

ANTI-LOCK BRAKE SYSTEM & TRACTION CONTROL

1995 Volvo 850

1995 BRAKES
Volvo - Anti-Lock & Traction Control Systems

850

* PLEASE READ THIS FIRST *

CAUTION: See ANTI-LOCK BRAKE SAFETY PRECAUTIONS article in the GENERAL INFORMATION section.

DESCRIPTION & OPERATION

SYSTEM DESCRIPTION

When ignition is turned on, control module activates warning indicators on instrument panel and performs an initial diagnostic test which ensures there are no internal faults in control module. At same time, main relay portion of combination relay is activated so hydraulic modulator valves are supplied with power. See Fig. 1. Control module then checks operation of valves by activating them in sequence.

If no fault is detected, warning indicators go out about 2 seconds after engine is started. When vehicle is driven, control module checks that it is receiving signals from wheel sensors. At 20 MPH, it checks that hydraulic pump is operating by activating pump relay so pump is started. This is confirmed by a signal from rotation sensor. In addition to the initial diagnostic tests, control module continuously checks that all signals and components are operating, and there are no internal faults in control module.

ABS SYSTEM

As vehicle is driven, control module monitors wheel speeds by computing their acceleration and deceleration. During braking, signal from brake light puts control module into standby mode. If any wheels start to lock, control module activates hydraulic modulator which adjusts hydraulic pressure.

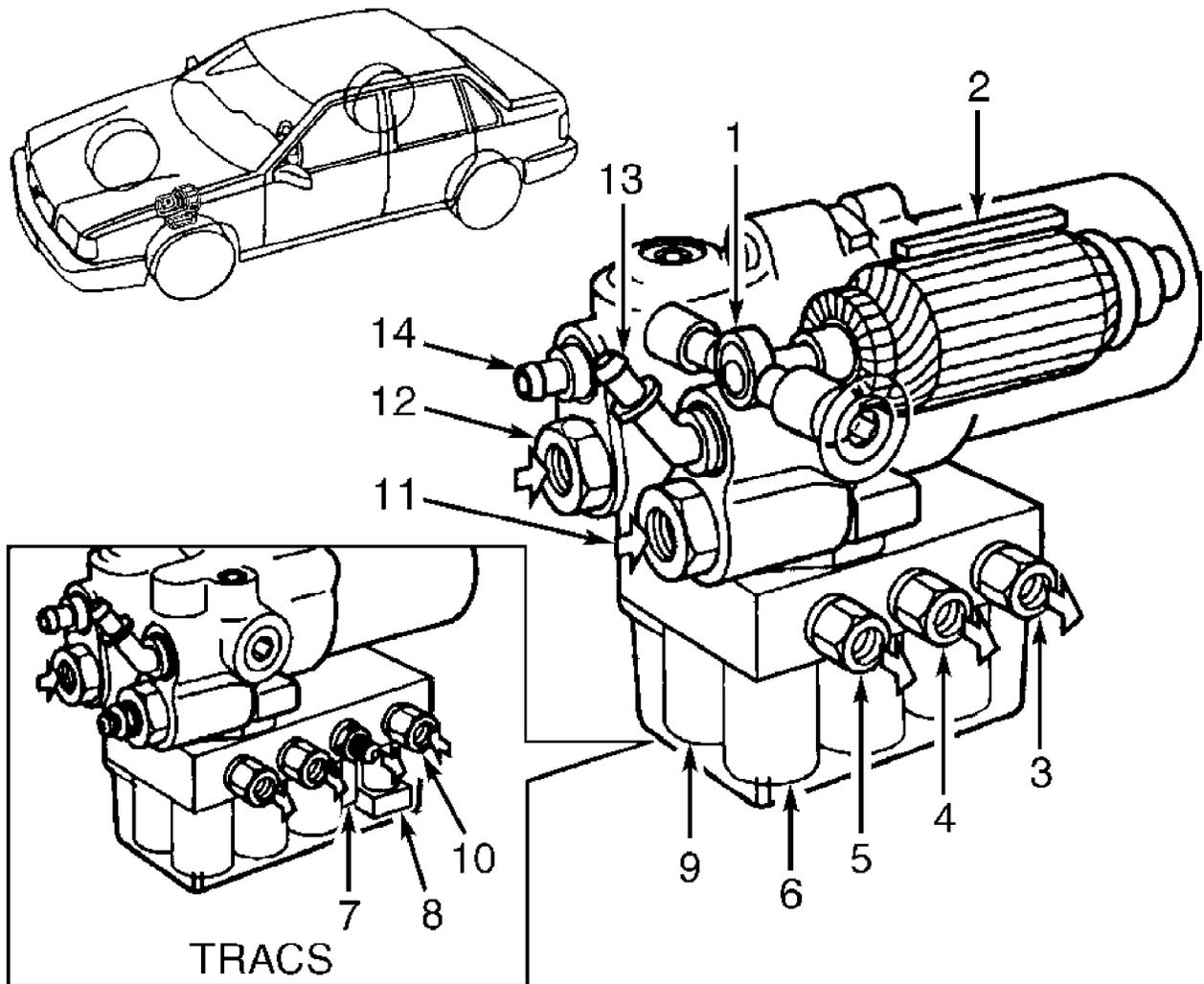
Control module also receives a brake pedal position signal from pedal sensor (in master cylinder) during braking. This information is used to control hydraulic modulator so it does not affect brake pedal position. See Fig. 2.

TRACS SYSTEM

TRACS is an optional traction control system that operates in conjunction with ABS system. If vehicle speed is less than 25 MPH and one of the drive wheels starts to slip, control module starts pump in hydraulic modulator, which pumps brake fluid to brake caliper of wheel that is slipping, applying braking force so both drive wheels have same speed. If brake is applied, brake light contact closes at same time as pressure switch breaks a circuit to control module. TRACS control stops and system goes into ABS control standby mode.

Because TRACS system is intended as an assist to starting on slippery surfaces, it is most effective at speeds less than 15 MPH, and less so between 15-25 MPH. TRACS is completely disengaged at speeds greater than 25 MPH. Hydraulic pump is in continuous operation while TRACS is engaged.

NOTE: For more information on brakes, see BRAKE SYSTEM article in the BRAKES section.

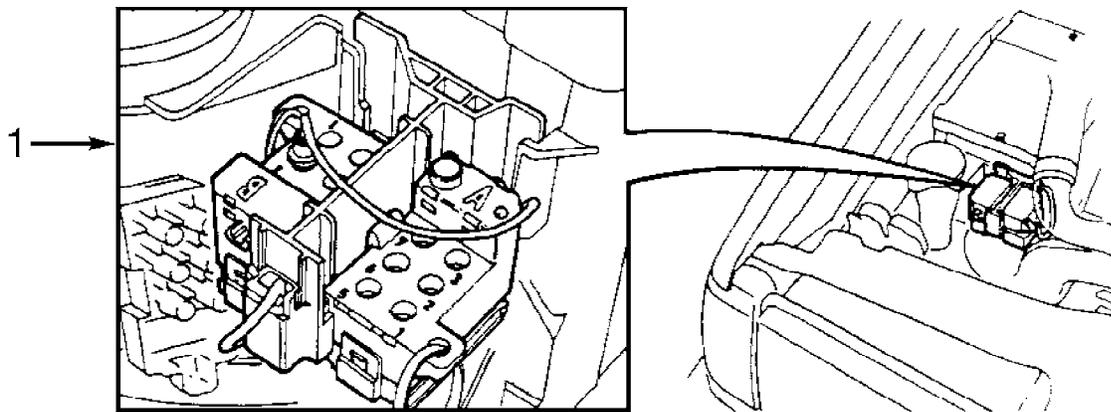
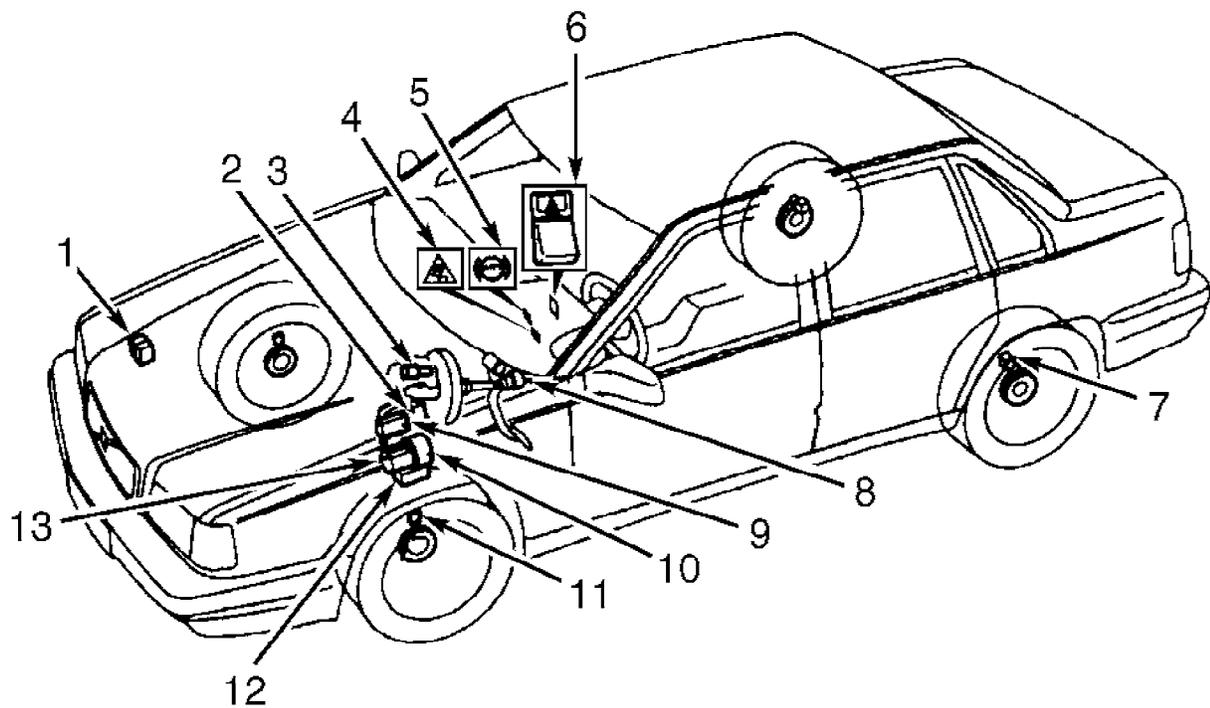


- 1. Hydraulic Pump
- 2. Rotation Sensor
- 3. Left Front Wheel Circuit
- 4. Right Front Wheel Circuit
- 5. Rear Wheel Circuit
- 6. Normally Closed Valve
- 7. Normally Open Valve

- 8. Pressure Switch
- 9. Normally Open Valve
- 10. Primary Circuit
- 11. Primary Circuit Connector
- 12. Secondary Circuit
- 13. Return Line Connector
- 14. Return Line Connector

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Fig. 1: Locating Hydraulic Modulator Components
Courtesy of Volvo Cars of North America



- | | |
|------------------------------|-------------------------|
| 1. Diagnostic Unit | 7. Wheel Sensor |
| 2. Control Module | 8. Brakelight Switch |
| 3. Pedal Sensor | 9. Combination Relay |
| 4. Warning Indicator (TRACS) | 10. Hydraulic Modulator |
| 5. Warning Indicator (ABS) | 11. Wheel Sensor |
| 6. TRACS Switch | 12. Pressure Switch |
| | 13. Rotation Sensor |

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Fig. 2: Locating ABS Components
 Courtesy of Volvo Cars of North America

BLEEDING BRAKE SYSTEM

NOTE: If system has been completely or partially drained of brake fluid, system must be pressure-bled. If only, for example, a brake caliper has been replaced or overhauled, following manual procedure should be satisfactory. Use only DOT 4 grade brake fluid.

