SERVICE MANUAL SECTION

ELECTRICAL SYSTEM TROUBLESHOOTING GUIDE — 1000 MODELS

Model: 1000
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S08295

11/30/2004

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DESCRIPTION

USE WITH CIRCUIT DIAGRAM BOOK S08294.

Refer to S08301 Instruments, for gauges and warning lights.

Refer to EGES-190 for T 444E Electronic Engine Control System Circuits Function and Diagnostics.

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

1. POWER DISTRIBUTION SYSTEM

1.1. DESCRIPTION

The primary power distribution points in the electrical wiring are the batteries, the cowl fuse panel junction feed stud, the key switch and the cab fuse panel. For power distribution diagrams, and fuse/circuit charts, refer to Electrical Circuit Diagram Manual S08294.

1.2. OPERATION

Twelve Volt Power Distribution (Battery)

Power is supplied by the vehicle batteries to the engine Electronic Control Module (ECM2) over battery cable circuit 14A, a 50A fuse, circuit 14B, battery/engine harness connector (411) and circuit 14B/97JA to the ECM module power relay (590B). Power is also supplied to the electronic device power stud through the battery cable circuit 14D, a 20A fuse, circuit 14C, connector (411), circuit 14J, dash connector (2) and circuit 14J. Also, power is supplied through circuit 14B/97LB to the IDM power relay (590A).

Power is also supplied by the vehicle batteries to the cranking motor solenoid battery stud (B) by a 2/0 wire. From the (B) stud, power is applied to circuits 90-FL/90/90B, fuse F21, circuit 90C and the hydraulic brake switch and circuit 97DK to brake/cruise interface relay, circuit 18-FL/18 and the glow plug magnetic switch, and circuit 14-FL/14A-FL/14/14M to the cowl junction feed stud and the fused power distribution center (590).

From the cowl junction feed stud, power is supplied through circuit 14H, fuse F24, to the horn circuitry, and fuse F23, to the body builder battery power circuitry. Power is also applied from the cowl junction feed stud through circuit 14K to the ignition relay (R20) and fuse F38, to the fuel heater relay circuitry and fuse F36, to the LCT XMSN module circuitry. The power distribution center (590) supplies power to the key switch (63) circuitry and the ignition relay (4G) on circuit 15, and to the start relay (590B) on circuit 17C. Power is also distributed to the cab fuse panel through circuits 14E and 14F.

The alternator supplies power over circuit 2/2-FL and 2A-FL to the cranking motor solenoid (B) stud.

Twelve Volt Power Distribution (Key Switch)

Power is fed to the key switch (63) from the cowl power distribution center (590) through fuse F31, circuits 15/15A and 15/15B, dash connector (2), circuit 15A/15D and circuit 15B/15D.

When the key switch is in the on or accessory position, power is supplied to circuit 12 going to the cab power distribution center and also circuit 1 going to the instrument panel alternator light.

When the key switch is in the on or start position, power is supplied to circuit 13C and the ignition relay (4G). The relay is grounded through 13-G/11-GB to the cab ground. This energizes the relay and allows power

to flow through fuse F31, circuit 15/15C, dash connector (2), circuit 15C, the relay contacts, and circuits 13 and 13A to the cab fuse panel.

When the key switch is in the start position, power is also supplied to the crank inhibit relay (4H) through circuit 17, the start interrupt connector (195) and circuit 17A.

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 (Battery)

Table 1 12 Volt Power Distribution (Battery)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	At cowl junction stud, measure voltage from the stud to ground.	Cowl junction stud to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 14/14–FL/14A–FL or 2/0 battery cable, then repair.
2.	Off	Disconnect engine/ battery harness connector (411). At battery cable, measure voltage from circuit 14B to ground.	(411), 14B to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open 50A fuse (408). If OK, locate cause of low or no voltage in circuit 14B or 14A, then repair or replace starting harness.

Table 1 12 Volt Power Distribution (Battery) (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
3.	Off	At (411) measure voltage from circuit 14C to ground.	(411), 14C to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open 20A fuse (413). If OK, locate cause of low or no voltage in circuit 14C or 14D, then repair or replace starting harness.
4.	Off	Disconnect engine/ battery harness connector (409). At battery cable, measure resistance of circuit 11–GA to ground.	(409), 11–GA to gnd.	< 1 ohm.	Go to next step.	Repair or replace battery cable.
5.	Off	At (409) measure resistance of circuit 11–GB to ground.	(409), 11–GB to gnd.	< 1 ohm.	Go to next step.	Repair or replace battery cable.
6.	Off	Reconnect (409) and (411) and disconnect cab feed connector (14). At (14) measure voltage from circuit 14F to ground.	(14), 14F to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open fuse F33. If OK, locate cause of no or low voltage in circuit 14F, then repair.
7.	Off	At (14) measure voltage from circuit 14E to ground.	(14), 14E to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open fuse F32. If OK, locate cause of no or low voltage in circuit 14E, then repair.
8.	Off	Reconnect (14) and at circuit breaker F8, measure voltage from circuit 14D to ground.	F8, 14D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 14D/14E, then repair.
9.	Off	At fuse F7, measure voltage from circuit 14C to ground.	F7, 14C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 14C/14E, then repair.
10.	Off	At fuse F4, measure voltage from circuit 14A to ground.	F4, 14A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 14A/14F, then repair.
11.	Off	At fuse F5, measure voltage from circuit 14B to ground.	F5, 14B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 14B/14F, then repair.

Table 1 12 Volt Power Distribution (Battery) (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
12.	Off	At fuse F21, measure voltage from hydraulic brake circuit 90B to ground.	F21, 90B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 90B, dash conn. (2), or circuit 90B/90/ 90–FL, then repair.
13.	Off	Disconnect brake/cruise interface relay relay (1133) and measure voltage from circuit 97DK to ground.	(1133), 97DK to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open cowl fuse F21. If OK, locate cause of no or low voltage in circuit 97DK, dash conn. (2), or circuit 90B/90/ 90–FL, then repair.
14.	Off	Disconnect ignition relay (4G) and measure voltage from circuit 15C to ground.	(4G), 15C to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open cowl fuse F31. If OK, locate cause of no or low voltage in circuit 15C, dash conn. (2), or circuit 15C/15, then repair.
15.	Off	Disconnect key switch connector (63) and measure voltage from circuit 15D to ground.	(63), 15D to gnd.	12 ± 1.5 volts.	Battery power distribution circuits check good.	Locate cause of no or low voltage in circuit 15D/15A or 15D/15B, dash conn. (2), or circuit 15A/15 or 15B/15, then repair.

12 Volt Power Distribution (Key Switch)

Table 2 12 Volt Power Distribution (Key Switch)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Disconnect key switch connector (63) and measure voltage from circuit 15D to ground.	(63), 15D to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open cowl fuse F31. If OK, locate cause of no or low voltage in circuit 15D/15A or 15D/15B, dash conn. (2), or circuit 15A/15 or 15B/15, then repair.

Table 2 12 Volt Power Distribution (Key Switch) (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
2.	Acc	At key switch, measure resistance from Pin B to A with switch in the accessory position.	(63), Pin B to A.	<1 ohm.	Go to next step.	Replace key switch.
3.	On	Measure resistance from Pin B to I with key switch (63) in the ignition position	(63), Pin B to I.	<1 ohm.	Go to next step.	Replace key switch.
4.	Start	Measure resistance from Pin B to S with key switch (63) in the start position.	(63), Pin B to S.	<1 ohm.	Go to next step.	Replace key switch.
5.	Off/ On	Reconnect conn. (63) and turn key switch to accessory position. At circuit breaker F17 and circuit 12, measure voltage to ground.	F17, 12 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 12, then repair.
6.	Off/ On	Disconnect dash connector (2). Move key switch to accessory position, and at (2) circuit 1, measure voltage to ground.	(2), 1 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit 1, then repair.
7.	Off/ On	Reconnect connector (2) and disconnect ignition relay (4G). Turn key switch on, and measure voltage from circuit 13C cavity 1 to ground.	(4G), 13C cav. 1 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 13C, then repair.
8.	Off	At (4G), measure resistance of circuit 13–G cavity 2 to ground.	(4G), 13–G cav. 2 to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connectionin circuit 13–G/ 11–GB, then repair.
9.	On	At (4G), measure voltage from circuit 15C cavity 3 to ground.	(4G), 15C cav. 3 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 15C, dash conn. (2) or circuit 15C/15, then repair.

Table 2 12 Volt Power Distribution (Key Switch) (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
10.	Off	At (4G) install jumper wire from circuit 15C cavity 3, to circuit 13 cavity 5. At circuit breaker F11, measure voltage from circuit 13 to ground.	F11, 13 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 13, then repair.
11.	Off	At circuit breaker F14, measure voltage from circuit 13A to ground.	F14, 13A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 13A, then repair.
12.	Off/ On	Remove jumper wire and reconnect relay (4G). Turn key on and at circuit breaker F14, measure voltage from circuit 13A to ground.	F14, 13A to gnd.	12 ± 1.5 volts.	Go to next step.	Replace ignition relay.
13.	Off/ On	Disconnect crank inhibit relay (4H). Turn key switch to start position and measure voltage from circuit 17A cavity 2 to ground.	(4H), 17A cav. 2 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 17A, start interrupt conn. (195) or circuit 17, then repair.
14.	Off	Reconnect crank inhibit relay (4H). Key switch circuits check good.				

1.4. COMPONENT LOCATIONS

(B) Cranking Motor Solenoid Stud..... On Cranking Motor Solenoid
(2) 22–Way Dash Connector..... At Left Front Cowl
(4G) Ignition Relay Connector..... Inside Cab Relay Panel
(4H) Crank Inhibit Relay Connector..... Inside Cab Relay Panel
(14) Cab Feed Connector..... Below Engine Harness 22–Way Dash Connector (2)
(63) Key Switch Connector..... Behind Key Switch
(195) Starter Interrupt Connector..... Left Side of Cab Fuse Panel
(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 Maxifuse..... Top of Batteries
(590) Power Distribution Center..... Cowl Fuse Panel
(1133) Brake/Cruise Interface Relay Connector..... Inside Cab Relay Panel

Refer to Figure 1, Figure 2, and Figure 3.

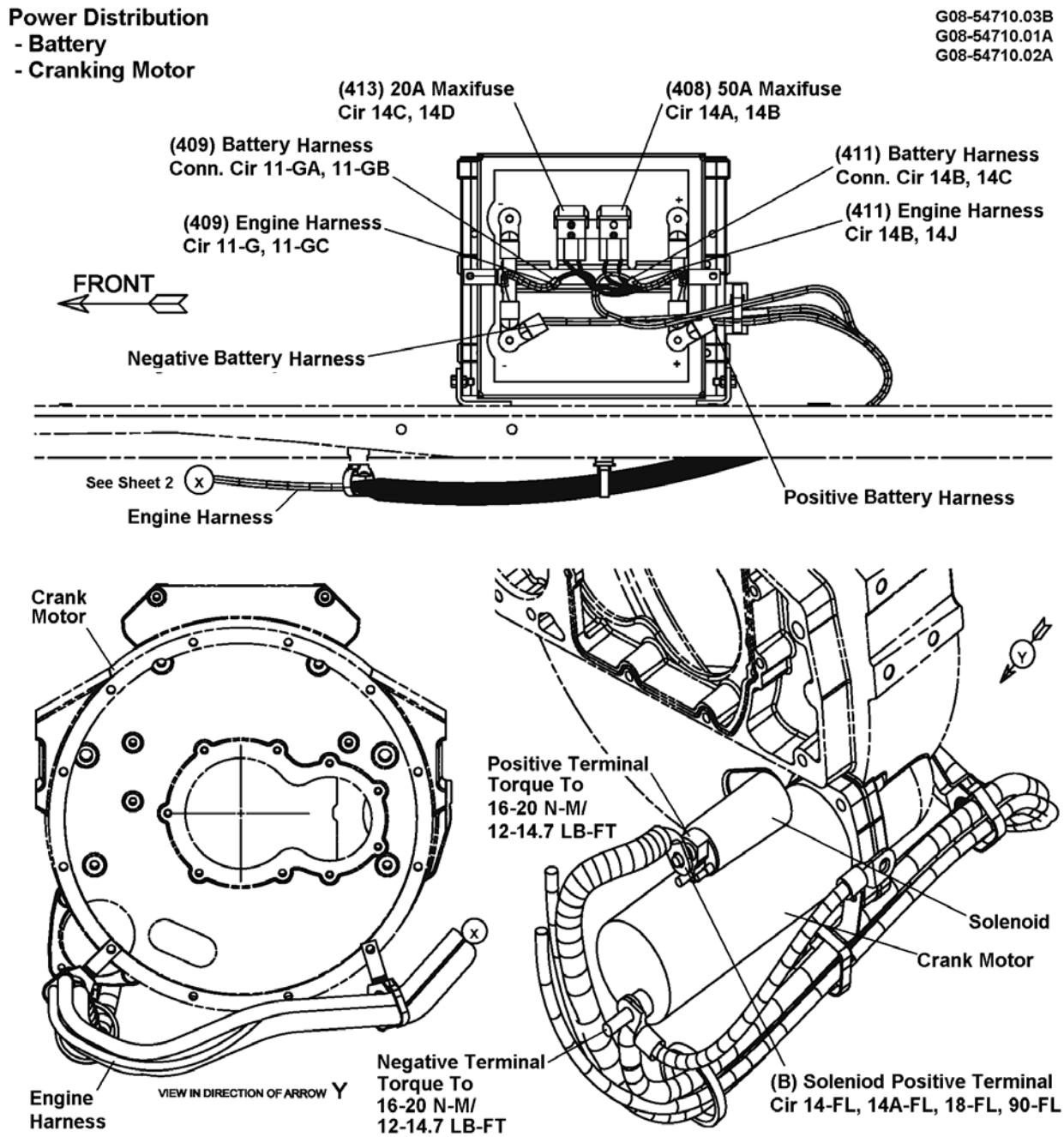

Figure 1 Power Distribution — Battery — Cranking Motor

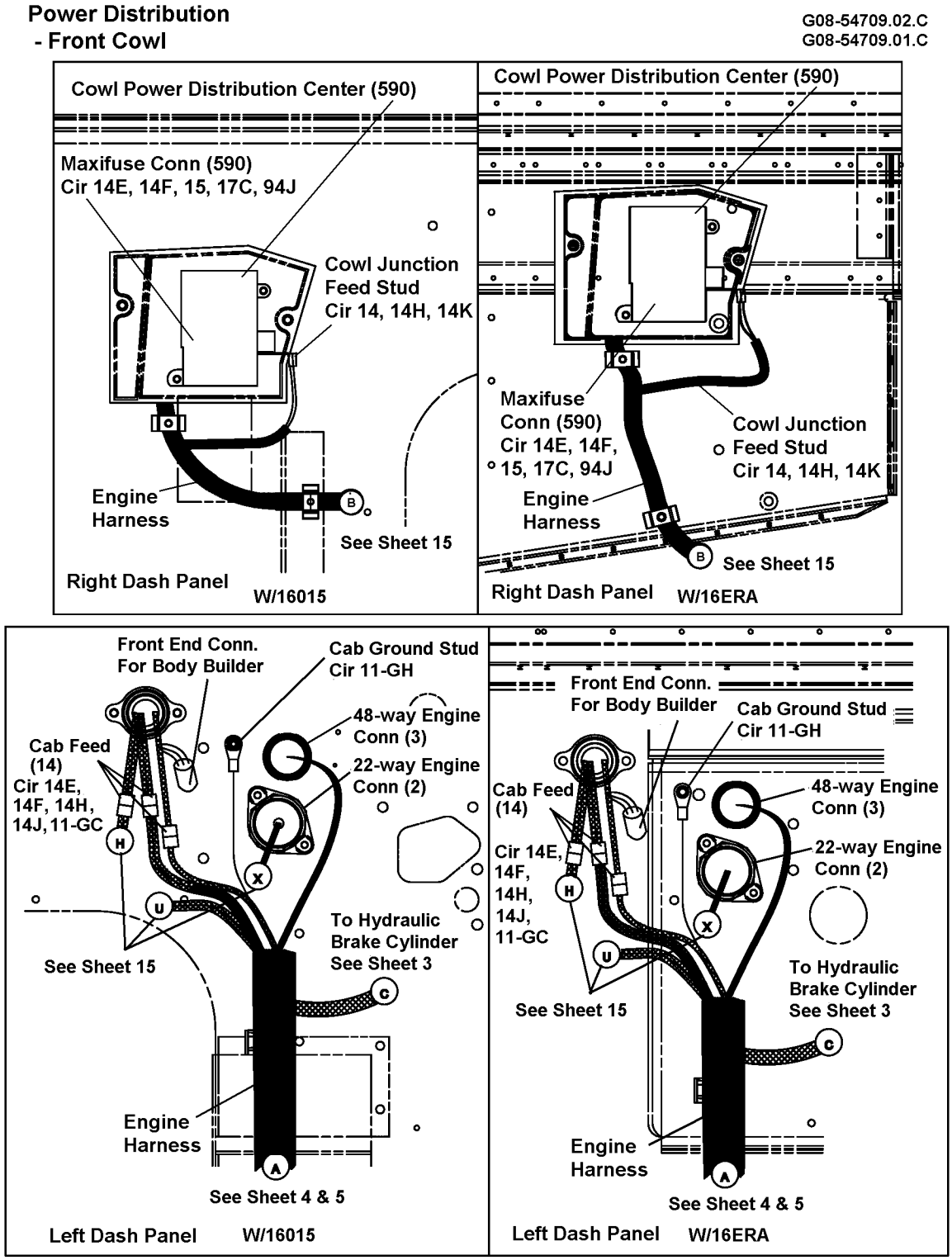

Figure 2 Power Distribution — Front Cowl

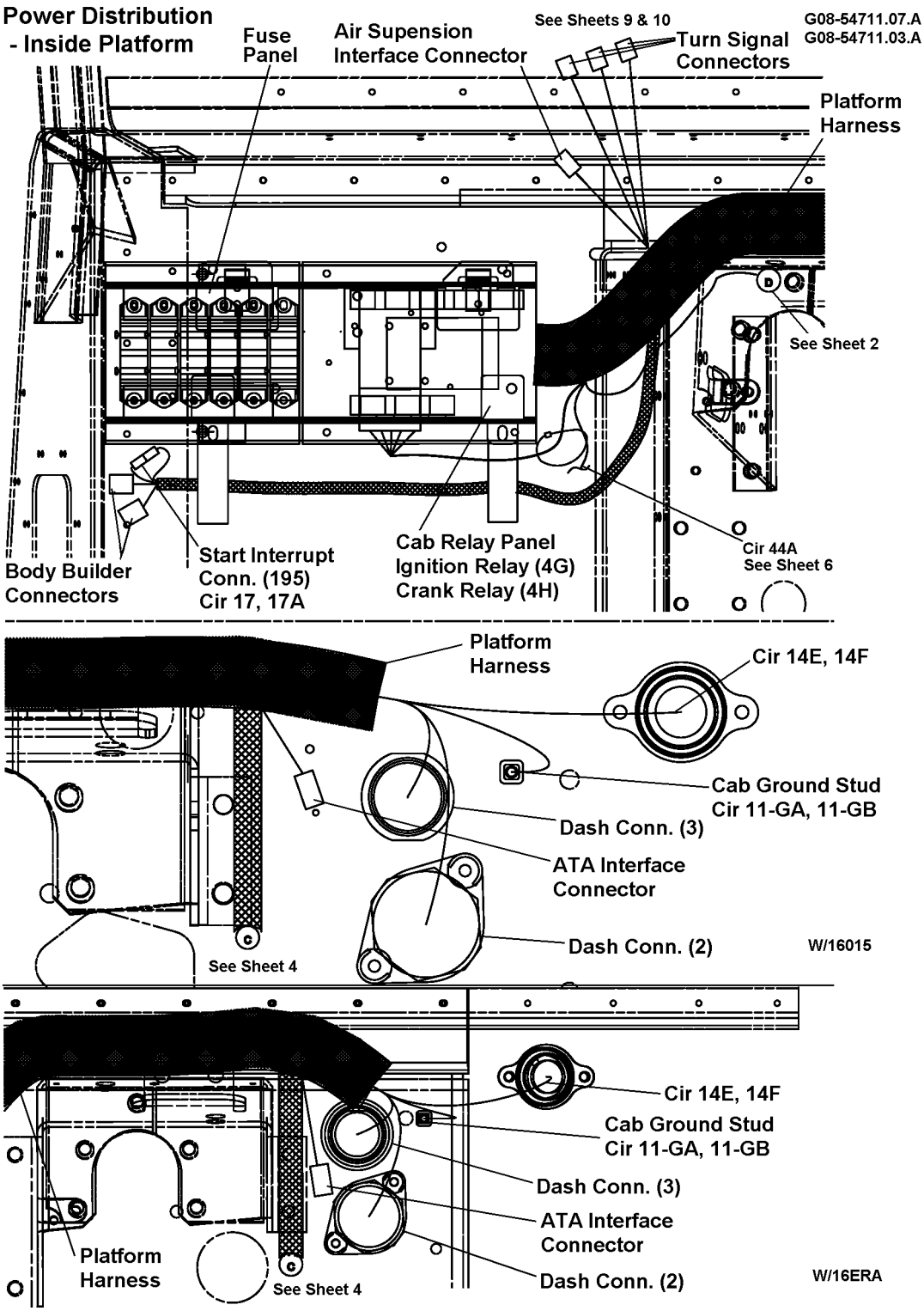

Figure 3 Power Distribution — Inside Platform

2. 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 cowl junction feed stud to circuit 14H, fuse F24, and circuit 85/85A to the coil of horn relay (4N). When the horn button is depressed, power flows through the horn relay coil, circuit 85C, inline connector (222), a blue wire to the horn slip ring (J3), the horn button switch, and a circuit ground wire to the steering column ground.

With the horn relay energized, power flows from circuit 85/85B, horn relay (4N), the relay contacts, circuit 85D, dash connector (2), and horn harness connector (134). With a single horn, power flows through circuit 85E to the high-note horn. The horn is grounded through circuit 85-G, connector (134) and circuit 85-G/ 11-GJ to the cranking motor ground stud. With dual horns, power flows through circuit 85D to a splice. From the splice, power flows through circuit 85E to the high-note horn and circuit 85F to the low-note horn.

The low-note horn is grounded through circuit 85-GF to a splice and the high-note horn is grounded through circuit 85-GE to the same splice. From the splice, ground is through circuit 85-G, connector (134), and circuit 85-G/11-GJ to the cranking motor ground stud.

Turn Signal Switch

Power is applied through circuit breaker F3, circuit 55, flasher (4A), and circuit 55A/60, to the turn signal switch connector (193). When the turn signal switch is moved to the left turn position, the switch contacts close and power is applied to the yellow wire, connector (193), and circuit 56 to a splice. From the splice, power is applied through circuit 56A to the body builder front end connector (13), and through circuit 56D to the body builder rear connector (194). Power is also supplied from the splice to circuit 56C and instrument cluster connector (27) to the left turn signal indicator. The ground path for the left turn signal indicator is connector (27), and circuit 28-GB/11-GA to cab ground (2G).

When the turn signal switch is moved to the right turn position, the switch contacts close and power is applied to the green wire, connector (193), and circuit 57 to a splice. From the splice, power is applied through circuit 57A to the body builder front end connector (13), and through circuit 57D to the body builder rear connector (194). Power is also supplied from the splice to circuit 57C and instrument cluster connector (27) to the right turn signal indicator. The ground path for the right turn signal indicator is connector (27), and circuit 28-GB/11-GA to cab ground (2G).

The ground path for the flasher (4A) is flasher GND circuit 11-GF and 11-GA to cab ground.

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.

Horn(s)

Table 3 Horn(s)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	At cowl fuse/relay block (1F), check fuse F24 for open condition.	(1F), F24.	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	Off	At (1F) cavity 9A, measure voltage from circuit 14H to ground.	(1F) cav. 9A, 14H to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 14H, then repair.
3.	Off	Remove horn relay from (4N). At socket cavity 1, measure voltage from circuit 85A to ground.	(4N) cav. 1, 85A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 85A/85, then repair.
4.	Off	At (4N) cavity 3, measure voltage from circuit 85B to ground.	(4N) cav. 3, 85B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 85B/85, then repair.
5.	Off	Bench test horn relay by measuring resistance from pin 30 to 87A.	Relay, pin 30 to 87A.	<1 ohm.	Go to next step.	Replace horn relay.

Table 3 Horn(s) (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
6.	Off	Bench test horn relay by applying +12 volts to pin 85, ground to pin 86, and measuring resistance from pin 30 to 87.	Energized relay, pin 30 to 87.	<1 ohm.	Go to next step.	Replace horn relay.
7.	Off	With horn button depressed, at (4N) measure voltage between circuit 85A cavity 1, and circuit 85C cavity 2.	(4N), 85A cav. 1 to 85C cav. 2.	12 ± 1.5 volts.	Go to next step.	Locate cause of open or poor connection in circuit 85C, horn harness conn. (222), the blue wire, slip ring (J3), the horn button or the steering column ground, then repair.
8.	Off	At (4N) use a test lead to jumper circuit 85A cavity 3 to 85D cavity 4. Does horn sound?			Install relay. Horn circuits check good.	Leave test lead connected and go to next step.
9.	Off	Disconnect horn harness connector (134) and measure voltage from circuit 85D to ground.	(134), 85D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 85D, dash conn. (2), then repair.
10.	Off	At (134), measure voltage from circuit 85D to 85–G.	(134), 85D to 85–G.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit 85–G/ 11–GJ, then repair.
11.	Off	Reconnect (134) and disconnect high-note horn connector (123). At (123), measure voltage from circuit 85D (circuit 85E w/dual horns) to ground.	(123), 85D or 85E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 85D or 85E/85D, then repair.
12.	Off	At (123), measure voltage from circuit 85D (circuit 85E w/dual horns) to circuit 85–G (85–GE w/dual horns).	(123), 85D or 85E to 85–G or 85–GE.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit 85–G (85–GE/ 85–G w/ dual horns), then repair. Install horn relay and reconnect (123).

Table 3 Horn(s) (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
13.	Off	Reconnect (123) and disconnect low-note horn connector (477). At (477), measure voltage from circuit 85F/85D to ground.	(477), 85F/85D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 85F/85D, then repair.
14.	Off	At (477), measure voltage from circuit 85F/85D to circuit 85–GF.	(477), 85F/85D to 85–GF.	12 ± 1.5 volts.	Replace horn. Go to next step.	Locate open or poor connection in circuit 85–GF/ 85–G, then repair.
15.	Off	Circuits check good. Reconnect (477), and install horn relay.				

Turn Signal Switch

Table 4 Turn Signal Switch

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	At cab fuse block, check fuse F3 for open condition.	F3	<1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	Off	Remove flasher from socket conn. (4A) and measure voltage from circuit 55 to ground.	(4A), 55 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 55, or the flasher GND circuits 11–GF and 11–GA to cab ground, then repair.
3.	Off	At conn. (4A) install a test jumper from circuit 55 to 55A/60. Operate turn signal. Does turn signal switch work?			Replace flasher.	Go to next step.
4.	Off	Disconnect turn signal connector (193) and measure voltage from circuit 55A/60 to ground.	(193), 55A/60 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 55A/60, then repair.
5.	Off	At (193), measure voltage from circuit 60 to ground.	(193), 60 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 60, then repair.

Table 4 Turn Signal Switch (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
6.	Off	Move turn signal switch to left turn position and at (193), measure resistance from red wire to yellow wire.	(193), red to yellow wire.	<1 ohm.	Go to next step.	Replace turn signal switch.
7.	Off	Move switch to right turn position and at (193), measure resistance from red wire to green wire.	(193), red to green wire.	<1 ohm.	Go to next step.	Replace turn signal switch.
8.	Off	Engage hazard button and at (193), measure resistance from black wire to yellow wire and then black wire to green wire.	(193), black to yellow, then black to green.	<1 ohm each test point.	Go to next step.	Replace turn signal switch.
9.	Off	Reconnect (193). Move turn signal to left turn position and at body builder front end connector (13), measure voltage from circuit 56A to ground.	(13), 56A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 56A/56, then repair.
10.	Off	Move turn signal to right turn position and at body builder front end connector (13), measure voltage from circuit 57A to ground.	(13), 57A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 57A/57, then repair.
11.	Off	At body builder rear lighting connector (194), measure voltage from circuit 57D to ground.	(194), 57D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 57D/57, then repair.
12.	Off	Move turn signal to left turn position and at (194), measure voltage from circuit 56D to ground.	(194), 56D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 56D/56, then repair.
13.	Off	Is the left turn signal indicator light on?			Go to Step 16.	Go to next step.
14.	Off	Disconnect cluster connector (27) and measure voltage from circuit 56C to ground.	(27), 56C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 56C/56, then repair.

Table 4 Turn Signal Switch (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
15.	Off	At (27), measure voltage from circuit 56C to circuit 28–GB.	(27), 56C to 28–GB.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit 28–GB/ 11–GA, then repair.
16.	Off	Move the turn signal to right turn position. Is the right turn signal indicator light on?			Go to Step 19.	Go to next step.
17.	Off	Disconnect cluster connector (27) and measure voltage from circuit 57C to ground.	(27), 57C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 57C/57, then repair.
18.	Off	At (27), measure voltage from circuit 57C to circuit 28–GB.	(27), 57C to 28–GB.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit 28–GB/ 11–GA, then repair.
19.	Off	Remove test jumper and install turn signal flasher. Do the body builder lights flash when turn signal switch is moved to a turn position?			Turn and hazard switch signal circuits check good.	Troubleshoot body builder installed turn signal circuits.

2.4. COMPONENT LOCATIONS

(4A) Turn Signal Flasher..... Inside Cab Relay Panel
(13) Front End Connector..... At Cowl Grommet, Front Side of Cowl
(27) 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
(4N) Horn Relay..... Inside Power Distribution Panel

Refer to Figure 4 Figure 5, Figure 6, and Figure 7.

