. (2), or fuel filter conn. (6704 or 6708), then repair.
17.	On	Remove jumper and reconnect WIF module (3116). At water probe connector, jumper circuit A19C to ground. Does light work?			Go to next step.	Replace WIF module.
18.	On	Remove water probe and install jumper from the probe to ground. Measure voltage from circuit A19C to water probe feed stud.	Water probe, A19C to probe feed stud.	12 ± 1.5 volts.	Install probe and connections. WIF system checks good.	Replace water probe.
19.	On	Remove fuel filter light connector (69) and measure voltage from circuit A19J to ground.	(69), A19J to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A19J or open fuse F25, then repair.
20.	On	Reconnect light connector (69) and disconnect fuel filter switch connector (N/L). Measure voltage from circuit A19B to ground.	Filter switch conn., A19B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A19B, dash conn. (2), or fuel filter conn. (6704 or 6708), then repair.
21.	Off	Fuel filter restriction light circuitry checks good. If condition persists, replace fuel filter switch.				

Table 43 Cruise Control/Remote Engine Controls

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	1. Turn key to RUN 2. Connect J1939 sniffer		Are both the engine (0x00) and the MSM (aka ESC) on the Datalink?	Go to step 2.	Go to step 9.
2.	Off	1. Disconnect J1939 sniffer. 2. Connect Master Diagnostics 3. Monitor the Cruise ON/OFF input 4. Exercise the Cruise ON/OFF switch		Does the input in MD change with the switch changes?	Go to step 3.	Go to step 4.
3.	Off	1. Monitor the Cruise Set/Resume input 2. Exercise the Cruise Set/Resume switch		Does the input in MD change with the switch changes?	MSM is functioning properly. Check that cruise control is enabled in the engine controller	Go to step 6.
4.	Off	1. Verify Cruise ON/OFF switch and wiring, OFF state 2. Disconnect MSM connector J2		Is pin 8 open to ignition when switch is OFF?	Go to step 5.	Repair wiring or switch, and retest
5.	Off	1. Verify Cruise ON/OFF switch and wiring, ON state		Is pin 8 shorted to ignition when switch is ON?	Replace MSM and retest	Repair wiring or switch, and retest

Table 43 Cruise Control/Remote Engine Controls (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
6.	Off	1. Verify Cruise SET/RES switch and wiring, normal state		Is pin 9 open to ground and ignition when switch is not pressed?	Go to step 7.	Repair wiring or switch, and retest
7.	Off	1. Verify Cruise SET/RES switch and wiring, RESUME state		Is pin 9 shorted to ground when switch is moved to RESUME?	Go to step 8.	Repair wiring or switch, and retest
8.	Off	1. Verify Cruise SET/RES switch and wiring, SET state 2. Turn Cruise ON/OFF switch to ON		Is pin 9 shorted to ignition when switch is moved to SET?	Replace MSM and retest	Repair wiring or switch, and retest
9.	Off	1. Leave J1939 sniffer connected		Is the engine (0x00) on the Datalink?	Go to step 10.	Go to step 13.
10.	Off	1. Turn the key to OFF. 2. Disconnect MSM connector J1. 3. Measure resistance across datalink pins in wiring harness		Is the resistance approx. 60 ohms?	Go to step 11.	Fix datalink wiring and retest
11.	Off	1. Turn the key to Ignition. 2. Measure the voltage at the MSM's harness ignition pin		Is the voltage 12-16 volts?	Go to step 12.	Fix wiring or fuse
12.	Off	1. Measure the resistance between the MSM's harness ground pin and ground		Is the resistance less than 10 ohms?	Replace MSM and retest	Fix ground wiring

Table 43 Cruise Control/Remote Engine Controls (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
13.	Off	1. Leave J1939 sniffer connected		Is the MSM (aka ESC) on the Datalink?	Check the engine's power connections and data link wiring.	Verify sniffer is working properly
1.	Off	Remove circuit breaker F21. and check for open condition.	F21.	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	Off	At fuse holder, measure voltage from circuit 90B to ground. Re-install fuse.	Fuse holder, 90B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuits 90–FL/90/90B, dash conn. (2), or circuit 90B, then repair or replace cable assembly.
3.	Off/ On	Disconnect MSM connector (3041). Turn key and cruise switch (391) on. At (3041), measure voltage from circuit 97CF cavity 8 to ground.	(3041), 97CF cav. 8 to gnd.	12 ± 1.5 volts.	Go to Step 6.	Go to next step.
4.	Off	Disconnect cruise on/off switch (391) and with switch in on position, measure resistance across terminals.	(391), across sw. terminals.	< 1 ohm.	Go to next step.	Replace cruise switch.
5.	On	At Brake/Cruise Interface Relay connector (1133), measure voltage from circuit 97B to ground. Reconnect connectors.	(1133), 97B to gnd.	12 ± 1.5 volts.	Repair open or poor connection in circuit 97B.	Check open circuit breaker F13. If okay, locate cause of low or no voltage in circuit 97B, then repair.
6.	On	With on/off switch on and set/resume switch held in set position, measure voltage at MSM connector (3041) from circuit 97CA cavity 9 to ground.	(3041), 97DJ cav. 9 to gnd.	12 ± 1.5 volts.	Go to Step 9.	Go to next step.

Table 43 Cruise Control/Remote Engine Controls (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
7.	Off	Disconnect cruise set/resume switch (392). With switch held in set position, measure resistance across terminals 1 to 2.	(392), across switch term. 1 to 2.	< 1 ohm.	Go to next step.	Replace set/resume switch.
8.	On	With on/off switch on and at connector (392), measure voltage from circuit 97DH to ground. Reconnect connectors.	(392), 97DH to gnd.	12 ± 1.5 volts.	Repair open in cir. 97DH or 97CA .	Locate cause of low or no voltage in circuit 97CA, then repair.
9.	On	With on/off switch on and set/resume switch held in resume position, measure voltage at MSM connector (3041) from circuit 97DK cavity 9 to ground.	(3041), 97DK cav. 9 to gnd.	0 volts.	Go to Step 11.	Go to next step.
10.	Off	Disconnect cruise set/resume switch (392). With switch held in resume position, measure resistance across terminals 2 to 3. Reconnect connectors.	(392), across switch term. 2 to 3.	< 1 ohm.	Repair open in cir. 97–GE, 97–GJ 97DK, or poor connection to Cab ground.	Replace set/resume switch.
11.	Off	Is the vehicle equipped with remote engine controls?			Go to next step.	Go to Step 20.
12.	On	Disconnect body builder installed remote engine controls connector (N/L) at cowl power distribution center. At connector, measure voltage from circuit 97DF to ground.	Remote engine controls conn. (N/L), 97DF to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open circuit breaker F11. If OK, locate cause of low or no voltage in circuit 97DF, dash conn. (3), or circuit 97DF, then repair.
13.	Off	Measure resistance of circuit 46B between (N/L) connector circuit 46B and ECM2 connector (6020), cavity 21.	(N/L), 46B to (6020) cav. 32.	< 1 ohm.	Go to next step.	Locate open in circuit 46B, then repair.

Table 43 Cruise Control/Remote Engine Controls (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
14.	Off	Measure resistance of circuit 46A between (N/L) connector circuit 46A and ECM2 connector (6020), cavity 14.	(N/L), 46A to (6020) cav. 14.	< 1 ohm.	Go to next step.	Locate open in circuit 46A, then repair.
15.	Off	Measure resistance of circuit 97CC between (N/L) connector and ECM2 connector (6020), cavity 20.	(N/L), 97CC to (6020) cav. 20.	< 1 ohm.	Go to next step.	Locate open in circuit 97CC, then repair.
16.	Off	Measure resistance of circuit 97CB between (N/L) connector and ECM2 connector (6020), cavity 19.	(N/L), 97CB to (6020) cav. 19.	< 1 ohm.	Go to next step.	Locate open in circuit 97CB, then repair.
17.	Off	Measure resistance of circuit 97AR between (N/L) connector and ECM2 connector (6020), cavity 11.	(N/L), 97AR to (6020) cav. 11.	< 1 ohm.	Go to next step.	Locate open in circuit 97AR, then repair.
18.	Off	Measure resistance of circuit 47B between (N/L) connector and ECM2 connector (6020), cavity 17.	(N/L), 47B to (6020) cav. 17.	< 1 ohm.	Go to next step.	Locate open in circuit 47B, then repair.
19.	Off	Reconnect connectors. If condition persists, refer to Miscellaneous Information in CT-471 Body Builder Book.				
20.	Off	Reconnect connectors. Cruise control circuitry checks good. If condition persists, refer to Engine Diagnostic Manuals for ECM2 diagnostics.				

Hydraulic Brake System Circuitry

Table 44 Hydraulic Brake System Circuitry

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove pump control relay (R1) and measure voltage from circuit A90 to ground.	(R1), A90 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in fusible link N90–FL/ N90FA, circuit A90, or conn. (2), then repair.
2.	On	At relay socket (R1), install jumper wire from cavity E, circuit A90 to cavity C, circuit A90S. Does pump motor run?			Remove jumper. Go to Step 5.	Go to next step.
3.	Off	At pump motor, disconnect connector and measure voltage from circuit A90S to ground.	Pump motor conn., A90S to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90S or conn. (2) or (88), then repair.
4.	Off	At pump motor connector, measure voltage from circuit N90S to pump casing.	Pump motor conn., N90S to pump case.	12 ± 1.5 volts.	Replace pump motor.	Locate open or poor connection in ground circuit from pump case to platform ground, then repair.
5.	Off	Bench test relay (R1) by measuring resistance from pin 30 to 87A.	Relay (R1), pin 30 to 87A.	< 1 ohm.	Go to next step.	Replace relay.
6.	Off	Bench test relay by applying +12 volts to pin 85, ground to pin 86, and measure resistance from pin 30 to 87.	Energized relay, pin 30 to 87.	< 1 ohm.	Go to next step.	Replace relay.
7.	Off	Remove fuse F2 and check for open condition.	F2	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
8.	Off	At fuse F2, measure voltage from cavity A, circuit A90A to ground.	F2, cav. A, A90A to gnd.	12 ± 1.5 volts.	Install fuse. Go to next step.	Locate cause of low or no voltage in circuit A90A or dash conn. (2), then repair. Re-install fuse.

Table 44 Hydraulic Brake System Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
9.	Off	Remove fuse F12 and check for open condition.	F12	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
10.	Off	At fuse F12, measure voltage from cavity A, circuit A14A to ground.	F12, cav. A, A14A to gnd.	12 ± 1.5 volts.	Install fuse. Go to next step.	Locate cause of low or no voltage in circuit A14A, then repair. Re-install fuse.
11.	Off	Remove fuse F18 and check for open condition.	F18	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
12.	On	At fuse F18, measure voltage from cavity A, circuit A13A to ground.	F18, cav. A, A13A to gnd.	12 ± 1.5 volts.	Install fuse. Go to next step.	Locate cause of low or no voltage in circuit A13A, then repair. Re-install fuse.
13.	Off	Remove stop light relay (R4). At socket cavity B circuit A70D, measure voltage to ground.	(R4) socket, cav. B, A70D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A70D or A70B, then repair.
14.	Off	Bench test relay (R4) by measuring resistance from pin 30 to 87A.	Relay (R4), pin 30 to 87A.	< 1 ohm.	Go to next step.	Replace relay.
15.	Off	Bench test relay by applying +12 volts to pin 85, ground to pin 86, and measure resistance from pin 30 to 87.	Energized relay, pin 30 to 87.	< 1 ohm.	Go to next step.	Replace relay.
16.	Off	Remove brake relay (R3). Measure resistance of circuit A70–G between cavity A of relay (R3) and cavity D of relay (R4).	(R3) cav. A to (R4) cav. D.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A70–G, then repair.
17.	Off	Re-install relay (R4). At relay (R3) socket, measure voltage from cavity E, circuit A90X to ground.	(R3), cav. E, A90X to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90U or A90X, then repair.

Table 44 Hydraulic Brake System Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
18.	Off	Bench test relay (R3) by measuring resistance from pin 30 to 87A.	Relay (R3), pin 30 to 87A.	< 1 ohm.	Go to next step.	Replace relay.
19.	Off	Bench test relay by applying +12 volts to pin 85, ground to pin 86, and measure resistance from pin 30 to 87.	Energized relay, pin 30 to 87.	< 1 ohm.	Go to next step.	Replace relay.
20.	Off	Re-install relay (R3). Disconnect connector from brake/stop light switch (209). At connector, measure voltage from circuit N90B to ground.	(209), N90B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit N90B, or dash conn. (2), then repair.
21.	Off	At connector (209), measure resistance from circuit N90–G to ground.	(209), N90–G to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit N90–G/ N11–GB, then repair.
22.	Off	At connector (209), measure voltage from circuit N70C to ground.	(209), N70C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit N70C or dash conn. (2), then repair.
23.	Off	At switch (209) and with brake pedal applied, measure resistance from blue wire terminal to black wire terminal.	(209), blue wire to black wire.	< 1 ohm.	Go to next step.	Replace brake/stop light switch.
24.	Off	Reconnect (209) and disconnect flow switch connector (N/L). Measure resistance from switch terminal to ground.	Flow switch terminal to gnd.	< 1 ohm.	Go to next step.	Replace flow switch.
25.	Off	Reconnect flow switch connector and disconnect differential pressure switch connector (91). Measure resistance from circuit N90L to ground.	(91), N90L to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit N90L, then repair.

Table 44 Hydraulic Brake System Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
26.	Off	At switch (91), measure resistance from each terminal to ground.	(91), sw. term. to gnd.	> 100K ohms.	Go to next step.	Replace switch.
27.	Off	Reconnect switch (91) and disconnect connector (88). At (88) measure resistance from circuit N90K to ground.	(88), N90K to gnd.	< 1 ohm.	Go to next step	Locate open or poor connection in circuit N90K, then repair.
28.	Off	Disconnect monitor module connector (86). At connector (86–A), measure resistance from circuit A90L to ground.	(86–A), A90L to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A90L/A90K, then repair.
29.	Off	At relay socket (R1), measure resistance from cavity A, circuit A90E to ground.	(R1), A90E to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A90E, then repair.
30.	Off	Remove blocking diode from connector (80). With pedal depressed, measure voltage from circuit A90F to ground.	(80), A90F to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90F, then repair.
31.	On	At (80) measure voltage from circuit A90T to ground.	(80), A90T to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90T, then repair.
32.	Off	With multimeter in diode test mode, test diode (80). Does diode test good?	Diode (80).	0.6V to 0.8V.	Go to next step.	Replace diode.
33.	Off	Re-install diode (80). With brake pedal depressed and at monitor module connector (86), measure voltage from (86–H) circuit A90C, and (86–G) circuit A90D to ground.	(86–H), A90C to gnd., (86–G), A90D to gnd.	12 ± 1.5 volts each test.	Go to next step.	Locate cause of low or no voltage in circuit A90C and/or 90D, then repair.
34.	On	At (86–E), measure voltage from circuit A90H to ground.	(86–E), A90H to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90H, then repair.

Table 44 Hydraulic Brake System Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
35.	Off	At (86–D), measure resistance from circuit 11–GD to ground.	(86–D), 11–GD to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 11–GD/ 11–GB/ 11–G, then repair.
36.	On	At pump control relay socket (R1), measure voltage from circuit A90J to ground.	(R1), A90J to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90J, then repair.
37.	Off/ On	Re-install pump control relay (R1). Turn key on and at connector (86–F), measure voltage from circuit N90Q to ground.	(86–F), N90Q to gnd.	Momentarily 12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit N90Q, dash conn. (2) or conn. (88), then repair.
38.	On	Disconnect alarm blocking diode (25). At connector, measure voltage from alarm circuit A90NA to ground. Alarm should activate.	(25), A90NA to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A90NA, fuse F24 and alarm feed circuit A13B, or check alarm operation, then repair.
39.	Off	With multimeter in diode test mode, test diode (25). Does diode test good?	Diode (25).	0.6 to 0.8 volt.	Go to next step.	Replace diode.
40.	On	At connector (25), measure voltage from warning light circuit A90N/A90M to ground. Warning light should activate.	(25), A90N/ A90M to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit A90N, cluster conn. (12), printed circuit board, or feed circuitA28C, then repair.
41.	Off	Measure resistance of circuit A90M between connectors (25) and (86–C).	(25), A90M to (86–C), A90M.	< 1 ohm.	Go to next step.	Locate open in circuit A90M, then repair.

Table 44 Hydraulic Brake System Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
42.	Off	Re-install monitor module (86). Disconnect body builder connector (169). With brakes applied, measure voltage from circuit A70A to ground.	(169), A70A to gnd.	12 ± 1.5 volts.	Reconnect conn. (169). Go to next step.	Locate cause of low or no voltage in circuit A70A, then repair.
43.	Off	Hydraulic brake pump motor and stop light circuitry checks good. With brakes applied, does pump motor run?			Go to next step.	Replace monitor module.
44.	On	With engine not running and brakes released, does pump motor run and warning system activate?			Go to next step.	Replace monitor module.
45.	On	With engine running, does alarm system deactivate?			End of test.	Replace monitor module.