1) Fill brake fluid reservoir to MAX level. Connect hose to bleed screw on either rear wheel. Submerge hose in bottle containing clean brake fluid. Hose must be below brake fluid surface.

2) Open bleed screw. Have an assistant slowly pump brake pedal 5 times, holding pedal down on last depression stroke. No air bubbles should be visible after last stroke. Close bleed screw.

3) Check brake fluid level after each open-and-close cycle of bleed screw. Bleed remaining wheels in the following order: other rear wheel, right front, and left front.

ADJUSTMENTS

NOTE: For adjustment information, see BRAKE SYSTEM article in the BRAKES section.

TROUBLE SHOOTING

ABS WARNING LIGHT

ABS warning light on instrument cluster should go out after starting engine, indicating system is okay. Individual components can be tested with appropriate test equipment. See DIAGNOSIS & TESTING.

DIAGNOSIS & TESTING

PRE-DIAGNOSIS INSPECTION

Perform a comprehensive visual inspection of system components before testing ABS system to isolate simple failures. Repair as necessary

SELF-DIAGNOSIS

Entering Self-Diagnosis

1) Diagnosis is carried out and Diagnostic Trouble Codes (DTCs) are accessed using diagnostic units in right front section of engine compartment. See Fig. 2. ABS/TRACS DTCs can be read manually through position No. 3 in diagnostic unit "A", and interpreted using diagnostic ABS/TRACS DTCs table.

2) Two diagnostic units are located in engine compartment. Diagnostic unit "A" has a Black housing. Diagnostic unit "B" has a Gray housing. Both diagnostic units have Black covers. Diagnostic unit "A" contains a diagnostic lead, LED, button for selecting different test functions, and 6 position sockets. Diagnostic unit "B" contains 6 position sockets only. To access DTCs, connect diagnostic lead to socket position No. 3 on diagnostic unit "A". Turn ignition on.

3) Each test function can be activated by pressing button on diagnostic unit "A" same number of times as test function identification number. DTCs are displayed in order of priority. Most serious DTCs are displayed first. If memory is full, DTC with lowest priority will be overwritten if a new DTC is added.

4) DTCs are displayed as a combination of 3 digits. Each digit corresponds to number of flashes. In addition, 3 digit DTCs can

be entered into system to change output parameters. DTCs should be entered with short (one second) and precise pressure on button. Wait until LED is lit steadily, enter first digit, wait until LED lights steady, enter second digit, again wait until LED lights steady, and enter third digit.

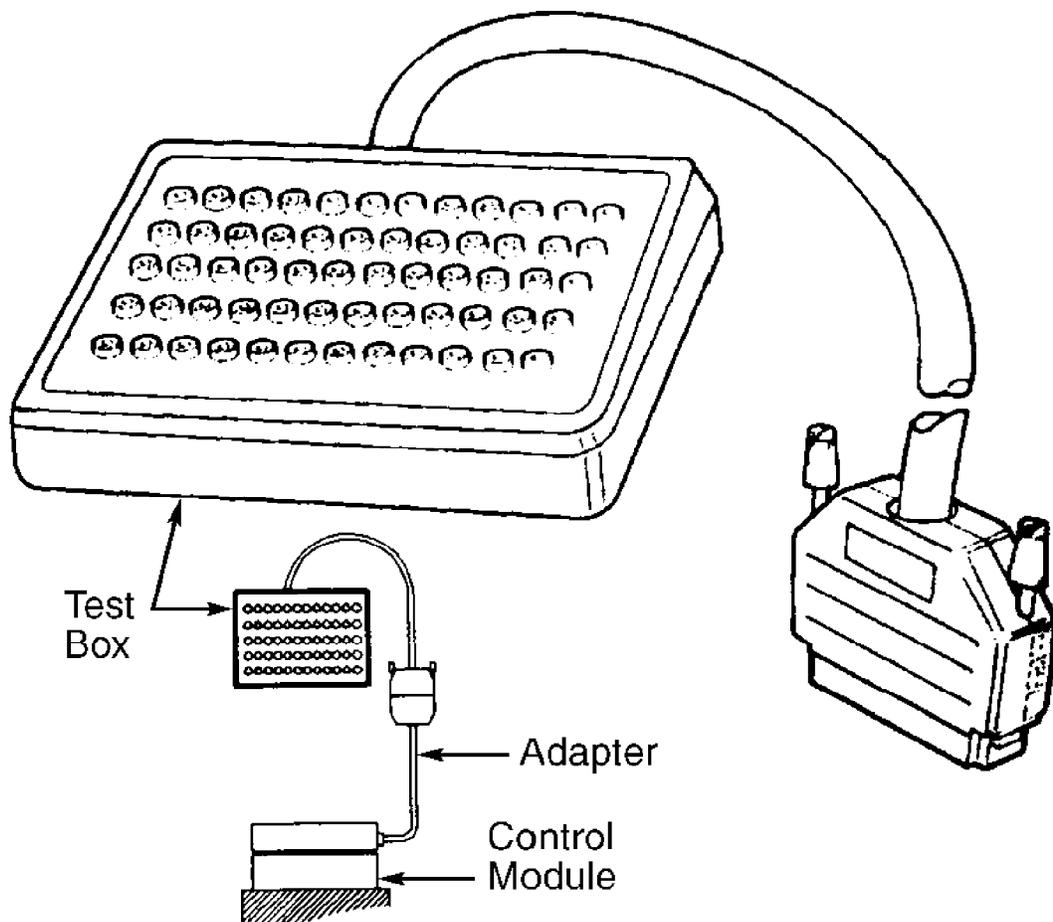
Test Mode No. 1 (Reading DTCs)

1) Turn ignition on. Select socket No. 3 on diagnostic unit "A". Press button once. System is now in test mode No. 1.

2) Count number of times LED flashes and write down DTC. Pressing button again will indicate if there are any further DTCs stored. When DTC which was displayed first is displayed again, there are no further DTCs. Repair any faults and erase DTCs.

Using Test Box (981 3190)

Many diagnostic procedures require voltage and resistance checks at control module connector. Use test box connected between control module and control module connector for these voltage/resistance checks. See Fig. 3. Control module is located on left side of engine compartment, next to hydraulic modulator. Do not directly probe control module connector.



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Fig. 3: Connecting Test Box (981 3190) To Control Module
Courtesy of Volvo Cars of North America

Erasing DTCs

1) Ensure all stored DTCs have been read. DTCs cannot be

erased until all DTCs have been read once and first DTC has reappeared.

2) Depress diagnostic button for at least 5 seconds, then release. See Fig. 2. Three seconds after button is released LED will light. While LED is lit press button again. Hold button down for at least 5 seconds and then release. LED will go out. Turn ignition off.

3) To ensure DTC is erased, turn ignition on. Press button briefly but firmly. If DTC 1-1-1 is displayed, DTCs have been erased. If DTCs have not been erased, repeat procedure.

Exiting Self-Diagnosis

After DTCs are deleted and DTC 1-1-1 has been displayed, drive vehicle at least 25 MPH. ABS warning light should go out. If light does not go out, ensure no new DTCs have been set.

Test Mode No. 4 (Activation)

1) Test mode No. 4 is used to reset information which lights service reminder indicator. This mode is also used to change rate of transfer.

2) Turn ignition on. Put diagnostic lead in socket No. 3 on diagnostic unit "A". See Fig. 2. Press button 4 times. System is now in test mode No. 4. When LED lights steady DTCs can be entered into system. Enter first digit while LED is lit. Wait until LED is lit steadily again before entering second digit. Repeat procedure for third digit. Enter DTC 3-1-1 (normal rate), 3-1-2 (x2 rate), or 3-1-3 (x10 rate). Wait for confirmation from control module. LED will flash rapidly several times.

NOTE: Normal rate is recommended for manual diagnosis.

ABS/TRACS FUNCTION CHECK

1) Turn ignition on. If ABS and TRACS warning lights come on for at least one second, go to next step. If ABS and TRACS warning lights do not come on for at least one second, go to ABS WARNING INDICATOR DOES NOT LIGHT or TRACS WARNING INDICATOR DOES NOT LIGHT under DIAGNOSIS & TESTING.

2) Wait 3 seconds. If ABS and TRACS warning lights go out, go to next step. If ABS and TRACS warning lights do not go out, check for DTCs. Go to TEST MODE NO. 1 (READING DTCs) under SELF-DIAGNOSIS. If DTCs cannot be read or are not displayed, go to ABS WARNING INDICATOR LIGHTS, NO DTC DISPLAYED or TRACS WARNING INDICATOR LIGHTS, NO DTC DISPLAYED under DIAGNOSIS & TESTING. If DTCs are present, go to ABS/TRACS DTCs table. Always begin diagnosis with highest DTC.

3) Check for DTCs. If DTCs cannot be read, go to DTCS CANNOT BE READ under DIAGNOSIS & TESTING. If no DTCs are displayed, test drive vehicle and note symptoms. Go to TEST DRIVING VEHICLE, then go to step 4). If DTCs are displayed, go to CHECKING INTERMITTENT FAULTS to determine probable cause of fault. Record, then erase DTCs. Test drive vehicle and note any other symptoms. Go to TEST DRIVING VEHICLE, then go to step 4).