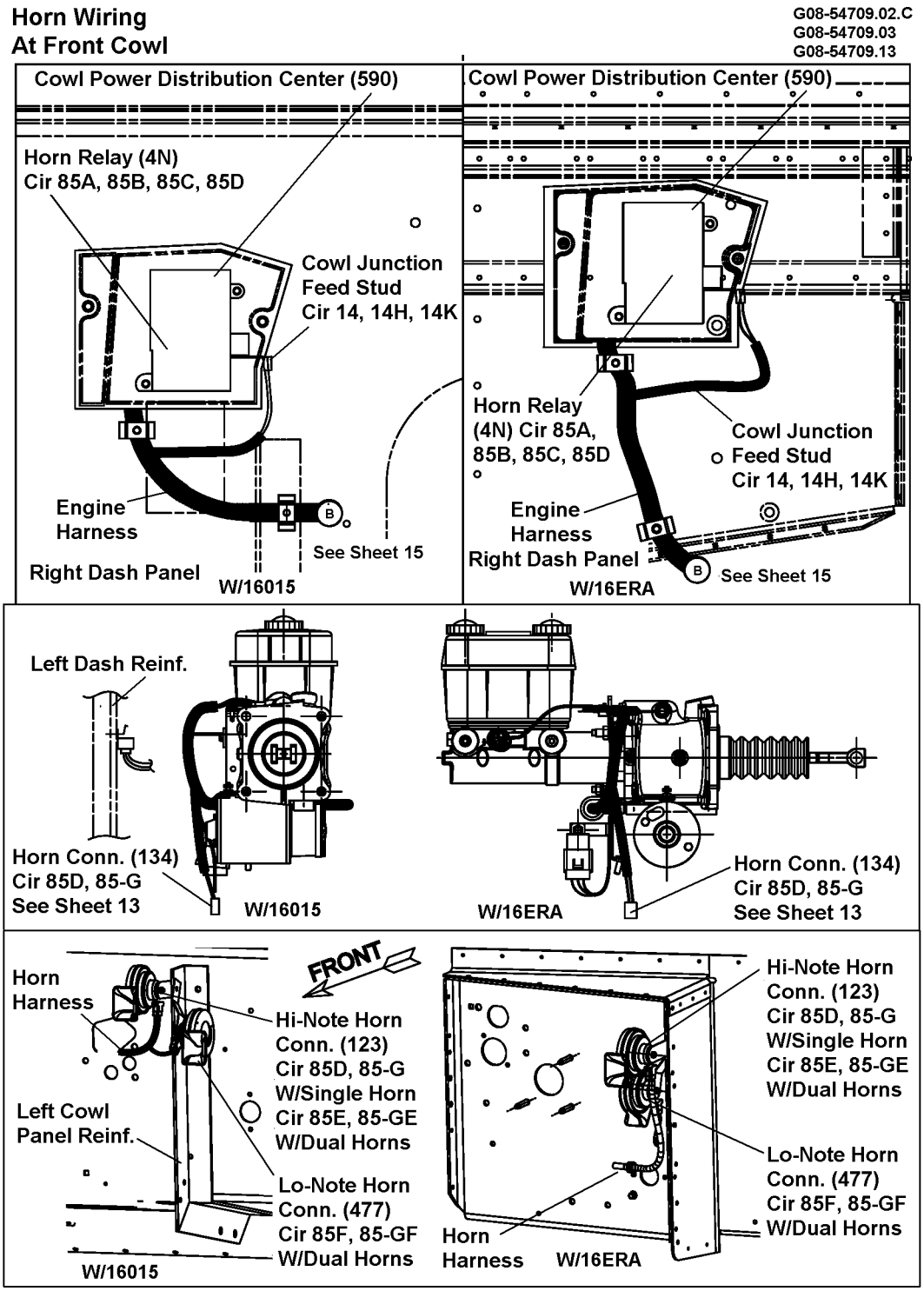

Figure 4 Horn Wiring at Front Cowl

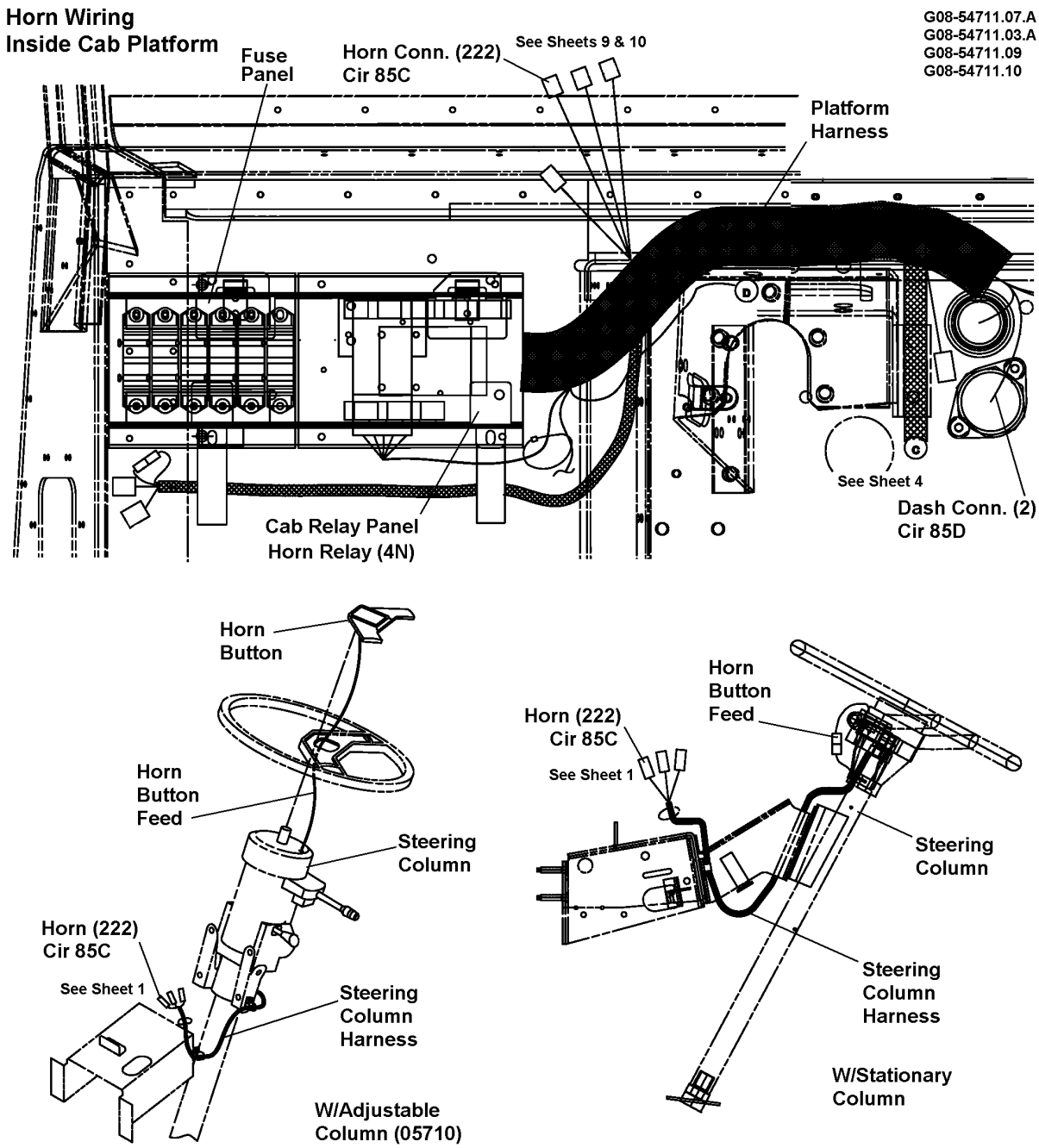

Figure 5 Horn Wiring Inside Cab Platform

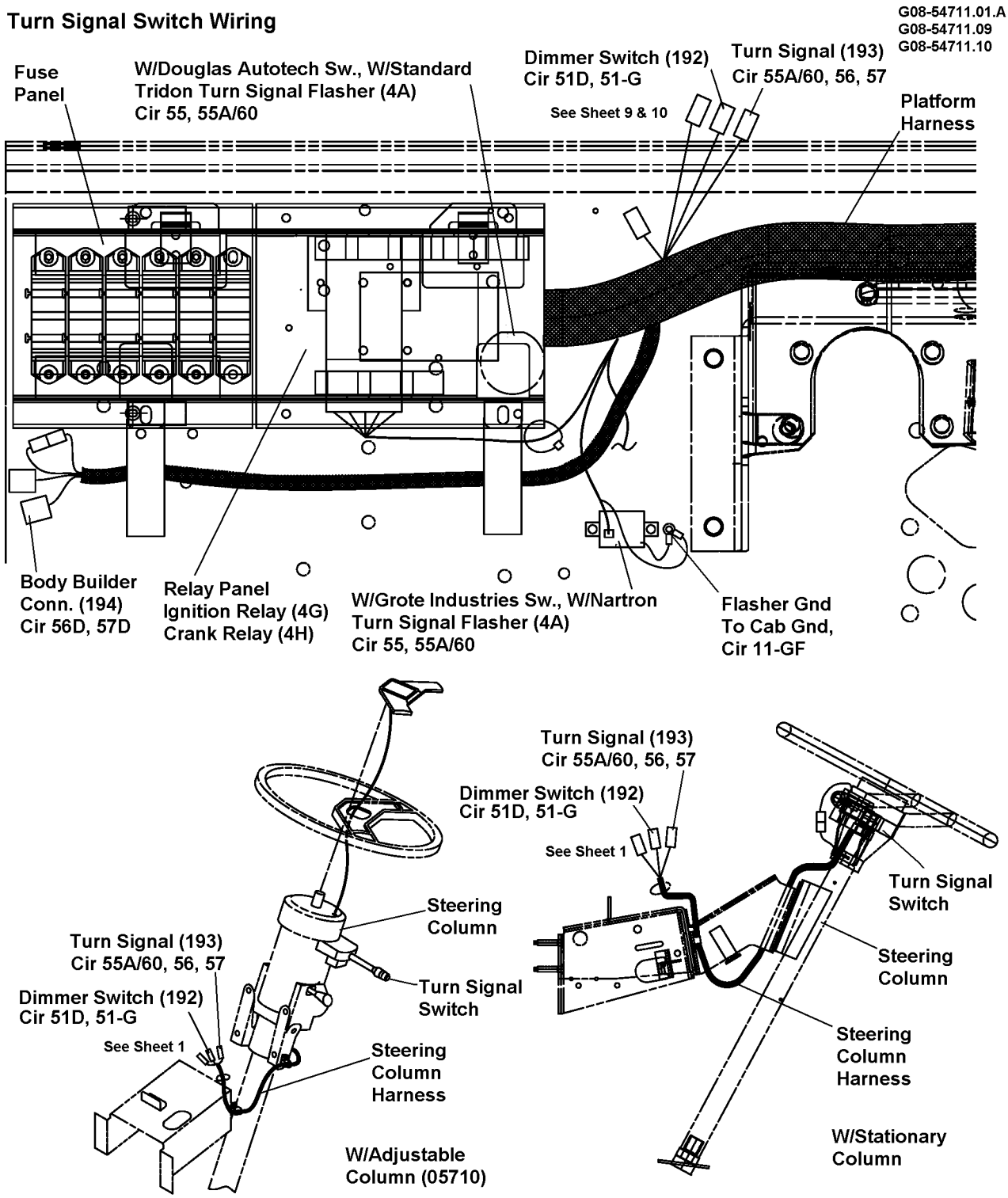

Figure 6 Turn Signal Switch Wiring

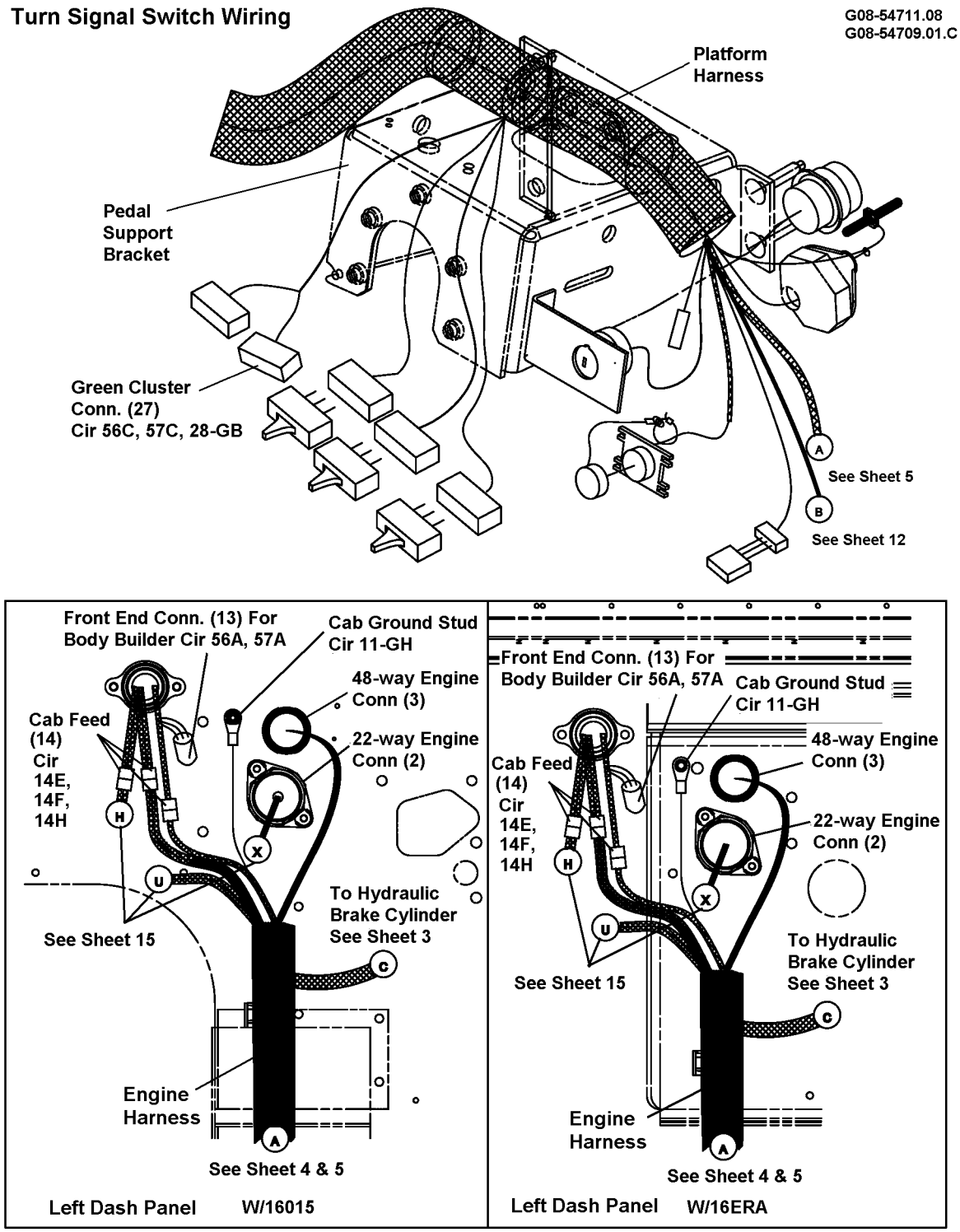

Figure 7 Turn Signal Switch Wiring

3. 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 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.

Charging System and Circuits

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

Cranking Motor System and Circuits

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, crank inhibit relay, start relay, the Electronic Control Module (ECM2), and a clutch switch with a manual transmission, or a neutral safety and backup (NSBU) switch with an Allison LCT automatic transmission.

Cranking Motor System and Circuits — Cranking Motor Thermal Overcrank Protection

On vehicles with thermal overcrank protection, excessive cranking will cause cranking motor temperature to reach a pre-set thermal overcrank limit. The thermal switch will then open causing the motor to disengage. When the crank motor cools, the switch closes, permitting the crank motor to operate again. The thermal switch interrupts the current to the cranking system start relay.

3.2. OPERATION

Battery Power

Vehicle batteries are connected in parallel with the positive battery cable connected to the cranking motor solenoid (B) terminal. The negative battery terminals are also connected in parallel with the negative cable connected to the cranking motor ground stud (G).

The negative battery terminal is grounded, from the cranking motor ground stud (G), through the battery cable, to the frame rail. The engine block, the cab, and the frame are also connected by ground cables or circuits to the cranking motor ground.

Charging System and Circuits

While the vehicle is running, the alternator supplies power through the (BAT) terminal and circuit 2/2–FL and 2A-FL (fuselinks with 2 or 4 gauge strips) to the cranking motor solenoid (B) stud. From the stud, power is supplied to the cowl junction feed stud and power distribution center (590) through circuit 14–FL/14A-FL/14/14M, to supply the electrical demands of the vehicle. In addition, the alternator also supplies and maintains battery voltage through the cranking motor solenoid (B) stud and the positive battery cable to the batteries.

The alternator is grounded through the (GND) terminal and circuit 2–G to the crank motor ground stud (G).

The system also includes an alternator indicator battery charge light. When the key switch is in the accessory or on position, power is applied to the instrument cluster indicator light through circuit 1 and cluster connector (28). The light is grounded through circuit 1C, dash connector (2) and circuit 1C to the alternator (I) terminal. When the engine starts and if the alternator is generating full power, the indicator light will go off.

For a complete discussion on operating principles for alternators, refer to GROUP 08 — ELECTRICAL in the Master Service Manual for the specific alternator being serviced.

Cranking Motor System and Circuits with Allison Automatic Transmission

NOTE – The ECM2 is programmed for the type of transmission installed and adjusts for the different voltages received at the ECM2 driveline disengagement terminal.

When the key switch (63) is in the on position, power is supplied through circuit 13C to the ignition relay (4G). The relay ground is through circuit 13-G/11-GB to cab ground. This energizes the relay and closes the normally open contacts. Battery power is then applied through the contacts, and circuit 13 to circuit breaker F9. From F9, power is supplied through circuit 97P, the 22-pin dash connector (2), and circuit 97P to the NSBU switch connector (3026) at the transmission.

When the transmission is in neutral, the neutral position switch contacts are closed. Power then flows through the contacts, switch connector (3026), circuit 97AU, dash connector (2), and circuit 97AU to the jumpered clutch switch connector (386).

From this connector, power is supplied to the crank inhibit relay (4H) contacts through circuit 97L. At the same time, power is also supplied through circuit 97A, the 48-pin dash connector (3), and circuit 97A to ECM2 (6020). The driveline disengagement switch terminal of the ECM2 will be at 12 volts. Providing the engine is not running, this signals the ECM2 to energize the crank inhibit relay by providing a ground to the relay coil through circuit 97H, dash connector (3), and circuit 97H. This allows power to flow from the key switch, through circuit 17, start interrupt connector (195) and circuit 17A to energize the relay.

The energized crank inhibit relay controls the start relay (590B) by providing power through circuit 17B, dash connector (2), and circuit 17B to the relay. This energizes the start relay which is grounded through circuit 17D, the thermal overcrank protection switch, and circuit 17-G/11-GJ to the crank motor ground stud (G).

Power is available at the start relay normally open contacts through fuse F30 and circuit 17C. With the start relay energized, power flows through the closed relay contacts and circuit 17E to the (S) terminal of the crank motor solenoid. The energized solenoid engages the crank motor’s shaft to rotate.

When the engine starts and the key is released, the ECM2 removes the ground from the crank inhibit relay (4H) which de-energizes the relay. This causes the start relay to de-energize and disengage the crank motor. As long as the engine is running, the ECM2 will not allow the cranking motor to be engaged.

NOTE – When the transmission is not in neutral, the NSBU switch (3026) contacts are open and 0 volts are available at the ECM2 (6020) driveline disengagement switch terminal and the crank inhibit relay (4H) contacts. This prevents the vehicle from being started.

For complete information on operation and servicing cranking motors used on these vehicles, refer to Group 08 - ELECTRICAL in the Master Service Manual.

Cranking Motor System and Circuits with Manual Transmission

When the key switch (63) is in the on position, power is supplied through circuit 13C to the ignition relay (4G). The relay ground is through circuit 13-G/11-GB to cab ground. This energizes the relay and closes the normally open contacts. Battery power is then applied through the contacts, and circuit 13 to circuit breaker F9.

From F9, power is supplied through circuit 97P, the 22-pin dash connector (2), and circuit 97P through the jumper splice when N/LCT XMSN, circuit 97AU, dash connector (2), and circuit 97AU to the clutch switch connector (386).

When the clutch pedal is depressed, power is switched from the ECM2 circuitry to the crank inhibit relay (4H) contacts through circuit 97L. The driveline disengagement switch terminal of the ECM2 will be at 0 volts. Providing the engine is not running, this signals the ECM2 to energize the crank inhibit relay by providing a ground through circuit 97H, dash connector (3), and circuit 97H to the relay. This allows power to flow from the key switch, through circuit 17, start interrupt connector (195) and circuit 17A to energize the relay.

The energized crank inhibit relay controls the start relay (590B) by providing power through circuit 17B, dash connector (2), and circuit 17B to the relay. This energizes the start relay which is grounded through circuit 17D, the thermal overcrank protection switch and circuit 17-G/11-GJ to the crank motor ground stud (G).

Power is available at the start relay normally open contacts through fuse F30 and circuit 17C. With the start relay energized, the contacts are closed and power flows through relay and circuit 17E to the (S) terminal of the crank motor solenoid. The energized solenoid engages the crank motor’s shaft to rotate.

When the engine starts and the key is released, the ECM2 removes the ground from the crank inhibit relay (4H) which de-energizes the relay. This causes the start relay to de-energize and disengage the crank motor. As long as the engine is running, the ECM2 will not allow the cranking motor to be engaged.

NOTE – When the clutch pedal is in the released position, 12 volt power is applied through the normally open clutch switch (386) contacts to the ECM2 (6020) driveline disengagement switch terminal. This prevents the vehicle from being started.

For complete information on operation and servicing cranking motors used on these vehicles, refer to Group 08 - ELECTRICAL in the Master Service Manual.

Cranking Motor System and Circuits — Cranking Motor Thermal Overcrank Protection

With thermal overcrank protection, the start relay control coil ground circuit 17D is connected to the normally closed thermal switch (N/L). The thermal switch is located in the end of the cranking motor. The thermal switch is grounded through connector (N/L), and circuit 17-G/11-GJ to the cranking motor ground (G) stud.

If excessive cranking causes the cranking motor temperature to reach pre-set thermal overcrank limits, the thermal switch opens. This causes the start relay (590B) to de-energize, turning off power to the cranking motor solenoid (S) terminal and disengaging the cranking motor.

When crank motor cools, the switch closes, permitting the crank motor to operate again.

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 1000 Stripped Chassis models 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 8)

Test each battery separately.

1. Disconnect both battery term. cables at each battery. Check each battery visually.
2. Examine the hydrometer eye (if no eye go to step 3).
   a. Eye shows green — go to step 4.
   b. Eye shows dark — recharge, then go to step 4.
   c. Eye shows yellow — replace battery.
3. Apply a 300A load for 15 seconds. Turn off load and wait one minute.
   a. If 12.4V or more — go to step 4.
   b. If less than 12.4V — recharge, then repeat step 3. If battery will not store charge above 12.4 volts, replace it.
4. Apply a test load equal to 50% of the battery CCA rating at –17.8°C(0°F). After 15 seconds, **with the load still applied,** measure and record terminal voltage _____. Turn the load off.

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

Table 5

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

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

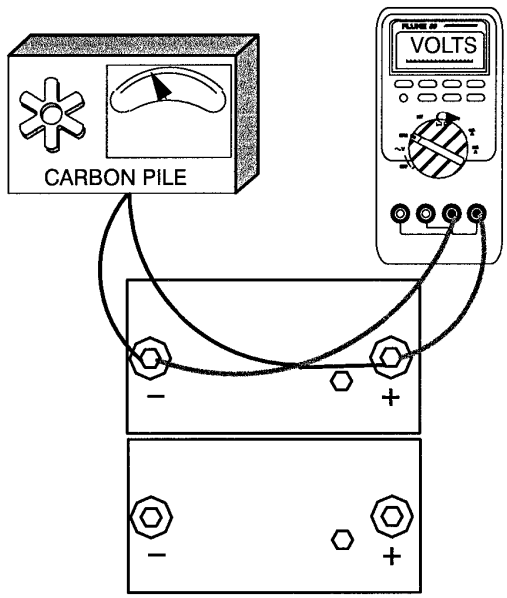

Figure 8 Battery Test Procedure

Batteries and Cables — Battery Cable Voltage Loss Test (Figure 9).

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

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

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

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

2. Connect carbon pile positive lead to 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.

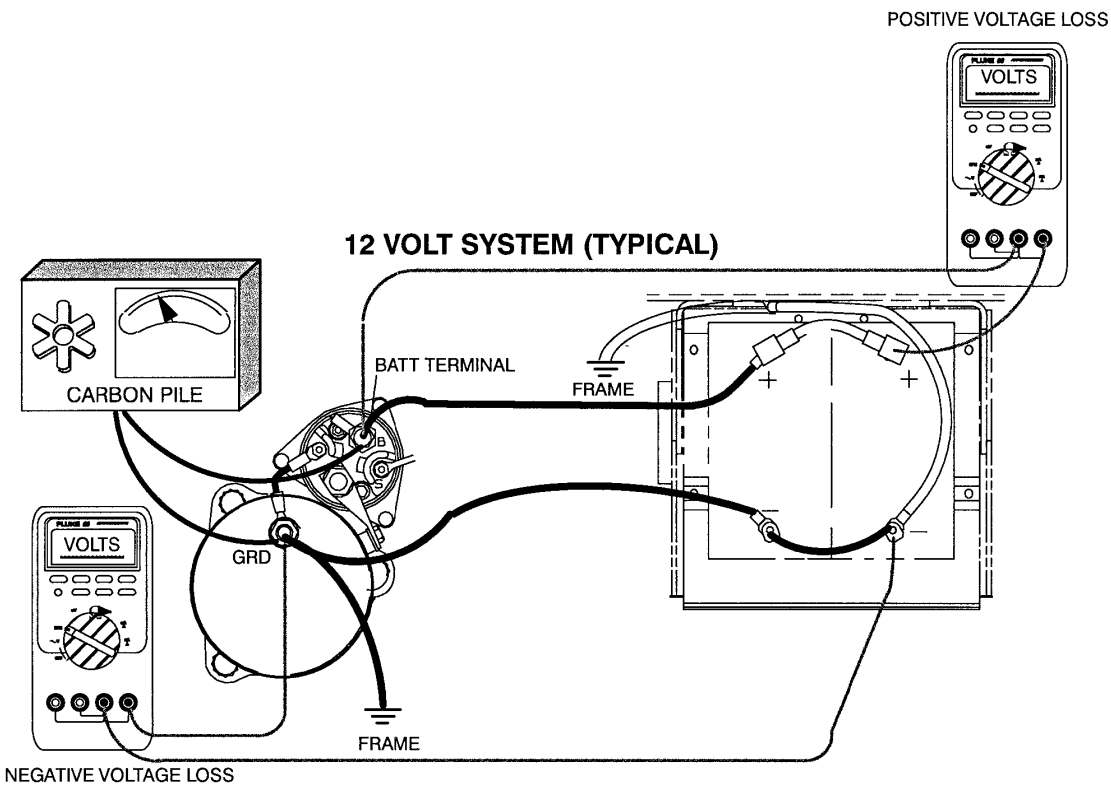

Figure 9 Battery Cable Voltage Loss Test

Vehicle Charging System

This section consists of six parts: Batteries Undercharged, Alternator Tests, Alternator Wiring Test — Part 1, Alternator Wiring Test — Part 2, Alternator Replacement Test, and Alternator Indicator Light Wiring.

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 BAT terminal of the alternator. A zero reading indicates an open in circuit 2, 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 S08294. 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 10)

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

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

   NOTE – Alternator output is at battery voltage.

2. Connect voltmeter across battery.

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

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

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

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

BATTERY Voltage (step 4) _____

minus

ALTERNATOR Voltage (step 6) _____

equals

SYSTEM LOSS _____

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

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

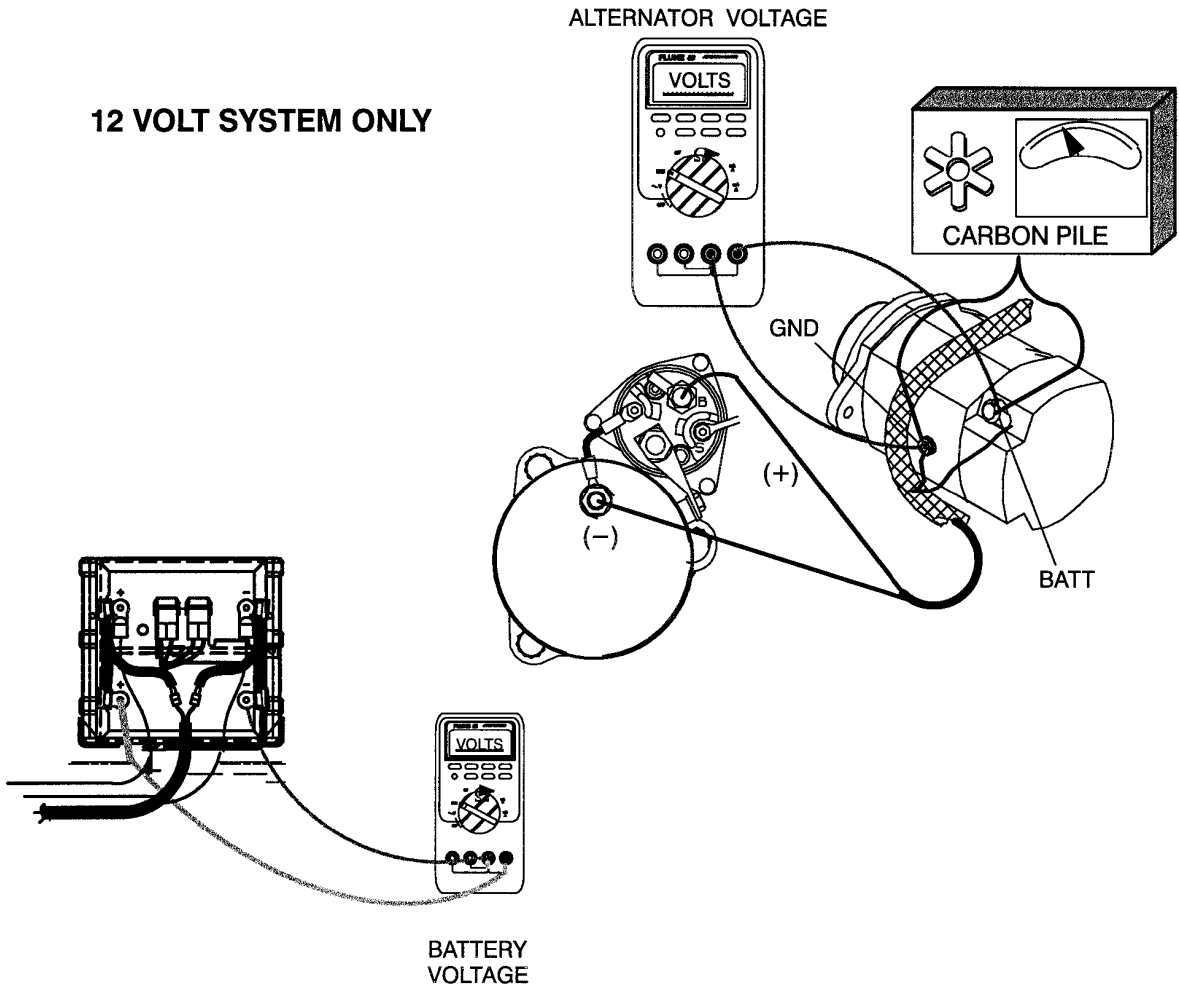

Figure 10 Alternator Wiring Test — Part 1 (12 Volt System Only)

Alternator Wiring Test — Part 2 (12 Volt System Only) (Figure 11)

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

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

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

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

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

   POSITIVE CIRCUIT LOSS (step 2) _____

   PLUS

NEGATIVE CIRCUIT LOSS (step 4) _____

equals

TOTAL SYSTEM LOSS _____

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

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

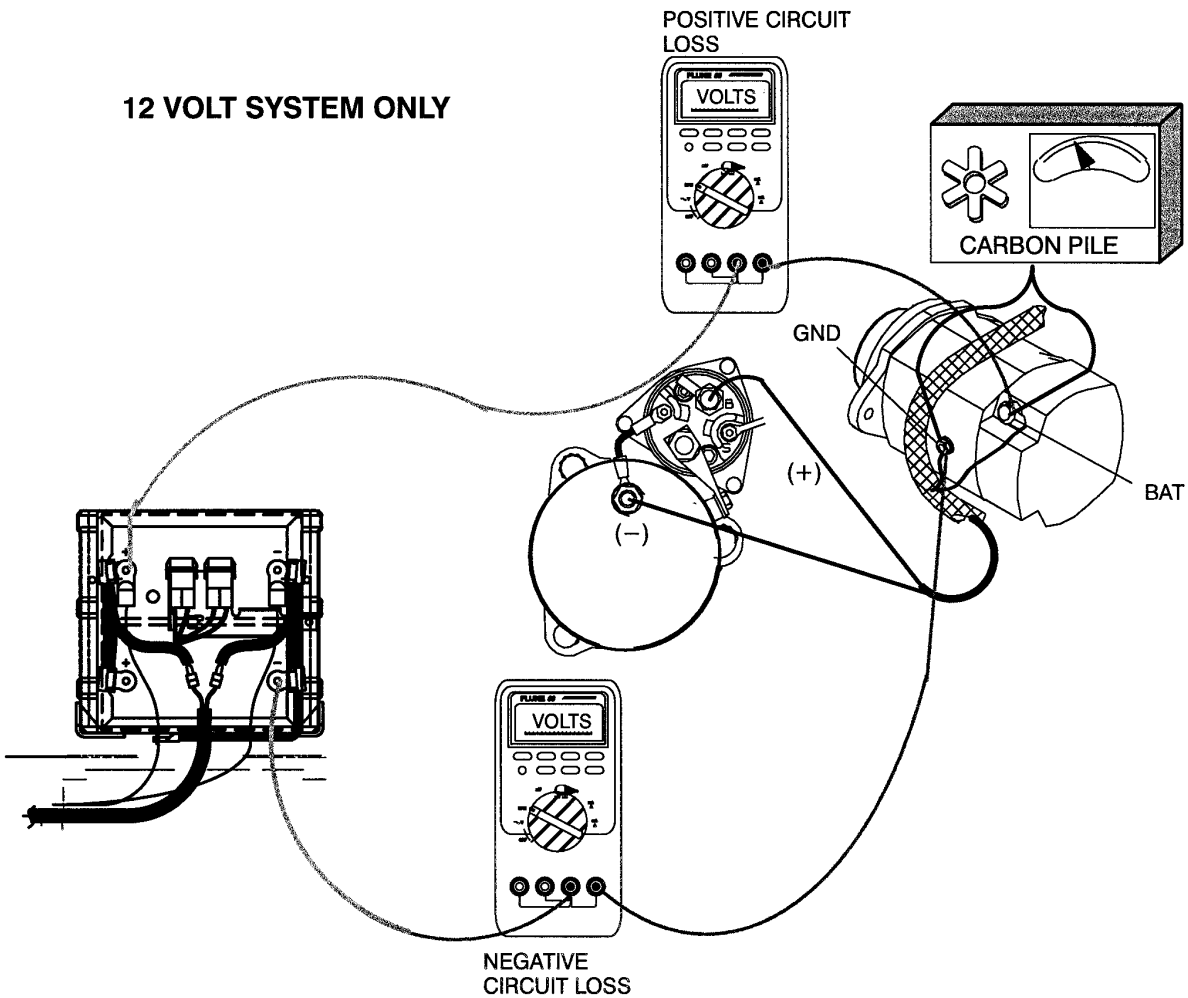

Figure 11 Alternator Wiring Test — Part 2 (12 Volt System Only)

Alternator Replacement Test (12 Volt System Only) (Figure 12)

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

2. With vehicle at shop temperature, connect the carbon pile, voltmeter (for step 3) and the ammeter (for step 4) as shown. To use an ammeter without induction clamp, connect meter leads to same terminals as the carbon pile.

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

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

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

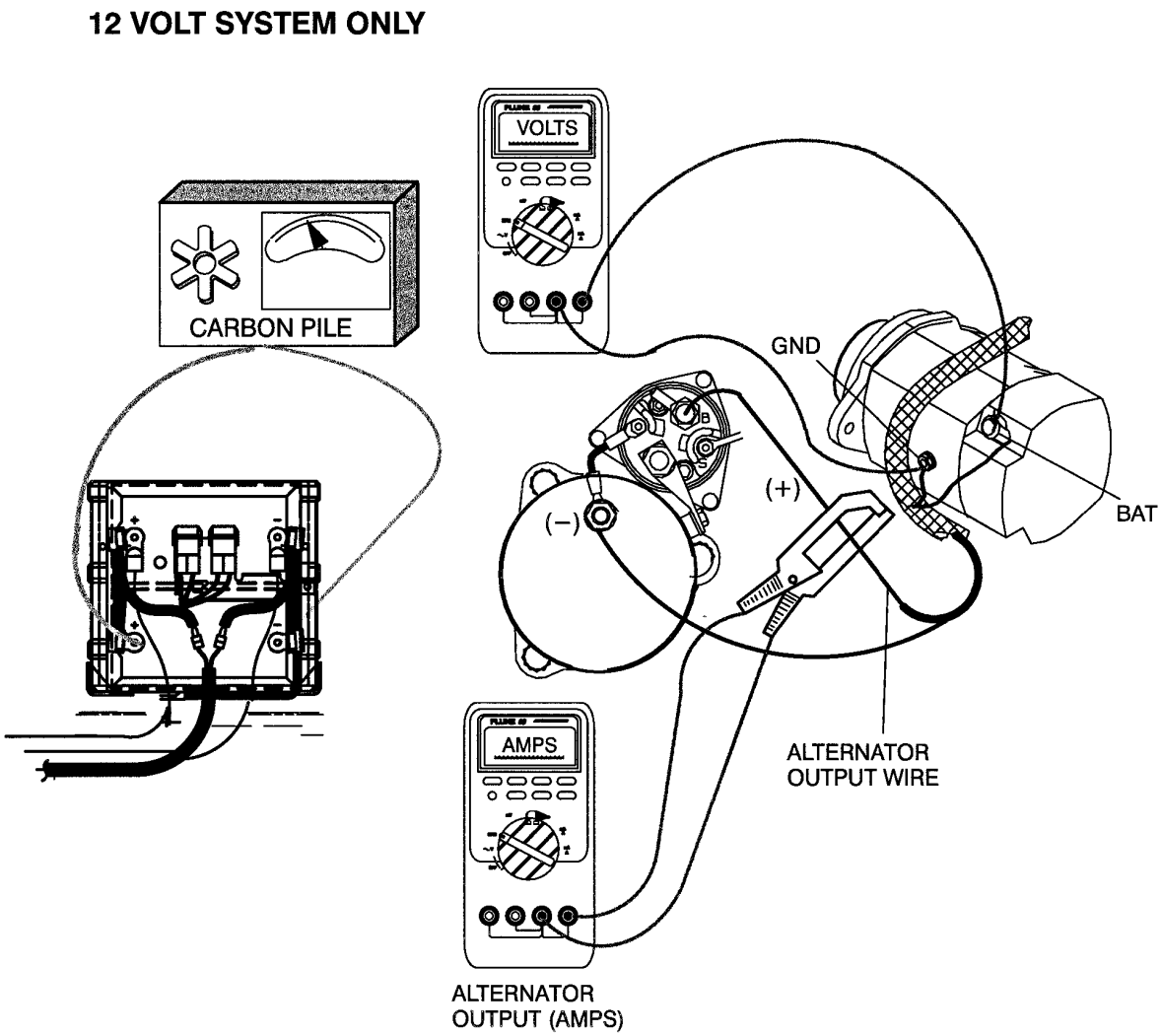

Figure 12 Alternator Replacement Test (12 Volt System Only)

Alternator Indicator Light Wiring

Table 6 Alternator Indicator Light Wiring

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Disconnect dash connector (2). At engine harness side, measure resistance of circuit 1C to ground.	(2), 1C to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in engine harness circuit 1C, then repair.
2.	Off	Disconnect cluster connector (28). Measure resistance of circuit 1 between cluster connector cavity 16 and dash connector (2) cavity O.	(28), cav. 16 to (2) cav. O.	< 1 ohm.	Go to next step.	Locate open or poor connection in cab harness circuit 1C, then repair.
3.	Off	At cluster (28), check continuity between pin 12 and pin 16.	(28), pin 12 to pin 16.	Continuity.	Go to next step.	Check bulb and socket and replace if necessary. If still no continuity, replace cluster.
4.	Off	Disconnect key switch connector (63). Measure resistance of circuit 1 between (63) cavity D to (28) cavity 12.	(63), cav. D cir. 1 to (28), cav. 12 cir. 1.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 1, then repair.
5.	Off	Reconnect connectors. Alternator indicator light circuits check good. If condition persists, repair or replace alternator.				

