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Working on the ABS system

The Anti-lock Braking System (ABS) is basically maintenance free.

Heat and sparks can cause damage

- disconnect plug from control unit before using electric welding equipment on car
- control unit cannot stand heat of paint drying oven or heat lamp more than 95°C (203°F) even for short time, -85°C (185°F) for more than 2 hours
- remove control unit if necessary

Disconnect battery

- disconnect ground strap on battery before removing control unit

When testing ABS

- do not drive car with tester connected

Check after brake job is finished

After repairing or replacing

- brake pads
 - discs
 - cable hoses
 - master cylinder
 - parking brake components
- test drive car faster than 6 km/h (4 mph)
 - indicator light must not come on if ABS system is **OK**

After work on ABS system

- hydraulic unit
 - electronic control unit
 - speed sensor
 - wiring harness
 - brake lines
 - proportional valves
- check ABS system using tester

Hydraulic unit, replacing

- disconnect battery ground strap
- disconnect brake lines
- remove hydraulic unit

CAUTION

When removing and installing brake lines make sure that the lines are identified or installed according to the designation on the hydraulic unit.

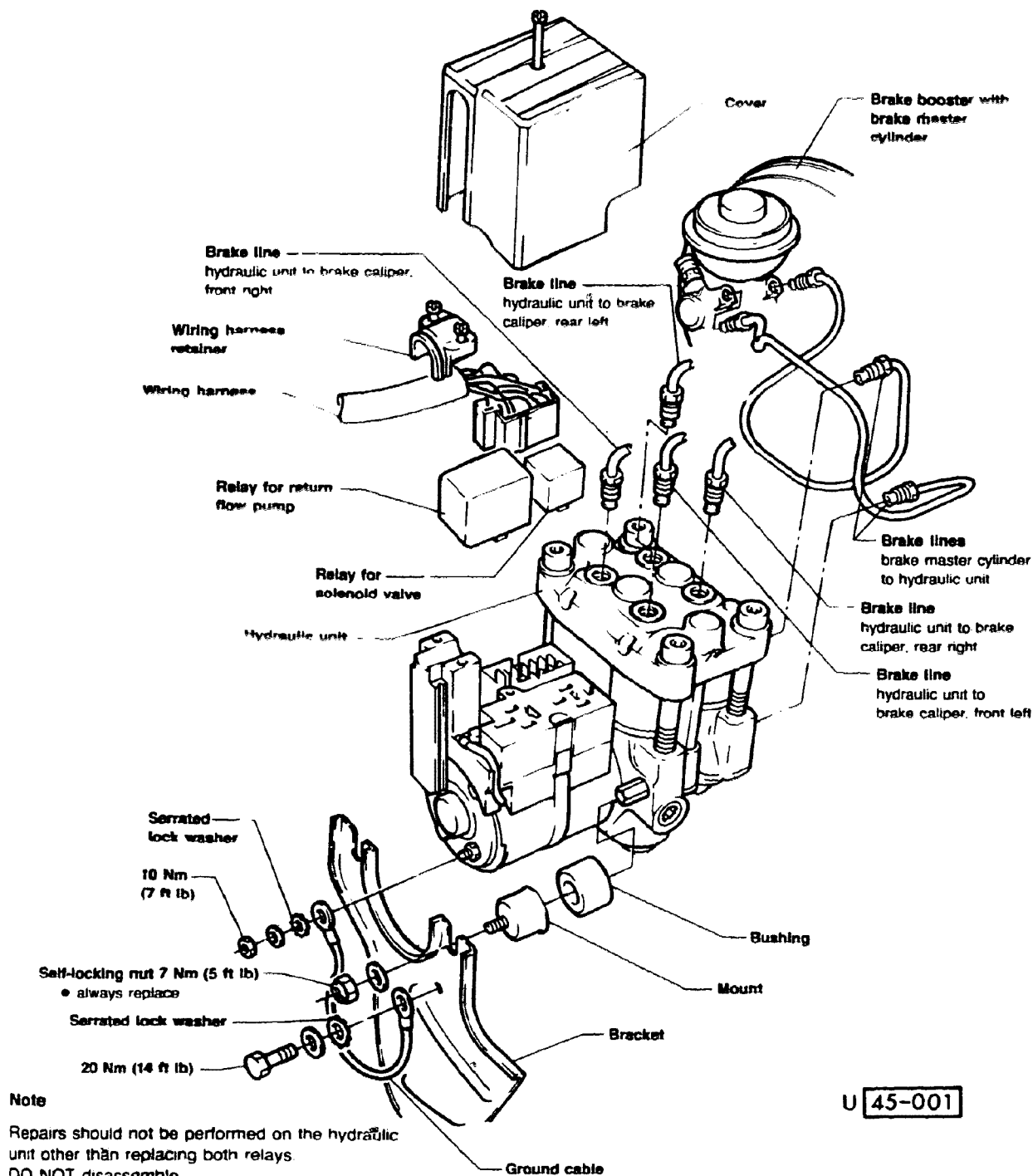
Install only original equipment brake lines

Seal brake lines and connections immediately during repairs.

Tightening torque of brake lines is 15 Nm (11 ft lb).

For all work which requires an open hydraulic system, bleed the brake system with brake filler/bleeder, **US 1116**.

In addition, a high and low pressure check should be performed on the brake system (see page 45.6).



Note

Repairs should not be performed on the hydraulic unit other than replacing both relays.
DO NOT disassemble

If necessary, replace complete hydraulic unit.

Check high and low pressure (see page 45.6)

U 45-001

Note

For Quattro hydraulic unit, see page 45.5

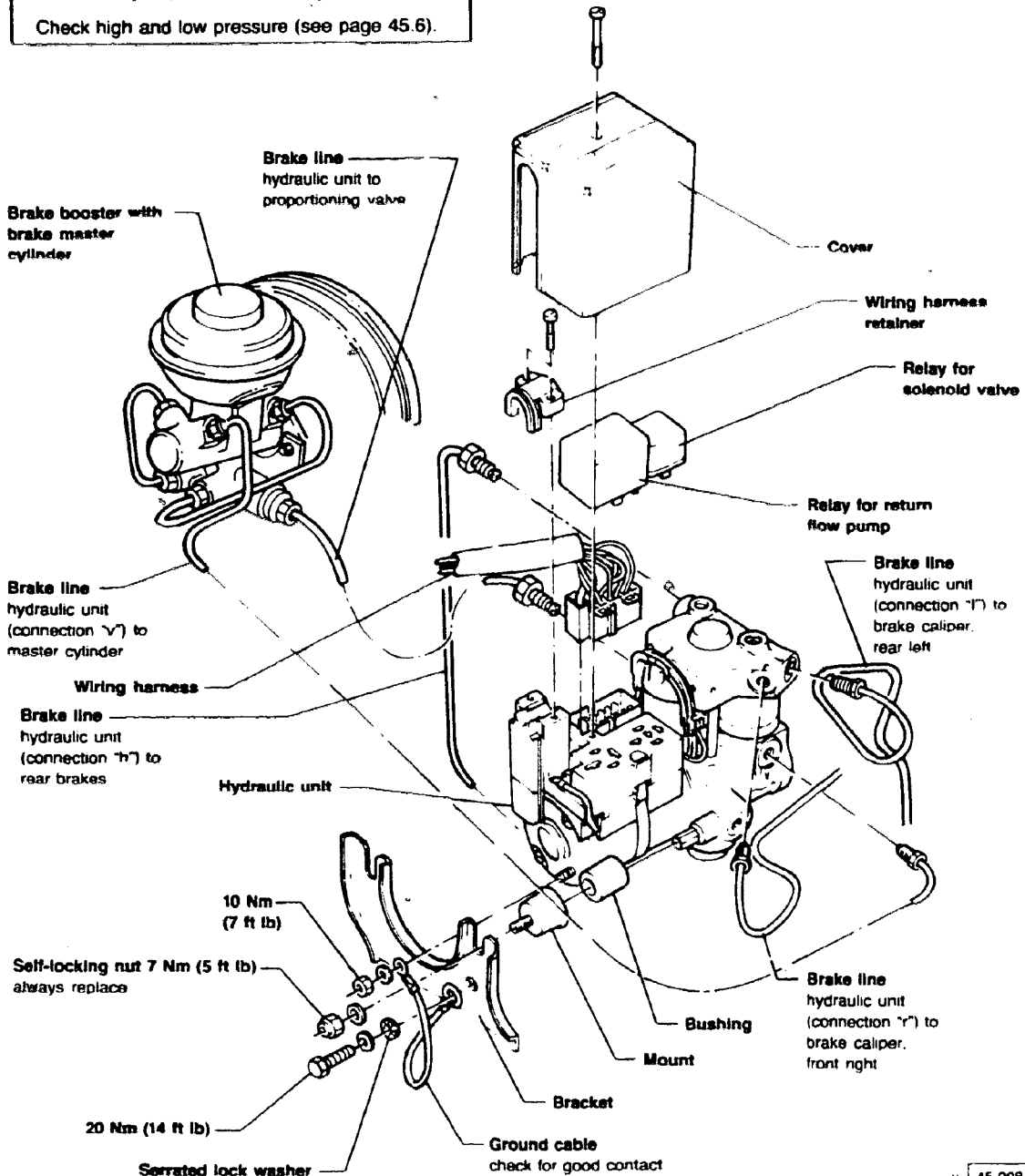
A-4

CAUTION

Repairs should not be performed on the hydraulic unit other than replacing both relays
DO NOT disassemble.