14.4. COMPONENT LOCATIONS

(1F) Body Builder Feed Stud..... Lower Left Platform Kick Panel
(2) Dash Connector..... Right Side of Platform, Inside
(2A) Chassis Connector..... Right Side of Platform, Outside
(6000) Control Box Engine Connector..... Rear Control Box
(9) Water-In-Fuel Light..... Below Voltmeter Gauge
(12) Instrument Cluster Connector..... Rear of Instrument Cluster Panel (Natural)
(14) Steering Column Inline Connector..... Left Side of Steering Column Support
(3116) Water-In-Fuel Module Harness..... Left, Center of Dash Panel
(20) Key Switch..... Right Side of Instrument Cluster
(25) Brake Warn Light Blocking Diode..... Left Side of Steering Column Support
(32) Auto. Transmission Module Shift Solenoid..... Right Side of Transmission
(42) Drain ValveConnector..... Bottom of Air Tank
(43) Drain Valve Jumper Connector..... At Air Tank
(69) Fuel Filter Light..... Below Voltmeter
(74) Air Dryer Jumper Connector..... On Right Frame Rail, Behind Engine
(75) Air Dryer..... On Air Dryer
(80) Hydraulic Brake Module Diode Assembly..... Platform Harness
(86) Hydraulic Brake Monitor Module..... Upper Left Corner of Platform
(88) Hydraulic Brake Booster Connector..... Behind First Clipping Location Along Left Frame Rail
(91) Hydraulic Brake Differential Press. Switch..... On Hydraulic Brake Booster
(9850) Chassis to Elect. Eng. Connector..... Right Frame Rail, Rear of Engine
(209) Brake/Stop Light Switch..... Below Brake Pedal
(6020) Engine Control Module (ECM2)..... Inside Rear Control Box
(385) Crank Relay..... Inside Rear Control Box

(401) Fuel Filter Inline Connector..... On Left Frame Rail
(6309) Ignition Relay..... Inside Rear Control Box
(R1) Hydraulic Brake Pump Control Relay..... Fuse Panel
(R3) Hydraulic Brake Relay..... Fuse Panel
(R4) Hydraulic Stop Light Relay..... Fuse Panel
(R5) Fuel Heater Relay..... Fuse Panel
(R6) Horn Relay..... Fuse Panel
(N/L) Fuel Filter Heater Connector..... On Fuel Filter
(N/L) Water Probe Connector..... On Fuel Filter
(N/L) Fuel Filter Vacuum Switch Connector..... On Fuel Filter

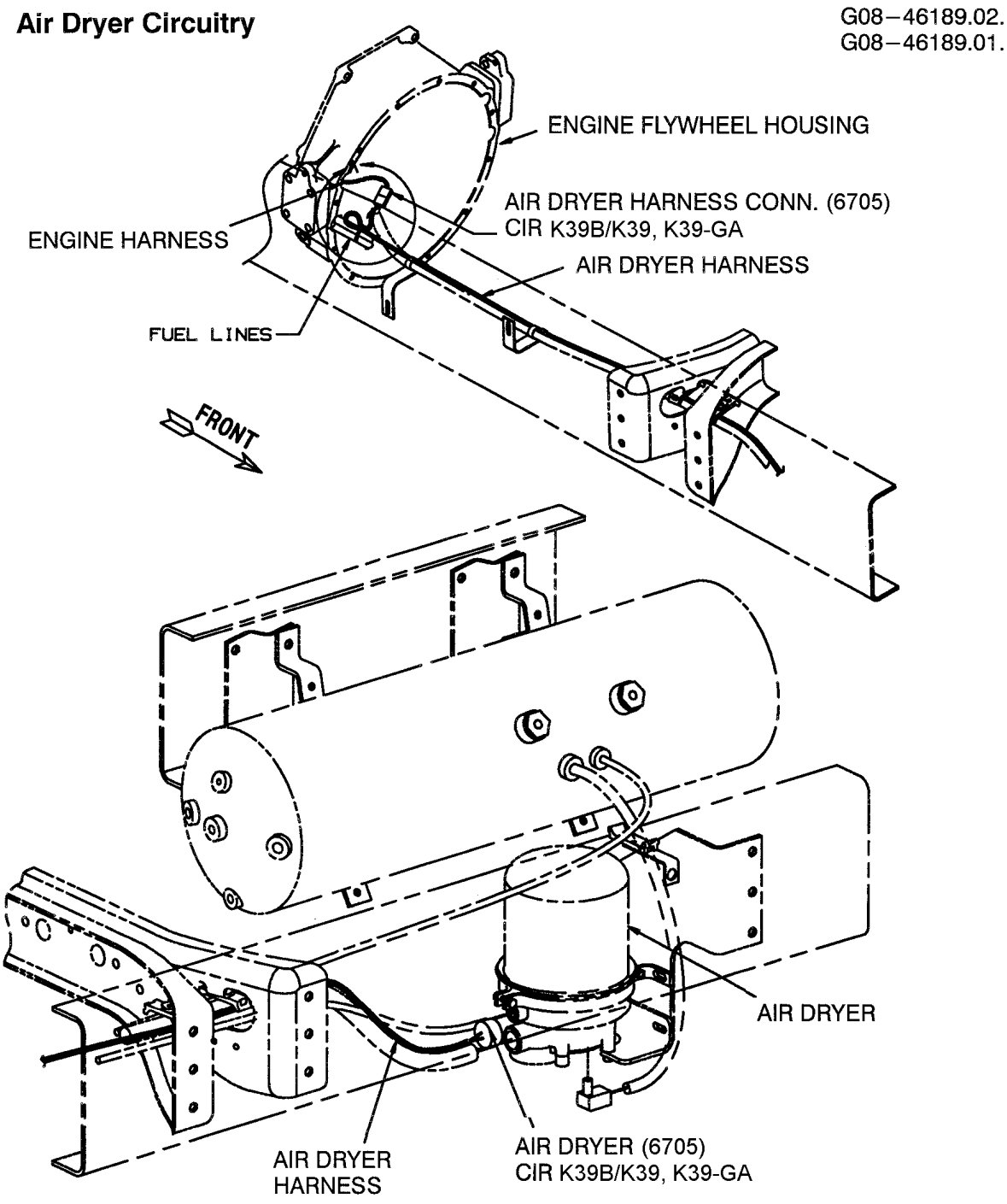

Figure 86 Air Dryer Circuitry

Drain Valve Wiring

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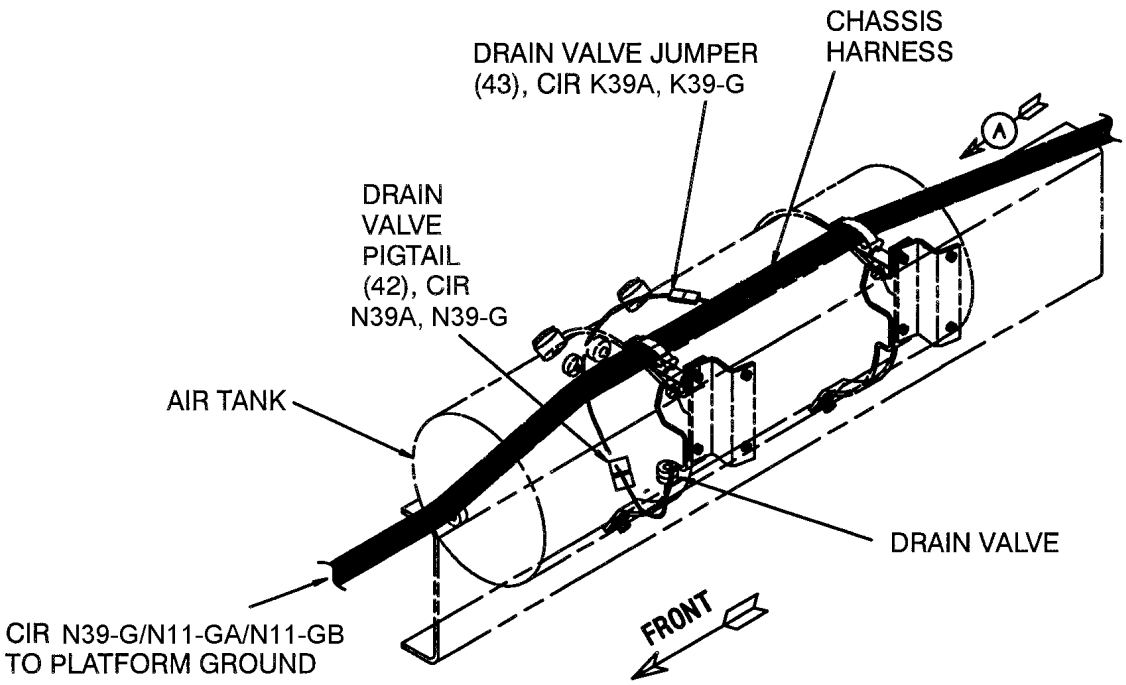

Figure 87 Drain Valve Wiring

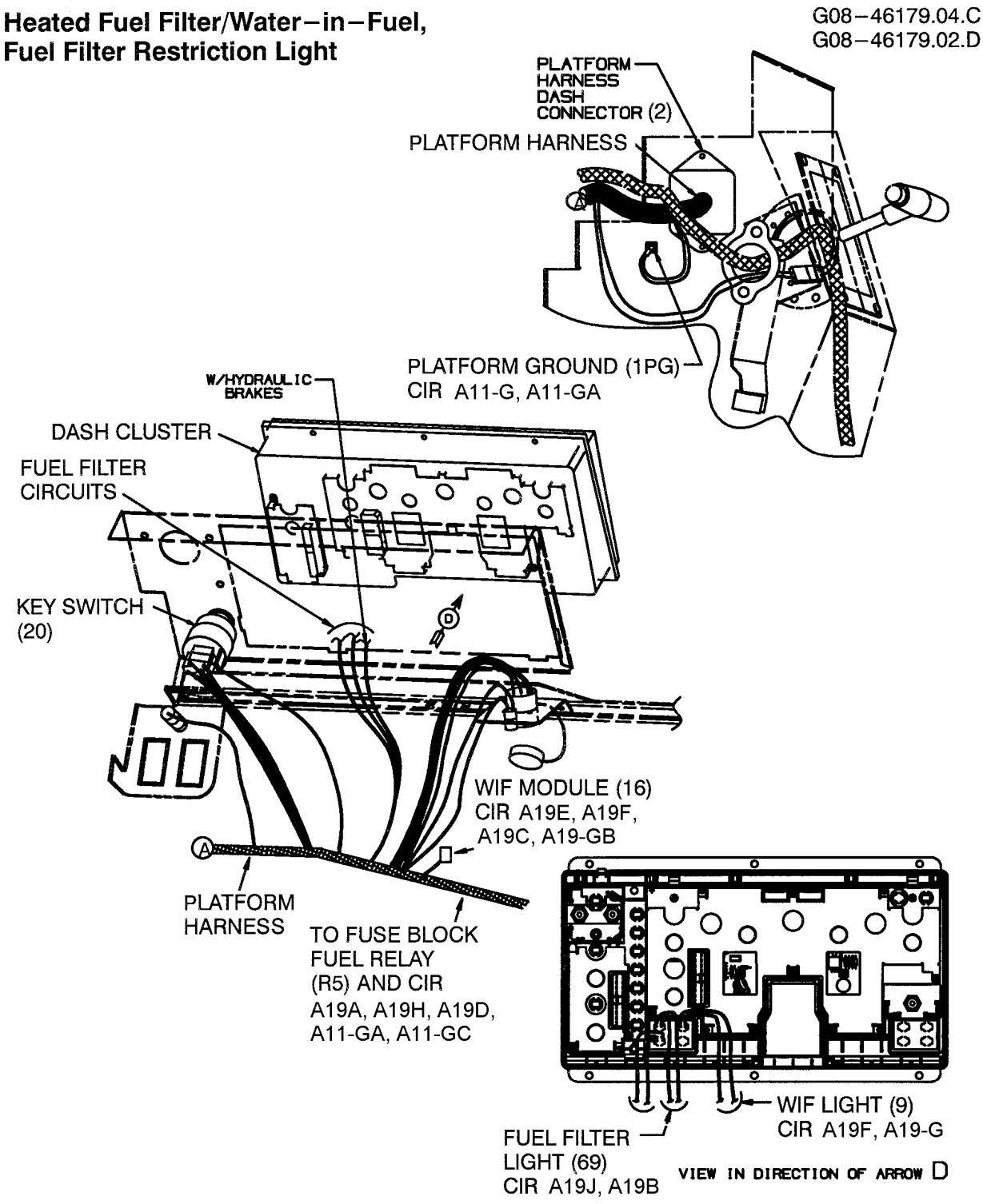

Figure 88 Heated Fuel Filter/Water-In-Fuel, Fuel Filter Restriction Light

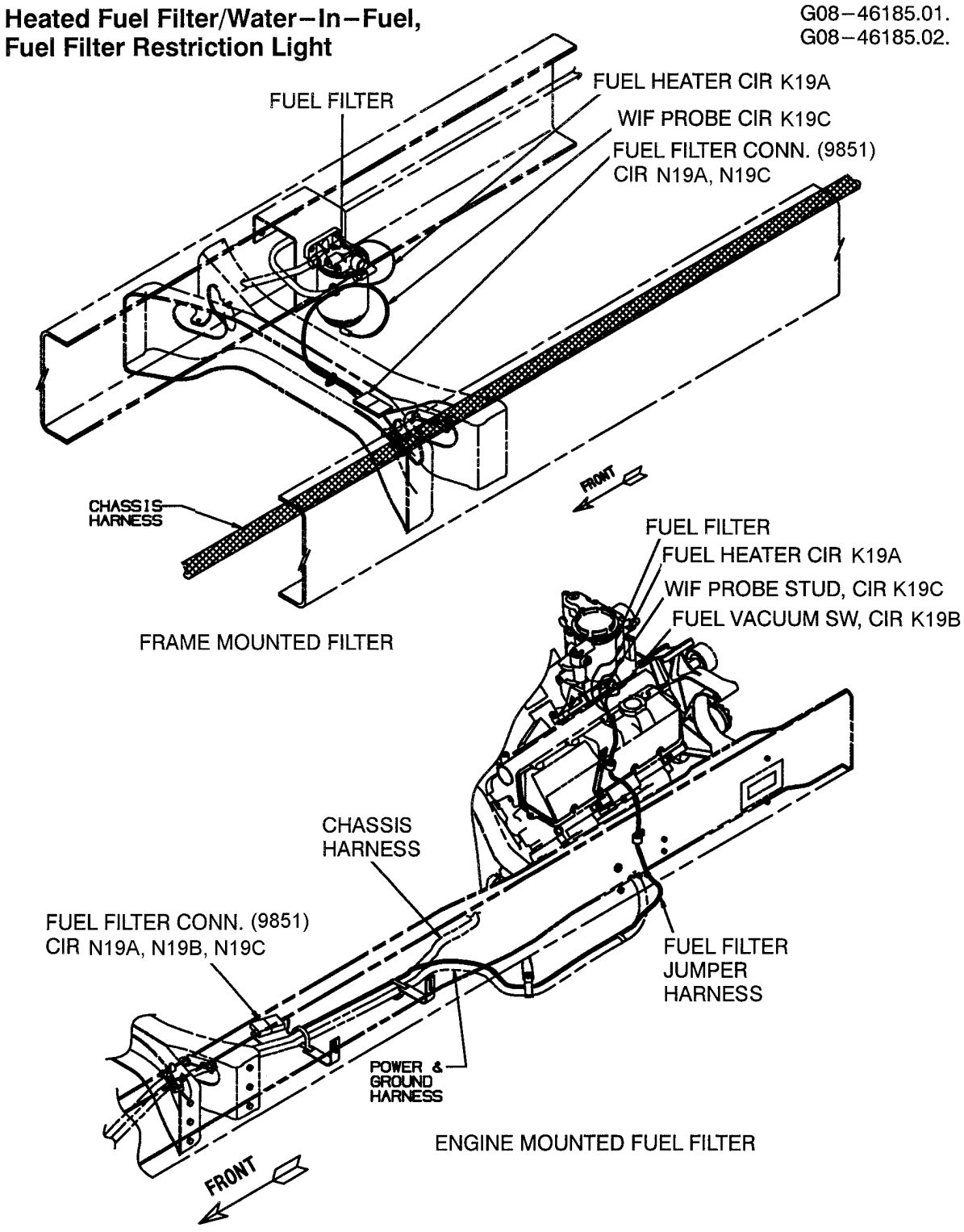

Figure 89 Fuel Filter Heater Wiring

Hydraulic Brake System

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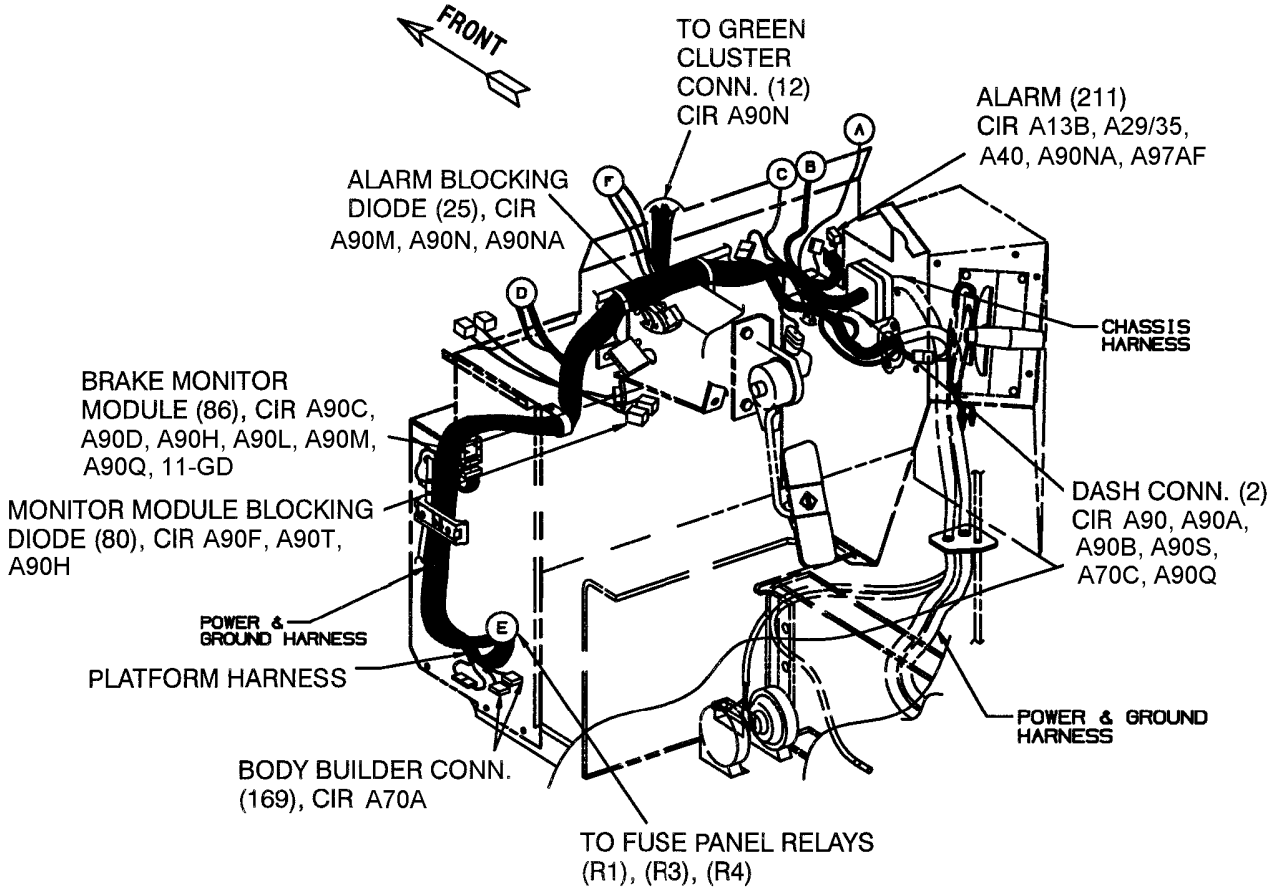

Figure 90 Hydraulic Brake System

Hydraulic Brake System

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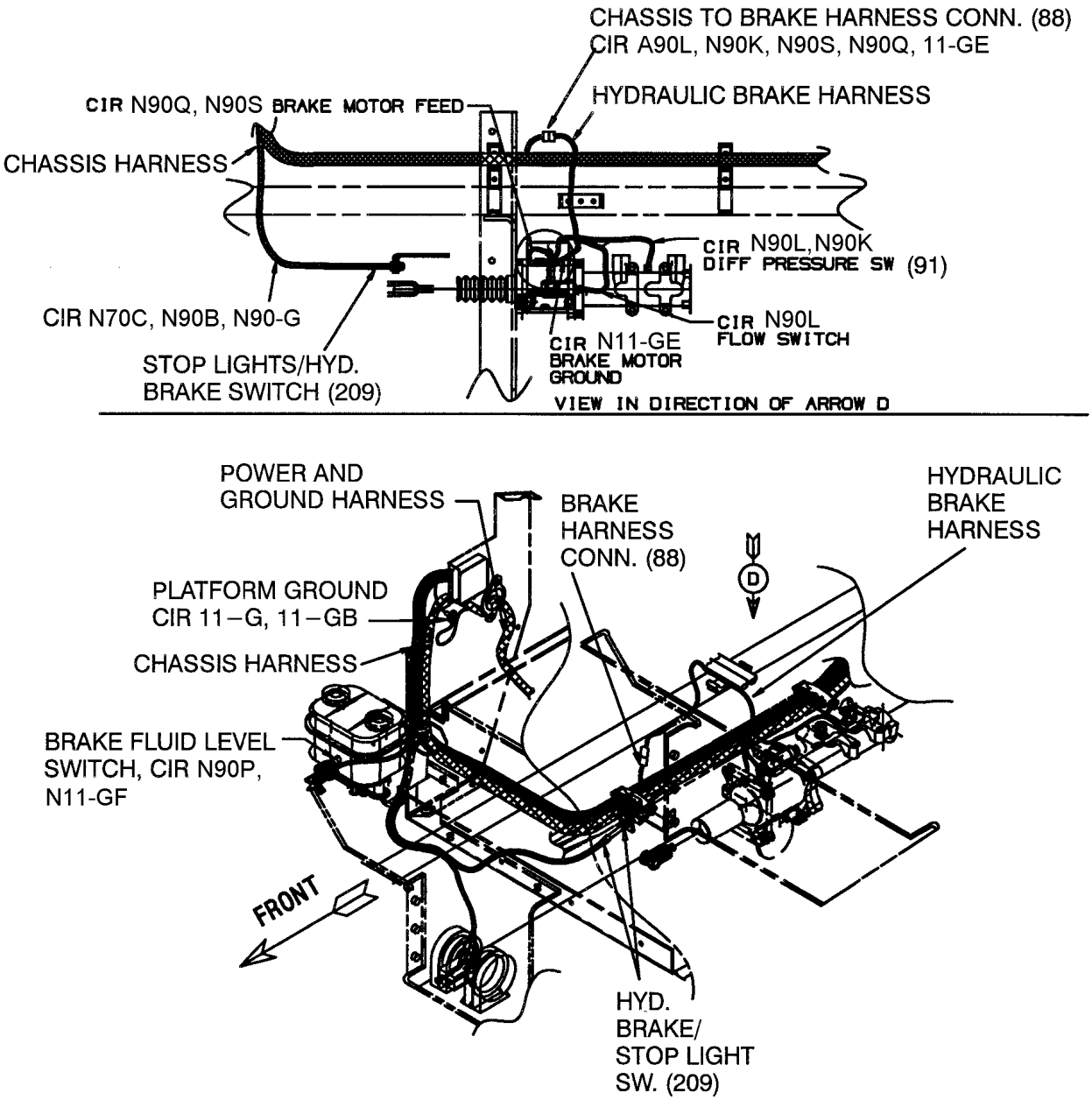


Figure 91 Hydraulic Brake System

15. RE 200/RE 300 LIGHT SYSTEMS

15.1. DESCRIPTION

Back-Up Lights With WTEC or LCT Transmission

The vehicle back-up lights are a set of lamps that come on when the vehicle transmission is shifted into reverse. This allows the driver to see while backing when dark.