4) If ABS and/or TRACS warning indicator lights during test drive, check for DTCs. If no DTCs are present, check if ABS or TRACS warning light circuit has been grounded.

5) If ABS and/or TRACS warning light does not light during test drive, check if any other symptoms of a faulty ABS or TRACS system are present. If symptoms are present, go to POOR BRAKING, BOTH FRONT WHEELS ARE COMPLETELY OR PARTIALLY LOCKED or NO TRACS FUNCTION under DIAGNOSIS & TESTING. If symptoms are not present, no faults are present, or problems or symptoms are intermittent.

TEST DRIVING VEHICLE

WARNING: Brake problems may make vehicle difficult to drive. Ensure test drive takes place in a safe area.

1) Erase any DTCs (if present). Turn ignition off. Start engine and check ABS or TRACS warning indicator light. If warning light is on, do not drive vehicle.

2) Drive vehicle at least 25 MPH to exit diagnostic mode.

Brake to a stop several times from a reasonable speed on a smooth, dry surface. Listen for unusual noises (clicking or popping) or if vehicle handles abnormally (pulls to one side, brake pedal feels unusual). If ABS warning light comes on, stop vehicle and record any DTCs. Make a note of conditions under which ABS warning light comes on.

CHECKING INTERMITTENT FAULTS

Initial Check

1) Read, record, and erase any ABS/TRACS DTCs. See TEST MODE NO. 1 (READING DTCs) under SELF-DIAGNOSIS. Test drive vehicle in an attempt to repeat conditions during which fault appears. Go to TEST DRIVING VEHICLE. After test drive, stop vehicle and check for DTCs. If DTCs are present, go to ABS/TRACS DTCs table to determine which circuit may be faulty.

2) If no DTCs are present, go to DIAGNOSIS & TESTING and diagnose problem by symptom. If fault DTC does not appear during test drive, a good description of how vehicle behaved at time of fault can possibly help in locating most likely cause of problem. Go to DIAGNOSIS & TESTING and diagnose problem by symptom.

Wiring Or Connector Faults

1) Check for poor contact between connectors or wiring. Most faults in ABS system disengage system entirely when vehicle is driven, even if fault disappears before ignition is turned off. With some intermittent faults, however, ABS function may return if fault disappears before ignition is turned off.

2) If system voltage is low, control module will light ABS/TRACS warning indicator. Indicator will remain lit until system voltage returns to normal. When system voltage to control module is correct, system returns to normal function.

3) If there is complete power loss to control module or hydraulic modulator, ABS/TRACS warning indicator lights temporarily. Affected circuits are the main relay, pump motor relay, fuses and related wiring.

ABS/TRACS DTCs TABLE

DTC	Probable Fault
1-1-1	No Faults Detected
1-2-1	Left Front Wheel Sensor, Circuit Fault At Speeds Less Than 25 MPH
1-2-2	Right Front Wheel Sensor, Circuit Fault At Speeds Less Than 25 MPH
1-2-3	Left Rear Wheel Sensor, Circuit Fault At Speeds Less Than 25 MPH
1-2-4	Right Rear Wheel Sensor, Circuit Fault At Speeds Less Than 25 MPH
1-4-1	Faulty Pedal Sensor, Short To Ground Or Voltage

1-4-2	Faulty Brake Light Switch, Open Or Short Circuit
1-4-3	Control Module Fault
1-4-4	Brake Discs Overheated
2-1-1	Left Front Wheel Sensor, Signal Absent When Moving Off
2-1-2	Right Front Wheel Sensor, Signal Absent When Moving Off
2-1-3	Left Rear Wheel Sensor, Signal Absent When Moving Off
2-1-4	Right Rear Wheel Sensor, Signal Absent When Moving Off
2-2-1	Left Front Wheel Sensor, Signal Absent In ABS Function
2-2-2	Right Front Wheel Sensor, Signal Absent In ABS Function
2-2-3	Left Rear Wheel Sensor, Signal Absent In ABS Function
2-2-4	Right Rear Wheel Sensor, Signal Absent In ABS Function
3-1-1	Left Front Wheel Sensor, Open Or Short Circuit
3-1-2	Right Front Wheel Sensor, Open Or Short Circuit
3-1-3	Left Rear Wheel Sensor, Open Or Short Circuit
3-1-4	Right Rear Wheel Sensor, Open Or Short Circuit
3-2-1	Left Front Wheel Sensor, Intermittent Disturbance At Speeds Greater Than 25 MPH
3-2-2	Right Front Wheel Sensor, Intermittent Disturbance At Speeds Greater Than 25 MPH
3-2-3	Left Rear Wheel Sensor, Intermittent Disturbance At Speeds Greater Than 25 MPH
3-2-4	Right Rear Wheel Sensor, Intermittent Disturbance At Speeds Greater Than 25 MPH
4-1-1	Left Front Wheel Inlet Valve, Open Or Short Circuit
4-1-2	Left Front Wheel Return Valve, Open Or Short Circuit
4-1-3	Right Front Wheel Inlet Valve, Open Or Short Circuit
4-1-4	Right Front Wheel Return Valve, Open Or Short Circuit
4-2-1	Rear Wheel Circuit Inlet Valve, Open Or Short Circuit
4-2-2	Rear Wheel Circuit Return Valve, Open Or Short Circuit
4-2-3	TRACS Valve, Open Or Short Circuit
4-2-4	TRACS Pressure Switch, Faulty Or Short Circuit
4-4-1	Control Module Fault
4-4-2	Pump Pressure Too Low
4-4-3	Pump Motor, Electrical Or Mechanical Fault

4-4-4	No Supply To Hydraulic Unit Valves
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DTC 1-2, 2-1, 2-2, 3-1, 3-2: WHEEL SENSOR FAULT

WHEEL SENSOR FAULT IDENTIFICATION TABLE (1)

DTC	Wheel Sensor Fault
1-2-1, 2-1-1, 2-2-1, 3-1-1, 3-2-1	Left Front
1-2-2, 2-1-2, 2-2-2, 3-1-2, 3-2-2	Right Front
1-2-3, 2-1-3, 2-2-3, 3-1-3, 3-2-3	Left Rear
1-2-4, 2-1-4, 2-2-4, 3-1-4, 3-2-4	Right Rear

(1) - See also ABS/TRACS DTCs table.

1) DTCs 1-2-1, 1-2-2, 1-2-3, or 1-2-4 are set when control module detects electromagnetic interference or excessive oscillation in a wheel sensor circuit at speeds lower than 25 MPH. Cause of interference can be electrical motor and ignition circuits or circuits temporarily shorted or broken.

2) DTCs 2-1-1, 2-1-2, 2-1-3, 2-1-4, 2-2-1, 2-2-2, 2-2-3, or 2-2-4 are set when control module detects there is no signal from a wheel sensor circuit, but finds circuit is intact. DTCs 3-1-1, 3-1-2, 3-1-3, or 3-1-4 are set when control module detects a wheel sensor circuit is broken or shorted.

3) DTCs 3-2-1, 3-2-2, 3-2-3, or 3-2-4 are set when control module detects electromagnetic interference or excessive oscillation in a wheel sensor circuit at speeds exceeding 25 MPH. Cause for interference can be electrical motor and ignition circuits.

4) Turn ignition off. Disconnect negative battery cable. Disconnect control module electrical connector. Connect Adapter (981 3196) to control module connector. Connect Test Box (981 3190) to adapter. See Fig. 3. Reconnect negative battery cable.

5) Check suspect wheel sensor circuits. Connect an ohmmeter between test box terminals No. 48 and 30 (left front), No. 47 and 29 (right front), No. 46 and 28 (left rear), or No. 45 and 27 (right rear). If ohmmeter indicates 1040-1160 ohms, go to next step. If ohmmeter does not indicate 1040-1160 ohms, go to step 8).

6) Check resistance between suspect sensor input terminal and ground. Connect an ohmmeter between test box terminal No. 48 and ground (left front), No. 47 and ground (right front), No. 46 and ground (left rear), or No. 45 and ground (right rear). If ohmmeter indicates no continuity, go to next step. If ohmmeter indicates continuity exists, go to step 9).

7) Connect a voltmeter and measure AC voltage between suspect wheel sensor terminals while turning wheel by hand. Connect voltmeter between test box terminals No. 48 and 30 (left front), No. 47 and 29 (right front), No. 46 and 28 (left rear), and No. 45 and 27 (right rear). If voltmeter indicates .05-.9 volt, go to step 10). If voltmeter does not indicate .05-.9 volt, check pulse wheel and sensor for excess dirt or damage. If pulse wheel is okay, replace wheel sensor.

8) If ohmmeter did not indicate 1040-1160 ohms in step 5), raise vehicle. Remove wheel so suspect sensor can be easily accessed. Clean area around sensor connector, then disconnect connector. Ensure all dirt on sensor and pulse wheel is removed before lowering vehicle. Connect an ohmmeter between sensor terminals. If ohmmeter indicates 1040-1160 ohms, check wiring for an open circuit. If ohmmeter does not indicate 1040-1160 ohms, replace wheel sensor.

9) If ohmmeter indicated continuity in step 6), raise

vehicle. Remove wheel so suspect sensor can be easily accessed. Clean area around sensor connector, then disconnect connector. Ensure all dirt on sensor and pulse wheel is removed before lowering vehicle. Connect an ohmmeter between sensor terminal No. 1 and ground. See Fig. 4. If ohmmeter indicates no continuity, check wiring for a short circuit. If ohmmeter indicates continuity, replace wheel sensor.

10) Connect ohmmeter between control module housing and ground, then between test box terminal No. 1 and ground. Ohmmeter should indicate continuity in both cases. If continuity is not present, check that sensor wiring is not too close to sources of interference, wiring is not loose, or pulse wheel is not damaged. If no problems are found, replace control module.

DTC 1-4-1: FAULTY PEDAL SENSOR, SHORT TO GROUND OR VOLTAGE

1) Connect test box to control module. See Fig. 3. Check pedal sensor circuit by connecting jumper wires between test box terminals No. 1, 2, 21, 34, and 36. Connect an ohmmeter between test box terminals No. 16 and 41. Ohmmeter should indicate about 249 ohms.

2) Turn ignition on. Depress brake pedal as far as possible and hold in place. Turn ignition off. Slowly release brake pedal while at same time taking readings from ohmmeter. It should be possible to observe 7 distinct resistance readings. See BRAKE PEDAL RESISTANCE READINGS table.

