SERVICE MANUAL SECTION

Lucas Varity/TRW Hydraulic Antilock Brake System

Truck Model: 1552
Start Date: 03/01/1999

Truck Model: 1652
Start Date: 03/01/1999

Truck Model: 3000 FE
Start Date: 03/01/1999

Truck Model: 3000 RE
Start Date: 03/01/1999

Truck Model: 3400
Start Date: 03/01/1999

Truck Model: 3800
Start Date: 03/01/1999

Truck Model: 4700
Start Date: 03/01/1999

Truck Model: 4900
Start Date: 03/01/1999

Truck Model: IC BUS
Start Date: 03/01/2000

Unit Code: 04083

Vendor: Lucas Varity, TRW

S040393

12/15/2003

Table of Contents

DESCRIPTION

This service section covers operation, diagnostics, troubleshooting, maintenance and component location for the Lucas-Varity Automotive (formerly Kelsey Hayes) EBC 410M hydraulic antilock brake system, used on medium duty trucks.

DESCRIPTION

The Lucas Varity Automotive (formerly Kelsey-Hayes Brake Systems) EBC 410M hydraulic antilock brake system (ABS) is designed to provide the optimum balance between stopping distance and vehicle stability during hard brake maneuvers or when stopping on wet or slippery surfaces.

SYSTEM

The system accomplishes this task by monitoring wheel rotation in order to identify wheel lockup. The wheel information is generated by wheel speed sensors, which are mounted at each wheel. The ABS electronic control unit (ECU) monitors the wheel speed output to identify conditions of wheel lock. When the ECU identifies a wheel which is about to lock, hydraulic pressure is momentarily reduced, allowing the wheel to “recover”.

The ABS is equipped with a warning lamp located in the vehicle instrument cluster. Each time the ignition is turned on the ABS performs a self check. The ABS warning lamp will illuminate and if the ABS passes the self check, the lamp will turn off a few seconds after the ignition is turned on. In the rare event of an ABS malfunction, the warning lamp will illuminate and codes identifying the source of the ABS malfunction will be electronically stored in the ECU. Retrieval of the malfunction codes is explained in the diagnostic section of this manual.

A fault has been detected if the warning lamp does not come on with ignition, fails to go off, or comes on at any other time.

NOTE – If an ABS fault develops, the ABS warning lamp will illuminate, the ABS will be disabled, and the vehicle brake system will simply function as a standard brake system. The standard brake system is still operational, but the anti-lock system will not operate to prevent wheel lock up if the driver over applies the brakes for existing conditions.

WARNING – Antilock brake systems are designed to enhance overall vehicle safety when a vehicle is driven within its normal safety limits. ABS cannot compensate for a vehicle which is being driven beyond the physical limits of control. Drivers operating an ABS equipped vehicle should employ safe driving skills and assume no additional driving risks.

COMPONENTS

Electro-Hydraulic Control Unit

The Electro-Hydraulic Control Unit (EHCU) performs all electronic and hydraulic functions of the ABS. The Electronic Control Unit (ECU) and the Hydraulic Control Unit (HCU) are joined together to form the EHCU. The EHCU is shock mounted to the left side frame rail, behind the rear cab crossmember. It regulates hydraulic pressure in the brake system during an antilock stop.

Electronic Control Unit

The Electronic Control Unit (ECU) is the upper module of the EHCU. It provides all of the electronic control for the EHCU including wheel speed and vehicle speed comparison, fault detection and valve activation.

Hydraulic Control Unit

The Hydraulic Control Unit (HCU) is the lower module of the EHCU. The HCU includes two hydraulic inputs and four outputs. It houses eight solenoid valves, four low pressure sumps, two pump elements and one motor. The HCU responds to instructions from the ECU, controlling the braking at each of the four locations independently.

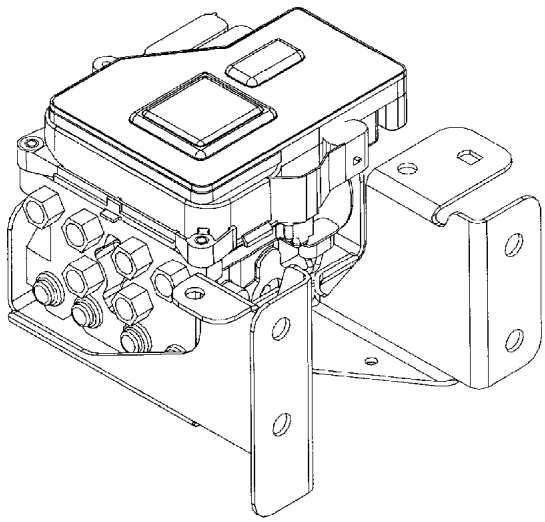


Figure 1 Electro-Hydraulic Control Unit

Wheel Speed Sensors

The wheel speed sensors are a magnetic coil/pickup type sensor. Each wheel speed sensor produces an AC voltage signal which is transmitted to the ECU to indicate how fast the wheel is turning. The speed of the wheel is directly proportional to the frequency of the wheel speed signal. Misadjusted or damaged wheel speed sensor(s) and damaged sensor wiring can cause inaccurate wheel speed signals.

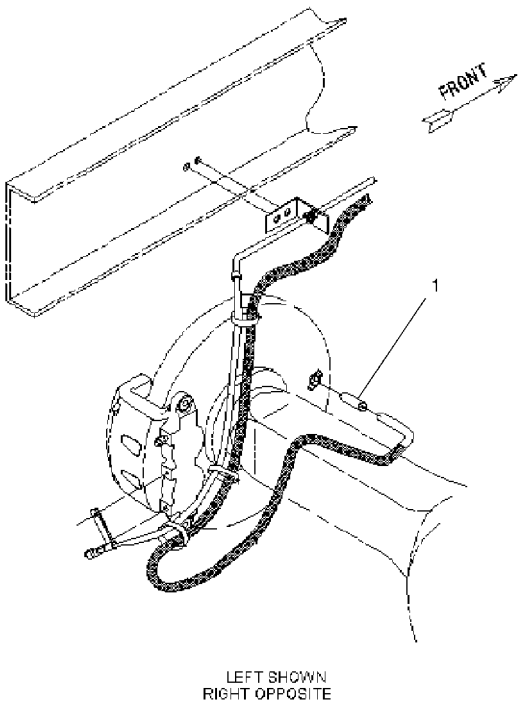


Figure 2 Rear Wheel Speed Sensor

1. WHEEL SPEED SENSOR

Disc Brake Rotor Teeth

The wheel speed sensors work with teeth on the disc brake rotor to produce an AC voltage signal which is used to determine wheel speed. The AC voltage is produced as the teeth pass through the magnetic field of the wheel speed sensor. Broken, missing, or severely corroded teeth can cause an inaccurate wheel speed signal.

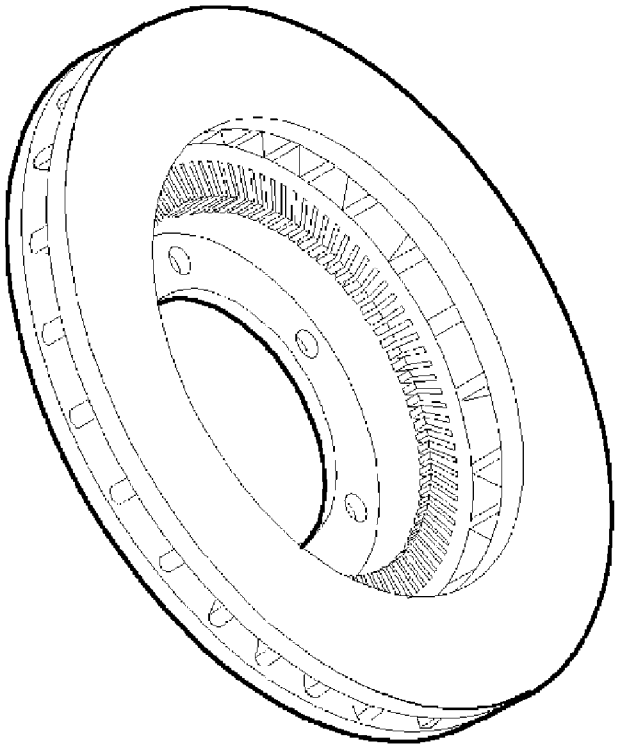


Figure 3 Brake Rotor With Tone Teeth

ABS Indicator Lamp Relay

The ABS lamp relay insures the ABS warning light will come on if there is an open in any circuit feeding the ABS system or if there is a problem with the ABS.

ABS Indicator Lamp

The system uses an amber ABS warning light in the instrument cluster to show system operation and malfunctions. A bulb check occurs each time the ignition switch is turned to the RUN position. The brake warning light and antilock brake light lamps should turn on for about three seconds then turn off. The ABS indicator also indicates system malfunctions. When the ECU detects a malfunction in the system, it turns ABS off and the ABS warning light lamp on.

The lamp may remain on or turn off after the fault is repaired or corrected, depending on the malfunction. To determine the specific cause of the malfunction, refer to the preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17).

Retrieval of the malfunction codes is explained in the diagnostic section of this manual.

Exhaust Brake and Transmission Disabling Circuit

Where applicable, the exhaust brake retarder, transmission retarder and transmission convertor lock-up are disabled when wheel slip occurs. This prevents these features from affecting rear wheel slippage.

OPERATION

NORMAL BRAKING MODE

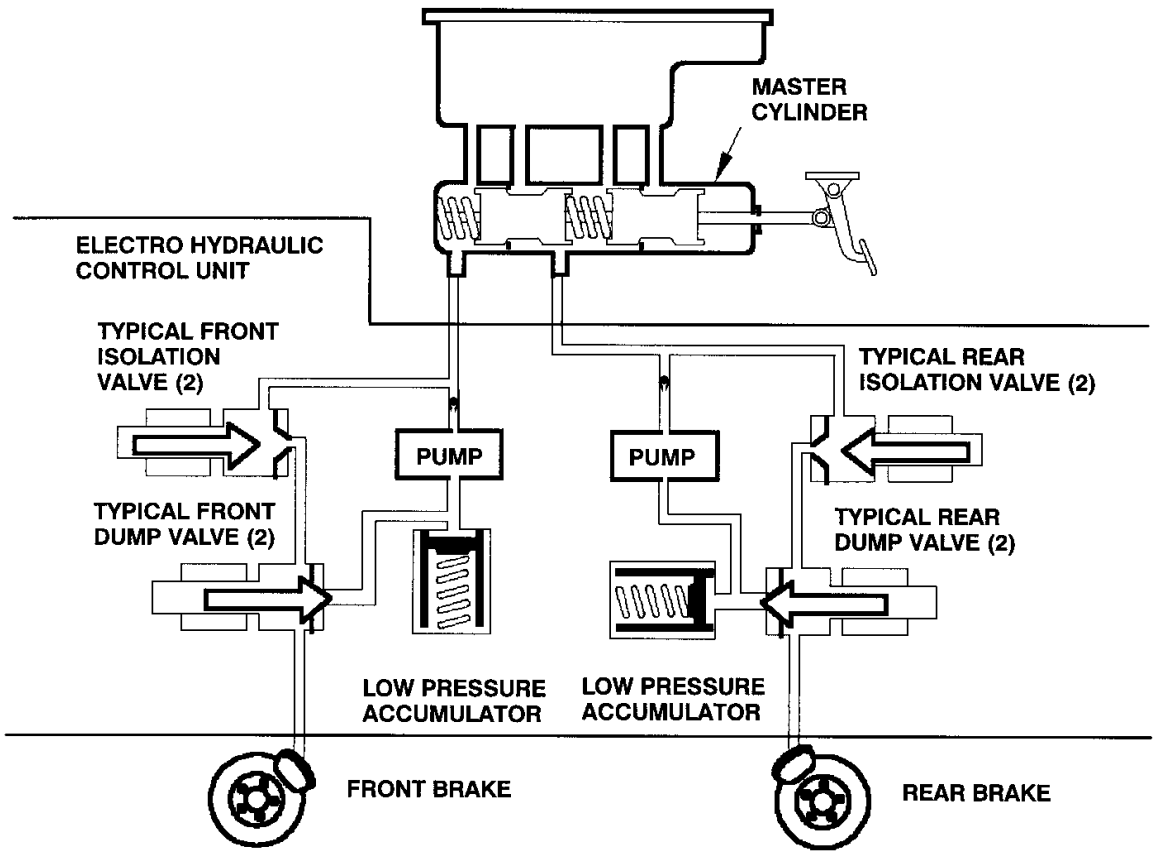


Figure 4 Normal Braking Mode

During normal braking (See Figure 4, page 5), pressure is applied with the brake pedal. Fluid travels through the master cylinder and into the HCU. The fluid travels through the normally open isolation valve, past the normally closed dump valve and out to the wheel cylinders. During normal braking the pump is not turned on. The low pressure accumulators are empty with only residual pressure stored in them. The ECU constantly monitors inputs from the wheel sensors for rapid deceleration. If the ABS system becomes disabled for any reason, the driver will always have regular brakes. The normally open isolation valve and normally closed dump valve will remain in these positions to allow normal fluid pressure to the wheels. The ABS will not activate without seeing brake switch activation and wheel slip. The vehicle must be going at least 10 km/h (6 mph) to begin ABS operation.

ABS BRAKING MODE

The antilock brake system will monitor the four wheel speed sensors and control the hydraulic pressure changes at each wheel until the vehicle has come to a complete stop or the brake pedal has been released.

The system operates through a four step process, which occurs approximately 18 times per second:

- Pressure isolate/maintain

- Pressure decrease
- Pressure increase
- Brake release (fluid return)

Sequence Of Events

1. With the vehicle at 10 km/h (6 mph) or greater, the driver depresses the brake pedal.

2. The brake switch closes and the wheel speeds begin to decrease as the master cylinder pressure and the brake pressure increase.

3. As the wheel speed continues to decrease from the vehicle speed (wheels starting to slip), the normally open isolation valve for the affected channel closes to stop additional pressure to the wheel. Refer to Isolation Mode (See Figure 5, page 7). The master cylinder pressure continues to increase as the driver depresses the pedal. The pressure to the brake is now limited to the ABS system pressure.

4. When the ECU determines the wheel is about to lock up, the normally closed dump valve is opened. Refer to Dump Mode (See Figure 6, page 8). This bleeds off some of the pressure at the caliper to allow the wheel to return to a speed closer to the vehicle speed.

5. The dump valve is again closed and isolation valve remains closed to allow the wheel speed to completely recover from the lock up.

6. Once the wheel has recovered from the lock-up tendency, the isolation valve is momentarily pulsed open to allow the master cylinder pressure and pump pressure to reach the brakes Refer to Re-apply Mode (See Figure 7, page 9). This controlled pressure rise continues until the wheel is at optimum brake output or until the brake pressure is brought up to master cylinder output pressure. The ABS allows the brake fluid to flow to the wheel, to build pressure until the wheels start to slip again, repeating steps 3 through 6. The following paragraphs describe the various modes in more detail.

Isolation Mode (Pressure Maintain)

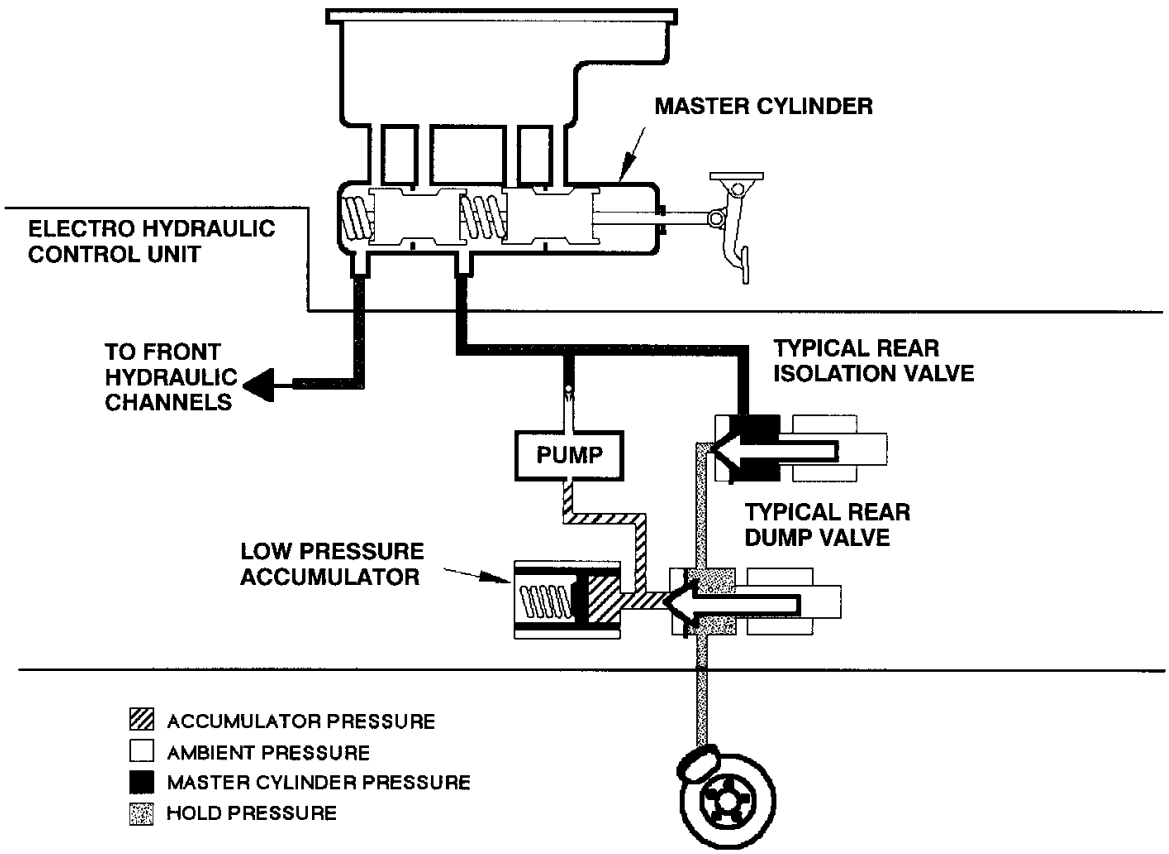


Figure 5 Isolation Mode (Pressure Maintain)

Refer to Isolation Mode (See Figure 5, page 7). The ECU is armed when the driver applies the brakes and sends a signal to the module to prepare for a possible antilock stop. Isolation will occur when the driver applies excessive braking for the given road conditions, causing the wheel(s) to decelerate at a rate greater than the vehicle is capable of. If the information from the wheel speed sensors indicates excessive wheel deceleration (imminent lock-up), the first step in the antilock sequence is to isolate the brake pressure being applied by the driver. The ECU sends a voltage, to the coil, to energize and close the isolation valve by pulling down on the armature with a magnetic force. This will prevent any additional brake pressure from reaching the wheel. Though each channel can operate independently, once any front channel (brake) sees excessive deceleration, both front ISO valves are energized and closed. Thus, with the isolation valves closed, further unnecessary increases in brake pressure will be prohibited.

Dump Mode (Pressure Decrease)

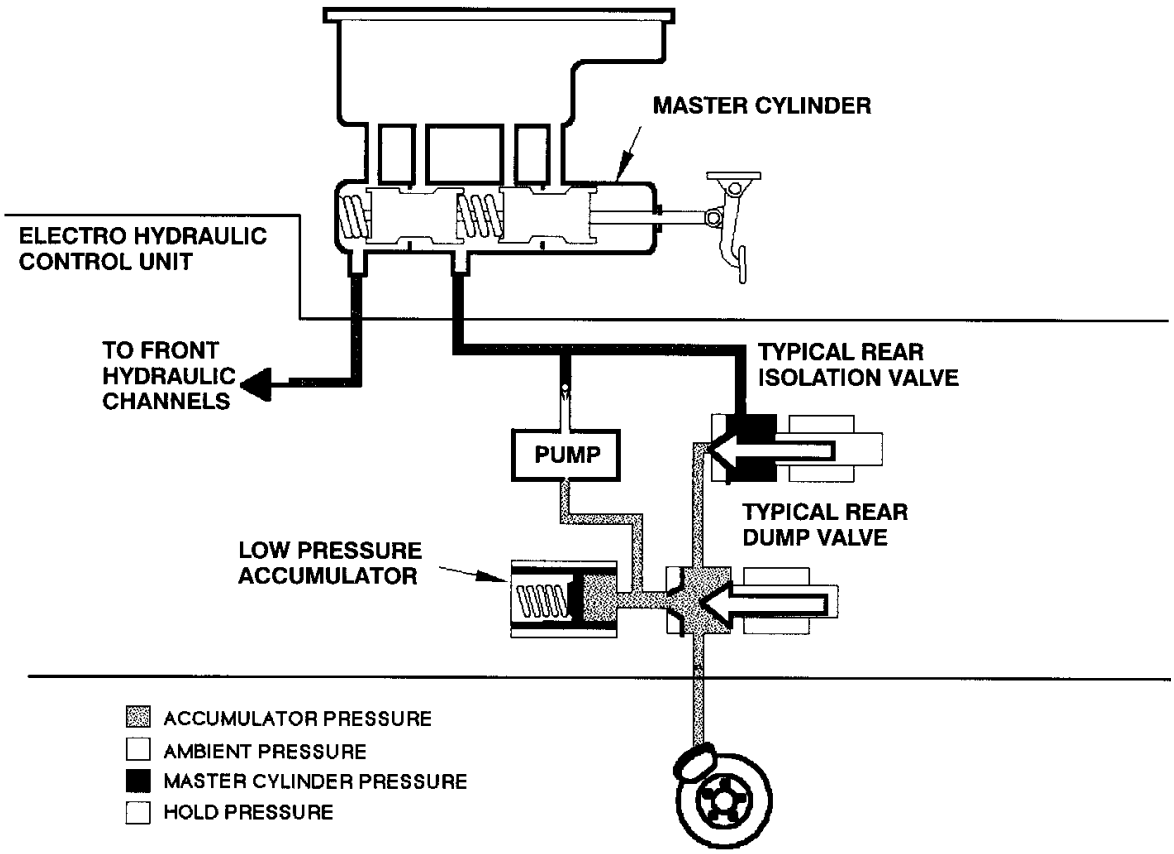


Figure 6 Dump Mode (Pressure Decrease)

Refer to Dump Mode (See Figure 6, page 8). Once the pressure is isolated, the ECU analyzes the wheel speed. If the wheel speed does not recover to the vehicle speed, brake pressure must be reduced in order to get the wheels rolling again. This is accomplished by dumping a portion of the brake fluid pressure into a low pressure accumulator (LPA). The ECU energizes the dump valve coil(s) to open the dump valve, allowing fluid from the wheels to be dumped into the LPA. Very short activation pulses open and close the dump valve passageway to control this action. Brake pressure is lowered at the wheel and allows the affected wheel to roll again. The fluid from the wheels forces a spring back and is stored in the LPA at approximately 1034 kPa (150 PSI). A portion of the fluid also primes the pump so it can begin building re-apply pressure. The dump valves are opened independently to control the deceleration of the wheel.

Re-Apply Mode (Pressure Increase)

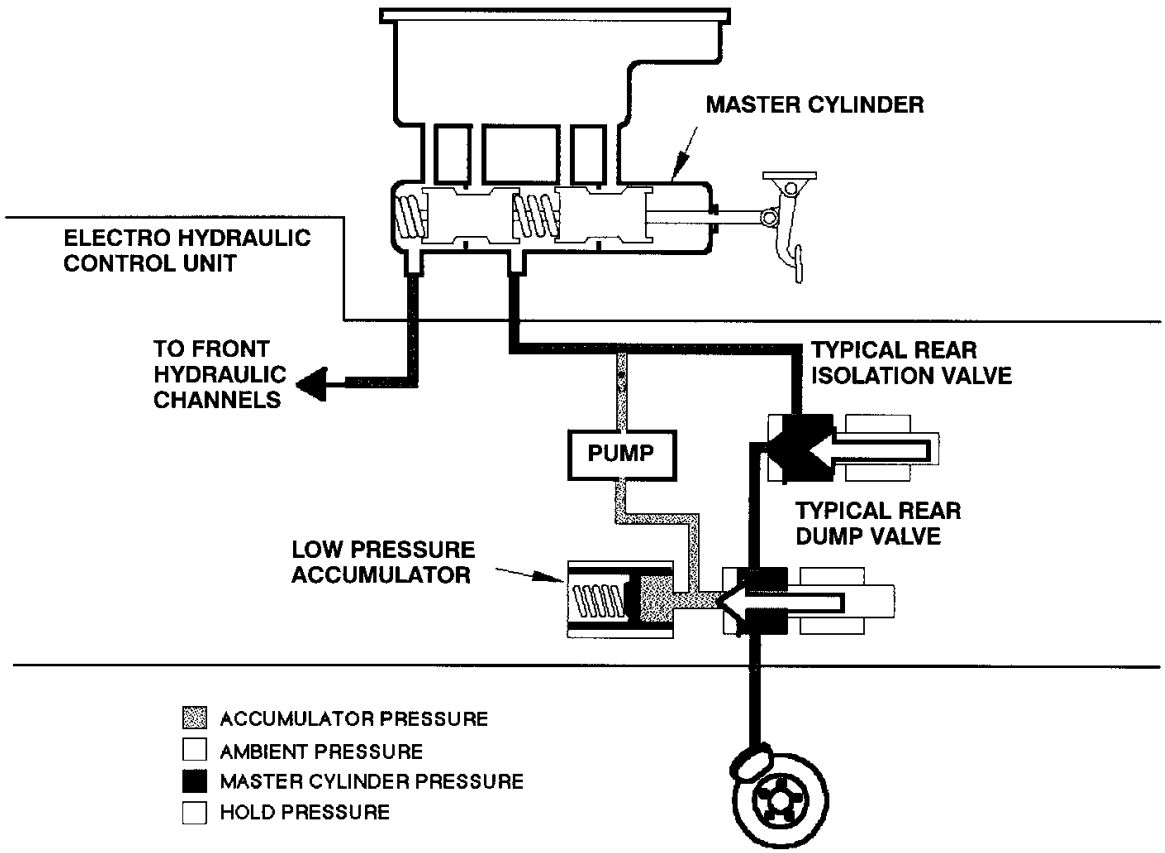


Figure 7 Re-apply Mode (Pressure Increase)

Refer to Re-apply Mode(See Figure 7, page 9). The re-apply sequence is initiated to obtain optimum braking at each wheel. The isolation valve is momentarily pulsed to allow master cylinder and pump pressure to reach the brakes. This controlled pressure rise continues until the wheel is at optimum brake output or until the brake pressure is brought up to the master cylinder output pressure. If more pressure is required, more fluid is drawn from the master cylinder and applied to the brakes. The driver will feel pedal pulsations, or pedal drop. This is normal and expected when in the antilock mode. As fluid is re-applied to the wheels, they begin to slow down at an optimum rate. If they approach imminent lock up again, the module will isolate, dump, and re-apply. These control cycles (isolation, dump, and re-apply) occur in millisecond intervals, allowing several cycles to occur each second. It occurs much faster with more control than manually pumping the brake pedal.

Brake Release

At the end of the antilock stop, when the driver releases the brake pedal, the motor will remain on for a short time to help drain any fluid left in the LPA. As the fluid drains back into the system, the spring force in the LPA pushes the piston to the home position. When the brake switch opens, the isolation valve is turned off and fluid may return through the isolation orifice.

ELECTRICAL CIRCUITS

NOTE – Use the electrical circuit diagram book for your truck model as a reference for the following explanations.

EHCU Power Circuits

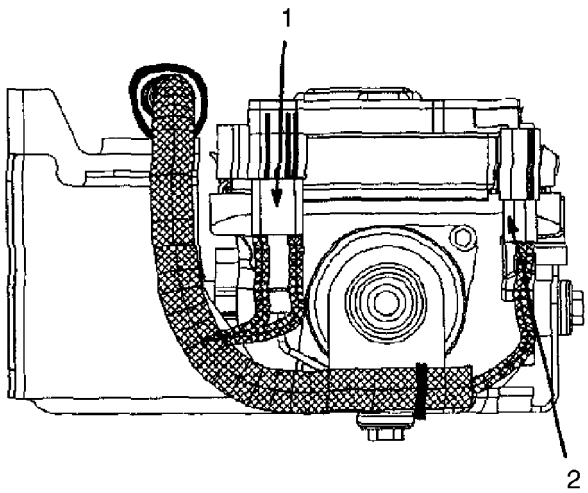


Figure 8 Electrical Connections

1. 2–WAY CONNECTOR (258)
2. 24–WAY CONNECTOR (279)

Ignition power to the ECU is supplied to pin 14 of 24-way connector (279) on circuit 94K with 1000 series models, 94 with the IC bus and circuit 94F with all other models.

Power to the pump motor is supplied on pin B of 2-way connector (258) from a 60 amp maxi fuse on circuit 94A with 3000RE models, circuit 94K or 94K with all other models.

Ground for the entire EHCU is supplied on pin A of 2-way connector (258) from ground on circuit 94-G.

Data Link Circuit

The ECU data link information is supplied on circuit 98J(+) or 98P(+) from connector (279) pin 5 to diagnostic connector (384)/(419), pin D on **6 pin** diagnostic connectors and pin H on **9 pin** connectors.

Brake Switch Circuit

On models other than the 3000FE/RE and IC bus, when the brakes are applied, 12 volts are supplied from stop light switch (51) on circuit 94C to ECU connector (279) pin 15.

On 3000RE models, 12 volts are supplied from brake relay (R3) on circuit 97Y through dash connector (2), on circuit 94C to ECU connector (279) pin 15.

On 3000FE models, 12 volts are supplied from brake switch (209) on circuit 90F to circuit 94C, through dash connector (2) to ECU connector (279) pin 15.

On the IC bus, when the brakes are applied, 12 volts are supplied from hydraulic brake switch (50) on circuit 94C to ECU connector (279) pin 15.

ABS Warning Light Circuit

The ABS indicator is illuminated for a five second bulb check when the ignition is turned on. The lamp also illuminates when ABS is initialized or a fault is detected.