If necessary, replace complete hydraulic unit

Check high and low pressure (see page 45.6).



45-008

A-5

Quattro

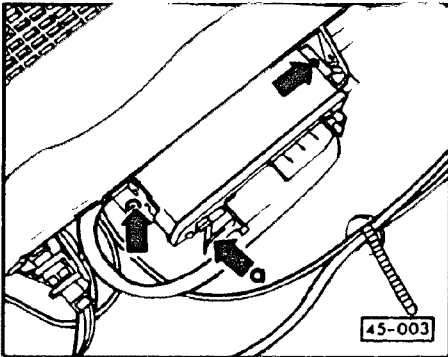
Hydraulic unit

45.5

High and low pressure, checking

Work sequence

- unscrew bleeder screw on one front brake caliper
- connect **VW 1310** and bleed
- install brake pedal depresser between brake pedal and driver's seat
- load brake pedal until gauge indicates **50 bar (725 psi)**
- watch gauge for 45 seconds
 - pressure drop must not be more than 4 bar (58 psi)
 - with a large pressure drop, replace hydraulic unit
- adjust brake pedal depresser so that gauge indicates a line pressure of 6 bar (87 psi)
- test for 3 minutes
 - pressure drop must not be more than 1 bar (14.5 psi)
 - if pressure drop is greater, replace hydraulic unit



► Fig. 1 Electronic control unit, removing/installing

Location: Under rear seat, left side

Note

Turn ignition **OFF** during removal/installation.

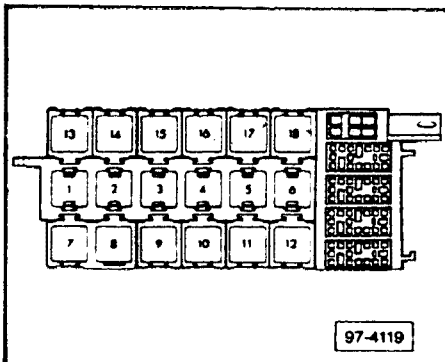
- connector held in control unit by spring (arrow a)
- control unit secured with screws (arrows)

Combination relay, removing/installing

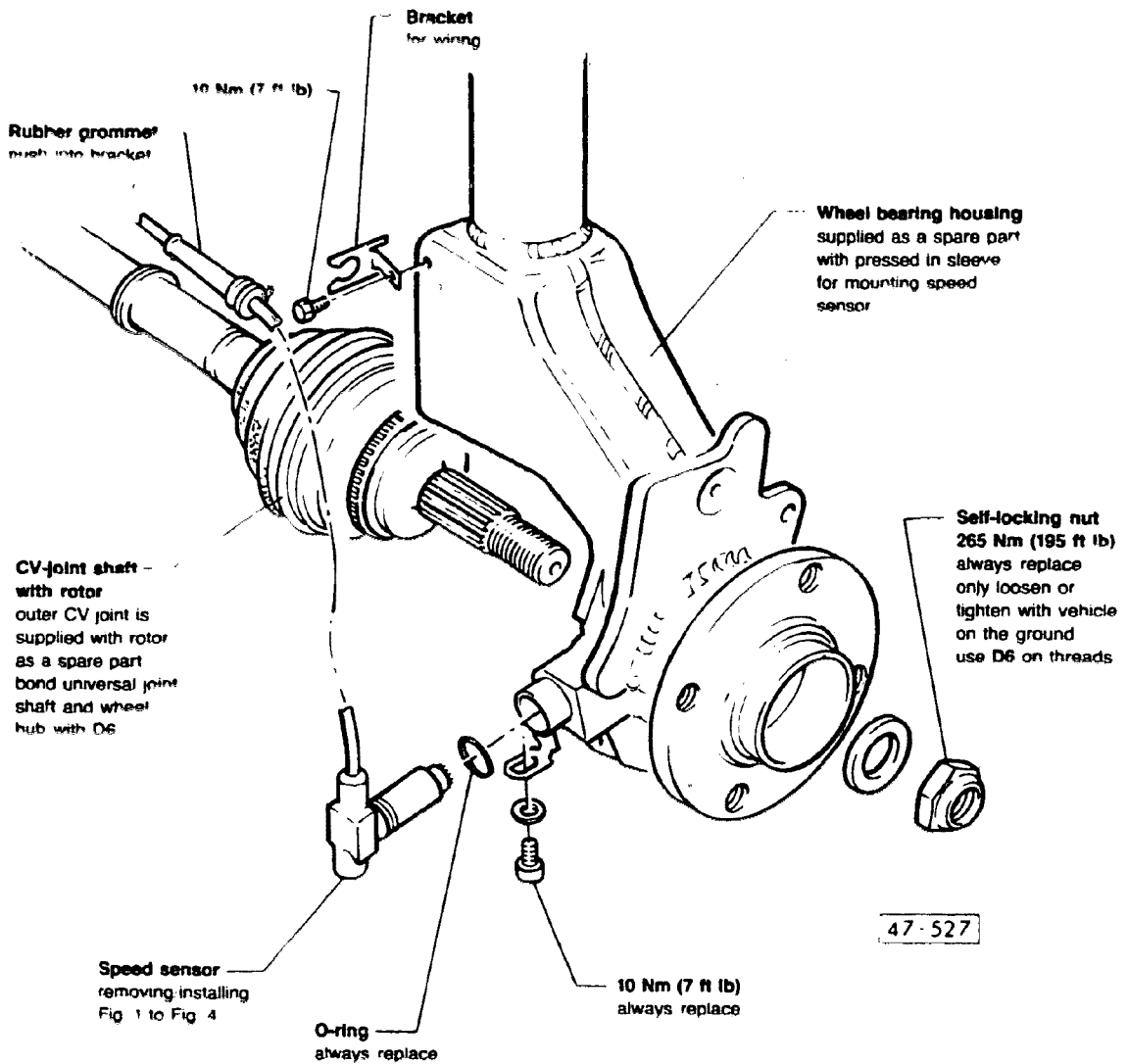
Location: under instrument panel, in auxiliary relay panel, relay position 1

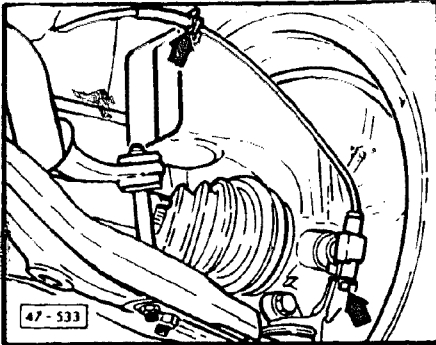
Note

Turn ignition **OFF** during removal/installation.



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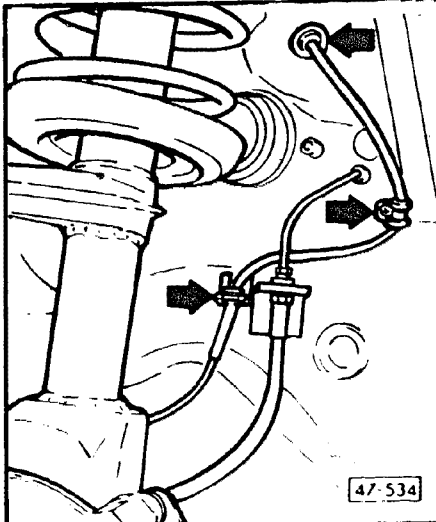


► **Fig. 1 Front axle speed sensors, removing/installing**

- remove mounting bolt (lower arrow) and take out speed sensor
- replace O-ring seal on sensor
- lubricate O-ring seal and sensor with brake assembly lubricant
- install sensor in housing until PVC tip touches rotor on CV-joint
- install new retaining bolt and tighten to 10 Nm (7 ft lb) while holding sensor against wheel bearing housing
- install wiring grommet in bracket on wheel bearing/strut housing (upper arrow)

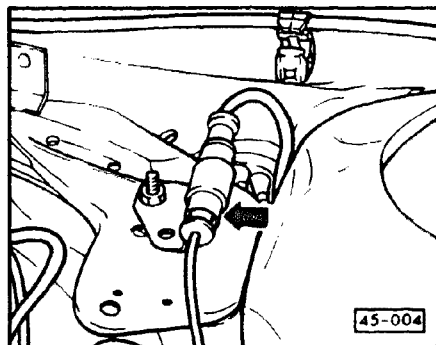
Note

At repeated installation of a speed sensor, remove the old PVC cap and insert a new PVC cap, Part No. 437 927 809. This ensures that the required air gap is maintained.