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 Motor Replacement Test, Engine Crank Inhibit System Circuit Tests, and Testing Thermal Overcrank Protection System.

Starter Solenoid Circuit Test — Part 1 (Figure 13)

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 a 50A fuse and the start relay (located in the cowl power distribution center, right side of cowl) 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 17E from the starter solenoid “S” terminal.

2. Connect) the carbon pile positive lead to circuit 17E 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 17E (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 start relay switch energize with a clicking sound. If the switch doesn’t “click,” either the start relay switch is defective or there is no voltage from the key switch circuit (refer to diagnostic test, Engine Crank Inhibit System Circuit Test).

4. Turn on and adjust the carbon pile to no more than 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 Engine Crank Inhibit System Circuit Test .

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

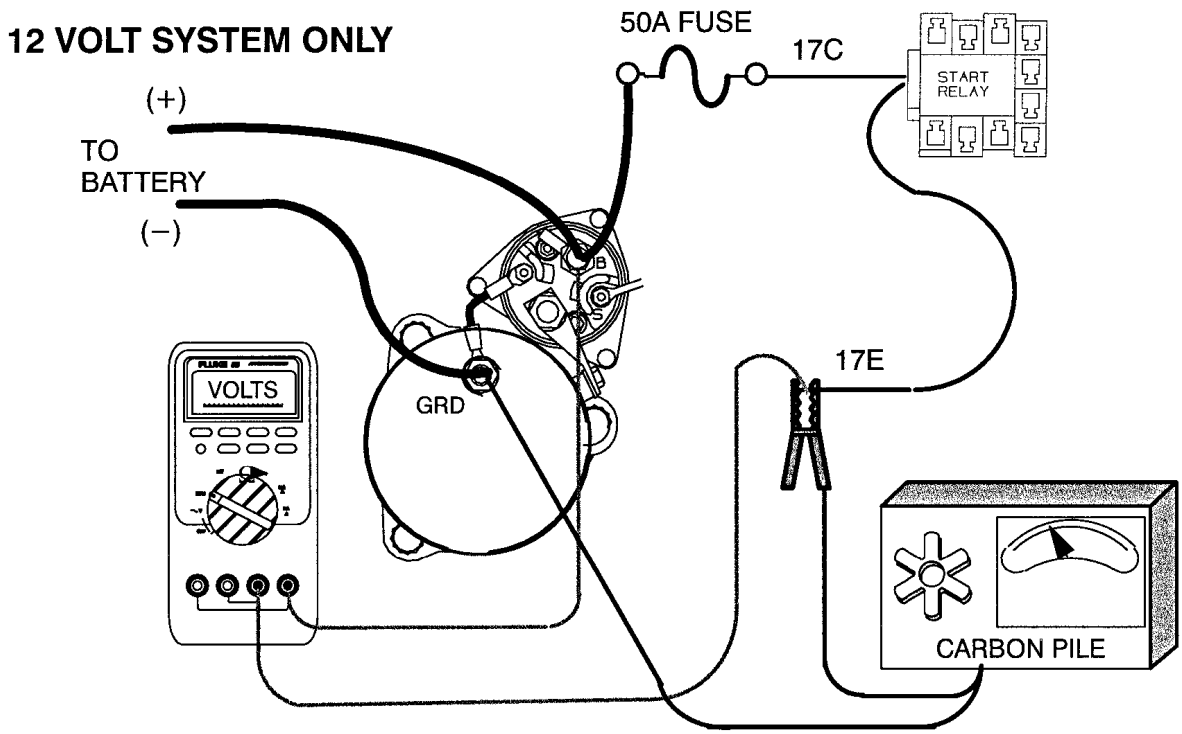

Figure 13 Starter Solenoid Circuit Test — Part 1

Starter Solenoid Circuit Test — Part 2 (Wire Voltage Loss) (Figure 14)

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 17E from “S” terminal at starter solenoid. Connect carbon pile to circuit 17E and to starter ground terminal. Turn the carbon pile on (will show 0 amps).

2. Disconnect start relay and install a jumper lead to cavity 1B, circuit 17C.

NOTE – Test lead will be at battery voltage.

Connect DMM from solenoid BAT terminal to start relay connector cavity 1B, circuit 17C (will show zero volts).

3. At relay connector, install other end of jumper lead to cavity 3C circuit 17E. 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 3C, 17E to circuit 17E at carbon pile. Connect to terminal and not to carbon pile clamp.

5. Turn on and adjust carbon pile to no more than a 50 amp load (no more than 10 seconds). Read and record second wire voltage loss. 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 start relay and retest per above mentioned test, Part 1.

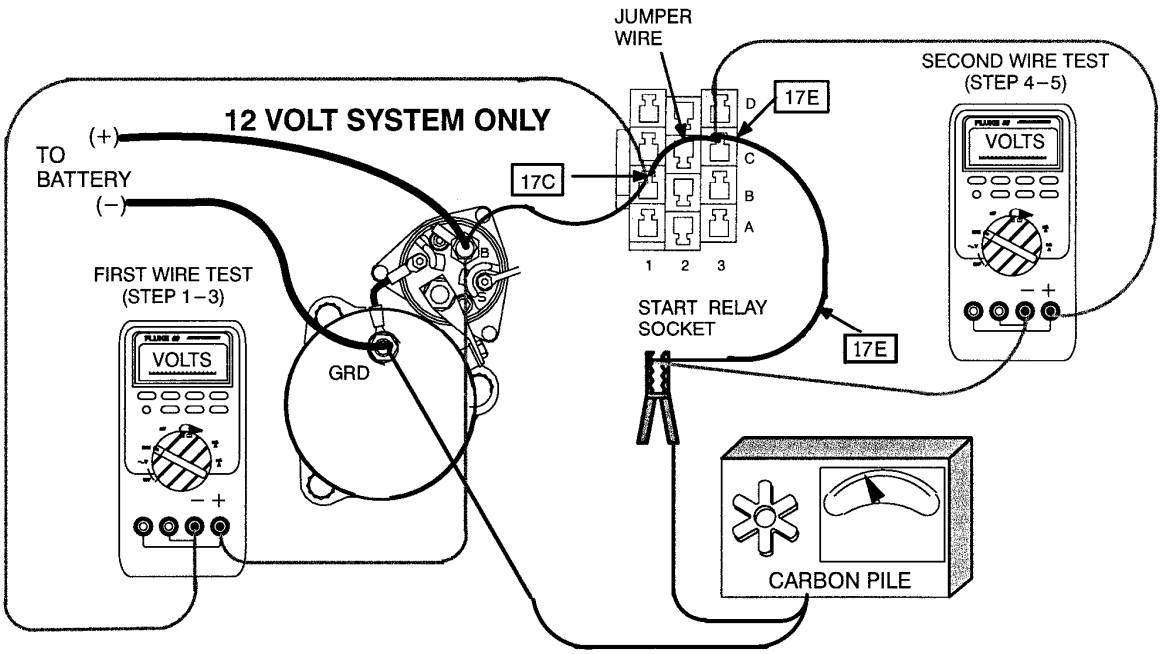

Figure 14 Starter Solenoid Circuit Test — Part 2

Starter Motor Replacement Test (Figure 15)

A. COLD WEATHER START RELAY PROBLEMS

The start relay 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 relay.

If this condition exists, install jumper wire from circuit 17C to 17E at starter relay connector.

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

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

B. CHECKING AVAILABLE VOLTAGE AT 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 solenoid “BAT” stud and starter motor 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.

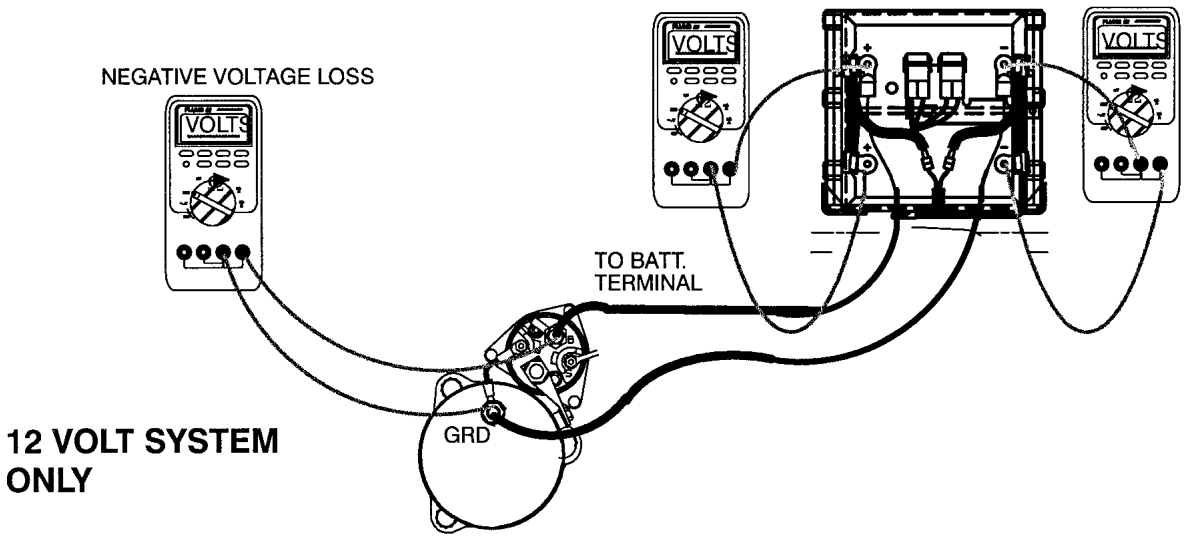

Figure 15 Starter Motor Replacement Test

Engine Crank Inhibit System Circuit Test

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

Table 7 Engine Crank Inhibit System Circuit Test

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Using suitable jumper, jump crank motor solenoid “B” terminal to “S” terminal Does crank motor operate?	Crank motor “B” to “S” terminal.		Go to next step.	Go to Starter Motor Replacement Test.
2.	Off/ Start	Remove start relay (590B). Turn key to start position and at conn. cavity 3B, measure voltage from circuit 17B to ground.	(590B), cav. 3B, 17B to gnd.	12 ± 1.5 volts.	Go to next step.	Reconnect start relay. Go to Step 7.

Table 7 Engine Crank Inhibit System Circuit Test (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
3.	Off	Check fuse F30 for open condition.	F30	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
4.	Off	At (590B) cavity 1B, measure voltage from circuit 17C to ground.	(590B), cav. 1B, 17C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 17C, then repair.
5.	Off	At conn. (590B), jump cavity 1B circuit 17C to cavity 3C circuit 17E.	(590B), cav. 1B, 17C to cav. 3C, 17E.	Crank motor operates.	Go to next step.	Locate open or poor connection in circuit 17E, then repair.
6.	Off	At conn. (590B), measure voltage across cavity 1B circuit 17C to cavity 1C circuit 17D.	(590B), cav. 1B, 17C to cav. 1C, 17D.	12 ± 1.5 volts.	Replace start relay.	Locate cause of low or no voltage in circuits 17D or 17–G/ 11–GJ, then repair. Install relay. If condition persists, refer to Testing Thermal Overcrank Protection System.
7.	Off/ On	Remove crank inhibit relay (4H). With auto. trans. in neutral or clutch pedal depressed, turn key on and at cavity 3, measure voltage from circuit 97L to ground.	(4H), cav. 3, 97L to gnd.	12 ± 1.5 volts.	Go to next step.	Go to Step 15.
8.	On	At (4H) cavity 2, measure voltage from circuit 17A to ground.	(4H), cav. 2, 17A to gnd.	12 ± 1.5 volts.	Go to next step.	Go to Step 25.
9.	On	At (4H) install jumper from cavity 2 circuit 17A to cavity 5 circuit 17B. Does motor crank?			Go to next step.	Locate open or poor connection in circuit 17B, or dash conn. (2), then repair.
10.	Off	Bench test relay (4H) by measuring resistance from terminal 30 to 87A.	(4H), term. 30 to 87A.	< 1 ohm.	Go to next step.	Replace crank inhibit relay.

Table 7 Engine Crank Inhibit System Circuit Test (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
11.	Off	Bench test relay (4H) by applying +12V to pin 85 and ground to pin 86. Measure resistance across terminal 30 to 87.	Energized relay (4H), term. 30 to 87.	< 1 ohm.	Go to next step.	Replace crank inhibit relay.
12.	Off/ On	Disconnect ECM2 conn. (6020). Turn key on. With automatic transmission in neutral or with clutch pedal released, measure voltage at cavity 26, circuit 97A to ground.	(6020), cav. 26, 97A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 97A, or dash connector (3), then repair. If still no voltage, replace clutch switch.
13.	On	With manual transmission and clutch pedal depressed, at (6020) cavity 26, measure voltage from circuit 97A to ground.	(6020), cav. 26, 97A to gnd.	0 volts.	Go to next step.	Replace clutch switch.
14.	Off	At crank inhibit relay conn. (4H) cavity 1, install jumper from circuit 97H to ground. At (6020) cavity 46, measure resistance of circuit 97H to ground.	(6020), cav. 46, 97H to gnd.	< 1 ohm.	Go to Step 27.	Locate open or poor connection in circuit 97H or dash conn. (3), then repair. If condition persists, refer to Engine Diagnostic Manual for trouble- shooting the ECM2.
15.	Off	Check circuit breaker F9 for open condition.	F9	< 1 ohm.	Go to next step.	Locate cause of overload condition and repair. Replace F9.
16.	On	At F9 cavity A, measure voltage from circuit 13 to ground.	F9, cav. A, 13 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 13, then repair.
17.	Off	Is vehicle equipped with a manual transmission?			Go to next step.	Go to Step 22.

Table 7 Engine Crank Inhibit System Circuit Test (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
18.	Off/ On	Disconnect clutch pedal conn. (386). Turn key on and at cavity C, measure voltage from circuit 97AU to ground.	(386), cav. C, 97AU to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuits 97AU, 97P, dash conn. (2), or NSBU switch (3026), then repair.
19.	Off	Measure resistance of circuit 97L between conn. (386) cavity A, and relay (4H) cavity 3.	(386), cav. A, to (4H), cav. 3, 97L.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 97L, then repair. If condition persists, replace clutch pedal sw.
20.	Off	At (386), with clutch pedal released, measure switch resistance across term. B to C.	(386), term. B to C.	< 1 ohm.	Go to next step.	Replace clutch switch and reconnect connector (386).
21.	Off	At (386) and with clutch pedal depressed, measure switch resistance across terminal A to C.	(386), term. A to C.	< 1 ohm.	Clutch pedal sw. and cir. OK. Reconnect (386).	Replace clutch switch and reconnect connector (386).
22.	Off/ On	Disconnect NSBU switch (3026). Turn key on and measure voltage from circuit 97P to ground.	(3026), 97P to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 97P or dash connector (2), then repair.
23.	Off	At switch (3026) and with transmission in neutral, measure resistance across terminals.	(3026), across terminals.	< 1 ohm.	Go to next step.	Replace switch.
24.	Off	At conn. (3026), install jumper wire from circuit 97AU to ground. At crank relay (4H) cavity 3, measure resistance of circuit 97L to ground.	(4H), cav. 3, 97L to gnd.	< 1 ohm.	Neutral position sw. and circuits OK. Reconnect (3026). Go to next step.	Locate open or poor connection in circuits 97AU, 97L, or dash conn. (2) or jumper conn. (386), then repair. Reconnect (3026).
25.	Off	Disconnect key switch connector (63). At cavity E, measure voltage from circuit 15D to ground.	(63), cav. E, 15D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 15D, then repair.

Table 7 Engine Crank Inhibit System Circuit Test (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
26.	Off	At key switch, install jumper from conn. (63) cavity E circuit 15D, to cavity F circuit 17. Does engine crank?			Replace key switch. Go to next step.	Locate open or poor connection in circuit 17, interrupt conn. (195), or circuit 17A, then repair. Go to next step.
27.	Off	Reconnect connectors. Cranking system circuitry checks good. If condition persists, refer to Engine Diagnostic Manual to troubleshoot the ECM2.				

Testing Thermal Overcrank Protection System

Table 8 Testing Thermal Overcrank Protection System

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove thermal switch connector (N/L) and measure resistance across switch terminals (crank motor must not be hot).	Thermal sw. across term.	< 2 ohms.	Go to next step.	Replace the thermal switch.
2.	Start	With key in start position, at engine harness connector, measure voltage from circuit 17D to ground.	Thermal sw. conn., 17D to gnd.	12 ± 1.5 volts.	Go to next step.	Go to Engine Crank Inhibit System Circuit Test.
3.	Start	With key in start position, at engine harness connector, measure voltage between circuits 17D and 17–G.	Thermal sw. conn., 17D to 17–G.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit 17G/11–GJ, then repair.
4.	Off	Thermal overcrank circuits check good.				

3.4. COMPONENT LOCATIONS

(B) Cranking Motor Solenoid Stud..... Front Side Of Cranking Motor Solenoid
(BAT) Alternator Stud..... Back Of Alternator
(G) Cranking Motor Ground Stud..... Front Side Of Cranking Motor
(GND) Alternator Ground Stud..... Back Of Alternator
(I) Alternator Accessory Feed..... Back Of Alternator

(N/L) Cowl Junction Feed Stud	Power Distribution Panel, Right Side Of Cowl
(S) Cranking Motor Solenoid Stud	Front Side Of Cranking Motor Solenoid
(2) 22–Way Dash Connector	At Left Front Cowl, Below Conn. (3)
(3) 48–Way Elect. Engine Dash Conn.	At Left Front Cowl, Above Conn. (2)
(4G) Ignition Relay Connector	Inside Cab Relay Panel
(4H) Crank Inhibit Relay Connector	Inside Cab Relay Panel
(28) Natural Instrument Cluster Conn.	Behind Instrument Cluster
(63) Key Switch Connector	Behind Key Switch
(195) Starter Interrupt Connector	Left Side of Cab Fuse Panel
(590) Cowl Power Distribution Center	Cowl Fuse Panel, Right Side of Cowl
(590B) Start Relay	In Cowl Power Distribution Panel Relay Block
(3026) NSBU switch	Left Side of Transmission, Forward of Modulator Shift Solenoid
(6020) Engine Control Module ECM2	Mounted to Right Valve Cover

Refer to Figure 16, Figure 17, Figure 18, Figure 19, Figure 20, Figure 21, and Figure 22.