Headlight System With Tilt Column and Douglas Turn Signal

A headlight system with a turn signal lever controlled dimmer switch is provided for illumination while driving.

Headlight System With Stationary Column and International Turn Signal

The headlight system provides illumination for driving and includes a turn signal operated Lift-To-Dim (LTD) switch and relay. The system also includes a turn signal lever operated Flash-To-Pass (FTP) switch and relay. This allows the driver to momentarily illuminate the high beam headlights and signal other drivers of the intent to pass.

Daytime Running Lights

The Daytime Running light feature allows the vehicle to operate in a “Lights On" condition at all times without driver input. This system operates the headlights at partial illumination but still helps to increase visibility even in bright sunshine.

Stop Light Switch (Air Brakes)

The stop light switch circuit controls voltage to the body builder connector, and is used by the body builder stop light circuits.

Panel Lights

Panel lights are low wattage bulbs that illuminate the instrument panel gauges, the automatic transmission shift selector and the cruise control panel light. The lights can be dimmed or brightened by the panel light variable dimmer control.

Daytime Running Lights With Engine Running Only

The Daytime Running light feature allows the vehicle to operate in a “Lights On" condition, only when the engine is running. This system operates the headlights at partial illumination but still helps to increase visibility even in bright sunshine.

Back-Up Lights With Fuller Manual Transmission

The vehicle back-up lights are a set of lamps that come on when the vehicle transmission is shifted into reverse. This allows the driver to see while backing when dark.

15.2. OPERATION

Back-Up Lights With WTEC Transmission Allison GEN 4

When the key switch (20) is moved to the start or ignition position, battery voltage is through the ignition switch relay (1711), circuits A13/A13H, fuse F24, circuit A71, dash connector (2–C5), circuit N71, chassis/engine harness connector (9850–3), circuit K71, back-up light relay connector (7505–1) and a black wire to the back-up light switch. When the back-up light relay contacts close, power flows through a white wire, connector

(7505–4) circuit K71A, chassis/engine harness connector (9850–4), circuit N71A, connector (2–G5), and circuit A71A to the body builder connector (169).

When the Allison ECU detects that the transmission is overheating or that there is a problem with the WTEC III system, it will apply a ground to circuit K#115 at connector (7204), pin 31. The battery voltage is through the ignition switch relay (1711), circuits A13/A13F, fuse F22, circuits A28 and A28C, and natural instrument cluster connector (12), pin 8, the “TRANS OIL TEMP” warning light, connector (12), pin 7, circuit A125, connector (377), circuit A125, connector (644), circuit N125, connector (523), circuit K#115, and ECU connector (7204), pin 31 to ground. This will cause the “TRANS OIL TEMP” warning light to illuminate.

Back-Up Lights With LCT Transmission

When the key switch (20) is moved to the start or ignition position, battery voltage is through the ignition switch relay (1711), circuits A13/A13H, fuse F24, circuit A71, dash connector (2–C5), circuit N71, chassis/engine harness connector (9850–3), circuit K71, back-up light switch connector (7303–11) and a black wire to the back-up light switch. When the back-up light switch contacts close, power flows through a white wire, connector (7303–10) circuit K71A, chassis/engine harness connector (9850–4), circuit N71A, connector (2–G5), and circuit A71A to the body builder connector (169).

Headlight System With Tilt Column and Douglas Turn Signal

Power flows from the (1F) battery feed stud through circuit A14D/A14C to fuse F14 and F15. When the headlight switch is in the PARK or on position, power flows through fuse F14, circuit A50A, to the headlight switch (23). This supplies power for the parking lights through circuit A58, and body builder connector (169), cavity H. Power is also applied to the panel lights through circuit A62.

When the headlight switch is in the on position, power flows through fuse F15, circuit A50, headlight switch (23), circuit A51, connector (4), a green wire, and to the dimmer switch.

With the dimmer switch in the low position, power flows through the low beam switch contacts, a blue wire, connector (4), and circuit A53/A53B to the body builder connector (170), cavity C.

With the dimmer switch in the high position, power flows through the high beam switch contacts, a brown wire, connector (4), and circuit A52/A52B to the body builder connector (170), cavity D. At the same time, power is also applied to the high beam dash indicator light through circuit A52A and the green cluster connector (11). Ground for the light is through circuit A28-G/A11-G to the platform ground.

Headlight System With Stationary Column and International Turn Signal

When the headlight dimmer switch is in the low beam position, and the headlight switch (23) is moved to the headlight on position, power flows from body builder feed stud (1F) through circuit A50, the closed headlight switch contacts, and circuit A66/A51A to the lift-to-dim relay (100) contacts, and circuit A51F to the relay coil. Power flows through the coil of relay (100) and through circuit A51D to the turn signal headlight dimmer switch connector (6). Power flows through the switch contacts, connector (6), and circuit A51-G/A11-GB to the platform ground. This energizes relay (100) and allows power to flow through circuit A53A/A53B to the body builder connector (170).

When the headlight dimmer switch is moved to the high beam position, the switch contacts open and the ground path to relay (100) is removed, which de-energizes the relay. Power then flows through circuit A52C/A52B to the body builder connector (170).

When the high beams are energized, power also flows from the A52C/A52B splice through circuit A52A, cluster connector (11), and the printed circuit board to the high beam indicator lamp. The indicator lamp is grounded through the printed circuit board, connector (11) and circuit A28-G/A11-G to the platform ground.

From the headlight switch, power is also applied through circuit A50B to the flash-to-pass relay (101) contacts and circuit A51C to the relay coil. When the turn signal lever is pushed forward and held in the flash-to-pass position, power flows through the coil of relay (101), circuit A51E, connector (6), dimmer switch contacts, connector (6), and circuit A51-G/A11-GB/A11–G to the platform ground. This energizes relay (101) and allows power to flow through the N.O. contacts and circuit A52D/A52B to the body builder connector (170).

Stop Light Switch (Air Brakes)

From the battery feed stud (1F), power is applied to circuit A14D/A14A, fuse F12, and circuit A70 to stop light switch (79). At the same time power is also applied through circuit A70B to stop light switch (78).

When the brake pedal is depressed, the stop light switch contacts close and power is applied to circuits A70B and A70C to the body builder connector (169).

Panel Lights

When the headlight switch (23) is in the park or on position, power is applied through circuit 62, fuse F21, circuit A62A, and connector (22) to the panel light dimmer control. The dimmer control ground is through connector (22), and circuit A62-GD/A11-GA to the platform ground. The dimmer control provides an adjustable voltage of 0 to 12 volts to the panel light junction (8) through circuit A62H.

From the panel light junction (8), power is applied through circuit A62C and dash cluster connector (11) to the center cluster lights. The lights are grounded through connector (11) and circuit A62-GB/A11-G to the platform ground. Power is also applied through circuit A62D and dash cluster connector (12) to the right cluster lights. The lights are grounded through connector (12) and circuit A62-GC/A11-G to the platform ground.

From the panel light junction (8), power is also applied to the transmission shift lever indicator light (7) through circuit A62E. The light ground is through circuit A62-GE/ A11-G to the platform ground.

From the panel light junction (8), power is also applied to the cruise/throttle set/coast resume/accel switch panel light (150) through circuit A62L. The light ground is through circuit A62-GF/A11-G to the platform ground.

From the panel light junction (8), power is also applied to the cruise/throtte on/off switch panel light (150) through circuit A62M. The light ground is through circuit A62-GH/A11-G to the platform ground.

From the panel light junction (8), power is also applied to the ATC switch panel light (150) through circuit A62N. The light ground is through circuit A62-GJ/A62-GH/A11-G to the platform ground. Power is also provided to the body builder connector (169) through circuit A62J.

Daytime Running Lights (DRL)

Power is supplied to USA DRL module (165) from (1F) junction block, through circuit A66F fuse F5 and circuit A66A. The module is provided a ground path through circuit A66-GA/A11–GB to cab ground.

When high beam/bright headlights are turned ON, a signal is sent to the USA DRL module (165) through circuit A66E, connector (4) and circuit A66E. Thus the module which supplies power to the fog light circuit A64A can switch OFF the fog lights when the high beam/bright headlights are selected.

The USA DRL module (165) is enabled via circuit A66 when the key switch (20) is moved to the ignition or accessories position. The module will then apply power to circuit A66C, connector (4), circuits A66C, A53, connector (4), circuit A53B to the low beam elements. The module will power the lights at about 60% of full power. When the headlight switch is moved to headlight ON position, the power from the headlight switch will override the module and power the lamps at 100%.

Back-Up Lights With Fuller Manual Transmission

When the key switch (20) is moved to the start or ignition position, battery voltage is through the ignition switch relay (1711), circuits A13/A13H, fuse F24, circuit A71, dash connector (2–C5), circuit N71, chassis/engine harness connector (9850–3), circuit K71, back-up light switch connector (304–A) and a black wire to the back-up light switch. When the back-up light switch contacts close, power flows through a white wire, connector (304–C), circuit K71A, chassis/engine harness connector (9850–4), circuit N71A, connector (2–G5), and circuit A71A to the body builder connector (169).

15.3. TROUBLESHOOTING

Before beginning these test procedures, do the following:

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

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

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

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

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

Back-Up Light System

Table 45 Back-Up Light System

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Check fuse F24 for open condition.	F24	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	On	At F24 and circuit A13H, measure voltage to ground.	F24, A13H to gnd.	12 ± 1.5 volts.	Install fuse. Go to next step.	Locate cause of low or no voltage in circuit A13H/A13, then repair.
3.	On	At body builder connector (169) and with transmission in reverse, measure voltage from cavity D, circuit A71A to ground.	(169), cav. D, A71A to gnd.	12 ± 1.5 volts.	Problem exists in body circuitry. Refer to body builder manual.	Go to next step.

Table 45 Back-Up Light System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
4.	Off	At body builder connector (169), install jumper from cavity D, circuit A71A to ground. Disconnect back-up light switch connector (7505). At connector, measure resistance from circuit A71A to ground.	(7505), A71A to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A71A, or engine/ chassis harness conn. (9850) or platform harness conn. (2), then repair.
5.	On	At connector (7505), measure voltage from circuit V71 to ground.	(7505), V71 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit V71, or engine/ chassis harness conn. (9850), or platform harness connector (2), then repair.
6.	Off	At switch (7505) and with transmission in reverse, measure resistance from black wire to white wire.	(7505), black wire to white wire.	< 1 ohm.	Go to next step.	Replace switch (7505).
7.	Off	Remove jumper and reconnect (7505). Back-up light switch circuitry checks good.				

Headlight System With Tilt Column and Douglas Turn Signal

Table 46 Headlight System With Tilt Column and Douglas Turn Signal

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove fuses F14 and F15. Check for open condition.	F14, F15.	< 1 ohm	Go to next step.	Locate cause of overload condition, then repair. Replace fuse(s).
2.	Off	At fuse F14, measure voltage from A14C/A14D to ground.	F14, A14C/A14D to gnd.	12 ± 1.5 volts.	Install fuses. Go to next step.	Locate cause of low or no voltage in circuit A14C/A14D, then repair. Install fuses.
3.	Off	Remove headlight switch connector (23). Measure voltage from circuit A50A to ground.	(23), A50A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A50A, then repair.

Table 46 Headlight System With Tilt Column and Douglas Turn Signal (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
4.	Off	At connector (23), measure voltage from circuit A50 to ground.	(23), A50 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A50, then repair.
5.	Off	With headlight switch (23) in park position, measure resistance across terminals that were connected to circuits A50A and A62, and A50A and A58.	(23), across A50A to A62 and A50A to A58.	< 1 ohm.	Go to next step.	Replace headlight switch.
6.	Off	With headlight switch (23) in on position, measure resistance across terminals that were connected to circuits A50 and A51.	(23), across A50 to A51.	< 1 ohm.	Go to next step.	Replace headlight switch.
7.	Off	Reconnect connector (23) and disconnect body builder connector (169). With headlight switch in park or on position, measure voltage from cavity H, circuit A58 to ground.	(169), cav. H, A58 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A58, then repair.
8.	Off	Reconnect connector (169) and disconnect dimmer switch connector (4). With headlight switch on, measure voltage from circuit A51 to ground.	(4), A51 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A51, then repair.
9.	Off	With dimmer switch in the low beam position, measure resistance at dimmer pigtail, from green wire to blue wire.	Dimmer pigtail, green wire to blue wire.	< 1 ohm.	Go to next step.	Replace dimmer switch.
10.	Off	With dimmer switch in high beam position, measure resistance at dimmer pigtail, from green wire to brown wire.	Dimmer pigtail, green wire to brown wire.	< 1 ohm.	Go to next step.	Replace dimmer switch.

Table 46 Headlight System With Tilt Column and Douglas Turn Signal (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
11.	Off	Reconnect (27) and disconnect body builder connector (170). With dimmer switch in low beam position and headlight switch on, measure voltage from cavity C, circuit A53B to ground.	(170), cav. C, A53B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A53B/A53, then repair.
12.	Off	With dimmer switch in high beam position and headlight switch on, measure voltage from cavity D, circuit A52B to ground.	(170), cav. D, A52B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A52B/A52, then repair.
13.	Off	Reconnect (170) and disconnect green cluster connector (11). With headlight switch on and dimmer switch in high beam position, measure voltage from cavity 4, circuit A52A to ground.	(11), cav. 4, A52A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A52A, then repair.
14.	Off	At (11) and with switches still set, measure voltage from cavity 4, circuit A52A to cavity 2, circuit A28–G.	(11), cav. 4, A52A to cav. 2, A28–G.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A28–G/ A11–G or platform ground, then repair.
15.	Off	Headlight, dimmer switch and high beam indicator circuits check good. If condition persists, refer to body builder manual.				

Headlight System With Stationary Column and International Turn Signal

Table 47 Headlight System

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove fuses F14 and F15. Check for open condition.	F14, F15.	< 1 ohm	Go to next step.	Locate cause of overload condition, then repair. Replace fuse(s).

Table 47 Headlight System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
2.	Off	At fuse F14, measure voltage from A14C/A14D to ground.	F14, A14C/A14D to gnd.	12 ± 1.5 volts.	Install fuses. Go to next step.	Locate cause of low or no voltage in circuit A14C/A14D, then repair. Install fuses.
3.	Off	Disconnect headlight switch connector (23). Measure voltage from circuit A50 to ground.	(23), A50 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A50, or for open in fuse F15, then repair.
4.	Off	With headlight switch in the on position, measure resistance from terminal that was connected to circuit A50 to terminal that was connected to circuit A51/A66.	Across switch (23).	< 1 ohm.	Go to next step.	Replace switch.
5.	Off	Reconnect headlight switch (23) and remove lift-to-dim relay (100). Move headlight switch to on position, and at relay socket cavity B, circuit A51F, measure voltage to ground.	(100), A51F to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A51F or A51A/A66, then repair.
6.	Off	Disconnect headlight dimmer switch connector (6) and at circuit A51–G, measure resistance to ground.	(6), A51–G to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A51–G/A11–GB, then repair.
7.	Off	With the headlight dimmer switch in the low beam position, measure resistance from cavity C to B of connector (6) that goes to switch.	(6), cav. C to B.	< 1 ohm.	Go to next step.	Replace turn signal assembly.
8.	Off	With the headlight dimmer switch in the high beam position, measure resistance from cavity C to B of connector (6) that goes to switch.	(6), cav. C to B.	> 100K ohms.	Go to next step.	Replace turn signal assembly.

Table 47 Headlight System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
9.	Off	At connector (6) that goes to headlight dimmer switch, measure resistance from cavity A to B.	(6), cav. A to B.	> 100K ohms.	Go to next step.	Replace turn signal assembly.
10.	Off	With the headlight dimmer switch held in the flash- to-pass position, measure resistance from cavity A to B of connector (6) that goes to switch.	(6), cav. A to B.	< 1 ohm.	Go to next step.	Replace turn signal assembly.
11.	Off	Reconnect connector (6) and place dimmer switch in low beam position. At lift-to- dim relay (100) socket cavity A, measure resistance of circuit A51D to ground.	(100), cav. A, A51D to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A51D, then repair.
12.	Off	Bench test relay (100) by measuring resistance from pin 30 to 87A.	Relay (100), pin 30 to 87A.	< 1 ohm.	Go to next step.	Replace lift-to-dim relay.
13.	Off	Bench test relay (100) by applying +12V to pin 85, ground to pin 86 and measuring resistance from pin 30 to 87.	Energized relay (100), pin 30 to 87.	< 1 ohm.	Go to next step.	Replace lift-to-dim relay.
14.	Off	Re-install relay (100) and remove flash-to-pass relay (101). With headlight switch on, measure voltage at socket cavity B, circuit A51C to ground.	(101), cav. B, A51C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A51C/A50B, then repair.
15.	Off	While holding dimmer switch in flash-to- pass position and at relay socket (101) cavity A, measure resistance from circuit A51E to ground.	(101), cav. A, A51E to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A51E, then repair.
16.	Off	Bench test relay (101) by measuring resistance from pin 30 to 87A.	Relay (101), pin 30 to 87A.	< 1 ohm.	Go to next step.	Replace flash-to-pass relay.

Table 47 Headlight System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
17.	Off	Bench test relay (101) by applying +12V to pin 85, ground to pin 86 and measuring resistance from pin 30 to 87.	Energized relay (101), pin 30 to 87.	< 1 ohm.	Go to next step.	Replace flash-to-pass relay.
18.	Off	Re-install relay (101) and disconnect body builder connector (170). While holding dimmer switch in flash-to- pass position, measure voltage from circuit A52B to ground.	(170), A52B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A52B/A52D, then repair.
19.	Off	With headlight switch on, move dimmer switch to high beam position. At (170), measure voltage from circuit A52B to ground.	(170), A52B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A52B/A52C, then repair.
20.	Off	With headlight switch on, move dimmer switch to low beam position. At (170), measure voltage from circuit A53B to ground.	(170), A53B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 53B/A53A, then repair.
21.	Off	Does high beam indicator illuminate properly?			Go to Step 24.	Go to next step.
22.	Off	Disconnect dash cluster connector (11). With headlight switch on and dimmer switch in high beam position, measure voltage from circuit A52A to ground.	(11), A52A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A52A, then repair.
23.	Off	At (11) and with switches still set, measure voltage from circuit A52A to A28–G.	(11), A52A to A28–G.	12 ± 1.5 volts.	Check lamp. If OK, replace cluster.	Locate open or poor connection in circuit A28–G/ A11–G, then repair.
24.	Off	Headlight, dimmer switch and high beam indicator circuits check good. If condition persists, refer to body builder manual.				