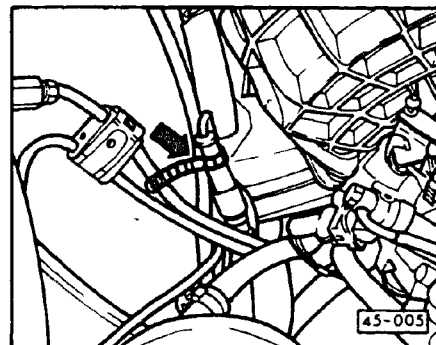
► **Fig. 2 Front axle speed sensor wiring harness, installing**

- route wiring through grommet to wheel housing (upper arrow)
- install rubber grommet on wiring to bracket on body (lower arrow)
- use a cable clamp where indicated (middle arrow)



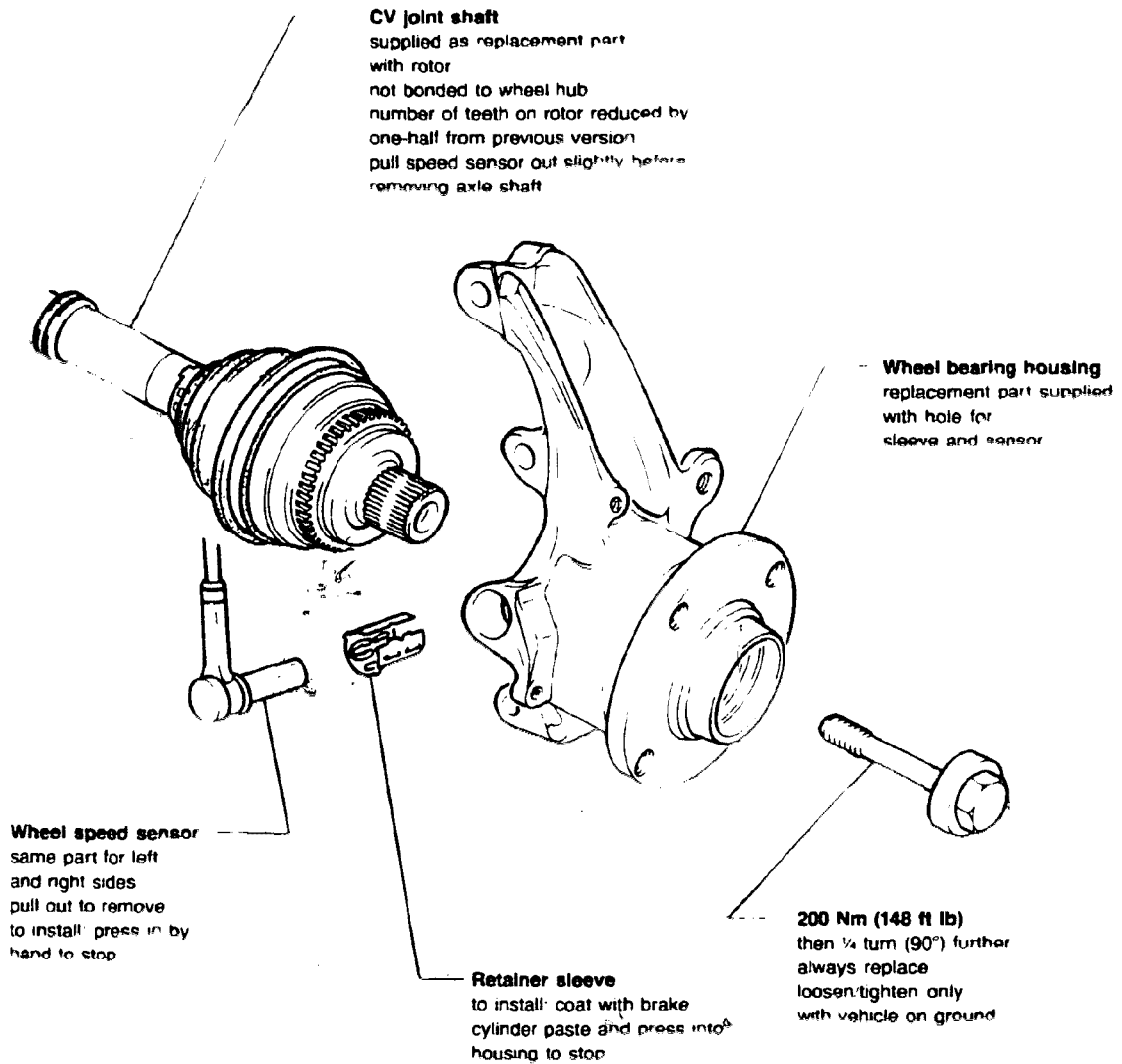
► **Fig. 3 Left front wheel speed sensor, disconnecting**

- remove electrical connector from bracket (arrow) and separate



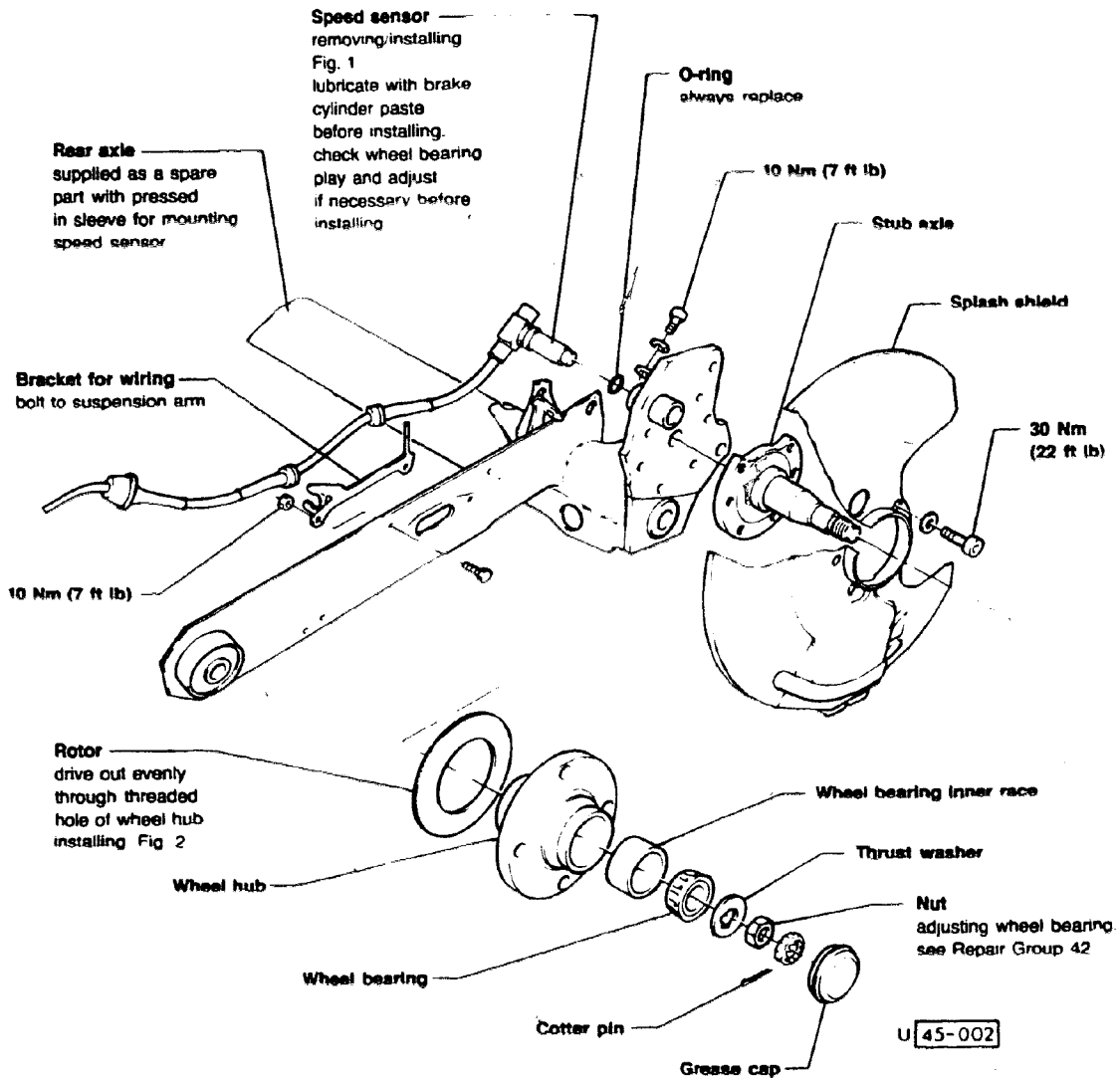
► **Fig. 4 Right front wheel speed sensor, disconnecting**

- loosen cable strap (arrow)
- remove electrical connector and separate



45-014

A-10

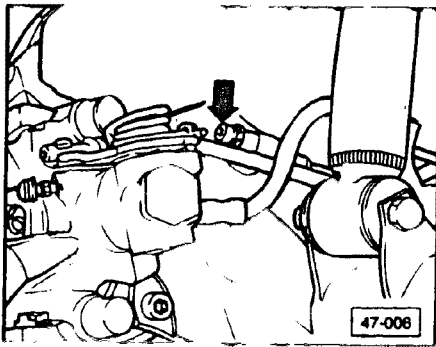


A-11

2-wheel drive

Rear axle ABS components
(up to VIN 89 JA 377 712)

45.9



► Fig. 1 Rear axle speed sensors, removing/installing (up to VIN 89 JA 377 712)

- remove mounting bolt (arrow) and take out speed sensor
- replace O-ring seal on sensor
- lubricate O-ring seal and sensor with brake assembly lubricant
- install sensor in housing until PVC tip touches rotor on CV-joint

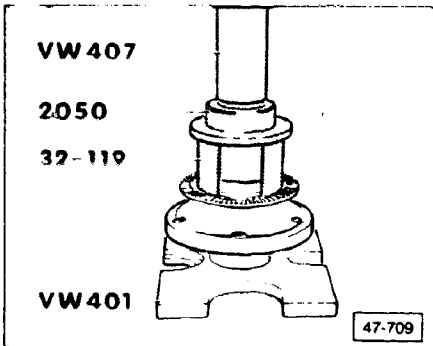
Note

During repeated installation of the speed sensor, remove the old PVC cap and replace it with a new one, Part No. 437 927 809. Only through the installation of the new PVC cap is the required air gap maintained.