BRAKE PEDAL RESISTANCE READINGS TABLE

Position	Ohms
7 (Pedal Fully Depressed)	Infinite
6	1032
5	817
4 (Pedal Midway)	690
3	563
2	436
1 (Pedal Fully Released)	249

3) If one resistance reading is incorrect, check wiring for short circuits. If wiring is okay, replace pedal sensor. Compare color of pedal sensor spacer sleeve with power brake booster color code. If all resistance readings are correct, replace control module.

DTC 1-4-2: FAULTY BRAKE LIGHT SWITCH, OPEN OR SHORT CIRCUIT

1) Check if brakelight works. If brakelight does not work, check bulb and wiring as necessary. If brakelight works, connect test box to control unit. See Fig. 3. Connect voltmeter between test box terminals No. 32 and 1. Depress brake pedal. If voltmeter indicates battery voltage, erase DTC and test drive vehicle. See TEST DRIVING VEHICLE under DIAGNOSIS & TESTING. If DTC occurs again, replace control module. If voltmeter does not indicate battery voltage, go to next step and check if circuit is open or shorted.

2) Remove 2 wires (Red and Yellow wires) from brakelight switch. Connect voltmeter between Red wire and ground. If battery voltage is present, go to next step. If battery voltage is not present, check wiring or fuse for an open circuit.

3) Connect a jumper wire between Red and Yellow wires. If brakelight lights, ensure brakelight switch is adjusted correctly. If switch is adjusted correctly, replace switch. If brakelight does not light, ensure wiring to brakelight bulbs is okay.

DTC 1-4-4: BRAKE DISCS OVERHEATED

1) DTC 1-4-4 is set when control module detects TRACS system has been used to such an extent that there is risk of brake overheating. In this instance, TRACS system is automatically disengaged and TRACS warning indicator lights. When control module calculates that brake temperature is normal again, TRACS function is engaged and warning light goes out.

2) If this DTC is set, perform a visual inspection of front wheel brakes to ensure no overheating damage has occurred. Erase DTC.

DTC 4-1-1, 4-1-2, 4-1-3, 4-1-4, 4-2-1, 4-2-2, 4-2-3: INLET, RETURN OR TRACS VALVE

VALVE CIRCUIT FAULT IDENTIFICATION TABLE (1)

DTC	Fault Description
4-1-1	Inlet Valve, Left Front Wheel
4-1-2	Return Valve, Left Front Wheel
4-1-3	Inlet Valve, Right Front wheel
4-1-4	Return Valve, Right Front Wheel
4-2-1	Inlet Valve, Rear Wheel Circuit
4-2-2	Return Valve, Rear Wheel Circuit
4-2-3	TRACS Valve

(1) - See also ABS/TRACS DTCs table.

1) These DTCs are set when control module detects a broken or shorted valve circuit. Connect test box to control module. See Fig. 3. Connect ohmmeter between test box terminal No. 3 and suspect inlet valve test box terminal No. 20 (left front), No. 38 (right front), No. 54 (rear), or No. 37 (TRACS valve). Resistance should be 6-8 ohms.

2) Connect ohmmeter between test box terminal 3 and suspect return valve test box terminal No. 2 (left front), No. 21 (right front), or No. 36 (rear). Resistance should be 3-5 ohms. If all resistance readings are to specification, go to next step. If resistance readings are not to specification, check for open circuit in wiring. If wiring is okay, replace hydraulic modulator.

3) Disconnect combination relay 15-pin connector located next to hydraulic modulator. See Fig. 4. Connect ohmmeter between test box terminal No. 1 and suspect inlet valve test box terminal No. 20 (left front), No. 38 (right front), or No. 54 (rear), then connect ohmmeter between test box terminal No. 1 and suspect return valve test box terminal No. 2 (left front), No. 21 (right front), or No. 36 (rear).

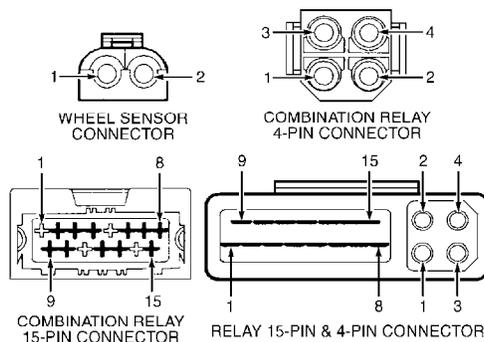


Fig. 4: Identifying ABS Connector Terminals
Courtesy of Volvo Cars of North America

4) If ohmmeter indicates no continuity, replace control

module. If ohmmeter indicates continuity, check wiring for a short to ground or voltage. If wiring is okay, replace hydraulic modulator.

DTC 4-2-4: TRACS PRESSURE SWITCH, OPEN OR SHORT CIRCUIT

1) This DTC is set when control module senses pressure switch has been shorted or grounded. Connect test box to control module. See Fig. 3. Check pressure switch by connecting an ohmmeter between test box terminals No. 13 and 26. Ohmmeter should indicate zero ohms. Connect ohmmeter between test box terminal No. 26 and ground. Ohmmeter should indicate no continuity.

2) If any reading is incorrect, check if wiring is broken or shorted. If wiring is okay, replace hydraulic modulator. If readings are correct, go to next step.

3) Connect an ohmmeter between test box terminals No. 13 and 26. Depress brake pedal. If ohmmeter indicates no continuity, ensure brakelight contact is operating. If brakelight contact is okay, erase DTC and test drive vehicle. See TEST DRIVING VEHICLE under DIAGNOSIS & TESTING. If DTC reoccurs, replace control module. If ohmmeter indicates continuity, check wiring for a short circuit. If a short circuit is not present, replace hydraulic modulator.

DTC 4-4-1: CONTROL MODULE FAULT

1) Control module is fitted with dual microprocessors. To compare results, microprocessors carry out all calculations in parallel. DTC sets when control module detects that calculations do not correspond with each other.

2) Connect test box to control module. See Fig. 3. Check control module by connecting an ohmmeter between control module housing and ground, then between test box terminal No. 1 and ground.

3) If ohmmeter indicates continuity in both cases, ensure wheel sensor wiring is not too close to sources of interference (electric motors, phone connections, etc.). If wheel sensor wiring is okay, erase DTC and test drive vehicle. See TEST DRIVING VEHICLE under DIAGNOSIS & TESTING. If DTC reoccurs, replace control module. If ohmmeter indicates an open circuit in both cases, replace control module.

DTC 4-4-3: PUMP MOTOR, ELECTRICAL OR MECHANICAL FAULT

1) DTC 4-4-3 is set when control module activates pump motor and detects that voltage between terminals No. 39 and 49 is not at least 500 millivolts AC. Disconnect combination relay 15-pin connector located next to hydraulic modulator. See Fig. 4.

2) Connect voltmeter between relay connector terminal No. 15 and ground. If battery voltage is present, go to next step. If battery voltage is not present, check for an open circuit in fuse or wiring.

3) Connect voltmeter between relay connector terminals No. 2 and 15. If battery voltage is present, go to next step. If battery voltage is not present, check wiring to ground for an open or short circuit.

4) Disconnect combination relay 4-pin connector located next to hydraulic modulator. Connect an ohmmeter between relay connector terminals No. 2 and 4. See Fig. 4. Ohmmeter should indicate 10-40 ohms. Connect ohmmeter between 4-pin connector terminal No. 2 and ground. Ohmmeter should indicate no continuity. If one reading is incorrect, replace hydraulic modulator. If both readings are correct, go to next step.

5) Connect jumper wire between 15-pin connector terminal No. 2 and 4-pin connector terminal No. 3. Connect another jumper wire between 15-pin connector terminal No. 15 and 4-pin connector terminal No. 1. If pump motor operates, leave jumper wires in place and go to

next step. If pump motor does not operate, replace hydraulic modulator.

6) Connect voltmeter between 4-pin connector terminals No. 4 and 2. Voltmeter should read greater than .5 volts AC while pump motor is running. Remove jumper wires. If voltage was to specification, go to next step. If voltage was not to specification, replace hydraulic modulator.

7) Connect an ohmmeter between 4-pin relay connector terminal No. 1 and 15-pin relay connector terminal No. 15. Ohmmeter should indicate no continuity. Connect ohmmeter between 4-pin relay connector terminal No. 3 and 15-pin relay connector terminal No. 2. Ohmmeter should indicate zero ohms. Connect ohmmeter between 4-pin relay connector terminal No. 2 and 15-pin relay connector terminal No. 8. Ohmmeter should indicate zero ohms.

8) Connect ohmmeter between 4-pin relay connector terminal No. 4 and 15-pin relay connector terminal No. 7. Ohmmeter should indicate zero ohms. Connect ohmmeter between 15-pin connector terminals No. 10 and 13. Ohmmeter should indicate 45-90 ohms.

9) If any resistance readings are not to specification, replace combination relay. If all resistance readings are to specification, connector connectors and go to next step.

10) Connect test box to control module. See Fig. 3. Connect a jumper wire between test box terminal No. 15 and voltage. If pump motor operates, go to next step. If pump motor does not operate, check if combination relay wiring is shorted or open. If wiring is okay, replace combination relay.

11) Connect ohmmeter between test box terminals No. 31 and 49. If ohmmeter indicates 10-40 ohms, go to next step. If ohmmeter does not indicate 10-40 ohms, check for an open circuit.

12) Connect an ohmmeter between test box terminals No. 1 and 49, then between test box terminals No. 1 and 31. If ohmmeter indicates an open circuit, replace control module. If ohmmeter indicates a closed circuit, check for a short to ground. If no short is present, replace combination relay.

DTC 4-4-4: NO SUPPLY TO HYDRAULIC UNIT VALVES

1) Connect test box to control module. See Fig. 3. Disconnect 15-pin combination relay connector located next to hydraulic modulator. See Fig. 4. Connect an ohmmeter between ground and test box terminals No. 3, 33, and 34. If ohmmeter indicates an open circuit, go to next step. If ohmmeter does not indicate an open circuit, check wiring for a short circuit.

2) Connect an ohmmeter between test box terminal No. 3 and 15-pin relay connector terminal No. 9. If ohmmeter indicates zero ohms, go to next step. If ohmmeter does not indicate zero ohms, go to step 7).