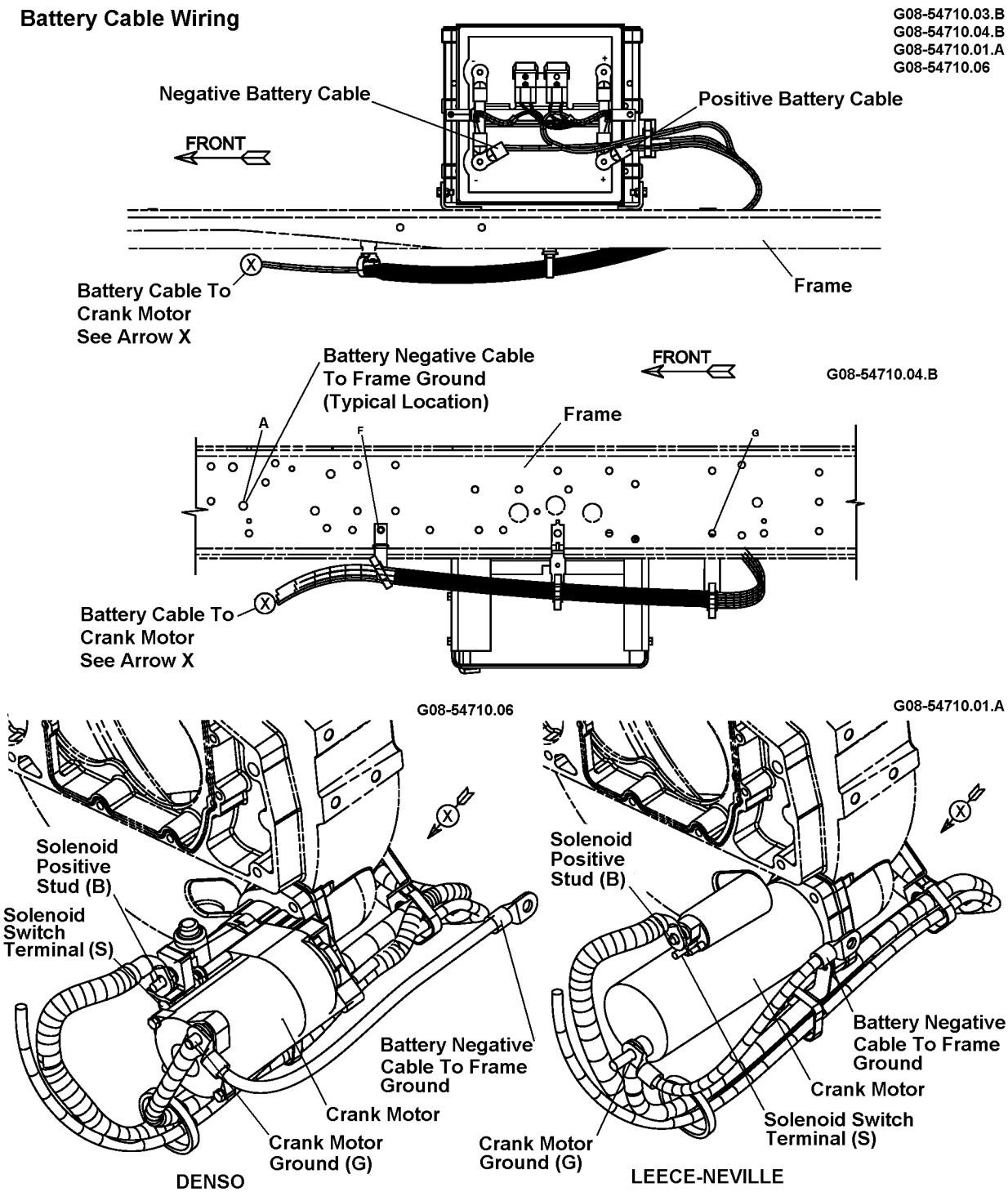

Figure 16 Battery Cable Wiring

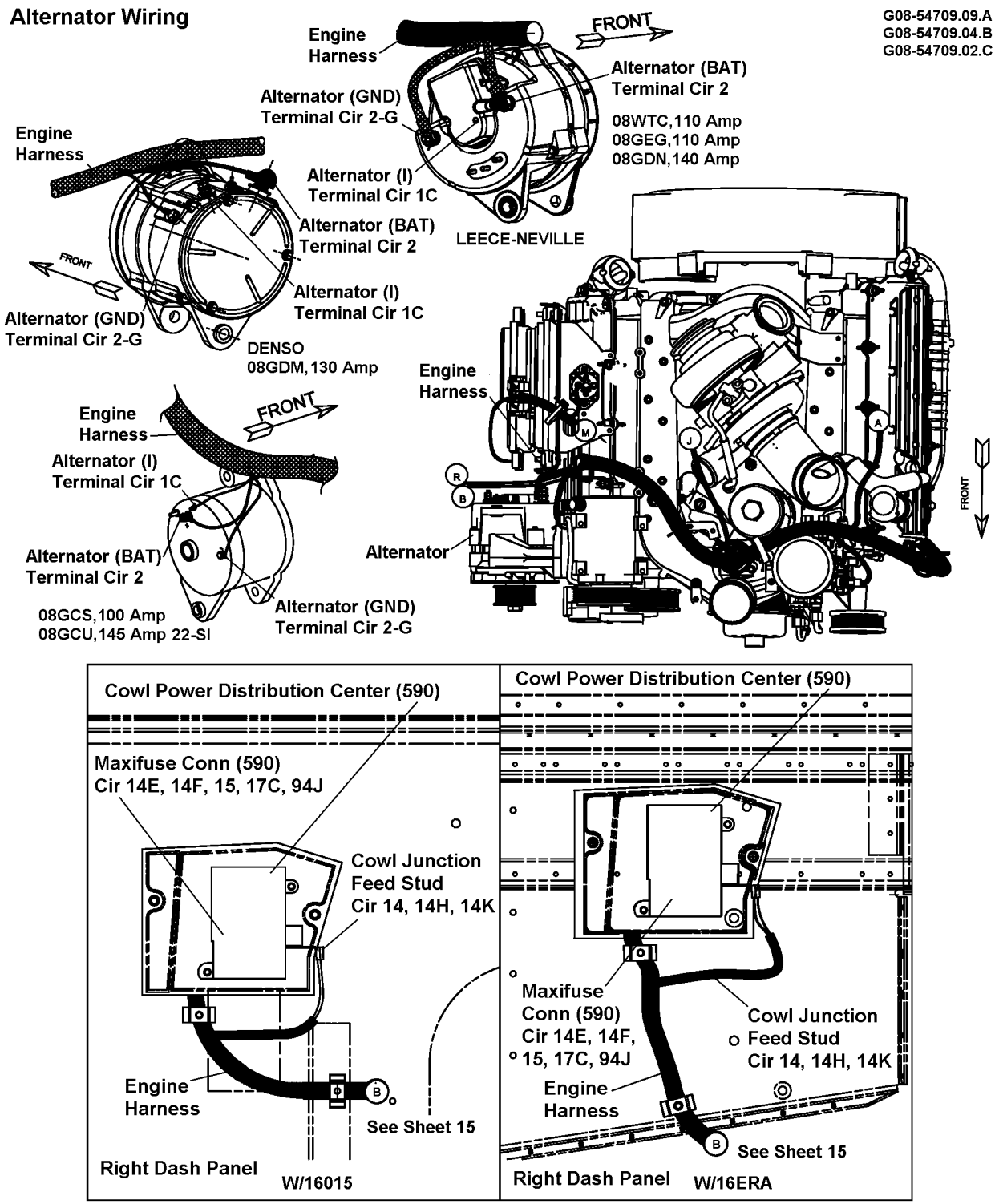

Figure 17 Alternator Wiring

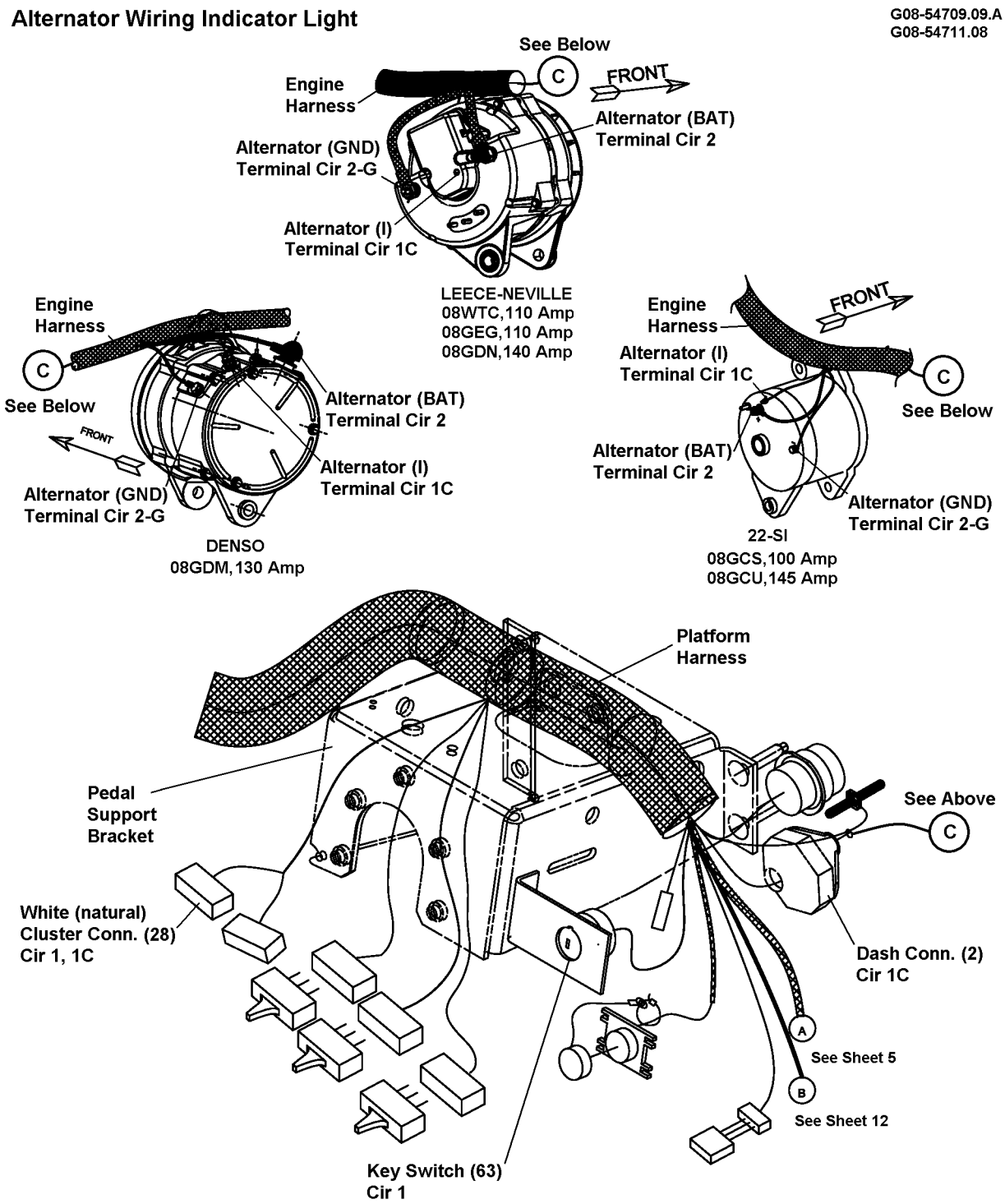

Figure 18 Alternator Wiring Indicator Light

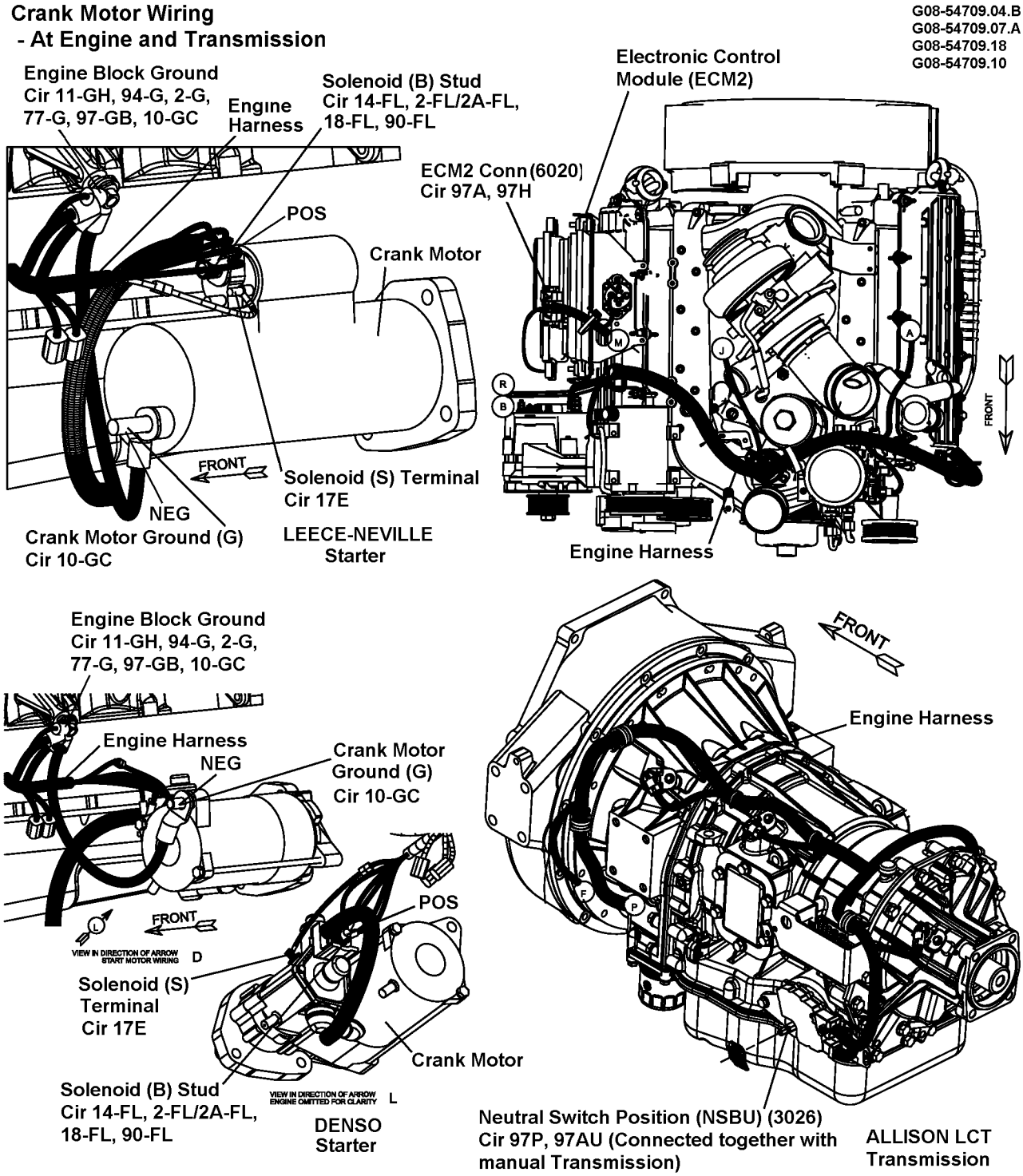

Figure 19 Crank Motor Wiring — At Engine and Transmission

Crank Motor Wiring
- Front Cowl

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G08-54709.01.C

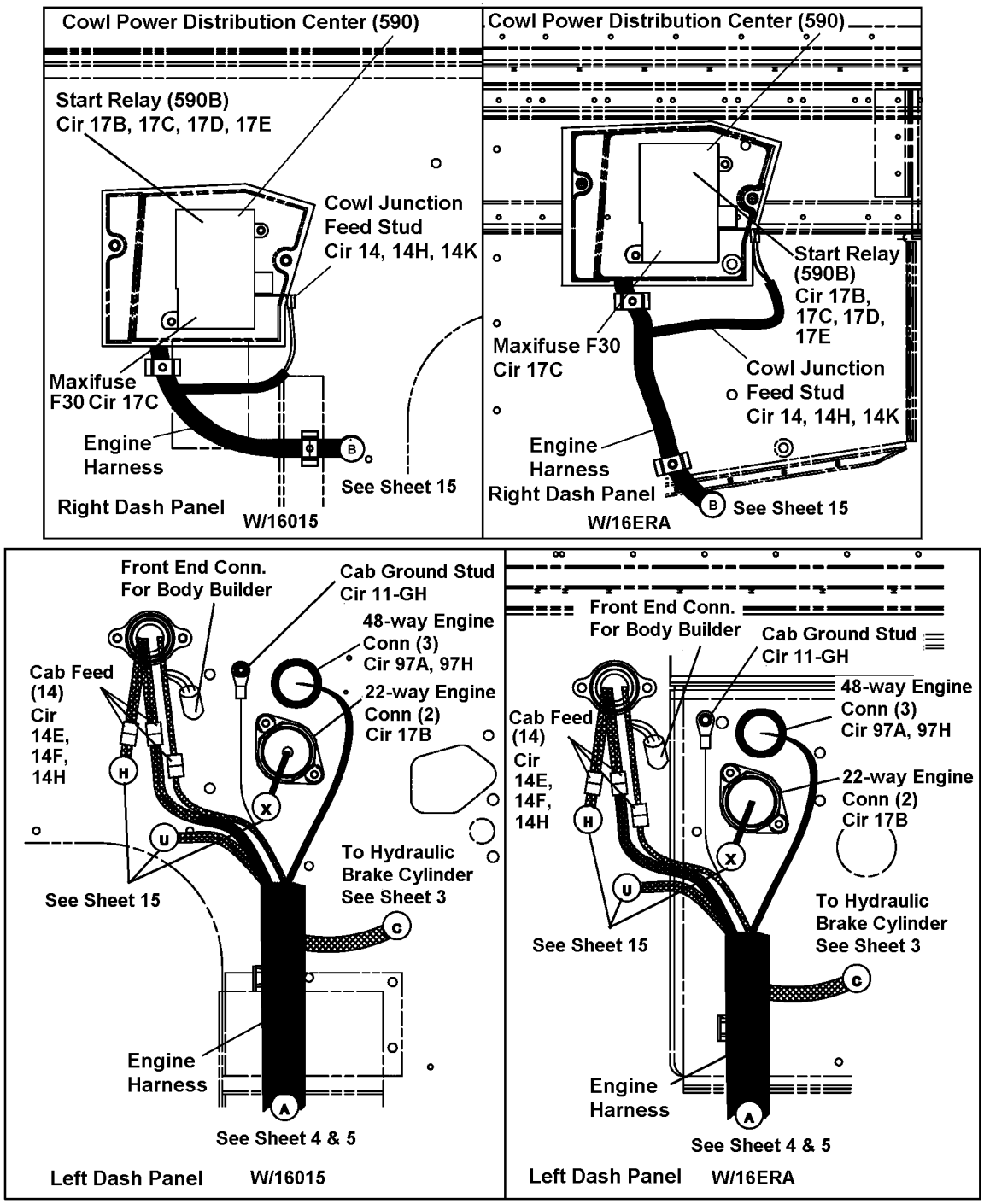


Figure 20 Crank Motor Wiring — Front Cowls

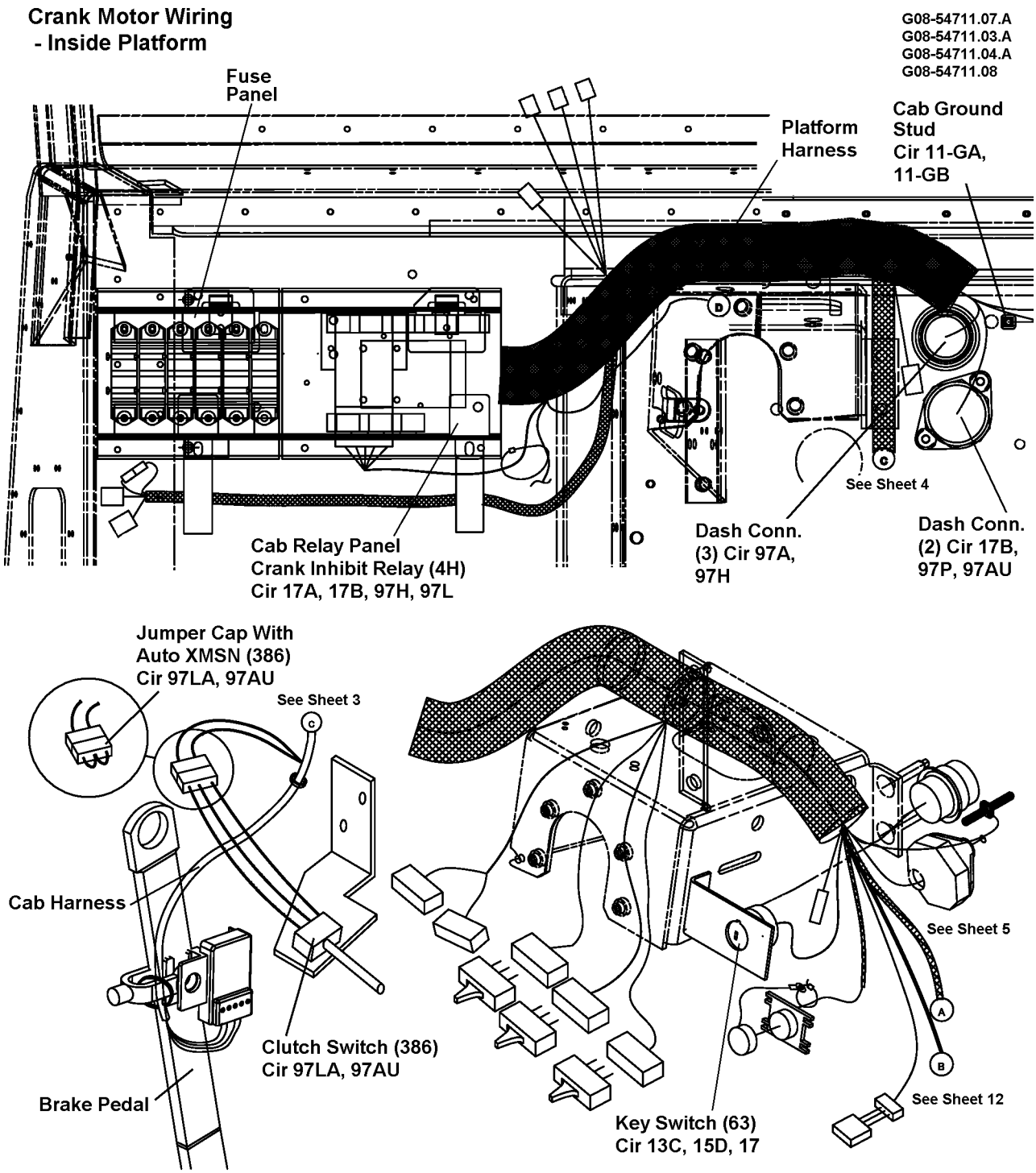


Figure 21 Crank Motor Wiring — Inside Platform

Leece-Neville Starting Motor With Thermal Overcrank Protection

G08-54709.08.A

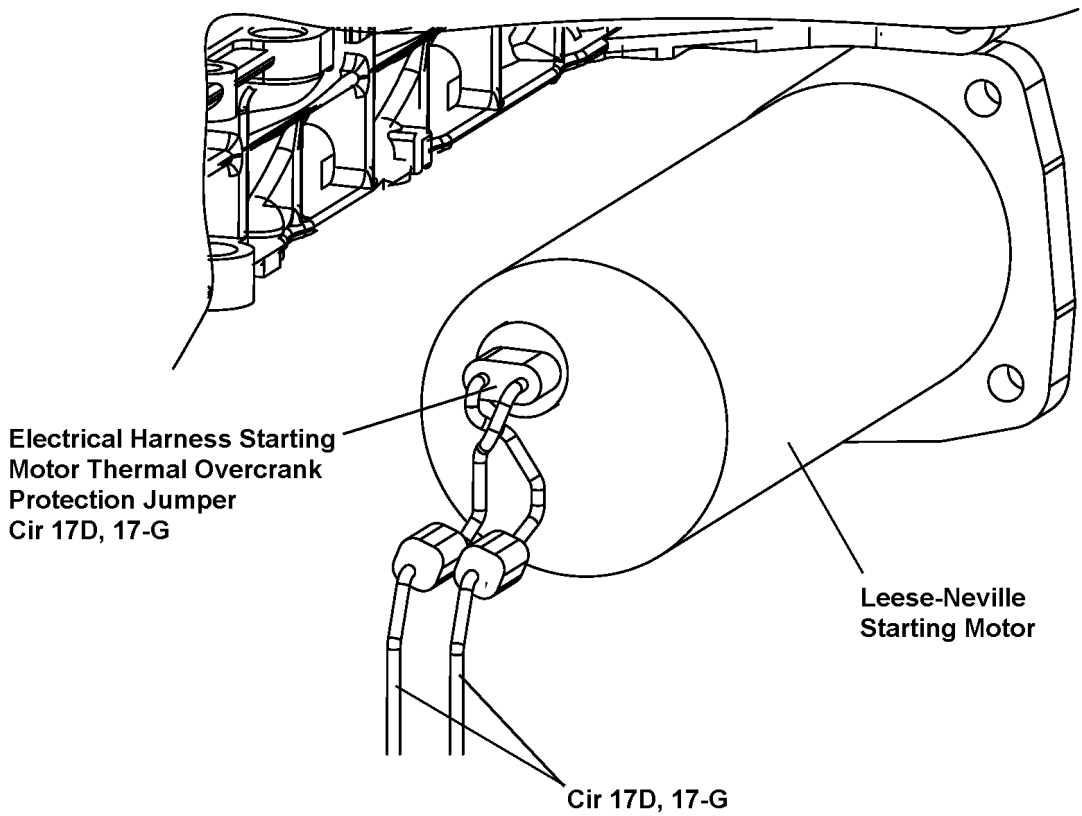


Figure 22 LEECE-NEVILLE Crank Motor with Thermal Overcrank Protection

4. CHASSIS ACCESSORIES

4.1. DESCRIPTION

Hydraulic Brake Systems

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 or drums. 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.

A hydraulic brake and stop light switch each signal the engine Electronic Control Module (ECM2) when the brakes are applied. The ECM2 uses these signals to control the cruise and engine remote controls, cold ambient protection and idle shutdown timer systems.

Heated Fuel Filter With Water-in-Fuel Light

The fuel filter heater is mounted in the fuel filter and when operating, it helps prevent fuel from gelling in the unfiltered side of the filter. The system consists of an ignition relay (R20), the filter heating element, and a normally open thermoswitch. The switch contacts close at approximately 45°F.

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.

Suspension Low Air Pressure Warning

The air suspension system permits the driver to lower the frame by releasing air from the suspension air bags through a cab control valve. The system includes an alarm and warning light which are activated when low air pressure in the system is detected. The system is also protected from inadvertently releasing air when the ignition key switch is on.

Allison 2400 (LCT) Automatic Transmission

Discussion of the LCT (Allison 2400 Series) transmission In this section is limited to the transmission control module (TCM) power circuits, data link connectivity, signals from the neutral safety back up (NSBU) switch and circuits to the shift selector control. For detailed information on transmission diagnostics, refer to the Allison service manual.

4.2. OPERATION

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 is fed a signal from the flow switch, causing the monitor to turn on a brake warning light and alarm and start the hydraulic reserve pump to provide additional braking power. The reserve pump and brake warning system are also activated when the differential pressure switch (301) is tripped due to a pressure loss in one half of the brake system.

When key switch (63) is in the ignition or start position, power is supplied through circuit 13C to the ignition relay (4G). The relay is grounded through circuit 13-G/11-GB to cab ground. This energizes the relay and switches battery power from circuit 15C, through the closed relay contacts and circuit 13 to circuit breaker F9. From the circuit breaker, power is supplied through circuit 90U, brake diode connector (47), and a blocking diode assembly (48). From the diode assembly, power is supplied to circuit 90H, dash connector (2), circuit 90H, and the hydraulic brake relay (300). From the diode assembly, power is also applied to circuit 90F and the brake monitor module (49). The brake monitor module (49) is grounded through circuits 90-G/11-GA to cab ground.

Battery power is applied to fusible link circuit through circuit 90-FL/90/90B, dash connector (2), circuit 90B, fuse F21, and circuit 90C to the hydraulic brake switch (50).

When the key switch is moved to the start or ignition position, the flow switch (381) contacts will be closed (engine is not running). A ground path is provided from the crank motor ground stud through circuit 11-GJ/90-G, flow switch connector (381), the switch, circuit 90R/90L, differential pressure switch connector (301), and circuit 90K to a splice.

From the splice, a ground path is provided through circuit 90M, dash connector (2), and circuit 90M to the brake monitor module alarm input (49-A). This causes the module to switch the alarm output (49-C) to ground which activates the warning system. From the splice, a ground circuit is also provided by way of circuit 90J to the hydraulic brake relay (300), causing it to energize. With the relay energized, power flows through the N.C.

contacts and circuit 90N 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).

The monitor module continuously monitors the continuity of the reserve pump motor and its power supply through circuit 90P, dash connector (2) and circuit 90P. An alarm and warning light will activate if the pump motor winding opens up, if the hydraulic brake relay (300) remains closed (provides power to circuit 90N and the reserve pump motor) after the engine is running and the flow switch opens up, or if no power is supplied to the pump motor when the flow switch or differential pressure switch contacts are closed.

When the brake monitor module switches its alarm output (49-C) to ground, the brake warning light and alarm are activated by power flowing through cluster connector (27), the light, cluster connector (28), and circuit 90T to the module.

If the ignition key is in the off position and the truck brakes are applied, the contacts of the hydraulic brake switch (50) close. With the contacts closed, power flows through circuit 90DD, connector (47), blocking diode assembly (48), connector (47) and circuit 90F to feed the brake monitor module at connector (49-E). From connector (47), power is also supplied to circuit 90E and the brake monitor module (49-G). This signal is compared to a signal provided from stop light switch (50) and circuit 90R to brake monitor module (49-H). If there is a voltage on just one of the two circuits, 90E or 90R, for longer than 14 ± 5 seconds, the warning light and alarm will be turned on.

When the brakes are applied, the brake switch (50) also applies voltage to circuit 97M, dash connector (3) and circuit 97M to the IDM2 (6011). This signals the IDM2 that the brakes have been applied.

Heated Fuel Filter

Power is applied from the cowl junction feed stud to circuit 14K and ignition relay (R20). When key switch (63) is in the ignition or start position, power is supplied through circuit breaker F16, circuit 13E/13F, dash connector (2), and circuit 13F to the ignition relay coil. The relay is energized through ground circuit 19-G/11-GJ to the crank motor ground stud.

With the ignition relay energized, power flows through the closed contacts and circuit 13L to fuse F38. From the fuse, power is supplied through circuit 19D, the fuel filter heater connector (6708) and circuit 19A to the fuel filter heater. The ground path is through the filter housing and its mounting bracket. When the temperature is 45°F (7°C) or less, the fuel filter heater switch contacts close and cause the heater element to activate.

Water-In-Fuel Light

With the key on, power is supplied through circuit breaker F16, circuit 19K to the water-in-fuel module (470). From the module, power is applied through circuit 19C, dash connector (2), and circuit 19C to fuel filter connector (6708) and circuit 19C to the fuel filter water probe.

The ground path for the water-in-fuel module (470) is not a dedicated circuit. The fuel filter housing is grounded through its mounting bracket and whenever water builds up to an unacceptable level in the filter, the water completes the circuit between the probe contacts and the housing. This energizes the water-in-fuel module.

When the water-in-fuel module becomes energized, power is applied through circuit 19L and cluster connector (28), pin 11, to the water-in-fuel light. This energizes the lamp as power flows through the lamp, cluster connector (27) and circuit 28-GB/11-GA to the cab ground stud (2G).

Suspension Low Air Pressure Warning

With key switch (63) in the ignition position, power is applied through circuit breaker F15, circuit 61 to the low air alarm (474), and circuit 61A, the air dump solenoid connector (475) and to the air dump solenoid. The solenoid

is grounded through a circuit to connector (475) and circuit 61-G/11-GB to cab ground (2G). This activates the solenoid and prevents air from being inadvertently released from the air dump control valve while the key is on.

With the key switch on, power is also supplied through circuit breaker F13, circuit 28 and dash connector (27) to the suspension low air warning light. From the warning light, power is supplied through cluster harness connector (28), pin 13, and circuit 40A to the low air alarm (474). From the alarm, power is supplied through circuit 40, air dump solenoid connector (475) and a circuit to the suspension low air pressure switch. When the system detects low air pressure, the switch contacts close which completes the circuit through a ground circuit to connector (475) and circuit 61-G/11-GB to cab ground (2G). This activates the alarm and warning light system.

Allison 2400 (LCT) Automatic Transmission

When key switch (63) is moved to the start or ignition position, power is fed through the energized ignition relay (R20), circuit 13L/13K to fuse F36. From the fuse, power is supplied through circuits 13K, 102, and 104 to contacts 2 and 4 of the engine/transmission harness gray connector (3031).

With the key switch in the start or ignition position, power is also applied through circuit breaker F9, circuit 97P, dash connector (2), circuit 97P, and the NSBU connector (3026) to the neutral position switch. Providing the transmission is in neutral, power flows through the switch, connector (3026), circuit 97AU, dash connector (2), and circuit 97AU, 97LA, 97A to the ECM2 (6020) and circuit 97L to the crank inhibit relay (4H) system. This allows the crank motor to be engaged.

4.3. 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.

Hydraulic Brake System

NOTE – For troubleshooting brake switch circuit input signals to the engine ECM, refer to the Engine Diagnostic Manual EGES-190 for T 444E or the Engine Diagnostic Manual EGES-240 for VT 365.

Table 9 Hydraulic Brake System

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	On/ Off	Does hydraulic brake pump motor run when key is off and brake pedal is depressed and **also** when key is on and brake pedal is not depressed?			Go to Step 4.	Go to Step 13.
2.	Off/ On	Does pump motor run with key on and brake pedal not depressed?			Go to next step.	Disconnect diode assembly (48) from connector (47), then go to Step 22.
3.	Off	Does pump motor run with key off and brake pedal depressed?			Go to next step.	Disconnect diode assembly (48) from connector (47), then go to Step 24.
4.	Off	Do the brake warning light and alarm work properly?			End test.	Go to next step.
5.	Off	Disconnect brake monitor module connector (49) and measure resistance from circuit 90M to ground.	(49), 90M to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 90M, dash connector (2), or circuit 90M, then repair.
6.	Off	At (49) circuit 90–G, measure resistance to ground.	(49), 90–G to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 90–G/ 11–G, then repair.
7.	On	At (49) circuit 90E, measure voltage to ground.	(49), 90E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 90E, then repair.
8.	On	At (49) circuit 90F, measure voltage to ground.	(49), 90F to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 90F, then repair.
9.	On	At (49) circuit 90P, measure voltage to ground.	(49), 90P to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 90P, then repair.

Table 9 Hydraulic Brake System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
10.	On	At (49) circuit 90T, measure voltage to ground.	(49), 90T to gnd.	12 ± 1.5 volts.	Go to next step.	Check bulb, alarm, and circuit 90T, then replace or repair problem.
11.	Off	At (49) circuit 90R and with brake pedal depressed, measure voltage to ground.	(49), 90R to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 90R/70B, then repair. If condition persists, refer to Section 5, Light Systems.
12.	Off/ On	Reconnect connector (49) and move key switch to ignition position. Do alarm and brake warning light operate?			Brake warning system circuits check good.	Replace brake monitor module. If condition persists, refer to CTS-5280, Hydro-Max II Brake Monitor System.
13.	Off	Remove hydraulic brake relay from socket (300). At circuit 90A, measure voltage to ground.	(300), 90A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 90–FL/ 90/90A, then repair.
14.	On/ Off	At socket (300) circuit 90H, measure voltage to ground. Turn key off and with brake pedal depressed, measure voltage from circuit 90H to ground.	(300), 90H to gnd.	12 ± 1.5 volts each test.	Go to next step.	Reconnect (300) and disconnect diode assembly (48) from connector (47). Go to Step 29.
15.	Off	At (300) circuit 90J, measure resistance to ground.	(300), 90J to gnd.	< 2 ohms.	Go to next step	Go to Step 18.
16.	Off	Disconnect circuit 90N from reserve pump motor. Install a jumper wire at relay socket (300) from circuit 90A to 90N. At reserve pump, measure voltage from circuit 90N to ground.	At pump motor, 90N to gnd.	12 ± 1.5 volts.	Go to next step	Locate cause of low or no voltage in circuit 90N, then repair.
17.	Off	Touch circuit 90N to reserve pump motor terminal. Does motor run?			Replace brake relay.	Replace reserve pump motor.

Table 9 Hydraulic Brake System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
18.	Off	Disconnect flow switch connector (381) and measure resistance across switch.	Across flow switch (381).	< 1 ohm.	Go to next step.	Replace flow switch.
19.	Off	At (381), measure resistance of circuit 90–G to ground.	(381), 90–G to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 90–G/ 11–GJ, then repair.
20.	Off	Reconnect flow switch connector and disconnect differential pressure switch connector (301). At (301) circuit 90L, measure resistance to ground.	(301), 90L to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 90L/90R, then repair.
21.	Off	At relay socket (300) circuit 90J, measure resistance to ground.	(300), 90J to gnd.	< 2 ohms.	Replace brake relay.	Locate open or poor connection in cir. 90J/90K, then repair. Reconnect (300).
22.	On	At (47) measure voltage from circuit 90U to ground.	(47), 90U to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open fuse F9 and locate cause of overload condition, then repair. Replace fuse. If fuse is OK, locate cause of low or no voltage in circuit 90U, then repair.
23.	Off	With multimeter in diode test mode, test diode assembly (48). Did diode assembly fail?	(48)	.2 to .6 volt.	Replace diode assembly.	Locate open or poor conn. in circuit 90H or dash conn. (2), then repair. Reconnect diode assembly.
24.	Off	At (47) and with brake pedal depressed, measure voltage from circuit 90D to ground.	(47), 90D to gnd.	12 ± 1.5 volts.	Go to Step 29.	Go to next step.
25.	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 9 Hydraulic Brake System (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
26.	Off	At fuse F21 circuit 90B, measure voltage to ground.	F21, 90B to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 90B or dash conn. (2), then repair.
27.	Off	Re-install fuse F21 and disconnect brake switch connector (50). At (50) measure voltage from circuit 90C to ground.	(50), 90C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 90C, then repair.
28.	Off	Measure resistance across switch (50) while brake pedal is depressed.	Across switch (50).	< 1 ohm.	Locate open in circuit 90D, then repair. Reconnect (50).	Replace brake switch.
29.	Off	Will multi-meter in diode test mode, test diode assembly (48). Did diode assembly fail?	(48)	.2 to .6 volt.	Replace diode assembly.	Locate open or poor connection in circuit 90H or dash conn. (2), then repair. Reconnect diode assembly.

Heated Fuel Filter, Water-In-Fuel Light

Table 10 Heated Fuel Filter, Water-In-Fuel Light

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 ignition relay (R20). At relay socket, measure voltage from cavity 1B, circuit 14K to ground.	(R20), cav.1B, cir. 14K to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit 14K, then repair.

Table 10 Heated Fuel Filter, Water-In-Fuel Light (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
4.	On	At (R20), measure voltage from cavity 3B circuit 13F to ground.	(R20), cav. 3B cir. 13F to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open circuit breaker F16. If OK, locate cause of low or no voltage condition in circuit 13F or dash conn. (2), then repair.
5.	On	At (R20), measure voltage from cavity 3B circuit 13F to cavity 1C circuit 11–GG.	(R20), cav. 3B cir. 13F to cav. 1C cir. 11–GG.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit 11–GG/ 11–GJ, then repair.
6.	Off	Bench test ignition relay (R20) by measuring resistance from pin 30 to 87A.	(R20), pin 30 to 87A.	< 1 ohm.	Go to next step.	Replace relay.
7.	Off	Apply +12V to relay pin 86 and ground to pin 85. Measure resistance from pin 30 to 87.	Energized relay, pin 30 to 87.	< 1 ohm.	Go to next step.	Replace relay.
8.	Off/ On	Reconnect relay (R20). Turn key on and at fuse F38 cavity 5A, measure voltage of circuit 19/92 to ground.	F38, cav. 5A cir. 19/92 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit 19/92, then repair.
9.	Off/On	Disconnect circuit 19A from fuel filter heater. Turn key on and measure voltage from circuit 19A to ground.	Fuel filter, 19A to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open fuse F38. If OK, locate cause of low or no voltage condition in circuit 19A, filter conn. (6708), or circuit 19D, then repair.
10.	On	With the fuel heater cooled to below 45°F, measure voltage from circuit 19A to the heater power stud.	Fuel filter, 19A to heater power stud.	12 ± 1.5 volts.	Heated fuel filter circuitry checks good.	Repair or replace heated fuel filter.

Table 10 Heated Fuel Filter, Water-In-Fuel Light (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
11.	Off/ On	Disconnect water-in-fuel module (470). Turn key on and at connector, measure voltage from circuit 19K to ground.	(470), 19K to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open circuit breaker F16. If OK, locate cause of low or no voltage condition in circuit 19K/13E, then repair.
12.	Off/ On	At WIF socket (470), Install jumper from circuit 19K to 19L and turn key on. Does warning light operate?			Go to Step 15.	Go to next step.
13.	Off/ On	Disconnect cluster connector (28). Turn key on and at cavity 11 circuit 19L, measure voltage to ground.	(28), cav. 11 cir. 19L to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit 19L, then repair.
14.	Off/ On	Replace lamp with a known good one. Reconnect (28) and turn key on. Does lamp operate?			Go to next step.	Replace cluster.
15.	Off/ On	At WIF module connector (470) move jumper across circuit 19K to 19C. At the fuel filter, disconnect circuit 19C from the water probe. Turn key on and measure voltage from circuit 19C to ground.	Water probe conn., 19C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit 19C, dash conn. (2), circuit 19C, fuel filter conn. (6708) or circuit 19C with, then repair.
16.	On	Remove jumper and reconnect WIF module (470). At water probe conn., jumper circuit 19C to ground. Does light work?	Water probe conn., jumper 19C to gnd.	Light works.	Go to next step.	Replace WIF module.

Table 10 Heated Fuel Filter, Water-In-Fuel Light (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
17.	On	Remove water probe and install jumper from the probe to ground. Measure voltage from circuit 19C to water probe feed stud.	Water probe, 19C to probe feed stud.	12 ± 1.5 volts.	Install probe and connections.	Replace water probe.
18.	Off	Remove jumper and reconnect connectors. WIF system checks good.				

Suspension Low Air Pressure Warning

Table 11 Suspension Low Air Pressure Warning

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Does the suspension air dump operate with the key off?			Go to Step 7.	Go to next step.
2.	Off/ On	Disconnect air dump solenoid connector (475). Turn key on and measure voltage from circuit 61A to ground.	(475), 61A to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open circuit breaker F15. If OK, locate cause of low or no voltage in circuit 61, low air alarm conn. (474) or circuit 61A, then repair.
3.	Off	At (475), measure resistance from circuit 61–G to ground.	(475), 61–G to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 61–G/ 11–GB, then repair.
4.	Off	At solenoid harness side of (475), measure resistance from cavity A to cavity B.	(475), cav. A to cav. B.	< 1 ohm.	Solenoid circuitry checks good.	Go to next step.
5.	Off	At solenoid harness side of (475), measure resistance from cavity A to solenoid feed terminal.	(475), cav. A to solenoid feed term.	< 1 ohm.	Go to next step.	Locate open or poor connection in solenoid harness feed circuit, then repair.

Table 11 Suspension Low Air Pressure Warning (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
6.	Off	At solenoid harness side of (475), measure resistance from cavity B to solenoid ground terminal.	(475), cav. B to solenoid gnd. term.	< 1 ohm.	Replace solenoid.	Locate open or poor connection in solenoid harness ground circuit, then repair.
7.	Off	Does the suspension low air pressure warning light operate properly?			Go to Step 14.	Go to next step.
8.	Off	Disconnect air dump solenoid connector (475). At cavity B, measure resistance of circuit 61–G to ground.	(475), 61–G to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 61–G/ 11–GB, then repair.
9.	On	At (475) cavity C, measure voltage from circuit 40 to ground.	(475), 40 to gnd.	12 ± 1.5 volts.	Go to Step 12.	Go to next step.
10.	Off	Disconnect cluster connector (28). Measure resistance from pin 13 circuit 40A to (475) circuit 40.	(28), pin 13 cir. 40A to (475) cir. 40.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 40A, alarm conn. (474) or circuit 40, then repair.
11.	Off	Check warning light bulb. Is bulb OK?			Replace cluster.	Replace bulb.
12.	Off/ On	Reconnect (475). Turn key on and at low air pressure switch feed, measure voltage to ground.	Low air press. sw. feed to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in air pressure switch feed circuit, then repair.
13.	Off	At air pressure switch, measure resistance from ground terminal to ground.	Low air press. sw. gnd. term. to gnd.	< 1 ohm.	Replace air pressure switch.	Locate open or poor connection in suspension low air pressure switch ground circuit, then repair.
14.	Off	Does the low air pressure alarm operate properly?			End test.	Go to next step.
15.	Off/ On	Disconnect low air alarm (474). Turn key on and measure voltage from socket cavity 2 circuit 61/61A to cavity 5 circuit 40/40A.	(474), cav. 2 61/61A to cav. 5 40/ 40A.	12 ± 1.5 volts.	Replace alarm.	Check for corrosion or poor connection in socket (474), then repair.

Allison 2400 (LCT) Automatic Transmission

Table 12 Allison 2400 (LCT) Automatic Transmission

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Start	Will engine crank over when the transmission is in neutral and the key switch (63) is moved to the start position?			Go to next step.	Refer to Engine Crank Inhibit System Circuit Test .
2.	Off	Remove ignition relay (R20). At relay socket, measure voltage from cavity 1B, circuit 14K to ground.	(R20), cav.1B, cir. 14K to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit 14K, then repair.
3.	On	At (R20), measure voltage from cavity 3B circuit 13F to ground.	(R20), cav. 3B cir. 13F to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open circuit breaker F16. If OK, locate cause of low or no voltage condition in circuit 13F or dash conn. (2), then repair.
4.	On	At (R20), measure voltage from cavity 3B circuit 13F to cavity 1C circuit 11–GG.	(R20), cav. 3B cir. 13F to cav. 1C cir. 11–GG.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit 11–GG/ 11–GJ, then repair.
5.	Off	Bench test ignition relay (R20) by measuring resistance from pin 30 to 87A.	(R20), pin 30 to 87A.	< 1 ohm.	Go to next step.	Replace relay.
6.	Off	Apply +12V to relay pin 86 and ground to pin 85. Measure resistance from pin 30 to 87.	Energized relay, pin 30 to 87.	< 1 ohm.	Go to next step.	Replace relay.
7.	Off/ On	Reconnect relay (R20). Turn key on and at fuse F36 cavity 5A, measure voltage of circuits 13L to ground.	F36, cav. 5A cir. 13L to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage condition in circuit 13L, then repair.

Table 12 Allison 2400 (LCT) Automatic Transmission (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
8.	Off/On	Disconnect Allison (LCT) TCM Gray conn. (3031), pins 2 & 4, circuits 13K/102/104 to transmission. Turn key on and measure voltage from pins 2 & 4 to ground.	Transmission (3031), pins 2 & 4 to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open fuse F36. If OK, locate cause of low or no voltage condition in circuit 13K/102/104, or TCM conn. (3031), then repair.
9.		Connect Allison (LCT) TCM Gray conn. (3031), and the transmission. circuits check good. If condition persists, refer to Engine Diagnostic Manual for troubleshooting the ECM2.				

4.4. COMPONENT LOCATIONS

(R20) Ignition Relay..... Cowl Fuse/Relay Panel
(2) 22–Way Dash Connector..... At Left Front Cowl, Below Conn. (3)
(2G) Cab Ground Stud..... Beside 48-Way Dash Conn. (Inside Cab)
(3) 48-Way Elect. Engine Dash Conn..... At Left Front Cowl, Above Conn. (2)
(4G) Ignition Relay Connector..... Inside Cab Fuse/Relay Panel
(4H) Crank Inhibit Relay Connector..... Inside Cab Fuse/Relay Panel
(27) Green Instrument Cluster Conn..... Behind Instrument Cluster
(28) Natural Instrument Cluster Conn..... Behind Instrument Cluster
(47) Blocking Diode Connector..... Right Side of Pedal Support Bracket
(48) Blocking Diode Assembly..... Attached to Blocking Diode Connector (47)
(49) Brake Warning Monitor Module..... Inside Cab Fuse/Relay Panel
(50) Hydraulic Brake Switch Connector..... Under Brake Pedal Support Bracket
(50) Brake Stop Light Switch Connector..... Under Brake Pedal Support Bracket
(63) Key Switch Connector..... Behind Key Switch
(300) Hydraulic Brake Relay Connector..... Dash Reinforcement, Left Side of Master Cylinder
(301) Differential Pressure Switch Connector..... Below and Left of Hydraulic Brake Reservoir
(381) Hydraulic Flow Switch Connector..... Upper Part of Master Cylinder, Behind Reservoir
(470) Fuel Filter WIF Module Connector..... Inside Dash Fuse/Relay Panel
(474) Air Suspension Alarm Connector..... Inside Dash Fuse/Relay Panel
(475) Air Dump Solenoid Connector..... Right Side of Dash Fuse/Relay Panel
(590A) Power Distribution Center..... Cowl Fuse/Relay Panel
(3030) Auto. Trans. Red Connector..... Chassis Left Side of Transmission
(3031) Auto. Trans. Gray Connector..... Chassis Left Side of Transmission
(3024) Allison Bulkhead Connector..... Right Rear of Transmission
(3025) Neutral Position NSBU Switch — TCM ..... Left Side of Transmission
(3026) Neutral Position NSBU Switch — Vehicle Connector..... Left Side of Transmission
(3043) Econ Mode Sw. Connector..... In The Shift Control Lever
(6011) Engine IDM2..... Mounted to Right Valve Cover
(6020) Engine Control Module 2 (ECM2)..... Mounted to Right Valve Cover
(6021) Engine Control Module 2 (ECM2)..... Mounted to Right Valve Cover
(6708) Fuel Filter Connector..... Top Front of Engine at Fuel Filter

See Figure 23, Figure 24, Figure 25, Figure 26, Figure 27, Figure 28, and Figure 29.

