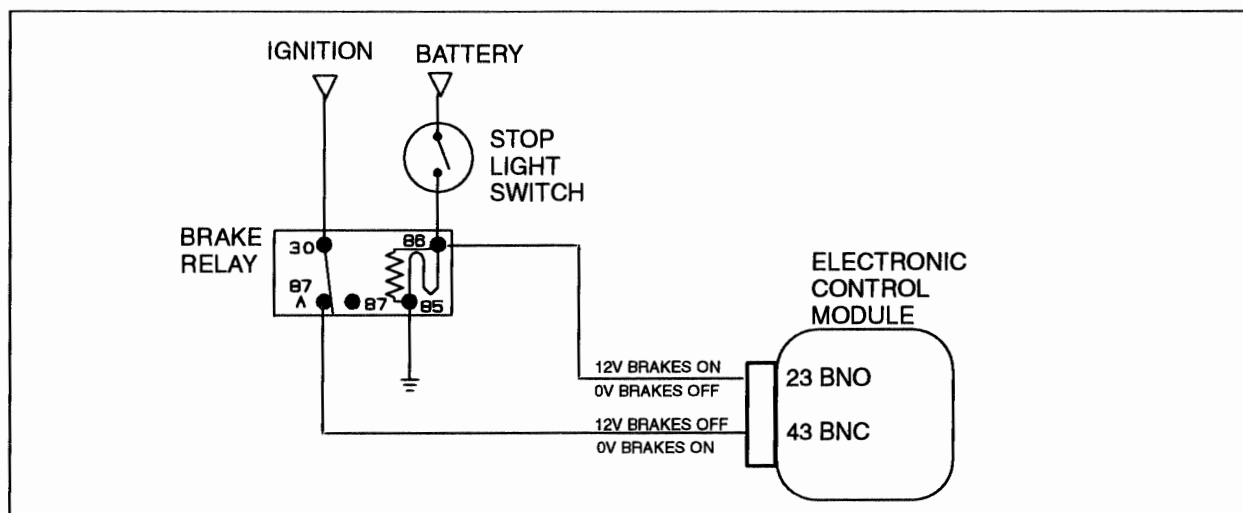


# ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

## BRAKE SWITCH/RELAY CIRCUITS (BRAKE)

### BRAKE SWITCH/RELAY CIRCUITS



#### SIGNAL FUNCTION

The service brake switch circuit function is to communicate to the ECM when the service brakes are applied and when the brakes are not applied. This information is used with cruise control and PTO operation, which are controlled by the ECM.

#### SERVICE BRAKE SWITCH(ES)

There are three configurations of switches used.

1. With tractor air brakes (code 4092) a single normally open switch is used. Air pressure closes the switch with brakes applied.
2. With truck air brakes (4091) two normally open, air operated switches are in parallel circuits.
3. With hydraulic brakes (04040) two mechanical switches are used, but only one of the switches is linked to the ECM. The switches are actuated by the brake pedal arm.

With the key ON and service brakes released, ignition voltage is applied to ECM terminal 43 and no voltage is applied to terminal 23.

When service brakes are applied, voltage is applied to ECM terminal 23 and the voltage to ECM terminal 43 is turned OFF.

#### FAULT DETECTION MANAGEMENT

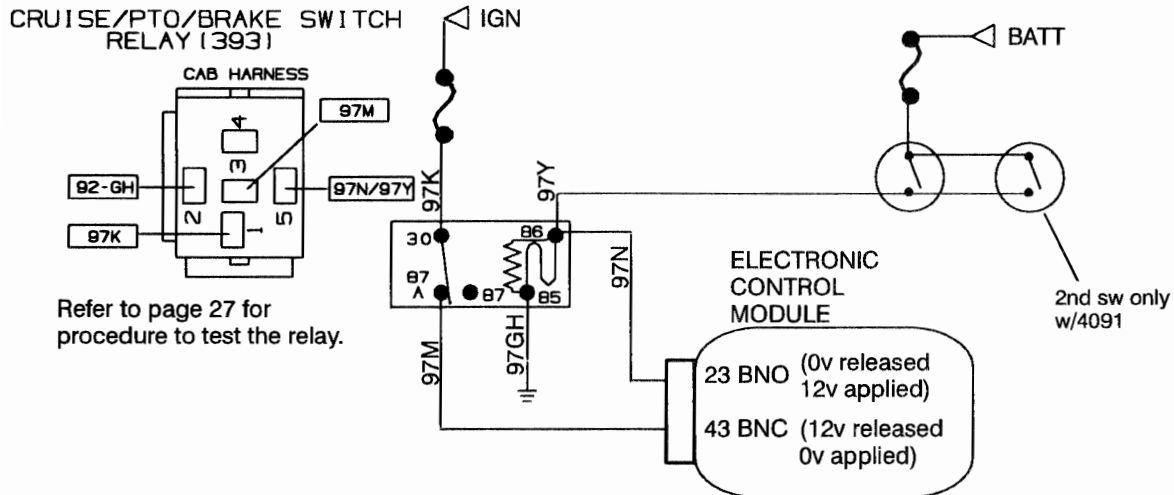
The ECM continuously monitors ECM terminals 23 (BNO) and 43 (BNC). The ECM expects to see 12V at one terminal and 0 volts at the other. If the signals disagree (12 volts at both or 0 volts at both), then flash code 222 is set as an active fault.