Stop Light Switch (Air Brakes)

Table 48 Stop Light Switch (Air Brakes)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Check fuse F12 for open condition.	F12	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	Off	At F12 and circuit A14A/A14D, measure voltage to ground.	F12, A14A/ A14D to gnd.	12 ± 1.5 volts.	Install fuse. Go to next step.	Locate cause of low or no voltage in circuit A14A/A14D, then repair. Re-install fuse.
3.	Off	Remove stop light connector (78) and (79). At connector (78), measure voltage from circuit A70B to ground.	(78), A70B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A70B or A70, then repair.
4.	Off	With brakes applied, measure resistance across switch terminals of each switch (78) and (79).	(78) and (79), across term.	< 1 ohm each switch.	Go to next step.	Replace stop light switch(es).
5.	Off	Reconnect stop light switch connectors (78) and (79) and disconnect body builder connector (169). With brakes applied and at (169), measure voltage from circuit A70B to ground.	(169), A70B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A70B or A70C, then repair.
6.	Off	Stop light switch circuitry to body builder connector (169) checks good.				

Panel Lights

Table 49 Panel Lights

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove fuse F21 and check for open condition.	F21	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.

Table 49 Panel Lights (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
2.	Off	The following steps must be performed with the headlight switch on. At fuse F21, measure voltage from A62 to ground.	F21, A62 to gnd.	12 ± 1.5 volts.	Re-install fuse. Go to next step.	Locate cause of low or no voltage in circuit A62, then repair. Re-install fuse.
3.	Off	Disconnect panel light switch connector (22). At harness connector, measure voltage from circuit A62A to ground.	(22), A62A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A62A, then repair.
4.	Off	At connector (22), measure voltage across circuit A62A to A62–GD.	(22), A62A to A62–GD.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A62–GD/ A11–G, then repair.
5.	Off	Adjust switch (22) to bright position and measure resistance across pigtail blue wire to yellow wire.	(22), pigtail blue to yellow wire.	< 1 ohm.	Go to next step.	Replace switch.
6.	Off	Reconnect switch connector (22) and disconnect bussed connector (8). At circuit A62H, measure voltage to ground.	(8), A62H to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A62H, then repair.
7.	Off	Reconnect connector (8) and disconnect body builder connector (169). At (169), measure voltage from circuit A62J to ground.	(169), A62J to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A62J, then repair.
8.	Off	Reconnect connector (169) and disconnect green dash cluster connector (11). At harness connector (11), cavity 1, measure voltage from circuit A62C to ground.	(11), cav. 1, A62C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A62C, then repair.

Table 49 Panel Lights (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
9.	Off	At (11), measure voltage across cavity 1, circuit A62C to cavity 11, circuit A62–GB.	(11), across A62C to A62–GB.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A62–GB/ A11–G, then repair.
10.	Off	Circuits to center cluster check good. Reconnect (11) and replace any lamps that fail to work. Do all lamps work?			Go to next step.	Replace dash cluster assembly.
11.	Off	Disconnect natural colored dash cluster connector (12). At harness connector (12), cavity 1, measure voltage from circuit A62D to ground.	(12), cav. 1, A62D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A62D, then repair.
12.	Off	At (12), measure voltage across cavity 1, circuit A62D to cavity 10, circuit A62–GC.	(12), across A62D to A62–GC.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A62–GC/ A11–G, then repair.
13.	Off	Circuits to center cluster check good. Reconnect (12) and replace any lamps that fail to work. Do all lamps work?			Go to next step.	Replace dash cluster assembly.
14.	Off	Disconnect automatic transmission light connector (7) and measure voltage from circuit A62E to ground.	(7), A62E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A62E, then repair.
15.	Off	At (7), measure voltage across circuit A62E to circuit A62–GE.	(7), across A62E to A62–GE.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A62–GE/ A11–G, then repair.
16.	Off	Automatic transmission light circuits check good. Reconnect connector (7). Does light operate?			Go to next step.	Replace lamp or socket assembly.

Table 49 Panel Lights (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
17.	Off	Disconnect cruise/throttle set/coast switch panel light (150) and measure voltage from circuit A62L to ground.	(150), A62L to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A62L, then repair.
18.	Off	At connector (150), measure voltage across circuit A62L to A62–GF.	(150), A62L to A62–GF.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A62–GF/ A11–G, then repair.
19.	Off	Cruise/throttle set/coast switch panel light circuits check good. Reconnect connector (150). Does light operate?			End test.	Replace lamp or socket assembly.
20.	Off	Disconnect cruise/throttle on/off switch panel light (150) and measure voltage from circuit A62M to ground.	(150), A62M to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A62M, then repair.
21.	Off	At connector (150), measure voltage across circuit A62M to A62–GH.	(150), A62M to A62–GH.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A62–GH/ A11–G, then repair.
22.	Off	Cruise/throttle on/off switch panel light circuits check good. Reconnect connector (150). Does light operate?			End test.	Replace lamp or socket assembly.
23.	Off	Disconnect ATC switch panel light (150) and measure voltage from circuit A62N to ground.	(150), A62N to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A62N, then repair.

Table 49 Panel Lights (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
24.	Off	At connector (150), measure voltage across circuit A62N to A62–GJ	(150), A62N to A62–GJ.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit A62–GJ/ A62–GH/A11–G, then repair.
25.	Off	ATC switch panel light circuits check good. Reconnect connector (150). Does light operate?			End test.	Replace lamp or socket assembly.

Daytime Running Lights (DRL)

Table 50 Daytime Running Lights (DRL)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove fuse F5 and check for open condition.	F5	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	Off	Re-install fuse F5, and at circuit A66F, measure voltage to ground.	F5, A66F to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A66F, then repair.
3.	Off	Remove fuse F6 and check for open condition.	F6	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
4.	Off	Re-install fuse F6, and at circuit A12B/A12, measure voltage to ground.	F6, A12B/A12 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A12B/A12, then repair.
5.	Off	Disconnect connector (224) and with headlight switch in headlight position and dimmer switch in dim position, at (4) circuit A66C, measure voltage to ground.	(4), A66C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A66C, then repair.
6.	Off	Move dimmer switch to high beam position and at connector (4) circuit A66E, measure voltage to ground.	(4), A66E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage circuit A66E, then repair.

Table 50 Daytime Running Lights (DRL) (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
7.	Off	Disconnect connector (165) and reconnect (4). With switches still set, at (165) measure voltage from circuit A66E to ground.	(165), A66E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage circuit A66E, then repair.
8.	Off	Move dimmer switch to dim position and at connector (165) circuit A66C, measure voltage to ground.	(165), A66C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage circuit A66C, then repair.
9.	Off	At connector (165) and circuit A66–GA, measure resistance to ground.	(165), A66–GA to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A66–GA, then repair.
10.	Off	Move key switch to accessories position and at connector (165) circuit A66, measure voltage to ground.	(165), A66 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A66, then repair.
11.	Off	Reconnect connector (165). DRL circuits check good.				

15.4. COMPONENT LOCATIONS

(1F) Body Builder Feed Stud	Lower Left Platform Kick Panel
(2F) Battery Feed Stud	Battery Compartment
(2) Dash Connector	Right Side of Platform, Inside
(4) Dimmer Switch Connector With Douglas Turn Signal	Bottom of Steering Column
(6) Dimmer Switch Connector With International Turn Signal	Bottom of Steering Column
(7) Auto. Trans. Shift Light	Behind Shift Lever
(8) Panel Light Junction Block	At Dash Cluster Harness Breakout
(11) Instrument Cluster Connector	Rear of Instrument Cluster Panel (Green)
(12) Instrument Cluster Connector	Rear of Instrument Cluster Panel (Natural)
(13) Turn Signal Switch Connector	Bottom of Steering Column
(22) Panel Light Dimmer	Beside Headlight Switch
(23) Headlight Switch	Left Side of Dash
(7505) Back-up Light Switch	On Transmission
(62) International Turn Signal Switch	Steering Column
(78) Stop Light Switch	Left Front, Under Instrument Panel
(79) Stop Light Switch	Left Front, Under Instrument Panel
(95) Douglas Turn Signal Switch	Steering Column
(100) Lift-to-Dim Relay	On Fuse Block Bracket
(101) Flash-to-Pass Relay	On Fuse Block Bracket
(150) Panel Light Cruise Switch	Behind Instrument Panel Cruise Switch
(165) USA DRL Module	Platform, Inside Top Left
(169) Body Builder Connector	Left Side of Dash, Above Fuse Block
(170) Front End Body Builder Connector	Left Side of Dash, Above Fuse Block
(9850) Chassis to Engine W/H Connector	Right Side, Rear of Engine
(4) USA DRL Connector	Platform Harness