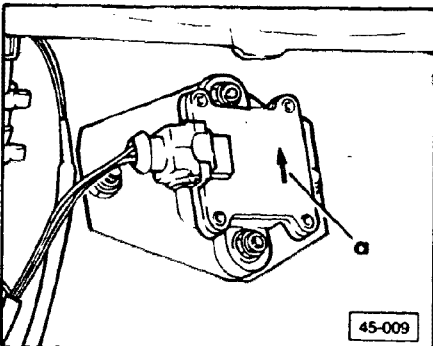
- install new retaining bolt and tighten to 10 Nm (7 ft lb) while holding sensor against wheel bearing housing
- install wiring grommets in brackets on wheel bearing/strut housing

Note

Both terminal connections for the rear speed sensor are located under the seat.



► Fig. 2 Rotor, pressing on



► Fig. 3 Acceleration switch, removing/installing

Location: under rear seat, left side

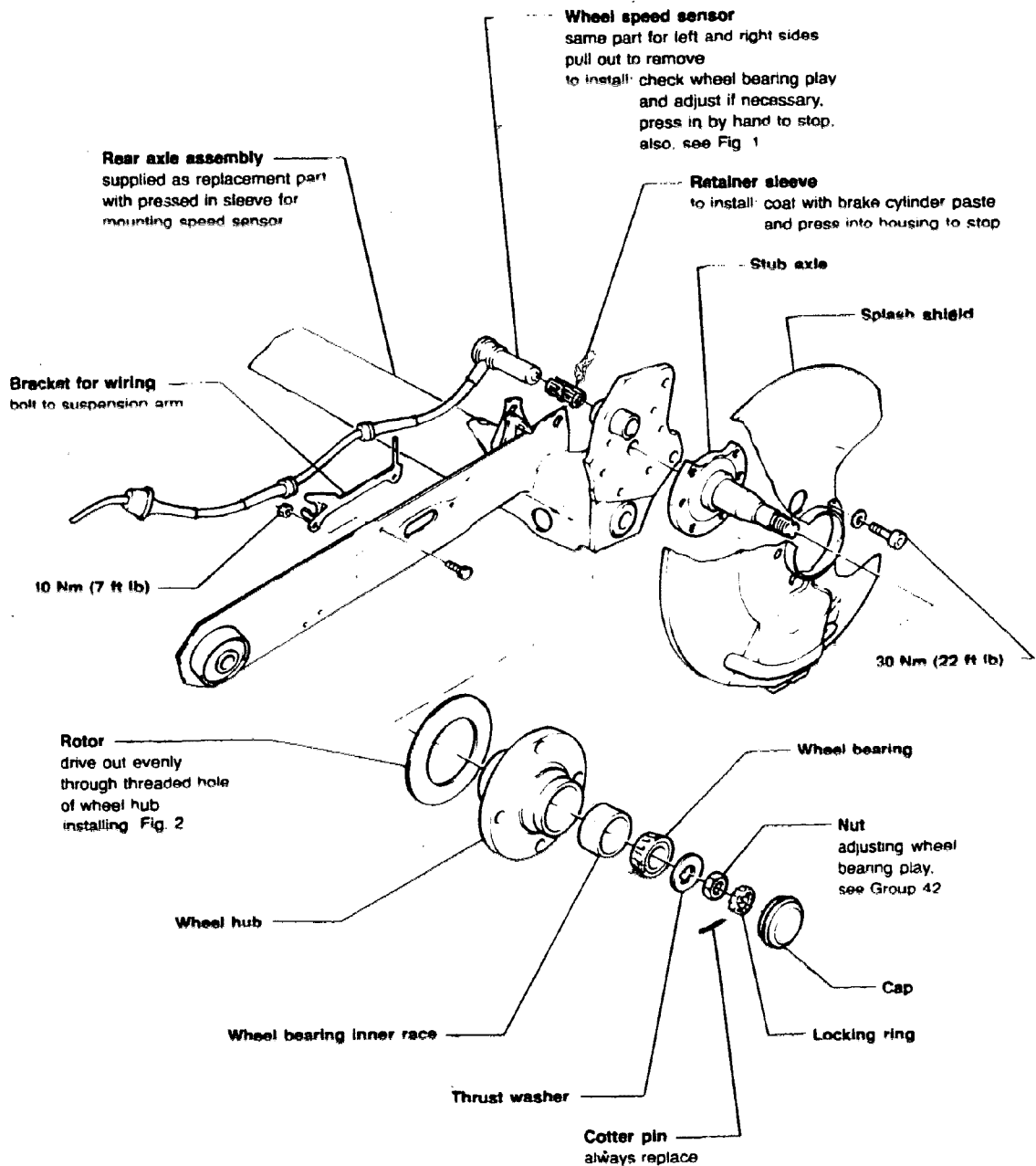
Note

Turn ignition **OFF** during removal/installation.

- arrow a on the switch points toward front of vehicle

Do not install the longitudinal acceleration switch in vehicles not originally equipped with it from the factory. Vehicles produced from April 1988 are equipped with the switch.

The longitudinal acceleration switch is not required for effective operation of the ABS system.



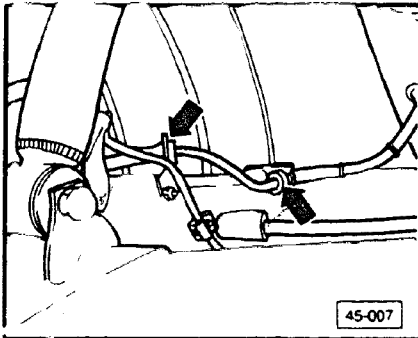
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A-13

2-wheel drive

Rear axle ABS components
(from VIN 89 JA 377 713)

45.10a

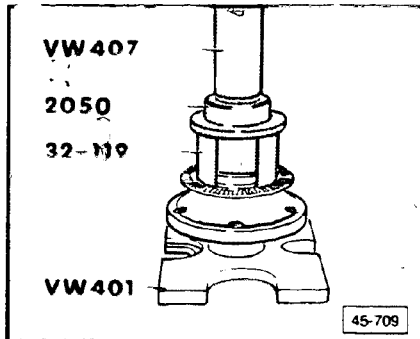


► Fig. 1 Wheel speed sensor, installing

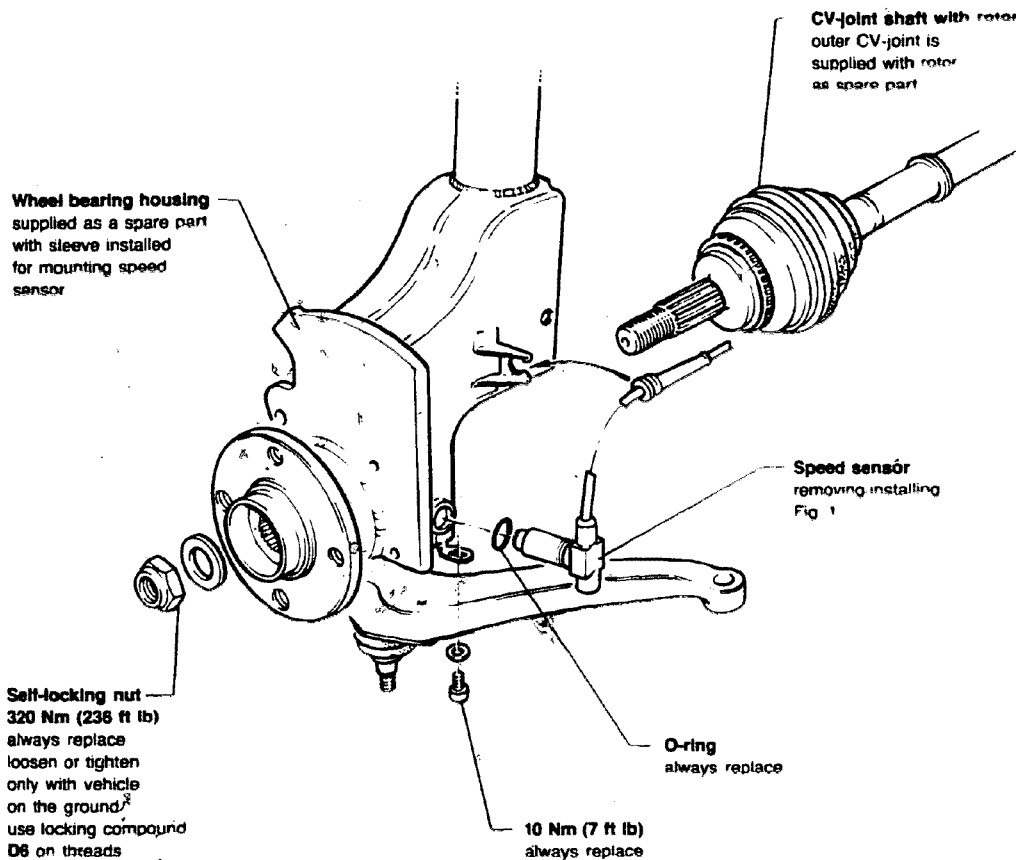
- install rubber grommets on sensor into bracket on suspension arm (arrows)

Note

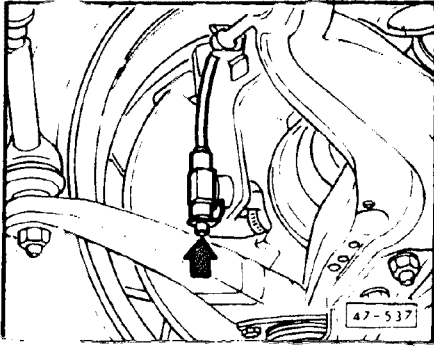
Both terminal connections for the rear wheel speed sensors are located under the rear seat.