When Flash code 222 is active, the Cruise and PTO systems are disabled. If the fault is intermittent, the system does not reset until the vehicle has been shut off and restarted.

This code does not turn ON the engine warning light.

### Brake Switch / Relay (BRAKE)

**Fault Codes:**  
**222 Brake Switch Circuit Fault**



**After removing connectors always check for damaged pins, corrosion, loose terminals etc.**

#### Connector Voltage Checks (Connector (393) with relay removed, Ignition Key ON and Brakes Released)

| Test Points     | Spec.          | Comments  |
|-----------------|----------------|---|
| Cir 97K to grd  | 12 ± 1.5 volts | < 10.5v check connections, if 0 volts, check for open/short to grd or blown fuse                            |
| Cir 97Y to grd  | < 1.0 volt     | > 1.0v check for short to VREF or 12v circuit or defective switch (switch adjustment with hydraulic brakes) |
| Cir 97K to 97GH | 12 ± 1.5 volts | < 10.5v check connections, if 0 volts, check for open in ground circuit 97GH                                |

#### (Connector (393) with relay removed, Ignition Key ON and Brakes Applied)

| Test Points     | Spec.          | Comments   |
|-----------------|----------------|--|
| Cir 97Y to 97GH | 12 ± 1.5 volts | < 10.5v check connections, if 0 volts check for open/short to grd or defective switch (switch adjustment with hydraulic brakes) or blown fuse. |
| Cir 97M to grd  | < 1.0 volt     | > 1.0 volt, check for short to VREF or 12 volt circuit   |

#### (Connector (379) with breakout box installed, brake relay installed, Ignition Key ON, and Brakes Applied)

| Test Points | Spec.          | Comments   |
|-------------|----------------|--|
| #23 to grd  | 12 ± 1.5 volts | < 10.5v check connections, if 0 volts check for open circuit 97N |
| #43 to grd  | < 1.0 volt     | > 1.0 volt short to BATT or VREF or defective relay              |

#### (Connector (379) with breakout box installed, brake relay installed, Ignition Key ON and Brakes Released)

| Test Points | Spec.          | Comments  |
|-------------|----------------|---|
| #23 to grd  | < 1.0 volt     | > 1.0 volt short to BATT or VREF or defective relay                                 |
| #43 to grd  | 12 ± 1.5 volts | < 10.5v check connections, if 0 volts check for open circuit 97N or defective relay |

### Fault Code Descriptions

222 = Voltage at ECM pins #23 (BNO) and #43 (BNC) are the same

## ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

### BRAKE SWITCH/RELAY CIRCUITS (BRAKE)

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#### DESCRIPTION

All vehicles equipped with Cruise and PTO utilize the Brake Switch Relay (393) to notify the ECM of a brake ON or brake OFF condition.

#### WITH HYDRAULIC BRAKES

With hydraulic brakes the system includes (2) normally open brake switches (50) and (51) and the Brake Switch Relay (393).

#### Service Brakes NOT Applied

With the key ON and service brakes NOT APPLIED, ignition power from 10A fuse F4 (fuse H1 w/FBC) goes through the normally closed contacts (30 to 87A) of the Brake Switch Relay (393) to the ECM at terminal 43. When the brakes are not applied, the ECM sees 12 volts at terminal 43, the BNC (brake normally closed) terminal.

When the brakes are not applied, note that no voltage is present on circuit 97N to ECM terminal 23, the Brake Normally Open terminal.

When the ECM sees 12 volts at terminal 43 and 0 volts at terminal 23, it's programmed to interpret this condition as **"service brakes are not applied."**

#### Service Brakes Applied

Battery Power through 10A fuse F33 (fuse E3 w/FBC) is always present at the normally open (N.O.) brake switch (50). Applying the service brakes closes switch (50). With this switch closed, two things occur:

1. Power is applied to the Brake Switch Relay (393) causing it to energize, opening the N.C. contacts (30 to 87A). This turns OFF the power to ECM terminal 43 (BNC). ECM terminal 43 sees 0 volts.
2. Power is also applied (circuit 97N) to ECM terminal 23, which is the Brake Normally Open terminal. ECM terminal 23 sees 12 volts.

When the ECM sees 0 volts at terminal 43 and 12 volts at terminal 23, it's programmed to interpret this condition as **"service brakes are applied."**

#### WITH AIR BRAKES

With air brakes the system includes (2) normally open brake switches (70) and (71) and the Brake Switch Relay (393).

#### Service Brakes NOT Applied

With the key ON and service brakes NOT APPLIED, Ignition power through 10A fuse F4 (fuse H1 w/FBC) goes through the normally closed contacts (30 to 87A) of the Brake Switch Relay (393) to ECM terminal 43. When the brakes are not applied, the ECM sees 12 volts at terminal 43, the BNC (brake normally closed) terminal.

When the brakes are not applied, note that no voltage is present on circuit 97N to ECM terminal 23, the Brake Normally Open terminal.

When the ECM sees 12 volts at terminal 43 and 0 volts at terminal 23, it's programmed to interpret this condition as **"service brakes are not applied."**

## BRAKE SWITCH/RELAY CIRCUITS (BRAKE)

### SERVICE BRAKES APPLIED

Battery Power through 10A fuse F9 (30A fuse D3 w/FBC) is always present at the normally open (N.O.) brake switches (70) and (71). Applying the service brakes closes switches (70) and (71). With switches (70) and/or (71) closed, two things occur:

1. Power is applied to the Brake Switch Relay (393) causing it to energize, opening the N.C. contacts (30 to 87A). This turns OFF the power to ECM terminal 43 (BNC). ECM terminal 43 sees 0 volts.
2. Power is also applied (circuit 97N) to ECM terminal 23, which is the ECM Brake Normally Open terminal. ECM terminal 23 sees 12 volts.