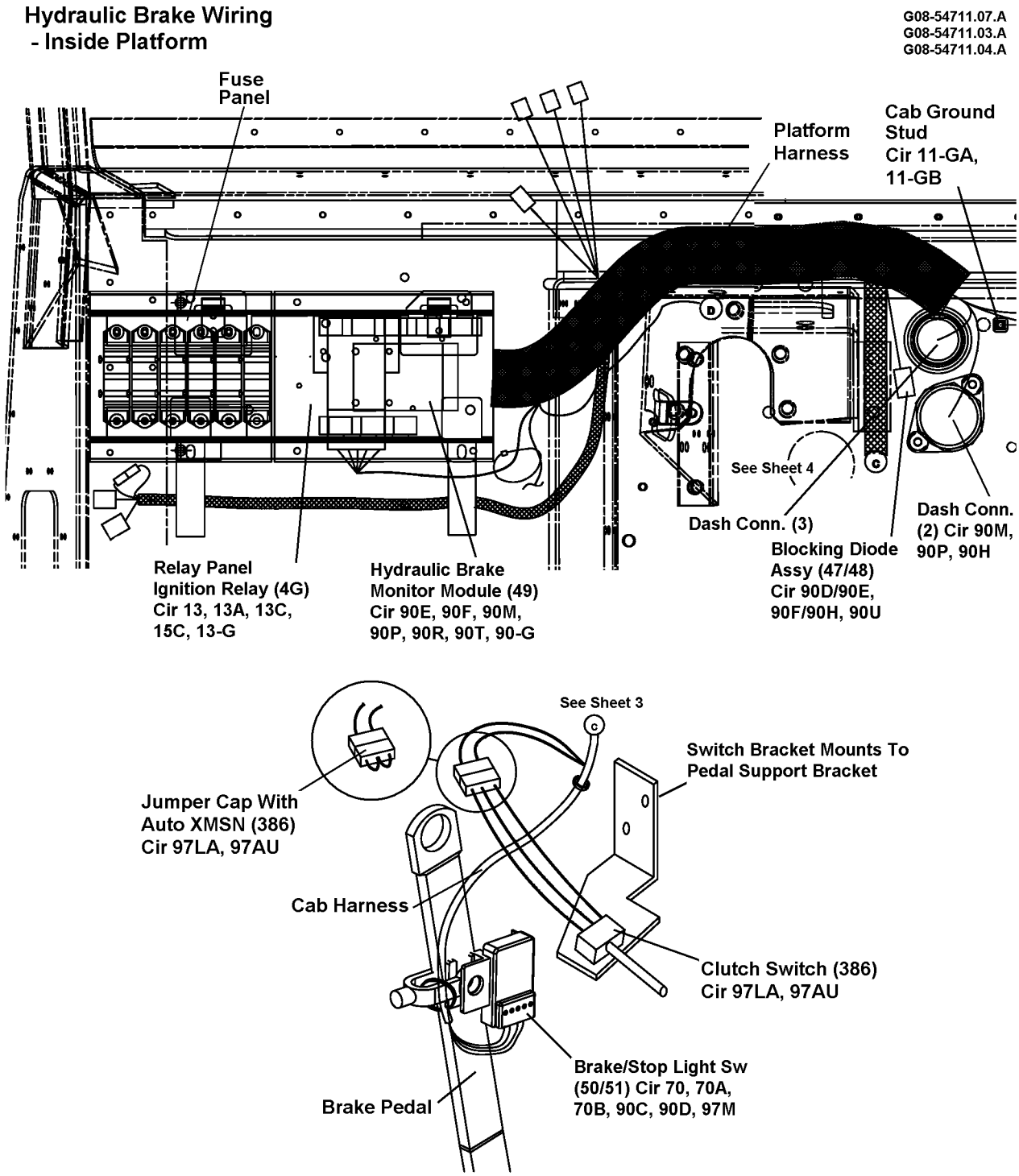


Figure 23 Hydraulic Brake Wiring — Inside Platform

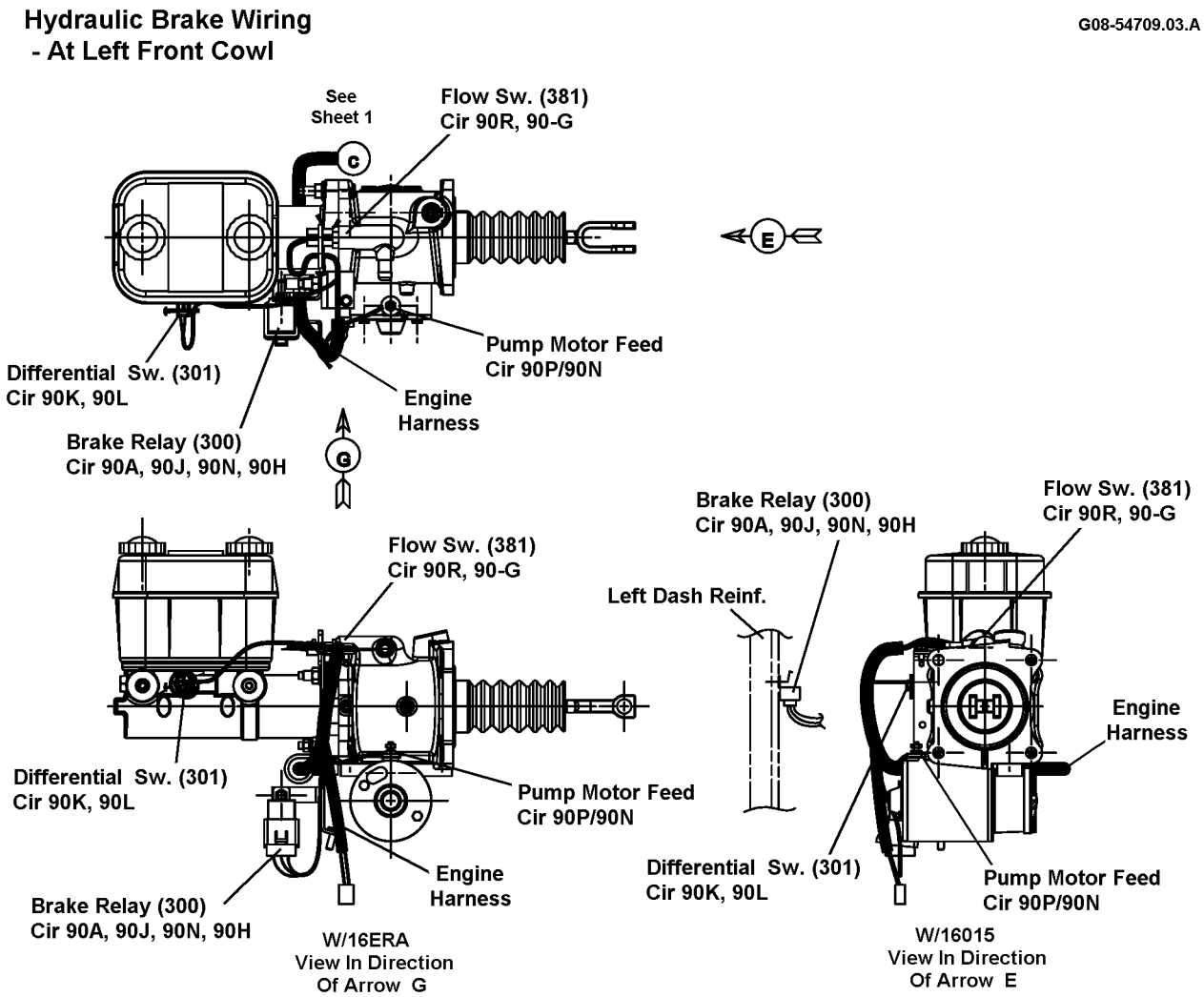


Figure 24 Hydraulic Brake Wiring — At Left Front Cowl

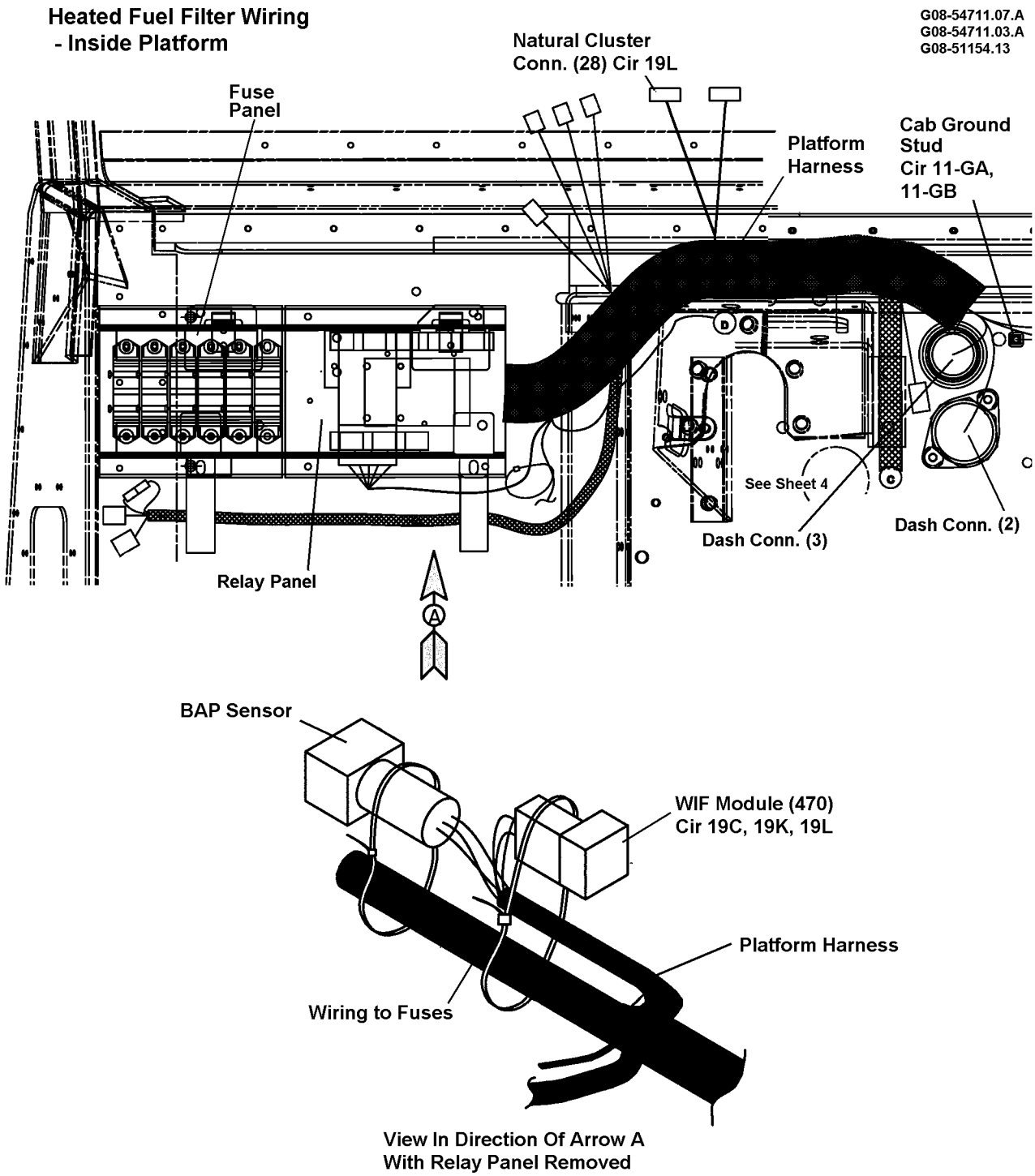
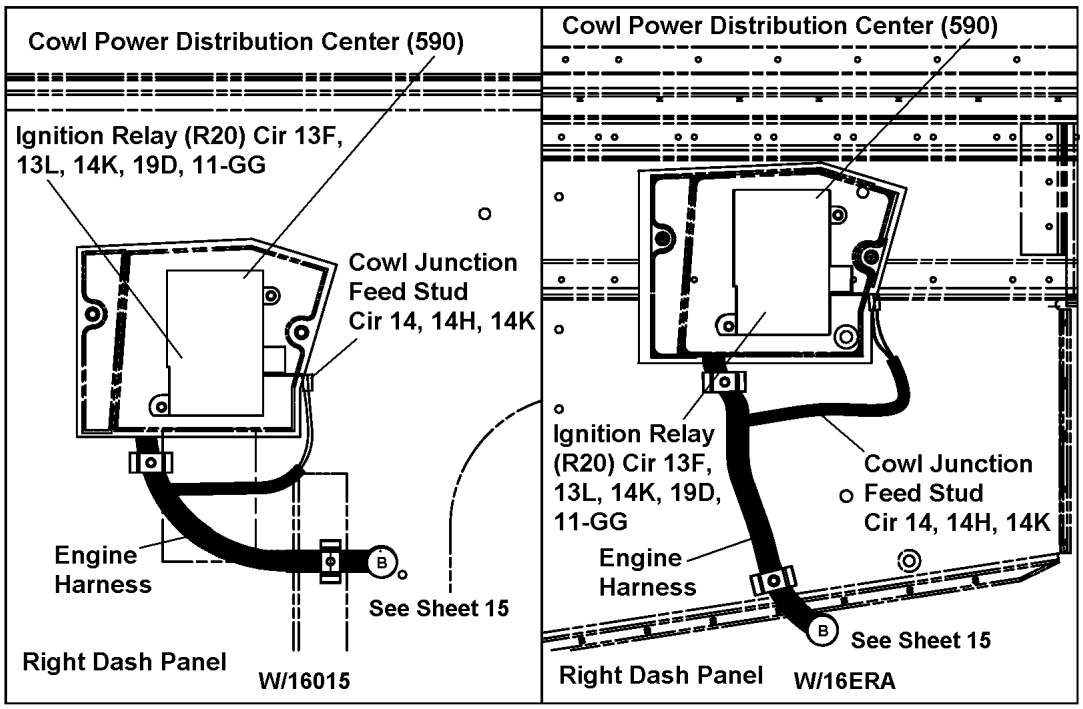


Figure 25 Heated Fuel Filter Wiring — Inside Platform

Heated Fuel Filter Wiring
- Engine Compartment

G08-54709.02.C
G08-54709.04.C
G08-51154.13



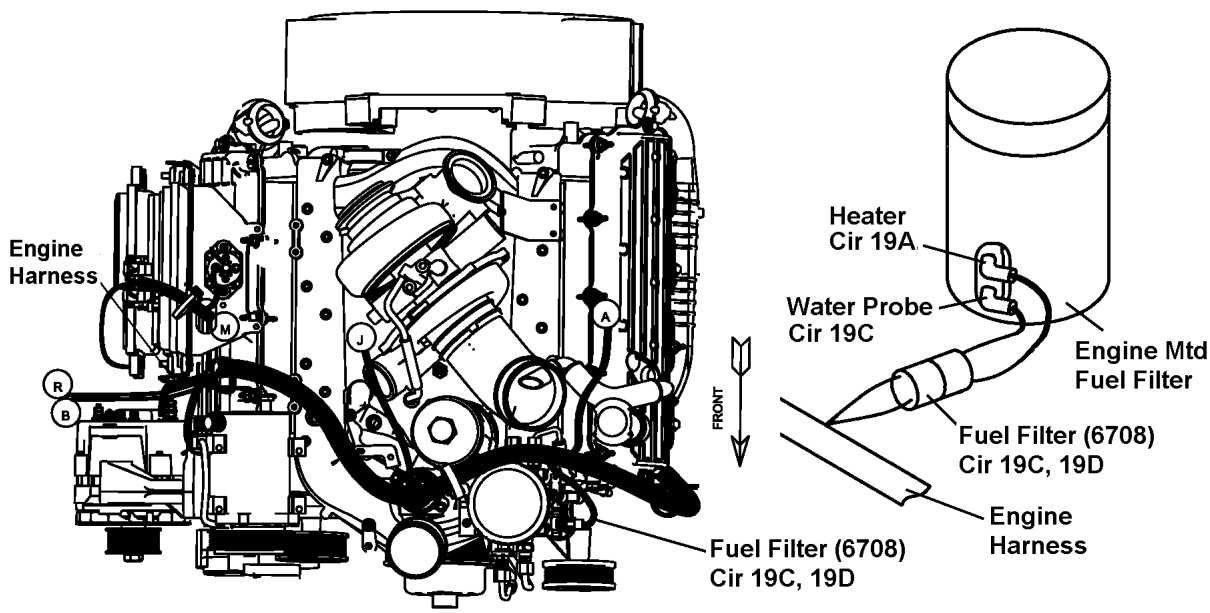


Figure 26 Heated Fuel Filter Wiring — Engine Compartment

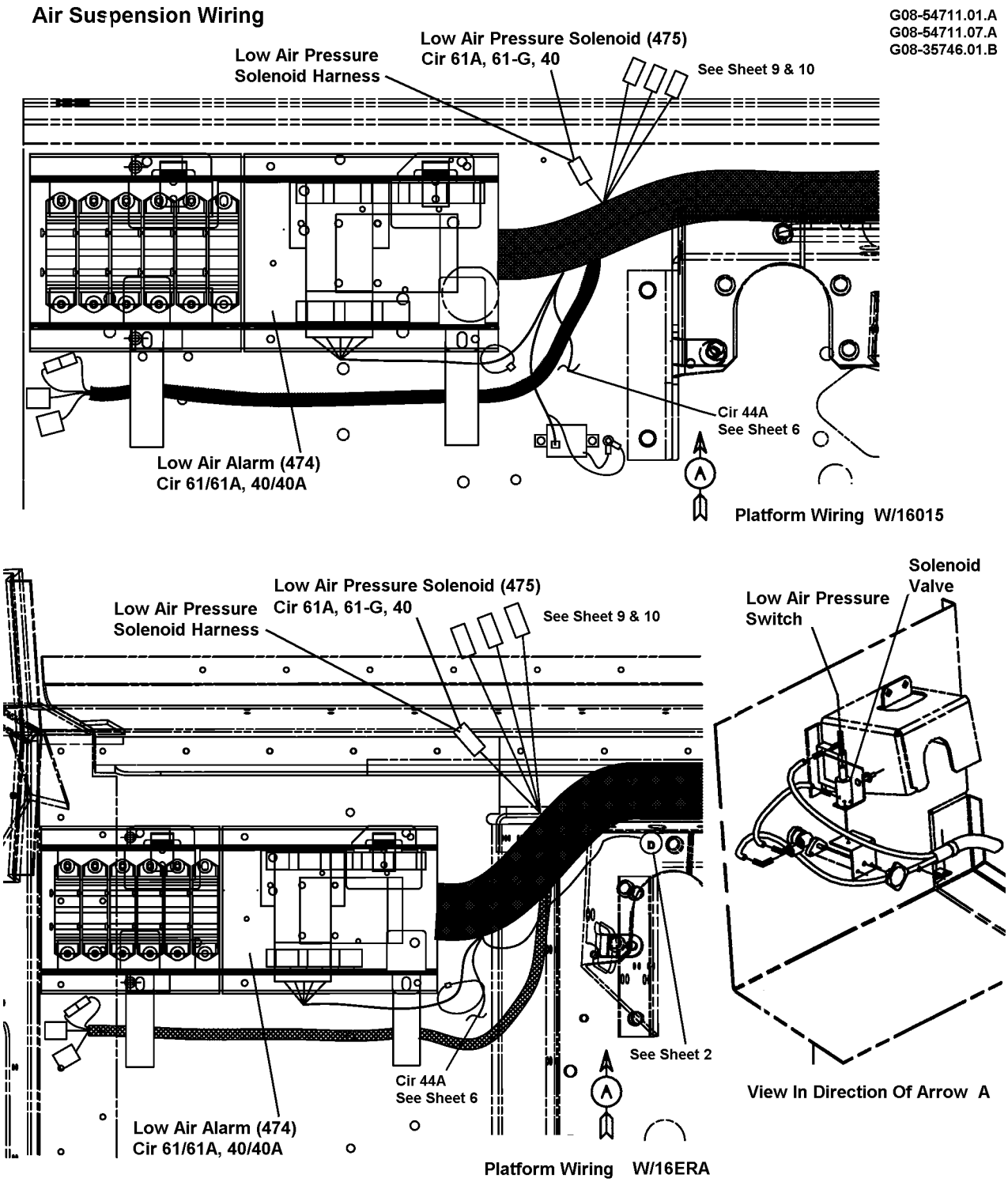


Figure 27 Air Suspension Wiring

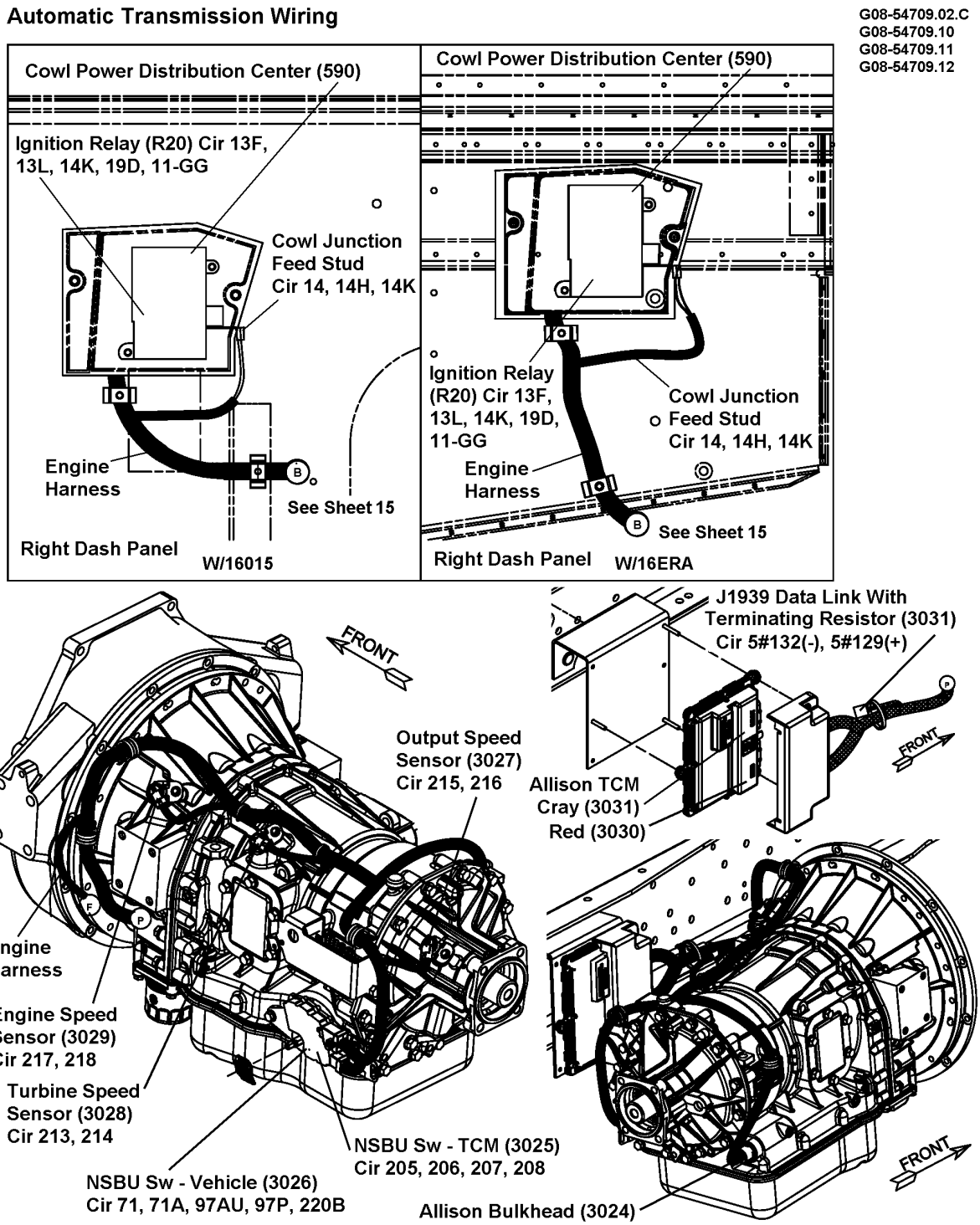


Figure 28 Automatic Transmission Wiring

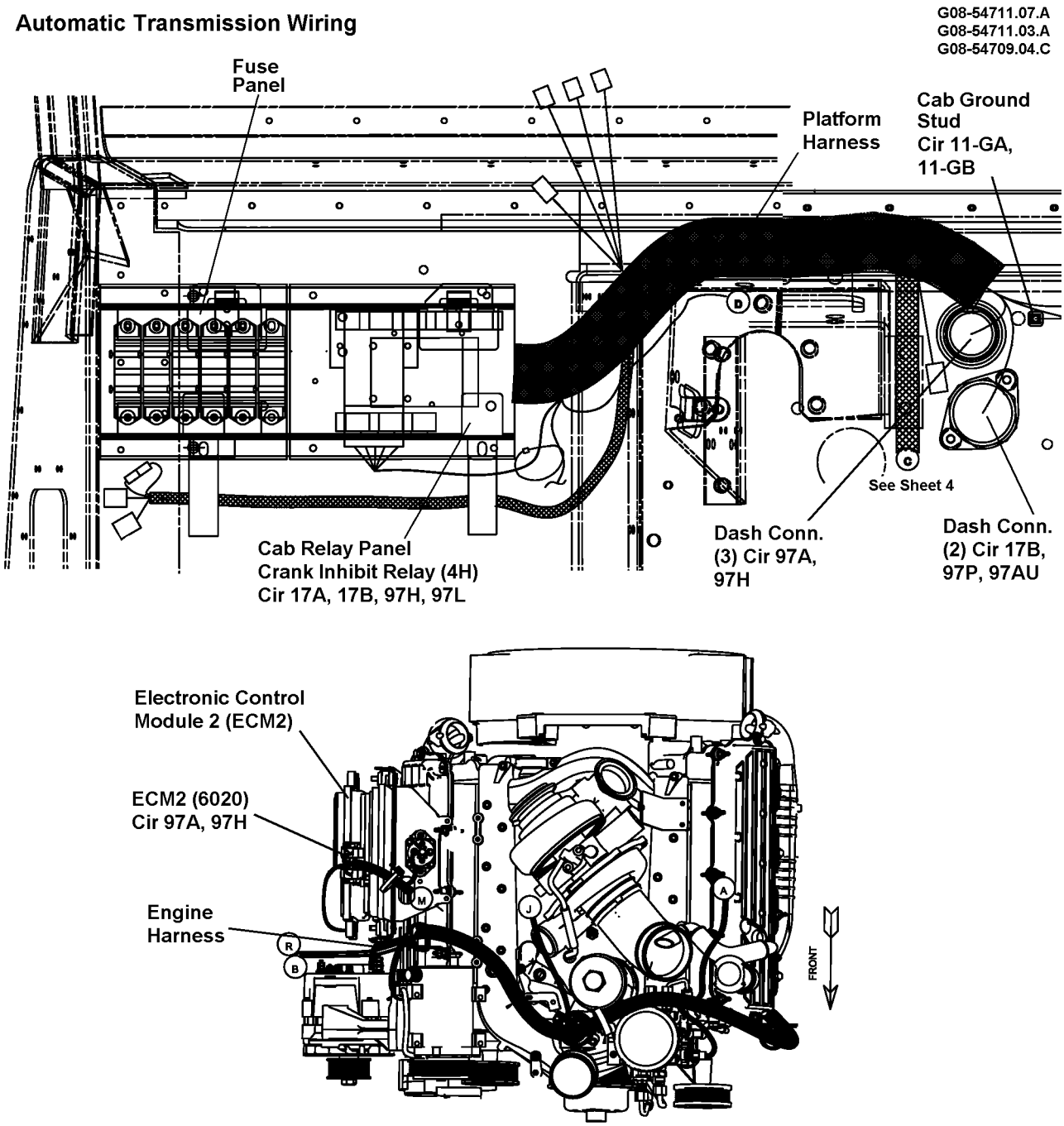


Figure 29 Automatic Transmission Wiring

5. LIGHT SYSTEMS

5.1. DESCRIPTION

Exterior Lights

All exterior light circuits are protected by fuses or circuit breakers in the cab fuse/relay panel. The lighting circuits are provided with power from a fused circuit located in the cowl power distribution center.

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 at night.

Headlight System — Headlight Circuitry With or Without Daytime Running Lights

The standard headlight system includes a headlight switch, turn signal lever controlled dimmer switch and a relay. If equipped with Daytime Running Lights (DRL), a control module is also used to provide illumination for daytime safety recognition and for nighttime driving.

Panel Lights and Switch Illumination

Panel lights are low wattage bulbs that illuminate instrument cluster gauges and the headlight switch. Depending on vehicle options, the system also illuminates the cruise control switches, transmission temperature gauge and the automatic transmission shifter back lighting.

Parking and Tail Lights

The headlight switch controls the parking lights and tail lights. Circuitry is provided to the body builder connections which supply power to these lights.

Stop Light Switch — With Hydraulic Brakes

The stop light switch circuit controls voltage to the body builder connector and is utilized by the body builder stop light circuits. In addition, the switch also provides a signal to the hydraulic brake monitor module. The stop light switch also supplies a signal to the engine ECM to indicate the brakes have been applied. The ECM uses this information to control various engine controlled features such as cruise control and vehicle retarder.

5.2. OPERATION

Exterior Lights

All fuses and circuit breakers providing exterior lights are supplied with battery voltage through the cowl power distribution center (590), fuse F33, and circuit 14F to cab feed connector (14). Power is then supplied through (14) and circuit 14F/14A to the cab fuse/relay panel. If all exterior lights are not functional, check this portion of the system first. For individual exterior light problems, refer to the following light system circuitry operations.

Back—Up Lights

When the key switch (63) is moved to the start or ignition position, power is applied through circuit breaker F15, circuit 71, connector (2), and circuit 71 [circuit 71, jumper harness connector (304) when N/LCT XMSN] to the back-up light switch NSBU (3026). When the transmission is placed in reverse, the back-up light switch contacts close and power flows through circuit 71A [a jumper harness connector (304) when N/LCT XMSN], connector (2), and circuit 71A to the body builder connector (194).

Headlight System — Headlight Circuitry Without Daytime Running Lights

When the headlight switch (60) is moved to the headlight on position, and the turn signal lever control dimmer switch is in the high beam position, power flows through circuit breaker F1, circuit 50, the closed headlight switch contacts, and circuit 51 to the dimmer relay (4J). Power flows through the closed contacts of the relay and through circuit 52C to a splice.

From the splice power is supplied through circuit 52 to the front end body builder connector (13) to illuminate the high beam headlights. From the splice, power is also applied through circuit 52A to the instrument cluster connector (27) and to the high beam indicator. The cluster ground is through circuit 28-GB/11-GA to cab ground (2G).

When the headlight switch is the headlight on position, power is also supplied through circuit breaker F2, circuit 58, the closed headlight switch contacts, and circuit 58B/51C to the dimmer relay coil. When the dimmer switch is moved to the low beam position, power flows through the relay coil, circuit 51D, and dimmer switch connector (192) to the closed contacts of the dimmer switch. The dimmer switch is ground through connector (192) and circuit 51-G/11-GA to cab ground (2G). This energizes the dimmer relay.

With the relay energized, power is switched from the high beam circuit 52C to the low beam circuit 53A. Power then flows through circuit 53A/53 to the front end body builder connector (13) to illuminate the low beam headlights.

Headlight System — Headlight Circuitry With Daytime Running Lights

When the headlight switch (60) is moved to the headlight on position, and the turn signal lever control dimmer switch is in the high beam position, power flows through circuit breaker F1, circuit 50, the closed headlight switch contacts, and circuit 51 to the dimmer relay (4J). Power flows through the closed contacts of the relay and through circuit 52C to a splice.

From the splice power is supplied through circuit 52 to the front end body builder connector (13) to illuminate the high beam headlights. From the splice, power is also applied through circuit 52A to the instrument cluster connector (27) and to the high beam indicator. The cluster ground is through circuit 28-GB/11-GA to cab ground (2G).

When the headlight switch is in the headlight on position, power is also supplied through circuit breaker F2, circuit 58, the closed headlight switch contacts, and circuit 58B/51C to the dimmer relay coil. When the dimmer switch is moved to the low beam position, power flows through the relay coil, circuit 51D, and dimmer switch connector (192) to the closed contacts of the dimmer switch. The dimmer switch is ground through connector (192) and circuit 51-G/11-GA to cab ground (2G). This energizes the dimmer relay.

With the relay energized, power is switched from the high beam circuit 52C to the low beam circuit 53A. Power then flows through circuit 53A/53 to the front end body builder connector (13) to illuminate the low beam headlights.

For Daytime Running Lights (DRL), an electronic module is utilized. Power flows through fuse F7 and circuit 66A to the DRL connector (15) to power the module. The ground path for the module is connector (15) and circuit 66-G/11-GB to cab ground (2G).

When the key switch (63) is moved to the ignition on or accessories position, voltage is applied to circuit 12, fuse F17, and circuit 66 to the DRL module. This powers up the DRL module, and allows it to monitor the voltage on the low beam headlight circuitry by way of circuit 66C.

Whenever the key switch is on and the headlight switch is off, circuit 66C will not detect voltage in the low beam circuitry. This causes the module to provide power to the high beam elements, over circuit 66E, at about

60% of full power. Whenever the headlights are switched on and high beams are selected, the power supplied through the headlight switch will override the 60% power level to a full 100% level.

Panel Lights and Switch Illumination

When the headlight switch (60) is in the park lights or headlights on position, power is supplied through circuit breaker F2, circuit 58, the closed switch contacts, and circuit 58B/62 to gauge cluster connector (28), pin 2. This supplies the back lighting power for the instrument cluster. Power then flows through the cluster, cluster connector (27), pin 1, and circuit 62A to a splice.

From the splice, power is supplied through circuit 62B to the rear end body builder connector (194). Power is also applied to circuit 62C and the headlight switch (60) illumination light. The light is grounded through circuit 62-GD/11-GB to cab ground (2G).

The power is also applied from the splice through circuit 62E to the cruise control switch on/off illumination light (391) and circuit 62F to the cruise control switch set/resume illumination light (392). Ground for the cruise switch on/off light is circuit 62-GA/11-GA and the set/resume switch light is 62-GB/11-GA to cab ground (2G).

The power is also supplied from the splice through circuit 62H, connector (204), to the automatic transmission panel light, to the automatic transmission shift connector (420). Ground for the panel light is through circuit 11-GE/11-GA to cab ground (2G).

Parking and Tail Lights

When the headlight switch (60) is in the park lights or headlights on position, power is supplied through circuit breaker F2, circuit 58, the closed switch contacts, and circuit 58B/58D to rear body builder connector (194). From the headlight switch, power is also supplied through circuit 58A to front end body builder connector (13). These connectors are provided for use by a body builder to supply power to the rear tail lights and parking lights.

Stop Light Switch

Power is applied through circuit breaker F21 and circuit 90C to the stop light switch connector (50). When the brake pedal is applied, the closed contacts of the stop light switch supplies power to the brake switch timing relay (1155) through circuit 90DD/90DC and grounded through circuit 90–GA.. Power is applied through circuit breaker F4 and circuit 70, the closed contacts of the brake switch timing relay (1155) to the body builder connector (194) through circuit 70B/70A.

When the brakes are applied, power is supplied to the IDM2 (6011), pin 11, through circuit 70B/97N, 48-pin dash connector (3) and circuit 97N. Also, power is supplied to the IDM2 (6011), pin 7, through circuit 90DD/97M, 48-pin dash connector (3) and circuit 97M. At the same time, power is supplied to the hydraulic brake monitor module (49) through circuit 70B/90R. The monitor module compares this signal to a signal it receives from the hydraulic brake switch.

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.

Exterior Lights

Table 13 Exterior Lights

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Check cowl fuse F33 for open condition.	F33	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace breaker.
2.	Off	Disconnect cab feed connector (14) and measure voltage from circuit 14F to ground.	(14), 14F to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 14F, then repair.
3.	Off	Reconnect (14). At cab fuse holder (1A) and fuse F4, measure voltage from circuit 14A to ground.	(1A), fuse F4, 14A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 14F/14A, then repair.
4.	Off	OEM exterior light system feed circuits check good.				

Back-Up Lights

Table 14 Back-Up Lights

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Check breaker F15 for open condition.	F15	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace breaker.

Table 14 Back-Up Lights (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
2.	Off/ On	Disconnect back-up light switch connector (317) and turn key on. Measure voltage from circuit 71 (black wire with 1652) to ground.	(317), 71 or black wire to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 71 [black wire, connector (304) or circuit 71 with 1652], dash conn. (2) or circuit 71, then repair.
3.	Off	Test back-up light switch (317) by placing transmission in reverse, and measuring resistance across terminals.	(317), across term.	< 1 ohm.	Go to next step.	Replace switch.
4.	Off	Reconnect (317) and disconnect dash connector (2). With transmission in reverse and at (2), measure resistance from circuit 71 to 71A.	(2), 71 to 71A.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 71A [71A, conn. (304) or white wire with 1652], then repair.
5.	Off/ On	Reconnect (2) and disconnect body builder connector (194). Turn key on and with transmission in reverse, measure voltage at (194) from circuit 71A to ground.	(194), 71A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 71A, then repair.
6.	Off	OEM back-up light circuits check good. If condition persists, troubleshoot body builder installed circuits.				