Ignition power for the lamp is supplied on circuit 94F on the IC bus or 94B on all other models.

The ABS indicator is normally on with ground supplied by a ground on circuit 94–GC through the normally closed contacts of the ABS warning light relay (4F) on the 1000 models, (R5) on the 4000 models, (R1) on the 3800 and 4000FBC models or (R4) on the IC bus. The ABS lamp is switched off when the relay is energized by a ground originating from the ECU on pin 7 of connector (279) on circuit 94K on 3000RE models, 94–GA on the IC bus and circuit 94H on all other models. This insures the warning light will always come on if there is an open in any of the circuits feeding the relay coil or a faulty ECU.

When there is a fault, the ECU will light the indicator by applying a ground from pin 1 of connector (279) on circuit 94H with the IC bus and circuit 94A on all other models, to circuit 94E and the ABS warning light.

Left Rear Wheel Speed Sensor Circuit

The AC signal from the left rear wheel speed sensor travels through 2-way connector (293) or (430) on circuits 94LR(H) and 94LR(L) and through 6-way connector (323) pins 1 and 3 to ECU connector (279) pins 9 and 21.

Right Rear Wheel Speed Sensor Circuit

The AC signal from the right rear wheel speed sensor travels through 2-way connector (295) or (432) on circuits 94RR(H) and 94RR(L) to ECU connector (279) pins 8 and 20.

Left Front Wheel Speed Sensor Circuit

The AC signal from the left front wheel speed sensor travels through 2-way connector (289) or (426A) on circuits 94LF(H) and 94LF(L) to ECU connector (279) pins 11 and 23.

Right Front Wheel Speed Sensor Circuit

The AC signal from the right front wheel speed sensor travels through 2-way connector (1004), on the 1000 series trucks, on circuits 94RF(H) and 94RF (L) to ECU connector (279) pins 10 and 22. The signal travels through 2-way connector (292) or (428), on models other than the 1000 series, through connector (1004) on circuits 94RF(H) and 94RF (L) to ECU connector (279) pins 10 and 22.

Retarder Circuits

On 1000 Series models, a 1K ohm resistor is wired from circuit 94F to ECU connector (279) pin 2 on circuit 24H. This resistor simulates the coil of the retarder interrupt relay to prevent the fault code which would result from an open relay coil. It is located in the wire harness, approximately 150mm (6 inches) from the EHCU.

3000 FE/RE models not equipped with an Allison electronic transmission have a 1K ohm resistor jumper on connector (377)/(168) from circuit 24H or 94J to circuit 13J. This resistor simulates the ABS/MD signal ground relay (569).

On 3000FE/RE models equipped with an Allison electronic transmission, during normal operation, the ABS/MD signal ground relay (569) is de-energized and the transmission retarder is not disabled. When the ABS is activated, a ground from the ECU on pin 2 of connector (279) will energize the relay and disable the transmission retarder. This prevents these features from interfering with ABS function.

3400, 3800, 4000 and 4000FBC models not equipped with retarder(s) have a 1K ohm resistor jumper on connector (377) from circuit 24H to circuit 13J. This resistor simulates the coil of the retarder interrupt relay to prevent the fault code which would result from an open relay coil.

On 3400, 3800, 4000 and 4000FBC models equipped with retarder(s), during normal operation, the retarder interrupt relay (286) is de-energized and there is no break in the signal path of the retarder circuits. When the ABS is activated a ground from the ECU on pin 2 of connector (279) will energize the relay and break the signal path of the retarder circuits. This will disable the exhaust brake, transmission retarder or engine brake, if equipped. This prevents these features from interfering with ABS function.

IC bus models not equipped with an Allison electronic transmission have a 1K ohm resistor jumper on connector (377) from circuit 94J to circuit 92. This resistor simulates the ABS/MD signal ground relay (569).

On IC bus models equipped with an Allison electronic transmission, during normal operation, the ABS/MD signal ground relay (569) is de-energized and the transmission retarder is not disabled. When the ABS is activated, a ground from the ECU on pin 2 of connector (279) will energize the relay and disable the transmission retarder. This prevents these features from interfering with ABS function.

DIAGNOSTICS

ELECTRONIC SERVICE TOOLS

EZ-Tech™

The International EZ-Tech (EST), with the appropriate software and interface cable, can be used to read or clear any diagnostic trouble codes (DTCs) and monitor many of the system switches and operating parameters.

See the appropriate EZ-Tech Users Guide for instructions on EZ-Tech use.

MPSI PRO-LINK 9000™

The PRO-LINK 9000 (EST), with the Lucas - Varity Hydraulic ABS cartridge and the appropriate interface cable, can be used to read or clear DTC codes and monitor many of the system switches and operating parameters.

Refer to the PRO-LINK 9000 manual for information on using the EST.

PRELIMINARY INSPECTION

When servicing the ABS, the following steps should be followed in order. Failure to follow these steps may result in the loss of important diagnostic data and may lead to difficult and time consuming diagnostic procedures:

1. Perform a preliminary diagnostic inspection. This should include:

   - Inspection of the master cylinder fluid reservoir for proper fluid levels and signs of leaks.
   - Inspection of the EHCU for any leaks or wiring damage.
   - Inspection for loose or damaged wheel bearings that may allow a wheel to wobble.
   - Inspection of the wheel speed sensor and speed sensor wiring.
   - Verification that tires meet legal tread depth requirements.

2. Perform the preliminary system check found in this section. If any diagnostic trouble codes (DTCs) are displayed, note the last malfunction that occurred. Diagnose and repair this malfunction first.

3. If no DTCs or mechanical component malfunctions are present, or if the failure is intermittent and not reproducible, test drive the vehicle while using the automatic snapshot feature of the EZ-Tech. Perform normal acceleration, stopping and turning maneuvers. If this does not reproduce the malfunction, perform an ABS stop, on a low coefficient surface such as gravel, from approximately 48-50 km/h (30-50 mph) while triggering the snapshot mode on any ABS DTC.

4. Once all system malfunctions have been corrected, clear the ABS DTCs and test drive the vehicle.

SELF DIAGNOSTICS

The ECU performs self-diagnostics of the ABS and can detect and isolate system failures. It will also perform certain features when commanded.

When a malfunction is detected, the ECU sets a DTC. The DTC must be read using the EZ-Tech or PRO-LINK 9000. There are no provisions for “Flash Code” DTCs. The DTCs in the ECU memory can only be erased by using the EZ-Tech or PRO-LINK 9000. DTCs cannot be cleared by unplugging the ECU, disconnecting the battery cables, or turning off the ignition. Be sure to verify proper system operation and absence of DTCs when the clearing procedure is completed.

The ECU will store the active DTCs and can hold up to eight inactive DTCs. The older inactive codes are lost as new inactive codes are stored.

Two features are available from the ECU only upon specific command from the EZ-Tech or PRO-LINK 9000:

- The “Zero-Speed System Test” or “Dealer’s Bleed Test” is used by service personnel to exercise the HCU valves when troubleshooting and bleeding the system.
- System reset is used to clear the DTCs.

FAIL-SAFE OVERVIEW

System fault monitoring is accomplished in the ECU. If a system fault is detected, including faults in the ECU itself, the ABS warning lamp will illuminate and braking will revert to the normal braking mode.

Fail-safe response to faults is set in one of three ways:

- Permanent latched
- Ignition latched
- Condition latched

Permanent latched faults cannot be cleared with the EZ-Tech or PRO-LINK 9000. The ECU must be replaced to restore the ABS to service.

Ignition latched faults will clear when the Ignition is switched off then on. The fault will remain in history until cleared with the EZ-Tech or PRO-LINK 9000.

Condition latched faults clear as soon as the condition causing the fault ceases to exist. The fault will remain in history until cleared with the EZ-Tech or PRO-LINK 9000.

SYMPTOM AND DIAGNOSTIC TROUBLE CODE TABLE

Table 1 Symptom and Diagnostic Trouble Code

DTC	SYMPTOM AND DESCRIPTION	TROUBLE-SHOOTING SECTION
None	No Communication With ECU	5.2
None	ABS Warning Light Constantly Off	5.3
None	ABS Warning Light Constantly On, No DTCs	5.4
21	Right Front Wheel Speed Sensor Circuit Open	5.5
22	Right Front Wheel Speed Sensor Signal Missing	5.6
23	Right Front Wheel Speed Sensor Signal Erratic	5.7
25	Left Front Wheel Speed Sensor Circuit Open	5.8
26	Left Front Wheel Speed Sensor Signal missing	5.9
27	Left Front Wheel Speed Sensor Signal Erratic	5.10
31	Right Rear Wheel Speed Sensor Circuit Open	5.11
32	Right Rear Wheel Speed Sensor Signal Missing	5.12
33	Right Rear Wheel Speed Sensor Signal Erratic	5.13
35	Left Rear Wheel Speed Sensor Circuit Open	5.14
36	Left Rear Wheel Speed Sensor Signal Missing	5.15
37	Left Rear Wheel Speed Sensor Signal Erratic	5.16
38	Wheel Speed Mismatch	5.17
41-58	Isolation Or Dump Solenoid Circuit Open Or Shorted	5.18
65	Open Relay Circuit / Missing Battery From Relay Input	5.19
66	Shorted Relay Circuit	5.20
67	Open Motor Circuit Or Shorted ECU Output	5.21
68	Locked (Stalled) Motor Or Open ECU Output	5.22
69	Excessive Dump Time	5.23
71-73	ECU Memory Errors/Circuitry Errors	5.24
74	Excessive Isolation Time	5.25
81	Stuck Brake Switch	5.26
86	ABS Warning Light Circuit Failure	5.27
87	Retarder Output Fault Detection (Open or Short to Ground or Battery)	5.28

CONNECTOR PIN-OUTS

EBCM 24–WAY CONNECTOR (279)

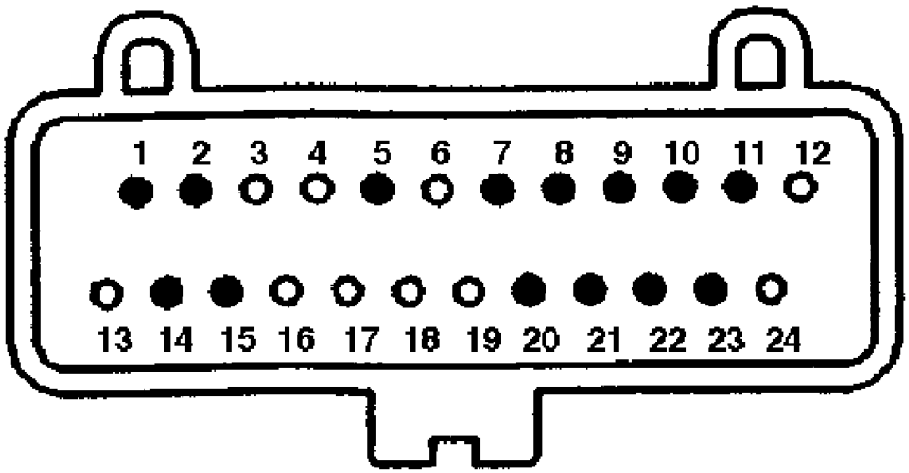


Figure 9 EBCM 24–way Female Harness Connector (279)

Table 2 EBCM 24–WAY CONNECTOR (279)

Terminal	Ckt. No.	Circuit Description
1	94A (94H on IC bus)	ABS WARNING LAMP
2	24H (94J on IC bus)	WHEEL SLIP SIGNAL OUTPUT
3		NOT USED
4		NOT USED
5	98J(+), 98P(+) on 3000RE	SERIAL DATA
6		NOT USED
7	94H (94–GA on IC bus)	ABS WARNING LAMP RELAY OUTPUT
8	94RR (H)	RIGHT REAR WHEEL SPEED SENSOR INPUT
9	94LR (H)	LEFT REAR WHEEL SPEED SENSOR INPUT
10	94RF (H)	RIGHT FRONT WHEEL SPEED SENSOR INPUT
11	94LF (H)	LEFT FRONT WHEEL SPEED SENSOR INPUT
12		NOT USED
13		NOT USED
14	94F (94 on IC bus)	SWITCHED IGNITION POWER
15	94C	BRAKE SWITCH INPUT
16		NOT USED

Table 2 EBCM 24–WAY CONNECTOR (279) (cont.)

Terminal	Ckt. No.	Circuit Description
17		NOT USED
18		NOT USED
19		NOT USED
20	94RR (L)	RIGHT REAR WHEEL SPEED SENSOR GROUND
21	94LR (L)	LEFT REAR WHEEL SPEED SENSOR GROUND
22	94RF (L)	RIGHT FRONT WHEEL SPEED SENSOR GROUND
23	94LF (L)	LEFT FRONT WHEEL SPEED SENSOR GROUND
24		NOT USED

EBCM 2–WAY CONNECTOR (258)

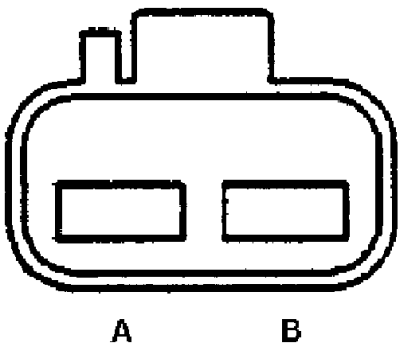


Figure 10 EBCM 2–way Female Harness Connector (258)

Table 3 EBCM 2–WAY CONNECTOR (258)

Terminal	Ckt. No.	Circuit Description
A	94-G	PUMP/LOGIC GROUND
B	94J (94K on the IC bus)	PUMP MOTOR POWER

TROUBLESHOOTING

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

B. Before beginning these test procedures, check any light or indicator lamp filaments that are suspected of being open (burned out). This is done to avoid unnecessary extensive circuit checks.

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

D. When the 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.

PRELIMINARY SYSTEM CHECK

The preliminary system check is an organized approach to identifying an Antilock Brake System (ABS) malfunction. It must be the starting point for any ABS complaint diagnosis because it directs the service technician to the next logical step in diagnosing the complaint. Serial data is transmitted/received by the ECU connector (279) terminal 5. The ECU is supplied switched ignition voltage through connector (279) pin 14 and ground through connector (258) terminal B.

NOTE – Insure the 60 amp. maxi fuse and the ABS ignition fuse(s) are not blown.

Follow the EZ-Tech or PRO-LINK 9000 instructions to verify data is being received by the EZ-Tech or PRO-LINK 9000.

Excessive resistance in the ground or power supply circuits will not allow communication with the ECU. If communication with the ECU is not possible, ensure the ABS ground connection is good and that there is no excessive resistance in any of the power supply circuits.

IMPORTANT – When probing connectors be careful not to damage or overexpand terminals. This could cause loose connections in the future.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 4 Preliminary System Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Insure the 60 amp. maxi fuse and the ABS ignition fuse(s) are not blown.		Fuses are not blown.	Go to next step.	Repair condition causing fuse to blow and replace fuse.
2.	Off/ On	Turn the ignition off for 10 seconds, then turn the ignition to run. Does the ABS warning light go on for 5 seconds, then go off and remain off?		ABS warning light comes on for 5 seconds.	Lamp is operating normally. ABS has no faults.	Go to next step.

Table 4 Preliminary System Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
3.	On	Is the ABS warning light off constantly? (Failed to perform bulb check.)		ABS warning light failed bulb check.	Go to ABS Warning Light Constantly Off. (See ABS WARNING LIGHT CONSTANTLY OFF, page 21)	Go to next step.
4.	Off/ On	Verify all ECU connectors are properly connected. Install the EZ-Tech or PRO-LINK 9000. Turn ignition to run. Using the EZ-Tech or PRO-LINK 9000, attempt to communicate with the ECU. Is data being received from the ECU?		Data is received from the ECU.	Go to next step.	Go to No Communication With ECU. (See NO COMMUNICATION WITH ECU, page 18)
5.	On	Using the EZ-Tech or PRO-LINK 9000, check for any DTC(s). Are any active or history DTCs displayed?		DTCs displayed.	Go to next step.	Go to Step 8.
6.	On	DTCs displayed?		DTCs displayed?	Go to trouble shooting table for displayed DTC. (See Table 1, page 14)	Go to next step.
7.	On	Does the lamp come on and stay on when there are no DTC's displayed?		Warning light comes on and stays on, no DTCs.	Go to ABS Warning Light Constantly On, No DTCs. (See ABS WARNING LIGHT CONSTANTLY ON, NO DTCS, page 23)	ABS is functioning properly.

NO COMMUNICATION WITH ECU

Communication problems with the ECU can be caused by a malfunctioning service tool, an open data link circuit, an open or short in the power circuits to the ECU, or a faulty ECU.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 5 No Communication With ECU

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	On	If data is not being received by the EZ-Tech or PRO-LINK 9000, the fault may reside in the cable, or the EZ-Tech or PRO-LINK 9000 may be malfunctioning. Check the EZ-Tech or PRO-LINK 9000 for good connections. Check EZ-Tech or PRO-LINK 9000 with another vehicle.	EZ- Tech or PRO-LINK 9000 connections and operation.	Good con-nections and cables. Function-ing EZ-Tech or PRO-LINK 9000.	Go to next step.	Replace cables, secure connections or replace the EZ-Tech or PRO-LINK 9000. Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17).
2.	Off	If data is not being received by the EZ-Tech or PRO-LINK 9000, there may be a problem in the datalink circuit. Disconnect EZ-Tech or Pro-Link 9000. Remove ECU connector (279). Measure the resistance from connector (279) terminal 5 and ground.	Conn. (279) term. 5 and ground.	Open	Go to next step.	Locate short in circuit 98J(+) or circuit 98P(+) to ground. Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17)
3.	Off	Measure the resistance between connector (279) terminal 5 and (384)/(419) terminal D on **6 pin** diagnostic connectors or (384)/(419) terminal H on **9 pin** diagnostic connectors.	Conn. (279) term. 5 and (384)/(419) terminal D on **6 pin** diagnostic connectors or (384)/(419) terminal H on **9 pin** diagnostic connectors.	< 1 ohm.	Data- link circuits check good. Go to next step.	Locate open in circuit 98J(+) or circuit 98P(+). Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17)

Table 5 No Communication With ECU (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
4.	Off/ On	Turn the ignition off and disconnect the 2-way ECU harness connector (258). Turn the ignition to run. Measure the voltage between terminal B of the harness connector and ground. Is the voltage within the specified range?	ECU 2-way harness conn. (258) term. B and ground.	12±1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 94J or 94K (94A with the 3000RE). Check 60 amp. maxifuse for open condition. Check circuit from starter. Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17)
5.	Off	Measure the resistance between terminal A of connector (258) and chassis ground. Is the resistance within the specified range?	Between conn. (258) term. A and chassis ground.	< 1 ohm.	Go to next step.	Repair open or high resistance in ground circuit 94-G to the ECU. Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17)
6.	Off/ On	Turn the ignition off and disconnect the 24-way ECU harness connector (279). Turn the ignition to run. Measure the voltage between terminal 14 of the harness connector and ground. Is the voltage within the specified range?	ECU 24-way harness conn. (279) term. 14 and ground.	12±1.5 volts.	Go to next step.	Locate cause of no or low voltage in circuit 94F, (94K or 94F with 1000 series) or 94 on the IC bus. Check ABS fuse. Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17)
7.	Off	Inspect the ECU terminals and the harness connector terminals for good terminal contact. Inspect the battery terminals and cable for good connection. Are contacts or connections in good condition?		Good terminals or contacts.	If no other cause for the malfunction can be found, replace the ECU.	Replace terminals or repair poor connection. Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17).

ABS WARNING LIGHT CONSTANTLY OFF

The ABS warning light is normally on (voltage supplied through the normally closed contacts of the ABS lamp relay), unless the ABS lamp relay is switched off by the ECU. This insures that the warning light will always be turned on if there is an open in any of the circuits or if the ECU is faulty. To turn the lamp off (after the bulb check) the ECU supplies a ground to energize the coil in the ABS lamp relay and open the contacts. If the ABS warning light is off constantly, there is an open or short to voltage in the lamp circuit between the instrument panel and the ABS lamp relay ground (this includes the ABS warning light relay contacts). Also check for an open instrument panel fuse or an open bulb.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 6 ABS Warning Light Constantly Off

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	Off	Check for an open instrument panel circuit breaker or fuse.		Circuit breaker or fuse not open.	Go to next step.	Identify cause of open circuit breaker or fuse. Reset circuit breaker or replace fuse. Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17)
3.	Off	Check for a burned out warning light.		Warning light not burned out.	Go to next step.	Replace warning light. Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17)
4.	Off/ On	Turn key to ignition position. Measure voltage between terminal A of the warning light connector cavity A and ground.	Warning light connector cavity A and ground.	12±1.5 volts.	Go to next step.	Locate cause of low or missing voltage on circuit 94B or 94F to the warning light connector. Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17)

Table 6 ABS Warning Light Constantly Off (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
5.	Off	Disconnect the ABS warning light relay. Bench check the relay. (See BENCH TESTING RELAYS, page 68)	ABS warning light relay.	Bench check good.	Go to next step.	Replace the malfunctioning ABS warning light relay. Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17)
6.	Off/ On	Use a jumper wire to connect cavity E of the relay connector to chassis ground. Turn ignition to on. Does the warning light turn on?		Warning light turns on	Go to next step.	Locate open in circuits between the relay and the warning light. Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17)
7.	Off	Remove the jumper. Measure the resistance between the ABS warning light relay cavity D and ground.	ABS warning light relay cavity D and ground.	< 1 ohm.	Go to next step.	Repair the open in the circuit 94-GB (94–GC on the IC bus). Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17)
8.	Off/ On	Turn key to ignition position. Measure the voltage between the ABS warning light relay connector, cavity B and ground.	ABS warning light relay, cavity B and ground.	12±1.5 volts.	Re-install relay. Go to next step.	Repair the open or short in the circuit 94D, then repair. Reconnect connectors. Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17)
9.	Off/ On	Disconnect the 24-way ECU harness connector (279). Turn the ignition on. Does the warning light illuminate?		Warning light illumin-ates.	If no other cause for the malfunction can be found, replace the ECU.	Go to next step.

Table 6 ABS Warning Light Constantly Off (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
10.	Off	Remove the warning light relay again. Measure the resistance between cavity A, at the relay connector, and chassis ground.	ABS warning light relay connector, cavity A and chassis ground.	Open.	Go to next step.	Repair the short in circuit 94H (94–GA on the IC bus). Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17)
11.	Off/ On	Reconnect the 24 way ECU harness connector and ABS warning light relay. Turn ignition to on. Does the warning light turn on, then off after bulb check?		ABS warning light turns off after bulb check.	ABS warning light circuits test good. Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)	Go to preliminary system check.

ABS WARNING LIGHT CONSTANTLY ON, NO DTCS

The ABS warning light is normally on (voltage supplied through the normally closed contacts of the ABS lamp relay) unless the lamp relay is switched off by the ECU. This insures that the warning light will always be turned on if there is an open in any of the circuits or if the ECU is faulty. To turn the lamp off (after the bulb check) the ECU supplies a ground to energize the ABS indicator light relay and open the contacts.

If the ABS warning light is on constantly, with no DTCs present, the ECU may be sending a false fault signal or the ABS indicator relay may not be energizing (no power, bad ground, missing signal from ECU, or an open in the circuit).

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 7 ABS Warning Light Constantly On, No DTCs

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	Off	Disconnect the ABS warning light relay. Bench check the relay. (See BENCH TESTING RELAYS, page 68)	ABS warning light relay.	Bench check good.	Go to next step.	Replace the ABS warning light relay. Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17)

Table 7 ABS Warning Light Constantly On, No DTCs (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
3.	Off/ On	Turn the ignition on. Measure the voltage between ABS warning light relay socket cavity B and ground.	ABS warning light relay socket cavity B and ground.	12±1.5 volts.	Leave relay out. Go to next step.	Locate cause of no or low voltage in circuit 94D, then repair. Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17)
4.	Off/ On	Disconnect the 24 way ECU harness connector (279). Turn the ignition on. Does the indicator lamp turn off?		Warning light turns off.	If no other cause for the malfunction can be found, replace the ECU.	Go to next step.
5.	Off	Measure the resistance between relay socket cavity E and chassis ground.	Relay socket cavity E and chassis ground.	Open.	Go to next step.	Repair the short to ground in circuit 94A (94H on the IC bus), to the warning light relay, or 94E, to the warning light. Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17)
6.	Off	Use a jumper wire to connect connector (279) cavity 7 to chassis ground. Measure the resistance between cavity A of the relay socket and chassis ground.	Connector (279) cavity 7 and chassis ground.	< 1 ohm.	Remove jumper and go to next step.	Repair the open in circuit 94H (94–GA on the IC bus). Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17)

Table 7 ABS Warning Light Constantly On, No DTCs (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
7.	Off	Measure the resistance between relay socket cavity E and chassis ground.	Relay socket cavity E and chassis ground.	Open.	Go to next step.	Repair the short to ground in circuit 94A (94H on the IC bus), to the warning light relay, or 94E, to the warning light. Return to preliminary system check (See PRELIMINARY SYSTEM CHECK, page 17)
8.	Off/ On	Reconnect all connectors. Turn ignition to on. Does the ABS indicator go off after the bulb check?		Indicator goes off after bulb check.	ABS warning light circuits check good. Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17).	Go to preliminary system check.

(DTC 21) RIGHT FRONT WHEEL SPEED SENSOR CIRCUIT OPEN

This DTC is set when there is no output from the wheel sensor for 1.0 second or there is excessive resistance for 1.0 second. When this DTC sets, the ABS is disabled and will remain disabled as long as the condition exists. The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech or PRO-LINK 9000. An intermittent malfunction may be caused by a poor connection, worn insulation or a broken wire inside the insulation. Any circuitry suspected of causing the DTC should be thoroughly checked for electrical discontinuity, physical damage and corrosion.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 8 (DTC 21) Right Front Wheel Speed Sensor Circuit Open

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)

Table 8 (DTC 21) Right Front Wheel Speed Sensor Circuit Open (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
2.	Off	Disconnect the right front wheel sensor harness connector from the wheel speed sensor pigtail. Measure the resistance between the terminals of the right front wheel speed sensor pigtail. Is the resistance correct?	Both terminals of the right front wheel speed sensor pigtail.	2025-2475 ohms.	Go to next step.	Replace right front wheel speed sensor. Go to Step 5.
3.	Off	Jumper both terminals of the 2-way wheel speed sensor harness connector. Measure the resistance between terminals 10 and 22 of the ECU harness connector (279). Is the resistance correct?	Terminals 10 and 22 of the wiring harness connector.	< 1 ohm.	Go to next step.	Repair open or high resistance in affected circuits. Go to Step 5.
4.	Off	Inspect the ECU connector terminals 10 and 22 for poor contacts or corrosion.		No evidence of damage or corrosion.	Go to next step.	Make necessary repairs. Go to next step.
5.	Off	Inspect the wheel speed sensor for chafing.		No evidence of chafing.	Go to next step.	Make necessary repair.
6.	Off/ On	Reconnect all connectors. Clear all DTCs with the EZ-Tech. Test drive vehicle above 10 mph. Does DTC 21 set as a current DTC?		DTC 21 does not set as a current DTC.	Malfunction has been repaired or is intermittent.	Call International Tech Central for approval to send in ECU.

(DTC 22) RIGHT FRONT WHEEL SPEED SENSOR SIGNAL MISSING

This DTC is set when the wheel sensor signal is low while the vehicle is traveling faster than 8 mph or a sudden change in sensor speed from 0 to >6 mph. When this DTC sets, the ABS is disabled and will remain disabled until the ignition is turned off (even if the cause is intermittent). The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech or PRO-LINK 9000. An intermittent malfunction may be caused by a backed-out sensor, damaged or severely corroded rotor teeth, a poor connection, chafed sensor wire, worn insulation or a broken wire inside the insulation. Any circuitry suspected of causing the DTC

should be thoroughly checked for electrical discontinuity, physical damage and corrosion. If the intermittent condition only occurs during humid conditions all wheel speed circuitry should be tested for salt water intrusion. Spray the suspected area with a salt water solution. Drive the vehicle above 15 mph for at least 30 seconds. If the DTC returns immediately, replace the suspect harness.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 9 (DTC 22) Right Front Wheel Speed Sensor Signal Missing

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	Off	Inspect the wheel speed sensor to tone ring gap for evidence of excessive gap		Sensor gap < 0.050 inch.	Go to next step.	Push sensor in completely by twisting and pushing.
3.	Off	Inspect the right front wheel speed sensor, sensor wire and connectors for signs of damage, chafing, or corrosion. Inspect the brake rotor for missing and/or heavily corroded teeth. Any deviation will affect the wheel speed sensor output signal. Is there evidence of damage?		No evidence of damage.	Go to next step.	Make necessary repairs.
4.	Off	Disconnect the right front wheel speed sensor harness connector from the wheel speed sensor pigtail. Measure the resistance between terminals of the right front wheel speed sensor pigtail connector. Is the resistance correct?	Terminals of the wheel speed sensor pigtail.	2025- 2475 ohms.	Go to next step.	Replace the right front wheel speed sensor. Go to Step 9.

Table 9 (DTC 22) Right Front Wheel Speed Sensor Signal Missing (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
5.	Off	Using an EZ-Tech® measure the A/C voltage generated between terminals of the right front wheel speed sensor pigtail while spinning the wheel at approximately 3 to 4 mph. Is the voltage correct?	Terminals of right front wheel speed sensor pigtail.	480 mV. min.	Go to next step.	Replace the right front wheel speed sensor. Go to Step 9.
6.	Off	Disconnect the 24-way ECU harness connector from the ECU. Measure the resistance between terminals 10 and 22 of the harness connector.	Terminals 10 and 22 of the harness connector.	Open.	Go to next step.	Repair short between circuits. Go to Step 9.
7.	Off	Reconnect the right front wheel speed sensor. Measure the resistance between terminal 10 of the harness connector and ground.	Terminal 10 of the harness connector and ground.	Open.	Go to next step	Repair short between circuits and ground. Go to Step 9.
8.	Off	Measure the resistance between terminal 22 of the harness connector and ground.	Terminal 22 of the harness connector and ground.	Open.	Go to next step.	Repair short between circuits and ground. Go to Step 9.
9.	Off	Inspect the 24-way ECU harness connector terminals 10 and 22 for poor contact or corrosion.		No evidence of damage or corrosion.	Go to next step.	Make necessary repairs.
10.	Off	Inspect suspension components and wheel bearings for excessive wear and/or play		No evidence of wear or damage.	Go to next step.	Make necessary repairs.
11.	Off/ On	Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Test drive vehicle over 10 mph. Does DTC 22 set as an active DTC?		DTC 22 does not set as an active DTC.	Malfunction has been repaired or is intermittent.	Call International Tech Central for approval to send in ECU.