When the ECM sees 0 volts at terminal 43 and 12 volts at terminal 23, it's programmed to interpret this condition as "**service brakes are applied.**"

The air brake stop light circuits work the same as Navistar vehicles without the electronic V8 engine. Refer to the Circuit Diagram book for complete circuit information.

### DIAGNOSTICS

#### FLASH CODE 222

#### SID 247 FMI 2

#### ECM: *BRAKE SWITCH CIRCUIT FAULT*

The ECM continuously monitors ECM terminals 23 (BNO) and 43 (BNC). The ECM expects to see 12V at one terminal and 0 volts at the other. If the signals disagree (12 volts at both or 0 volts at both), then flash code 222 is set as an active fault.

When Flash code 222 is active, the Cruise and PTO systems are disabled. If the fault is intermittent, the system does not reset until the vehicle has been shut off and restarted.

This code does not turn ON the engine warning light.

### WIRING CAUSES

A faulty brake switch, faulty brake switch relay, open fuses and/or open or short circuits (HIGH or LOW) can cause code 222 to set.

### TROUBLESHOOTING

The ProLink EST can be used to monitor the brake switch operation. If the monitor indicates that the brake switch is not operating properly, or code 222 is active, perform the tests in this section.

### BEFORE TROUBLESHOOTING

- A. Before troubleshooting, make sure that the batteries are fully charged! Check battery cables and grounds for clean, tight connections free of damage. Voltage tests will give misleading readings if the batteries are not fully charged.
- B. Before troubleshooting, inspect circuit connectors for pushed back, loose or damaged (spread or bent) terminals, or wires with cut strands, etc. Wires and connections must be free of damage or corrosion. When some connectors corrode, a light white residue will be present that must be removed.
- C. Before troubleshooting, inspect the suspect circuit grounds for clean, tight connections, free of any damage.

### TESTING BNO/BNC BRAKE SWITCH SYSTEM

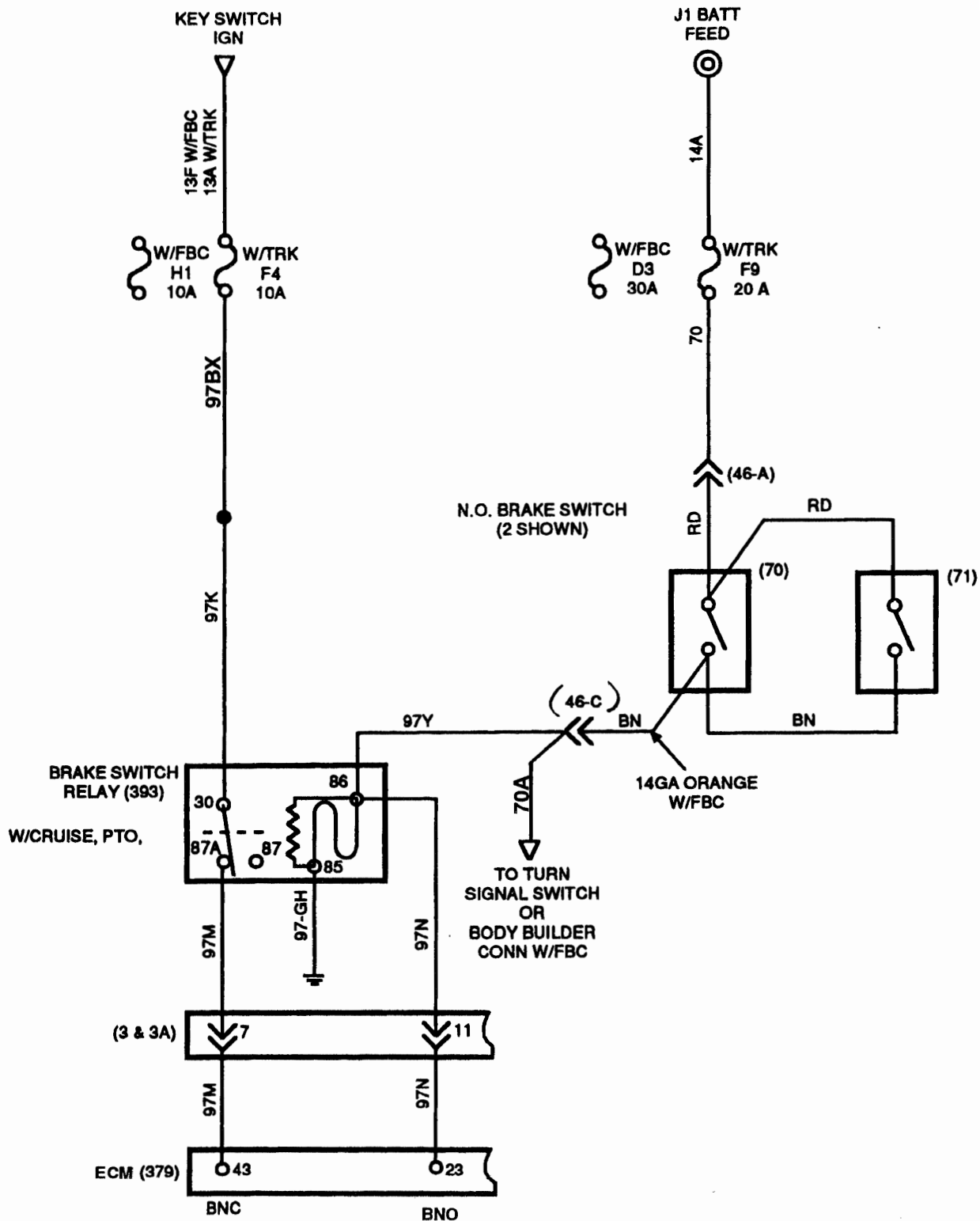
Air Brake Switch and Hydraulic Brake Switch circuit tests must be performed before Brake Switch Relay Circuit test.

# ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

## BRAKE SWITCH/RELAY CIRCUITS (BRAKE)

### CIRCUIT DIAGRAM

### AIR BRAKE BNO/BNC SWITCH/RELAY CIRCUITS





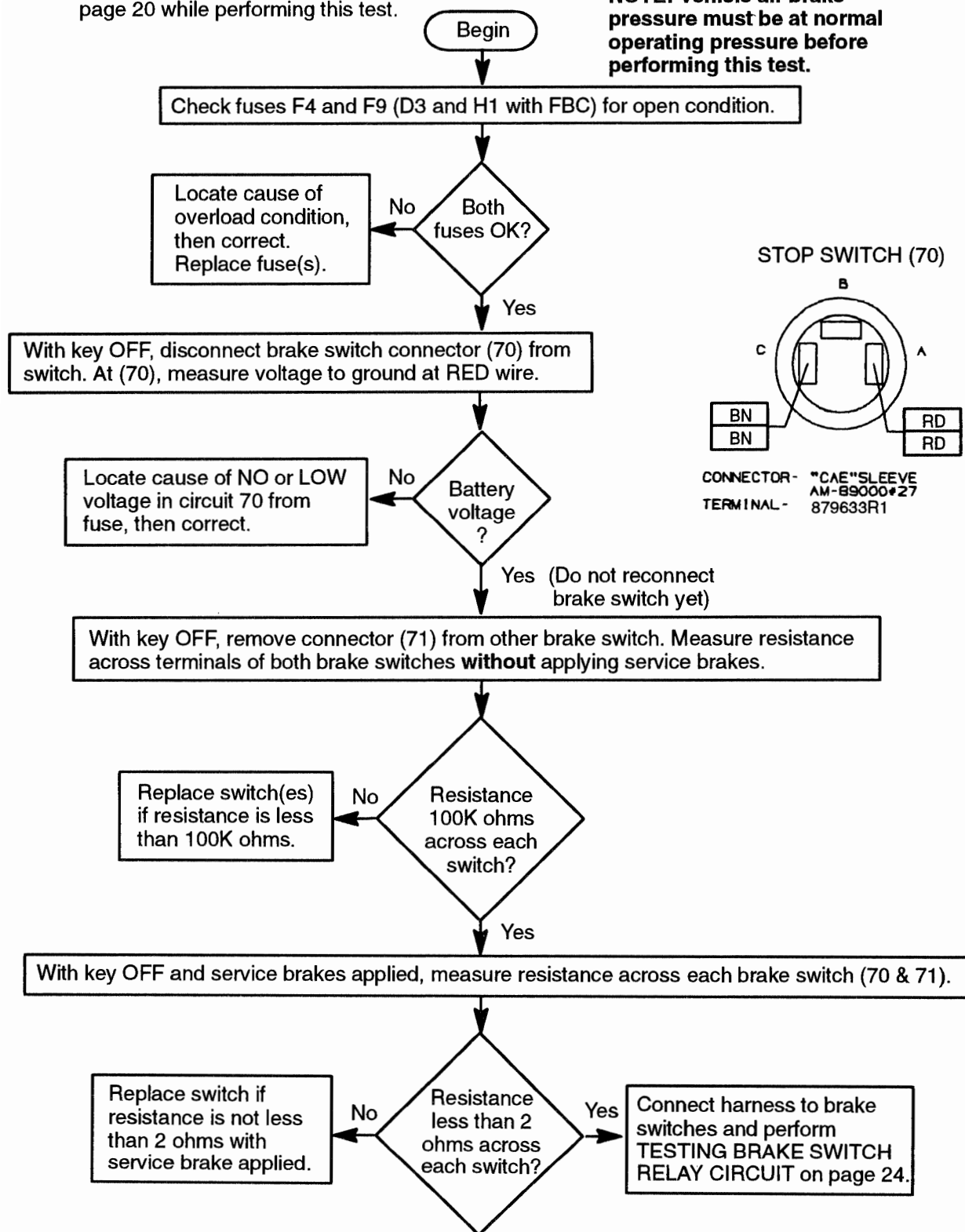
## ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

### BRAKE SWITCH/RELAY CIRCUITS (BRAKE)

#### AIR BRAKE SWITCH CIRCUIT TEST

NOTE: Refer to circuit diagram on page 20 while performing this test.