► Fig. 2 Rotor, pressing on



47-526

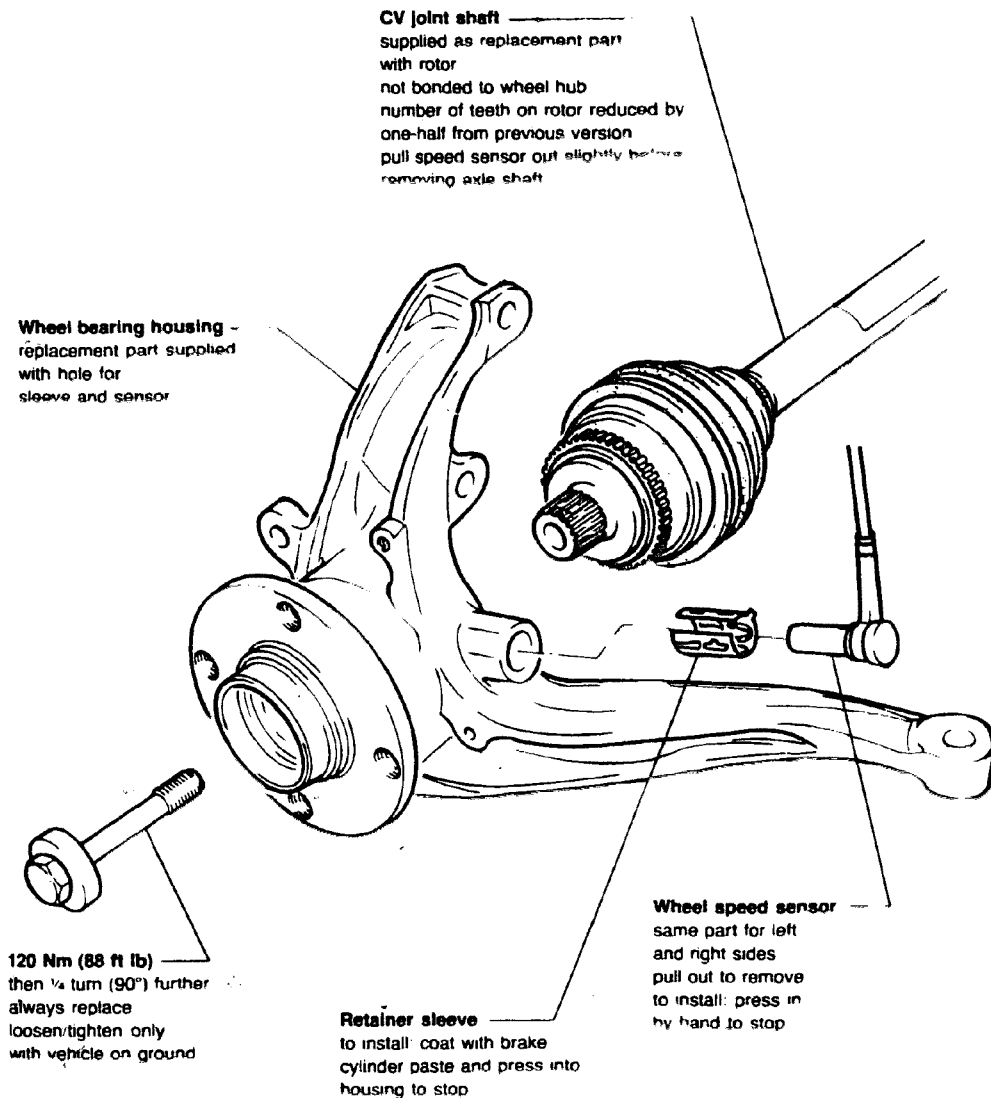


► **Fig. 1 Rear axle speed sensors, removing/ installing**

- remove mounting bolt (arrow) and take out speed sensor
- replace O-ring seal on sensor
- lubricate O-ring seal and sensor with brake assembly lubricant
- install sensor in housing until PVC tip touches rotor on CV-joint
- install new retaining bolt and tighten to 10 Nm (7 ft lb) while holding sensor against wheel bearing housing
- install wiring grómmets in brackets on wheel bearing/strut housing

Note

Both terminal connections for the rear speed sensor are located under the rear seat.



45-013

A-17

Quattro

Rear wheel ABS components
 (from VIN 89 JA 377 713)

45.13

CAUTION

- switch ignition **OFF** before connecting or disconnecting ABS control unit connector
- disconnect ABS control unit connector before using electrical welding equipment on the vehicle
- disconnect the battery connections before charging the battery or replacing the hydraulic modulator
- remove ABS control unit before drying paint repairs in an oven if temperatures will be above 85°C (185°F) for more than two hours
- do not use mini-spare tires on vehicles equipped with ABS. Use wheels and tires of matching/size on ABS equipped vehicles
- do not drive the vehicle with the anti-lock brake tester connected

General repair notes

The complete testing procedure using the ABS 2-LED Tester must be done after any repairs are made to the following:

- hydraulic modulator
- ABS control unit
- wheel speed sensors
- ABS wiring harness

It is also necessary to perform the test procedure if the brake lines or brake pressure regulators are replaced because of accident damage.

After repairs to the brake system that do not affect the anti-lock system components, do the following operational test of the ABS:

- switch ignition **ON**
 - ABS indicator light lights
- drive vehicle with differential locks **NOT** engaged at speed over 4 mph (6 km/h)
 - ABS indicator light must not light

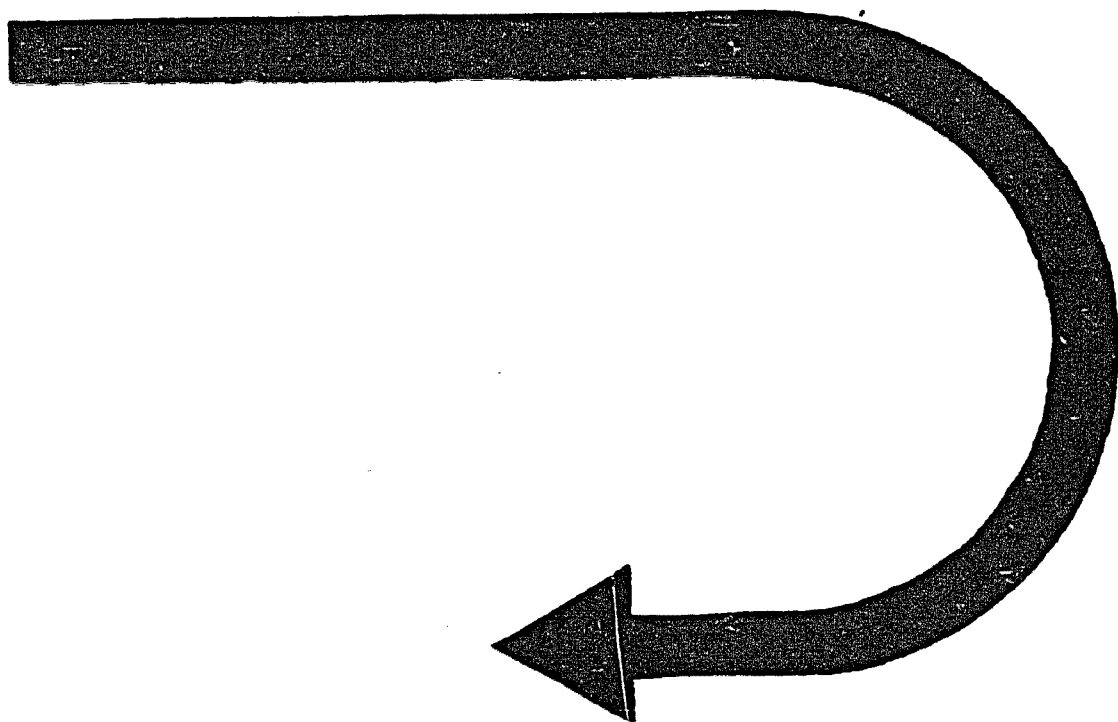
Do this test after repairing/replacing the following components:

- brake pads and/or brake discs
- brake hoses
- brake servo or master cylinder
- brake cables and hand brake components