(DTC 23) RIGHT FRONT WHEEL SPEED SENSOR SIGNAL ERRATIC

This DTC is set when the right front sensor output is suddenly prevented from toggling while vehicle speed is above 12 mph (brakes off) or 20 mph (brakes on or in antilock mode in the last second). When this DTC sets, the ABS is disabled for as long as the condition exists (for a single occurrence) or will remain disabled until the ignition is turned off (for three or more occurrences). The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech or PRO-LINK 9000. An intermittent malfunction may be caused by a backed out sensor, worn bearings, a warped rotor, damaged rotor teeth, a poor connection, chafed sensor wire, worn insulation or a broken wire inside the insulation. Any circuitry suspected of causing the DTC should be thoroughly checked for electrical discontinuity, physical damage and corrosion.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 10 (DTC 23) Right Front Wheel Speed Sensor Signal Erratic

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	Off	Inspect the wheel speed sensor to tone ring gap for evidence of excessive gap.		Sensor gap < 0.050 inch.	Go to next step	Push sensor in completely by twisting and pushing.
3.	Off	Inspect the right front wheel speed sensor, sensor wire and connectors for signs of damage, chafing, or corrosion. Inspect the brake rotor for missing and/or heavily corroded teeth. Inspect for warped rotor. Any deviation will affect the wheel speed sensor output signal. Is there evidence of damage? Inspect for warped rotor		No evidence of damage.	Go to next step.	Make necessary repairs. Go to Step 7.

Table 10 (DTC 23) Right Front Wheel Speed Sensor Signal Erratic (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
4.	Off	Disconnect the wheel speed sensor from the harness pigtail connector. Measure the resistance between terminals of the right front wheel speed sensor pigtail. Is the resistance correct?	Terminals of right front wheel speed sensor pigtail.	2025- 2475 ohms.	Go to next step.	Replace wheel speed sensor. Go to Step 7.
5.	Off	Disconnect the 24 way ECU harness connector (279) from the ECU and inspect for damage. Inspect the wheel speed sensor harness and sensor harness connector for signs of damage or corrosion. Are all connections complete?		No evidence of damage or corrosion.	Go to next step.	Make necessary repairs. Go to Step 7.
6.	Off	Reconnect the wheel speed sensor to the harness pigtail. Measure the resistance between terminals 10 and 22 of the ECU wiring harness connector. Is the resistance correct?	Terminals 10 and 22 of the wiring harness connector.	2025- 2475 ohms.	Repair open or high resistance in the affected circuits. Go to Step 7.	Go to next step.
7.	Off	Inspect the 24-way ECU harness connector terminals 10 and 22 for poor contact or corrosion.		No evidence of damage or corrosion.	Go to next step.	Make necessary repairs. Go to next step.

Table 10 (DTC 23) Right Front Wheel Speed Sensor Signal Erratic (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
8.	Off	Inspect suspension components and wheel bearings for excessive wear and/or play.		No Evidence of wear or damage.	Go to next step.	Make necessary repairs.
9.	Off/ On	Reconnect all connectors. Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Test drive vehicle over 10 mph. Does DTC 23 set as an active DTC?		DTC 23 does not set as an active DTC.	Malfunction has been repaired or is intermittent.	Call International Tech Central for approval to send in ECU.

(DTC 25) LEFT FRONT WHEEL SPEED SENSOR CIRCUIT OPEN

This DTC is set when there is no output from the wheel sensor for 1.0 second or there is excessive resistance for 1.0 second. When this DTC sets, the ABS is disabled and will remain disabled as long as the condition exists. The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech® or PRO-LINK 9000. An intermittent malfunction may be caused by a poor connection, worn insulation or a broken wire inside the insulation. Any circuitry suspected of causing the DTC should be thoroughly checked for electrical discontinuity, physical damage and corrosion.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 11 (DTC 25) Left Front Wheel Speed Sensor Circuit Open

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	Off	Disconnect the left front wheel sensor harness connector from the wheel speed sensor pigtail. Measure the resistance between the terminals of the left front wheel speed sensor pigtail. Is the resistance correct?	Both terminals of the left front wheel speed sensor pigtail.	2025-2475 ohms.	Go to next step.	Replace left front wheel speed sensor. Go to Step 5.

Table 11 (DTC 25) Left Front Wheel Speed Sensor Circuit Open (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
3.	Off	Jumper both terminals of left front wheel speed sensor harness connector. Measure the resistance between terminals 11 and 23 of the ECU harness connector (279). Is the resistance correct?	Terminals 11 and 23 of the wiring harness connector.	< 1 ohm.	Go to next step.	Repair open or high resistance in affected circuits. Go to Step 5.
4.	On	Inspect the ECU connector terminals 11 and 23 for poor contacts or corrosion.		No evidence of damage or corrosion.	Go to next step.	Make necessary repairs. Go to next step.
5.	Off	Inspect the wheel speed sensor for chafing.		No evidence of chafing.	Go to next step.	Make necessary repair.
6.	Off/ On	Reconnect all connectors. Clear all DTCs with the EZ-Tech. Test drive vehicle above 10 mph. Does DTC 25 set as a current DTC?		DTC 25 does not set as a current DTC.	Malfunction has been repaired or is intermittent.	Call International Tech Central for approval to send in ECU.

(DTC 26) LEFT FRONT WHEEL SPEED SENSOR SIGNAL MISSING

This DTC is set when the wheel sensor signal is low while the vehicle is traveling faster than 8 mph or a sudden change in sensor speed from 0 to >6 mph. When this DTC sets, the ABS is disabled and will remain disabled until the ignition is turned off (even if the cause is intermittent). The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech® or PRO-LINK 9000. An intermittent malfunction may be caused by a backed-out sensor, damaged rotor teeth, a poor connection, chafed sensor wire, worn insulation or a broken wire inside the insulation. Any circuitry suspected of causing the DTC should be thoroughly checked for electrical discontinuity, physical damage and corrosion. If the intermittent condition only occurs during humid conditions all wheel speed circuitry should be tested for salt water intrusion. Spray the suspected area with a salt water solution. Drive the vehicle above 15 mph for at least 30 seconds. If the DTC returns immediately, replace the suspect harness.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 12 (DTC 26) Left Front Wheel Speed Sensor Signal Missing

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	Off	Inspect the wheel speed sensor to tone ring gap for evidence of excessive gap.		Sensor gap < 0.050 inch.	Go to next step	Push sensor in completely by twisting and pushing.
3.	Off	Inspect the left front wheel speed sensor, sensor wire and connectors for signs of damage, chafing or corrosion. Check the brake rotor for missing and/or heavily corroded teeth. Any deviation will affect the wheel speed sensor output signal. Is there evidence of damage?		No evidence of damage.	Go to next step.	Make necessary repairs. Go to Step 9.
4.	Off	Disconnect the left front wheel speed sensor harness connector from the wheel speed sensor. Measure the resistance between the terminals of the left front wheel speed sensor pigtail connector. Is the resistance correct?	Terminals of the wheel speed sensor pigtail.	2025-2475 ohms.	Go to next step.	Replace the left front wheel speed sensor. Go to Step 9.
5.	Off	Using an EZ-Tech, measure the A/C voltage generated between terminals of the left front wheel speed sensor pigtail while spinning the wheel at approx. 3 to 4 MPH. Is the voltage correct?	Terminals of left front wheel speed sensor pigtail.	480 mV. min.	Go to next step.	Replace the left front wheel speed sensor. Go to Step 9.

Table 12 (DTC 26) Left Front Wheel Speed Sensor Signal Missing (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
6.	Off	Disconnect the 24-way ECU harness connector from the ECU. Measure the resistance between terminals 11 and 23 of the harness connector.	Terminals 11 and 23 of the harness connector.	Open.	Go to next step.	Repair short between circuits. Go to Step 9.
7.	Off	Reconnect the left front wheel speed sensor. Measure the resistance between terminal 11 of the harness connector and ground.	Terminal 11 of the harness connector and ground.	Open.	Go to next step.	Repair short between circuits and ground. Go to Step 9.
8.	Off	Measure the resistance between terminal 23 of the harness connector and ground.	Terminal 23 of the harness connector and ground.	Open.	Go to next step.	Repair short between circuits and ground. Go to Step 9.
9.	Off	Inspect the 24-way ECU harness connector terminals 11 and 23 for poor contact or corrosion.		No vidence of damage or corrosion.	Go to next step.	Make necessary repairs. Go to next step.
10.	Off	Inspect suspension components and wheel bearings for excessive wear and/or play.		No evidence of wear or damage.	Go to next step.	Make necessary repairs.
11.	Off/ On	Reconnect all connectors. Clear all DTCs with the EZ-Tech PRO-LINK 9000. Test drive vehicle over 10 mph. Does DTC 26 set as a current DTC?		DTC 26 sets as an active DTC.	Malfunction has been repaired or is intermittent.	Call International Tech Central for approval to send in ECU

(DTC 27) LEFT FRONT WHEEL SPEED SENSOR SIGNAL ERRATIC

This DTC is set when the left front sensor output is suddenly prevented from toggling while the vehicle speed is above 12 mph (brakes off) or 20 mph (brakes on or in antilock mode in the last second). When this DTC sets, the ABS is disabled for as long as the condition exists (for a single occurrence) or will remain disabled until the ignition is turned off (for three or more occurrences). The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech® or PRO-LINK 9000. An intermittent malfunction may be caused by a backed out sensor, worn bearings, a warped rotor, damaged rotor teeth, a poor connection,

chafed sensor wire, worn insulation or a broken wire inside the insulation. Any circuitry suspected of causing the DTC should be thoroughly checked for electrical discontinuity, physical damage and corrosion.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 13 (DTC 27) Left Front Wheel Speed Sensor Signal Erratic

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	Off	Inspect the wheel speed sensor to tone ring gap for evidence of excessive gap.		Sensor gap < 0.050 inch.	Go to next step.	Push sensor in completely by twisting and pushing.
3.	Off	Inspect the right front wheel speed sensor, sensor wire and connectors for signs of damage, chafing, or corrosion. Inspect the brake rotor for missing and/or heavily corroded teeth. Inspect for warped rotor. Any deviation will affect the wheel speed sensor output signal. Is there evidence of damage?		No evidence of damage.	Go to next step.	Make necessary repairs. Go to Step 9.
4.	Off	Disconnect the wheel speed sensor from the harness pigtail connector. Measure the resistance between terminals of the left front wheel speed sensor pigtail. Is the resistance correct?	Terminals of left front wheel speed sensor pigtail.	2025- 2475 ohms.	Go to next step.	Replace wheel speed sensor. Go to Step 7.

Table 13 (DTC 27) Left Front Wheel Speed Sensor Signal Erratic (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
5.	Off	Disconnect the 24 way ECU harness connector (279) from the ECU and inspect for damage. Inspect the wheel speed sensor harness and sensor harness connector for signs of damage or corrosion. Are all connections complete?		No evidence of damage or corrosion.	Go to next step.	Make necessary repairs. Go to Step 9.
6.	Off	Reconnect the wheel speed sensor to the harness pigtail. Measure the resistance between terminals 11 and 23 of the ECU wiring harness connector. Is the resistance correct?	Terminals 11 and 23 of the wiring harness connector.	2025- 2475 ohms.	Go to next step.	Repair open or high resistance in the affected circuits. Go to Step 9.
7.	Off	Inspect the 24-way ECU harness connector terminals 11 and 23 for poor contact or corrosion.		No evidence of damage or corrosion.	Go to next step.	Make necessary repairs. Go to next step.
8.	Off	Inspect suspension components and wheel bearings for excessive wear and/or play.		No evidence of wear or damage.	Go to next step.	Make necessary repairs.
9.	Off/ On	Reconnect all connectors. Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Test drive vehicle over 10 mph. Does DTC 27 set as an active DTC?		DTC 27 does not set as an active DTC.	Malfunction has been repaired or is intermittent.	Call International Tech Central for approval to send in ECU.

(DTC 31) RIGHT REAR WHEEL SPEED SENSOR CIRCUIT OPEN

This DTC is set when there is no output from the wheel sensor for 1.0 second or there is excessive resistance for 1.0 second. When this DTC sets, the ABS is disabled and will remain disabled as long as the condition exists. The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech or PRO-LINK 9000. An intermittent malfunction may be caused by a poor connection, worn insulation

or a broken wire inside the insulation. Any circuitry suspected of causing the DTC should be thoroughly checked for electrical discontinuity, physical damage and corrosion.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 14 (DTC 31) Right Rear Wheel Speed Sensor Circuit Open

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	Off	Disconnect the right rear wheel sensor harness connector from the wheel speed sensor pigtail. Measure the resistance between the terminals of the right rear wheel speed sensor pigtail. Is the resistance correct?	Both terminals of the right rear wheel speed sensor pigtail.	2025- 2475 ohms.	Go to next step.	Replace right rear wheel speed sensor. Go to Step 6.
3.	Off	Jumper both terminals of the 2-way wheel speed sensor harness connector. Measure the resistance between terminals 8 and 20 of the ECU harness connector (279). Is the resistance correct?	Terminals 8 and 20 of the wiring harness connector.	< 1 ohm.	Go to next step.	Repair open or high resistance in affected circuits. Go to Step 6.
4.	Off	Inspect the ECU connector terminals 8 and 20 for poor contacts or corrosion.		No evidence of damage or corrosion.	Go to next step.	Make necessary repairs. Go to next step.
5.	Off	Inspect the wheel speed sensor for chafing.		No evidence of chafing.	Go to next step.	Make necessary repair.
6.	Off/ On	Reconnect all connectors. Clear all DTCs with the EZ-Tech. Test drive vehicle above 10 mph. Does DTC 31 set as a current DTC?		DTC 31 does not set as a current DTC.	Malfunction has been repaired or is intermittent.	Call International Tech Central for approval to send in ECU.

(DTC 32) RIGHT REAR WHEEL SPEED SENSOR SIGNAL MISSING

This DTC is set when the wheel sensor signal is low while the vehicle is traveling faster than 8 mph or a sudden change in sensor speed from 0 to >6 mph. When this DTC sets, the ABS is disabled and will remain disabled until the ignition is turned off (even if the cause is intermittent). The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech® or PRO-LINK 9000. An intermittent malfunction may be caused by a backed-out sensor, damaged rotor, a poor connection, chafed sensor wire, worn insulation or a broken wire inside the insulation. Any circuitry suspected of causing the DTC should be thoroughly checked for electrical discontinuity, physical damage and corrosion. If the intermittent condition only occurs during humid conditions all wheel speed circuitry should be tested for salt water intrusion. Spray the suspected area with a salt water solution. Drive the vehicle above 15 mph for at least 30 seconds. If the DTC returns immediately, replace the suspect harness.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 15 (DTC 32) Right Rear Wheel Speed Sensor Signal Missing

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	Off	Inspect the wheel speed sensor to tone ring gap for evidence of excessive gap.		Sensor gap < 0.050 inch.	Go to next step.	Push sensor in completely by twisting and pushing.
3.	Off	Inspect the right rear wheel speed sensor, sensor wire and connectors for signs of damage, chafing, or corrosion. Inspect the brake rotor for missing and/or heavily corroded teeth. Any deviation will affect the wheel speed sensor output signal. Is there evidence of damage?		No evidence of damage.	Go to next step.	Make necessary repairs. Go to Step 11.

Table 15 (DTC 32) Right Rear Wheel Speed Sensor Signal Missing (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
4.	Off	Disconnect the right rear wheel speed sensor harness connector (295) from the wheel speed sensor pigtail. Measure the resistance between terminal A and B of the right rear wheel speed sensor pigtail connector. Is the resistance correct?	Terminals A and B of the wheel speed sensor pigtail.	2025- 2475 ohms.	Go to next step.	Replace the right rear wheel speed sensor. Go to Step 11.
5.	Off	Using an EZ-Tech® measure the A/C voltage generated between terminals A and B of the right rear wheel speed sensor pigtail while spinning the wheel at approx. 3–4 mph. Is the voltage correct?	Terminals A and B of right rear wheel speed sensor pigtail.	480 mV. min.	Go to next step.	Replace the right rear wheel speed sensor. Go to Step 11.
6.	Off	Disconnect the 24-way ECU harness connector from the ECU. Measure the resistance between terminals 8 and 20 of the harness connector.	Terminals 8 and 20 of the harness connector.	Open.	Go to next step.	Repair short between circuits. Go to Step 11.
7.	Off	Reconnect the right rear wheel speed sensor. Measure the resistance between terminal 8 of the harness connector and ground.	Terminal 8 of the harness connector and ground.	Open.	Go to next step.	Repair short between circuits and ground. Go to Step 11.
8.	Off	Measure the resistance between terminal 20 of the harness connector and ground.	Terminal 20 of the harness connector and ground.	Open.	Go to next step.	Repair short between circuits and ground. Go to Step 11.

Table 15 (DTC 32) Right Rear Wheel Speed Sensor Signal Missing (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
9.	Off	Inspect the 24-way ECU harness connector terminals 8 and 20 for poor contact or corrosion.		No evidence of damage or corrosion.	Go to next step.	Make necessary repairs. Go to next step.
10.	Off	Inspect suspension components and wheel bearings for excessive wear and/or play		No evidence of wear or damage	Go to next step.	Make necessary repairs.
11.	Off/ On	Reconnect all connectors. Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Test drive vehicle over 10 mph. Does DTC 32 set as an active DTC?		DTC 32 does not set as an active DTC.	Malfunction has been repaired or is intermittent.	Call International Tech Central for approval to send in ECU.

(DTC 33) RIGHT REAR WHEEL SPEED SENSOR SIGNAL ERRATIC

This DTC is set when the Right rear sensor output is suddenly prevented from toggling while vehicle speed is above 12 mph (brakes off) or 20 mph (brakes on or in antilock mode in the last second). When this DTC sets, the ABS is disabled for as long as the condition exists (for a single occurrence) or will remain disabled until the ignition is turned off (for three or more occurrences). The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech or PRO-LINK 9000. An intermittent malfunction may be caused by a backed out sensor, worn bearings, a warped rotor, damaged rotor teeth, a poor connection, chafed sensor wiring, worn insulation or a broken wire inside the insulation. Any circuitry suspected of causing the DTC should be thoroughly checked for electrical discontinuity, physical damage and corrosion.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 16 (DTC 33) Right Rear Wheel Speed Sensor Signal Erratic

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	Off	Inspect the wheel speed sensor to tone ring gap for evidence of excessive gap		Sensor gap < 0.050 inch.	Go to next step	Push sensor in completely by twisting and pushing

Table 16 (DTC 33) Right Rear Wheel Speed Sensor Signal Erratic (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
3.	Off	Inspect the wheel speed sensor, sensor wire and connectors for signs of damage, chafing, or corrosion. Inspect brake rotor for missing and/or heavily corroded teeth. Inspect for warped rotor. Any deviation will affect the wheel speed sensor output signal. Is there evidence of damage?		No evidence of damage.	Go to next step.	Make necessary repairs. Go to Step 9.
4.	Off	Disconnect the wheel speed sensor from the harness pigtail connector. Measure the resistance between terminals of the right rear wheel speed sensor pigtail. Is the resistance correct?	Terminals of right rear wheel speed sensor pigtail.	2025- 2475 ohms.	Go to next step.	Replace wheel speed sensor. Go to Step 9.
5.	Off	Disconnect the 24 way ECU harness connector (279) from the ECU and inspect for damage. Inspect the wheel speed sensor harness and sensor harness connector for signs of damage or corrosion. Are all connections complete?		No evidence of damage or corrosion.	Go to next step.	Make necessary repairs. Go to Step 9.
6.	Off	Reconnect the wheel speed sensor to the harness pigtail. Measure the resistance between terminals 8 and 20 of the ECU wiring harness connector. Is the resistance correct?	Terminals 8 and 20 of the wiring harness connector.	2025- 2475 ohms.	Go to next step.	Repair open or high resistance in the affected circuits. Go to Step 7.

Table 16 (DTC 33) Right Rear Wheel Speed Sensor Signal Erratic (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
7.	Off	Inspect the 24-way ECU harness connector terminals 8 and 20 for poor contact or corrosion.		No evidence of damage or corrosion.	Go to next step.	Make necessary repairs. Go to next step.
8.	Off	Inspect suspension components and wheel bearings for excessive wear and/or play.		No evidence of wear or damage.	Go to next step.	Make necessary repairs.
9.	Off/ On	Reconnect all connectors. Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Test drive vehicle over 10 mph. Does DTC 33 set as an active DTC?		DTC 33 does not set as an active DTC.	Malfunction has been repaired or is intermittent.	Call International Tech Central for approval to send in ECU.

(DTC 35) LEFT REAR WHEEL SPEED SENSOR CIRCUIT OPEN

This DTC is set when there is no output from the wheel sensor for 1.0 second or there is excessive resistance for 1.0 second. When this DTC sets, the ABS is disabled and will remain disabled as long as the condition exists. The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech® or PRO-LINK 9000. An intermittent malfunction may be caused by a poor connection, worn insulation or a broken wire inside the insulation. Any circuitry suspected of causing the DTC should be thoroughly checked for electrical discontinuity, physical damage and corrosion.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 17 (DTC 25) Left Rear Wheel Speed Sensor Circuit Open

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)

Table 17 (DTC 25) Left Rear Wheel Speed Sensor Circuit Open (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
2.	Off	Disconnect the left rear wheel sensor harness connector from the wheel speed sensor pigtail. Measure the resistance between the terminals of the left rear wheel speed sensor pigtail. Is the resistance correct?	Both terminals of the left rear wheel speed sensor pigtail.	2025- 2475 ohms.	Go to next step	Replace left rear wheel speed sensor. Go to Step 6.
3.	Off	Jumper both terminals of the 2-way wheel speed sensor harness connector. Measure the resistance between terminals 9 and 21 of the ECU harness connector (279). Is the resistance correct?	Terminals 9 and 21 of the wiring harness connector.	< 1 ohm.	Go to next step.	Repair open or high resistance in affected circuits. Go to Step 6.
4.	Off/ On	Inspect the ECU connector terminals 9 and 21 for poor contacts or corrosion.		No evidence of damage or a backed-out sensor.	Go to next step.	Make necessary repairs. Go to next step.
5.	Off	Inspect the wheel speed sensor for chafing		No evidence of chafing.	Go to next step.	Make necessary repair.
6.	Off/ On	Reconnect all connectors. Clear all DTCs with the EZ-Tech. Test drive vehicle above 10 mph. Does DTC 35 set as a current DTC?		DTC 35 does not set as a current DTC.	Malfunction has been repaired or is intermittent.	Call International Tech Central for approval to send in ECU.

(DTC 36) LEFT REAR WHEEL SPEED SENSOR SIGNAL MISSING

This DTC is set when the wheel sensor signal is low while the vehicle is traveling faster than 8 mph or a sudden change in sensor speed from 0 to >6 mph. When this DTC sets, the ABS is disabled and will remain disabled until the ignition is turned off (even if the cause is intermittent). The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech® or PRO-LINK 9000. An intermittent malfunction may be caused by a backed-out sensor, damaged rotor teeth, a poor connection, chafed sensor wire, worn insulation or a broken wire inside the insulation. Any circuitry suspected of causing the DTC should be thoroughly checked for electrical discontinuity, physical damage and corrosion. If the intermittent condition only occurs during humid conditions all wheel speed circuitry should be tested for salt water intrusion. Spray

the suspected area with a salt water solution. Drive the vehicle above 15 mph for at least 30 seconds. If the DTC returns immediately, replace the suspect harness.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 18 (DTC 36) Left Rear Wheel Speed Sensor Signal Missing

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	Off	Inspect the wheel speed sensor to tone ring gap for evidence of excessive gap.		Sensor gap < 0.050 inch.	Go to next step.	Push sensor in completely by twisting and pushing.
3.	Off	Inspect the left rear wheel speed sensor, sensor wire and connectors for signs of damage, chafing or corrosion. Inspect the brake rotor for missing and/or heavily corroded teeth. Any deviation will affect the wheel speed sensor output signal. Is there evidence of damage?		No evidence of damage.	Go to next step.	Make necessary repairs. Go to Step 11.
4.	Off	Disconnect the left rear wheel speed sensor harness connector (293) from the wheel speed sensor. Measure the resistance between terminal A and B of the left rear wheel speed sensor pigtail connector. Is the resistance correct?	Terminals A and B of the wheel speed sensor pigtail.	2025- 2475 Ohms.	Go to next step.	Replace the left rear wheel speed sensor. Go to Step 11.

Table 18 (DTC 36) Left Rear Wheel Speed Sensor Signal Missing (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
5.	Off	Using an EZ-Tech® measure the A/C voltage generated between terminals A and B of the left rear wheel speed sensor pigtail while spinning the wheel at approximately 3 to 4 mph. Is the voltage correct?	Terminals A and B of left rear wheel speed sensor pigtail.	480 mV. min.	Go to next step.	Replace the left rear wheel speed sensor. Go to Step 11.
6.	Off	Disconnect the 24-way ECU harness connector from the ECU. Measure the resistance between terminals 9 and 21 of the harness connector.	Terminals 9 and 21 of the harness connector.	Open.	Go to next step.	Repair short between circuits. Go to Step 11.
7.	Off	Reconnect the left rear wheel speed sensor. Measure the resistance between terminal 9 of the harness connector and ground.	Terminal 9 of the harness connector and ground.	Open.	Go to next step.	Repair short between circuits and ground. Go to Step 11.
8.	Off	Measure the resistance between terminal 21 of the harness connector and ground.	Terminal 21 of the harness connector and ground.	Open.	Go to next step.	Repair short between circuits and ground. Go to Step 9.
9.	Off	Inspect the 24-way ECU harness connector terminals 9 and 21 for poor contact or corrosion.		No evidence of damage or corrosion.	Go to next step.	Make necessary repairs. Go to next step.

Table 18 (DTC 36) Left Rear Wheel Speed Sensor Signal Missing (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
10.	Off	Inspect suspension components and wheel bearings for excessive wear and/or play.		No evidence of wear or damage.	Go to next step.	Make necessary repairs.
11.	Off	Reconnect all connectors. Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Test drive vehicle over 10 mph. Does DTC 36 set as an active DTC?		DTC 36 does not set as an active DTC.	Malfunction has been repaired or is intermittent.	Call International Tech Central for approval to send in ECU.

(DTC 37) LEFT REAR WHEEL SPEED SENSOR SIGNAL ERRATIC

This DTC is set when the Left rear sensor output is suddenly prevented from toggling while vehicle speed is above 12 mph (brakes off) or 20 mph (brakes on or in antilock mode in the last second). When this DTC sets, the ABS is disabled for as long as the condition exists (for a single occurrence) or will remain disabled until the ignition is turned off (for three or more occurrences). The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech or PRO-LINK 9000. An intermittent malfunction may be caused by a backed out sensor, worn bearings, a warped rotor, damaged rotor teeth, a poor connection, chafed sensor wire, worn insulation or a broken wire inside the insulation. Any circuitry suspected of causing the DTC should be thoroughly checked for electrical discontinuity, physical damage and corrosion.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 19 (DTC 37) Left Rear Wheel Speed Sensor Signal Erratic

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	Off	Inspect the wheel speed sensor to tone ring gap for evidence of excessive gap		Sensor gap < 0.050 inch.	Go to next step.	Push sensor in completely by twisting and pushing.

Table 19 (DTC 37) Left Rear Wheel Speed Sensor Signal Erratic (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
3.	Off	Inspect the right front wheel speed sensor, sensor wire and connectors for signs of damage, chafing, or corrosion. Inspect the brake rotor for missing and/or heavily corroded teeth. Inspect for warped rotor. Any deviation will affect the wheel speed sensor output signal. Is there evidence of damage?		No evidence of damage.	Go to next step.	Make necessary repairs. Go to Step 9.
4.	Off	Disconnect the wheel speed sensor from the left rear harness pigtail connector. Measure the resistance between terminals of the left rear wheel speed sensor pigtail. Is the resistance correct?	Terminals of left rear wheel speed sensor pigtail.	2025- 2475 ohms.	Go to next step.	Replace wheel speed sensor. Go to Step 9.
5.	Off	Disconnect the 24 way ECU harness connector (279) from the ECU and inspect for damage. Inspect the wheel speed sensor harness and sensor harness connector for signs of damage or corrosion. Are all connections complete?		No evidence of damage or corrosion.	Go to next step.	Make necessary repairs. Go to Step 9.
6.	Off	Measure the resistance between terminals 9 and 21 of the ECU wiring harness connector. Is the resistance correct?	Terminals 9 and 21 of the wiring harness connector.	2025- 2475 ohms.	Go to next step.	Repair open or high resistance in the affected circuits. Go to Step 9.

Table 19 (DTC 37) Left Rear Wheel Speed Sensor Signal Erratic (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
7.	Off	Inspect the 24-way ECU harness connector terminals 9 and 21 for poor contact or corrosion.		Connector and contacts in good condition?	Go to next step.	Repair or replace damaged connectors. Go to next step.
8.	Off	Inspect suspension components and wheel bearings for excessive wear and/or play		No evidence of wear or damage.	Go to next step.	Make necessary repairs.
9.	Off	Reconnect all connectors. Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Test drive vehicle over 10 mph. Does DTC 37 set as an active DTC?		DTC 37 does not set as an active DTC.	Malfunction has been repaired or is intermittent.	Call International Tech Central for approval to send in ECU.