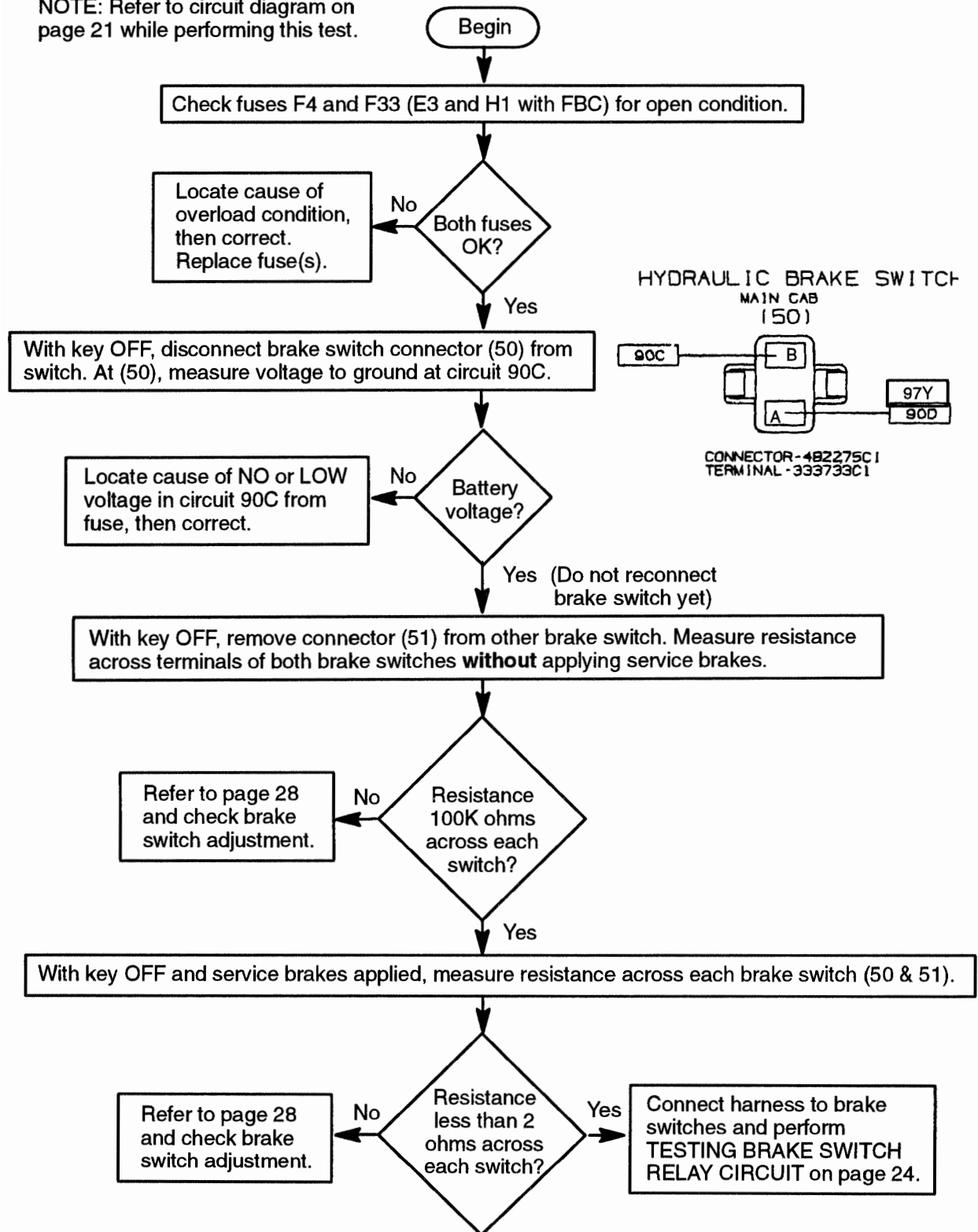
NOTE: Vehicle air brake pressure must be at normal operating pressure before performing this test.



## BRAKE SWITCH/RELAY CIRCUITS (BRAKE)

## HYDRAULIC BRAKE SWITCH CIRCUIT TEST

NOTE: Refer to circuit diagram on page 21 while performing this test.