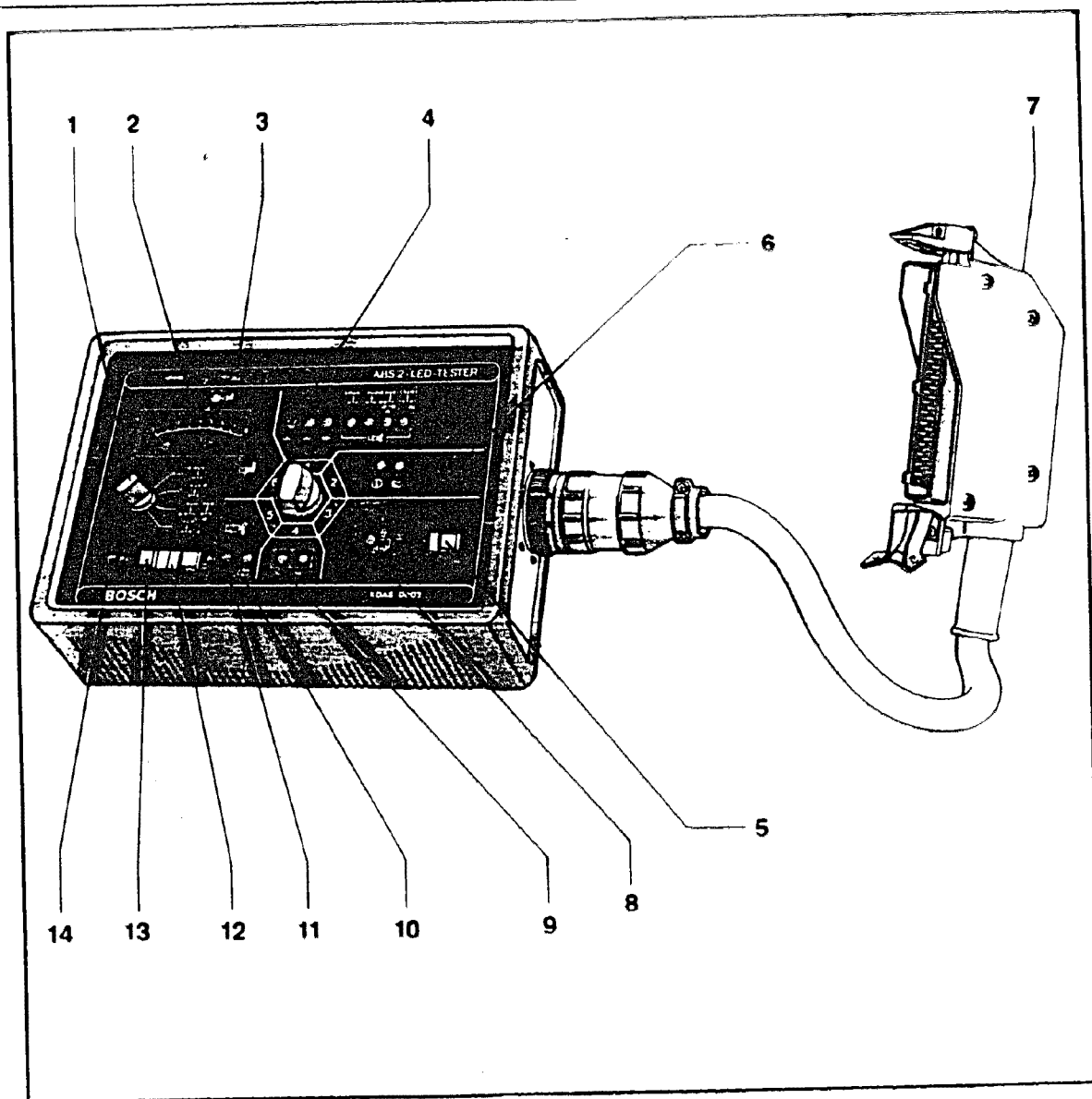
Note

During a final test drive, make sure that at least one controlled braking sequence is performed with the ABS **ON**.

CONTINUED IN THE
BEGINNING OF NEXT ROW



Anti-Lock Braking System



The Bosch ABS 2 LED-Tester will check the following:

- hydraulic modulator and relays
- wheel speed sensors
- warning light
- cable harness/connectors
- brake light switch signal
- alternator signal

The tester is not designed to check the electronic control unit.

Note

Certain steps of the test sequence require two technicians

1 — Rotary switch

used during program switch positions #5 and #6 to select the solenoid/wheel to be tested

2 — Analog gauge

used to check the operation of the selected wheel speed sensor

3 — LED

indicator for battery voltage

4 — 7 LEDs

indicate the condition of: ground connections warning light diode internal resistance of solenoid valves OFF position of solenoid valve relay.

- 5 — **Push button**
used to operate return pump
- 6 — **2 LEDs**
monitor alternator connections and brake light switch connections
- 7 — **Adapter plug**
for connecting the tester to the ABS wiring harness in the vehicle
- 8 — **LED**
that monitors return pump operation
- 9 — **2 LEDs**
(Not Applicable)
- 10 — **LED**
monitors the ON position of the solenoid valve relay
- 11 — **LED**
indicates current availability for the pressure hold check of the selected solenoid valve
- 12 — **Pushbutton**
used during functional check of selected solenoid valve (pressure hold)
- 13 — **Pushbutton**
used during functional check of selected solenoid valve (pressure reduction)
- 14 — **LED**
indicates current availability for the pressure reduction check of the selected solenoid valves

Program switch positions	Test of:	Additional steps:	Desired result:	If desired result is not obtained, go to page:
During Entire Test	Power supply	switch ignition ON	LED stays lit 	45 19
1	Grounds Warning light diode Solenoid valves internal resistance Solenoid valve relay OFF position	switch ignition ON	2 wheel drive - all seven LEDs stay lit 4 wheel drive - six LEDs stay lit (all LEDs except the one inside the dashed lines)	45 20 & 45 21
2	Alternator voltage Stop lamp switch	- switch ignition ON - start engine, let engine idle - switch ignition ON - operate brake pedal	- LED lights up  - LED goes out  - LED lights up  - LED goes out each time brake pedal is depressed 	45 24
3	Return pump motor relay Return pump	- ignition ON - depress pushbutton  - release pushbutton 	- LED lights up  - the pump motor runs  - LED continues to stay lit for a few seconds after the pushbutton is released 	45.25
4	Longitudinal acceleration sensor aL (only on vehicles so equipped)	switch ignition ON	LED lights up 	- acceleration sensor defective - replace

Program switch positions	Test of:	Additional steps:	Desired result:	If desired result is not obtained, go to page:
5	Relay for solenoid valves Solenoid valve maintain pressure function (Requires 2 people) Solenoid valve reduce pressure function (Requires 2 people) The LED surrounded by the dashed line IS NOT used during Position #5 when testing the Quattro 3 channel system (4 wheel drive)	- switch ignition ON - lift vehicle - put the transmission in neutral with the handbrake released - set the wheel selector switch to the wheel to be tested first - depress 'P = ' pushbutton and hold - depress brake pedal - release 'P = ' pushbutton while keeping brake pedal depressed - Do not release the brake pedal - depress 'P  pushbutton while keeping the brake pedal depressed - release 'P  pushbutton while keeping the brake pedal depressed - release brake pedal in between each wheel, being tested Note Each channel must be tested separately and consecutively.	- LED  lights up and must stay lit constantly as long as program switch is in position #5 - LED 'P = ' lights up - LED 'P = ' stays lit test wheel should now be able to be rotated by hand using second person - LED 'P = ' goes out and the test wheel locks up and cannot be rotated - LED 'P  Lights Up Test wheel should now be able to rotate by hand using second person - LED 'P  goes out and the test wheel locks up and cannot be rotated	45.27

Note

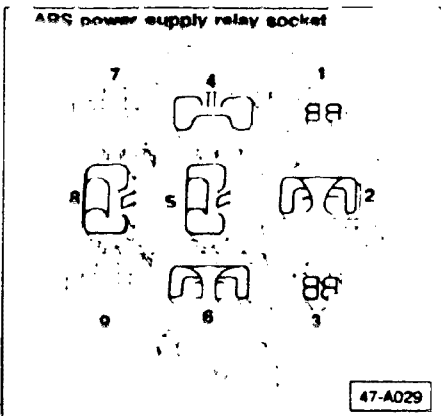
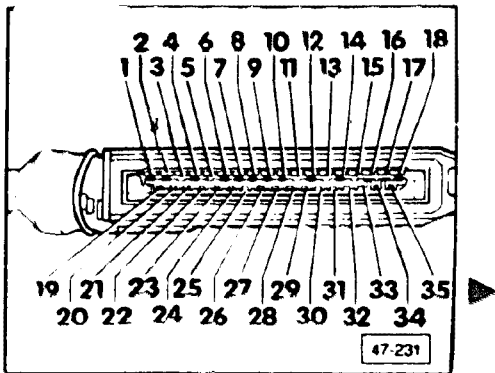
Vehicle wheels must be off the ground to perform steps 5 and 6. Carry out all testing consecutively for each wheel.

Program switch positions	Test of:	Additional steps:	Desired result:	If desired result is not obtained, go to page:
6	Wheel Speed Sensors The LED surrounded by the dashed line IS used during Position #6 when testing any Audi ABS system	- put the transmission in neutral with the handbrake released - set the wheel selector switch to the wheel to be tested first Note When testing the driven axle, the wheel NOT being tested must be held still	turn the wheel by hand until the LED above the analog gauge lights up without flickering (speed approximately 1 revolution per second) The reading must be greater than 0.8 Note Each sensor must be tested separately	45 28 - 45 29

Final check:

- assemble system
- start engine; anti-lock indicator light in vehicle must go out
- while the engine is running, acutate switch for anti-lock; indicator light in vehicle must come on
- switch off engine and start it again; anti-lock indicator light must go out
- drive vehicle at a speed above 20 mph (30 kph); anti-lock indicator must not come on
- if the center and/or rear differential lock is engaged, the ABS indicator light must come on (Quattro only)

If the ABS system does not function properly at the conclusion of the test procedure, replace the control unit and test drive the vehicle.