3) Connect ohmmeter between test box terminal No. 34 and 15-pin connector terminal No. 12. If ohmmeter indicates zero ohms, go to next step. If ohmmeter does not indicate zero ohms, check wiring for an open circuit.

4) Turn ignition on. Connect voltmeter between 15-pin relay terminal No. 3 and ground, then between terminal No. 4 and ground. If battery voltage is present, turn ignition off and go to next step. If battery voltage is not present, turn ignition off and check wiring for an open circuit.

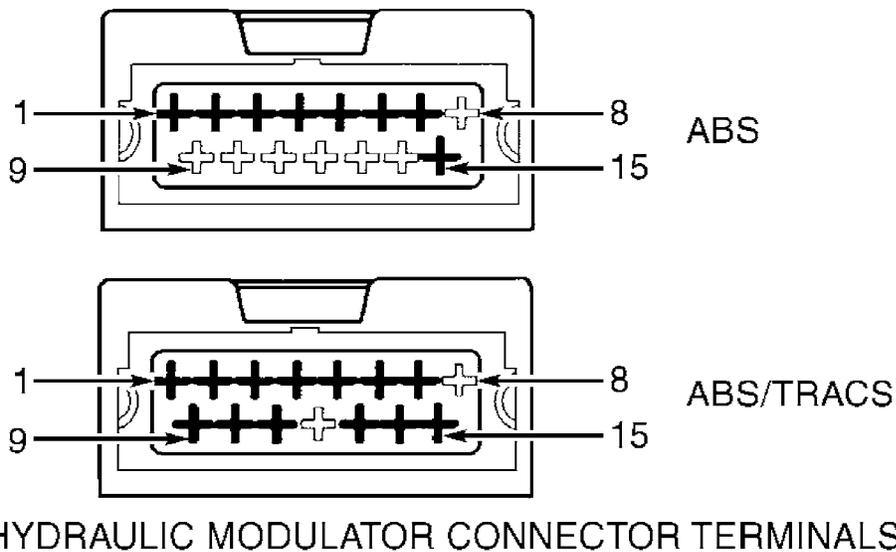
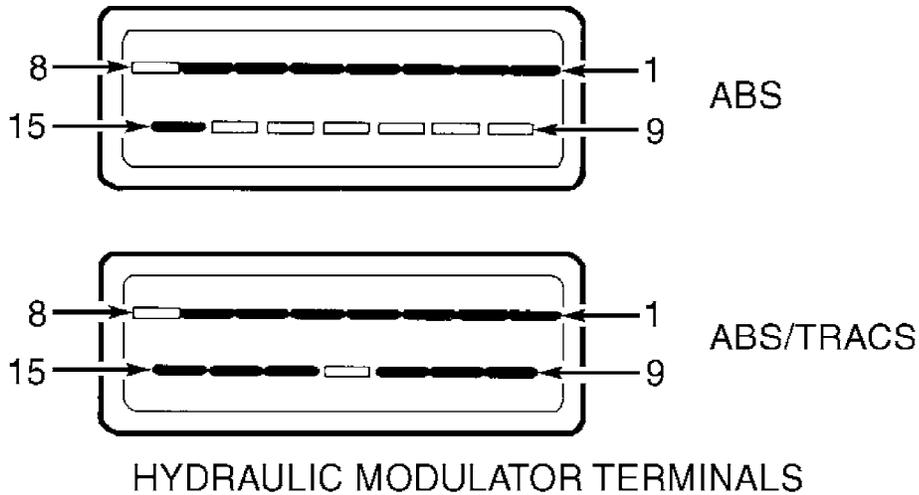
5) Connect ohmmeter between 15-pin relay connector terminals No. 9 and 10. Ohmmeter should indicate zero ohms. Connect ohmmeter between 15-pin connector terminals No. 3 and 12. Ohmmeter should indicate 45-90 ohms. If both readings are correct, go to next step. If one reading is incorrect, replace combination relay.

6) Reconnect 15-pin connector. Turn ignition on. Connect a jumper wire between test box terminals No. 1 and 34. Connect a

voltmeter between test box terminals No. 1 and 3. If voltmeter indicates battery voltage, turn ignition off and replace control module. If voltmeter does not indicate battery voltage, turn ignition off and replace combination relay.

7) If ohmmeter did not indicate zero ohms in step 2), disconnect 15-pin hydraulic modulator connector. See Fig. 5. Connect an ohmmeter between 15-pin hydraulic modulator connector terminals No. 1 and 15. If ohmmeter indicates zero ohms, go to next step. If ohmmeter does not indicate zero ohms, replace hydraulic modulator.

8) Connect an ohmmeter between hydraulic modulator terminal No. 1 and test box terminal No. 3. If ohmmeter indicates zero ohms, check if wiring is okay between hydraulic modulator connector terminal No. 15 and 15-pin combination relay terminal No. 9. If ohmmeter does not indicate zero ohms, check wiring for an open circuit.



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Fig. 5: Identifying Hydraulic Modulator Connector Terminals
 Courtesy of Volvo Cars of North America

ABS WARNING INDICATOR DOES NOT LIGHT

1) Connect test box to control module. See Fig. 3. Disconnect combination relay 15-pin connector located next to hydraulic modulator. See Fig. 4. Connect voltmeter between test box terminals No. 1 and 52. Turn ignition on. Voltmeter should indicate battery voltage. Turn ignition off. If voltage reading is to specification, go to next step. If voltage reading is not to specification, check bulb and wiring to warning light. If bulb and wiring are okay, replace instrument cluster.

2) Disconnect combination relay 15-pin connector. Turn ignition on. Connect a jumper wire between 15-pin connector terminal No. 6 and ground. If fuse blows, ensure wiring is not shorted. If fuse does not blow, ABS warning light should light. Turn ignition off. If warning light does not operate, check wiring for an open circuit. If warning light operates, go to next step.

3) Connect positive lead of diode tester to 15-pin combination relay connector terminal No. 6 and negative lead to terminal No. 2. Diode tester should indicate continuity. Change polarity on diode tester. Diode tester should indicate no continuity. If resistance readings are not to specification, replace combination relay and go to next step. If resistance readings are to specification, leave relay connector disconnected and go to next step.

4) Put a jumper wire between test box terminals No. 1 and 52. Turn ignition on. ABS warning light should light. Turn ignition off. If light does not operate, check wiring for an open circuit. If light does operate, reconnect system and check if ABS warning indicator is operating correctly. If ABS warning indicator still does not operate, replace control module.

ABS WARNING INDICATOR LIGHTS, NO DTC DISPLAYED

1) Test drive vehicle at 25 MPH. If light goes out, system is okay. If light does not go out, connect test box to control module. See Fig. 3.

2) Connect a jumper wire between test box terminals No. 1 and 34. Connect voltmeter between test box terminals No. 1 and 33. Turn ignition on. If voltmeter shows battery voltage, leave jumper wire in place and go to next step. If voltmeter does not show battery voltage, check wiring for an open circuit. If wiring is okay, replace combination relay.

3) Turn ignition on. Connect ohmmeter between test box terminals No. 1 and 52. If no continuity is present, replace control module. If continuity is present, go to next step.

4) Turn ignition off. Disconnect combination relay 15-pin relay connector. See Fig. 4. Connect an ohmmeter between test box terminals No. 1 and 52. If no continuity is present, replace combination relay. If continuity is present, check instrument cluster wiring for a short circuit.

TRACS WARNING INDICATOR DOES NOT LIGHT

1) Ensure control module has Blue label which is intended for TRACS system. If control module does not have Blue label, replace control module. If control module has Blue label, go to next step.

2) Connect test box to control module. See Fig. 3. Connect jumper wire between test box terminals No. 1 and 44. Turn ignition on. TRACS warning light should light. Turn ignition off.

3) If TRACS warning light comes on, replace control module. If warning light does not come on, check if bulb is okay. If bulb is okay, check wiring to bulb for an open circuit. If wiring is okay, replace instrument cluster.

TRACS WARNING INDICATOR LIGHTS, NO DTC DISPLAYED

1) Ensure control module has Blue label which is intended for TRACS system. If control module does not have Blue label, replace control module. If control module has Blue label, go to next step.

2) Connect test box to control module. See Fig. 3. Turn ignition on. Connect ohmmeter between test box terminals No. 1 and 44. Ohmmeter should indicate no continuity. Turn ignition off. If ohmmeter reading was to specification, replace control module. If ohmmeter reading was not to specification, check for short circuit in instrument cluster wiring.

BRAKE WARNING INDICATOR DOES NOT LIGHT

1) If brake warning indicator does not light when brake fluid level is low, go to step 4). If brake warning indicator does not light when ignition is turned on, go to next step.

2) Disconnect brake fluid level switch connector. Connect a jumper wire between connector terminals No. 1 and 2. Start engine. Ensure charge indicator light goes out, and brake warning indicator lights. Turn engine off.

3) If system operates as described, replace instrument cluster. If system does not operate as described, ensure bulb is okay and there are no open circuits in brake fluid level switch wiring. If bulb and wiring are okay, replace instrument cluster.

4) If brake warning indicator does not light when brake fluid level is low, disconnect brake fluid level switch connector. Connect jumper wire between switch connector terminals No. 1 and 2. Start engine. Ensure charge indicator light goes out, and brake warning indicator lights. Turn engine off.

5) If system operates as described, replace brake fluid level switch. If system does not operate as described, check for an open circuit in brake fluid level switch wiring.

BRAKE WARNING INDICATOR DOES NOT GO OUT

1) Ensure brake fluid reservoir level is correct and filled as necessary. If fluid level was okay, disconnect brake fluid level switch connector. Start engine. Brake warning indicator should go out. Turn engine off.

2) If system operates as described, replace brake fluid level switch. If system does not operate as described, check if brake fluid level switch wiring is shorted to ground. If wiring is okay, replace instrument cluster.

DTCS CANNOT BE READ

1) Connect test box to control module. See Fig. 3. Disconnect diagnostic lead from diagnostic unit. See Fig. 2. Turn ignition on. Connect voltmeter between test box terminals No. 1 and 53. If voltmeter indicates battery voltage, go to next step. If voltmeter does not indicate battery voltage, ensure fuse and wiring do not have an open circuit.

2) Connect an ohmmeter between test box terminals No. 1 and 23. Ensure diagnostic lead is removed from diagnostic unit. If ohmmeter indicates an open circuit, go to next step. If ohmmeter indicates a closed circuit, check wiring for a short circuit.