(DTC 38) WHEEL SPEED MISMATCH

This DTC is set when the vehicle speed is greater than 12 mph, any wheel speed differs by more than 20% from the other three, and there is no unexpected wheel acceleration (anything that generates consistent differences between wheel speed signals). When this DTC sets, the ABS is disabled and will remain disabled until the ignition is turned off (even if the cause is intermittent). The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech or PRO-LINK 9000. DTC 38 is usually set by having significantly different tires on the vehicle or the wrong number of teeth on the brake discs. The ABS will compensate for the error and keep functioning when there is one mismatched tire with a tire speed difference exceeding 8% but within 20% of the other three wheels.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 20 (DTC 38) Wheel Speed Mismatch

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)

Table 20 (DTC 38) Wheel Speed Mismatch (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
2.	Off	Check for mismatched tires or brake rotors with different number of teeth than the rotors on the other wheels.		Tires not mis-matched. Teeth correct.	Go to next step.	Replace mismatched tires or rotor. Go to next step.
3.	Off	Install the EZ-Tech or PRO-LINK 9000 and clear all DTCs. Use the EZ-Tech or PRO-LINK 9000 to monitor and compare the wheel speeds while driving. Does the EZ-Tech or PRO-LINK 9000 indicate a faulty sensor?		EZ-Tech or PRO-LINK 9000 indicates faulty sensor.	Malfunction has been repaired or is intermittent. If DTC 38 persists the ECU may need replaced.	Go to DTC 23, 33, 27, 37 depending on which sensor is affected.

(DTC 41–58) ISOLATION OR DUMP SOLENOID CIRCUIT OPEN OR SHORTED

These DTCs are set after the ABS bulb check is completed and if there is low voltage on the ECU solenoid driver circuit when it is expected to be high (solenoid not energized). When these DTCs set, the ABS is disabled and will remain disabled until the ignition is turned off (even if the condition is intermittent). These DTCs are cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech or PRO-LINK 9000. DTCs 41-58 are usually set by an open solenoid coil within the ECU. The isolation and dump solenoid coils are located within the ECU and are not serviceable. If the test does not repair the DTC, the ECU must be replaced. If DTCs 41-58 are set with other DTCs, check for a poor ECU ground or poor ECU power feed.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 21 (DTC 41–58) ISOLATION OR DUMP SOLENOID CIRCUIT OPEN OR SHORTED

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)

Table 21 (DTC 41–58) ISOLATION OR DUMP SOLENOID CIRCUIT OPEN OR SHORTED (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
2.	Off/ On	Inspect the ECU harness connector (279) for poor contacts or corrosion.		Connector and contacts in good condition?	Go to next step.	Repair or replace damaged connectors. Go to next step.
3.	Off/ On	Reconnect all connectors. Turn ignition on. Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Turn ignition from off to on. Does DTC 41-58 set as an active DTC?		DTC 41-58 set as an active DTC.	If no other cause for the malfunction can be found, replace the ECU.	Malfunction has been repaired or is intermittent.

(DTC 65) OPEN RELAY CIRCUIT / MISSING BATTERY FROM RELAY INPUT

This DTC is set if the ECU microprocessor commands the pump motor relay “on” and there is low feedback voltage on the low side of all eight solenoids. When this DTC sets, the ABS is disabled and will remain disabled until the ignition is turned off (even if the condition is intermittent). The DTC is cleared by repairing the cause of the condition and running “clear DTCs” with the EZ-Tech. DTC 65 is usually set by an open relay coil or damaged relay contacts in the pump motor relay. The relay is located within the ECU and is not serviceable. If DTC 65 is set with other DTCs, first repair the other DTCs, clear DTCs and run the “Zero-Speed System Test” or “Dealers Bleed Test” three times with a service tool. If DTC 65 resets, refer to the following table.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 22 (DTC 65) Open Relay Circuit / Missing Battery From Relay Input

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)

Table 22 (DTC 65) Open Relay Circuit / Missing Battery From Relay Input (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
2.	Off/ On	Inspect the ECU harness connector (279) for poor contacts or corrosion.		Connector and contacts in good condition.	Go to next step.	Repair or replace damaged connectors. Go to next step.
3.	Off/ On	Reconnect all connectors. Turn ignition on. Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Turn ignition from off to on. Does DTC 65 set as an active DTC?		DTC 65 sets as an active DTC.	Malfunction has been repaired or is intermittent.	If no other cause for the malfunction can be found, replace the ECU.

(DTC 66) SHORTED RELAY CIRCUIT

This DTC is set after the ABS bulb check is completed and if there is high feedback voltage on the low side of the motor. When this DTC sets, the ABS is disabled and will remain disabled until the ignition is turned off (even if the condition is intermittent). The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech or PRO-LINK 9000. DTC 66 is usually set when the relay contacts are stuck closed. The relay is located within the ECU and is not serviceable. If the test does not repair the DTC the ECU must be replaced.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 23 (DTC 66) Shorted Relay Circuit

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)

Table 23 (DTC 66) Shorted Relay Circuit (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
2.	Off/ On	Inspect the ECU harness connector (279) for poor contacts or corrosion.		Connectors and contacts in good condition.	Go to next step.	Repair or replace damaged connectors. Go to next step.
3.	Off/ On	Reconnect all connectors. Turn ignition on. Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Turn ignition from off to on. Does DTC 66 set as an active DTC?		DTC 66 sets as an active DTC.	Malfunction has been repaired or is intermittent.	If no other cause for the malfunction can be found, replace the ECU.

(DTC 67) OPEN MOTOR CIRCUIT OR SHORTED ECU OUTPUT

This DTC is set when the ECU internal relay is on, the pump motor is off, and a low voltage is on one side of the pump motor when it is expected to be high. When this DTC sets, the ABS is disabled and will remain disabled until the ignition is turned off (even if the condition is intermittent). The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech or PRO-LINK 9000. The pump motor is located in the HCU assembly and cannot be separately repaired. DTC 66 can be caused by poor power and ground at the 2-way ECU connector or the 2-way motor harness from the ECU to the pump motor. The ECU or the HCU must be replaced if the tests show the pump motor or ECU circuits have failed.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 24 (DTC 67) Open Motor Circuit Or Shorted ECU Output

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)

Table 24 (DTC 67) Open Motor Circuit Or Shorted ECU Output (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
2.	Off/ On	Turn the ignition off and disconnect the 2-way ECU harness connector (258). Turn the ignition to run. Measure the voltage between terminal A and B of the harness connector. Is the voltage within the specified range?	ECU 2-way harness connector (258) terminal A and B.	12±1.5 volts.	Go to next step.	Locate cause of no or low voltage to circuit 94J or 94K (94A with the 3000RE). Check 60 amp. maxifuse for open condition. Check circuit from starter. Locate cause of bad ground on circuit 94-G. Go to Step 5.
3.	Off	Disconnect the 2-way, ECU to HCU interconnect from the ECU (this is located between the EHCU and the frame rail). Measure the resistance between terminal 1 and 2 of the pump motor pigtail connector. Is the resistance correct?	Terminal 1 and 2 of the 2-way pump motor pigtail connector.	0.1 to 1 ohm.	Go to next step.	Replace the HCU.
4.	Off	Inspect the ECU harness connector (268) for poor contacts or corrosion.		Connector and contacts in good condition.	Go to next step.	Repair or replace damaged connectors. Go to next step.
5.	Off/ On	Reconnect all connectors. Turn ignition on. Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Turn ignition from off to on. Does DTC 67 set as an active DTC?		DTC 67 sets as a current DTC.	Malfunction has been repaired or is intermittent.	If no other cause for the malfunction can be found, replace the ECU.

(DTC 68) LOCKED (STALLED) MOTOR OR OPEN ECU OUTPUT

This DTC is set when the vehicle speed is 8 mph or greater, the ECU internal relay is on, the pump motor commanded on then off, and high feedback voltage from the low side of the pump motor continuously for 100ms. When this DTC sets, the ABS is disabled and will remain disabled until the ignition is turned off (even if the condition is intermittent). The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech or PRO-LINK 9000. DTC 68 is usually caused by a seized pump motor, but can be caused by shorted pump motor windings or by poor power/ground at the 2-way ECU connector. The

pump motor is integral to the HCU assembly and cannot be serviced separately. The ECU or HCU must be replaced if these tests show the pump motor ECU internal circuits have failed.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 25 (DTC 68) Locked (Stalled) Motor Or Open ECU Output

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	Off	Disconnect the 2-way pump motor pigtail connector from the ECU. Measure the resistance between both terminals of the 2-way ECU harness connector. Is the resistance correct?	Both terminals of the 2-way ECU harness connector.	0.1 to 1 ohm.	Go to next step.	Replace the HCU.
3.	Off/ On	Inspect the ECU harness connector (268) for poor contacts or corrosion.		Connector and contacts in good condition.	Go to next step.	Repair or replace damaged connectors. Go to next step.
4.	Off/ On	Reconnect all connectors. Turn ignition on. Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Turn ignition from off to on. Does DTC 68 set as an active DTC?		DTC 68 sets as an active DTC.	Malfunction has been repaired or is intermittent.	If no other cause for the malfunction can be found, replace the ECU.

(DTC 69) EXCESSIVE DUMP TIME

This DTC is set when dump time (pressure reduction) exceeds 9 seconds, caused by locked rotors or excessively low road surface friction. When this DTC sets, the ABS is disabled and will remain disabled until the ignition is turned off (even if the condition is intermittent). The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech® or PRO-LINK 9000. If any other DTCs are set, repair those first. If there are no other DTCs set ensure the ABS is operating properly by performing the “Zero-Speed System Test” or “Dealer’s Bleed Test” with the EZ-Tech® or PRO-LINK 9000.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 26 (DTC 69) Excessive Dump Time

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	Off	This fault should only occur during an ABS stop. Inspect brake rotors and insure they are not locked-up.	Brake rotors	Not locked-up.	Go to next step.	Make necessary repairs. Go to Step 6.
3.	Off	Inspect the wheel speed sensor to tone ring gap for evidence of excessive gap.		Sensor gap < 0.050 inch.	Push sensor in completely by twisting and pushing.	Go to next step.
4.	Off	Inspect wheel speed sensor to rotor tone ring gap on all wheels. Inspect rotor teeth for damage and/or corrosion.		No evidence of incorrect gap or rotor damage/ corrosion.	Go to next step.	Make necessary repairs.
5.	Off/ On	Inspect the ECU harness connector (279) for poor contacts or corrosion.		Connector and contacts in good condition.	Go to next step.	Repair damage. Go to next step.
6.	Off/ On	Reconnect all connectors. Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Test drive vehicle above 10 mph. Does DTC 69 set as an active DTC?			Malfunction has been repaired or is intermittent.	Call International Tech Central for approval to send in ECU.

(DTC 71-73) ECU MEMORY/CIRCUITRY ERRORS

This ECU initiates a self-test when the ignition is turned to the run position. This internal self-test verifies all ABS circuitry is operating correctly. These DTCs will set when there is a memory error. DTC 71 or 72 are permanently latched. The ABS is disabled and will remain disabled until the ECU is replaced. DTC 73 is ignition latched. The ABS will be disabled until the ignition is cycled and the fault goes away. DTC 73 will remain in history until it is cleared by requesting “System Reset” with the EZ-Tech or PRO-LINK 9000. DTCs 71 through 73 are set by internal diagnosis. The ECU must be replaced if these tests show the ECU circuitry has failed.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 27 (DTC 71-73) ECU Memory/Circuitry Errors

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	On	Install EZ-Tech or PRO-LINK 9000 and attempt to clear DTCs. Turn ignition off for 5 seconds, then on. Did DTCs reappear?		DTCs cleared and did not reappear.	Malfunction has been repaired or is intermittent.	If no other cause for the malfunction can be found, replace the ECU.

(DTC 74) EXCESSIVE ISOLATION TIME.

This DTC is set when isolation time (pressure hold) exceeds 120 seconds. When this DTC sets, the ABS is disabled and will remain disabled until the ignition is turned off (even if the condition is intermittent). The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech or PRO-LINK 9000. If any other DTCs are set, repair them first. If no other DTCs are set, ensure the ABS is working properly by performing the “Zero-Speed System Test” or “Dealer’s Bleed Test” with the EZ-Tech or PRO-LINK 9000.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 28 (DTC 74) Excessive Isolation Time.

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	Off	Inspect the wheel speed sensor to tone ring gap for evidence of excessive gap.		Sensor gap < 0.050 inch.	Go to next step.	Push sensor in completely by twisting and pushing.
3.	Off	Inspect rotor teeth for damage and/or corrosion.		No evidence of rotor damage/ corrosion.	Go to next step.	Make necessary repairs.

Table 28 (DTC 74) Excessive Isolation Time. (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
3.	Off/On	Inspect ECU harness conn. (279) for poor contacts or corrosion.		Connector and contacts in good condition.	Go to next step.	Repair damage. Go to next step.
4.	Off/ On	Reconnect all connectors. Clear all DTCs with EZ-Tech or PRO-LINK 9000 using the hydraulic software. Test drive vehicle above 10 mph. Does DTC 74 set as an active DTC?			Malfunction has been repaired or is intermittent.	Call International Tech Central for approval to send in ECU.

(DTC 81) STUCK BRAKE SWITCH

This DTC is set when the brake switch has not toggled after the vehicle has exceeded a speed of 35 mph for 10 seconds followed by 1 second of rest. When this DTC sets, the ABS is disabled and will remain disabled until the ignition is turned off (even if the condition is intermittent). This condition could be caused by faulty brake switch circuit wiring, a bad brake switch or a mechanically stuck brake. The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech or PRO-LINK 9000. If any other DTCs are set, repair those first. If there are no other DTCs set, ensure the ABS is operating properly by test driving the vehicle above 35 mph.

NOTE – This DTC may be set by a driver who keeps one foot on the brake and one on the accelerator while the vehicle is in motion.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 29 (DTC 81) Stuck Brake Switch – 1000, 3400, 3800 & 4000 models

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)

Table 29 (DTC 81) Stuck Brake Switch – 1000, 3400, 3800 & 4000 models (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
2.	Off/ On	Install the EZ-Tech or PRO-LINK 9000. Turn the ignition to run. Use the hydraulic ABS software to check the status of the brake switch while applying and releasing the brake pedal. Does the EZ-Tech or PRO-LINK 9000 indicate the brake switch to be opening and closing?		EZ-Tech or PRO-LINK 9000 indicates the brake switch to be opening and closing.	Go to Step 7.	Go to next step.
3.	Off	Disconnect brake switch connector (51). Measure voltage from circuit 70 to ground.	(51), circuit 70 to ground.	12±1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 70, then repair. Go to Step 7.
4.	Off	Measure resistance across switch while brake pedal is depressed and released.	Across switch (51).	Switching between open and closed.	Go to next step.	Replace brake/stop light switch assembly. Go to Step 7.
5.	Off	Reconnect brake switch connector (51). Disconnect the 24-way ECU harness connector. Measure the voltage between terminal 15 of the ECU harness connector (279) and ground while the brake pedal is released. Is the voltage correct?	Terminal 15 of the 24-way ECU harness connector (279) and ground.	0 volts with brake released and 12 volts with brake depressed.	Go to next step.	Locate short or open in circuit 70C or 94C. Go to Step 7.

Table 29 (DTC 81) Stuck Brake Switch – 1000, 3400, 3800 & 4000 models (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
6.	Off	Inspect the ECU harness connector (279) for poor contacts or corrosion. Repair damage if evident.		Connector and contacts in good condition.	Go to next step.	Repair or replace damaged connectors. Go to next step.
7.	Off/ On	Reconnect all connectors. Turn ignition on. Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Test drive vehicle above 35 mph, then come to a complete stop. Does DTC 81 set as an active DTC?		DTC 81 sets as an active DTC.	Malfunction has been repaired or is intermittent.	If no other cause for the malfunction can be found, replace the ECU.

Table 30 (DTC 81) Stuck Brake Switch – 3400FE models

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	Off/ On	Install the EZ-Tech or PRO-LINK 9000. Turn the ignition to run. Use the hydraulic ABS software to check the status of the brake switch while applying and releasing the brake pedal. Does the EZ-Tech or PRO-LINK 9000 indicate the brake switch to be opening and closing?		EZ-Tech or PRO-LINK 9000 indicates the brake switch to be opening and closing.	Go to Step 7.	Go to next step.
3.	Off	Disconnect brake switch connector (209). Measure voltage on connector at circuit 90B.	(209), circuit 90B.	12±1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 90B, then repair. Go to Step 7.

Table 30 (DTC 81) Stuck Brake Switch – 3400FE models (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
4.	Off	Measure resistance across switch (209) while brake pedal is depressed and released.	Across switch (209).	Switch opening and closing.	Go to next step.	Replace brake/stop light switch assembly. Go to Step 7.
5.	Off	Reconnect brake switch connector (209). Disconnect the 24-way ECU harness connector. Measure the voltage between terminal 15 of the ECU harness connector (279) and ground while the brake pedal is released. Is the voltage correct?	Terminal 15 of the 24-way ECU harness connector (279) and ground.	0 volts with brake released and >11 volts with brake depressed.	Go to next step.	Locate short in circuit 90F or 94C. Go to Step 7.
6.	Off	Inspect the ECU harness connector (279) for poor contacts or corrosion. Repair damage if evident.		Connector and contacts in good condition.	Go to next step.	Repair or replace damaged connectors. Go to next step.
7.	Off/ On	Reconnect all connectors. Turn ignition on. Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Test drive vehicle above 35 mph, then come to a complete stop. Does DTC 81 set as an active DTC?		DTC 81 sets as an active DTC.	Malfunction has been repaired or is intermittent.	If no other cause for the mal- function can be found, replace the ECU.

Table 31 (DTC 81) Stuck Brake Switch – 3000RE models

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	Off/ On	Install the EZ-Tech or PRO-LINK 9000. Turn the ignition to run. Use the hydraulic ABS software to check the status of the brake switch while applying and releasing the brake pedal. Does the EZ-Tech or PRO-LINK 9000 indicate the brake switch to be opening and closing?		EZ-Tech or PRO-LINK 9000 indicates the brake switch to be opening and closing.	Go to Step 13.	Go to next step.
3.	Off	Disconnect connector from stop light switch (209). At connector measure voltage from circuit 90B to ground.	(209), circuit 90B to ground.	12±1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 90B, then repair. Go to Step 13.
4.	Off	At connector (209), measure resistance from circuit 90-G to ground.	(209), circuit 90-G to ground.	< 1 ohm.	Go to next step.	Locate open or poor connection in circuit 90-G/11-GB, then repair. Go to Step 13.
5.	Off	At switch (209) with brake pedal depressed, measure resistance from blue wire terminal to black wire terminal.	(209), blue wire to black wire.	< 1 ohm.	Go to next step.	Replace stop light switch. Go to Step 13.
6.	Off	Remove brake relay (R3). Bench check the relay.(See BENCH TESTING RELAYS, page 68)	Relay coil and contacts.	Relay checks good.	Go to next step.	Replace brake relay (R3). Go to Step 13.
7.	Off	Reconnect stop light switch. Measure voltage between cavity A of the relay socket and ground.	Cavity A of the relay socket and ground.	12±1.5 volts.	Go to next step.	Locate cause of low or no voltage through stop light switch (209) or circuit 70C, then repair. Go to Step 13.

Table 31 (DTC 81) Stuck Brake Switch – 3000RE models (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
8.	Off	Measure the voltage between cavity B of the relay socket and ground. Is the voltage correct?	Cavity B of the relay socket to ground.	12±1.5 volts.	Go to next step.	Locate cause of incorrect voltage on circuit 90U and repair. Go to Step 13.
9.	Off	With the brake pedal depressed, measure the resistance between cavity A of the relay socket and ground. Is the resistance correct?	Cavity A of the relay socket to ground.	< 1 ohm.	Go to next step.	Repair or replace defective stop light switch (209) or circuit 70C. Go to Step 13.
10.	Off	Install brake relay (R3). Disconnect the 24-way ECU harness connector. Measure the voltage between terminal 15 of the ECU harness connector (279) and ground while the brake pedal is released. Is the voltage correct?	Terminal 15 of the 24-way ECU harness connector (279) and ground.	0 volts with brake released.	Go to next step.	Locate short to voltage in circuit 97Y, 97M, 97N or 94C. Go to Step 13.
11.	Off	Measure the voltage between terminal 15 of the ECU harness connector (279) and ground with the brake pedal depressed. Is the voltage correct?	Terminal 15 of the 24-way ECU harness connector (279) and ground.		Go to next step.	Locate open in circuit 97Y or 94C, then repair. Go to Step 13.

Table 31 (DTC 81) Stuck Brake Switch – 3000RE models (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
12.	Off	Inspect the ECU harness connector (279) for poor contacts or corrosion. Repair damage if evident.		Connector and contacts in good condition.	Go to next step.	Repair or replace damaged connectors. Go to next step.
13.	Off/ On	Reconnect all connectors. Turn ignition on. Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Test drive vehicle above 35 mph, then come to a complete stop. Does DTC 81 set as an active DTC?		DTC 81 sets as an active DTC.	Malfunction has been repaired or is intermittent.	If no other cause for the mal- function can be found, replace the ECU.

Table 32 (DTC 81) Stuck Brake Switch – IC bus models

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	Off/ On	Install the EZ-Tech or PRO-LINK 9000. Turn the ignition to run. Use the hydraulic ABS software to check the status of the brake switch while applying and releasing the brake pedal. Does the EZ-Tech or PRO-LINK 9000 indicate the brake switch to be opening and closing?		EZ-Tech or PRO-LINK 9000 indicates the brake switch to be opening and closing.	Go to Step 8.	Go to next step.

Table 32 (DTC 81) Stuck Brake Switch – IC bus models (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
3.	Off	Disconnect the 24-way ECU harness connector. Measure the voltage between terminal 15 of the ECU harness connector (279) and ground with the brake pedal released. Is the voltage correct?	Terminal 15 of the 24-way ECU harness connector (279) and ground.	0 volts with brake released and 12 volts with the brake depressed.	Go to Step 8.	Go to next step.
4.	Off	Disconnect brake switch connector (50). Measure voltage from circuit 70 to ground.	(51), circuit 70 to ground.	12±1.5 volts.	Go to next step.	Locate cause of low or no voltage in circuit 70, then repair. Go to Step 8.
5.	Off	Measure resistance across switch while brake pedal is depressed and released.	Across switch (50).	Switching between open and closed.	Go to next step.	Replace brake switch assembly. Go to Step 8.
6.	Off	Reconnect brake switch connector (50). Measure the voltage between terminal 15 of the ECU harness connector (279) and ground while the brake pedal is released. Is the voltage correct?	Terminal 15 of the 24-way ECU harness connector (279) and ground.	0 volts with brake released and 12 volts with brake depressed.	Go to next step.	Locate short or open in circuit 70A or 94C. Go to Step 8.
7.	Off	Inspect the ECU harness connector (279) for poor contacts or corrosion. Repair damage if evident.		Connector and contacts in good condition.	Go to next step.	Repair or replace damaged connectors. Go to next step.
8.	Off/ On	Reconnect all connectors. Turn ignition on. Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Test drive vehicle above 35 mph, then come to a complete stop. Does DTC 81 set as an active DTC?		DTC 81 sets as an active DTC.	Malfunction has been repaired or is intermittent.	If no other cause for the mal- function can be found, replace the ECU.

(DTC 86) ABS WARNING LIGHT CIRCUIT FAILURE

This DTC is set when there is high voltage on the ABS warning light circuit when it is expected to be low (lamp commanded on). When this DTC sets, the ABS is not disabled. The DTC is cleared by repairing the cause of the condition and requesting “System Reset” with the EZ-Tech or PRO-LINK 9000. DTC 86 is usually set by a shorted ABS lamp bulb or shorted ABS lamp relay coil, although it can be set by a short to voltage in the wiring between the ABS lamp and the ECU or a short to voltage in the wiring between the ABS lamp relay and the ECU.

Table 33 (DTC 86) ABS Warning Light Circuit Failure

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	On	Turn the ignition to run and observe the amber ABS indicator. Did the warning light turn on, then off after 5 seconds?		Warning light turns on, then off after 5 seconds?	Go to Step 8.	Go to next step.
3.	Off	Check the ABS lamp bulb for a direct short.	ABS lamp bulb.	Bulb shorted.	Replace bulb. Go to last step.	Reconnect bulb to socket and install in cluster. Go to next step.
4.	Off/ On	Remove the ABS lamp relay. Bench check the ABS warning lamp relay. (See BENCH TESTING RELAYS, page 68)	ABS lamp relay.	Bench checks good.	Go to next step. Leave relay out.	Replace ABS warning lamp relay. Go to Step 8.
5.	Off/ On	Disconnect the 24-way ECU harness connector (279) from the ECU. Turn ignition to run. Measure the voltage between ECU harness connector (279), terminal 7, circuit 94H and ground.	(279) between circuit 94H and ground.	0 volts.	Go to next step. Leave relay out.	Repair short in circuit 94H. Go to Step 8.

Table 33 (DTC 86) ABS Warning Light Circuit Failure (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
6.	Off/ On	Remove the ABS lamp bulb from the instrument cluster. Disconnect connector from the ABS lamp. Turn ignition to run. Measure the voltage between (279) terminal 1, circuit 94A (or 94K with the 3000RE) and ground.	(279) between circuit 94A and ground.	0 volts.	Go to next step.	Repair short to voltage in circuit 94A. Go to Step 8.
7.	Off	Inspect the ECU harness connector (279) for poor contacts or corrosion.		Connector and contacts in good condition.	Go to next step.	Repair damage. Go to next step.
8.	Off/ On	Reconnect all connectors and install relays. Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Turn the ignition from off to on. Does DTC 86 set as an active DTC?		DTC 86 sets as a current DTC.	Malfunction has been repaired or is intermittent.	If no other cause for the malfunction can be found, replace the ECU.

(DTC 87) RETARDER OUTPUT FAULT DETECTION (OPEN OR SHORT TO GROUND OR BATTERY).

This DTC is set when anything keeps the ECU retarder output feedback voltage low when it's off (retarder pin is not grounded) or high when it's on (retarder pin is grounded). When this DTC sets, the ABS warning light will not light and ABS will not be disabled. The DTC is cleared by repairing the cause of the condition and requesting "System Reset" with the EZ-Tech or PRO-LINK 9000. If any other DTCs are set, repair them first.

NOTE – Use the electrical circuit diagram book, for your truck model, as a reference for the following procedures.

Table 34 (DTC 87) Retarder Output Fault Detection (Open Or Short To Ground Or Battery).

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
1.	Off	Has the preliminary system check been performed?		Preliminary system check performed.	Go to next step.	Go to preliminary system check. (See PRELIMINARY SYSTEM CHECK, page 17)
2.	On	(Skip this step for 1000 series vehicles.) Disconnect 8-way connector (377) or (168) w/3000FE. Turn ignition on. Measure the voltage between female connector (377) or (168) w/3000FE, cavity F and ground.	(377) or (168) w/3000FE, cavity F and ground.	12±1.5 volts.	Go to next step.	Locate cause of low or no voltage on circuit 13J or 92 w/IC bus. Go to last step.
3.	Off	Verify if this vehicle equipped with a retarder.		Equipped with a retarder.	Go to Step 5.	No retarder. Go to next step.
4.	Off	If not equipped with a retarder, measure resistance of the resistor connected to (377) or (168) between pins D and F. (On 1000 models the resistor is hard wired in the harness.)	Resistor connected to (377) or (168) w/3000FE.	Approximately 1 K ohms.	Go to Step 6.	Replace 1K Ohm resistor. Go to last step.
5.	Off/ On	If equipped with a retarder, measure resistance between pins D and F of male connector (377) or (168).	Between pins D and F of (377) or (168).	Approximately 1 K ohms.	Go to next step.	Locate open in coil of relay (286)/(569) or problems with circuits to transmissions with retarders. Go to last step.
6.	Off	Disconnect ECU connector (279). Measure the resistance from (279) cavity 2, circuit 24H (circuit 94J on the 3000RE & IC bus) to ground.	279) cavity 2, circuit 24H (circuit 94J on the 3000RE & IC bus) to ground.	Open.	Go to next step.	Repair the short to ground in circuit 24H or (94J w/3000RE & IC bus). Go to last step.

Table 34 (DTC 87) Retarder Output Fault Detection (Open Or Short To Ground Or Battery). (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES- IN SPEC.	NO-OUT OF SPEC.
7.	Off	On 8-way retarder connector (377) or (168) w/3000FE. Install a jumper from cavity D of the female connector to ground. Measure the resistance from (279) cavity 2, circuit 24H (circuit 94J w/3000FE) to ground.	(377) or (168) with 3000FE, cavity D to ground.	< 1 ohm.	Remove jumper. Go to next step.	Remove jumper. Repair the open in circuit 24H or 94J. Go to last step.
8.	Off/ On	Reconnect all connectors. Clear all DTCs with the EZ-Tech or PRO-LINK 9000 using the hydraulic ABS software. Turn the ignition from off to on. Does DTC 87 set as an active DTC?			Malfunction has been repaired or is intermittent.	If no other cause for the malfunction can be found, replace the ECU.

BENCH TESTING RELAYS

International circuits use suppressed relays(See Figure 11, page 69) for controlling power to load devices. The suppression feature (a resistor circuit parallel to the relay coil) prevents voltage spikes from damaging electronic components in the vehicle. **These relays must be replaced with approved International parts.** The part number and relay circuit diagram are embossed on the relay body. The terminals are numbered on the relay in the same manner as in the circuit diagrams.

Relay Test Procedure:

1. With relay removed, measure resistance between terminals 30 and 87A. If resistance is less than 5 ohms, go to Step 2; otherwise replace the relay.

2. Measure resistance between terminals 30 and 87. If resistance is 100K ohms or more, go to Step 3; otherwise replace the relay.