LED   not lit

- check these first
 - battery is fully charged
 - fuses #3 and #12 on the fuse/relay panel are OK
 - fuse on top of the anti-lock power supply relay is OK
- check for continuity between terminal 20 on the ABS control unit connector and ground at battery ground strap
- switch ignition OFF
- check continuity of the wire between terminal 10 of the ABS control unit connector and ground
- check for battery voltage between terminals 1 and 10 of ABS control unit plug
 - approximately battery voltage

If **NOT OK**,

- remove anti-lock power supply relay
- check for battery voltage between contacts 2 and 4 and contacts 5 and 4

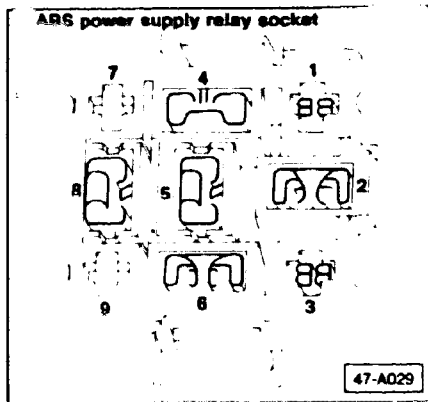
If **NOT OK**,

- repair wiring
- connect voltmeter between contacts 8 and 4
- press and hold the anti-lock switch
 - approximately battery voltage

If **NOT OK**,

- repair wiring or replace ABS switch and recheck

more

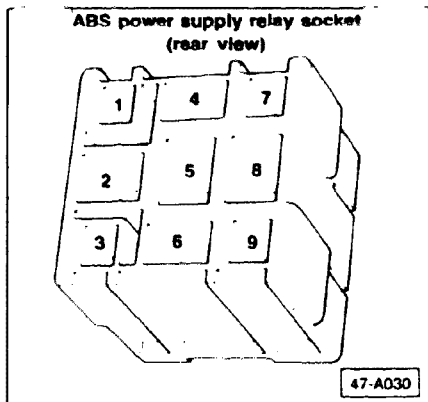


LED   not in
(on Quattro models)

- connect voltmeter between contacts 1 and 5 of power supply relay socket
- lock rear differential
 - approximately battery voltage
- unlock rear differential
 - 0.0 volts

If NOT OK

- repair wiring or replace differential lock switch
- install ABS power supply relay



- check for voltage between contacts 6 and 4 on back of relay socket
 - approximately battery voltage

If NOT OK

- replace ABS power supply relay and recheck

LED  does not light (tester in 'Position 1')

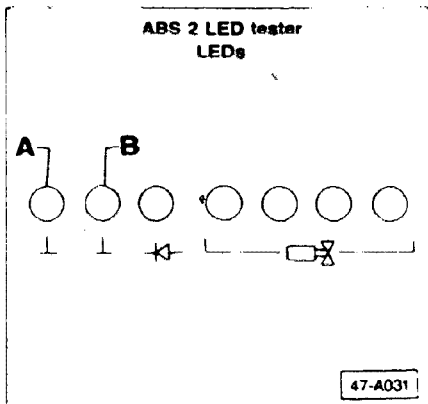
Note

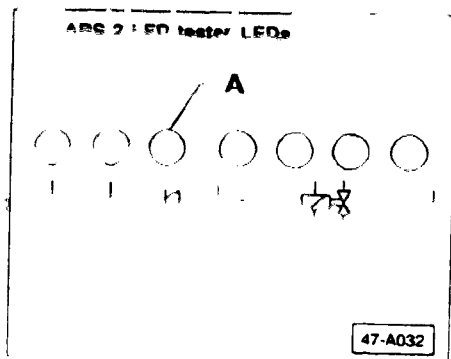
Weaker illumination of an LED indicates a contact resistance in the corresponding current path.

- check for continuity between terminal 34 of ABS control unit plug and ground connection at battery ground strap (LED A)
- check for continuity between terminal 10 of ABS control unit plug and ground connection at battery ground strap (LED B)

If NOT OK

- repair wiring as necessary





LED  **does not light**
(tester in 'Position 1')

- check continuity between terminal 32 of ABS control unit connector and terminal 12 of black hydraulic modulator connector (LED A)

If NOT OK,

- repair wiring as necessary
- check for continuity between terminal 20 of ABS control unit connector and ground connection at battery ground strap

If NOT OK,

- repair wiring as necessary

Note

If terminal 20 is disconnected, the battery LED will not be lit.

- check for defective ABS **ON/OFF** switch
- check for defective ABS **ON/OFF** switch wiring
- check ABS warning light bulb
- check warning light bulb diode

ABS warning light bulb diode, checking

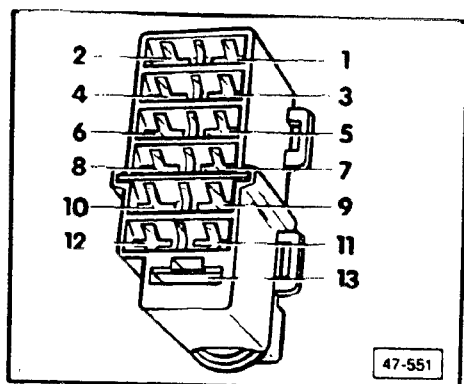
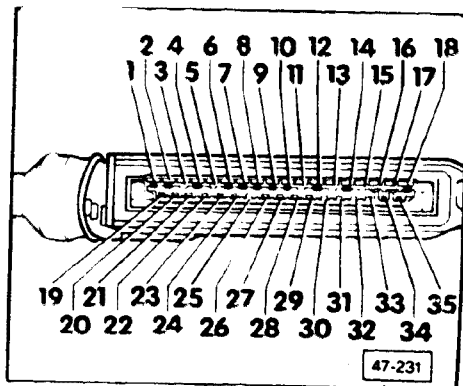
- check continuity between terminal 10 of black hydraulic modulator connector and terminal 29 of the ABS control unit plug

If NOT OK,

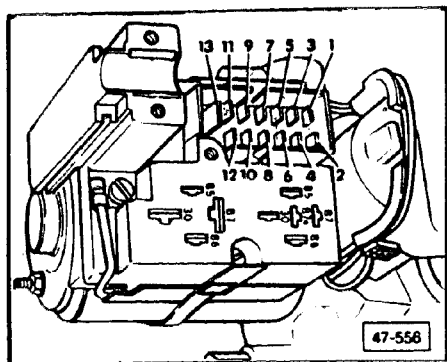
- repair wiring as necessary
- measure for continuity and contact resistance both ways between male terminals 10 and 12 in the socket on top of the hydraulic modulator
 - ohmmeter must indicate continuity (K ohm reading) in one direction and no continuity in the other direction

Note

The diode is not replaceable. The hydraulic modulator must be replaced as a unit.



Black hydraulic modulator connector



All  LEDs and  LED do not light up (tester in 'Position 1')

Solenoid valve relay, checking

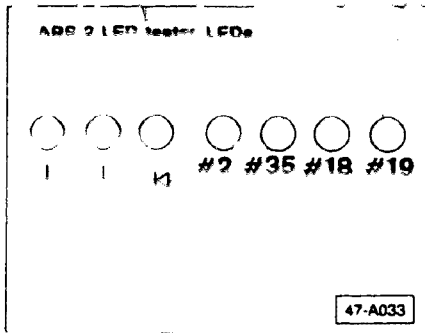
- switch ignition OFF
- remove solenoid valve relay from hydraulic modulator
- measure continuity between terminals 87a and 30
 - 0 ohm
- measure resistance between terminals 85 and 86 of solenoid valve relay
 - approximately 70 to 120 ohms
- remove black connector from top of hydraulic modulator
- check for continuity between terminal 8 on connector and ground
- check for continuity between male terminal 8 of hydraulic modulator and terminal 87a of the solenoid valve relay socket
- check for continuity between terminal 12 of the black hydraulic modulator connector and contact 32 of the ABS control unit connector

If NOT OK

- repair wiring as necessary

If the above checks are OK and LEDs DO NOT light,

- replace solenoid valve relay



All  LED does not light
(tester in 'Position 1')

#2 LED out

- check for continuity between terminal 2 on ABS control unit connector and terminal 3 on black hydraulic modulator connector

If NOT OK,

- repair wiring as necessary

#35 LED out

- check for continuity between terminal 35 on ABS control unit connector and terminal 5 on the black hydraulic modulator connector

If NOT OK,

- repair wiring as necessary

#13 LED out

- check for continuity between terminal 18 of ABS control unit connector and terminal 7 on the black hydraulic modulator connector