Headlight System — Headlight Circuits Without Daytime Running Lights

Table 15 Headlight System — Headlight Circuits Without Daytime Running Lights

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Disconnect headlight switch connector (60) and at circuit 50, measure voltage to ground.	(60), 50 to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open circuit breaker F1. If OK, locate cause of low or no voltage in circuit 50, then repair.

Table 15 Headlight System — Headlight Circuits Without Daytime Running Lights (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
2.	Off	At (60), measure voltage from circuit 58 to ground.	(60), 58 to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open circuit breaker F2. If OK, locate cause of low or no voltage in circuit 58, then repair.
3.	Off	With headlight switch (60) in the on position, measure resistance across terminals 5 and 6 that were connected to circuits 50 and 51.	Across switch (60) terminals 5 and 6.	< 1 ohm.	Go to next step.	Replace switch.
4.	Off	With headlight switch (60) still on, measure resistance across terminals 2 and 3 that were connected to circuits 58 and 58A.	Across switch (60) terminals 2 and 3.	< 1 ohm.	Go to next step.	Replace switch.
5.	Off	At (60), measure resistance across terminals 1 and 2 that were connected to circuits 58B and 58A.	Across switch (60) term. 1 and 2.	< 1 ohm.	Go to next step.	Replace switch.
6.	Off	Remove dimmer relay (4J) and reconnect headlight switch (60). Move headlight switch to on position, and at relay socket, measure voltage from circuit 51 to ground.	(4J), 51 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 51, then repair.
7.	Off	With headlight switch still on, at relay socket (4J), measure voltage from circuit 51C to ground.	(4J), 51C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 51C/58B, then repair.
8.	Off	Disconnect dimmer switch connector (192). At platform harness circuit 51–G, measure resistance to ground.	(192), 51–G to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 51–G/ 11–GA, then repair.

Table 15 Headlight System — Headlight Circuits Without Daytime Running Lights (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
9.	Off	At (192), measure resistance of dimmer switch from cavity B to cavity A, with the switch in the low beam position and then in the high beam position.	(192), cav. A to cav. B.	< 1 ohm in low beam, > 100K ohms in high beam.	Go to next step.	Replace switch.
10.	Off	Reconnect connector (192), place dimmer switch in low beam position, and at relay socket (4J) circuit 51D, measure resistance to ground.	(4J), 51D to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 51D, then repair.
11.	Off	Bench test dimmer relay (4J) by measuring resistance from terminal 3 to 4.	Relay (4J), term. 3 to 4.	< 1 ohm.	Go to next step.	Replace dimmer relay.
12.	Off	Bench test relay (4J) by applying +12V to pin 1, ground to pin 2, and measuring resistance from pin 3 to 5.	Energized relay (4J), pin 3 to 5.	< 1 ohm.	Go to next step.	Replace dimmer relay.
13.	Off	Re-install relay (4J), disconnect front end body builder connector (13). With dimmer switch at low beam, measure voltage at circuit 53 to ground.	(13), 53 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 53/53A, then repair.
14.	Off	Move dimmer switch to high beam position, and at (13), measure voltage from circuit 52 to ground.	(13), 52 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 52/52C, then repair.
15.	Off	With headlight switch on and dimmer switch in high beam position, does high beam indicator illuminate?			Go to Step 18.	Go to next step.
16.	Off	Disconnect cluster connector (27) and with switches still set, measure voltage at cavity 4 circuit 52A to ground.	(27), cav. 4 52A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 52A/52C, then repair.

Table 15 Headlight System — Headlight Circuits Without Daytime Running Lights (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
17.	Off	Replace high beam indicator bulb with known good bulb and reconnect (27). Does light illuminate?			Go to next step.	Replace cluster.
18.	Off	Circuits to high beam indicator and headlight system OEM front end connector check good. If condition persists, troubleshoot body builder installed circuits.				

Headlight System — Headlight Circuits With Daytime Running Lights

Table 16 Headlight System — Headlight Circuits With Daytime Running Lights

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Do DRL circuits function properly?			Go to next step.	Go to Step 20.
2.	Off	Disconnect headlight switch connector (60) and at circuit 50, measure voltage to ground.	(60), 50 to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open circuit breaker F1. If OK, locate cause of low or no voltage in circuit 50, then repair.
3.	Off	At (60), measure voltage from circuit 58 to ground.	(60), 58 to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open circuit breaker F2. If OK, locate cause of low or no voltage in circuit 58, then repair.
4.	Off	With headlight switch (60) in the on position, measure resistance across terminals 5 and 6 that were connected to circuits 50 and 51.	Across switch (60) term. 5 and 6.	< 1 ohm.	Go to next step.	Replace switch.
5.	Off	With headlight switch (60) still on, measure resistance across terminals 2 and 3 that were connected to circuits 58 and 58A.	Across switch (60) terminals 2 and 3.	< 1 ohm.	Go to next step.	Replace switch.

Table 16 Headlight System — Headlight Circuits With Daytime Running Lights (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Do DRL circuits function properly?			Go to next step.	Go to Step 20.
6.	Off	At (60), measure resistance across terminals 1 and 2 that were connected to circuits 58B and 58A.	Across switch (60) term. 1 and 2.	< 1 ohm.	Go to next step.	Replace switch.
7.	Off	Remove dimmer relay (4J) and reconnect headlight switch (60). Move headlight switch to on position, and at relay socket, measure voltage from circuit 51 to ground.	(4J), 51 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 51, then repair.
8.	Off	With headlight switch still on, at relay socket (4J), measure voltage from circuit 51C to ground.	(4J), 51C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 51C/58B, then repair.
9.	Off	Disconnect dimmer switch connector (192). At platform harness circuit 51–G, measure resistance to ground.	(192), 51–G to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 51–G/ 11–GA, then repair.
10.	Off	At (192), measure resistance of dimmer switch from cavity B to cavity A, with the switch in the low beam position and then in the high beam position.	(192), cav. A to cav. B.	< 1 ohm in low beam, > 100K ohms in high beam.	Go to next step.	Replace switch.
11.	Off	Reconnect connector (192), place dimmer switch in low beam position, and at relay socket (4J) circuit 51D, measure resistance to ground.	(4J), 51D to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 51D, then repair.
12.	Off	Bench test dimmer relay (4J) by measuring resistance from terminal 3 to 4.	Relay (4J), term. 3 to 4.	< 1 ohm.	Go to next step.	Replace dimmer relay.

Table 16 Headlight System — Headlight Circuits With Daytime Running Lights (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Do DRL circuits function properly?			Go to next step.	Go to Step 20.
13.	Off	Bench test relay (4J) by applying +12V to pin 1, ground to pin 2, and measuring resistance from pin 3 to 5.	Energized relay (4J), pin 3 to 5.	< 1 ohm.	Go to next step.	Replace dimmer relay.
14.	Off	Re-install relay (4J), disconnect front end body builder connector (13). With dimmer switch at low beam, measure voltage at circuit 53 to ground.	(13), 53 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 53/53A, then repair.
15.	Off	Move dimmer switch to high beam position, and at (13), measure voltage from circuit 52 to ground.	(13), 52 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 52/52C, then repair.
16.	Off	With headlight switch on and dimmer switch in high beam position, does high beam indicator illuminate?			Go to Step 19.	Go to next step.
17.	Off	Disconnect cluster connector (27) and with switches still set, measure voltage at cavity 4 circuit 52A to ground.	(27), cav. 4 52A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 52A/52C, then repair.
18.	Off	Replace high beam indicator bulb with known good bulb and reconnect (27). Does light illuminate?			Go to next step.	Replace cluster.
19.	Off	Circuits to high beam indicator and headlight system OEM front end connector check good. If condition persists, troubleshoot body builder installed circuits.				

Table 16 Headlight System — Headlight Circuits With Daytime Running Lights (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Do DRL circuits function properly?			Go to next step.	Go to Step 20.
20.	Off	Check fuse F7 for open condition.	F7	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
21.	Off	Check circuit breaker F17 for open condition.	F17	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace circuit breaker.
22.	Off	Disconnect DRL module connector (15) and measure voltage from circuit 66A to ground.	(15), 66A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 66A, then repair.
23.	Off	At (15) measure voltage from circuit 66A to 66–G.	(15), 66A to 66–G.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit 66–G/ 11–GB, then repair.
24.	On	At (15) measure voltage from circuit 66 to ground.	(15), 66 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 66, then repair.
25.	Off	With headlight switch on, dimmer switch in low beam position and at (15), measure voltage from circuit 66C to ground.	(15), 66C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 66C/53A, then repair.
26.	Off	With headlight switch on, dimmer switch in high beam and at (15), measure voltage from circuit 66E to ground.	(15), 66E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate open or poor connection in circuit 66AE/52C, then repair.
27.	Off/ On	Reconnect DRL connector (15). With headlight switch off and parking brake disengaged, turn key switch on. Do headlights illuminate at approx. 60% brightness?			DRL module and OEM head-light circuits check good.	Replace DRL module.

Panel Lights and Switch Illumination

Table 17 Panel Lights and Switch Illumination

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	With the headlight switch on, does the instrument cluster back lighting illuminate?			Go to Step 5.	Go to next step.
2.	Off	Disconnect cluster connector (28). With headlight switch in park or on position, measure voltage from cavity 2 circuit 62 to ground.	(28), cav. 2 cir. 62 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 62/58B, then repair.
3.	Off	Turn headlight switch off. Reconnect (28) and disconnect cluster connector (27). Install jumper wire from cluster terminal 2 to ground. Go to next step.				
4.	Off	Turn headlight switch on and with panel dimmer in full bright position, measure voltage from cluster (27) terminal 1 to ground.	(27), term. 1 to gnd.	12 ± 1.5 volts.	Panel back lighting and circuits check good. Reconnect connectors.	Replace cluster.
5.	Off	With headlight switch on, does the headlight switch illuminate?			Go to Step 8.	Go to next step.
6.	Off	Disconnect headlight switch connector (60). Install jumper wire from cavity 2 circuit 58 to cavity 1 circuit 58B. Measure voltage from cavity 7 circuit 62C to ground.	(60), cav. 7 cir. 62C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 62C/62A, then repair.
7.	Off	Remove jumper and at (60), measure resistance from cavity 8 circuit 62–GD to ground.	(60), cav. 8 cir. 62–GD to gnd.	< 1 ohm.	Replace switch.	Locate open or poor connection in circuit in circuit 62–GD/ 11–GB, then repair.
8.	Off	With headlight switch on, does the cruise on/off switch illuminate?			Go to Step 11.	Go to next step.

Table 17 Panel Lights and Switch Illumination (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
9.	Off	Disconnect cruise on/off switch (391). With headlight switch on, measure voltage from circuit 62E to ground.	(391), 62E to gnd.	12 ± 1.5 volts.	Go to next step	Locate cause of low or no voltage in circuit 62E, then repair.
10.	Off	At (391) measure resistance from circuit 62–GA to ground.	(391), 62–GA to gnd.	< 1 ohm.	Replace switch.	Locate open or poor connection in circuit 62–GA/ 11–GA, then repair.
11.	Off	With headlight switch on, does the cruise set/resume switch illuminate?			Go to Step 14.	Go to next step.
12.	Off.	Disconnect cruise set/resume switch (392). With headlight switch on, measure voltage from circuit 62F to ground.	(392), 62F to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 62F, then repair.
13.	Off	At (392) measure resistance from circuit 62–GB to ground.	(392), 62–GB to gnd.	< 1 ohm.	Replace switch.	Locate open or poor connection in circuit 62–GB/ 11–GA, then repair.
14.	Off	With headlight switch on, does the transmission shift panel back lighting illuminate?			Go to Step 16.	Go to next step.
15.	Off	Disconnect shift panel back lighting connector (420). With headlight switch on, measure voltage from circuit 62H to ground.	Shift panel conn. (420), 62H to gnd.	12 ± 1.5 volts.	Replace shift panelback light or assembly. Go to next step.	Locate cause of low or no voltage in circuit 62H, then repair.
16.	Off	Panel lights and switch illumination circuits check good.				

Parking Light and Tail Light Feed Circuits

Table 18 Parking Light and Tail Light Feed Circuits

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	With headlight switch in park position, do the tail lights work?			Go to Step 3.	Go to next step.
2.	Off	Disconnect rear end body builder connector (194). With light switch in park position, measure voltage from circuit 58D to ground.	(194), 58D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 58D/58B, then repair.
3.	Off	With headlight switch in park position, do the parking lights work?			Go to Step 6.	Go to next step.
4.	Off	Disconnect headlight switch connector (60). At switch, measure resistance across terminals 1 and 3.	(60), across term. 1 and 3.	< 1 ohm.	Go to next step.	Replace switch.
5.	Off	Reconnect (60) and disconnect front end body builder conn. (13). Measure voltage from circuit 58A to ground.	(13), 58A to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 58A, then repair.
6.	Off	OEM parking light and tail light circuits check good. If condition persists, troubleshoot body builder installed circuits.				

Stop Light Switch

Table 19 Stop Light Switch

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Check circuit breaker F21 for open condition.	F21	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
2.	Off	Disconnect stoplight switch connector (50), and measure voltage from circuit 90C to ground.	(50), 90C to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage circuit 90C, then repair.

Table 19 Stop Light Switch (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
3.	Off	At switch (50), measure resistance across switch terminals with brakes applied.	(50), across terminals.	< 1 ohm.	Go to next step.	Replace switch.
4.	Off	Check circuit breaker F4 for open condition.	F4	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
5.	Off	Remove brake switch timing relay (1155) and reconnect switch (50). With brakes applied, and at relay socket, measure voltage from circuit 70 to ground.	(1155), 70 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 70, then repair.
6.	Off	With brake switch still on, at brake switch timing relay socket (1155), measure voltage from circuit 90DC to ground.	(1155), 90DC to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 90DD/90DC, then repair.
7.	Off	At brake switch timing relay socket (1155) harness circuit 90–GA, measure resistance to ground.	(1155), 90–GA to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 90–GA, then repair.
8.	Off	Bench test brake switch timing relay (1155) by measuring resistance from terminal 3 to 4.	Relay (1155), term. 3 to 4.	< 1 ohm.	Go to next step.	Replace brake switch timing relay.
9.	Off	Bench test brake switch timing relay (1155) by applying +12V to pin 1, ground to pin 2, and measuring resistance from pin 3 to 5.	Energized relay (1155), pin 3 to 5.	< 1 ohm.	Go to next step.	Replace brake switch timing relay.
10.	Off	Re-install relay (1155), disconnect brake monitor module connector (49). Measure resistance between connector (49) cavity H circuit 90R and connector (50) circuit 70B.	(49), cir. 90R to (50) cir. 70B.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 70B/90R, then repair.

Table 19 Stop Light Switch (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
11.	Off	Disconnect body builder connector (194). Measure resistance of circuit 70A between connector (194) cavity A and connector (50).	(194), cav. A cir. 70A to (50) cir. 70A.	< 1 ohm.	Go to next step.	Locate open in circuit 70A, then repair.
12.	Off	Reconnect (49), (50) and (194) and disconnect IDM2 connector (6011). Measure voltage from circuit 97N, cavity 11 to ground with brakes applied.	(6011), 97N cav. 11 to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 97N, dash conn. (3), or circuit 97N/70B, then repair.
13.	Off	Reconnect (6011). OEM stoplight switch circuitry checks good. If condition persists, troubleshoot body builder installed circuits.				

5.4. COMPONENT LOCATIONS

(2) 22–Way Dash Connector..... At Left Front Cowl, Below Conn. (3)
(2G) Cab Ground Stud..... Beside 48-Way Dash Connector (Inside Cab)
(3) 48-Way Elect. Engine Dash Connector..... At Left Front Cowl, Above Conn. (2)
(4J) Dimmer Relay Connector ..... Inside Cab Fuse/Relay Panel
(13) Front End Body Builder Connector..... At Cowl Grommet, Front Side of Cowl
(14) Cab Feed Connector..... Below Engine Harness 22–Way Dash Connector
(15) DRL Module Connector..... Inside Cab Fuse/Relay Panel
(27) Green Instrument Cluster Connector..... Behind Instrument Cluster
(28) Natural Instrument Cluster Connector..... Behind Instrument Cluster
(349) Brake Warning Monitor Module..... Inside Cab Fuse/Relay Panel
(50) Brake Stop Light Switch Connector..... Under Brake Pedal Support Bracket
(60) Headlight Switch Connector..... Behind Headlight Switch
(63) Key Switch Connector..... Behind Key Switch
(192) Dimmer Switch Connector..... Upper Left Side of Steering Column Support
(194) Body Builder Connector..... Left Side of Cab Fuse/Relay Panel
(304) Back-up Light Switch (Inline) Connector..... Upper Left Side of Transmission
(317) Back-up Light Switch Connector..... At Back-Up Light Switch on Transmission
(379) Engine Control Module..... Mounted to Right Valve Cover
(391) Cruise On/Off Switch Connector..... Behind Cruise On/Off Switch
(392) Cruise Set/Resume Switch Connector..... Behind Cruise Set/Resume Switch
(420) Shift Lever Connector..... Left of Shift Lever
(476) Trans. Temperature Gauge Connector..... Above Steering Column Support
(590) Power Distribution Center..... Cowl Fuse/Relay Panel
(1155) Brake switch timing relay ..... Inside Cab Fuse/Relay Panel
(6011) IDM2 Engine Control Module..... Mounted to Right Valve Cover

See Figure 30, Figure 31, Figure 32, Figure 33, Figure 34, Figure 35, and Figure 36.