3. Using 12V battery source and test leads, connect (+) lead to terminal 85 and (-) lead to terminal 86. If relay energizes with an audible click sound, go to Step 4; otherwise replace the relay.

4. While relay is energized, measure resistance between terminals 30 and 87. If resistance is less than 5 ohms, go to Step 5; otherwise replace the relay.

5. While the relay is energized, measure resistance between terminals 30 and 87A. If resistance is 100K ohms or more, the relay is good; otherwise replace relay.

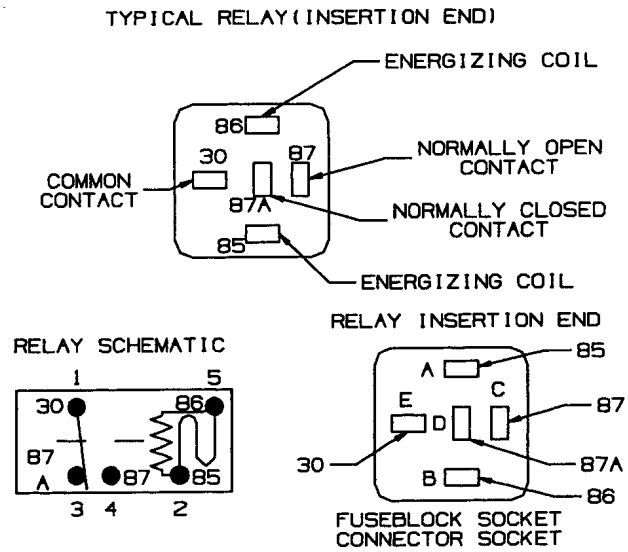


Figure 11 Relay Schematic

QUICK REFERENCE GUIDE

A Quick Reference Card is available and shown in Figure 45 and Figure 46.

COMPONENT LOCATIONS

Refer to Figure 12, Figure 13, Figure 14, Figure 15, Figure 16, Figure 17, Figure 18, Figure 19, Figure 20, Figure 21, Figure 22, Figure 23, Figure 24, Figure 25, Figure 26, Figure 27, Figure 28, Figure 29, Figure 30, Figure 31, Figure 32, Figure 33, Figure 34, Figure 35, Figure 36, Figure 37, Figure 38, Figure 39, and Figure 40.

G08–51582

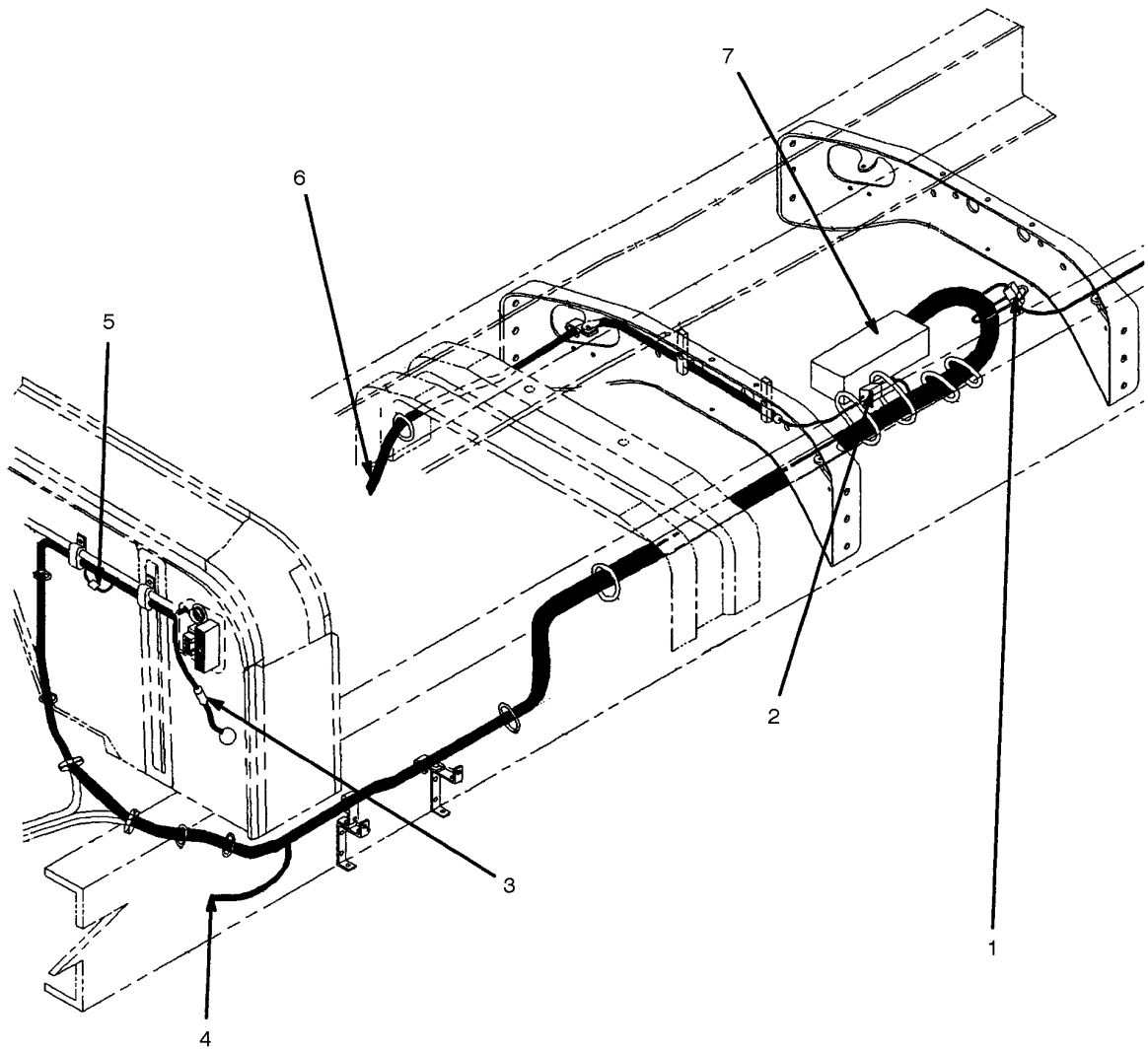


Figure 12 ABS Chassis Harness (Typical)

1. CHASSIS HARNESS TO REAR WHEEL SENSOR HARNESS CONNECTOR (323)
2. CONNECTOR (1004)
3. CHASSIS HARNESS TO CAB HARNESS 6–WAY CONNECTOR (261)
4. CHASSIS HARNESS TO LEFT FRONT WHEEL SENSOR HARNESS CONNECTOR (289) OR (426A)
5. CHASSIS HARNESS TO ENGINE HARNESS 2–WAY CONNECTOR (1002)
6. CHASSIS HARNESS TO RIGHT FRONT WHEEL SENSOR HARNESS CONNECTOR (292) OR (428)
7. EHCU LOCATION

G04−51343.04, G04−51341.02

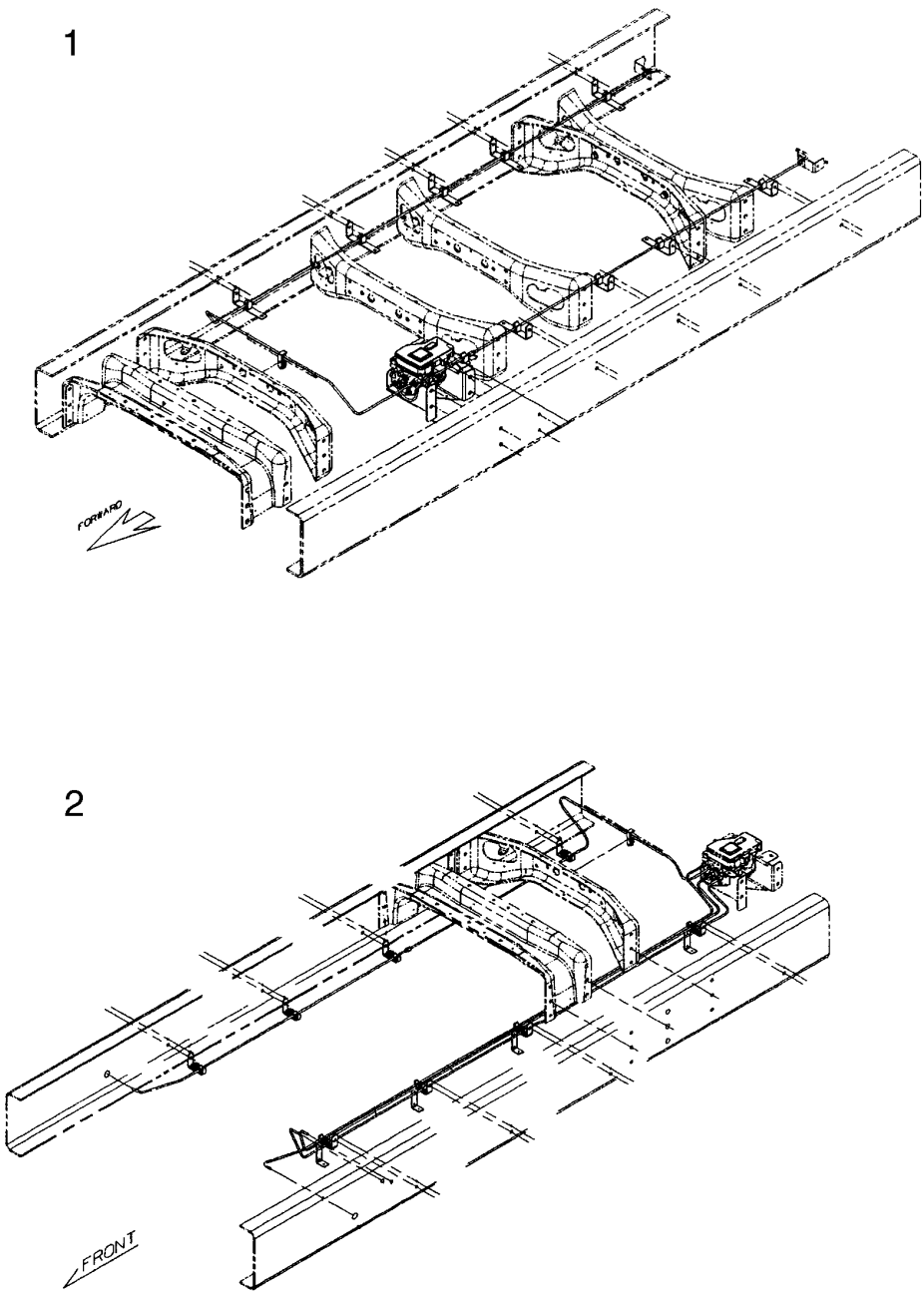


Figure 13 ABS Hydraulic Routing (Typical)

1. REAR TUBING
2. FRONT TUBING

G08–51512

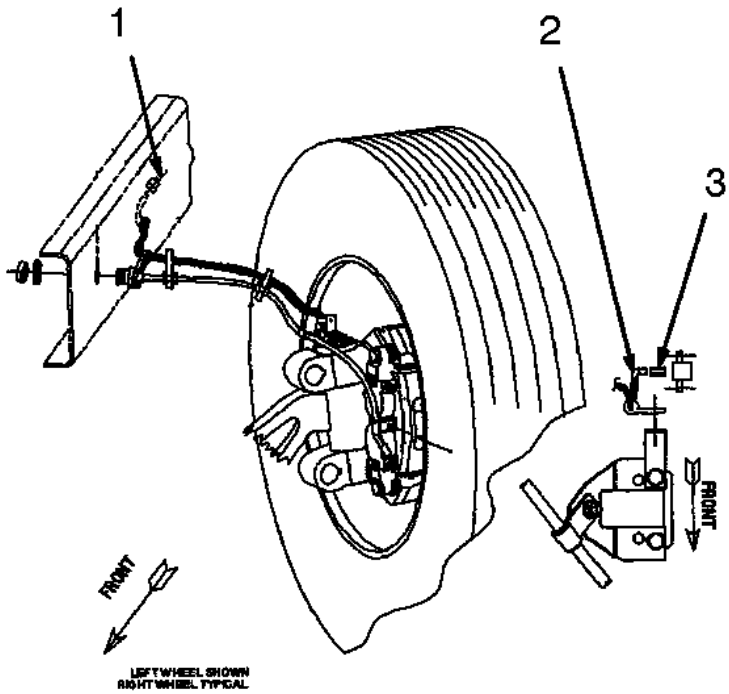


Figure 14 Front Wheel Speed Sensor

1. SENSOR HARNESS CONNECTOR
2. WHEEL SPEED SENSOR
3. SENSOR CLIP

G08−51593.3

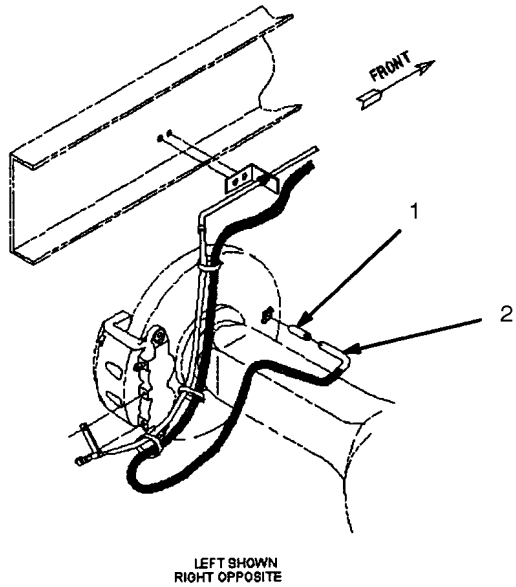


Figure 15 Rear Wheel Speed Sensor

1. SENSOR CLIP
2. WHEEL SPEED SENSOR

G08–51154.02

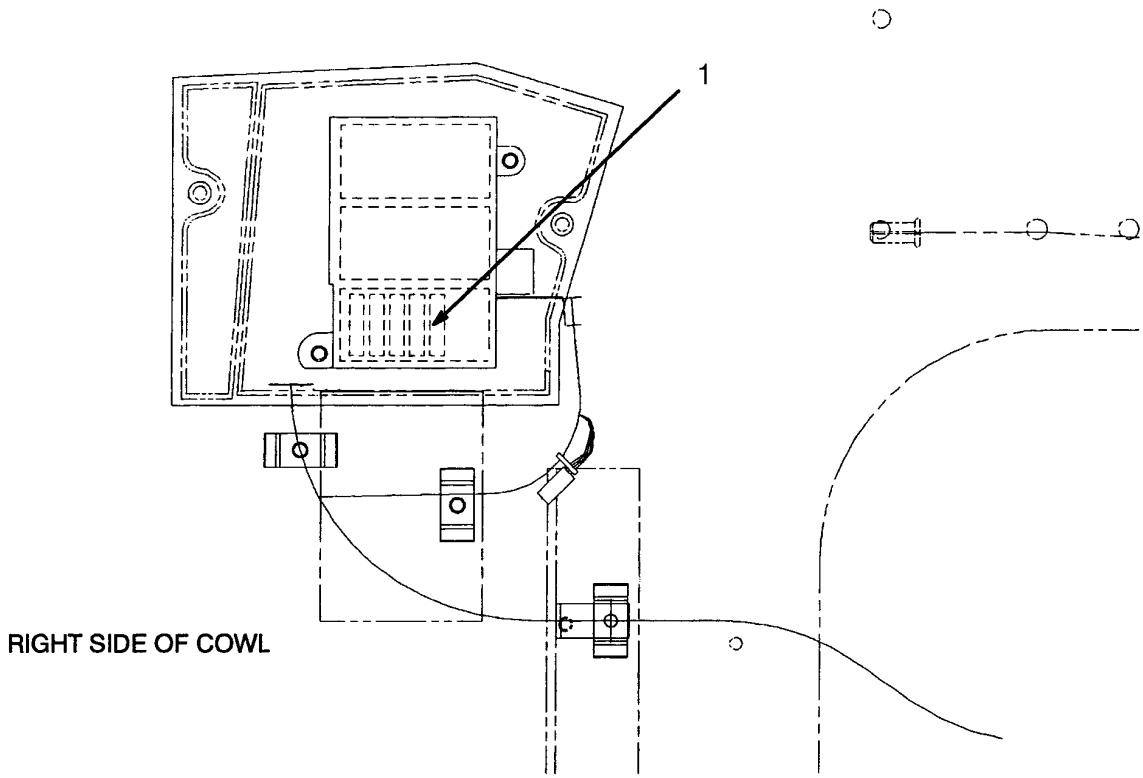


Figure 16 Engine Wiring – 1000 Series

1. F34 60 AMP ABS MAXIFUSE

G08–51162.02

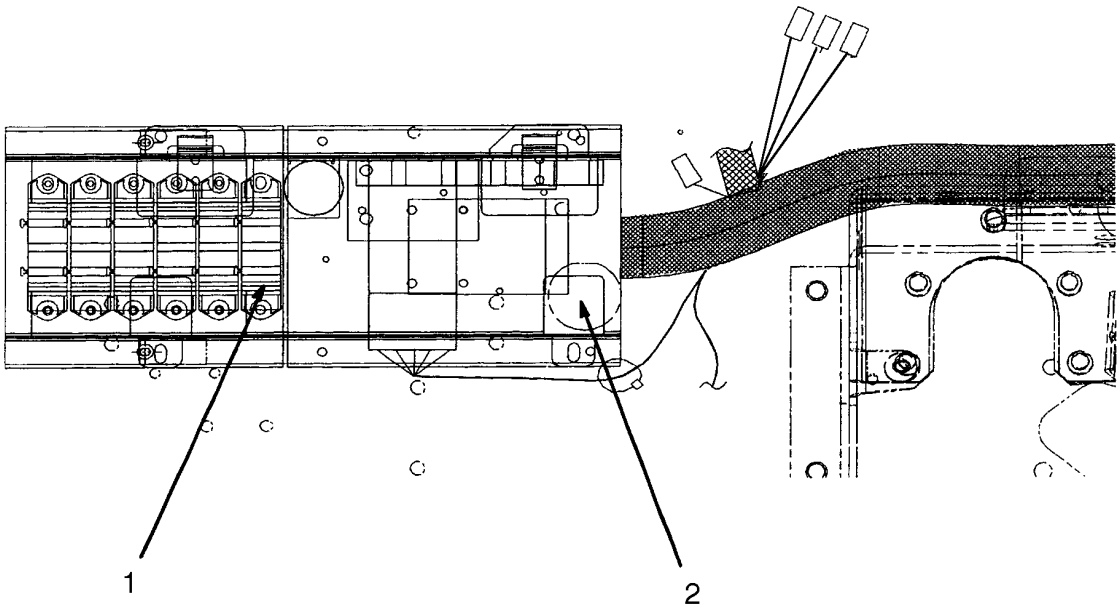


Figure 17 Fuse Panel – Inside Platform 1000 Series

1. F22 10 AMP ABS
2. ABS WARNING LIGHT RELAY (4F)

G08–51162.09

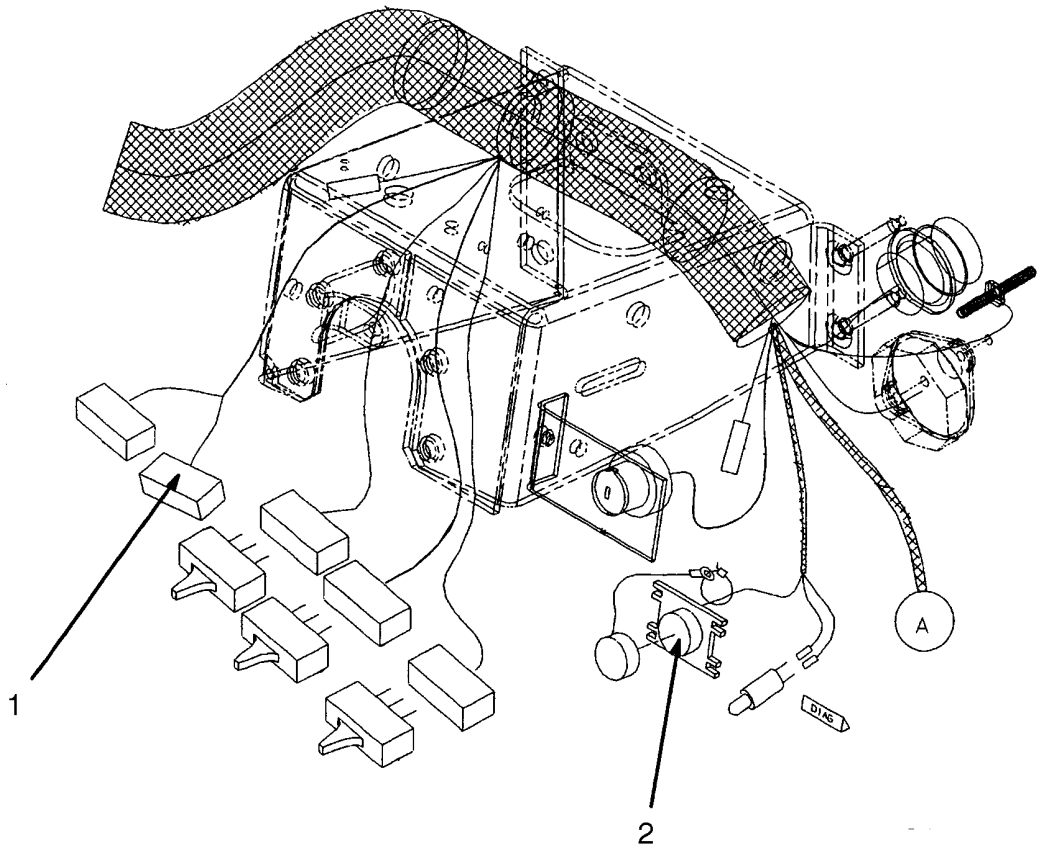


Figure 18 Platform Wiring – 1000 Series

1. GREEN INSTRUMENT CLUSTER CONNECTOR (28)
2. DIAGNOSTIC CONNECTOR

G08–51154.07

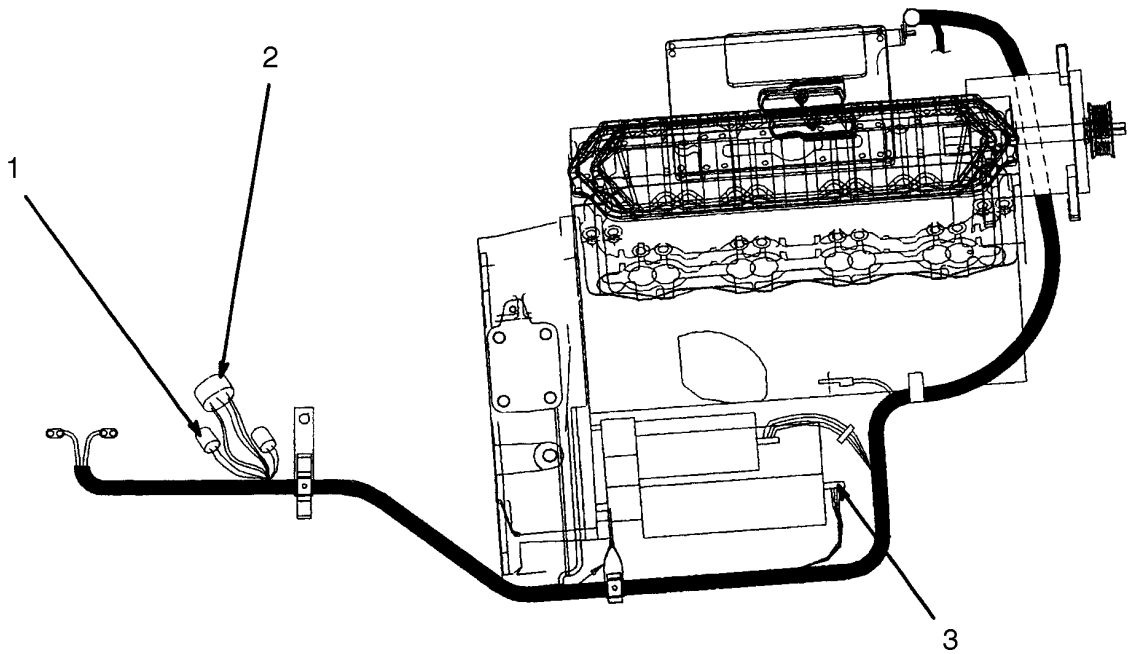


Figure 19 Engine Wiring – 1000 Series

1. CIRCUITS 94–G & 94J
2. CIRCUITS 98J, 94A, 94H, 94C & 94F
3. CIRCUIT 94–G

G08–50853.01

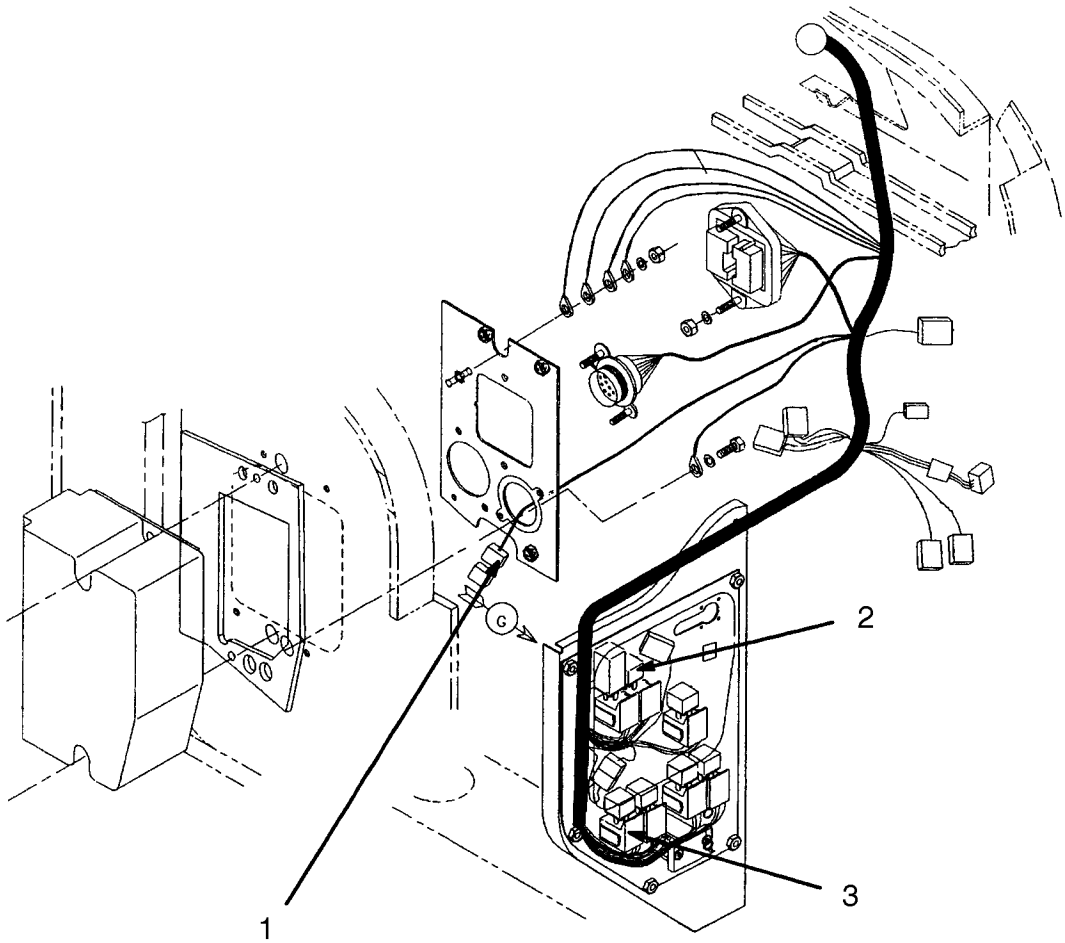


Figure 20 Cab Wiring – 3800 Bus and 4000 FBC

1. ABS 6–WAY CONNECTOR (621)
2. RETARDER RELAY
3. ABS WARNING LIGHT RELAY

G08−50853.03

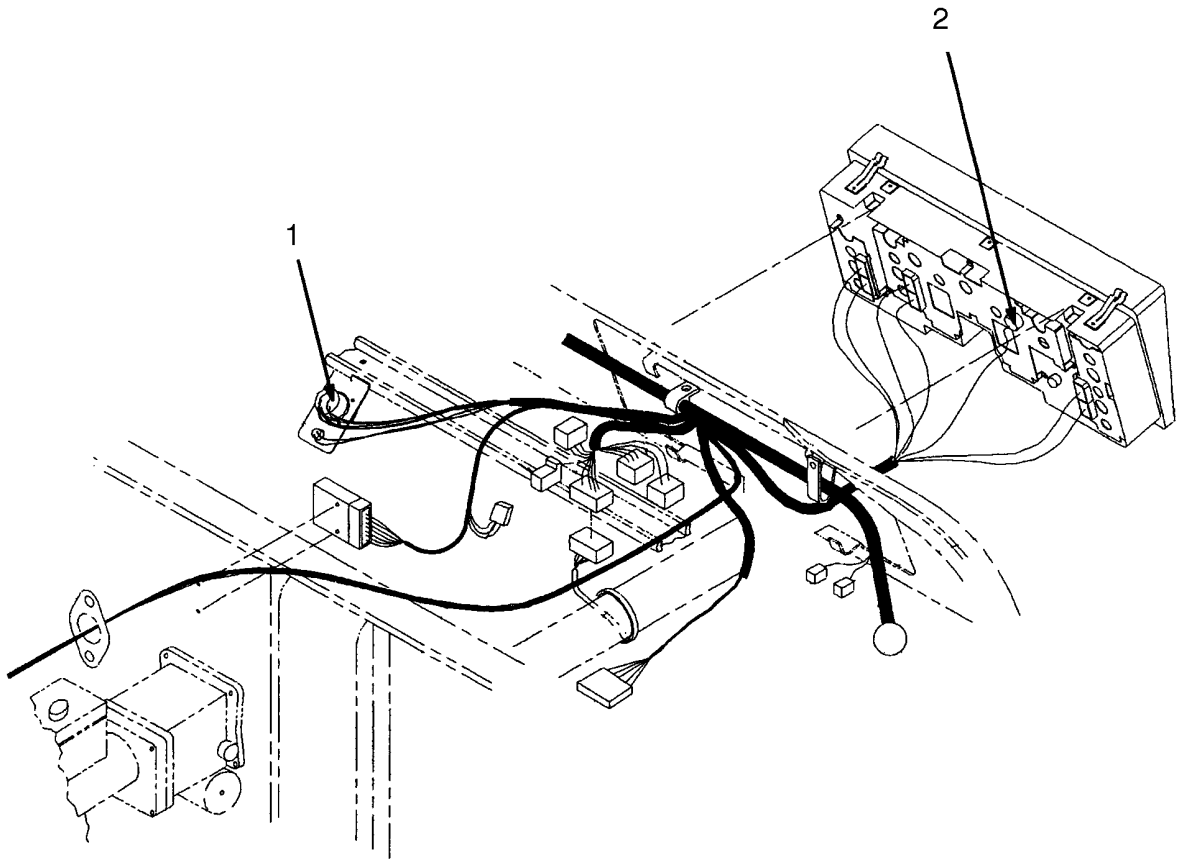
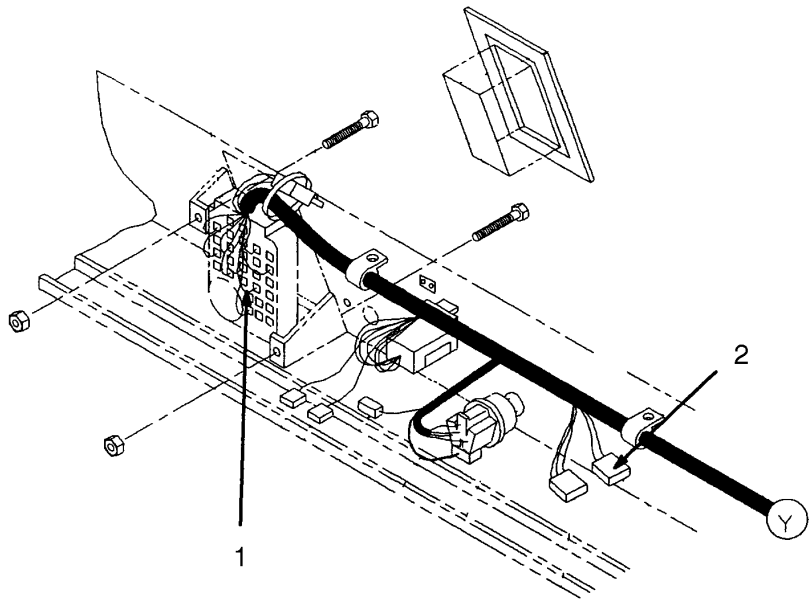