3) Connect ohmmeter between test box terminal No. 23 and diagnostic unit connector terminal A3. See Fig. 2. Ohmmeter should indicate zero ohms. Turn ignition off. If reading is to specification, go to next step. If reading is not to specification, check wiring for an open circuit.

4) Turn ignition on. Connect voltmeter between diagnostic unit output connector terminal A4 and ground. See Fig. 2. If voltmeter indicates battery voltage, go to next step. If voltmeter does not

indicate battery voltage, check fuse and wiring for an open circuit.

5) Connect voltmeter between diagnostic unit output connector terminals A8 and A4. See Fig. 2. Voltmeter should indicate battery voltage. Turn ignition off. If voltmeter indicates battery voltage, check if diagnostic unit operates by diagnosing another system (EFI, ignition, etc.). If diagnostic output is okay, replace control module. If voltmeter does not indicate battery voltage, check wiring for an open circuit.

POOR BRAKING

1) Raise and support vehicle. Release hand brake and shift into Neutral. Depress brake pedal, then release. Turn wheel with suspect defective valve by hand. If wheel turns, go to next step. If wheel does not turn, check for frozen or sticking pads, caliper, springs, and other components.

2) Connect test box to control module. See Fig. 3. Connect jumper wire between test box terminals No. 1 and 34. Connect another jumper wire between suspect return valve terminal and test box terminal No. 1. See TEST BOX RETURN VALVE TERMINAL IDENTIFICATION table.

TEST BOX RETURN VALVE TERMINAL IDENTIFICATION TABLE

Return Valve	Terminal No.
Left Front	2
Right Front	21
Rear	36

3) Wait 30 seconds. Depress brake pedal and hold in place. Turn ignition on, but for not more than 20 seconds. Turn wheel with suspected defective valve by hand. Wheel should turn. Turn ignition off. If system operates to specification, go to next step. If system does not operate to specification, replace hydraulic modulator.

4) Connect a jumper wire between test box terminal No. 1 and suspect inlet valve test box terminal. See TEST BOX INLET VALVE TERMINAL IDENTIFICATION table.

TEST BOX INLET VALVE TERMINAL IDENTIFICATION TABLE

Inlet Valve	Terminal No.
Left Front	20
Right Front	38
Rear	54

5) Wait 30 seconds. Turn ignition on, but not for more than 20 seconds. Depress brake pedal and hold in place. Turn wheel with suspected defective valve by hand. Wheel should turn. Turn ignition off. If system operates as specified, problem may be intermittent. Go to CHECKING INTERMITTENT FAULTS under DIAGNOSIS & TESTING. If system does not operate as specified, replace hydraulic modulator.

BOTH FRONT WHEELS ARE COMPLETELY OR PARTIALLY LOCKED

1) If both front wheels are completely or partially locked, go to next step. If only one wheel is locked or partially locked, problem is mechanical.

2) Connect test box to control module. See Fig. 3. Connect jumper wires between test box terminals No. 1 and 34, terminals No. 1

and 21, and terminals No. 1 and 2. Wait 30 seconds. Turn ignition on, but not for more than 20 seconds. Wheels should turn. Turn ignition off and visually check brakes.

3) If system operates as specified, replace hydraulic modulator. If system does not operate as specified, fault is mechanical.

NO TRACS FUNCTION

1) Turn ignition on. Turn TRACS system on. TRACS indicator light should operate. Turn ignition off. If system operates as specified, go to next step. If system does not operate as specified, check wiring to switch for an open circuit. If wiring is okay, replace switch.

2) Connect test box to control module. See Fig. 3. Turn ignition on. Connect a jumper wire between test box terminals No. 1 and 25. Indicator light should operate. Turn ignition off. If system operates as specified, check if fault is intermittent. If fault remains, replace control module. If system does not operate as specified, check wiring to switch for an open circuit. If wiring is okay, replace switch.

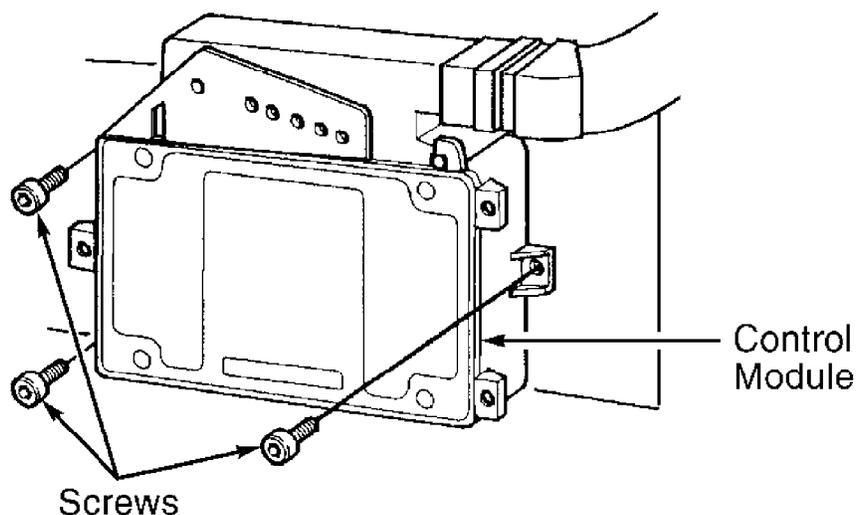
REMOVAL & INSTALLATION

CONTROL MODULE

Removal & Installation

1) Turn ignition off. Disconnect negative battery cable. Clean area around control module connector, then disconnect connector. Remove 3 screws and carefully lift control module from vehicle. See Fig. 6.

2) To install, reverse removal procedure. Tighten control module screws to 48 INCH lbs. (5 N.m). Reconnect electrical connector and negative battery cable. Check for DTCs, ensuring DTC 1-1-1 is displayed.



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Fig. 6: Removing Control Module
Courtesy of Volvo Cars of North America

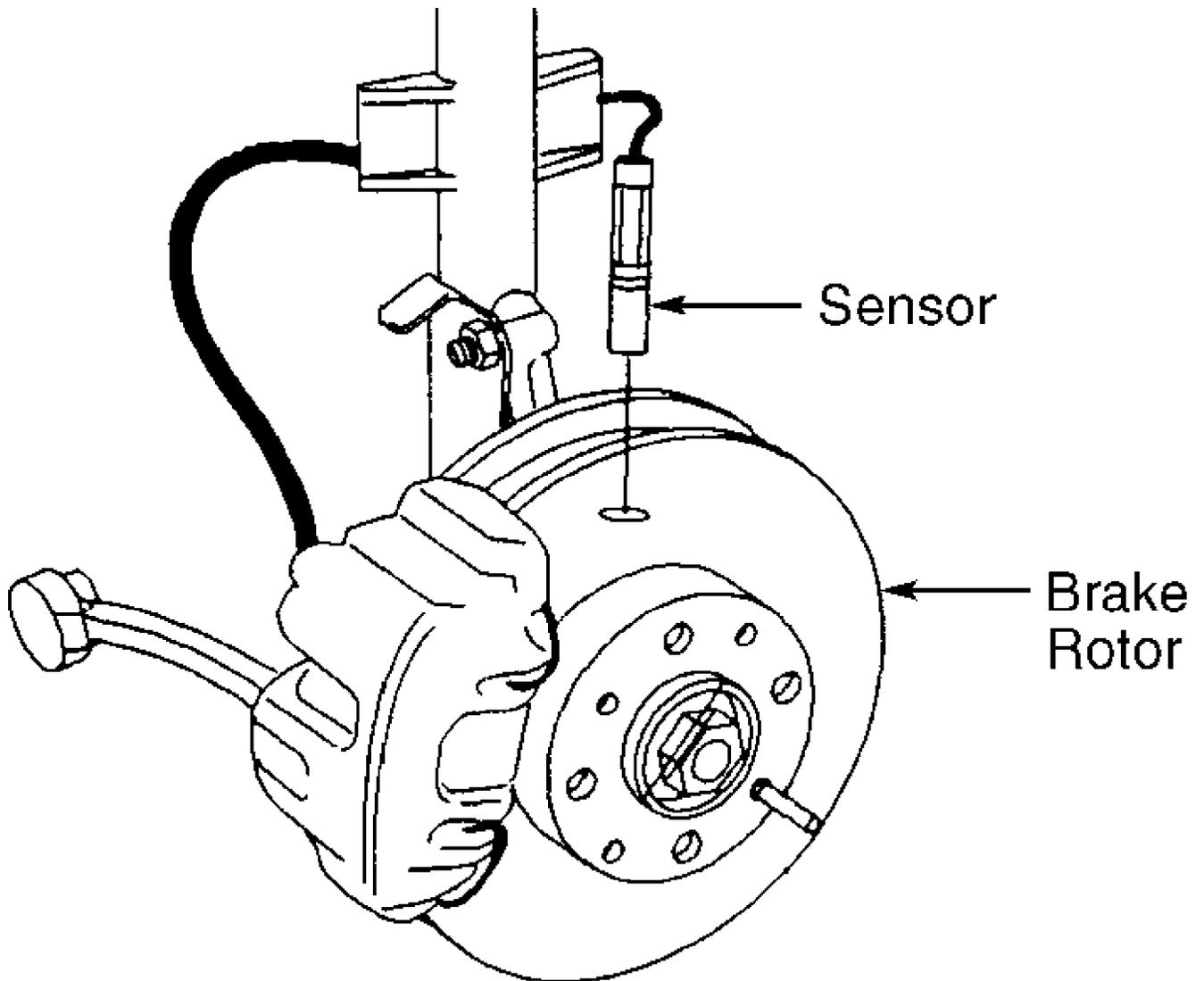
FRONT & REAR WHEEL SENSOR

Removal

Turn ignition off. Disconnect negative battery cable. Remove wheel. Carefully clean sensor and electrical connector. Remove sensor mounting bolt and pull out sensor. Disconnect electrical connector. See Fig. 7 or 8.