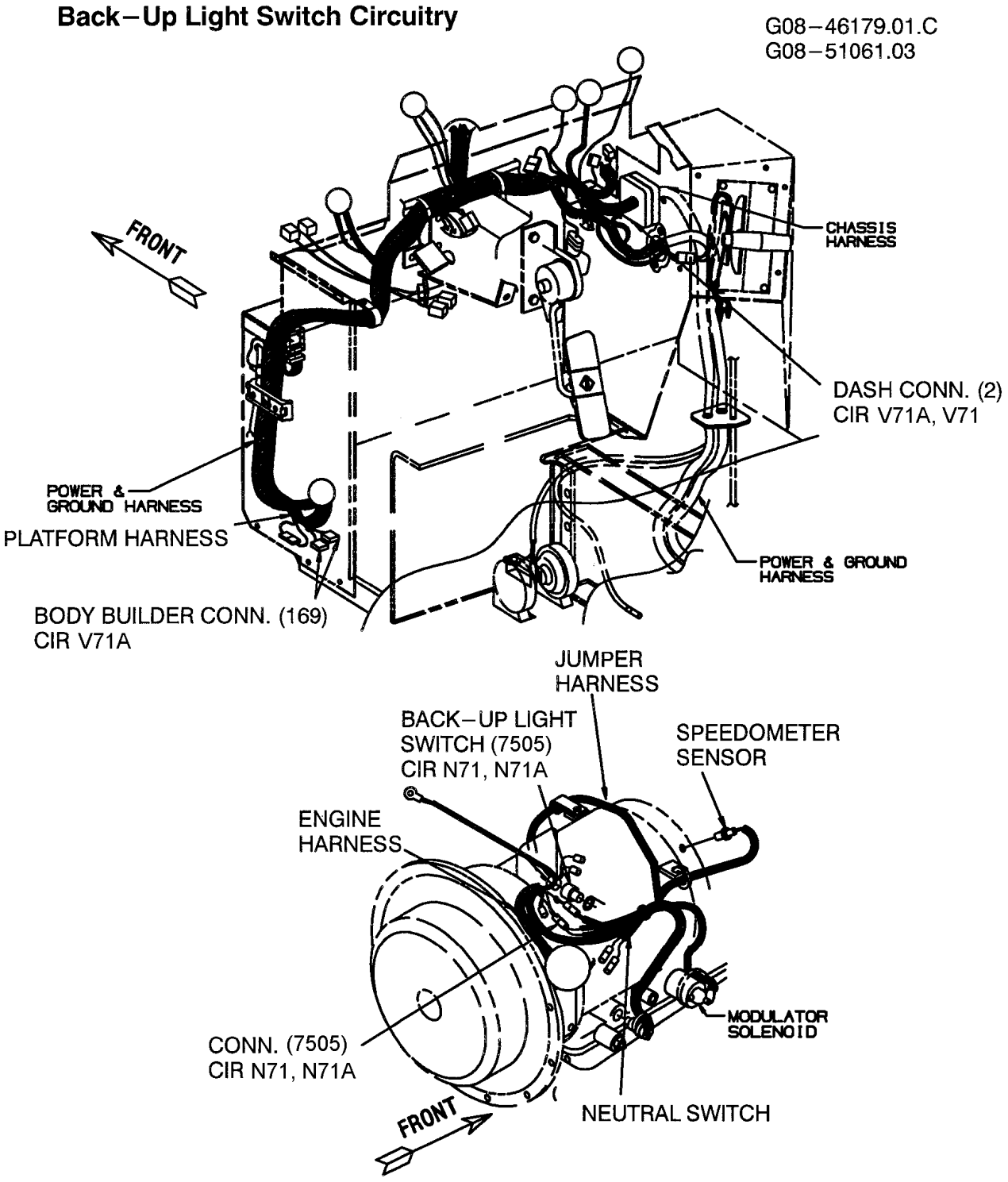


Figure 92 Back-Up Light Switch Circuitry

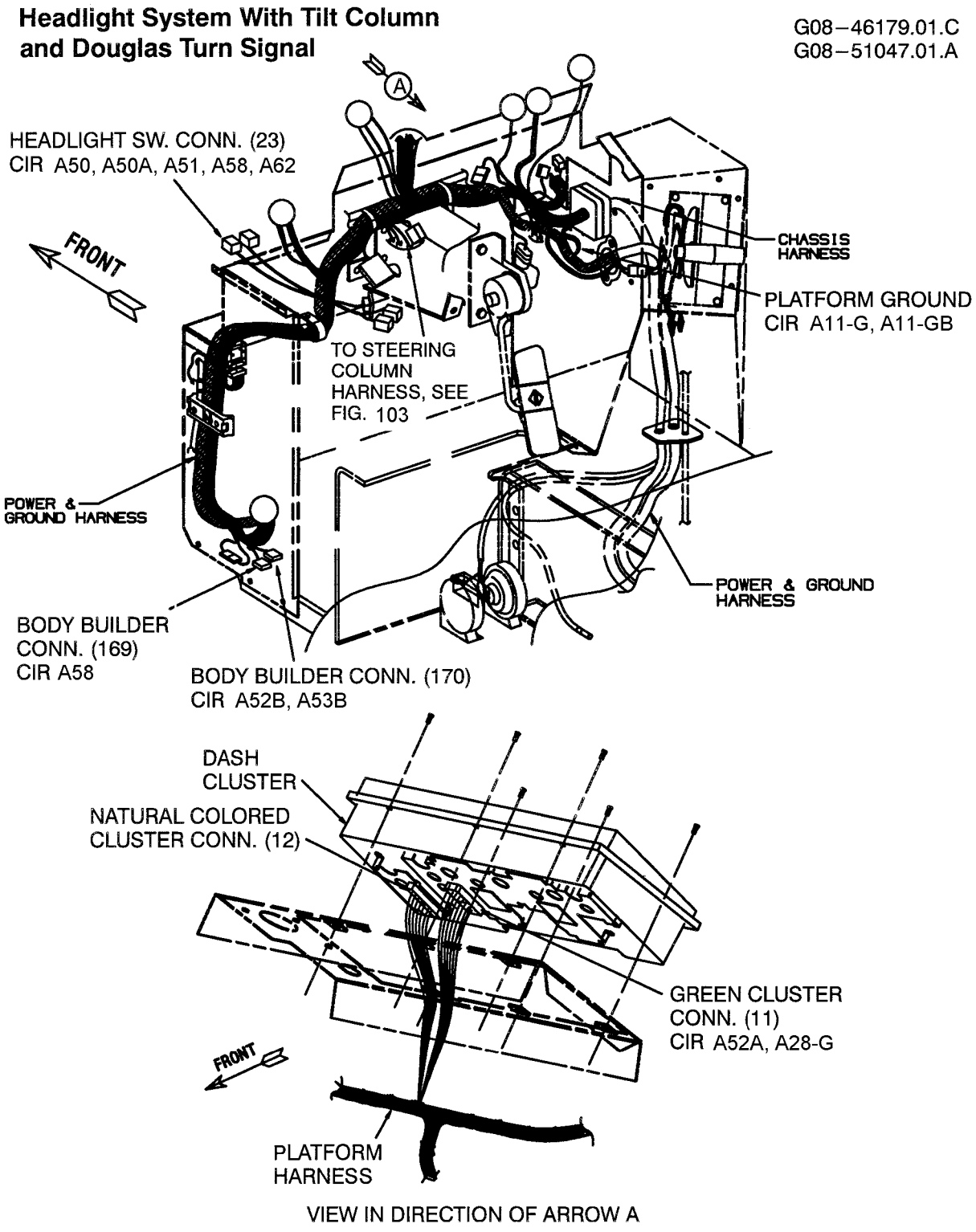


Figure 93 Headlight System With Tilt Column and Douglas Turn Signal

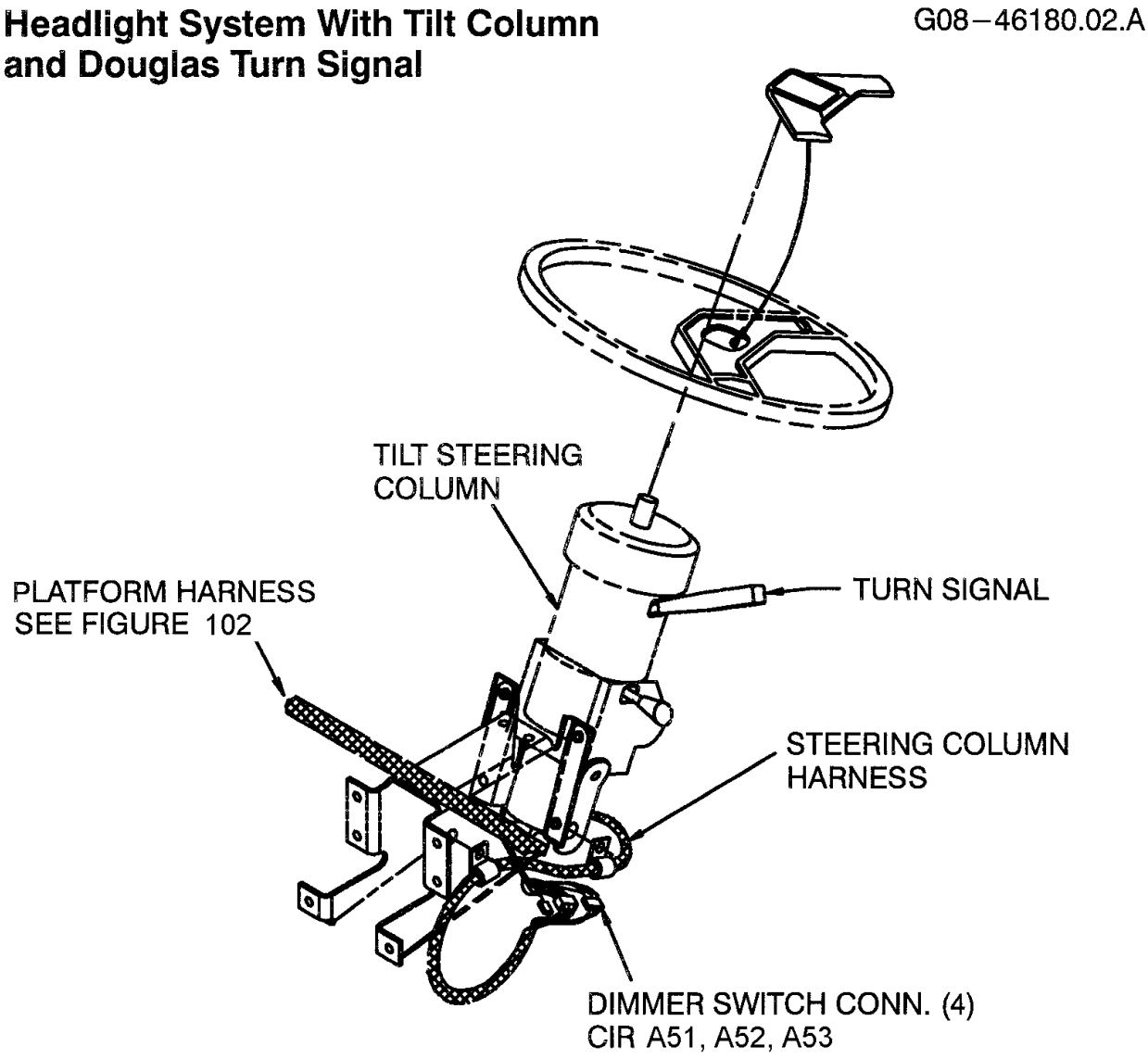


Figure 94 Headlight System With Tilt Column and Douglas Turn Signal

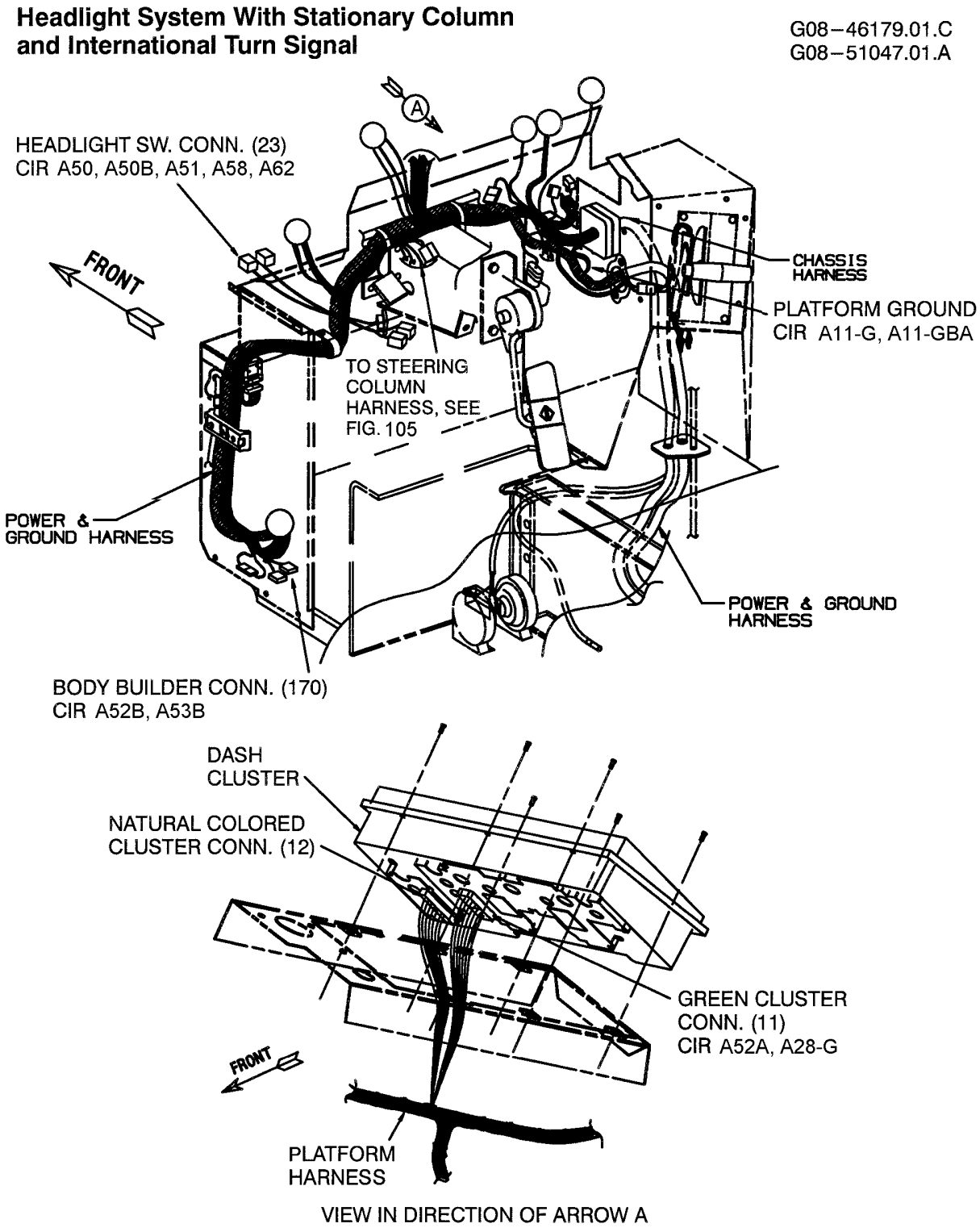


Figure 95 Headlight System With Stationary Column and International Turn Signal

Headlight System With Stationary Column and International Turn Signal

G08−46180.01.A

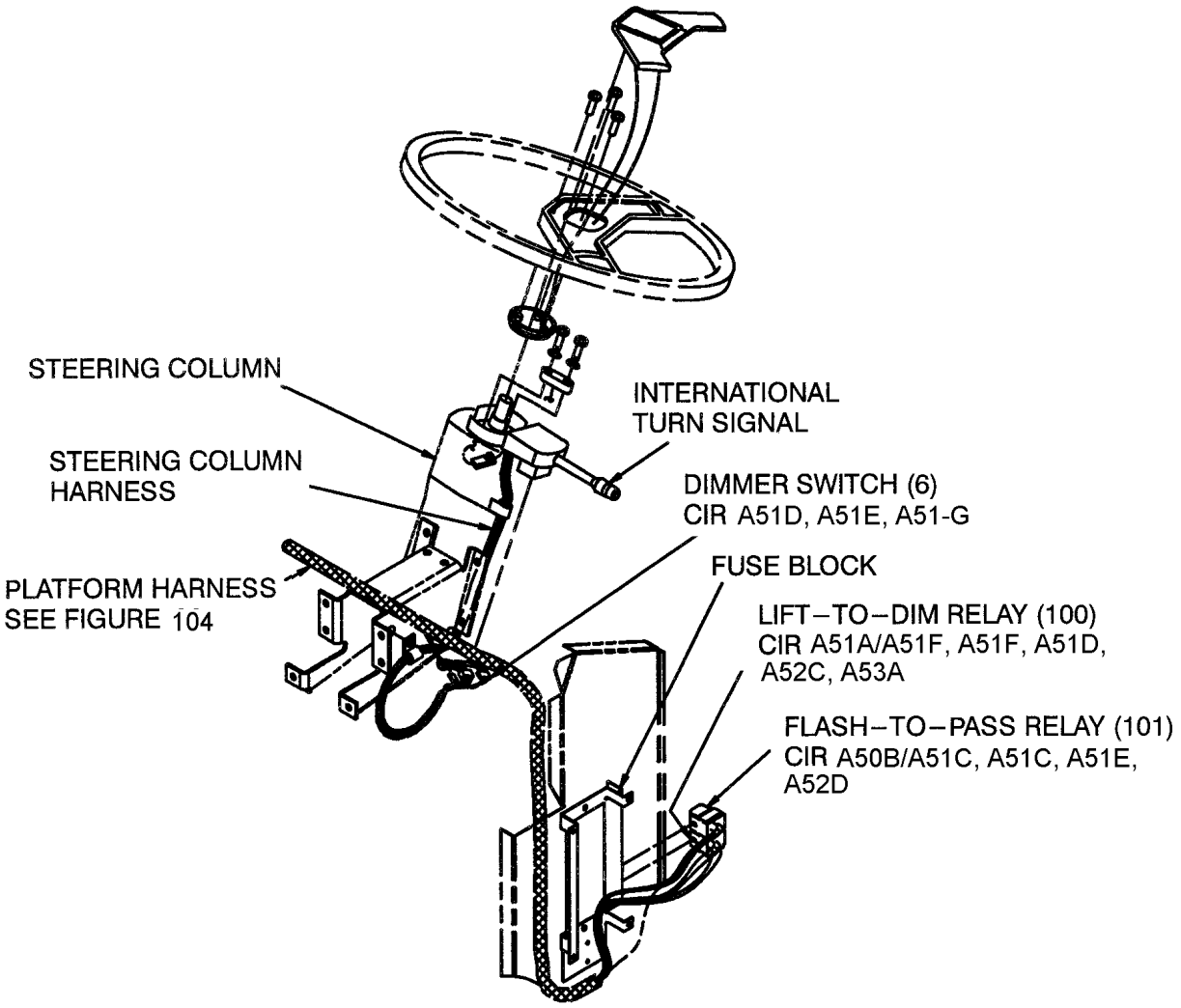


Figure 96 Headlight System With Stationary Column and International Turn Signal

Stop Light Switch Circuitry (Air Brakes)

G08−46179.01.C

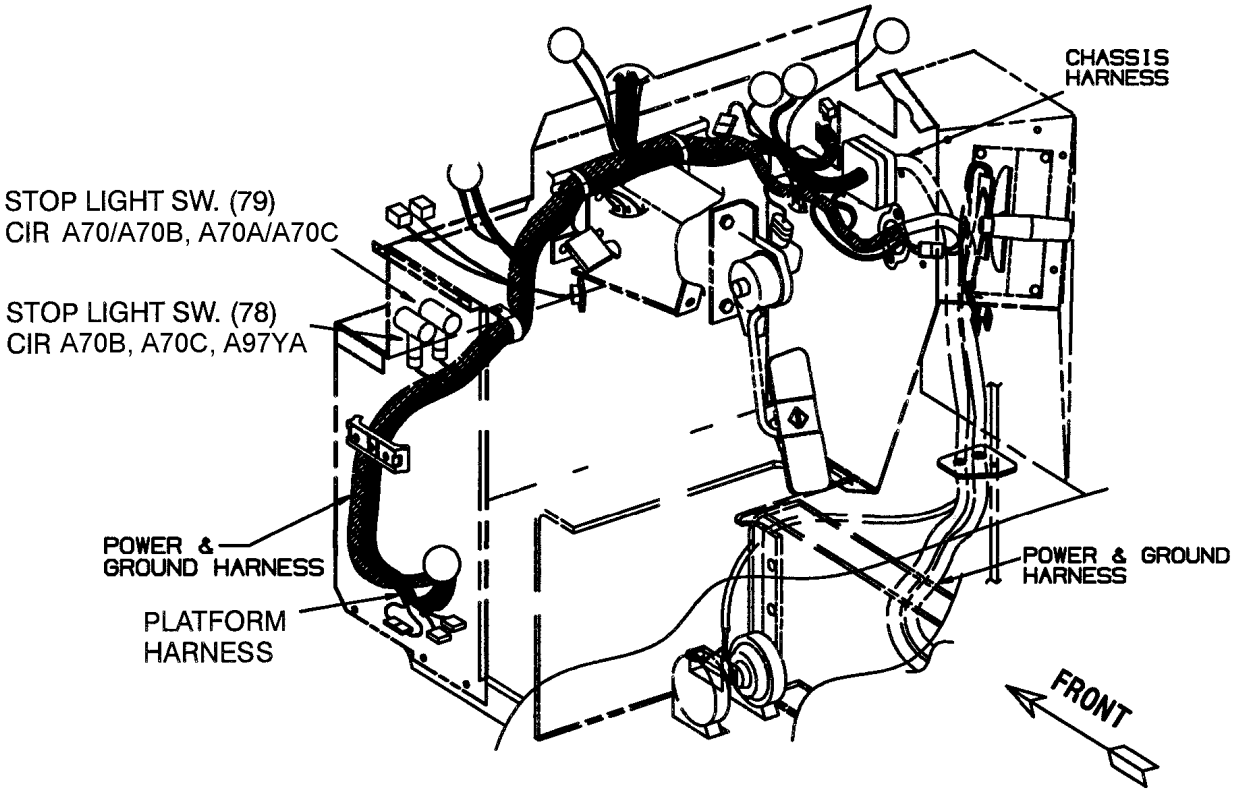


Figure 97 Stop Light Switch Circuitry (Air Brakes)

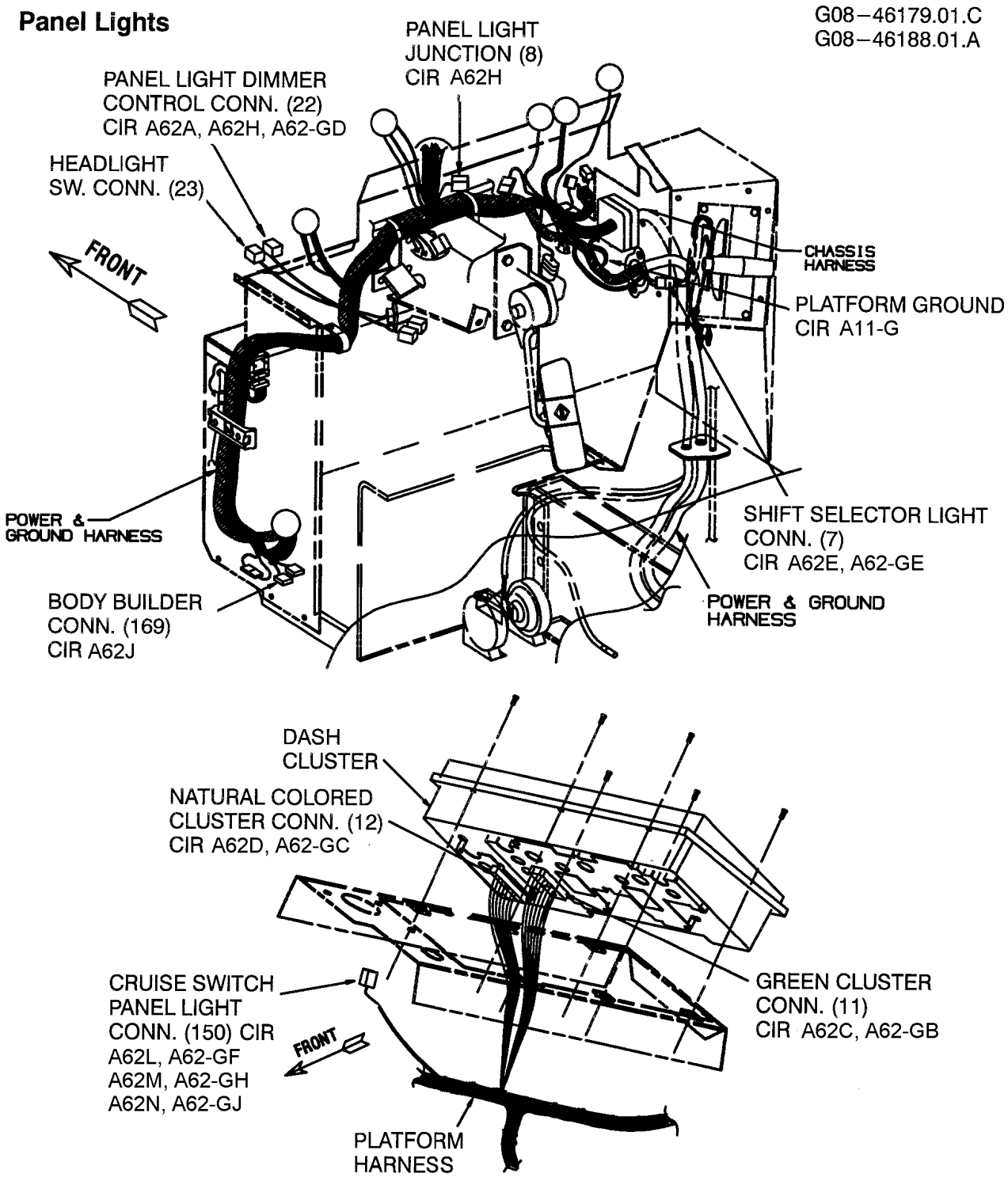


Figure 98 Panel Lights

Daytime Running Lights (DRL)

G08–51386.01

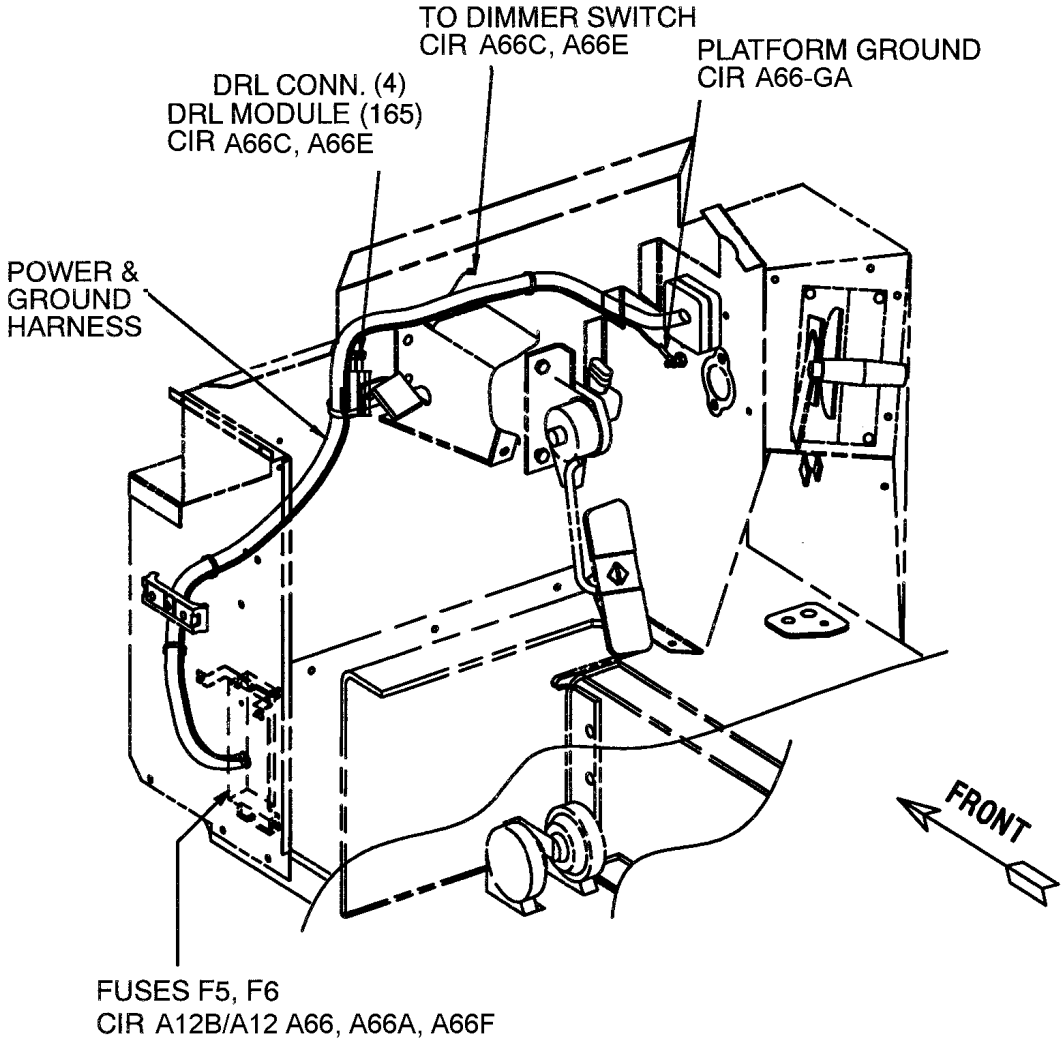


Figure 99 Daytime Running Lights (DRL)S

16. RE 200/RE 300 ELECTRONIC ENGINES

16.1. DESCRIPTION

ATA Data Link and Diagnostic/ Programming Connector

A diagnostic/programming ATA data link connector allows an Electronic Service Tool (EST) to communicate with the engine Electronic Control Module (ECM2), the Injector Driver Module (IDM2) and the Multiplexed Signal Module (MSM). The data communication link carries serial data transmissions between the ECM2 and the electronic service tool and is used to transmit calibration, programming and diagnostic information. The data link provides communication capabilities for:

- Engine parameter data transmission
- Diagnostics and troubleshooting
- Customer programming of vehicle parameters
- Production line programming of vehicle features
- Field programming.