Figure 21 Cab Wiring – 3800 Bus and 4000 FBC

1. DATALINK CONNECTOR
2. ABS INDICATOR LIGHT

G08–50853.04



G08–50805.04

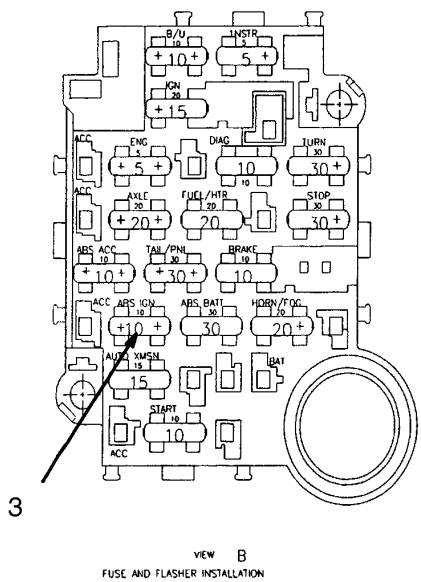


Figure 22 Cab Wiring – 3800 Bus and 4000 FBC

1. FUSE PANEL
2. (RETARDER) ABS/ALLISON INTERCONNECT (377)
3. F1 ABS IGNITION FUSE

G08–50849.05

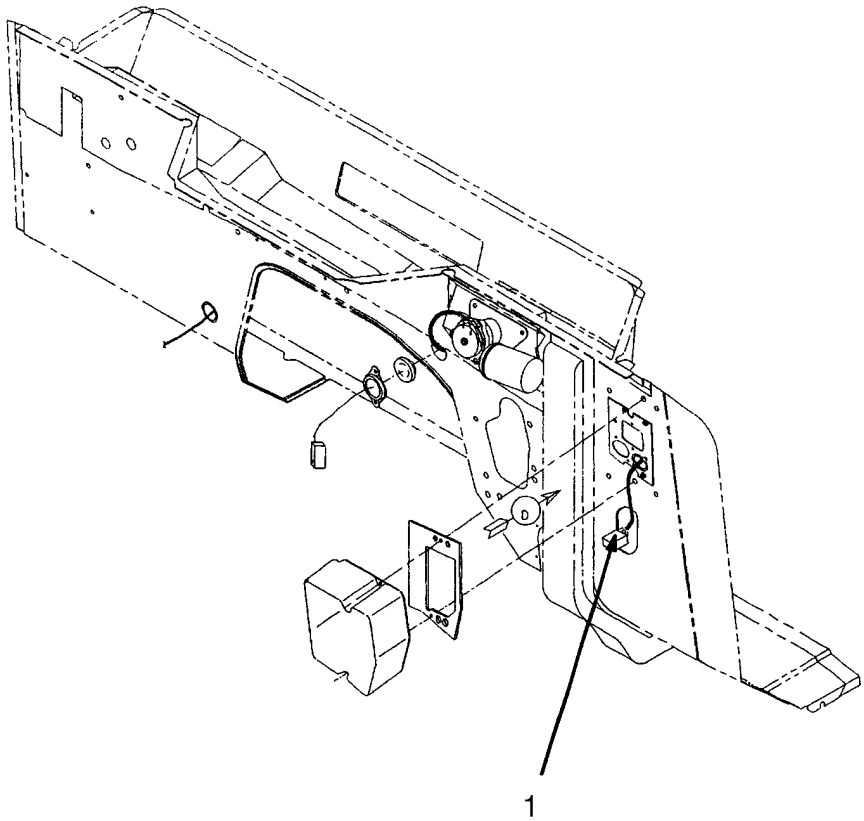


Figure 23 Cab Wiring – 3400 and 4000

1. 6–WAY CONNECTOR (261) CIRCUITS 98J, 94H, 94C, 94F & 24H

G08–50784.03

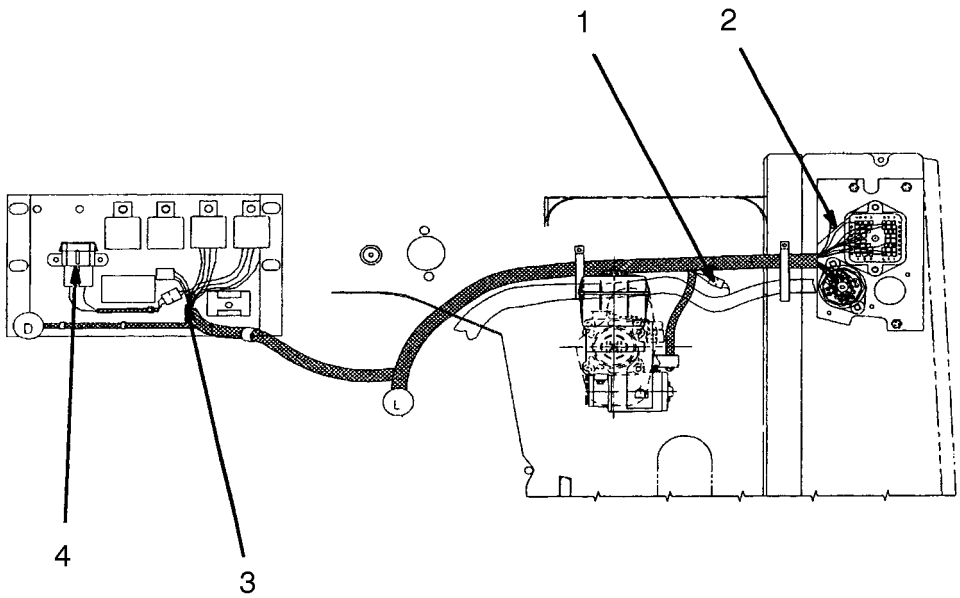


Figure 24 Engine Wiring – 3400, 3800 and 4000

1. CIRCUITS 94J & 94G
2. CIRCUITS 11–GH & 94–G
3. CIRCUITS 94J & 94K
4. 60 AMP MAXIFUSE

G08–50849.01 & 02

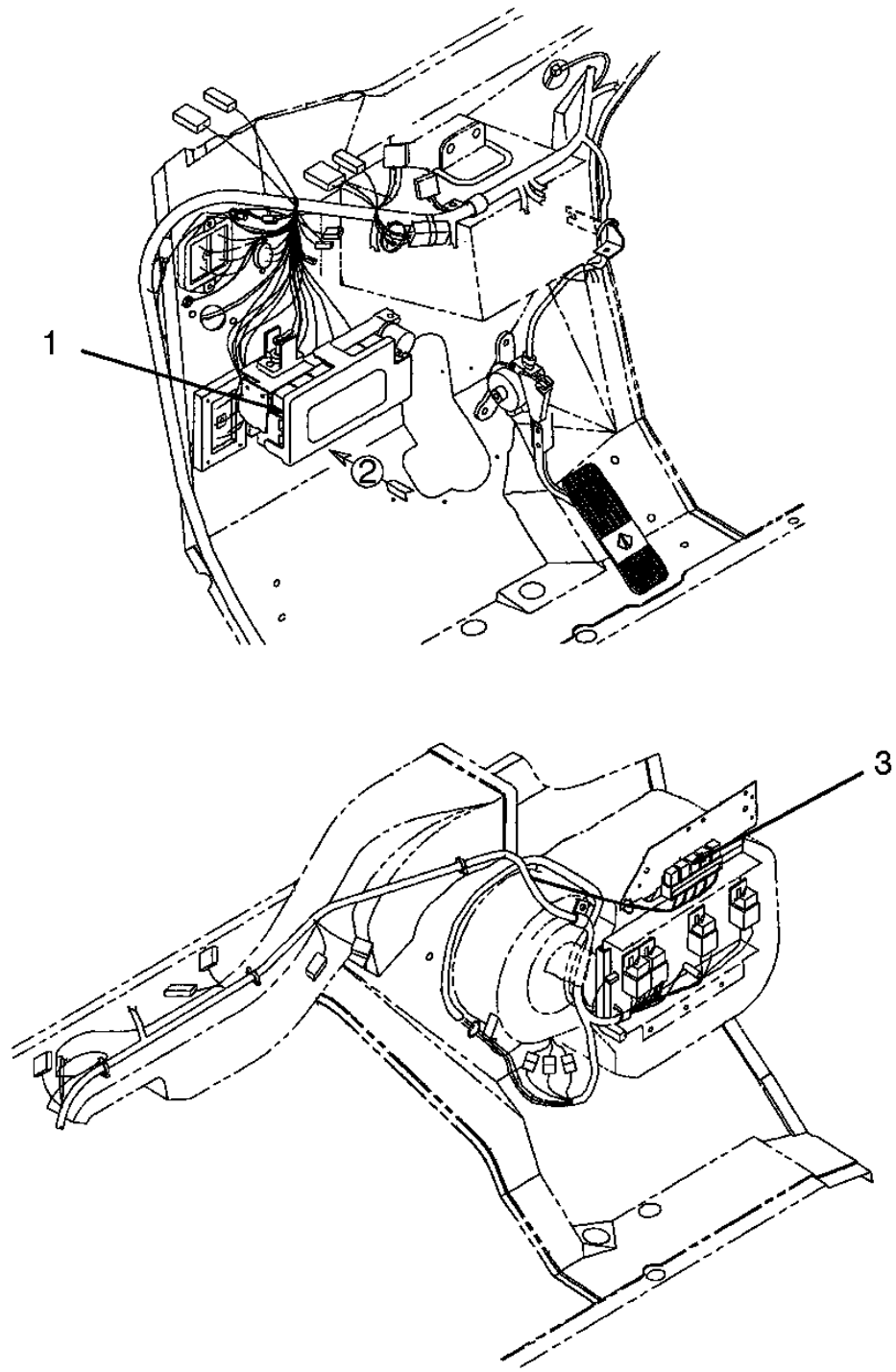


Figure 25 Cab Wiring – 3400 and 4000

1. FUSE BLOCK
2. SEE FIGURE 26 (below)
3. RETARDER INTERRUPT RELAY (286)

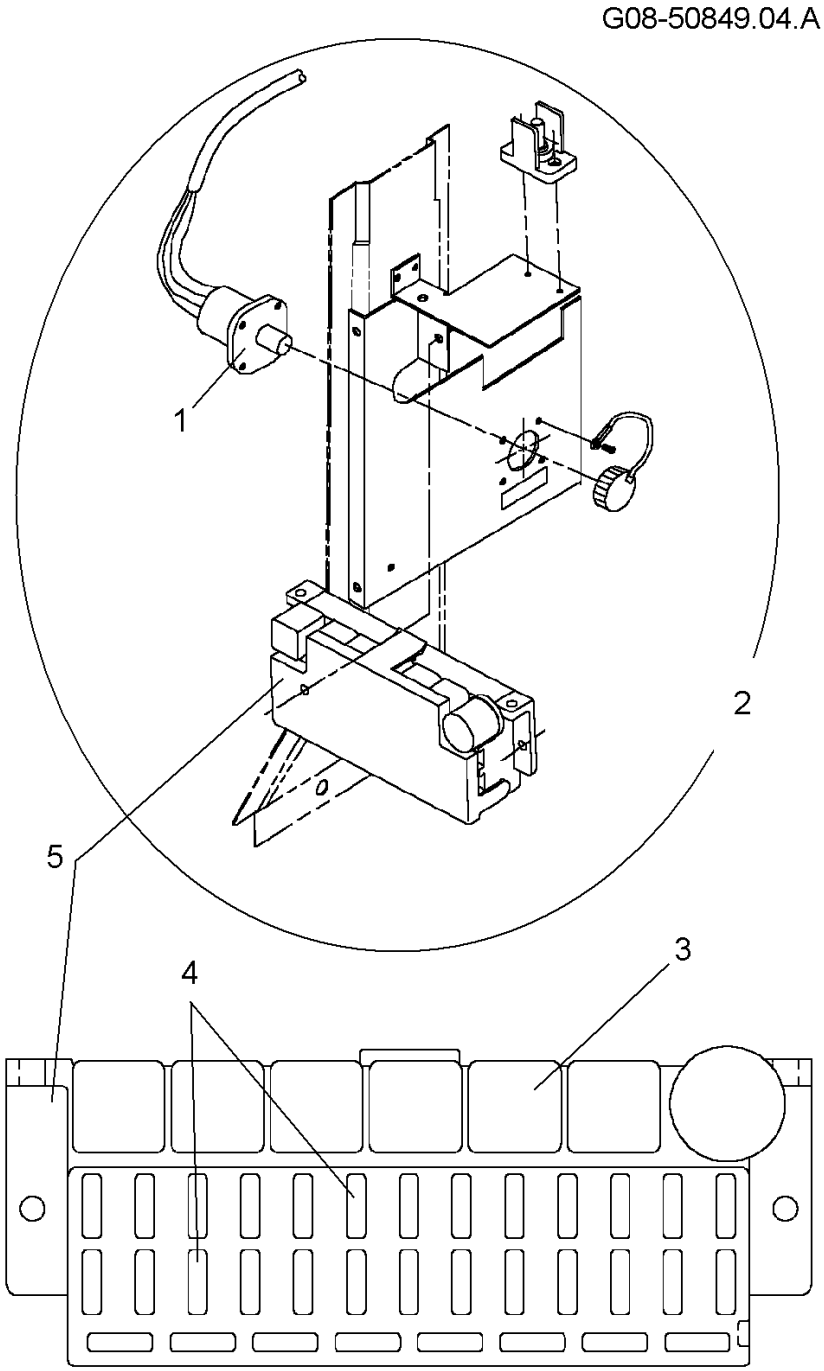
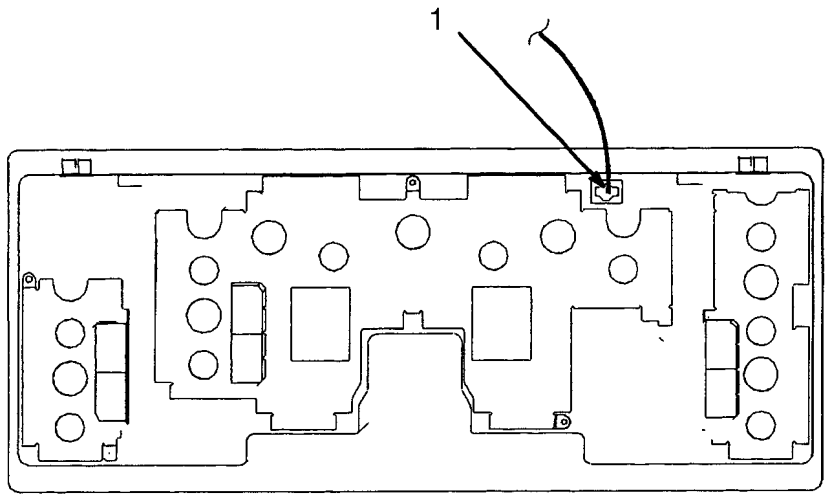


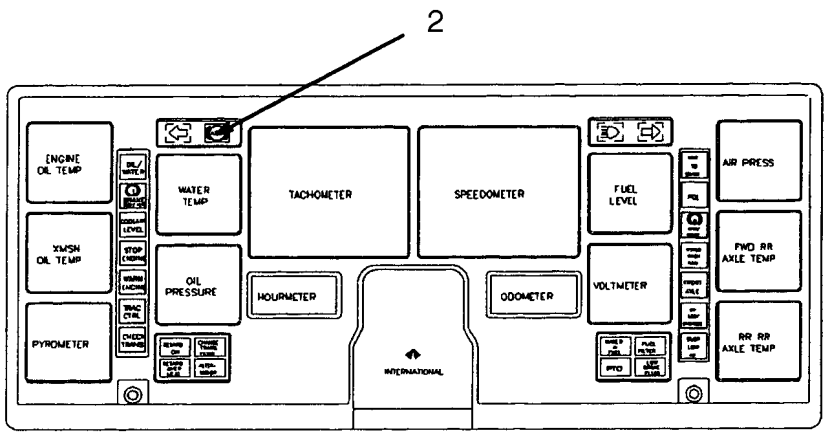
Figure 26 Cab Wiring – 3400 and 4000

1. DIAGNOSTIC CONNECTOR
2. VIEW IN DIRECTION OF ARROW 2 IN FIGURE 25 (above)
3. ABS WARNING LIGHT RELAY
4. IGNITION FUSES
5. FUSE AND RELAY PANEL

G08–44209.02



INSTRUMENT CLUSTER
REAR VIEW
VIEW C



INSTRUMENT CLUSTER
FRONT VIEW

Figure 27 3000, 3800 and 4000 Instrument Cluster

1. ABS WARNING LIGHT
2. ABS WARNING LIGHT

G08–51806.01

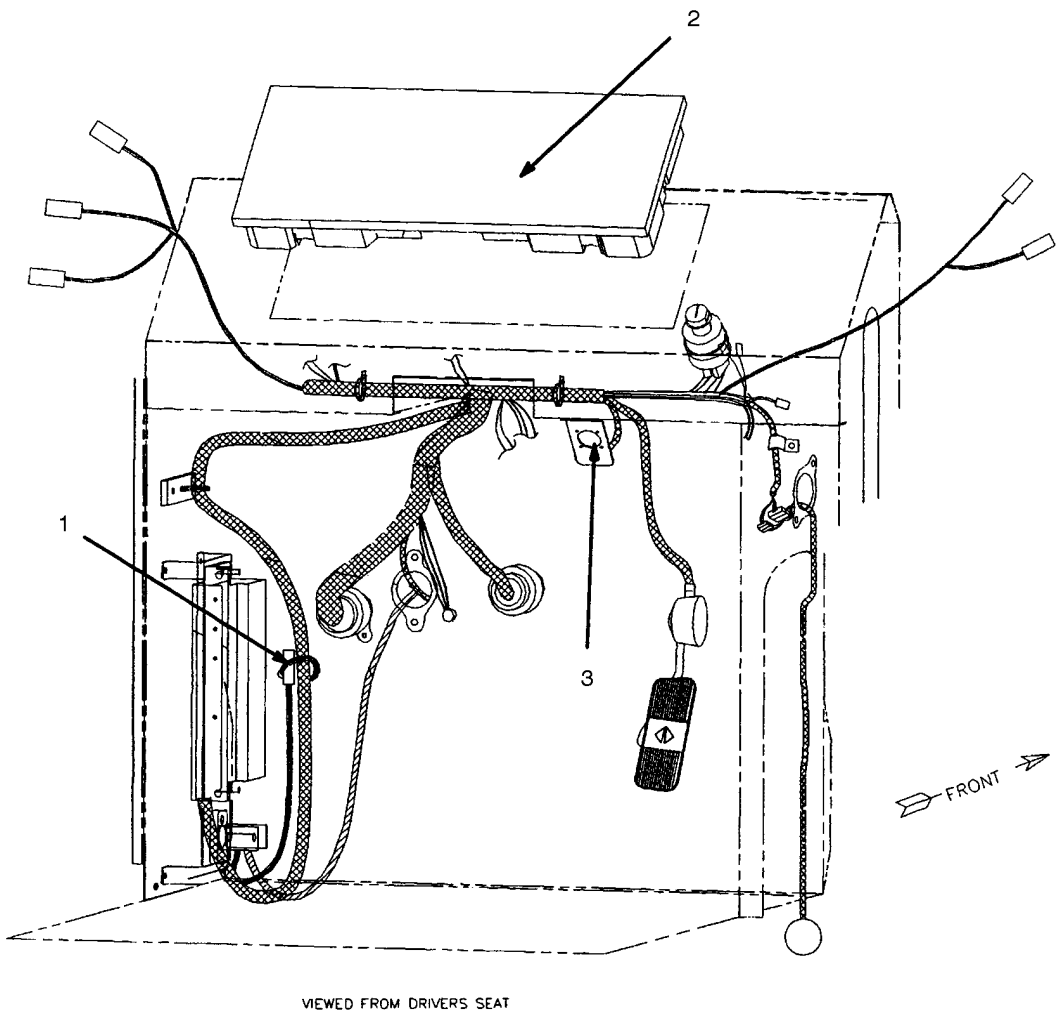


Figure 28 Platform Wiring – 3000FE

1. 60 AMP MAXIFUSE
2. INSTRUMENT CLUSTER
3. DIAGNOSTIC CONNECTOR (384)