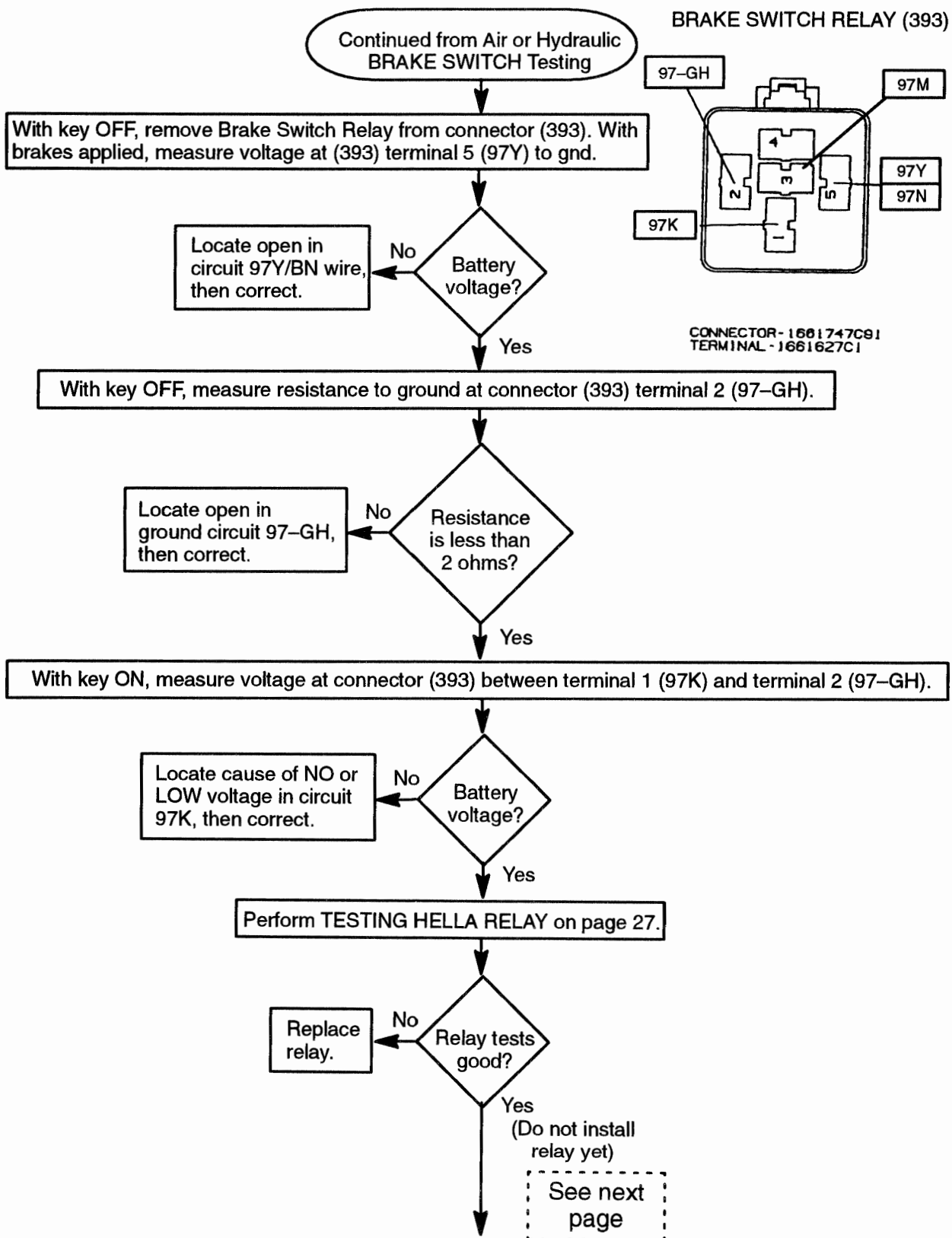




## ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

### BRAKE SWITCH/RELAY CIRCUITS (BRAKE)

#### BRAKE SWITCH RELAY CIRCUIT TEST

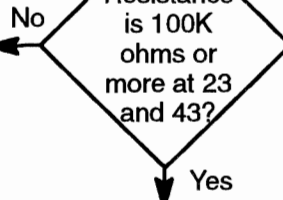


## BRAKE SWITCH/RELAY CIRCUITS (BRAKE)

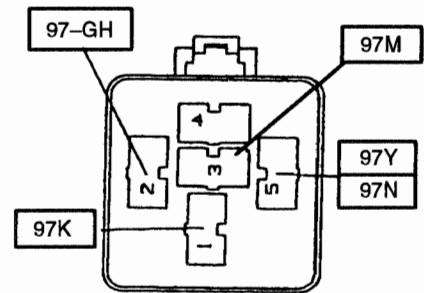
## BRAKE SWITCH RELAY CIRCUIT TEST (Continued)

With key OFF, remove connector (379) from ECM, then connect breakout box to harness, **but not to ECM**. Measure resistance to ground terminals at breakout box terminals 23 and 43.

Locate short circuit to ground in circuit where terminal (23 OR 43) resistance is less than 100K ohms, then correct.



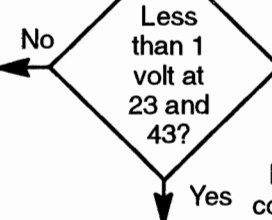
BRAKE SWITCH RELAY (393)



CONNECTOR - 1661747C91  
TERMINAL - 1661627C1

With key ON and SERVICE BRAKES RELEASED, measure voltage to ground at breakout box terminals 23 and 43.

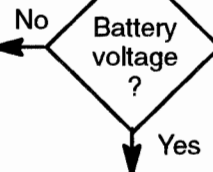
Locate short to "HOT" wire in circuit where terminal (23 OR 43) voltage was more than 1 volt, then correct.



Install relay in connector (393).

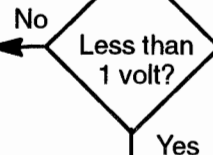
With key ON and BRAKES RELEASED, measure voltage at breakout box terminal 43.

Locate open in circuit 97M, then correct.



With key ON and BRAKES RELEASED, measure voltage at breakout box terminal 23.

Replace ECM.