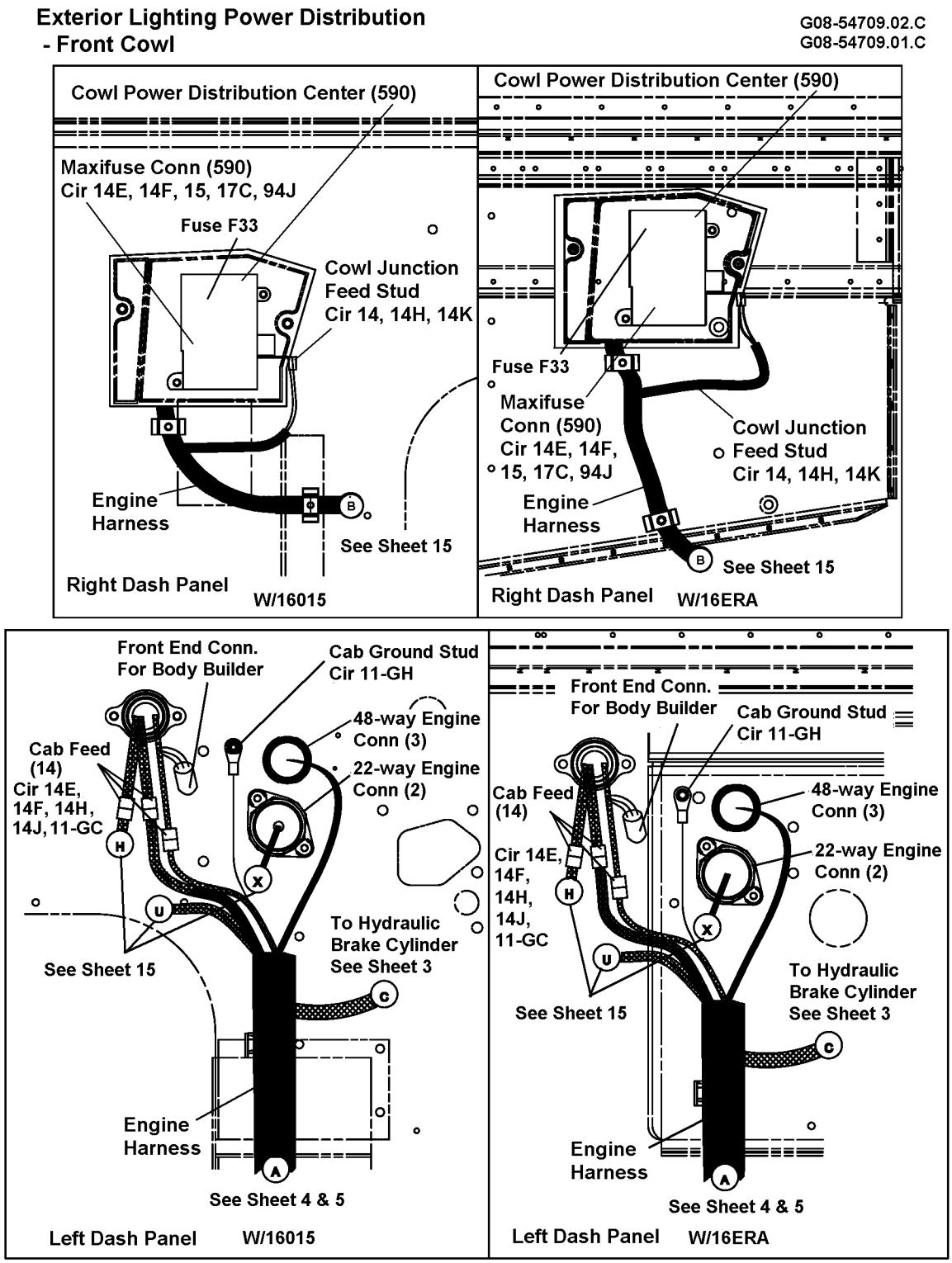


Figure 30 Exterior Lighting Power Distribution — Front Cowl

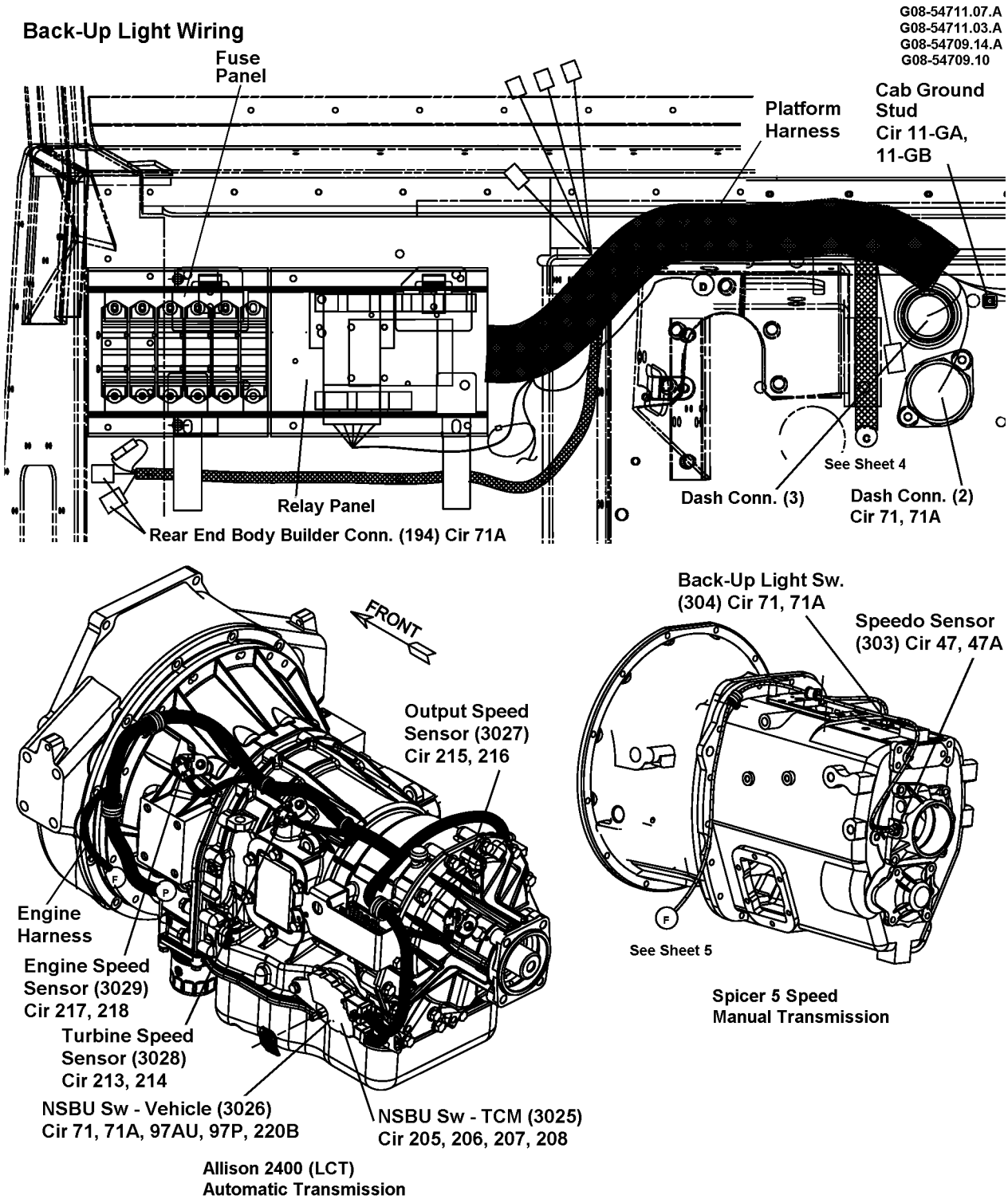


Figure 31 Back-Up Light Wiring

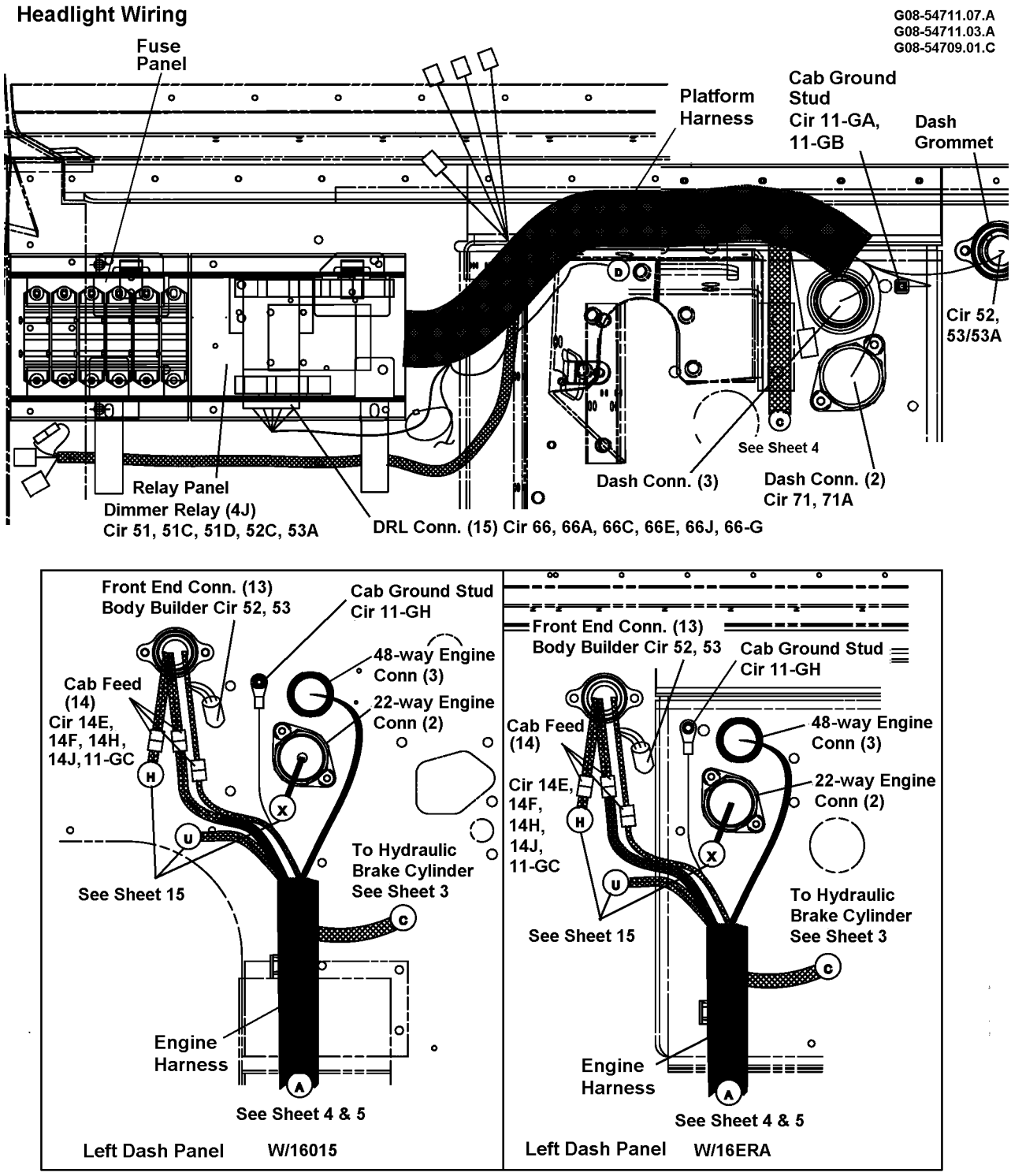


Figure 32 Headlight Wiring

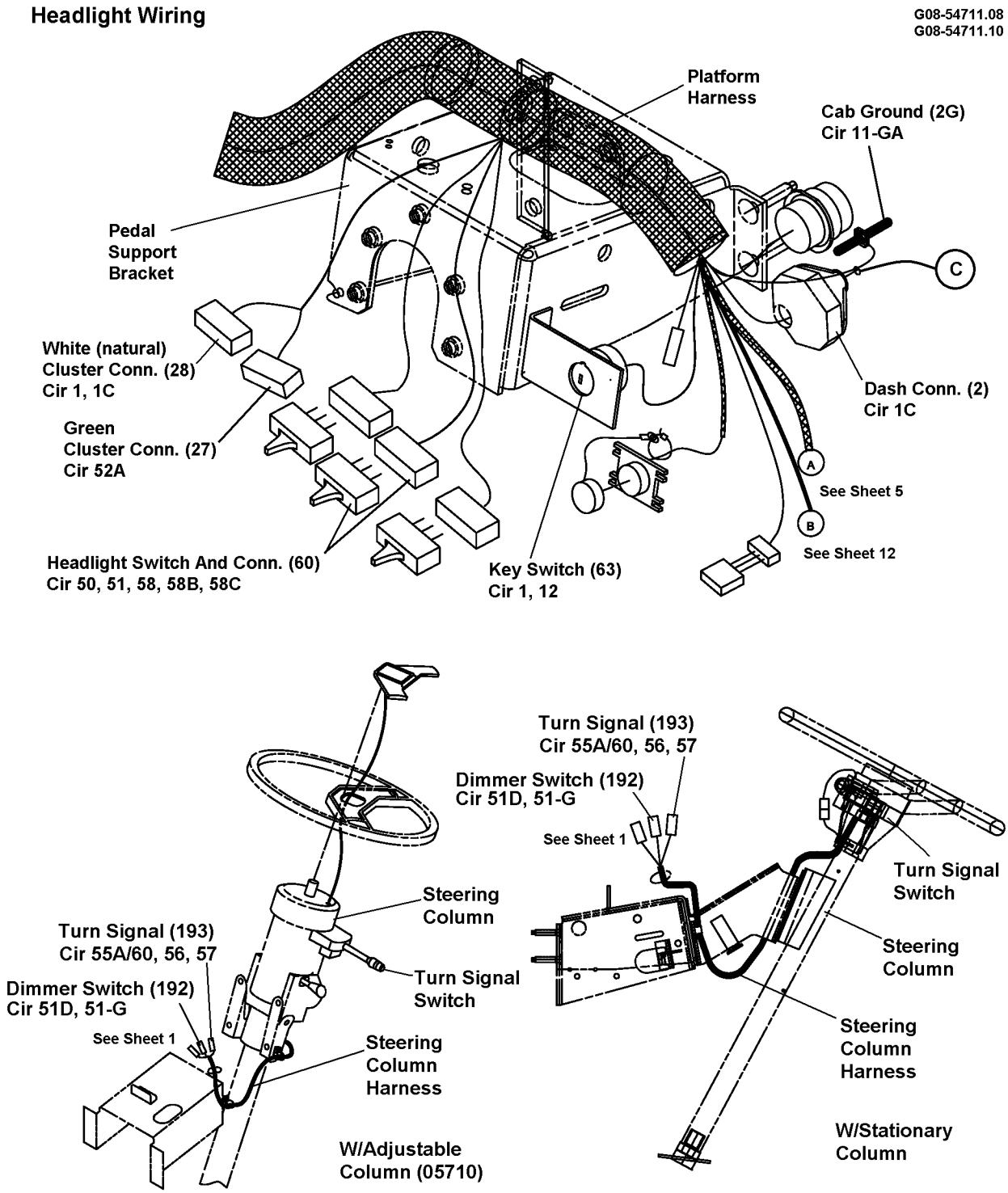


Figure 33 Headlight Wiring

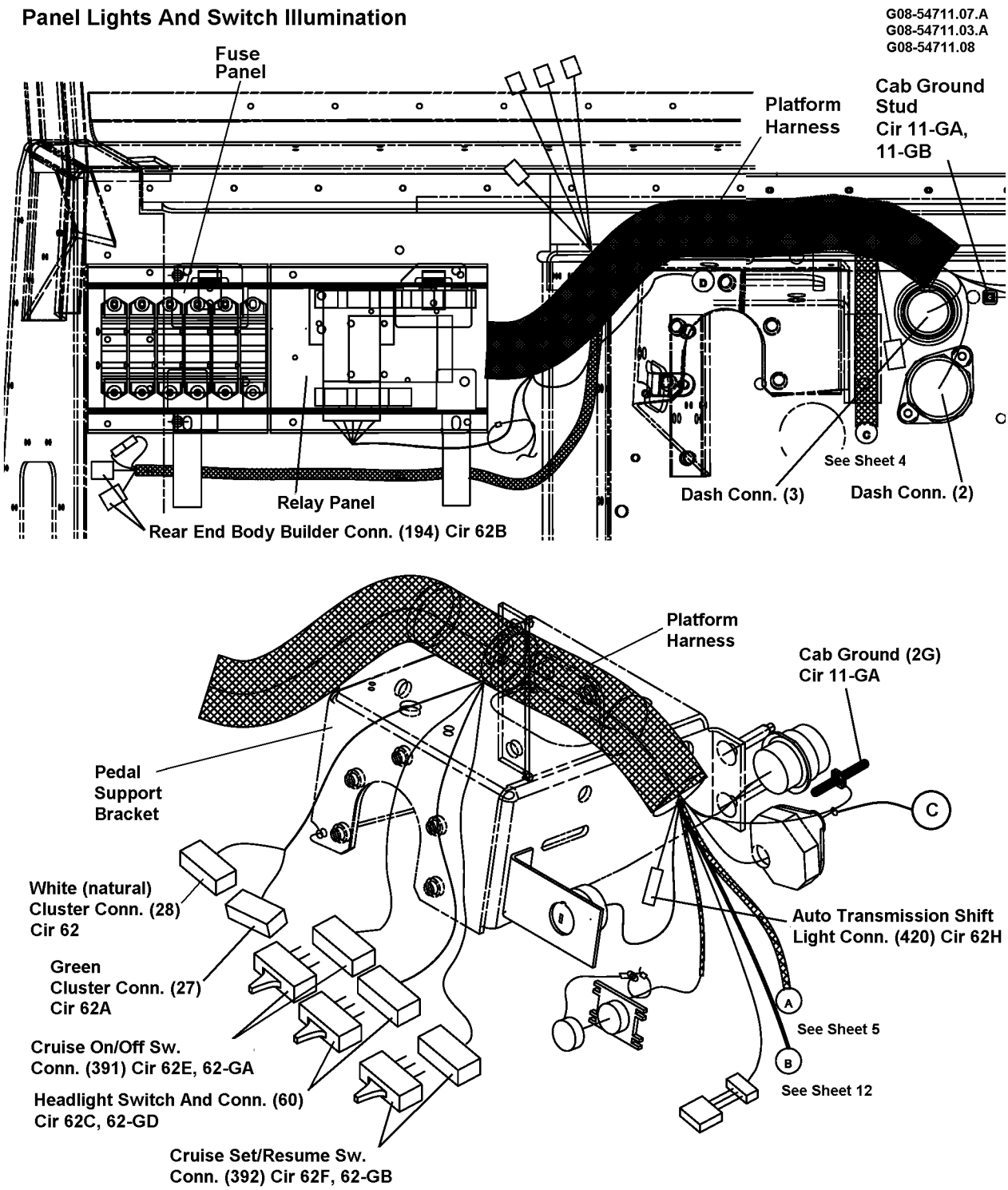


Figure 34 Panel Lights and Switch Illumination

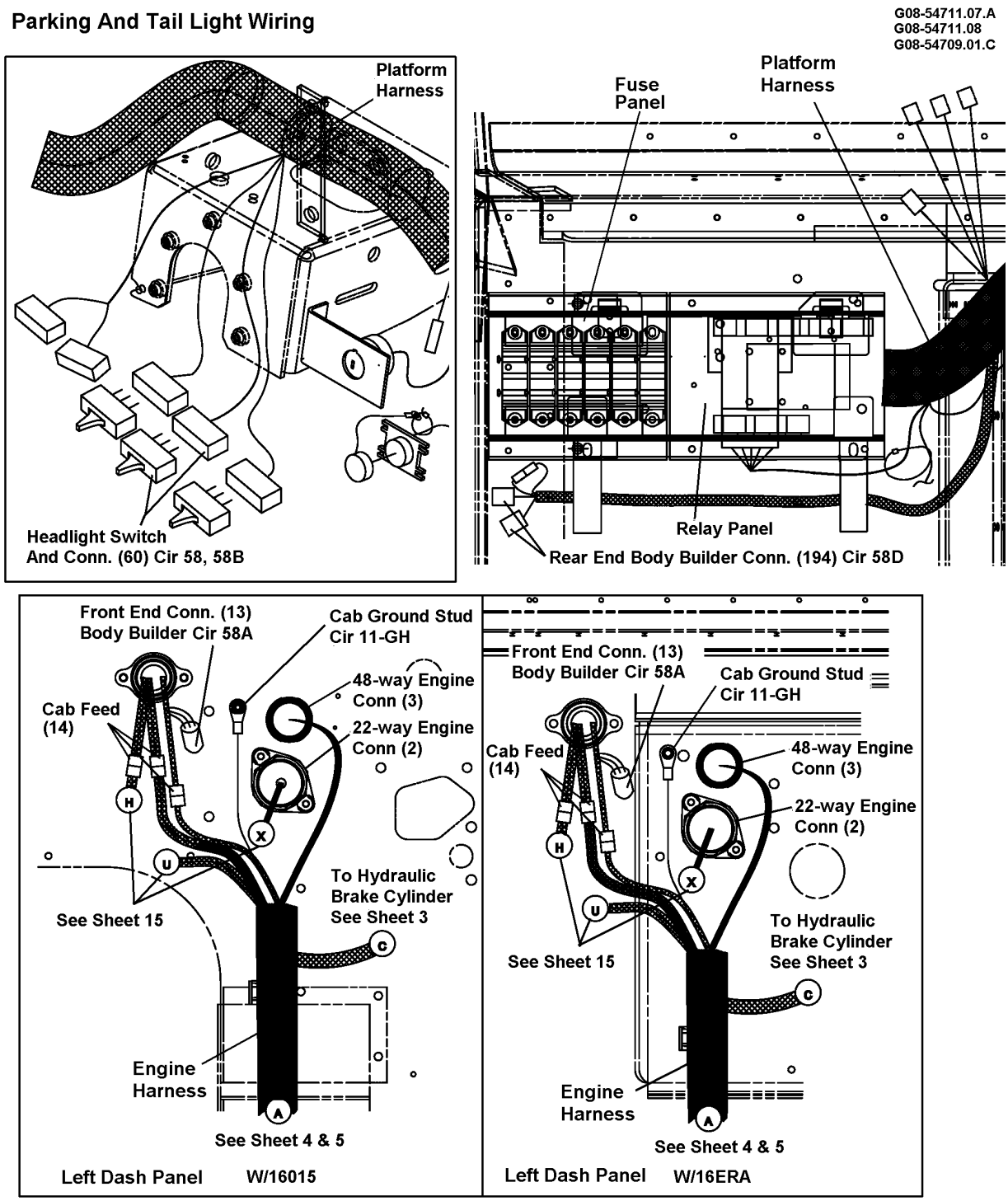


Figure 35 Parking and Tail Light Wiring

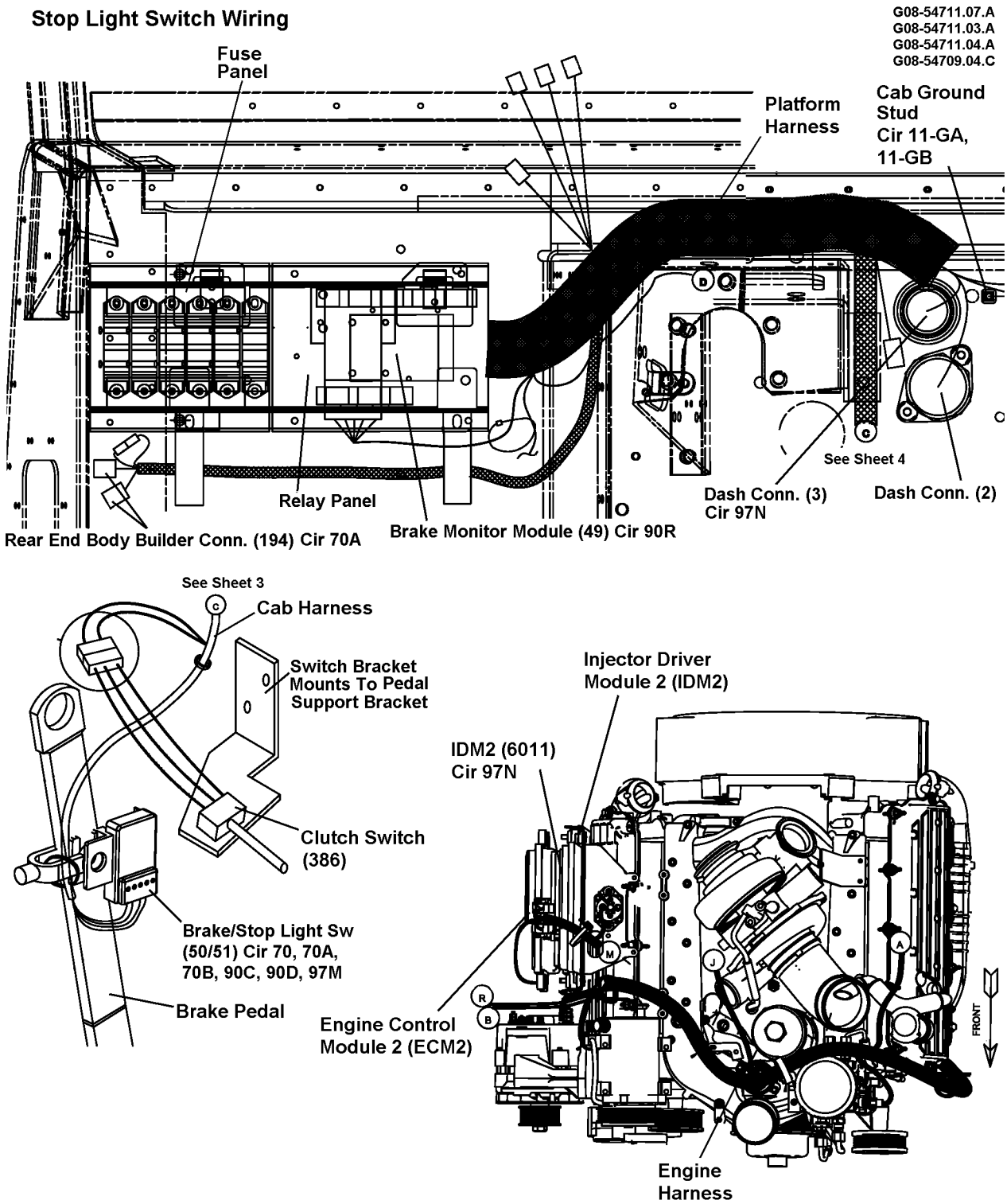


Figure 36 Stop Light Switch Wiring

6. ELECTRONIC COMPONENTS

6.1. 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.

Electronic Device Powering

These vehicles are provided with uninterrupted battery source power and ground circuitry for supplying electronic devices. The power and ground studs are located inside the cab fuse/relay panel.

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.

6.2. 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 F6 and circuit 97C. Ground for the EST is through 97-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 98B(+)/98E(+) and circuit 98D(-)/98F(-) to the instrument cluster (27). Communication with the ECM2 or IDM2 is through circuit 98B(+)/98A(+) and circuit 98D(-)/98C(-) to the 48-pin dash connector (3). From the dash connector (3), the communication circuits are 98AB(+)/98A(+) to ECM2 connector (6021) pin 20 and 98CB(-)/98C(-) to pin 21, and circuits are 98AB(+)/98AA(+) to IDM2 connector (6011) pin 2 and 98CB(-)/98CA(-) 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 98B(+)/98H(+) and 98D(-)/98G(-).

Electronic Device Powering

Uninterrupted battery power is supplied to power stud (1DVA) through circuit 14D, 20A maxifuse (413), circuit 14C, engine harness connector (411) and circuit 14J to the 22-pin dash connector (2). From (2), power is applied to circuit 14J and the power stud.

The ground stud (2DVA) ground path is through circuit 11-GC to the 22-pin dash connector (2). From (2), the path is through circuit 11-GC, engine harness connector (409) and circuit 11-GB to the battery ground post.

ECM Power and Ground

Power is supplied by the batteries to circuit 14A, a 50A maxifuse (408), circuit 14B, engine harness to positive battery cable connector (411), circuit 14B/97JA to the ECM power relay (590B) coil and circuit 14B/97HB, fuse (F39), circuit 97HA to contacts. Also, power is supplied through circuit 14B/97LB to the IDM power relay (590A) coil and circuit 97TC to contacts.

From the ECM power relay (590B) coil, power is applied to circuit 97J and pin 5 of the ECM2 (6020). Also, from the IDM2 power relay (590A) coil, power is applied to circuit 97LA and pin 8 of the IDM2 (6011).

When key switch (63) is moved to the ignition position, power is supplied through fuse F12, circuit 97CR, the 48-pin dash connector (3), and circuit 97CR and a splice. From the splice power is applied to pin 3 of the ECM2 (6020) on circuit 97UA . 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 (590B) which energizes the relay. With the relay (590B) energized, power is applied through the closed contacts to circuit 97TA and a splice. From the splice power is applied to the ECM2 (6021) pins 1 and 2 on circuits 97CL and 97CK respectively, and to the IDM2 (6011) pin 10 on circuit 97AL.

Also, when key switch (63) is moved to the ignition position, power is supplied through fuse F12, circuit 97CR, the 48-pin dash connector (3), and circuit 97CR and a splice. From the splice power is applied to pin 9 of the IDM2 (6011) on circuit 97UB . 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 (590A) which energizes the relay. With the relay (590A) energized, power is applied through the closed contacts to circuit 97TA and a splice. From the splice power is applied to the IDM2 (6011) pin 12 on circuit 97Y, and the IDM2 (6011) pin 6 on circuit 97LD, fuse (F40) and circuit 97LC.

Grounds for the ECM2 (6020) pins 6 and 7 are through circuits 97-GW and 97-GV respectively, to a splice. From the splice, ground is through circuit 11-G, the engine harness to negative battery cable harness connector (409) and circuit 11-GA to the negative battery terminal. Also, grounds for the IDM2 (6011) pin 1 is through circuit 97-GA to a splice. From the splice, ground is through circuit 11-G, the engine harness to negative battery cable harness connector (409) 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 99C, dash connector (3), circuit 99C to a splice, and circuit 99J to the APS/IVS (382). The APS then returns a variable voltage signal (depending on pedal position) through connector (382), circuit 99B, connector (3), and circuit 99B to the ECM2. The APS is grounded through circuit 99A/97W, connector (3), and circuit 97W/97WB 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 (63) is in the on or start position, the Idle Validation Switch (IVS) (382) receives 12 volt ignition voltage through circuit breaker F10, and circuit 99E. When the pedal is not in the idle position (throttle applied), the IVS sends this 12 volt signal to the ECM over circuit 99D, connector (3), and circuit 99D to the ECM2 (6021).

The ECM2 compares the inputs it receives on circuit 99B and circuit 99D from the APS/IVS to verify when the pedal is in the idle position. If the APS signal from circuit 99B indicates throttle is being applied, then the ECM2 expects to see 12 volts at IVS circuit 99D. If the APS signal, circuit 99B, indicates throttle is not applied, then the ECM2 expects to see 0 volts at the IVS circuit 99D. 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 99C, dash connector (3), circuit 99C to a splice, and circuit 97BL to BAP sensor (437). The BAP sensor returns a variable voltage signal (represents atmospheric pressure) on circuit 97CD, connector (3) and circuit 97CD to the ECM2 (6020). The BAP sensor is grounded by circuit 97Z/97W, connector (3), circuit 97W/97WB to the ECM2 (6021) signal ground.

Air Temperature Sensor (ATS)

The IDM2 (6011) sends a regulated 5 volt reference signal through circuit 97AX to the Air Temperature Sensor (463). 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 97BU/97WB to the ECM2 (6021) signal ground.

Cruise Control/Remote Engine Controls

When key switch (63) is in the ignition or start position, power is supplied through circuit 13C to the ignition relay (4G). The relay is grounded through circuits 13-G/11-GB to cab ground. This energizes the relay (4G) and switches battery power from circuit breaker F31, circuits 15/15C, dash connector (2), circuits 15C/15D, through the closed relay contacts and circuit 13A to circuit breaker F13. From the circuit breaker, power is supplied through circuit 97B to the brake/cruise interface relay (1133). The brake/cruise interface relay (1133) is grounded through circuits 97-GJ/11-GA to cab ground.

Battery power is applied to fusible link circuit through circuits 90-FL/90/90B, dash connector (2), circuit 90B, circuit breaker F21 and circuit 97DK 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 97DJ. When the switch is in the On position, power flows through the closed switch contacts and circuit 97CF to the MSM (3041). The MSM (3041) 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 97DH. Momentarily depressing the Set portion of this switch supplies a 12 volt signal to the MSM (3041) through circuits 97DH/97CA 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 (3041) through circuits 97–GE/97–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. When the key switch is on, power is supplied through circuit breaker F11, circuit 97K, dash connector (3) and circuit 97DF to the body builder switch connections (N/L), located at the cowl power distribution center. The ECM2 (6020) signal circuits 46A, 46B, 47B, 97AR, 97CC and 97CB can also be found at this location.

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

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.

ATA Data Link and Diagnostic/ Programming Connector

Table 20 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 97C 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 97C, then repair.
2.	Off	Disconnect ECM2 connector (6021) and install jumper wires from cavity 20 circuit 98A(+) and cavity 21 circuit 98C(-) to ground.			Go to next step.	
3.	Off	At (384) measure resistance of circuits 98B(+)/98A(+) and 98A(+) to ground.	(384), 98B(+) to gnd.	< 2 ohms.	Go to next step.	Locate open or poor connection in circuits 98B(+)/ 98A(+) and 98A(+) or dash conn. (3), then repair.

Table 20 ATA Data Link and Diagnostic/ Programming Connector (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
4.	Off	At (384) measure resistance of circuits 98D(-)/98C(-) and 98C(-) to ground.	(384), 98D(-) to gnd.	< 2 ohms.	Go to next step.	Locate open or poor connection in circuits 98D(-)/98C(-) and 98C(-) 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 98AA(+) and cavity 3 circuit 98CA(-) to ground.			Go to next step.	
6.	Off	At (384) measure resistance of circuits 98B(+)/98A(+) and 98AA(+) to ground.	(384), 98B(+) to gnd.	< 2 ohms.	Go to next step.	Locate open or poor connection in circuits 98B(+)/ 98A(+) and 98AA(+) or dash conn. (3), then repair.
7.	Off	At (384) measure resistance of circuits 98D(-)/98C(-) and 98CA(-) to ground.	(384), 98D(-) to gnd.	< 2 ohms.	Go to next step.	Locate open or poor connection in circuits 98D(-)/98C(-) and 98CA(-) or dash conn. (3), then repair.
8.	Off	Remove jumpers and reconnect (6011). Disconnect cluster connector (27) and install jumper wires from cavity 7 circuit 98E(+) and cavity 9 circuit 98F(-) to ground.			Go to next step.	
9.	Off	At (384) measure resistance of circuit 98B(+)/98E(+) to ground.	(384), 98B(+) to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 98B(+)/ 98E(+), then repair.
10.	Off	At (384) measure resistance of circuits 98D(-)/98F(-) to ground.	(384), 98D(-) to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 98D(-)/ 98F(-), then repair.

Table 20 ATA Data Link and Diagnostic/ Programming Connector (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
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.
12.	Off	At ATA interface connector (374), measure resistance from circuit 98G(-) to (384) circuit 98D(-).	(374), 98G(-) to (384) 98D(-).	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 98D(-)/ 98G(-), then repair.
13.	Off	Data communication link circuitry checks good. If condition persists, refer to Engine Diagnostic Manual.				

Electronic Device Power Wiring

Table 21 Electronic Device Power Wiring

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	At power stud (1DVA), measure voltage from circuit 14J to ground.	(1DVA), 14J to gnd.	12 ± 1.5 volts.	Go to Step 5.	Go to next step.
2.	Off	Remove 20A fuse from connector (413) and check for open condition.	(413), 20A fuse.	< 1 ohm.	Go to next step.	Replace fuse.
3.	Off	At (413) measure voltage from circuit 14D to ground.	(413), 14D to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 14D, then repair or replace cable assembly.
4.	Off	Re-install fuse. Disconnect engine harness connector (411) and measure voltage from circuit 14C to ground. Reconnect (411).	(411), 14C to gnd.	12 ± 1.5 volts.	Locate open or poor connection in cir. 14J or dash conn. (2), then repair.	Locate cause of low or no voltage in circuit 14C, then repair.
5.	Off	At power stud (2DVA), measure resistance from circuit 11–GC to ground.	(2DVA), 11–GC to gnd.	< 1 ohm.	Go to Step 7.	Go to next step.

Table 21 Electronic Device Power Wiring (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
6.	Off	Disconnect engine harness connector (409) and measure resistance of circuit 11–GB to ground. After corrections, go to next step.	(409), 11–GB to gnd.	< 1 ohm.	Locate open or poor connection in cir. 11–GC or dash conn. (2), then repair.	Locate open in circuit 11–GB, then repair or replace cable assembly.
7.	Off	Reconnect connectors. Electronic device powering circuits check good.				

ECM Power and Ground System Circuitry

Table 22 ECM Power and Ground System Circuitry

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Remove 50A power module maxifuse (408) and check for open condition.	Maxifuse (408).	< 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 F39 for open condition.	F39	< 1 ohm.	Go to next step.	Locate cause of overload condition, then repair. Replace fuse.
4.	Off	At F39 fuse cavity A, measure voltage from circuit 97HB to ground.	F39, cav. A, 97HB 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 97LD to ground.	F40, cav. A, 97LD to gnd.	12 ± 1.5 volts.	Go to next step.	Refer to 12 Volt Power Distribution (Battery) in Section 1.

Table 22 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 13 to ground.	F12, cav. A, 13 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 (409). At cable cavity A, measure resistance of circuit 11–GA to ground.	(409), cav. A, 11–GA to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 11–GA, then repair or replace cable assembly.
12.	Off	Locate open or poor connection in circuits 11–G/97–GV, 11–G/97–GW, or 11–G/97–GA, then repair.				
13.	On	At (6020) harness cavity 3, measure voltage from circuit 97UA to ground.	(6020), cav. 3, 97UA 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 97UB to ground.	(6011), cav. 9, 97UB to gnd.	12 ± 1.5 volts.	Go to Step 16.	Go to next step.

Table 22 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 (3). Turn key on and at cavity 15, measure voltage from circuit 97CR to ground.	(3), cav. 15, 97CR to gnd.	12 ± 1.5 volts.	Repair 97C/97UA or 97C/97UB between (3) and (6020) or (6011).	Locate cause of low or no voltage in circuit 97CR, then repair.
16.	Off	At (6020), measure voltage from harness cavity 5 circuit 97J to ground.	(6020), cav. 5, 97J to gnd.	12 ± 1.5 volts.	Go to Step 20.	Go to next step.
17.	Off	Remove ECM power relay (590B). At socket cavity 8B, measure voltage from circuit 97JA to ground.	(590B), cav. 8B, 97JA to gnd.	12 ± 1.5 volts.	Go to Step 19.	Go to next step.
18.	Off	Disconnect dash connector (411). At cavity A, measure voltage from circuit 14B/97JA to ground.	(411), cav. A, 14B/97JA to gnd.	12 ± 1.5 volts.	Repair 14B/97JA between (411) and (590B).	Locate cause of low or no voltage in circuit 14B, then repair.
19.	Off	Measure resistance of circuit 97J between relay (590B), socket cavity 6C, and ECM2 connector (6020), cavity 5.	(590B), cav. 6C to (6020), cav. 5.	< 1 ohm.	Replace relay.	Locate open or poor connection in circuit 97JA, 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 (590B). At socket cavity 6B, measure voltage from circuit 14B/97HB, fuse F39, and 97HA to ground.	(590B), cav. 6B, 14B/97HB, F39, and 97HA to gnd.	12 ± 1.5 volts.	Go to Step 23.	Go to next step.
22.	Off	Disconnect positive battery/ engine harness connector (411) and at circuit 14B, measure voltage to ground.	(411), 14B to gnd.	12 ± 1.5 volts.	Repair 14B between (411) and (590B).	Locate cause of low or no voltage in circuit 14B, then repair.

Table 22 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 (590B), socket cavity 8C, and ECM2 connector (6021), cavities 1, 2, and IDM2 connector (6011), cavity 10.	(590B), cav. 8C to (6021), cav. 1, 2, and (6011), cav. 10.	<1 ohm each check.	Replace relay.	Locate open or poor connection in circuits 97TA/97CL, 97TA/97CK, or 97TA/97AL, then repair.
24.	Off	At (6011), measure voltage from harness cavity 8 circuit 97LA to ground.	(6011), cav. 8, 97LA to gnd.	12 ± 1.5 volts.	Go to Step 28.	Go to next step.
25.	Off	Remove IDM power relay (590A). At socket cavity 8B, measure voltage from circuit 97LB to ground.	(590A), cav. 8B, 97LB to gnd.	12 ± 1.5 volts.	Go to Step 27.	Go to next step.
26.	Off	Disconnect dash connector (411). At cavity A, measure voltage from circuit 14B/97LB to ground.	(411), cav. A, 14B/97LB to gnd.	12 ± 1.5 volts.	Repair 14B/97LB between (411) and (590A).	Locate cause of low or no voltage in circuit 14B, then repair.
27.	Off	Measure resistance of circuit 97LA between relay (590A), socket cavity 6C, and IDM2 connector (6011), cavity 8.	(590A), cav. 6C to (6011), cav. 8.	< 1 ohm.	Replace relay.	Locate open or poor connection in circuit 97LB, 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 (590A). At socket cavity 6B, measure voltage from circuit 14B/97TC to ground.	(590A), cav. 6B, 14B/97TC to gnd.	12 ± 1.5 volts.	Go to Step 31.	Go to next step.
30.	Off	Disconnect positive battery/ engine harness connector (411) and at circuit 14B, measure voltage to ground.	(411), 14B to gnd.	12 ± 1.5 volts.	Repair 14B between (411) and (590A).	Locate cause of low or no voltage in circuit 14B, then repair.

Table 22 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 (590A), socket cavity 8C, and IDM2 connector (6011), cavities 6 and 12.	(590A), cav. 8C to (6011), cav. 6 and 12.	<1 ohm each check.	Replace relay.	Locate open or poor connection in circuits 97TA/97Y, 97TA/97LD, or 97TA, F40 and 97LC, 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 23 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 99E to ground.	(382), cav. F, 99E to gnd.	12 ± 1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 99E, then repair.
4.	Off	At (382), install jumper from cavity A, circuit 99B to ground. Disconnect ECM2 connector (6021). At cavity 18, measure resistance from circuit 99B to ground.	(6021), cav. 18, 99B to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 99B or dash conn. (3), then repair.

Table 23 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 99A and ground. At (6021) cavity 24, measure resistance of circuit 97W to ground.	(6021), cav. 24, 97WB to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 97W, dash conn. (3), or circuit 97W/99A, then repair.
6.	Off	At (382), move jumper to cavity C, circuit 99J and ground. At (6021) cavity 4, measure resistance of circuit 99C to ground.	(6021), cav. 4, 99C to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 99C, dash conn. (3), or circuit 99C/99J, then repair.
7.	Off	At (382), move jumper to cavity D, circuit 99D and ground. At (6021) cavity 12, measure resistance of circuit 99D to ground.	(6021), cav. 12, 99D to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 99D, or dash conn. (3), 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 (437). Install jumper wire from cavity 1, circuit 97Z to ground. Disconnect ECM2 connector. (6021). At cavity 24, measure resistance of circuit 97W to ground.	(6021), cav. 24, 97W to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 97W, dash conn. (3), or circuit 97W, then repair.
11.	Off	At (437), move jumper wire to cavity 2, circuit 97BL and ground. At (6021) cavity 4, measure resistance of circuit 99C to ground.	(6021), cav. 4, 99C to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 99C, dash conn. (3), or circuit 99C/97BL, then repair.

Table 23 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 97CD and ground. At (6020) cavity 24, measure resistance of circuit 97CD to ground.	(6020), cav. 24, 97CD to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 97CD 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.
15.	Off	Disconnect ATS connector (463). Install jumper wire from cavity B, circuit 97AX to ground. Disconnect IDM2 connector (6011). At cavity 5, measure resistance from circuit 97AX to ground.	(6011), cav. 5, 97AX to gnd.	< 1 ohm	Go to next step.	Locate open or poor connection in circuit 97AX, then repair.
16.	Off	At (463), move jumper to cavity A, circuit 97BU and ground. At (6021) cavity 24, measure resistance of circuit 97W to ground.	(6021), cav. 24, 97W to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 97W/ 97BU, 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 24 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 shifter		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 shifter. 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 24 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 shifter 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 24 Cruise Control/Remote Engine Controls (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
13.	Off	1. Leave J1939 shifter connected		Is the MSM (aka ESC) on the Datalink?	Check the engine's power connections and data link wiring.	Verify shifter 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 24 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 24 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.				

6.4. 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

See Figure 37, Figure 38, Figure 39, Figure 40, Figure 41, Figure 42, Figure 43, Figure 44 and Figure 45.