ECM2 Power and Ground

The engine Electronic Control Module 2 (ECM2) monitors and controls engine performance to ensure maximum performance and adherence to emission standards. The ECM2 also monitors and controls vehicle features such as cruise control and starter engagement. The module is provided with 12 volt operating power through a relay when the key switch is in the ignition position. The circuitry is protected by a 50 amp fuse that is part of the battery cable assembly. Control module ground is to the negative post of the batteries.

APS/IVS

The Accelerator Pedal Position Sensor (APS) is a potentiometer type sensor which, when supplied with a 5 volt reference signal from the Electronic Control Module 2 (ECM2), provides a linear analog voltage signal that indicates the driver's demand for power. The APS signal is used in calculating desired fuel quantity and injector timing.

The Idle Validation Switch (IVS) is a 0/12 volt switch that provides the ECM2 with a redundant signal to verify when the pedal is in the idle position.

These two functions are integrated into one component mounted on the accelerator pedal. The pedal assembly is serviceable to the extent that the APS/IVS can be replaced without replacing the complete pedal.

BAP

The Barometric Air Pressure sensor (BAP) is a variable capacitance sensor, that when supplied with a 5 volt reference signal from the ECM2, produces a linear analog voltage signal that varies with altitude. The BAP signal is used by the ECM2 to adjust timing and fuel quantity, to optimize engine operation and control smoke throughout all altitude conditions.

ATS

The ambient Air Temperature Sensor (ATS) is a thermistor type sensor that has a variable resistance which changes when exposed to different temperatures. The ECM2 and IDM2 measures the signal from the sensor and uses the data to adjust timing and fuel rate to limit smoke emissions in cold weather starting.

Cruise Control/Remote Engine Controls

The cruise control system controls engine and vehicle speed using automotive style on/off and set/resume switches. Speed control is disabled when the off switch is depressed, the brake is applied, the clutch pedal is depressed or an automatic transmission is placed in neutral.

The clutch pedal switch supplies the Driveline Disengaged Signal (DDS) to the ECM2 and the brake switches also supply input signals to the ECM2. These signals indicate pedal positions and are used by the ECM2 in operating the cruise control system.

The Vehicle Speed Sensor (VSS) and the Camshaft Position sensor (CMP) provide vehicle speed and engine RPM signals to the ECM2. This information is also used by the ECM2 to control the system.

Circuity for remote engine speed controls are provided for use by a body builder. For information on remote engine controls for body builder applications, refer to Miscellaneous Information in CT-471 Body Builder Book.

16.2. OPERATION

ATA Data Link and Diagnostic / Programming Connector

The 9-pin ATA data link connector (384) supplies power for an Electronic Service Tool (EST) through fuse F28 and circuit A97C. Ground for the EST is through A97-GK to cab ground (1PG).

The EST is able to communicate with the engine control system through a twisted pair of wire circuits. The connector serial data transmission lines are through circuit A98E(+) and circuit A98F(-) to the instrument cluster (11). Communication with the ECM2 or IDM2 is through circuit K3AB and circuit K3AB(-) to the 48-pin dash connector (6000). From the dash connector (6000), the communication circuits are K3AA(+) to ECM2 connector (6021) pin 20 and K3AA(-) to pin 21, and circuits are K3AB(+) to IDM2 connector (6011) pin 2 and K3AB(-) to pin 3.

The communication system also includes an ATA interface connector (374) for use with aftermarket requirements. The communication link for the interface is through circuits A98B(+)/A98H(+) and A98D(-)/A98G(-).

ECM Power and Ground

Power is supplied by the batteries to circuit 14A, a 40A inlinefuse (1C-A), circuit 14B, engine harness to positive battery cable connector (412), circuit 14B/N97AA to connector (6323), circuit N97X to connector (6000), circuit V97X to split circuit V97JA to the ECM2 power relay (6005) coil and circuit K97HB, fuse (1B—B4), circuit V97HA to contacts. Also, power is supplied through circuit V97LB to the IDM2 power relay (6006) coil and circuit V97TC to contacts.

From the ECM2 power relay (6005) coil, power is applied to circuit V97J and pin 5 of the ECM2 (6020). Also, from the IDM2 power relay (6005) coil, power is applied to circuit V97LA and pin 8 of the IDM2 (6011).

When key switch (20) is moved to the ignition position, power is supplied through fuse F12, circuit V97CR, the 48-pin dash connector (6000), and circuit V97CR and a splice. From the splice power is applied to pin 3 of the ECM2 (6020) on circuit V97UA . This signals the ECM2 that the ignition switch is on and causes the ECM2 to internally switch pin 5 to ground. This completes the circuit for the ECM2 power relay (6005) which energizes the relay. With the relay (6005) energized, power is applied through the closed contacts to circuit V97TA and a splice. From the splice power is applied to the ECM2 (6021) pins 1 and 2 on circuits K97FL and K97ZA respectively, and to the IDM2 (6011) pin 10 on circuit K97AZ.

Also, when key switch (20) is moved to the ignition position, power is supplied through fuse F12, circuit V97CR, the 48-pin dash connector (6000), and circuit V97CR and a splice. From the splice power is applied to pin 9 of the IDM2 (6011) on circuit K97M . This signals the IDM2 that the ignition switch is on and causes the IDM2 to internally switch pin 9 to ground. This completes the circuit for the IDM2 power relay (6006) which energizes the relay. With the relay (6006) energized, power is applied through the closed contacts to circuit V97TC and a splice. From the splice power is applied to the IDM2 (6011) pin 12 on circuit K97Y, and the IDM2 (6011) pin 6 on circuit K97LC, fuse (1B-B3) and circuit V97LC.

Grounds for the ECM2 (6020) pins 6 and 7 are through circuits K97-GW and K97-GV respectively, to a splice. From the splice, ground is through circuit 11-G, the engine harness to negative battery cable harness connector (665) and circuit 11-G to the negative battery terminal. Also, grounds for the IDM2 (6011) pin 1 is through circuit K97-GA to a splice. From the splice, ground is through circuit 11-G, the engine harness to negative battery cable harness connector (665) and circuit 11-G to the negative battery terminal.

Accelerator Position Sensor (APS) and Idle Validation Switch (IVS)

The engine Electronic Control Module (ECM2) determines the position of the accelerator pedal by processing the input signals from the Accelerator Position Sensor (APS) and Idle Validation Switch (IVS).

The ECM2 sends a regulated 5 volt signal through the ECM2 connector (6021), circuit K99C, dash connector (9851), circuit N99C to a splice, and circuit A99C to the APS/IVS (382). The APS then returns a variable voltage signal (depending on pedal position) through connector (382), circuit N99B, connector (9851), and circuit N99B to the ECM2. The APS is grounded through circuit A99A/A97W, connector (3), and circuit A97W/A97WB to the ECM2 signal ground.

The ECM2 learns the lowest and highest pedal positions by reading and storing the minimum and the maximum voltage levels from the APS. In this manner the ECM2 “auto-calibrates" the system to allow maximum pedal sensitivity.

The ECM2 auto-calibrates as the key is on, but when the key is turned off, these values are lost. When the key is turned on again, this process starts over. When the pedal is disconnected (or a new one is installed), the pedal does not need to be calibrated, as the calibration happens when the key is turned on.

When the key switch (20) is in the on or start position, the Idle Validation Switch (IVS) (382) receives 12 volt ignition voltage through circuit breaker F10, and circuit A99E. When the pedal is not in the idle position (throttle applied), the IVS sends this 12 volt signal to the ECM over circuit A99D, connector (9851), and circuit N99D to the ECM2 (6021).

The ECM2 compares the inputs it receives on circuit A99B and circuit A99D from the APS/IVS to verify when the pedal is in the idle position. If the APS signal from circuit A99B indicates throttle is being applied, then the ECM2 expects to see 12 volts at IVS circuit A99D. If the APS signal, circuit A99B, indicates throttle is not applied, then the ECM2 expects to see 0 volts at the IVS circuit A99D. The timing process is critical between the APS and the IVS sensors. For this reason, it is very difficult to determine if the APS/IVS assembly is working properly using a volt-ohmmeter.

Barometric Air Pressure (BAP) Sensor

The ECM2 (6021) sends a regulated 5 volt signal from ECM2 (6021) through circuit K99C, dash connector (9851), circuit K99C to a splice, and circuit K97BL to BAP sensor (6702). The BAP sensor returns a variable voltage signal (represents atmospheric pressure) on circuit K97CD, connector (9851) and circuit K97CD to the ECM2 (6020). The BAP sensor is grounded by circuit K97Z/K97W, connector (6000), circuit K97W/K97WB to the ECM2 (6021) signal ground.

Air Temperature Sensor (ATS)

The IDM2 (6011) sends a regulated 5 volt reference signal through circuit K97B to the Air Temperature Sensor (6303). As the temperature changes, the sensor changes resistance and provides the IDM2 (6011) with an air temperature signal voltage. The sensor is grounded through circuit K97S to the ECM2 (6021) signal ground.

Cruise Control/Remote Engine Controls

When the key switch (20) is moved to the start or ignition position, battery voltage is through the ignition switch relay (1711), circuits A13/A13F, fuse F23, is through circuit A97B to the brake/cruise interface relay (1133). The brake/cruise interface relay (1133) is grounded through circuits A97-GM/A11-GB to cab ground.

Battery power is applied to fusible link circuit through circuits N14A-FL/N14–FL, circuit A14/A14A, circuit breaker F12 and circuit A97DK to the brake/cruise interface relay (1133) contacts. Power is supplied to the cruise control On/Off switch (391) through the closed relay contacts and circuit A97DJ. When the switch is in the On position, power flows through the closed switch contacts and circuit A97CF to the MSM (3115). The MSM (3115) received the On position of the cruise control On/Off switch and is communicated to the ECM2.

The cruise control Set/Resume switch (392) to be operational, with the cruise control On/Off switch (391) in the On position and power is applied from the switch to the cruise Set/Resume switch (392) through circuit A97DH. Momentarily depressing the Set portion of this switch supplies a 12 volt signal to the MSM (3115) through circuits A97DH/A97CA and is communicated to the ECM2. This engages the cruise control and causes the ECM2 to maintain the current engine RPM. If the cruise control speed is already set, depressing the switch in the Set position causes the engine RPM to decrease until the switch is released.

With the cruise control On/Off switch (391) in the On position, depressing the Resume portion of the Set/Resume switch (392) supplies a 0 volt ground signal to the MSM (3115) through circuits A97–GE/A97–GL to cab ground and is communicated to the ECM2. If the cruise control speed has not been engaged, momentarily depressing the switch causes the ECM2 to resume the last engine RPM setting.

If the cruise control is already engaged, momentarily depressing the resume portion of the switch will cause the engine RPM and speed to increase in small incremental amounts until the desired speed is reached.

Engine control circuits are also provided for remote, preset and variable speed switches and a remote accelerator pedal for completion by the body builder when remote engine controls are required.

For information on remote engine controls for body builder applications, refer to Miscellaneous Information in CT-471 Body Builder Book.

16.3. TROUBLESHOOTING

Before beginning these test procedures, do the following:

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

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

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

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

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

ATA Data Link and Diagnostic/ Programming Connector

Table 51 ATA Data Link and Diagnostic/ Programming Connector

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	At ATA connector (384), measure voltage from cavity B circuit A97C to ground.	(384), cav. B, 97C to gnd.	12 ± 1.5 volts.	Go to next step.	Check fuse F6 for open condition. If okay, locate cause of low or no voltage in circuit A97C, then repair.
2.	Off	Disconnect ECM2 connector (6021) and install jumper wires from cavity 20 circuit A98A(+) and cavity 21 circuit A98C(-) to ground.			Go to next step.	
3.	Off	At (384) measure resistance of circuits A98B(+)/A98A(+) and A98A(+) to ground.	(384), A98B(+) to gnd.	< 2 ohms.	Go to next step.	Locate open or poor connection in circuits A98B(+)/ A98A(+) and A98A(+) or dash conn. (3), then repair.
4.	Off	At (384) measure resistance of circuits A98D(-)/A98C(-) and A98C(-) to ground.	(384), A98D(-) to gnd.	< 2 ohms.	Go to next step.	Locate open or poor connection in circuits A98D(-)/A98C(-) and A98C(-) or dash conn. (3), then repair.
5.	Off	Remove jumpers and reconnect (6021). Disconnect IDM2 connector (6011) and install jumper wires from cavity 2 circuit A98AA(+) and cavity 3 circuit A98CA(-) to ground.			Go to next step.	

Table 51 ATA Data Link and Diagnostic/ Programming Connector (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
6.	Off	At (384) measure resistance of circuits A98B(+)/A98A(+) and A98AA(+) to ground.	(384), A98B(+) to gnd.	< 2 ohms.	Go to next step.	Locate open or poor connection in circuits A98B(+)/ A98A(+) and A98AA(+) or dash conn. (6000), then repair.
7.	Off	At (384) measure resistance of circuits A98D(-)/A98C(-) and A98CA(-) to ground.	(384), A98D(-) to gnd.	< 2 ohms.	Go to next step.	Locate open or poor connection in circuits A98D(-)/A98C(-) and A98CA(-) or dash conn. (6000), then repair.
8.	Off	Remove jumpers and reconnect (6011). Disconnect cluster connector (11) and install jumper wires from cavity 7 circuit A98E(+) and cavity 9 circuit A98F(-) to ground.			Go to next step.	
9.	Off	At (384) measure resistance of circuit A98B(+)/A98E(+) to ground.	(384), A98B(+) to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A98B(+)/ A98E(+), then repair.
10.	Off	At (384) measure resistance of circuits A98D(-)/A98F(-) to ground.	(384), A98D(-) to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A98D(-)/ A98F(-), then repair.
11.	Off	Reconnect (27). At ATA interface connector (374), measure resistance from circuit 98H(+) to (384) circuit 98B(+).	(374), 98H(+) to (384) 98B(+).	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 98B(+)/ 98H(+), then repair.

Table 51 ATA Data Link and Diagnostic/ Programming Connector (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
12.	Off	At ATA interface connector (374), measure resistance from circuit A98G(-) to (384) circuit A98D(-).	(374), A98G(-) to (384) A98D(-).	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A98D(-)/ A98G(-), then repair.
13.	Off	Data communication link circuitry checks good. If condition persists, refer to Engine Diagnostic Manual.				

ECM Power and Ground System Circuitry

Table 52 ECM Power and Ground System Circuitry

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove 40A power module maxifuse (1C-A) and check for open condition.	Maxifuse ((1C-A).	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	Off	At fuse holder, measure voltage from circuit 14A to ground. Re-install fuse.	Fuse holder, 14A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 14A, then repair or replace cable assembly.
3.	Off	Check fuse 1B—B4 for open condition.	1B—B4	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
4.	Off	At 1B—B4 fuse cavity A, measure voltage from circuit V97HB to ground.	1B—B4 cav. A, V97HB to gnd.	12 ± 1.5 volts.	Go to next step.	Refer to 12 Volt Power Distribution (Battery) in Section 1.
5.	Off	Check fuse F40 for open condition.	F40	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
6.	Off	At F40 fuse cavity A, measure voltage from circuit V97LD to ground.	F40, cav. A, V97LD to gnd.	12 ± 1.5 volts.	Go to next step.	Refer to 12 Volt Power Distribution (Battery) in Section 1.

Table 52 ECM Power and Ground System Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
7.	Off	Check fuse F12 for open condition.	F12	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
8.	On	At F12 fuse cavity A, measure voltage from circuit A13 to ground.	F12, cav. A, A13 to gnd.	12 ± 1.5 volts.	Go to next step.	Refer to 12 Volt Power Distribution (Key Switch) in Section 1.
9.	Off	Disconnect ECM2 connector (6020) and measure resistance of circuits at harness cavities 6 and 7 to ground.	(6020), cav. 6 and 7 to gnd.	< 5 ohms.	Go to next step.	Go to next step.
10.	Off	Disconnect IDM2 connector (6011) and measure resistance of circuits at harness cavity 1 to ground.	(6011), cav. 1 to gnd.	< 5 ohms.	Go to Step 13.	Go to next step.
11.	Off	Disconnect engine harness/ negative battery cable connector (665). At cable cavity A, measure resistance of circuit 11–G to ground.	(665), cav. A, 11–G to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 11–G, then repair or replace cable assembly.
12.	Off	Locate open or poor connection in circuits 11–G/K97–GV, 11–G/K97–GW, or 11–G/K97–GA, then repair.				
13.	On	At (6020) harness cavity 3, measure voltage from circuit K97UA to ground.	(6020), cav. 3, K97UA to gnd.	12 ± 1.5 volts.	Go to next step.	Go to next step.
14.	On	At (6011) harness cavity 9, measure voltage from circuit K97UB to ground.	(6011), cav. 9, K97UB to gnd.	12 ± 1.5 volts.	Go to Step 16.	Go to next step.

Table 52 ECM Power and Ground System Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
15.	Off/ On	Disconnect dash connector (6000). Turn key on and at cavity 15, measure voltage from circuit K97CR to ground.	(6000), cav. 15, K97CR to gnd.	12 ± 1.5 volts.	Repair K97C/K97UA or K97C/K97UB between (3) and (6020) or (6011).	Locate cause of low or no voltage in circuit K97CR, then repair.
16.	Off	At (6020), measure voltage from harness cavity 5 circuit V97J to ground.	(6020), cav. 5, V97J to gnd.	12 ± 1.5 volts.	Go to Step 20.	Go to next step.
17.	Off	Remove ECM power relay (6005). At socket cavity 8B, measure voltage from circuit V97JA to ground.	(6005), cav. 8B, V97JA to gnd.	12 ± 1.5 volts.	Go to Step 19.	Go to next step.
18.	Off	Disconnect dash connector (412). At cavity A, measure voltage from circuit 14B/N97JA to ground.	(412), cav. A, 14B/N97JA to gnd.	12 ± 1.5 volts.	Repair 14B/97JA between (412) and (6005).	Locate cause of low or no voltage in circuit 14B, then repair.
19.	Off	Measure resistance of circuit V97J between relay (6005), socket cavity 6C, and ECM2 connector (6020), cavity 5.	(6005), cav. 6C to (6020), cav. 5.	< 1 ohm.	Replace relay.	Locate open or poor connection in circuit N97JA, then repair.
20.	On	At (6021) measure voltage from harness cavities 1, 2, and at (6011) cavity 10 to ground.	(6021), cav. 1, 2 and (6011), cav. 10 to gnd.	12 ± 1.5 volts.	Go to Step 24.	Go to next step.
21.	Off	Remove ECM power relay (6005). At socket cavity 6B, measure voltage from circuit V97HB, fuse 1B-B4, and V97HA to ground.	(6005), cav. 6B, V97HB, 1B-B4 and V97HA to gnd.	12 ± 1.5 volts.	Go to Step 23.	Go to next step.
22.	Off	Disconnect positive battery/ engine harness connector (412) and at circuit 14B, measure voltage to ground.	(411), 14B to gnd.	12 ± 1.5 volts.	Repair 14B between (412) and (6005).	Locate cause of low or no voltage in circuit 14B, then repair.