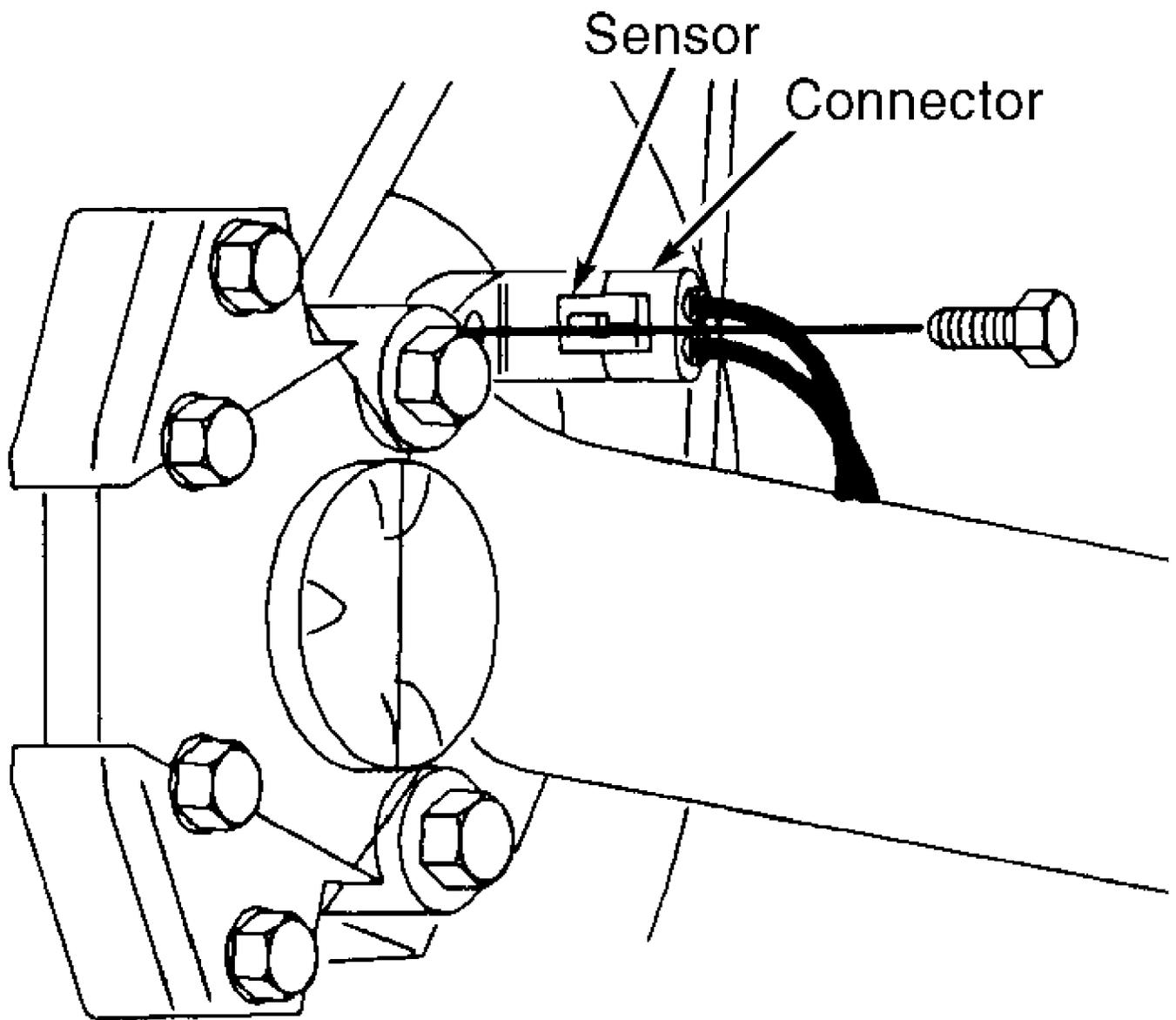
Installation

Clean dirt and rust from sensor seat so sensor is located correctly against pulse wheel. Using a soft brush, brush dirt from pulse wheel. Replace sensor and tighten screw to 84 INCH lbs. (10 N. m). Reconnect electrical connector. Install wheel. Display any DTCs stored in control module, then erase them. Test drive vehicle, ensuring ABS warning indicator goes out. Display any DTCs, ensuring DTC 1-1-1 is displayed.



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Fig. 7: Removing Front Wheel Sensor
Courtesy of Volvo Cars of North America



93H82898

Fig. 8: Removing Rear Wheel Sensor
Courtesy of Volvo Cars of North America

HYDRAULIC MODULATOR

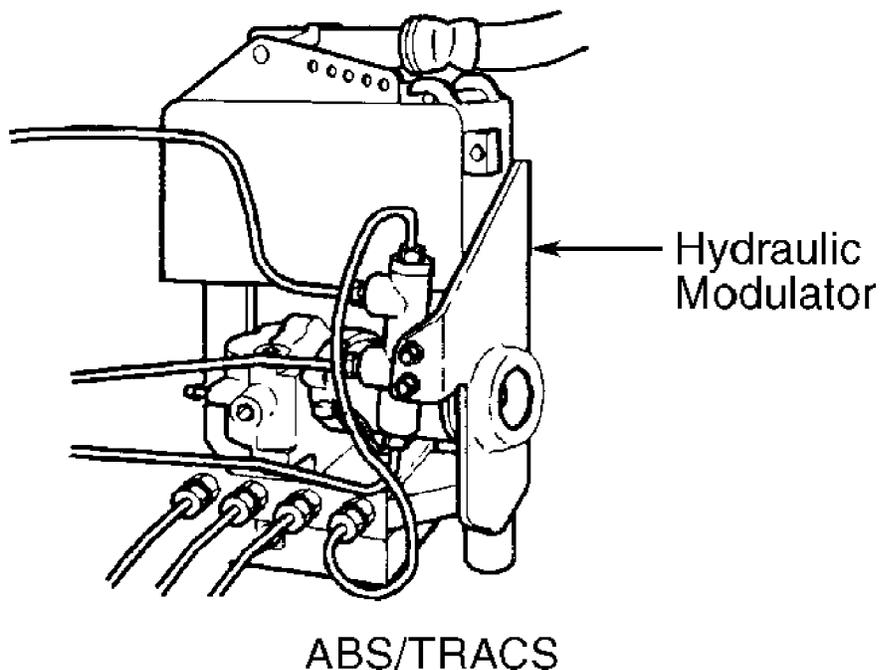
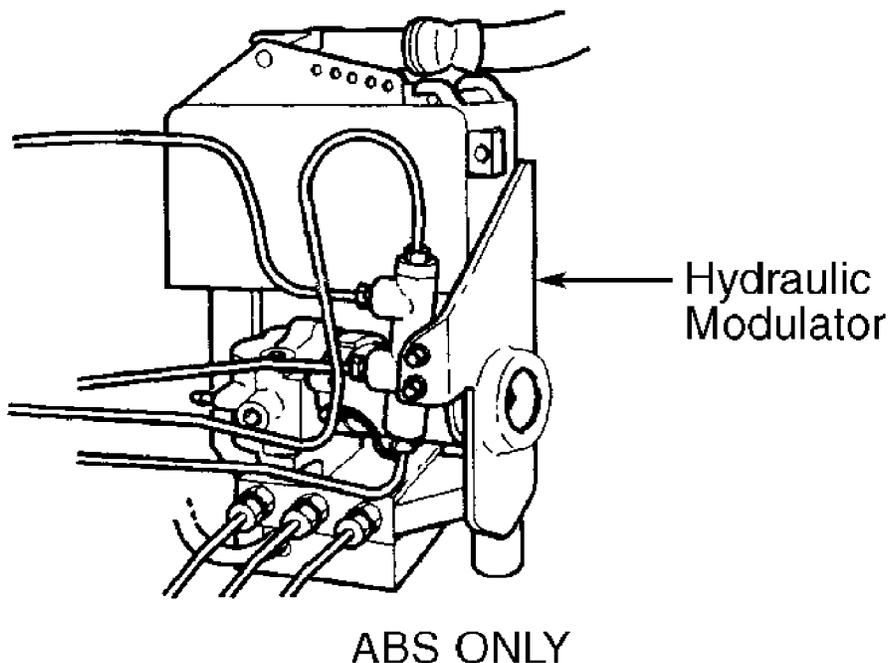
NOTE: If hydraulic modulator is damaged, it should be replaced as a complete unit. Hydraulic modulator, reducing valve, and control module are located on same bracket in engine compartment. Entire bracket assembly must be removed.

Removal

1) Turn ignition off. Drain system of brake fluid. Clean area around brake hose and brake line connections on hydraulic modulator and clutch master cylinder. Place rags under clutch master cylinder to prevent damage to paint. Remove air cleaner assembly.

2) Disconnect negative battery cable. Remove 2 clutch master

cylinder-to-reducing valve brake lines. Remove 3 brake lines on side of hydraulic modulator. If vehicle is equipped with TRACS, there is an additional brake line from reducing valve. See Fig. 9. Plug lines and openings on hydraulic modulator so no dirt can enter system.



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Fig. 9: Locating Brake Lines On Hydraulic Modulator
Courtesy of Volvo Cars of North America

3) Disconnect hydraulic modulator 15-pin connector located next to hydraulic modulator on left shock tower. See Fig. 5. Remove 2

connector mounting screws. To avoid confusion, twist wiring to this connector together with wiring to 55-pin control module connector. Remove combination relay. Disconnect hydraulic modulator-to-combination relay 4-pin connector. Allow connector to hang free, ensuring it does not come into contact with brake fluid.

4) Remove nut securing hydraulic modulator to bracket on shock tower. Remove 2 nuts to shock tower and lift mounting enough to free hydraulic modulator bracket. Remove 2 brake hoses to brake fluid reservoir.

NOTE: One hose is difficult to reach. Remove it after bracket has been lifted out.

5) Carefully lift bracket with hydraulic modulator, reducing valve, and control module from engine compartment. Cut wiring tie and remove rolled wire from hydraulic modulator bracket. Remove 2 brake lines to reducing valve. Remove 4 hydraulic modulator mounting bolts. Remove hydraulic modulator.

Installation

To install hydraulic modulator, reverse removal procedure. Bleed brake system. Check for stored DTCs and erase them. Test drive vehicle and check brake operation. Ensure ABS warning light goes out. Read off DTCs and ensure DTC 1-1-1 is displayed.

PEDAL SENSOR

Removal & Installation

Turn ignition off. Disconnect negative battery cable. Depress brake pedal several times to remove any vacuum from power brake booster. Disconnect electrical connector. See Fig. 10. Stretch spring clip and remove sensor from power brake booster.