G08–51806.01

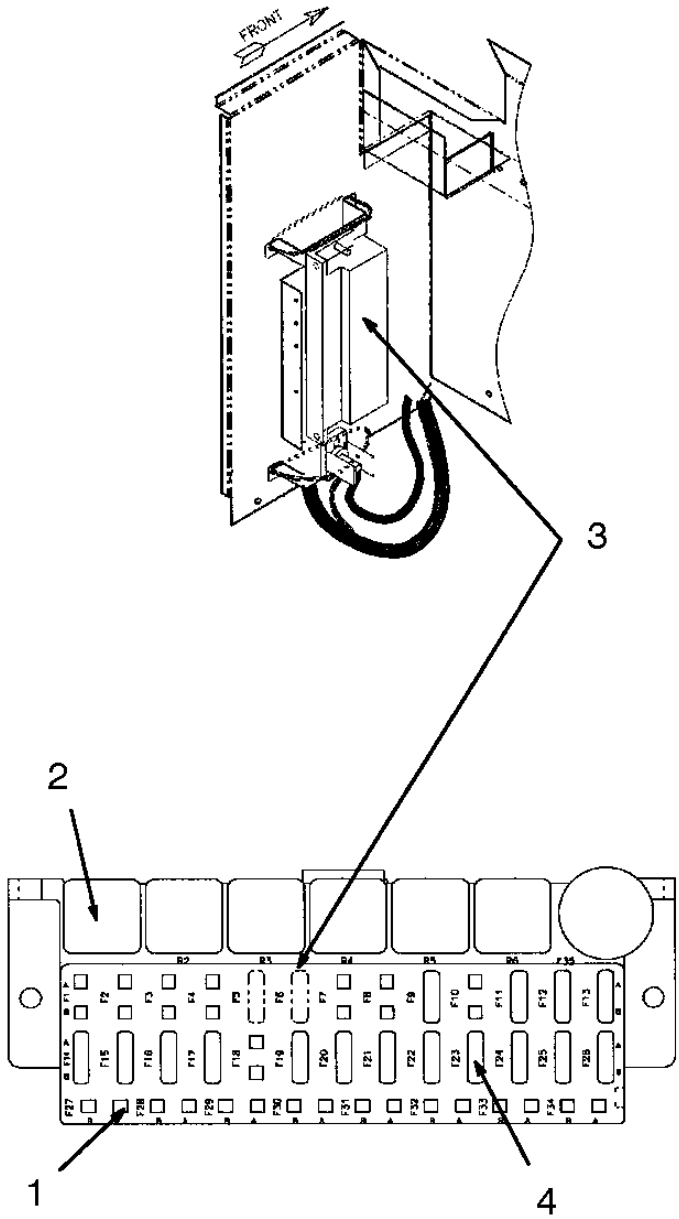


Figure 29 Platform Wiring 3000FE

1. IGNITION FUSE
2. HYDRAULIC ABS WARNING LIGHT RELAY
3. FUSE AND RELAY PANEL
4. IGNITION FUSE

G08−51806.06

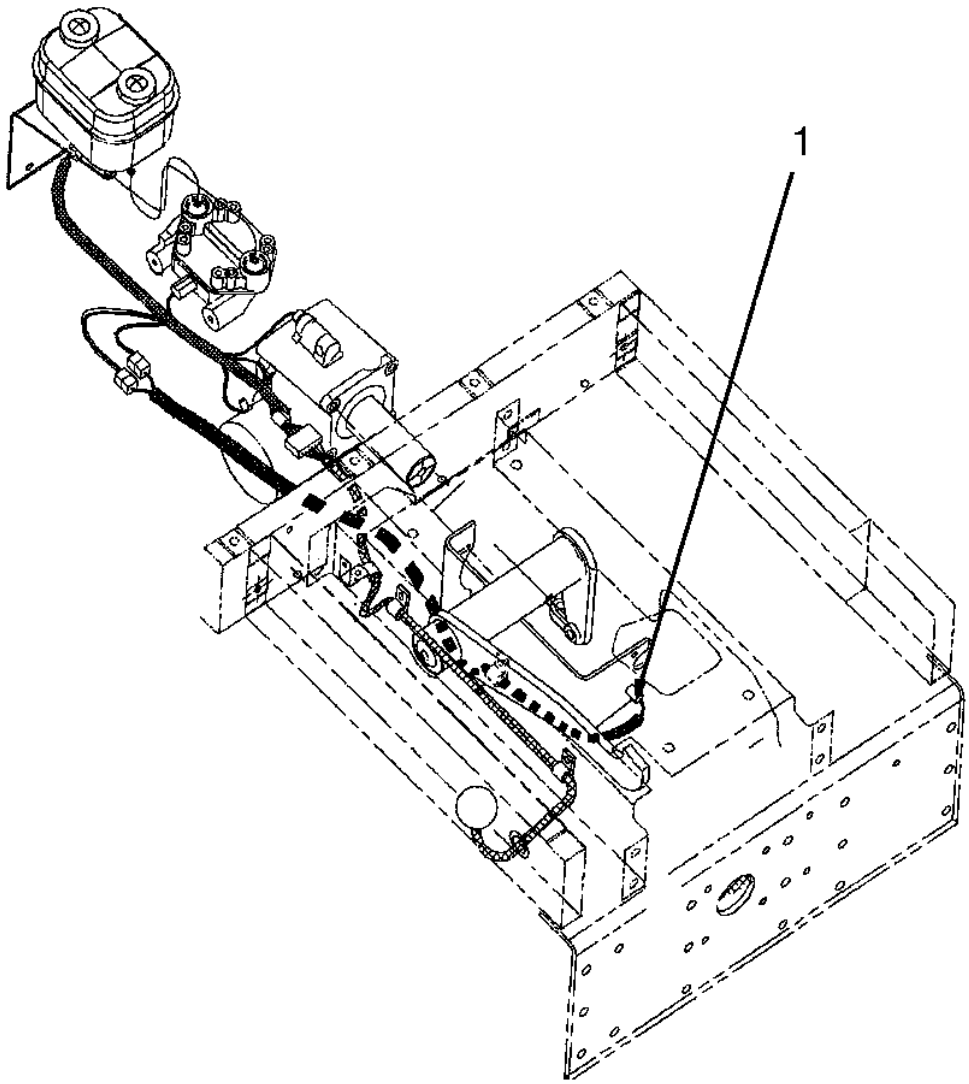


Figure 30 Platform Wiring 3000FE

1. STOP LIGHT SWITCH (209)

G08−51861.04

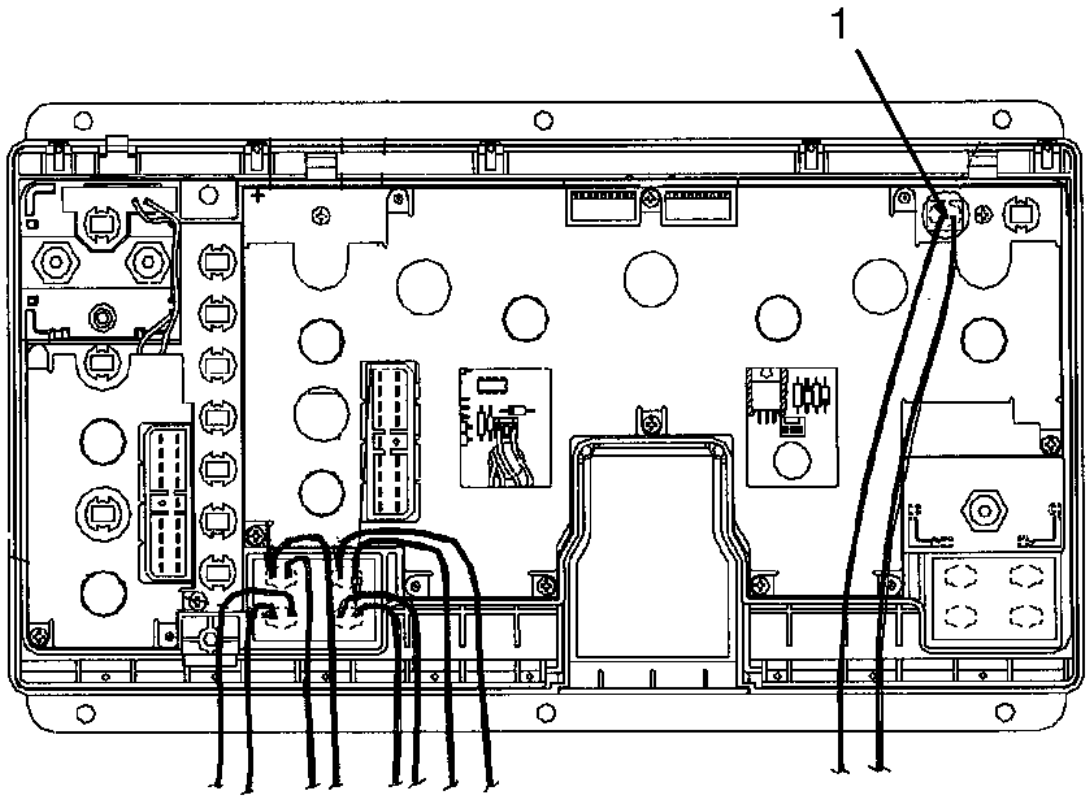


Figure 31 Instrument Panel Wiring – 3000FE and 3000RE

1. ABS WARNING LIGHT

G08−51861.02

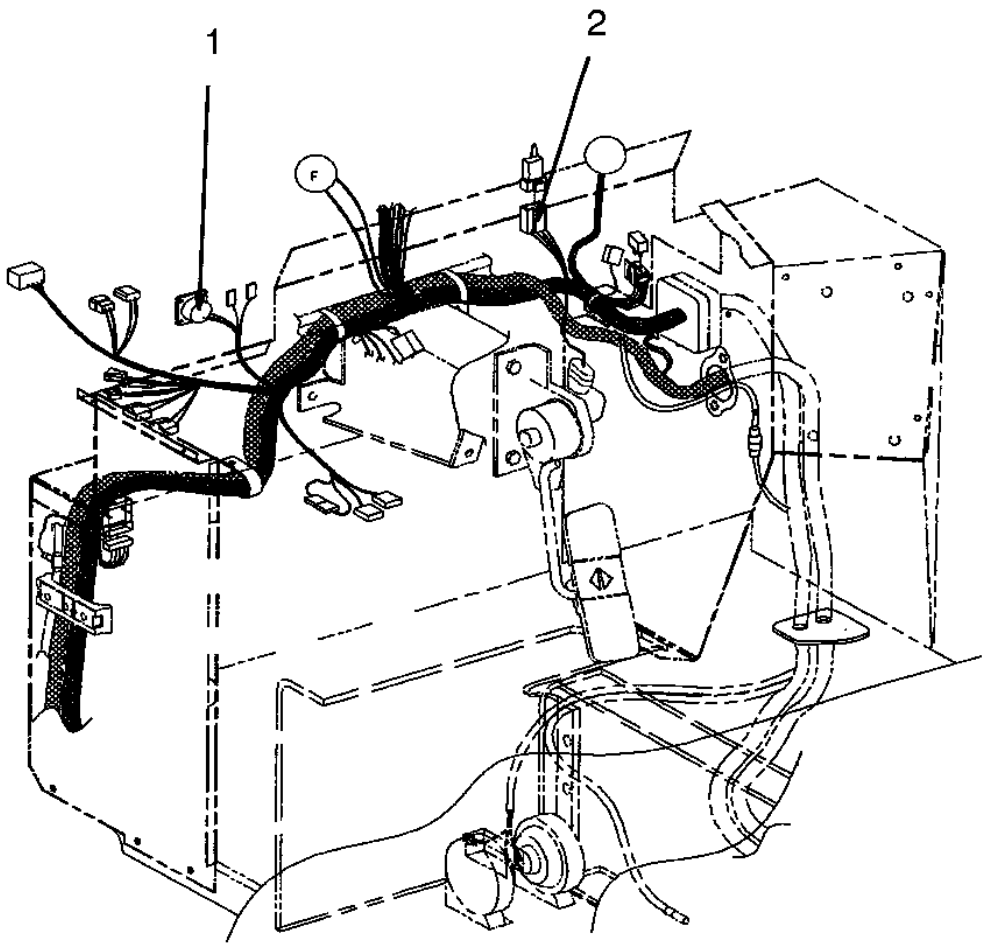


Figure 32 Platform Wiring – 3000RE

1. DIAGNOSTIC CONNECTOR (387)
2. (RETARDER) ABS/ALLISON TRANSMISSION INTERCONNECT (377) OR (168) ON 3000FE

G08–51861.07 & .05

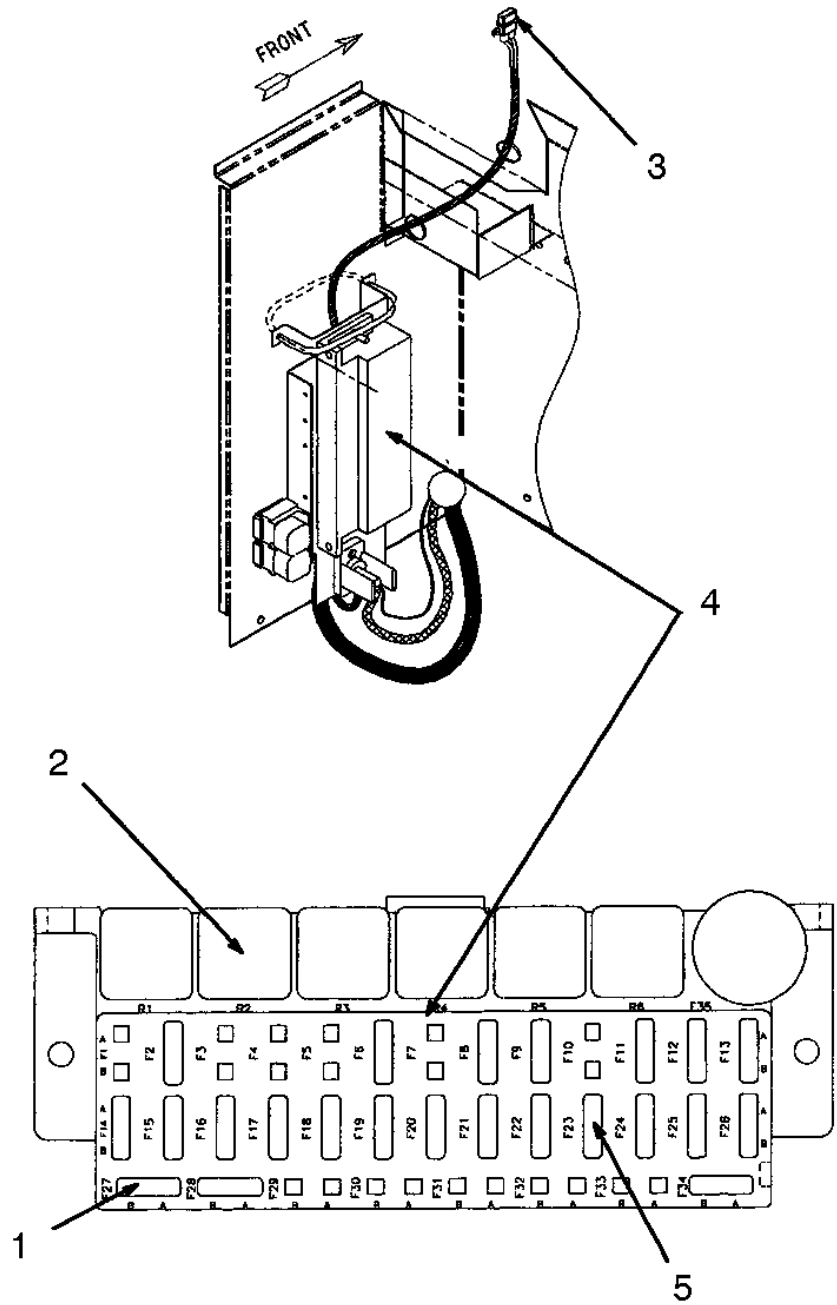


Figure 33 Platform Wiring – 3000RE

1. IGNITION FUSE
2. HYDRAULIC ABS WARNING LIGHT RELAY
3. 60 AMP MAXIFUSE
4. FUSE AND RELAY PANEL
5. IGNITION FUSE

Rear Control Box Wiring 3000RE

G08–51039.01

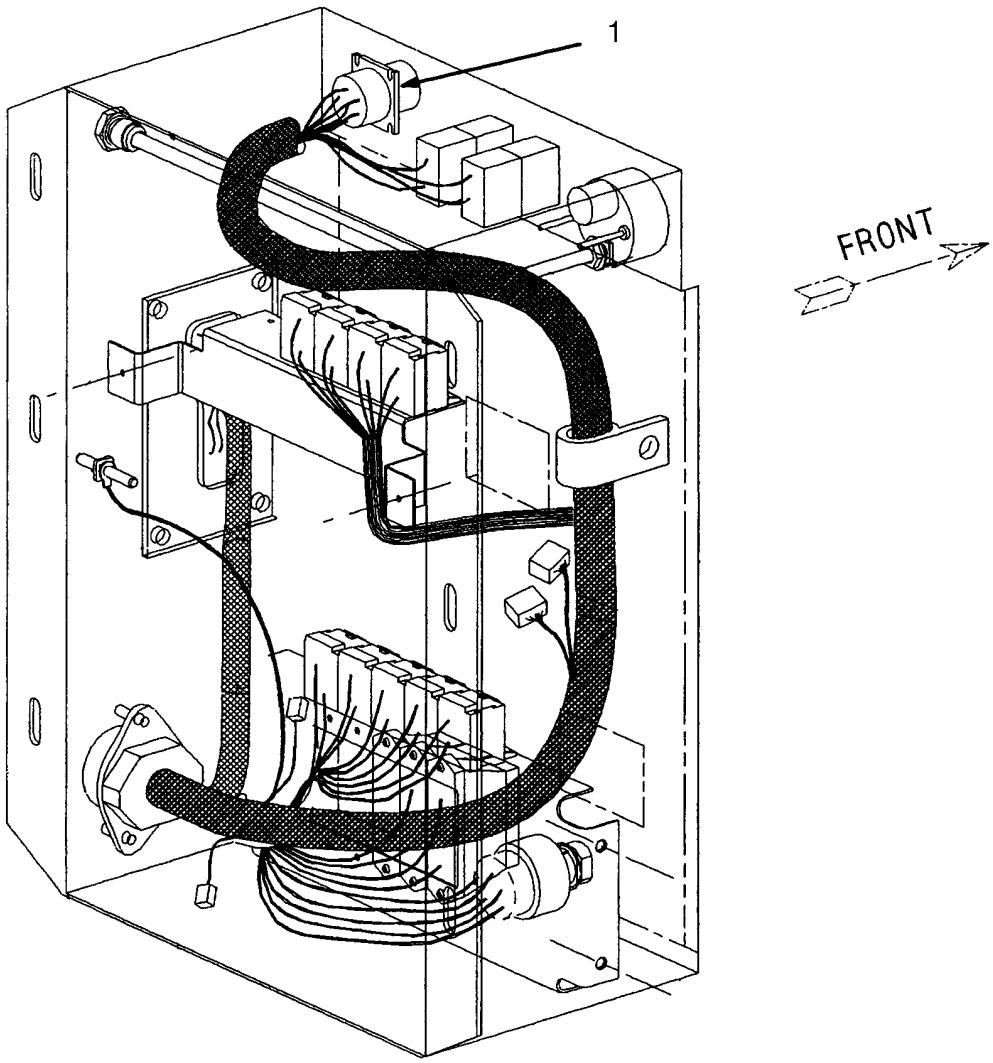


Figure 34 Rear Control Box Wiring – 3000RE

1. REAR DIAGNOSTIC CONNECTOR (387)

G08–51767.01

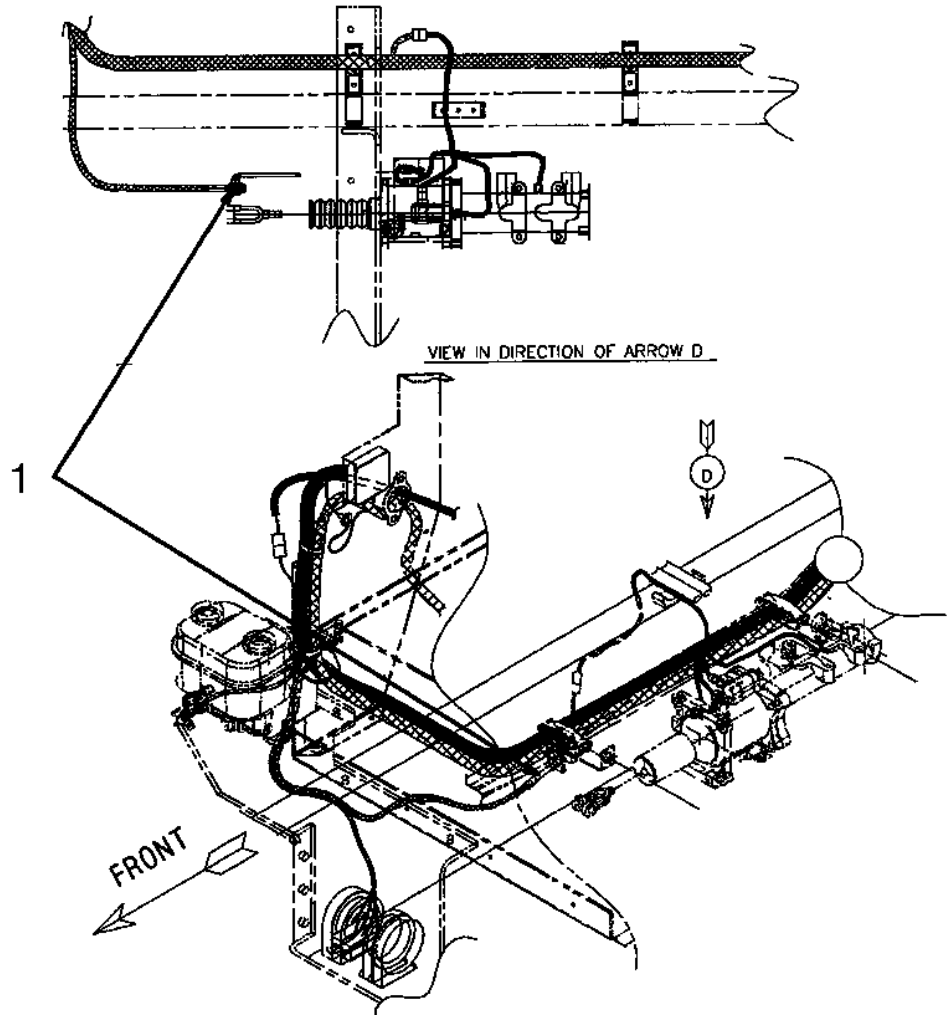


Figure 35 Chassis Wiring – 3000RE

1. STOP LIGHT SWITCH (209)

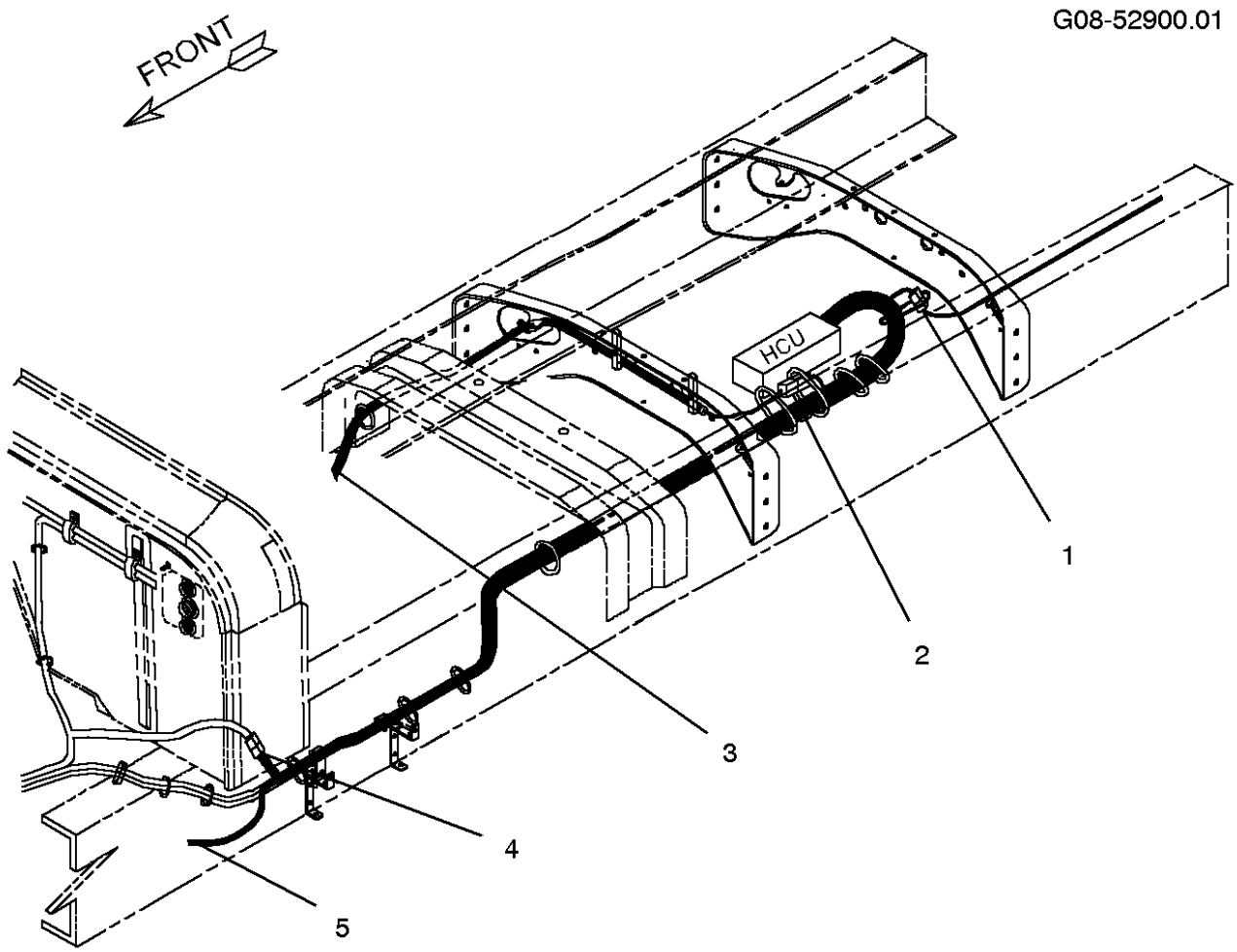


Figure 36 Chassis Wiring – IC bus

1. CHASSIS HARNESS TO REAR WHEEL SENSOR HARNESS CONNECTOR (323)
2. CONNECTOR (1004)
3. CHASSIS HARNESS TO RIGHT FRONT WHEEL SENSOR HARNESS CONNECTOR (428)
4. 2–WAY (1002) & 6–WAY (261) ABS INTERCONNECT TO ENGINE HARNESS
5. CHASSIS HARNESS TO LEFT FRONT WHEEL SENSOR HARNESS CONNECTOR (426A)

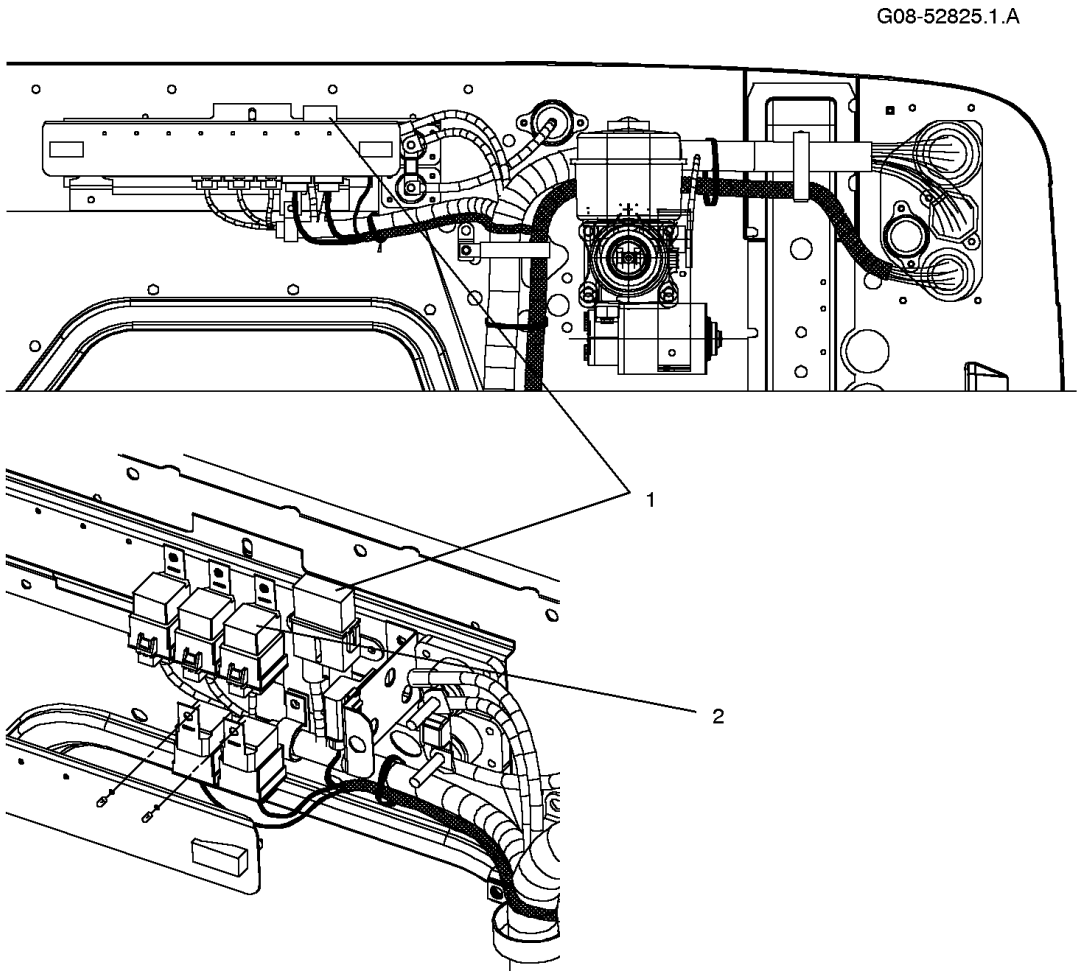


Figure 37 Engine Wiring – IC bus

1. 60A MAXIFUSE (329)
2. ABS SIGNAL GROUND RELAY (629) WILL BE IN ONE OF THESE RELAY LOCATIONS

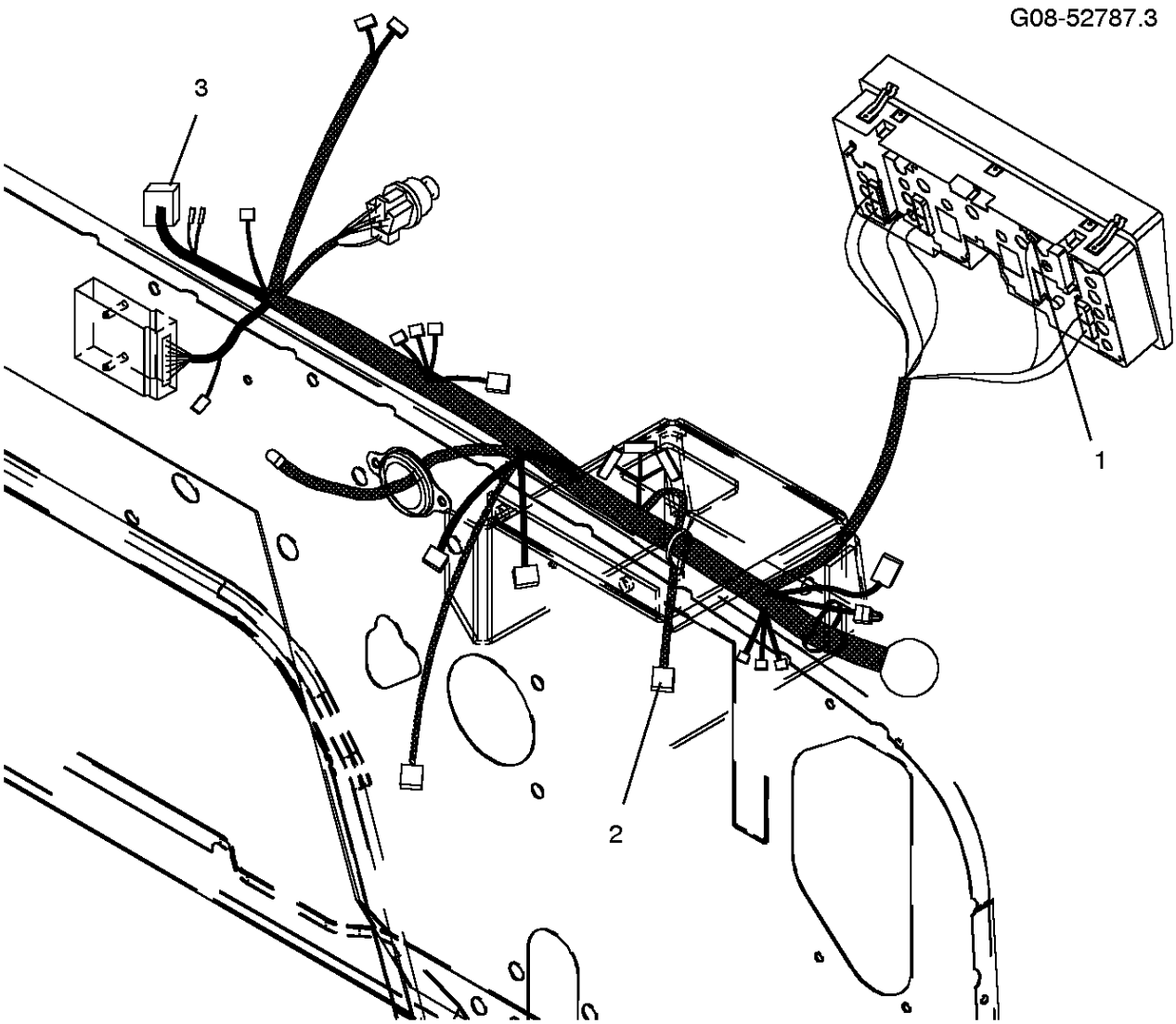


Figure 38 Cab Wiring – IC bus

1. ABS WARNING LIGHT
2. HYDRAULIC BRAKE SWITCH CONNECTOR (50)
3. DIAGNOSTIC CONNECTOR (419)

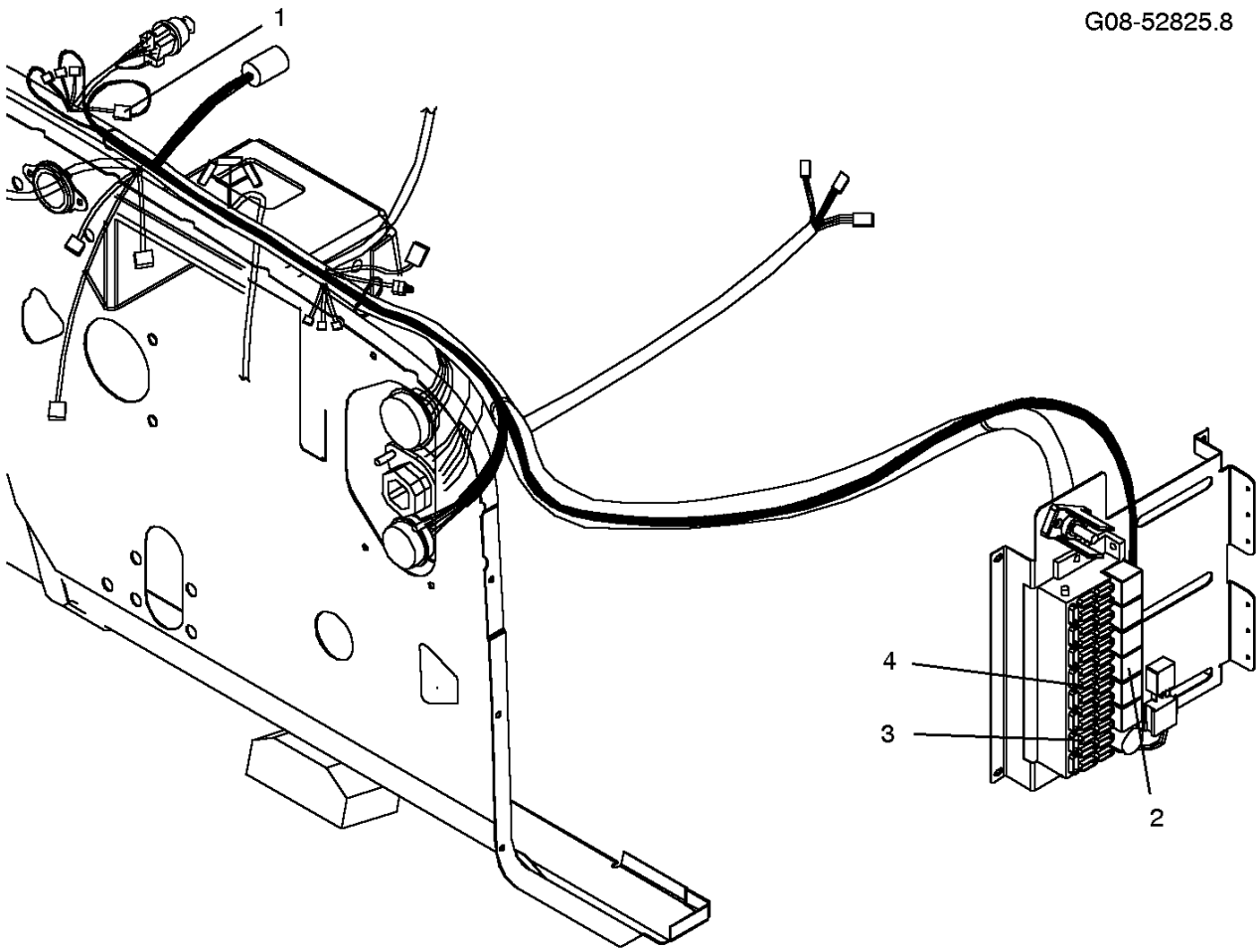


Figure 39 Engine Wiring – IC bus

1. 8–WAY ABS/ALLISON INTERCONNECT (377)
2. ABS WARNING LIGHT RELAY
3. ABS WARNING LIGHT FUSE (F24)
4. ABS IGNITION FUSE (F20)