Table 52 ECM Power and Ground System Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
23.	Off	Measure resistance of circuits between relay (6005), socket cavity 8C, and ECM2 connector (6021), cavities 1, 2, and IDM2 connector (6011), cavity 10.	(6005), cav. 8C to (6021), cav. 1, 2, and (6011), cav. 10.	<1 ohm each check.	Replace relay.	Locate open or poor connection in circuits V97TA/V97CL, V97TA/V97CK, or V97TA/V97AL, then repair.
24.	Off	At (6011), measure voltage from harness cavity 8 circuit V97LA to ground.	(6011), cav. 8, V97LA to gnd.	12 ± 1.5 volts.	Go to Step 28.	Go to next step.
25.	Off	Remove IDM power relay (6006). At socket cavity 8B, measure voltage from circuit V97LB to ground.	(6006), cav. 8B, V97LB to gnd.	12 ± 1.5 volts.	Go to Step 27.	Go to next step.
26.	Off	Disconnect dash connector (412). At cavity A, measure voltage from circuit V97LB to ground.	(412), cav. A, V97LB to gnd.	12 ± 1.5 volts.	Repair V97LB between (412) and (6006).	Locate cause of low or no voltage in circuit 14B, then repair.
27.	Off	Measure resistance of circuit V97LA between relay (6006, socket cavity 6C, and IDM2 connector (6011), cavity 8.	(6006), cav. 6C to (6011), cav. 8.	< 1 ohm.	Replace relay.	Locate open or poor connection in circuit V97LB, then repair.
28.	On	At (6011) measure voltage from harness cavities 6 and 12 to ground.	(6011), cav. 6 and 12 to gnd.	12 ± 1.5 volts.	Go to Step 32.	Go to next step.
29.	Off	Remove IDM power relay (6006). At socket cavity 6B, measure voltage from circuit V97TC to ground.	(6006), cav. 6B, V97TC to gnd.	12 ± 1.5 volts.	Go to Step 31.	Go to next step.
30.	Off	Disconnect positive battery/ engine harness connector (412) and at circuit 14B, measure voltage to ground.	(412), 14B to gnd.	12 ± 1.5 volts.	Repair 14B between (412) and (6006).	Locate cause of low or no voltage in circuit 14B, then repair.

Table 52 ECM Power and Ground System Circuitry (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
31.	Off	Measure resistance of circuits between relay (6006), socket cavity 8C, and IDM2 connector (6011), cavities 6 and 12.	(6006), cav. 8C to (6011), cav. 6 and 12.	<1 ohm each check.	Replace relay.	Locate open or poor connection in circuits V97TA/V97Y, V97TA/V97LD, or V97TA, 1B—B4 and V97LC, then repair.
32.	Off	Reconnect connectors. Power module and ground system circuits check good. Should condition persist, refer to Engine Diagnostics Manual for ECM2 diagnostics.				

Accelerator (APS/IVS), Barometric Air Pressure (BAP), and Ambient Air Temperature Sensor (ATS) Systems

Table 53 Accelerator (APS/IVS), Barometric Air Pressure (BAP), and Ambient Air Temperature Sensor (ATS) Systems

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Is a fault code present for APS/IVS sensor/switch?			Go to next step.	Go to Step 9.
2.	Off	Check circuit breaker F25 for open condition.	F10	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace circuit breaker.
3.	On	Disconnect APS/IVS conn. (382) and at cavity F, measure voltage from circuit A99E to ground.	(382), cav. F, A99E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit A99E, then repair.
4.	Off	At (382), install jumper from cavity A, circuit A99B to ground. Disconnect ECM2 connector (6021). At cavity 18, measure resistance from circuit A99B to ground.	(6021), cav. 18, A99B to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A99B or dash conn. (9851), then repair.

Table 53 Accelerator (APS/IVS), Barometric Air Pressure (BAP), and Ambient Air Temperature Sensor (ATS) Systems (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
5.	Off	At (382), move jumper to cavity B, circuit A99A and ground. At (6021) cavity 24, measure resistance of circuit K97W to ground.	(6021), cav. 24, K97WB to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit K97W, dash conn. (3), or circuit K97W/K99A, then repair.
6.	Off	At (382), move jumper to cavity C, circuit A99J and ground. At (6021) cavity 4, measure resistance of circuit A99C to ground.	(6021), cav. 4, A99C to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A99C, dash conn. (3), or circuit A99C/A99J, then repair.
7.	Off	At (382), move jumper to cavity D, circuit A99D and ground. At (6021) cavity 12, measure resistance of circuit A99D to ground.	(6021), cav. 12, A99D to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A99D, or dash conn. (9851), then repair.
8.	Off	Remove jumper and reconnect connectors. APS/IVS circuits check good. Is problem corrected?			End test.	Replace APS/IVS. If problem persists, refer to Engine Diagnostic Manual for ECM2 diagnostics.
9.	Off	Is a fault code present for BAP sensor?			Go to next step.	Go to Step 14.
10.	Off	Disconnect BAP sensor connector (6702). Install jumper wire from cavity 1, circuit K97Z to ground. Disconnect ECM2 connector. (6021). At cavity 24, measure resistance of circuit K97W to ground.	(6021), cav. 24, K97W to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit K97W, dash conn. (6000), or circuit K97W, then repair.
11.	Off	At (6702), move jumper wire to cavity 2, circuit K97BL and ground. At (6021) cavity 4, measure resistance of circuit K99C to ground.	(6021), cav. 4, K99C to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit A99C, dash conn. (6000), or circuit K99C/K97BL, then repair.

Table 53 Accelerator (APS/IVS), Barometric Air Pressure (BAP), and Ambient Air Temperature Sensor (ATS) Systems (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
12.	Off	At (437), move jumper wire to cavity 3, circuit K97CD and ground. At (6020) cavity 24, measure resistance of circuit K97CD to ground.	(6020), cav. 24, K97CD to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit K97CD or dash conn. (6000), then repair.
13.	Off	Remove jumper and reconnect connectors. BAP system circuits check good. Is problem corrected?			End test.	Replace BAP sensor. If problem persists, refer to Engine Diagnostic Manual for ECM2 diagnostics.
14.	Off	Is a fault code present for the ATS system?			Go to next step.	End test.
15.	Off	Disconnect ATS connector (6703). Install jumper wire from cavity B, circuit K97AX to ground. Disconnect IDM2 connector (6011). At cavity 5, measure resistance from circuit K97AX to ground.	(6011), cav. 5, K97AX to gnd.	< 1 ohm	Go to next step.	Locate open or poor connection in circuit K97AX, then repair.
16.	Off	At (6703), move jumper to cavity A, circuit K97BU and ground. At (6021) cavity 24, measure resistance of circuit K97W to ground.	(6021), cav. 24, K97W to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit K97W/ K97BU, then repair.
17.	Off	Remove jumper and reconnect connectors. ATS system circuits check good. Is problem corrected?			End test.	Replace ATS. If problem persists, refer to Engine Diagnostic Manual for ECM2 diagnostics.

Cruise Control/Remote Engine Controls

Table 54 Cruise Control/Remote Engine Controls

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	1. Turn key to RUN 2. Connect J1939 sniffer		Are both the engine (0x00) and the MSM (aka ESC) on the Datalink?	Go to step 2.	Go to step 9.
2.	Off	1. Disconnect J1939 sniffer. 2. Connect Master Diagnostics 3. Monitor the Cruise ON/OFF input 4. Exercise the Cruise ON/OFF switch		Does the input in MD change with the switch changes?	Go to step 3.	Go to step 4.
3.	Off	1. Monitor the Cruise Set/Resume input 2. Exercise the Cruise Set/Resume switch		Does the input in MD change with the switch changes?	MSM is functioning properly. Check that cruise control is enabled in the engine controller	Go to step 6.
4.	Off	1. Verify Cruise ON/OFF switch and wiring, OFF state 2. Disconnect MSM connector (3115)		Is pin 8 open to ignition when switch is OFF?	Go to step 5.	Repair wiring or switch, and retest
5.	Off	1. Verify Cruise ON/OFF switch and wiring, ON state		Is pin 8 shorted to ignition when switch is ON?	Replace MSM and retest	Repair wiring or switch, and retest

Table 54 Cruise Control/Remote Engine Controls (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
6.	Off	1. Verify Cruise SET/RES switch and wiring, normal state		Is pin 9 open to ground and ignition when switch is not pressed?	Go to step 7.	Repair wiring or switch, and retest
7.	Off	1. Verify Cruise SET/RES switch and wiring, RESUME state		Is pin 9 shorted to ground when switch is moved to RESUME?	Go to step 8.	Repair wiring or switch, and retest
8.	Off	1. Verify Cruise SET/RES switch and wiring, SET state 2. Turn Cruise ON/OFF switch to ON		Is pin 9 shorted to ignition when switch is moved to SET?	Replace MSM and retest	Repair wiring or switch, and retest
9.	Off	1. Leave J1939 sniffer connected		Is the engine (0x00) on the Datalink?	Go to step 10.	Go to step 13.
10.	Off	1. Turn the key to OFF. 2. Disconnect MSM connector (3114). 3. Measure resistance across datalink pins in wiring harness		Is the resistance approx. 60 ohms?	Go to step 11.	Fix datalink wiring and retest
11.	Off	1. Turn the key to Ignition. 2. Measure the voltage at the MSM's harness ignition pin		Is the voltage 12-16 volts?	Go to step 12.	Fix wiring or fuse
12.	Off	1. Measure the resistance between the MSM's harness ground pin and ground		Is the resistance less than 10 ohms?	Replace MSM and retest	Fix ground wiring

Table 54 Cruise Control/Remote Engine Controls (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
13.	Off	1. Leave J1939 sniffer connected		Is the MSM (aka ESC) on the Datalink?	Check the engine's power connections and data link wiring.	Verify sniffer is working properly
1.	Off	Remove circuit breaker F12. and check for open condition.	F12.	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	Off	At fuse holder, measure voltage from circuit A14 to ground. Re-install fuse.	Fuse holder, A14 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuits N14A-FL/N14–FL, dash conn. (2), or circuit A14, then repair or replace cable assembly.
3.	Off/ On	Disconnect MSM connector (3115). Turn key and cruise switch (391) on. At (3115), measure voltage from circuit A97CF cavity 8 to ground.	(3115), A97CF cav. 8 to gnd.	12 ± 1.5 volts.	Go to Step 6.	Go to next step.
4.	Off	Disconnect cruise on/off switch (391) and with switch in on position, measure resistance across terminals.	(391), across sw. terminals.	< 1 ohm.	Go to next step.	Replace cruise switch.
5.	On	At Brake/Cruise Interface Relay connector (1133), measure voltage from circuit A97B to ground. Reconnect connectors.	(1133), A97B to gnd.	12 ± 1.5 volts.	Repair open or poor con- nection in circuit A97B.	Check open circuit breaker F23. If okay, locate cause of low or no voltage in circuit A97B, then repair.
6.	On	With on/off switch on and set/resume switch held in set position, measure voltage at MSM connector (3115) from circuit 97DE cavity 9 to ground.	(3115), A97DE cav. 9 to gnd.	12 ± 1.5 volts.	Go to Step 9.	Go to next step.

Table 54 Cruise Control/Remote Engine Controls (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
7.	Off	Disconnect cruise set/resume switch (392). With switch held in set position, measure resistance across terminals 1 to 2.	(392), across switch term. 1 to 2.	< 1 ohm.	Go to next step.	Replace set/resume switch.
8.	On	With on/off switch on and at connector (392), measure voltage from circuit A97DH to ground. Reconnect connectors.	(392), A97DH to gnd.	12 ± 1.5 volts.	Repair open in cir. A97DH or A97CA .	Locate cause of low or no voltage in circuit A97CA, then repair.
9.	On	With on/off switch on and set/resume switch held in resume position, measure voltage at MSM connector (3115) from circuit A97DE cavity 9 to ground.	(3115), A97DE cav. 9 to gnd.	0 volts.	Go to Step 11.	Go to next step.
10.	Off	Disconnect cruise set/resume switch (392). With switch held in resume position, measure resistance across terminals 2 to 3. Reconnect connectors.	(392), across switch term. 2 to 3.	< 1 ohm.	Repair open in cir. A97–GE, A97–GJ A97DE, or poor connection to Cab ground.	Replace set/resume switch.
11.	Off	Is the vehicle equipped with remote engine controls?			Refer to body builder book.	Go to Step 12.
12.	Off	Reconnect connectors. Cruise control circuitry checks good. If condition persists, refer to Engine Diagnostic Manuals for ECM2 diagnostics.				

16.4. COMPONENT LOCATIONS

(1DVA) Electronic Device Power Stud	Inside Cab Fuse/Relay Panel
(2DVA) Electronic Device Ground Stud	Inside Cab Fuse/Relay Panel
(2) 22–Way Dash Connector	At Left Front Cowl, Below Conn. (3)
(9851) 48-Way Elect. Engine Dash Connector	At Left Front Cowl, Above Conn. (2)
(63) Key Switch Connector	Behind Key Switch
(374) ATA Interface Connector	Left of Dash Connectors (2) and (3)
(384) ATA Data Link Connector	Right of Key Switch
(391) Cruise On/Off Switch Connector	Behind Cruise On/Off Switch
(392) Cruise Set/Resume Switch Connector	Behind Cruise Set/Resume Switch
(408) 50A Sealed Maxifuse	Top of Batteries
(409) Negative Battery to Engine Harness Connector	Part of Battery Cable at Battery Box
(412) Positive Battery to Engine Harness Connector	Part of Battery Cable at Battery Box
(413) 20A Sealed Maxi-Fuse	Top of Batteries
(6702) BAP Sensor Connector	Inside Dash Fuse/Relay Panel
(6703) Air Temp. Sensor Connector	In Air Inlet Pipe
(6006) IDM2 Power Relay	Cowl Fuse/Relay Panel
(6005) ECM2 Power Relay	Cowl Fuse/Relay Panel
(590B) Power Distribution Center	Cowl Fuse/Relay Panel
(6011) Engine Control Module IDM2	Mounted to Right Valve Cover
(6020) Engine Control Module ECM2	Mounted to Right Valve Cover
(6021) Engine Control Module ECM2	Mounted to Right Valve Cover
(6000) Control Box Connector	Cowl Fuse/Relay Panel