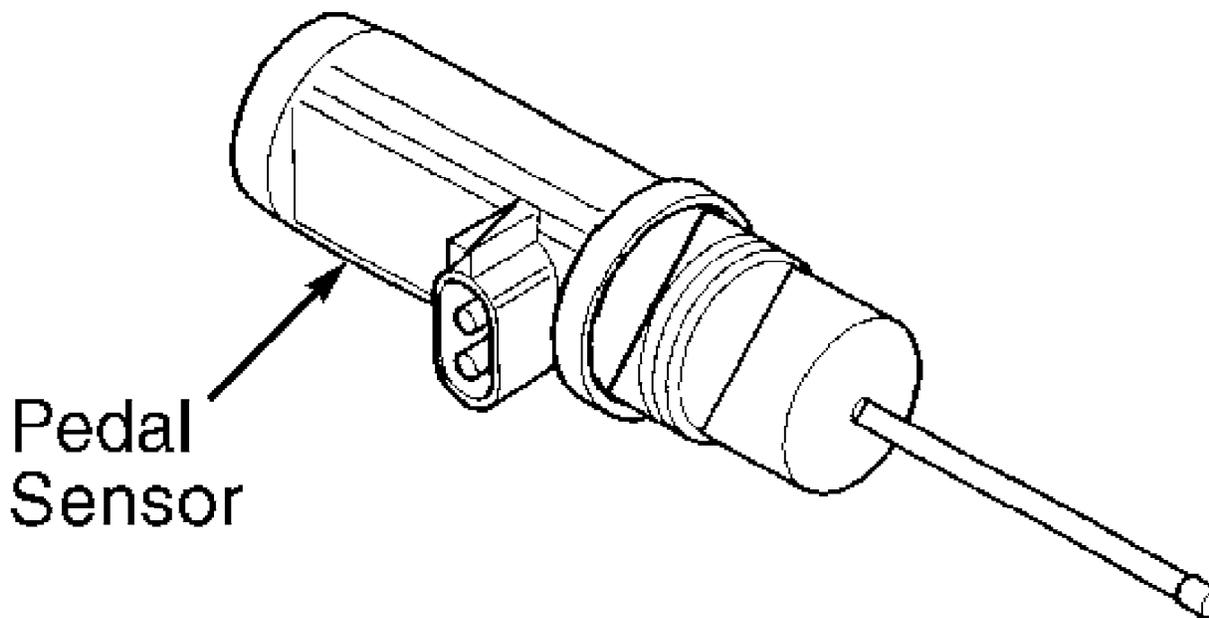


Fig. 10: Locating Pedal Sensor
Courtesy of Volvo Cars of North America

Installation

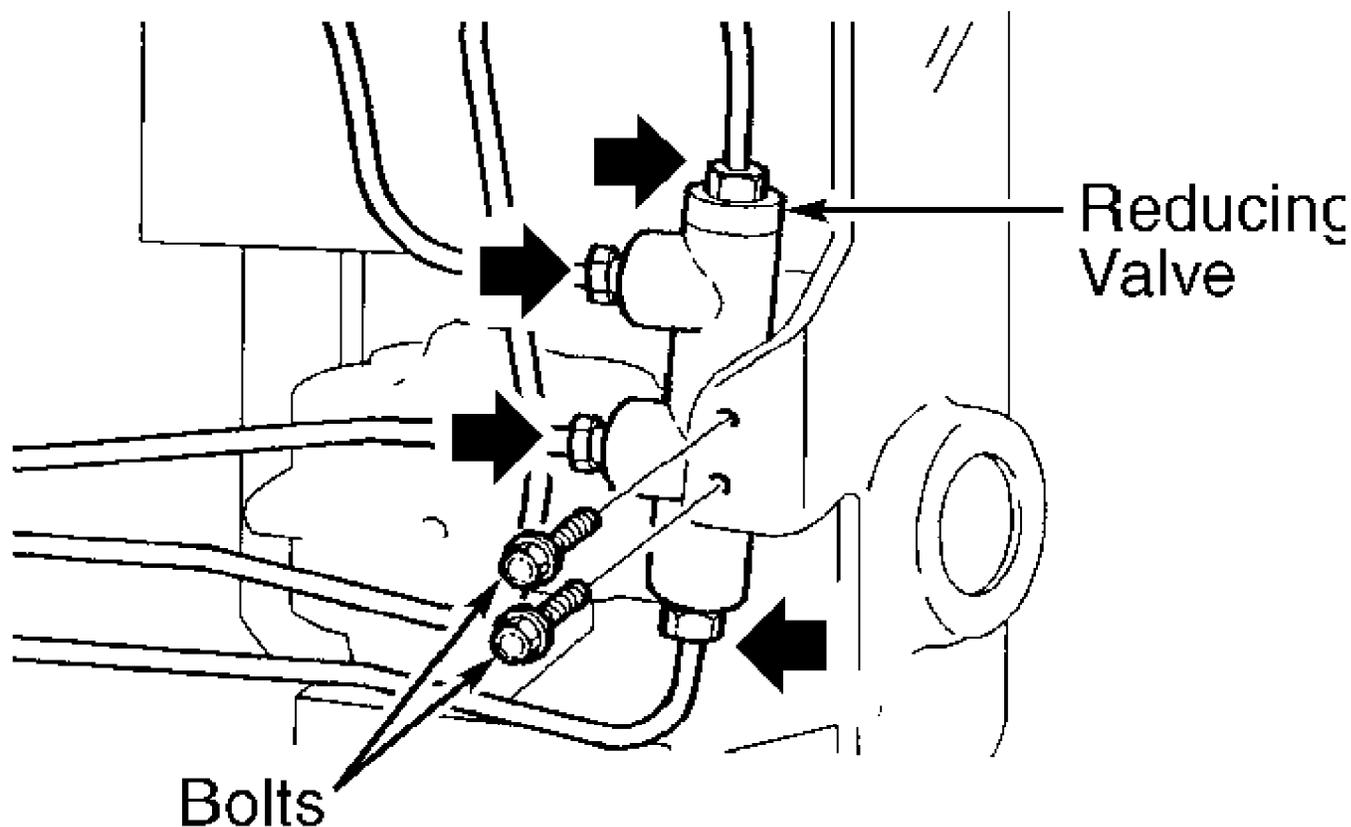
Check power brake booster color code and select spacer of

correct color. Replace spacer on pedal sensor. Install NEW sealing ring on sensor. Replace pedal sensor with NEW spring clip in power brake booster and press sensor in until it snaps in place. Reconnect electrical connector and negative battery cable.

REDUCING VALVE

Removal & Installation

Clean area around brake line nipples on valve so no dirt gets into braking system. Place rags under valve to protect paint. Loosen brake line nuts. Remove both mounting bolts. See Fig. 11. Remove valve. To install, reverse removal procedure.



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Fig. 11: Removing Reducing Valve
Courtesy of Volvo Cars of North America

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	INCH Lbs. (N.m)
Control Module Screws	48 (5)
Wheel Sensor Screws	84 (10)

WIRING DIAGRAM

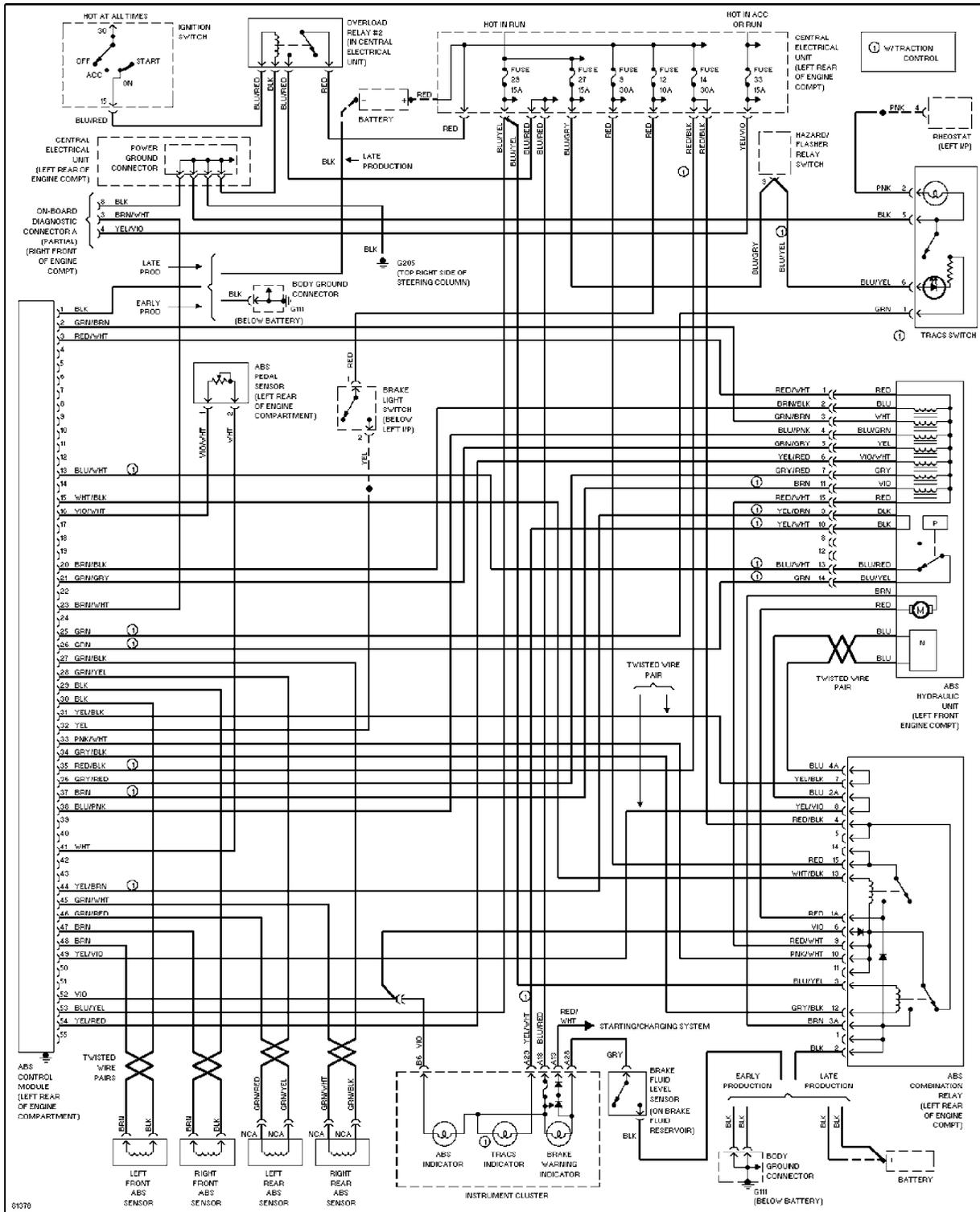


Fig. 12: Anti-Lock & Traction Control System Wiring Diagram