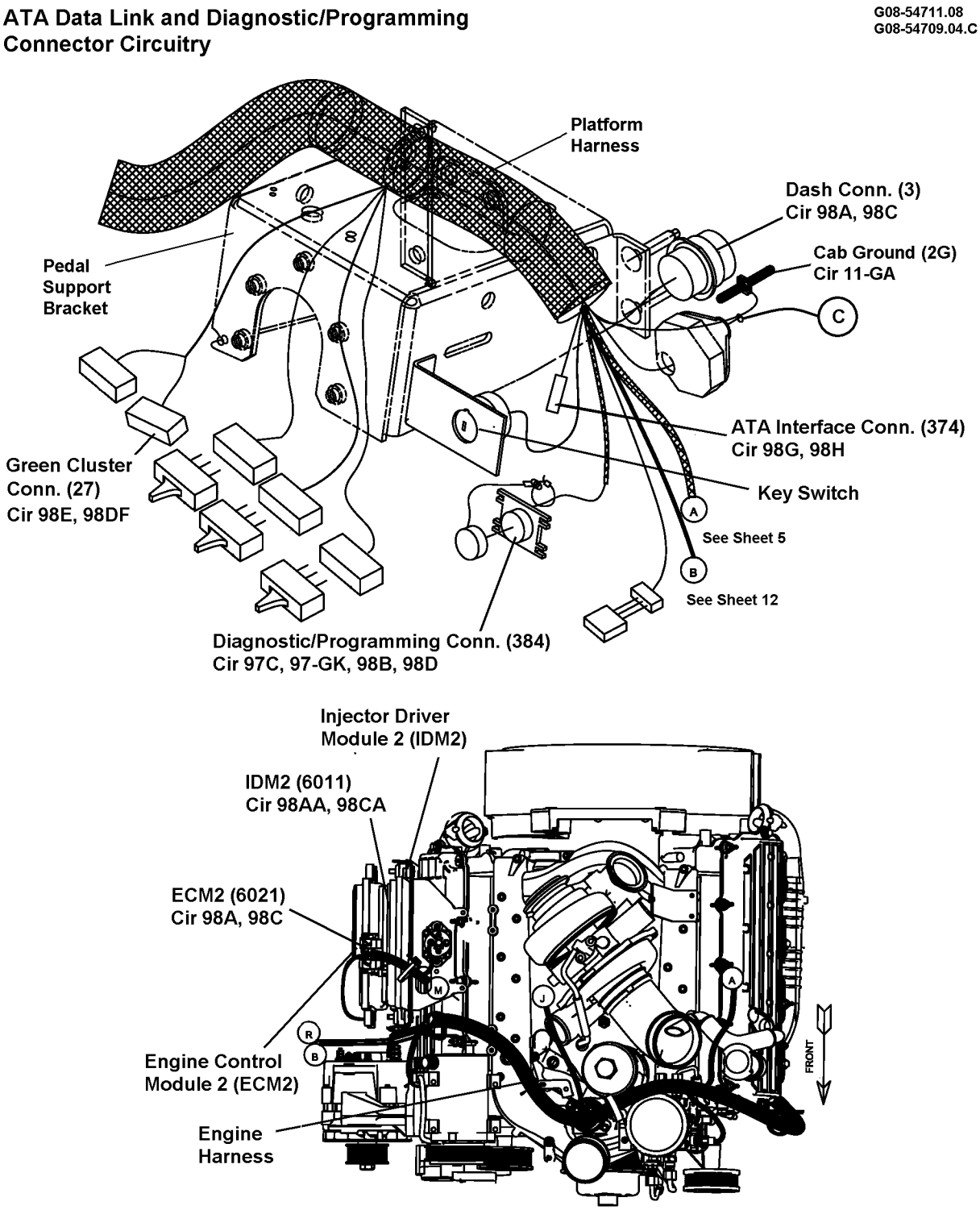


Figure 37 ATA Data Link and Diagnostic/Programming Connector Circuitry

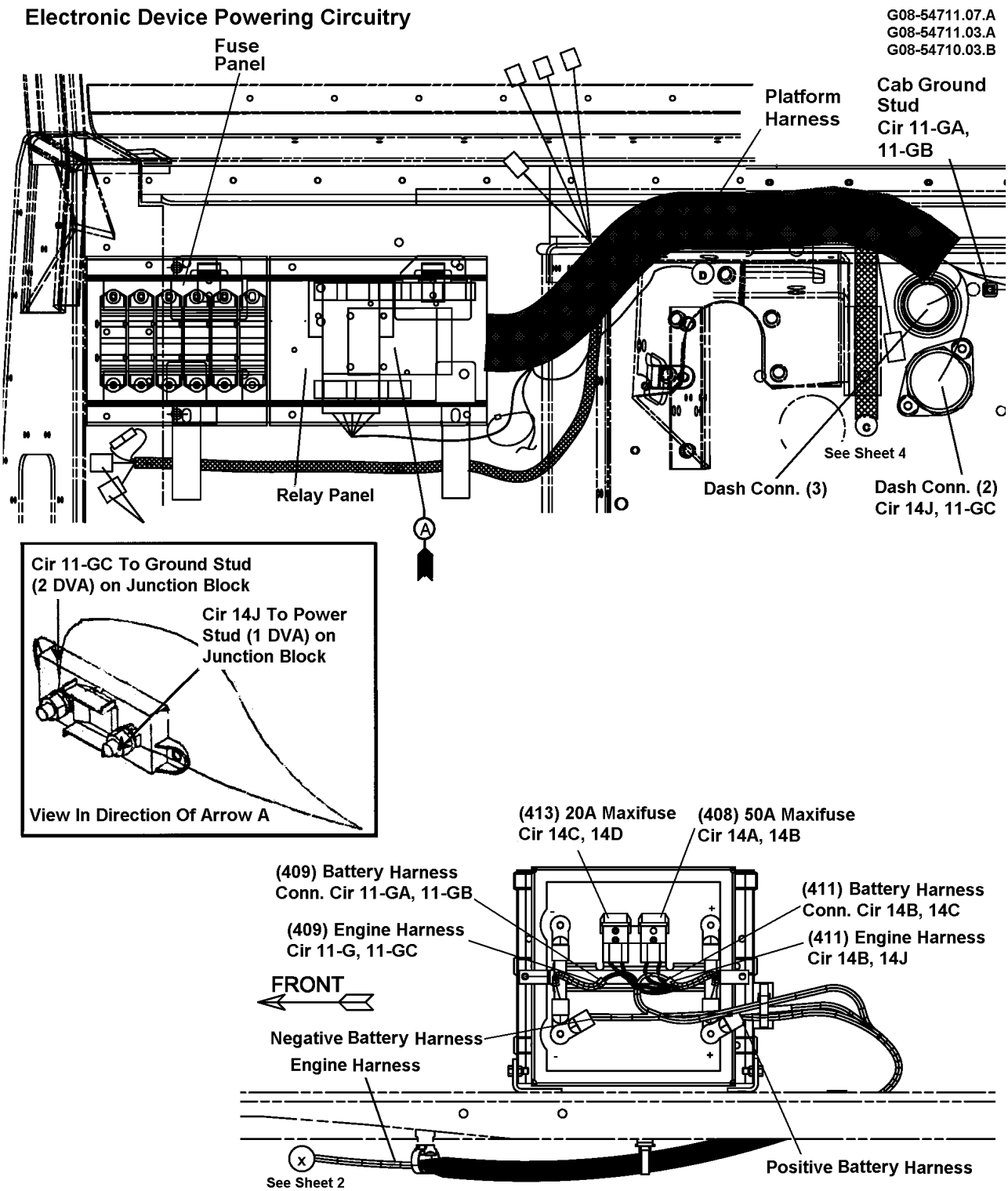


Figure 38 Electronic Device Powering Circuitry

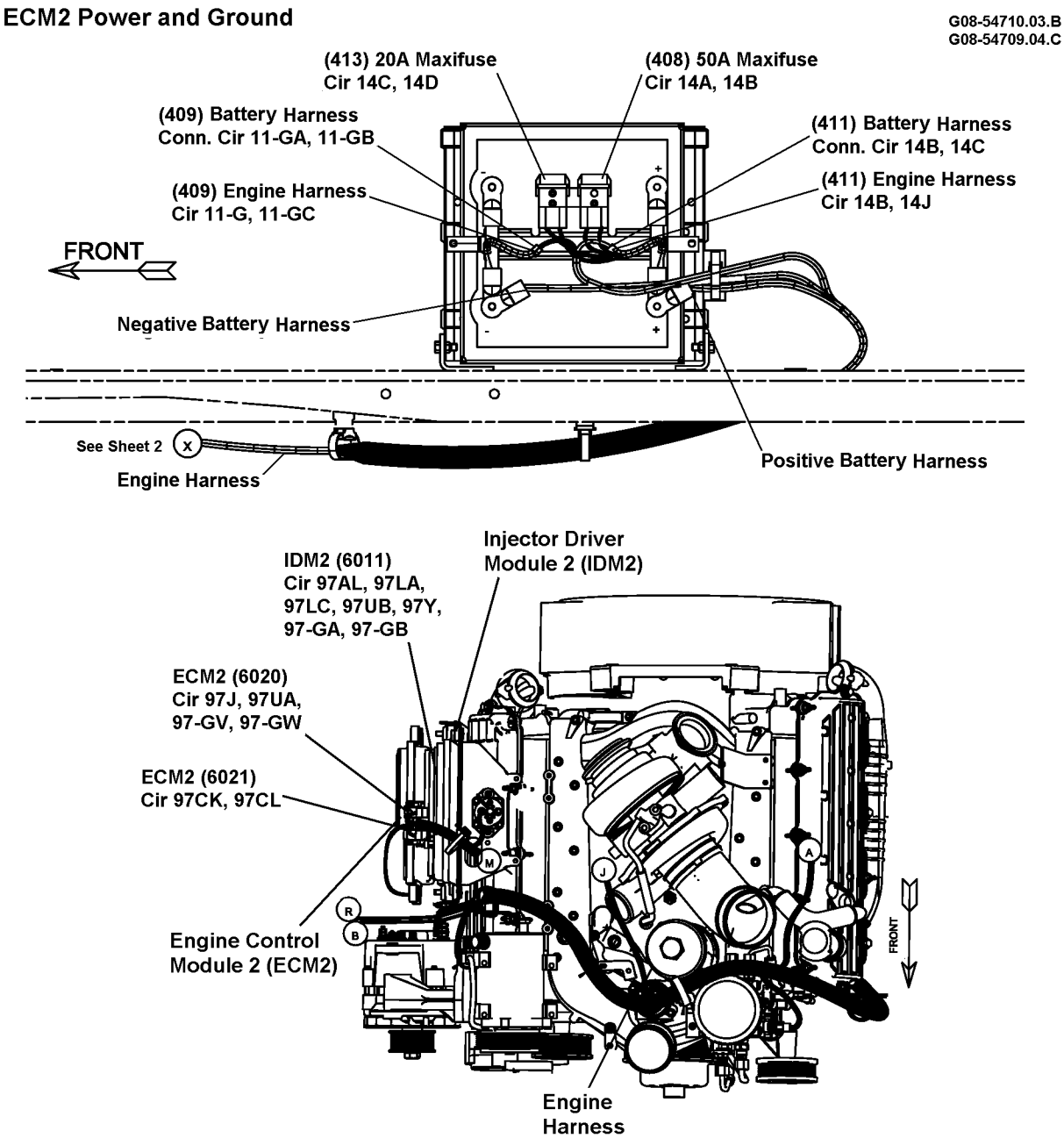


Figure 39 ECM2 Power And Ground Wiring At Battery Harness

ECM2 Power and Ground
- Front Cowl

G08-54709.02.C
G08-54709.01.C

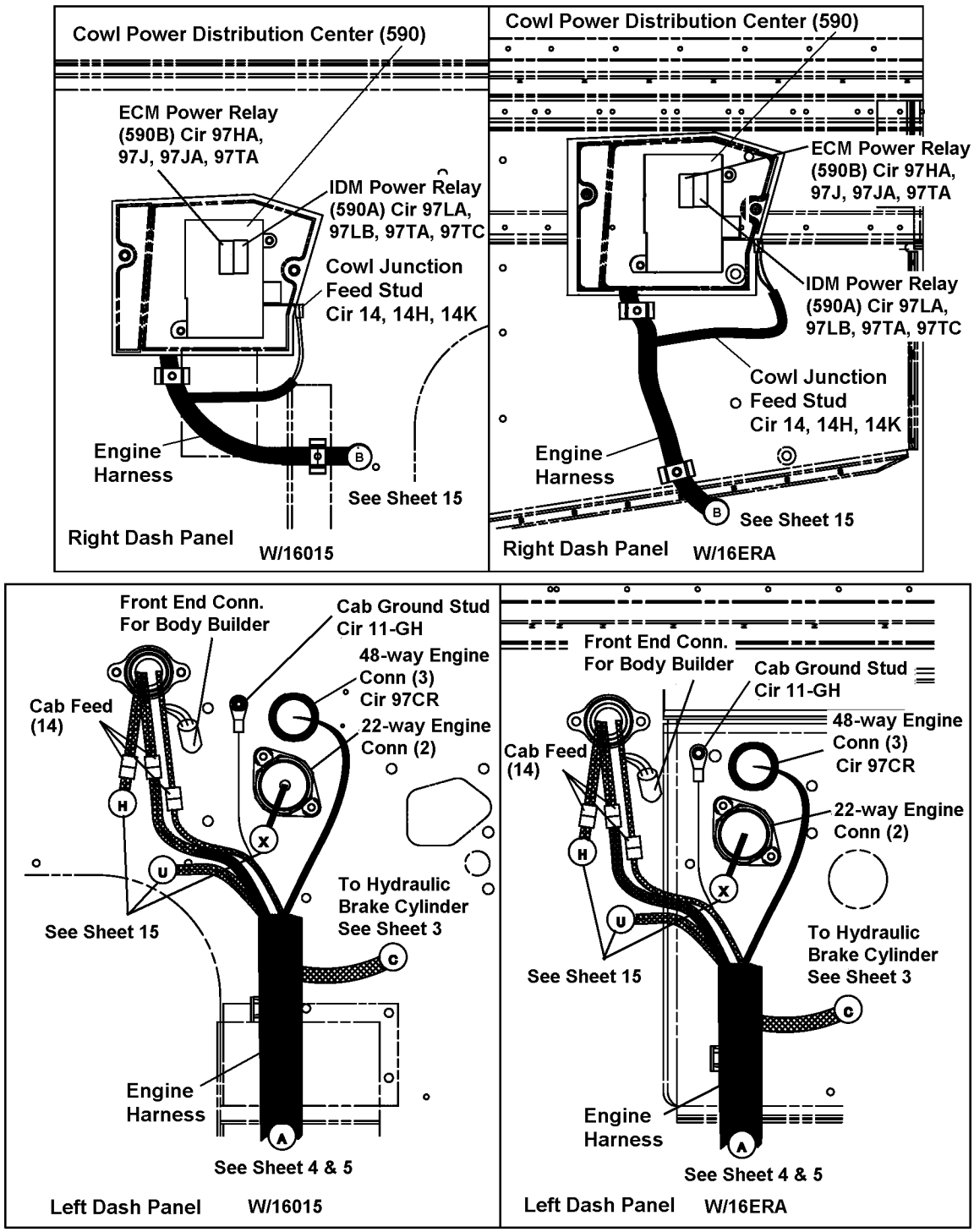


Figure 40 ECM2 Power and Ground — Front Cowl

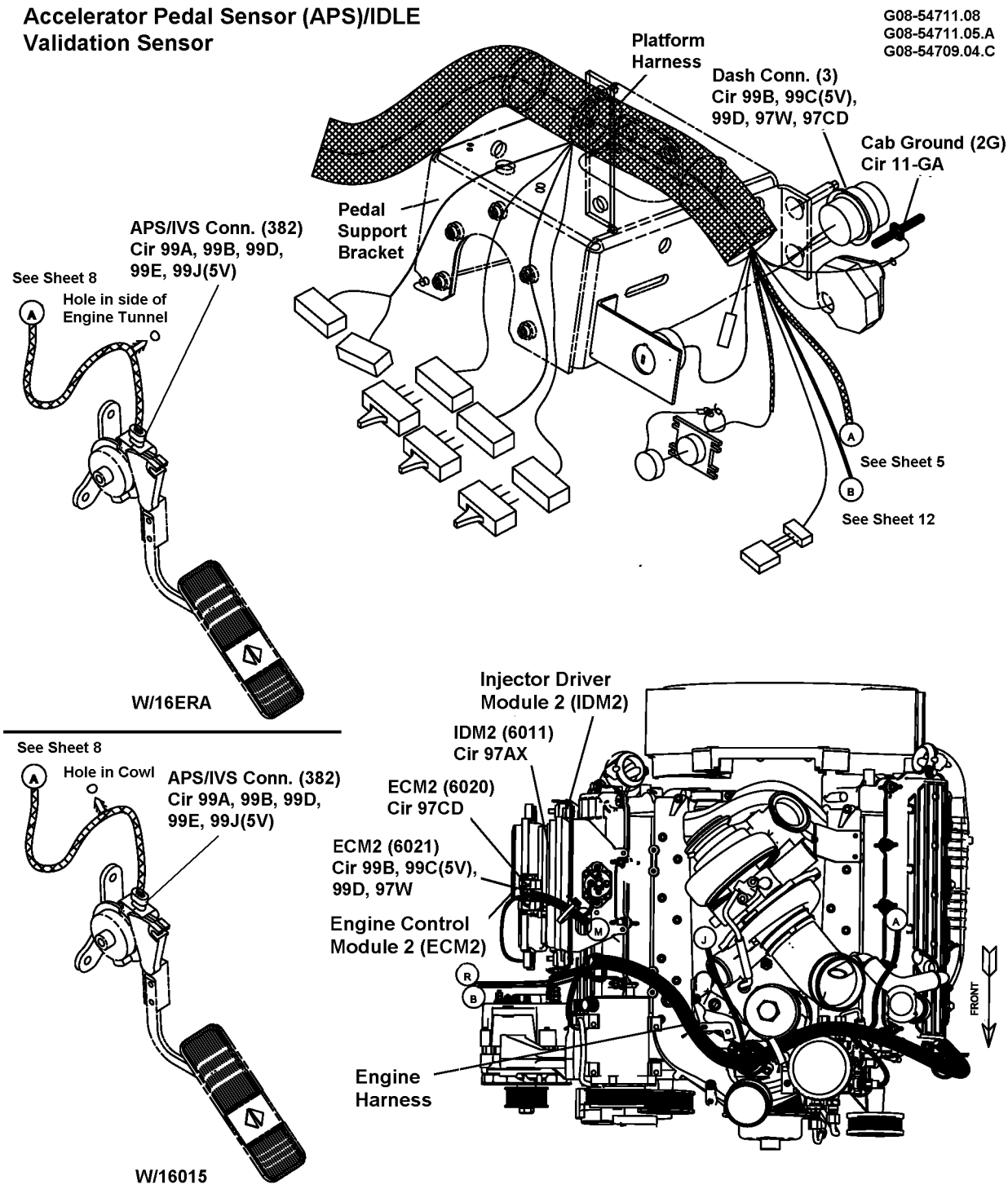


Figure 41 Accelerator Pedal Sensor (APS)/Idle

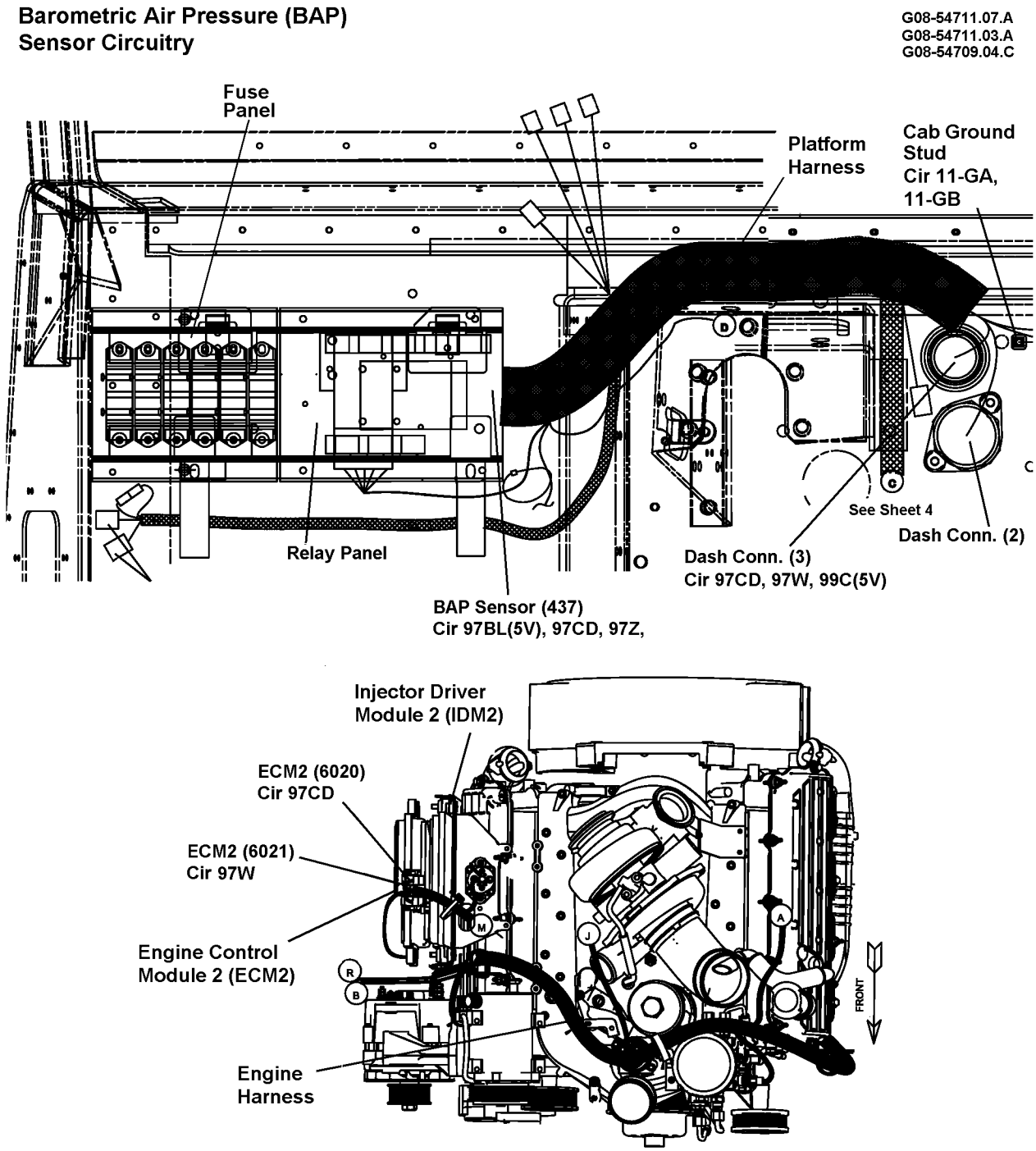


Figure 42 Barometric Air Pressure (BAP) Sensor Circuitry

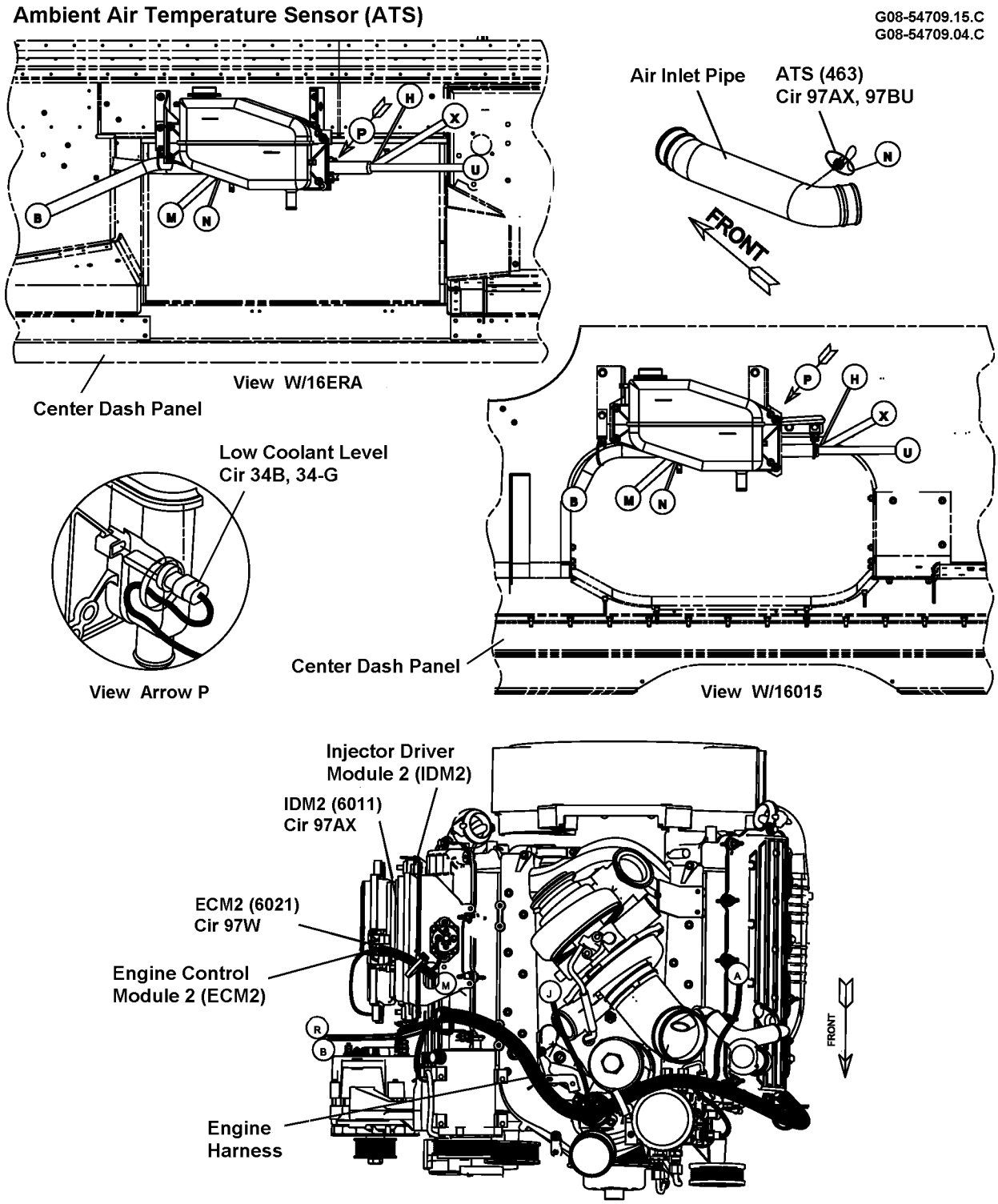


Figure 43 Ambient Air Temperature Sensor (ATS)

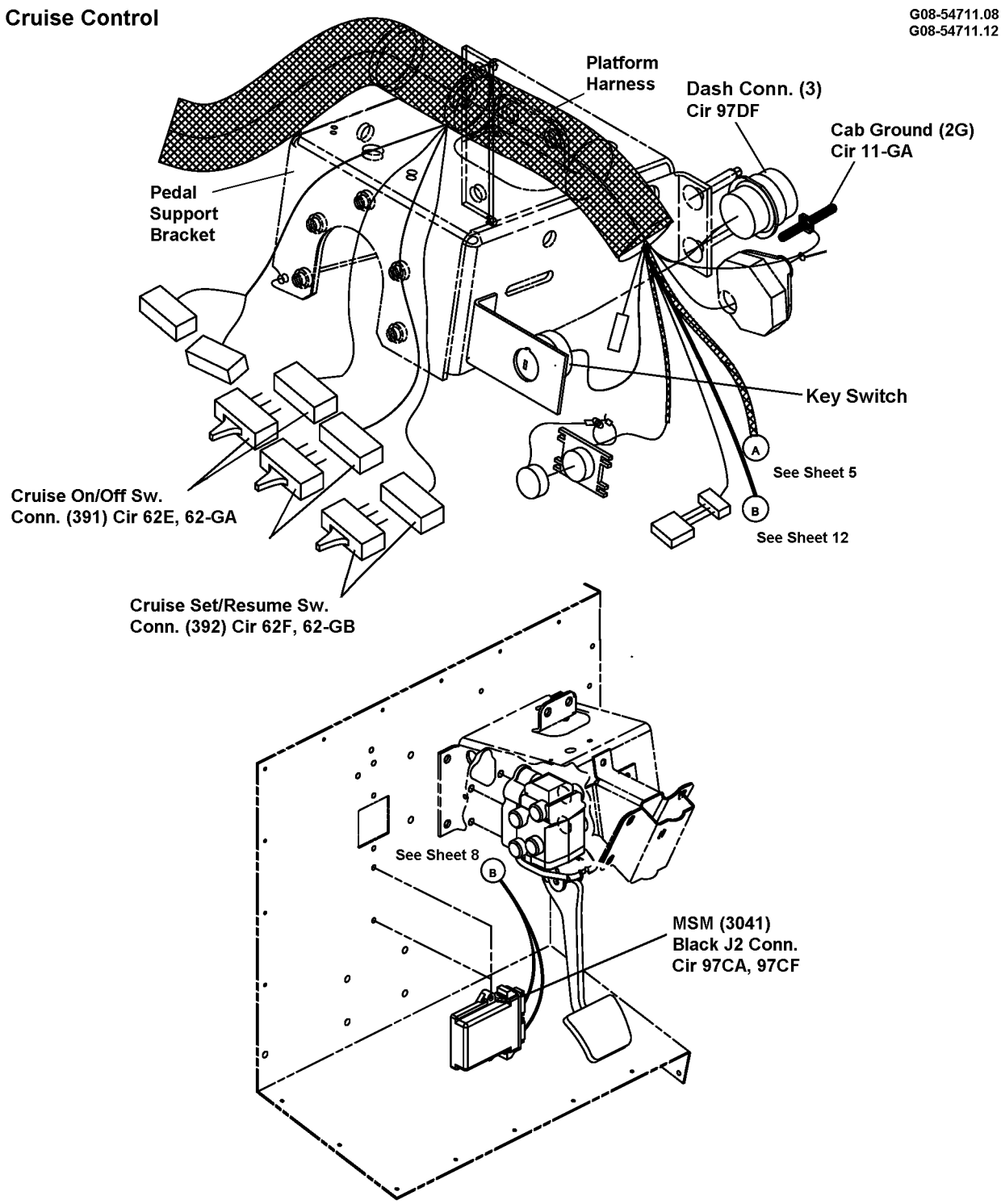


Figure 44 Cruise Control

Remote Engine Control Connector

G08-54709.04.C
G08-54709.02.C

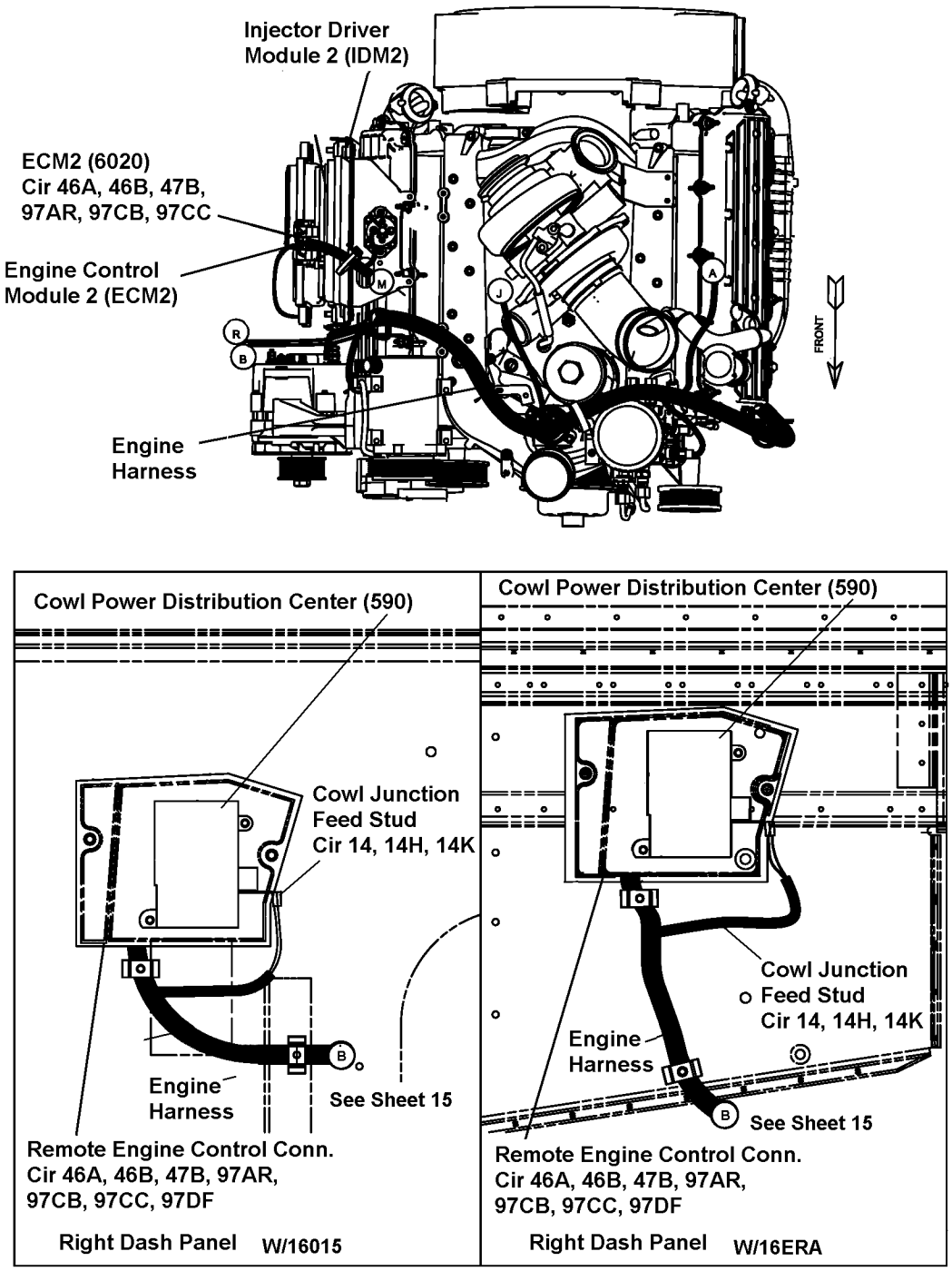


Figure 45 Remote Engine Control Connector

7. MISCELLANEOUS

7.1. DESCRIPTION

In addition to the uncompleted chassis circuits previously covered for the Light Systems in Section 5, a number of other incomplete circuits are also provided depending on standard and optional features selected. These are:

- Heater Blower Motor
- Cargo Lights
- Wiper Controls for Dual Motors
- Freon Compressor Clutch

The body builder needs to complete the circuitry in order for the component to operate.

7.2. OPERATION

OEM Installed Heater Blower Motor Circuitry

Power is supplied through circuit breaker F8 and circuit 75A to the contacts of the blower motor relay (4I). When key switch (63) is in the accessories or on position, power is supplied through the key switch and circuit 12 to fuse F18. Power is applied through the fuse and circuit 75 to the coil of the relay. The relay is grounded through circuit 75–G/11–GB to cab ground (2G). This causes the relay to energize.

With the relay energized, power is applied through the closed contacts and circuit 75C to the body builder connector (589). This connector is provided for use by the body builder to supply the heater fan switch and motor.

OEM Installed Cargo Light Circuitry

Power is supplied to the body builder connector (589) through fuse F5 and circuit 63 for the body builder installed cargo light circuits.

OEM Installed Wiper Control Circuitry For Dual Wiper Motors

Power and ground circuits are provided in the platform harness for completion by the body builder. With the key switch in the accessories or on position, power is supplied to the wiper motor and washer pump controls through fuse F18 and circuit 82 to the body builder connector (589). Ground for the controls is through the body builder connector and circuit 82–G/11–GB to the cab ground (2G).

OEM Installed Freon Compressor Clutch Circuitry

The engine harness provides for power to be supplied through dash connector (2) cavity G and circuit 77F to the freon compressor clutch connector (6200). Ground for the freon compressor clutch is through circuit 77–G to the engine block ground.

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.

OEM Installed Heater Blower Motor Wiring

Table 25 OEM Installed Heater Blower Motor Wiring

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off/ On	Disconnect body builder connector (589). Turn key on and measure voltage from circuit 75C to ground.	(589), 75C to gnd.	12 ± 1.5 volts.	Go to Step 6.	Go to next step.
2.	Off	Disconnect heater relay (4I). Measure resistance of circuit 75C from (4I) to (589).	(4I), 75C to (589).	< 1 ohm.	Go to next step.	Locate open in circuit 75C, then repair.
3.	Off	At (4I), measure voltage from circuit 75A to ground.	(4I), 75A to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open circuit breaker F8. If okay, locate cause of low or no voltage in circuit 75A, then repair.
4.	On	At (4I) measure voltage from circuit 75 to ground.	(4I), 75 to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open fuse F18. If okay, locate cause of low or no voltage in circuit 75, then repair.

Table 25 OEM Installed Heater Blower Motor Wiring (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
5.	Off	At (4I), measure resistance of circuit 75–G to ground.	(4I), 75–G to gnd.	< 1 ohm.	Replace relay.	Locate open or poor connection in circuit 75–G/ 11–GB, then repair.
6.	Off	Reconnect (589) and troubleshoot body builder installed fan switch and fan motor circuitry.				

OEM Installed Cargo Light Circuitry

Table 26 OEM Installed Cargo Light Circuitry

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Disconnect body builder connector (589) and measure voltage from circuit 63 to ground.	(589), 63 to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open fuse F5. If okay, locate cause of low or no voltage in circuit 63, then repair.
2.	Off	Reconnect (589) and troubleshoot body builder installed cargo light circuitry.				

OEM Installed Wiper Control Circuitry for Dual Wiper Motors

Table 27 Installed Wiper Control Circuitry for Dual Wiper Motors

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off/ On	Disconnect body builder connector (589). Turn key on and measure voltage from circuit 82 to ground.	(589), 82 to gnd.	12 ± 1.5 volts.	Go to next step.	Check for open fuse F18. If okay, locate cause of low or no voltage in circuit 82, then repair.

Table 27 Installed Wiper Control Circuitry for Dual Wiper Motors (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
2.	Off	At (589) measure resistance of circuit 82–G to ground.	(589), 82–G to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuits 82–G/ 11–GB, then repair.
3.	Off	Reconnect (589) and troubleshoot body builder installed wiper control circuitry.				

OEM Installed Freon Compressor Clutch Circuitry

Table 28 OEM Installed Compressor Clutch Circuitry

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off/ On	Disconnect freon compressor clutch connector (6200). Turn key switch and air conditioner on and measure voltage from circuit 77F to ground.	Compressor clutch conn. (6200), 77F to gnd.	12 ± 1.5 volts.	Replace freon compressor clutch.	Go to next step.
2.	Off	Disconnect 22–pin dash connector (2) and measure resistance of circuit 77F between (2) and clutch connector (6200).	(2), 77F to (6200).	< 1 ohm.	Go to next step.	Locate open in circuit 77F, then repair.
3.	Off	At (6200), measure resistance of circuit 77–G to ground.	(6200), 77–G to gnd.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuits 77–G/ 11–GB, then repair.
4.	Off	Reconnect (6200) and troubleshoot body builder installed air conditioner control circuitry.				

7.4. COMPONENT LOCATIONS

(2) 22–Way Dash Connector..... At Left Front Cowl, Below Connector (3)
(2G) Cab Ground Stud..... Beside 48-Way Dash Connector (Inside cab)
(4I) Blower Motor Relay Connector..... Inside Cab Fuse/Relay Panel
(63) Key Switch Connector..... Behind Key Switch
(589) Body Builder Connector..... Left Side of Cab Fuse Panel
(6200) Freon Compressor Clutch Connector..... At Freon Compressor

Refer to Figure 46.

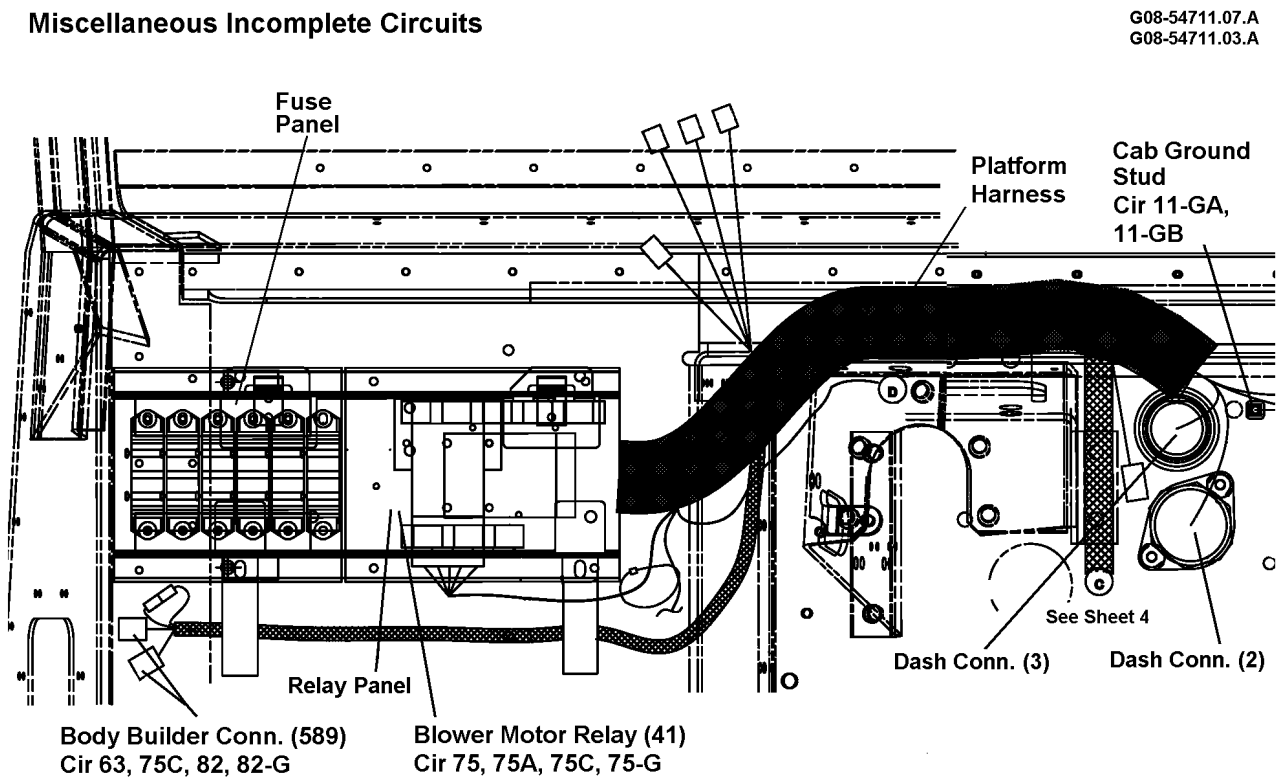


Figure 46 Miscellaneous Incomplete Circuits