ATA Data Link and Diagnostic/Programming Connector Circuitry G08-54490.02.B

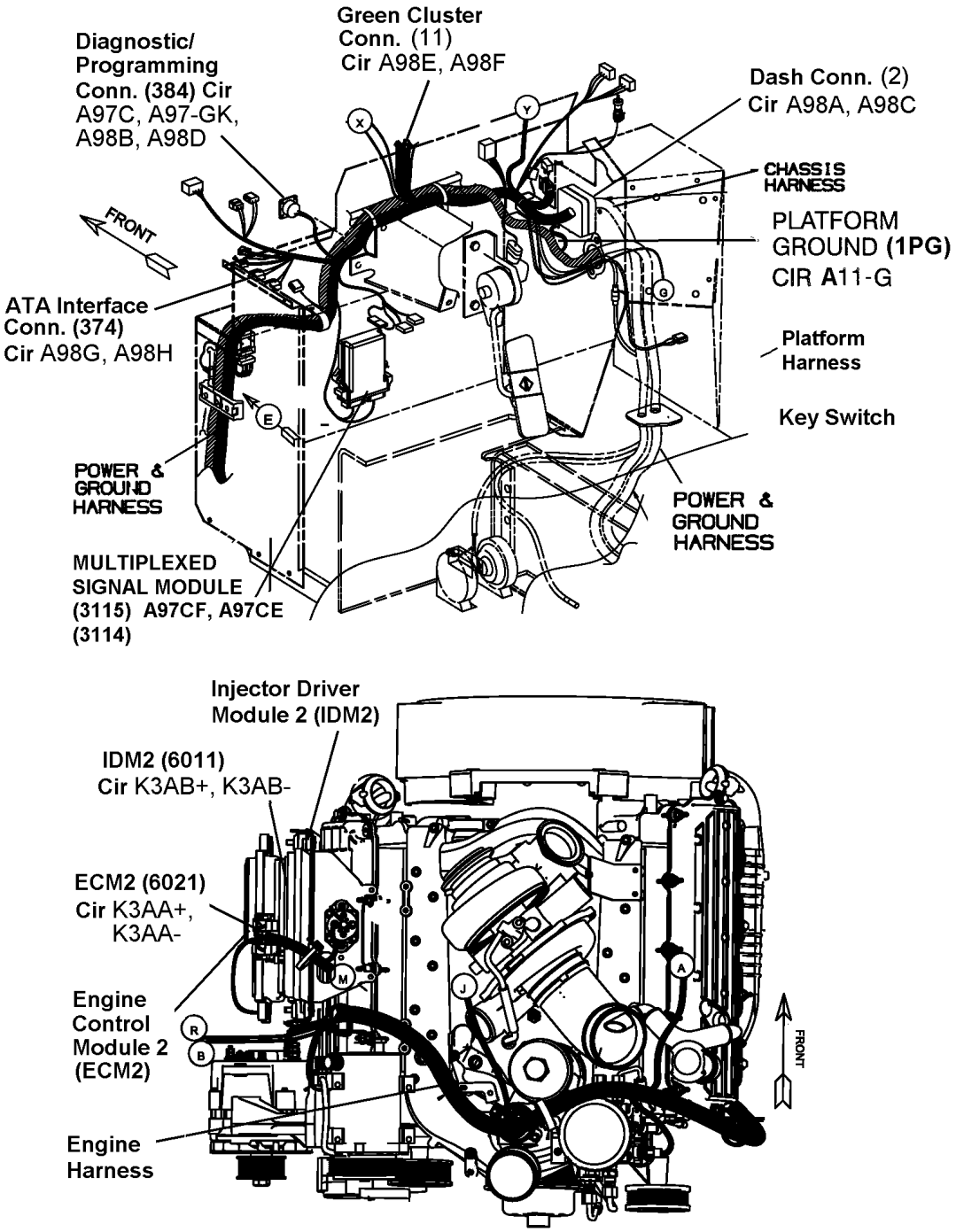


Figure 100 ATA Data Link and Diagnostic/Programming Connector Circuitry

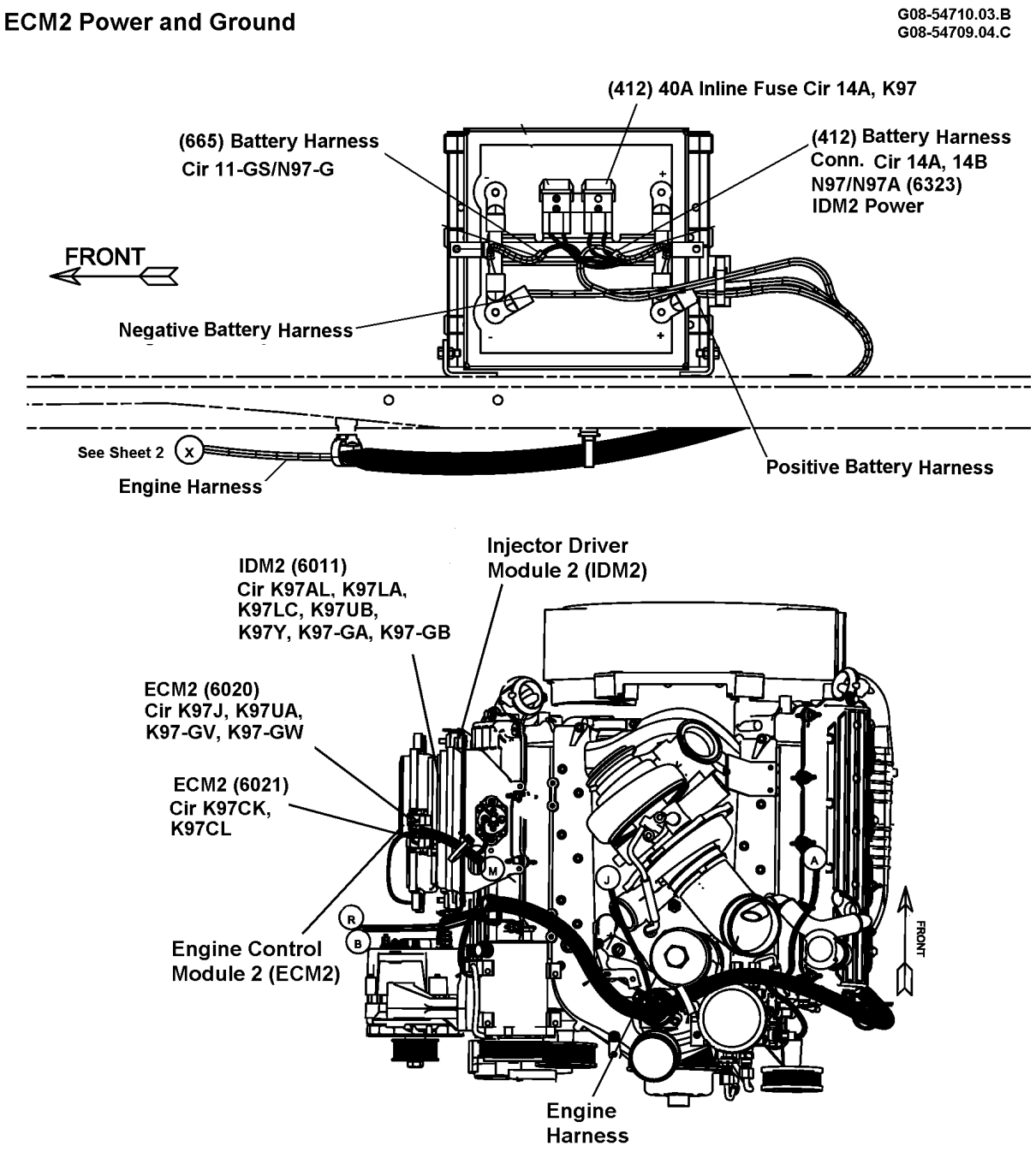


Figure 101 ECM2 Power And Ground Wiring At Battery Harness

ECM2 Power and Ground
Front and Rear Control Box

G08-54490.02.B
3594297C93.01.B

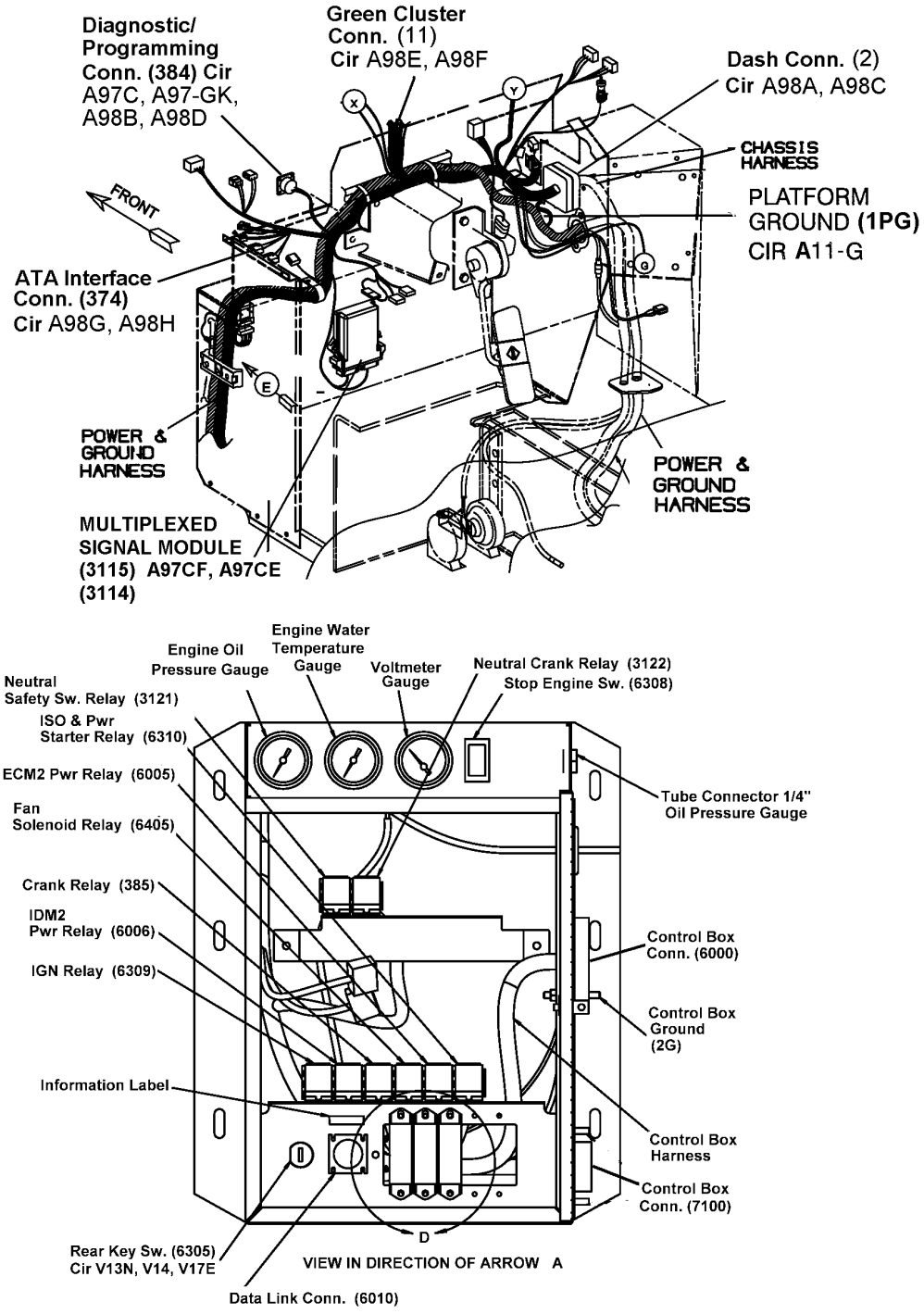


Figure 102 ECM2 Power and Ground — Front and Rear Control Box

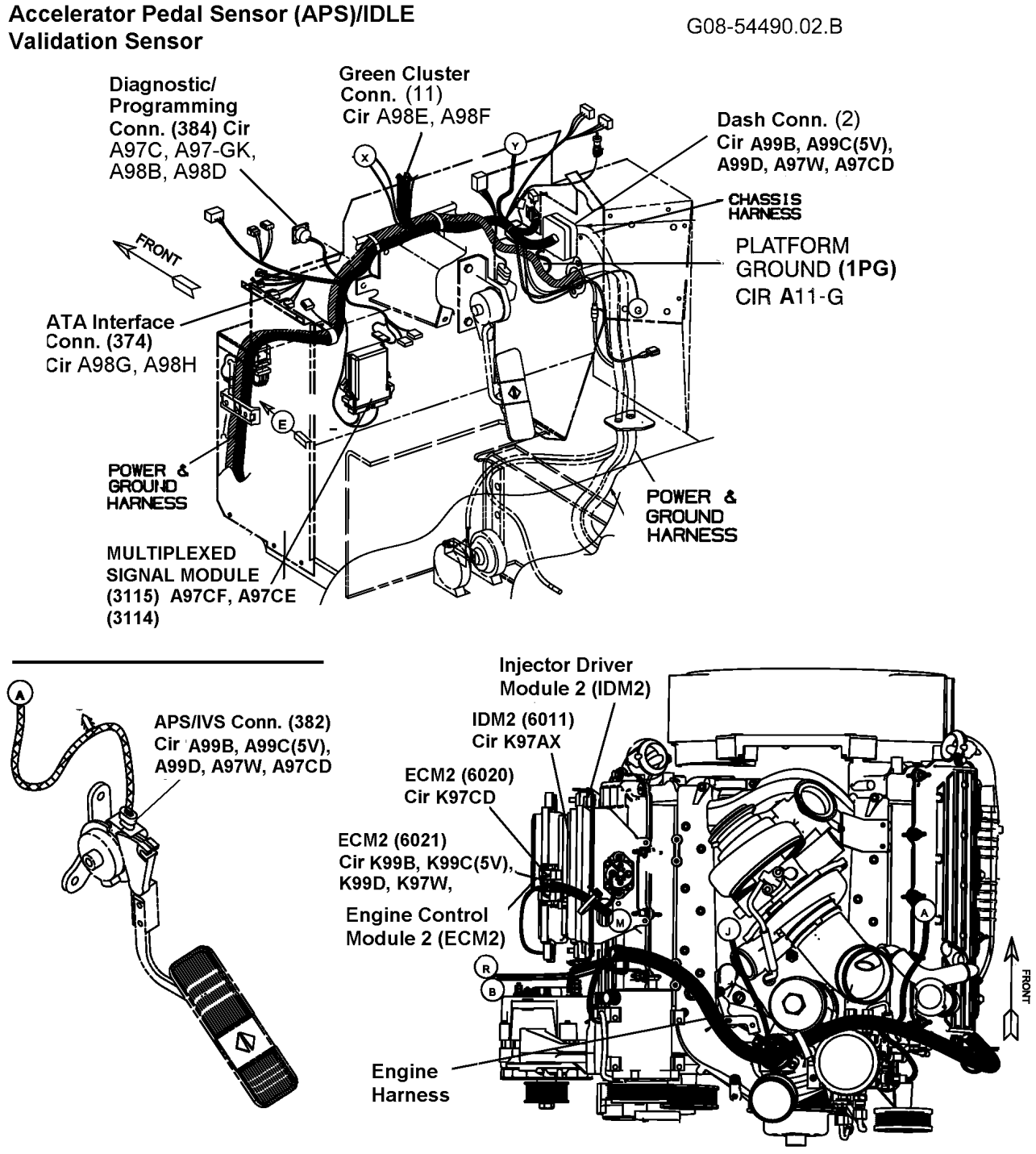


Figure 103 Accelerator Pedal Sensor (APS)/Idle

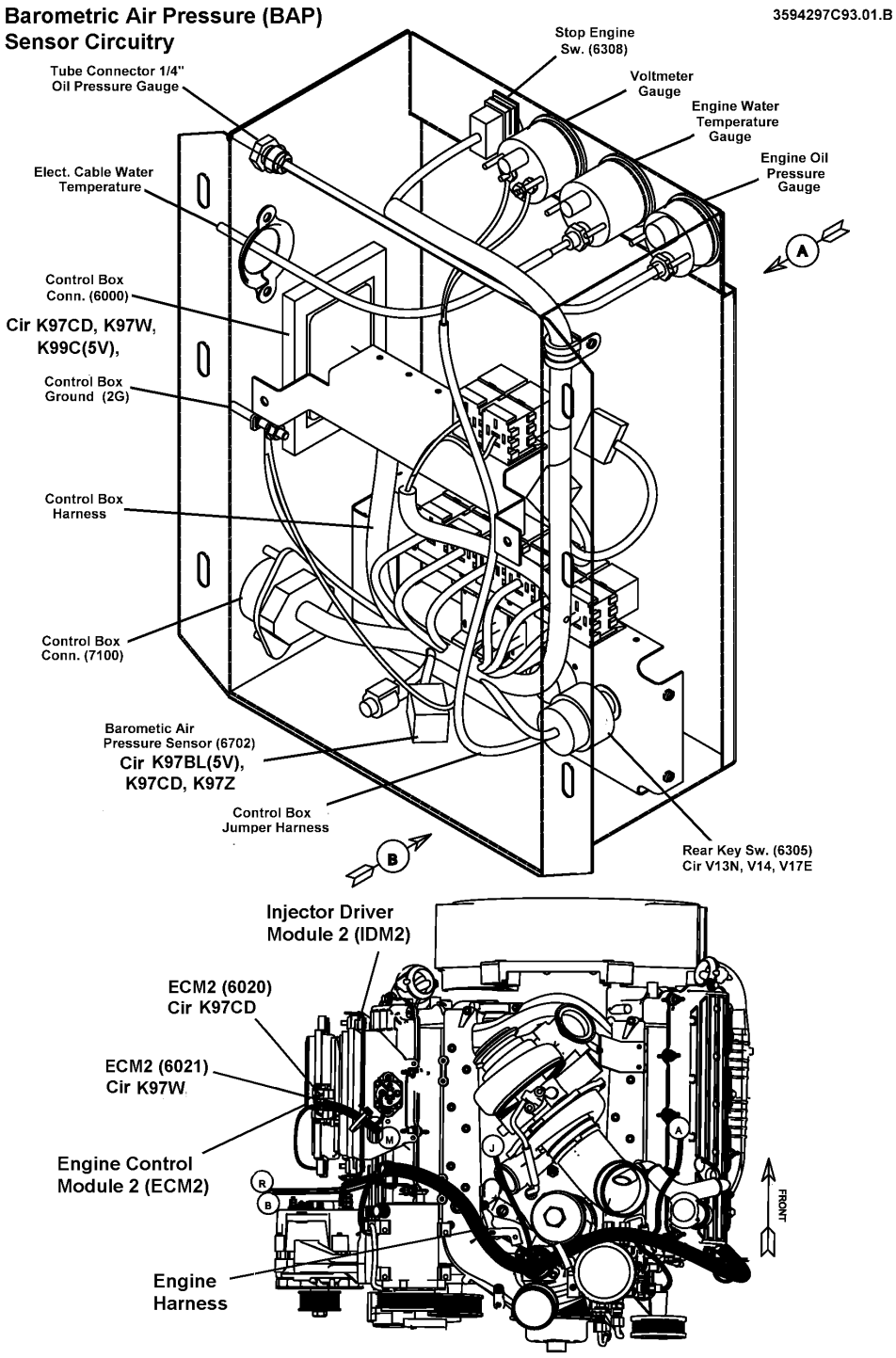
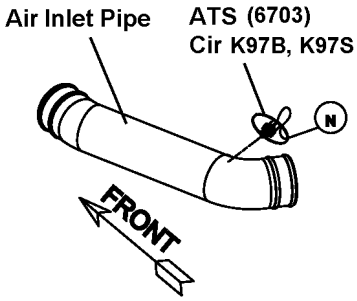


Figure 104 Barometric Air Pressure (BAP) Sensor Circuitry

Ambient Air Temperature Sensor (ATS) G08-54546.10.B



LOCATED IN FRONT OF SURGE TANK,
ON THE LEFT REAR SIDE OF ENGINE.

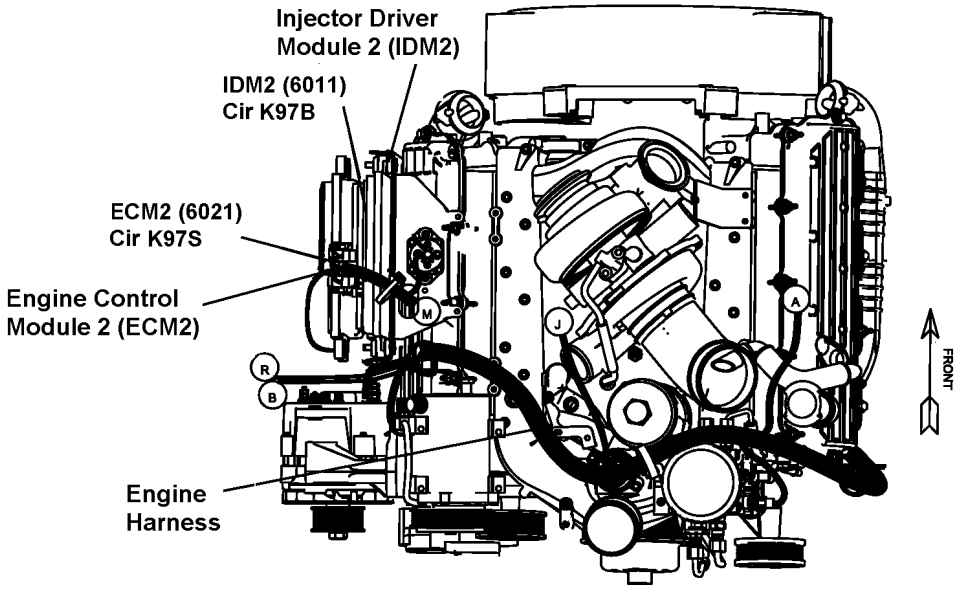


Figure 105 Ambient Air Temperature Sensor (ATS)

Cruise Control G08-54490.02.B

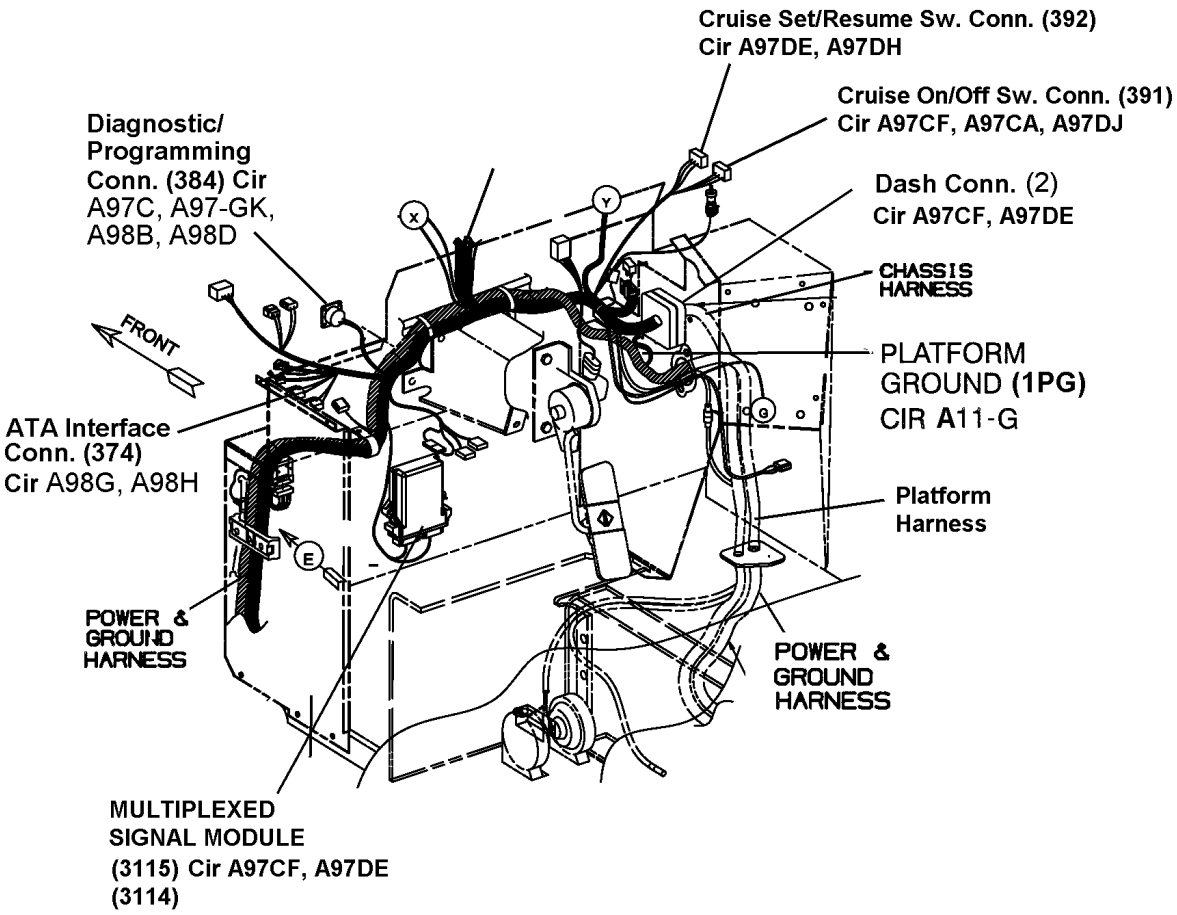


Figure 106 Cruise Control