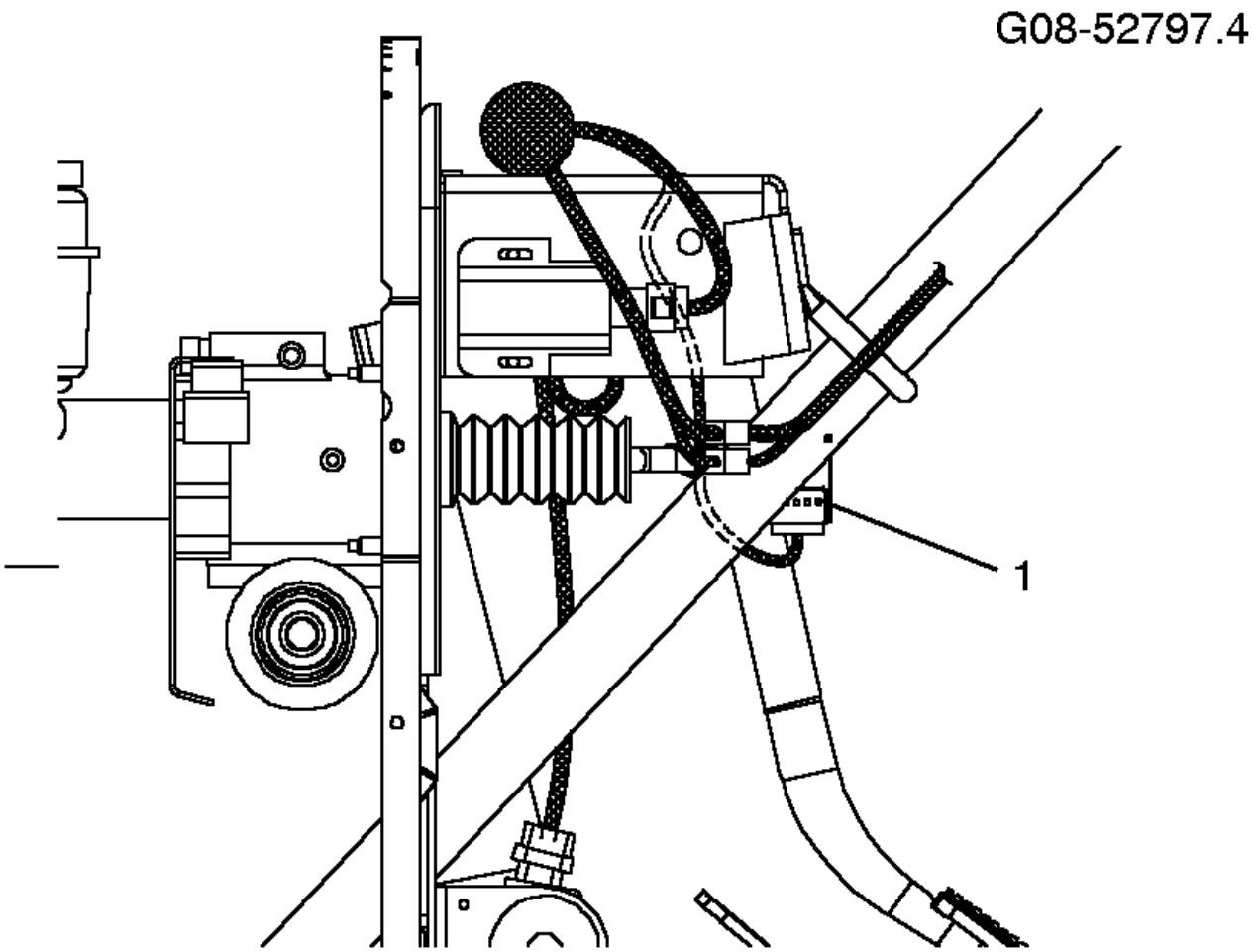


Figure 40 Engine Wiring – IC bus

1. HYDRAULIC BRAKE SWITCH

REMOVE

ELECTRONIC CONTROL UNIT

EHCU

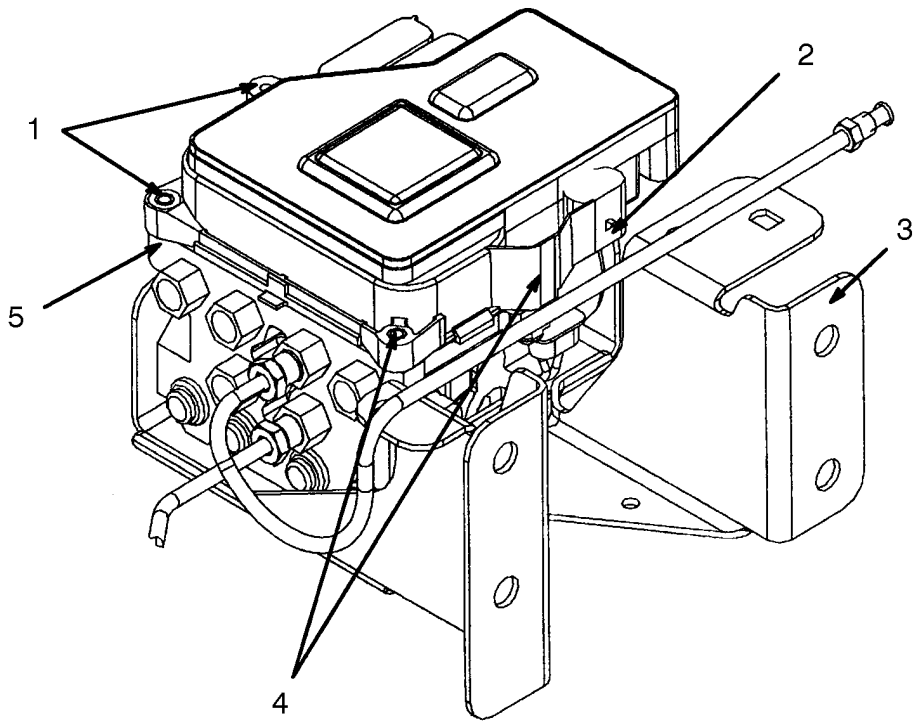


Figure 41 Electro–Hydraulic Control Unit

1. ECU BOLTS
2. ECU TO HCU INTERCONNECT
3. MOUNTING BRACKET
4. ECU BOLTS
5. ELECTRO HYDRAULIC CONTROL UNIT (EHCU)

NOTE – In some installations there may not be enough room to remove the ECU from the EHCU without removing the EHCU. If the ECU needs to be replaced, it is advantageous to remove the ECU without removing the EHCU.

IMPORTANT – Avoid touching the pins of the electrical connectors on the ECU. Damage could occur, due to electrostatic discharge.

1. Disconnect the negative battery terminal.

2. Disconnect the 2-way and 24-way electrical connectors from the ECU (See Figure 8, page 10).

NOTE – It may be necessary to cut retainers and move the wire harness to gain access to the electrical interconnect.

3. Disconnect the 2-way connector from the electrical interconnect between the ECU and HCU (it is located on the side of the EHCU next to the frame rail).

4. Remove the four Torx® bolts that fasten the ECU to the HCU (See Figure 43, page 102).

IMPORTANT – Always insure surfaces and gaskets are kept clean to prevent contamination.

5. Remove the ECU from the HCU. A light amount of force may be required.

ELECTRO-HYDRAULIC CONTROL UNIT

IMPORTANT – Avoid touching the pins of the electrical connectors on the ECU. Damage could occur, due to electrostatic discharge.

1. Disconnect the negative battery terminal.

2. Disconnect the 2 electrical connectors from the ECU.

IMPORTANT – Be prepared to catch brake fluid draining from brake lines when they are disconnected.

3. Disconnect the six brake lines to the HCU (See Figure 44, page 104).

4. Remove the three bolts fastening the EHCU to the EHCU bracket.

5. Remove the EHCU from the EHCU bracket.

FRONT WHEEL SENSORS

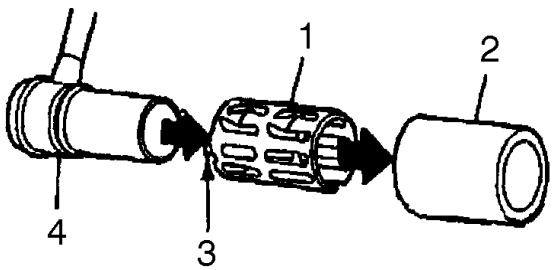


Figure 42 Wheel Speed Sensor

1. SPRING CLIP
2. SENSOR HOLDER
3. SPRING CLIP TAB
4. SENSOR

1. Block the wheels of the vehicle.

2. Remove the sensor from the brake anchor plate (See Figure 14, page 72), using a twisting motion if necessary. **Do not pull** on the cable to remove.

3. Remove any fasteners holding the sensor cable to other components

4. Disconnect the sensor cable from the chassis harness.

REAR WHEEL SENSORS

1. Block the wheels of the vehicle

2. Remove the sensor from the brake anchor plate (See Figure 15, page 73), using a twisting motion if necessary. **Do not** pull on the cable to remove.

3. Remove any fasteners holding the sensor cable to other components.

4. Disconnect the sensor cable from the chassis harness.

DISASSEMBLE

CAUTION – Do not remove the pump motor from the HCU. The pump motor is not a replaceable unit.

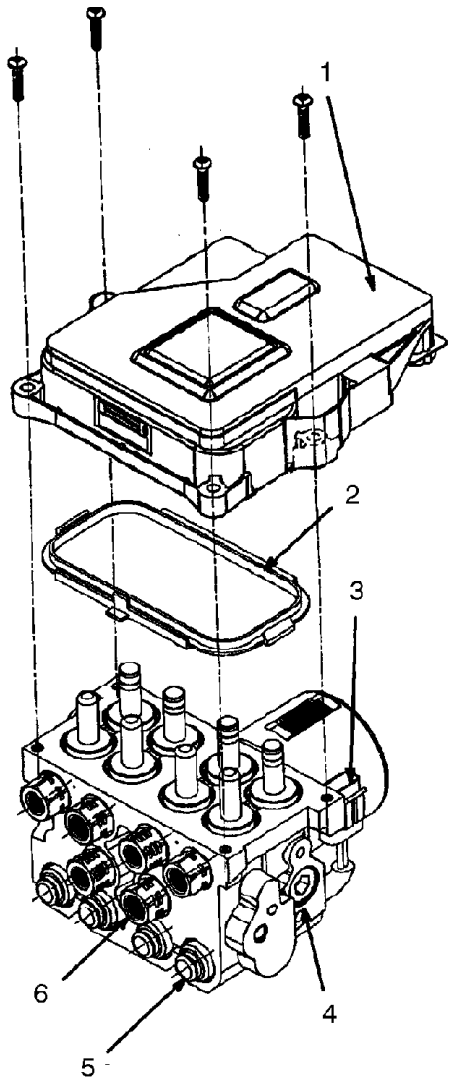


Figure 43 Electro-Hydraulic Control Unit – Exploded View

1. ELECTRONIC CONTROL UNIT
2. EHCU GASKET
3. ELECTRICAL INTERCONNECT
4. HYDRAULIC CONTROL UNIT
5. ACCUMULATOR PORT COVERS (4 EACH)
6. TUBE NUT ADAPTERS (6 EACH)

ELECTRO-HYDRAULIC CONTROL UNIT

IMPORTANT – Do not pry on the ECU or HCU with a mechanical aid. Excessive force will cause damage to the units.

1. Remove the EHCU (refer to removal of the EHCU).

IMPORTANT – Important: Avoid touching the pins of the electrical connectors on the ECU. Damage could occur, due to electrostatic discharge.

2. Disconnect the 2-way connector from the electrical interconnect between the ECU and HCU (it is located on the side of the EHCU that was next to the frame rail).

IMPORTANT – Always insure hydraulic connections and components are kept clean to prevent contamination.

3. Remove the four T-25 Torx® bolts which fasten the ECU to the HCU.

4. Remove the ECU from the HCU. A light amount of force may be required.

RE-ASSEMBLE

ELECTRO-HYDRAULIC CONTROL UNIT

IMPORTANT – Do not reuse the ECU gasket or mounting bolts. Always install new gasket and mounting bolts with the replacement ECU.

1. Install a new ECU gasket onto the HCU.

IMPORTANT – Do not use RTV or any other type of sealant on the ECU gasket or mating surfaces.

2. Mate the ECU with the HCU.

3. Install four new Torx® T-25 ECU bolts and tighten them to 5 Nm (39 in-lbs.) in an X pattern.

4. Connect the 2-way connector from the interconnect on the HCU to the ECU (it is located on the side of the EHCU that will face the frame rail).

INSTALL

ELECTRONIC CONTROL UNIT

IMPORTANT – Avoid touching the pins of the electrical connectors on the ECU. Damage could occur, due to electrostatic discharge.

1. Disconnect the negative battery terminal.

IMPORTANT – Do not reuse the ECU gasket or mounting bolts. Always install new ones.

2. Install a new ECU gasket onto the ECU.

IMPORTANT – Do not use RTV or any other type of sealant on the ECU gasket or mating surfaces.

3. Mate the ECU with the HCU.

4. Install four new Torx® T-25 ECU bolts and tighten them to 5 Nm (40 in-lbs.) in an X pattern.

5. Connect the 2-way connector from the interconnect on the HCU to the ECU (it is located on the side of the EHCU that will face the frame rail).

6. Connect the 2-way and 24-way electrical connectors to the ECU (See Figure 8, page 10).

ELECTRO-HYDRAULIC CONTROL UNIT

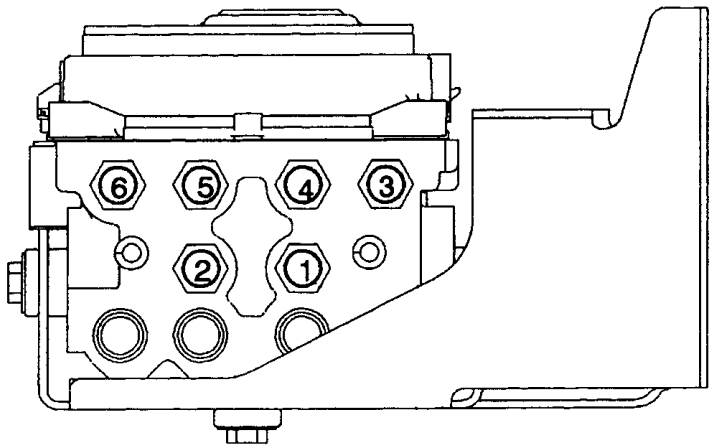


Figure 44 Hydraulic Line Locations

PORT 1. SECONDARY TUBE
PORT 2. PRIMARY TUBE
PORT 3. RIGHT REAR CROSSOVER TUBE
PORT 4. “J” TUBE LEFT REAR
PORT 5. RIGHT FRONT CROSSOVER TUBE
PORT 6. LEFT FRONT TUBE

1. Install EHCU into the EHCU bracket.
2. Install three nuts which fasten the EHCU to the EHCU bracket and tighten them to 24 Nm (18 ft-lbs).
3. Insure the negative battery cable is disconnected.
4. Connect the 2-way and 24-way electrical connectors to the ECU (See Figure 8, page 10).
5. Connect negative battery cable to the battery.
6. Reconnect six brake lines (See Figure 44, page 104) and tighten to 16 Nm (12 lbf-ft.)
7. Bleed the brakes and EHCU (see ABS Bleeding).

FRONT WHEEL SENSOR

IMPORTANT – It may be necessary to transfer the wire retainers from the old wheel speed sensor wire to the replacement part. Use caution installing the retainers on the new wire to ensure it is not damaged.

1. Push the sensor spring clip into the bushing in the steering knuckle (See Figure 14, page 72)until it stops.

NOTE – Be sure the sensor spring clip is installed with the flange stop against the steering knuckle.

2. Push the sensor completely into the sensor spring clip until it contacts the tooth wheel. No clearance between the sensor and tooth wheel is required.

3. Route the cable to the frame rail. Be sure to route the cables in a way that will prevent pinching or chafing and will allow sufficient movement for suspension travel.

4. Connect the sensor cable to the chassis harness. Connect the sensor cable to the chassis harness.

5. Install any fasteners that held the old sensor cable in place.

REAR WHEEL SENSOR

IMPORTANT – It may be necessary to transfer the wire retainers from the old wheel speed sensor wire to the replacement part. Use caution installing the retainers on the new wire to ensure it is not damaged.

1. Push the sensor spring clip into the mounting block(See Figure 15, page 73) until it stops .

NOTE – Be sure the sensor spring clip is installed with the flange stops on the inboard side (vehicle inboard).

2. Push the sensor completely into the sensor spring clip until it contacts the tooth wheel. No clearance between the sensor and tooth wheel is required.

3. Route the cable to the frame rail. Be sure to route the cables in a way that will prevent pinching or chafing and will allow sufficient movement for suspension travel.

4. Connect the sensor cable to the chassis harness.

5. Install any fasteners that hold the sensor cable in place.

MAINTENANCE

ABS BLEEDING

NOTE – This special procedure is normally only required when replacing the HCU or the ABS has been activated when air is suspected in the brake lines.

The following steps outline the two person procedure:

1. Gain access to the system bleed screws.

2. Begin by bleeding the system at the right rear wheel, then left rear, then front wheels.

3. Install a clear hose on the bleed screw. Immerse the opposite end of the hose into a container partially filled with clean DOT 3 Brake fluid. Install a clear hose on the bleed screw. Immerse the opposite end of the hose into a container partially filled with clean DOT 3 Brake fluid.

4. Have an assistant pump the brakes and then slowly press the brake pedal until it reaches full travel and hold.

5. Open the bleed screw 1/2 to 1 full turn to let air out of system. Close bleed screw before all pressure is released.

6. Have your assistant release the brake pedal and wait 10-15 seconds for the master cylinder pistons to return to home position.

7. Repeat steps 4 through 6 until clean, air free, brake fluid is present at each of the wheel bleed screws. (This procedure may use more than a pint of fluid per wheel. Check the master cylinder fluid level every 4 to 6 strokes of the brake pedal to avoid running the system dry).

8. Re-bleed all four wheels using steps 4 through 7 to remove the remaining air from the brake system.

9. Use the EZ-Tech or PRO-LINK 9000 to run the “Zero-Speed System Test” or “Dealer’s Bleed Test” four times consecutively while applying the brake pedal firmly.

10. Re-bleed all four wheels using steps 4 through 7 to remove the remaining air from the brake system.

11. Evaluate the brake pedal feel before attempting to drive the vehicle and re-bleed as many times as necessary to obtain appropriate pedal feel.

SOFT PEDAL OR EXCESSIVE PEDAL TRAVEL

Soft pedal or excessive pedal travel may be the result of a leaking master cylinder, wheel cylinder, or defective HCU. The following steps will assist in determining if the HCU is the cause:

1. Remove the rubber boots from the 4 HCU low pressure accumulators (See Figure 43, page 102).

NOTE – One of the accumulator ports is blocked by the EHCU bracket. It may not be possible to perform this test on the blocked port.

2. Insert a clean steel probe into each low pressure accumulator.

3. Have an assistant press hard and quickly on the brake pedal while watching for travel of the probe. If there is any travel of the probe, the HCU will need to be replaced. If there is not any travel of the probe, the master cylinder or wheel cylinders may be faulty.

COMPRESSING DISK BRAKE CYLINDERS

When compressing disk brake cylinders open the brake cylinder bleeder valve before compressing the cylinder. This will insure contamination is not forced into fluid lines.

TORQUE

Table 35 Torque Chart

Location	Nm	Ft-Lbs	In-Lbs.
EHCU Bracket Mounting Bolts	24	18	
ECU to HCU	5		40
EHCU to Bracket	9	7	
Front Brake line to EHCU	16	12	
Rear Brake Line to EHCU	16	12	

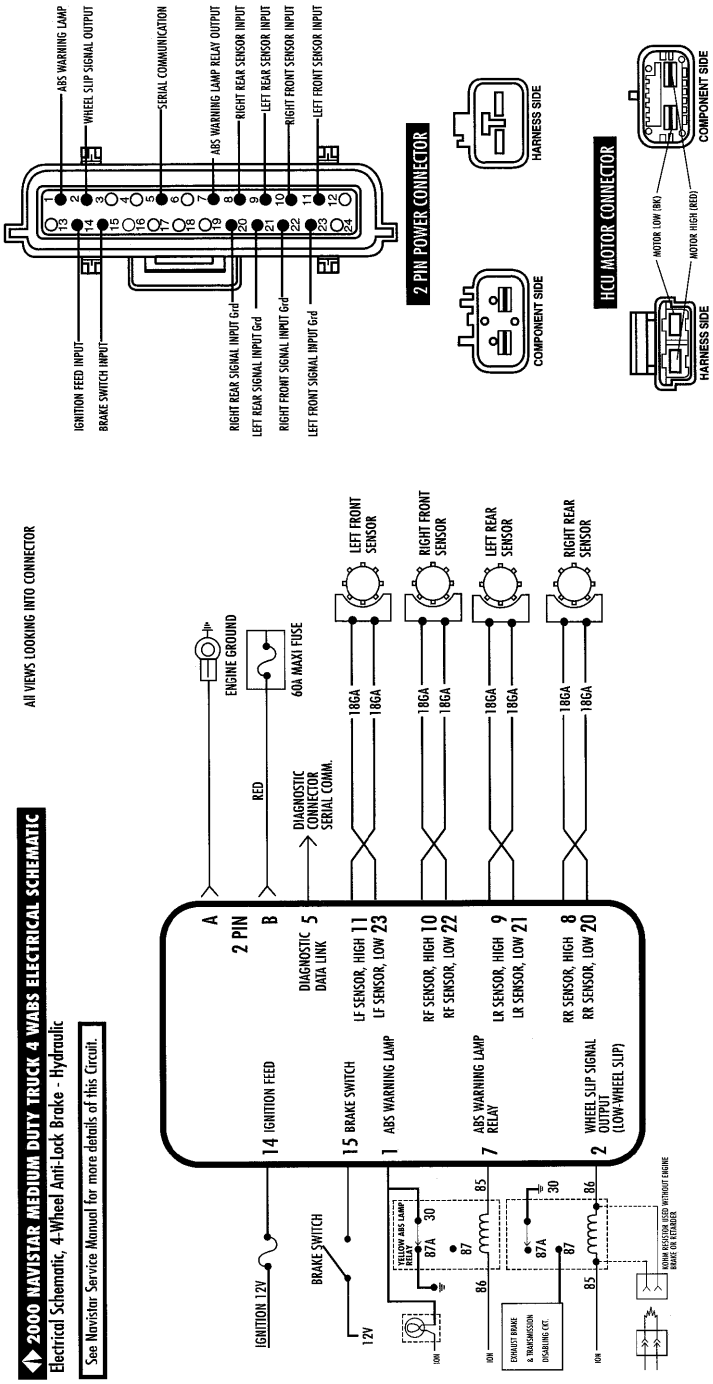


Figure 45 Quick Reference Guide, Page 1

DIAGNOSTIC TROUBLE CODES (DTC)	POSSIBLE CONTRIBUTING 4WABS COMPONENT AND VEHICLE FAULTS
ELECTRICAL FAILURE IN HYDRAULIC VALVE CIRCUIT 45/46-Front Left Isolation / Dump Coil Open. 41/42-Front Right Isolation / Dump Coil Open. 55/56-Left Rear Isolation / Dump Coil Open. 51/52-Right Rear Isolation / Dump Coil Open. 47/48-Front Left Isolation / Dump Coil Shorted. 43/44-Front Right Isolation / Dump Coil Shorted. 57/58-Left Rear Isolation / Dump Coil Shorted. 53/54-Right Rear Isolation / Dump Coil Shorted.	• Open or shorted valve coil. • Poor connection or terminal back out at 2 pin power connector or 24 pin connector. • Open or shorted valve driver in anti-lock brake control module. • Multiple codes suspect poor power and ground.
INTERRUPTION OF WHEEL SPEED SENSOR SIGNAL	
25/26/27-Front Left Open / Missing / Erratic Speed Sensor. 21/22/23-Front Right Open / Missing / Erratic Speed Sensor. 35/36/37-Left Rear Open / Missing / Erratic Speed Sensor. 31/32/33-Right Rear Open / Missing / Erratic Speed Sensor.	• Poor connection or terminal back out at affected sensor 2-way, or anti-lock brake control module connectors. • Open or short (steady or intermittent) in affected circuit(s) between anti-lock brake control module and affected sensor. • Mismatch Tires. • Open or shorted sensor coil. • Damaged or missing tone (exciter) ring. • Sensor contact with tone (exciter) ring. • Sensor air gap too large • Excessive wheel end play.
38-Wheel Sped Error.	• Different size tires. • Extended tire spinning.
BRAKE RETARDER RELAY	
87-Retarder output fault detection.	• Possible open or short to exhaust brake or relay.

DIAGNOSTIC TROUBLE CODES (DTC)	POSSIBLE CONTRIBUTING 4WABS COMPONENT AND VEHICLE FAULTS
ELECTRICAL FAILURE OF RELAY OR RELAY CIRCUIT 65/66-Open / Shorted Relay Failure	• Poor connections or terminal back out at 24-way anti-lock brake control module connector or 2 pin power connector. • Open or Short (steady or intermittent), power supply or ground circuits. • Open 60A fuse.
ABS FAILURE OF HCU MOTOR OR MOTOR CIRCUIT	
67/68-Open / Shorted Hydraulic Pump Motor.	• Open motor winding. • Shorted anti-lock brake control module motor driver output. • Open circuit in series with motor feedback circuit. • Seized HCU motor or pump. • Short circuit in motor winding. • Defective (shorted) pump motor driver circuit in anti-lock brake control module.
ABS WIRING, LAMP, AND BRAKE SWITCH FAILURE	
81-Stuck Brake Switch. Loss of Ignition Voltage - No Code Loss of Signal Ground - No Code Loss of Power Ground - No Code 86-Shorted ABS Indicator Lamp	• Brake Switch Stuck Closed. • Short to Power on Brake Switch Circuit. • Loss of Power or Ground to ABS Module. • Blown Ignition Fuse. • Shorted Bulb. • Short to B+ on Low Side of Bulb. • Faulty Lamp Relay. • Faulty Lamp Driver.
ABS CONTROL MODULE FAILURE	
71/72/73-RAM/ROM / Watchdog Error.	• Degradation of CPU or memory within Microprocessor.
ABS SYSTEM TIME OUT	
69-Excessive dump time. 74-Excessive isolation time.	• Driver Abuse resulting in prolonged continuous ABS activity. • Damaged tone (exciter) ring. • Locked foundation brake component. • Severely flat spotted tires.

VEHICLE SYSTEM/POSSIBLE CAUSES

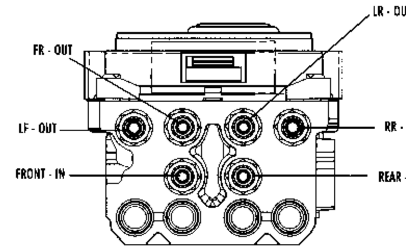
UNWARRANTED ABS ACTIVITY
- Intermittent open or shorted connection or circuit between anti-lock brake control module and wheel speed sensor.
- Damaged tone (exciter) ring.
- Borderline sensor air gap.
- Metal chips on sensor or metallic debris between tone (exciter) ring teeth.
- Excessive wheel end play.
- "Grabby" caliper pads or drum shoe linings.
- Loose sensor.

WHEELS LOCK UP
- Hung up parking brake.
- Stuck wheel cylinder or caliper.
- Contaminated brake pads or shoes.
- Inlet (isolation) valve partially stuck closed.
- Hydraulically inoperative outlet dump valve.

SOFT BRAKE PEDAL
- Poor brake system bleed.
- Hydraulic leak in base brake component, line, or hose.
- Outlet (Dump valve leaky or stuck open.)

HARD BRAKE PEDAL
- Defective booster (base brake).
- Pinched brake line or hose.
- Vacuum leak in vacuum hose to booster.
- Inlet (isolation) valve stuck closed.

LACK OF VEHICLE DECELERATION
- Worn or contaminated pad or shoe linings.
- Pinched brake line or hose.
- Inoperative wheel cylinder or caliper.
- Leaky outlet (Dump) valve.



BRAKE PIPE PORT ORIENTATION

TRW Automotive
1-800-546-4227

Figure 46 Quick Reference Guide, Page 2