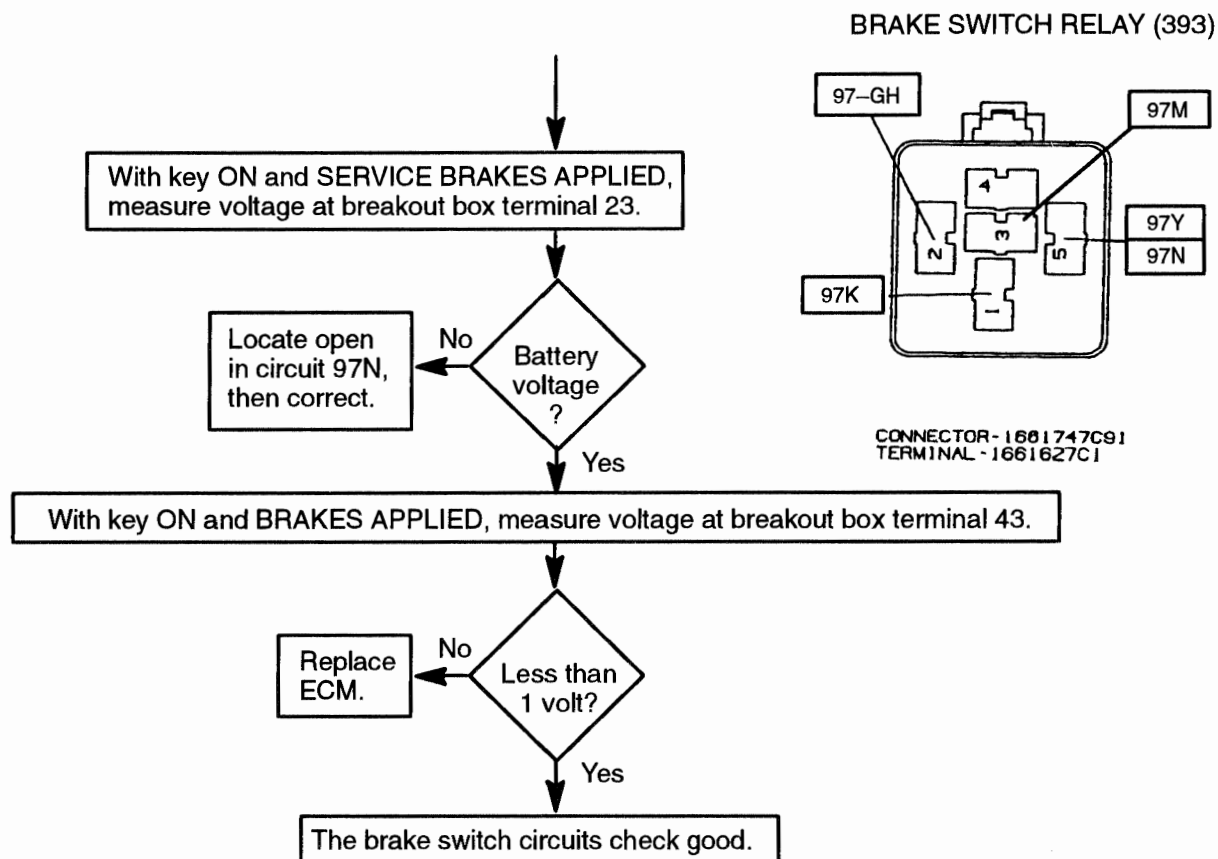


See next page

## ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

### BRAKE SWITCH/RELAY CIRCUITS (BRAKE)

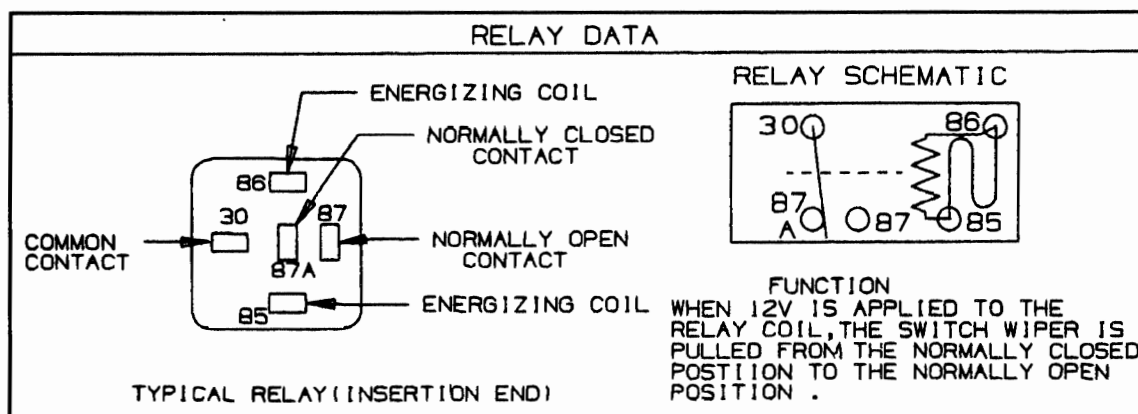
#### BRAKE SWITCH RELAY CIRCUIT TEST (Continued)



## BRAKE SWITCH/RELAY CIRCUITS (BRAKE)

## TESTING HELLA RELAYS

Refer to **Figure 3.5-2** for this test.



**Figure 3.5-2 Hella Relay**

With relay removed from connector:

1. Measure resistance between terminals 30 and 87A. If resistance is less than 2 ohms, go to step 2. If resistance is more than 2 ohms, replace the relay.
2. Measure resistance between terminals 30 and 87. If resistance is 100K ohms or more go to step 3. If resistance is less than 100K ohms replace the relay.
3. Connect (+) battery lead to terminal 85 and (-) lead to 86. The relay should energize with an audible click. If the relay energizes, go to step 4. If the relay does not energize, replace the relay.
4. With relay energized, measure resistance between terminals 30 and 87A. If the resistance is 100K ohms or more, go to step 5. If resistance is less than 100K ohms, replace the relay.
5. With relay energized, measure resistance between terminals 30 and 87. If resistance is less than 2 ohms the relay tests good. If resistance is greater than 2 ohms, replace the relay.

# ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

## BRAKE SWITCH/RELAY CIRCUITS (BRAKE)

### PROCEDURE FOR ADJUSTING HYDRAULIC STOP LIGHT BRAKE

Disconnect cab harness from switches. See Figure 3.5-3

1. With PAL nut on upper switch finger tight, connect #1 test light leads to switch. Adjust switch until light just comes ON. Note position of key/tab on connector body.
2. Hold PAL nut and rotate switch clockwise 1 full turn. Key/tab should be in the same position as in step 1.

**NOTE:** The #1 test light should be off and the switch set so that the brake pedal must be moved 0.50 inches at point of contact to make the light come on.

3. Tighten PAL nut on upper switch and watch key/tab so the switch is not turned when tightening the PAL nut.

4. With PAL nut on the lower switch finger tight, connect #2 test light leads to switch. Adjust the lower switch so that with the pedal depressed, both lights come on at the same time.

A. **NOTE:** If test light #2 (lower switch) comes on first, move lower switch closer to the pedal.

If test light #1 (upper switch) comes on first, move lower switch away from the pedal.

5. Tighten PAL nut on both switches and test one more time.
6. Remove test lights and install connector with circuits 70/70A and 70B/70C on the upper switch and connector with circuits 90A and 90B on the lower switch.

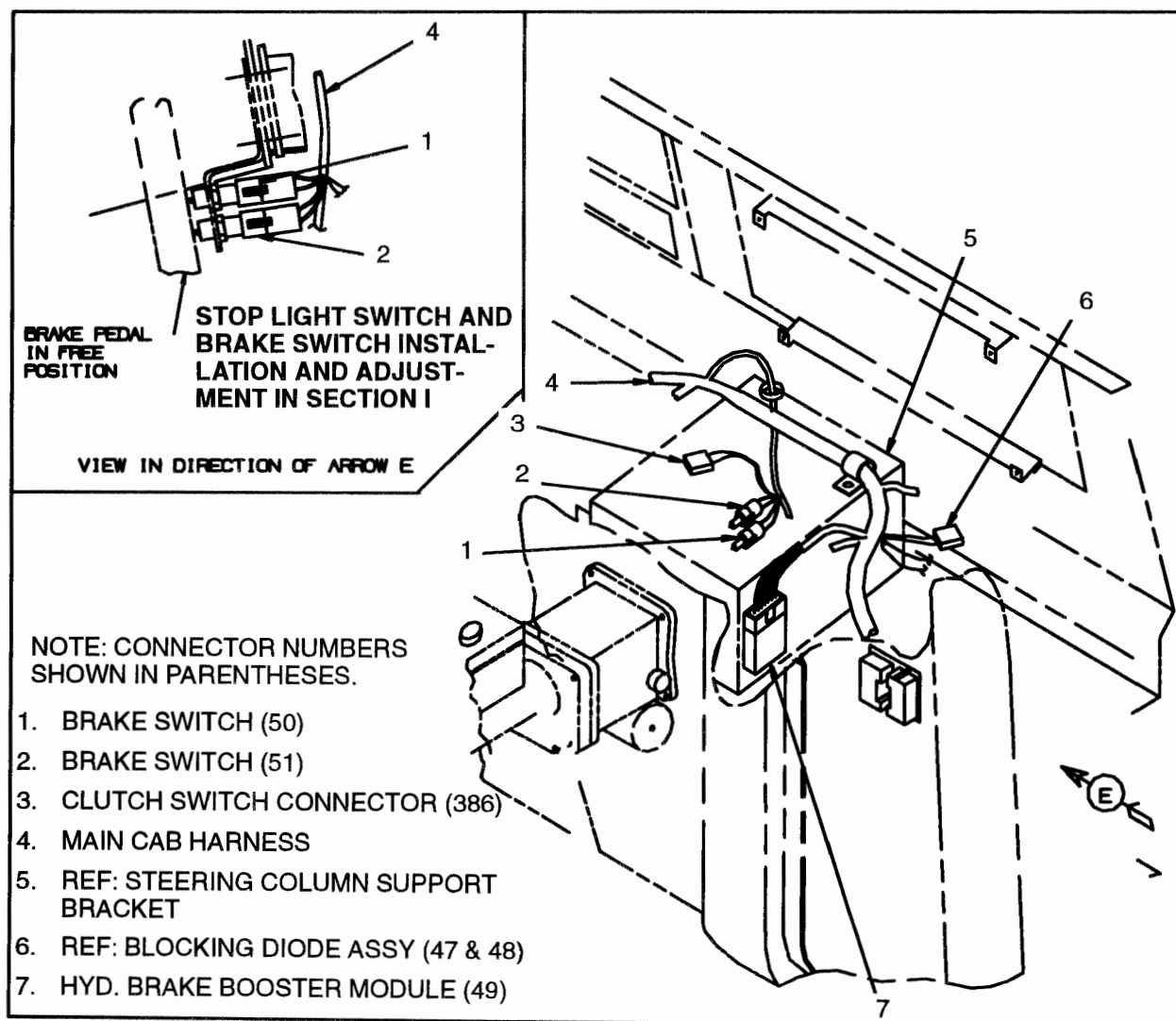


Figure 3.5-3 – Truck BNO/BNC Hydraulic Brake Switches