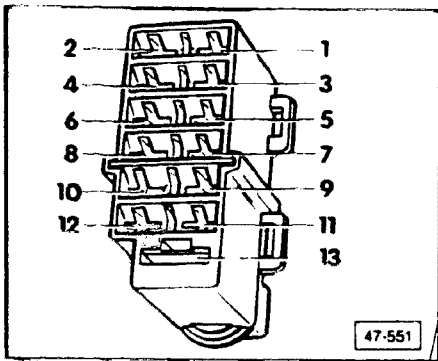
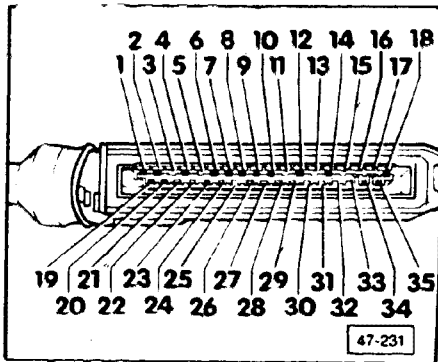
#19 LED out

(on 2-wheel drive models only)

- check for continuity between terminal 19 on ABS control unit connector and terminal 1 on black hydraulic modulator connector

If NOT OK,

- repair wiring as necessary



LED  does not light
(tester in 'Position 2')

- check for continuity between terminal 61 on back of the alternator and terminal 15 of the ABS control unit connector

If NOT OK,

- repair wiring as necessary

LED  does not go out when engine is started

- check alternator output

LED  does not light

- check for continuity between brake light switch terminal and terminal 25 on ABS control unit connector

If NOT OK,

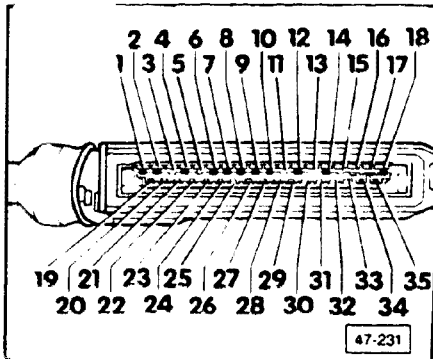
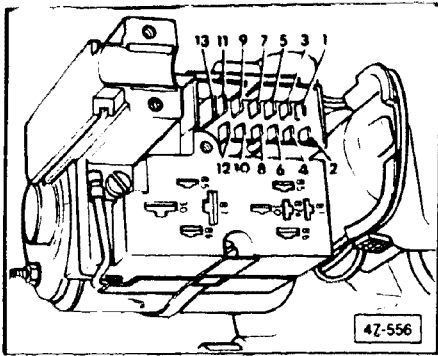
- repair wiring as necessary

OR

- check for short circuit in brake light switch

LED  does not go out when brake pedal is depressed

- check brake light switch adjustment
- check mechanical function of brake light switch



ABS return pump does not run (tester in 'Position 3')

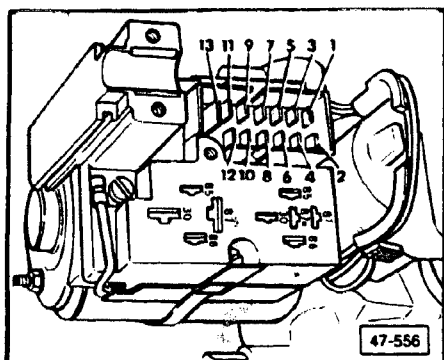
- switch ignition **OFF**
- remove ABS return pump relay
- check for continuity between terminal 11 of the black hydraulic modulator connector and terminal 28 of the ABS control unit connector
- check for continuity between terminal 9 of the black hydraulic modulator connector and terminal 14 of the ABS control unit connector
- check for continuity between terminal 2 of the black hydraulic modulator connector and terminal 1 of the ABS control unit connector
- check for continuity between positive terminal on return pump motor and male terminal 9 on top of the hydraulic modulator
- switch ignition **ON**
- check voltage of terminal 2 and terminal 13 of the black hydraulic modulator connector
 - approximately battery voltage

If **NOT OK**,

- repair wiring as necessary

If all of above checks are correct and the return pump does not run,

- replace the return pump relay



ABS return pump does not run (return pump relay is OK) (tester in 'Position 3')

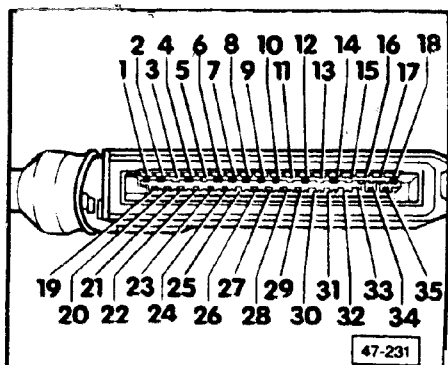
- switch ignition OFF
- remove black hydraulic modulator connector
- check for continuity between male terminal 11 in the hydraulic modulator socket and terminal 85 in the return pump relay socket
- check for continuity between male terminal 13 in the hydraulic modulator socket and terminal 87 in the return pump relay socket
- check for continuity between male terminal 11 in the hydraulic modulator socket and terminal 28 of the ABS control unit connector

If NOT OK,

- repair wiring as necessary

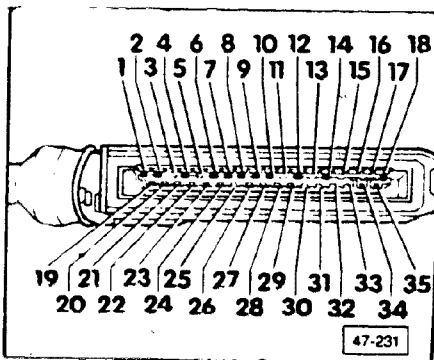
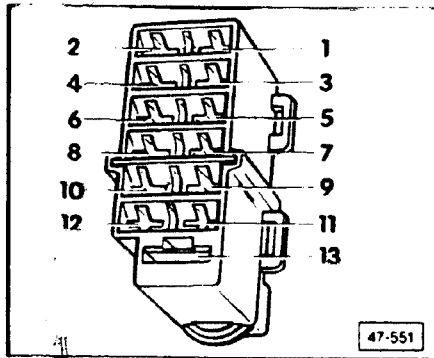
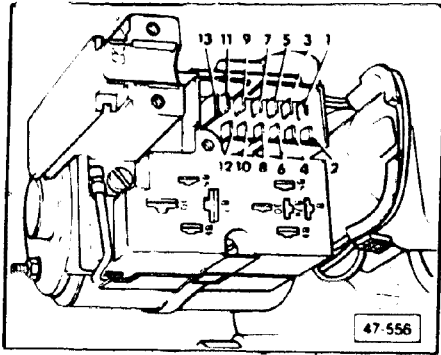
If all of the above checks are correct and the return pump does not run,

- replace the hydraulic modulator



LED does not light (tester in 'Position 5')

- check solenoid valve relay page (ABS book page 14)



Solenoid valves do not work (solenoid valve relay is OK) (tester in 'Position 5')

- switch ignition **OFF**
- remove black hydraulic modulator connector
- measure voltage at terminal 4
 - approximately battery voltage
- check for continuity between male terminal 4 in hydraulic modulator socket and terminal 87 in the socket for the solenoid valve relay
- check for continuity between male terminal 6 in hydraulic modulator socket and terminal 85 in the socket for the solenoid valve relay
- check for continuity between terminal 86 in the socket for the solenoid valve relay and terminal 86 in the socket for the return pump relay
- check for continuity between terminal 86 in the solenoid valve relay socket and male terminal 2 in the socket on top of hydraulic modulator
- check for continuity between terminal 6 of black hydraulic modulator connector and terminal 27 of ABS control unit connector
- switch ignition **ON**
- measure voltage at terminal 2 of black hydraulic modulator connector
 - approximately battery voltage

If NOT OK,

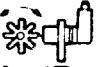
- repair wiring as necessary

If all of above checks are correct and the solenoids do not function,

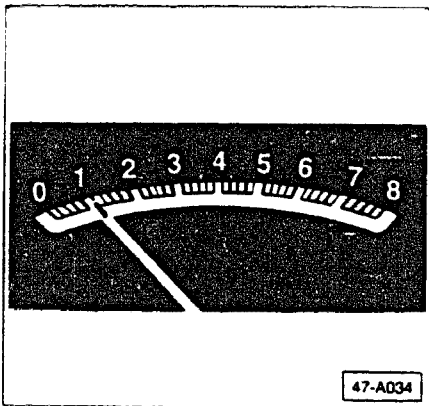
- replace hydraulic modulator

Wrong solenoid valve operates (tester in 'Position 5')

- check for proper connections of brake lines to hydraulic modulator
- using Wiring Diagram, check for proper wiring between hydraulic modulator and the ABS control unit

LED   **flashes off and on**
(selector in 'Position 6')

Wheel tested is being turned too fast or too slow



Sensor signal on test meter is not above minimum value

- check for excessive air gap between wheel speed sensor and ring gear
- check for loose or defective ring gear
- check for excessive wheel bearing play

No response from selected sensor (tester in 'Position 6')

- switch ignition **OFF**
- disconnect wheel speed sensor connector of sensor to be tested

Note

Front sensor plug connectors are located under the front hood near the shock towers
Rear sensor plug connectors are located under the rear seat cushion.

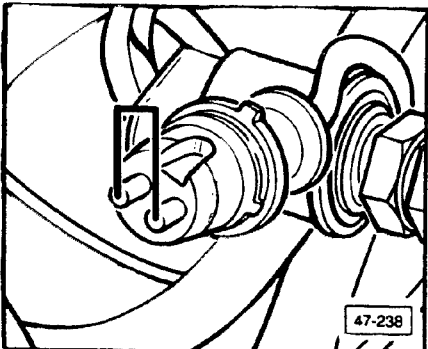
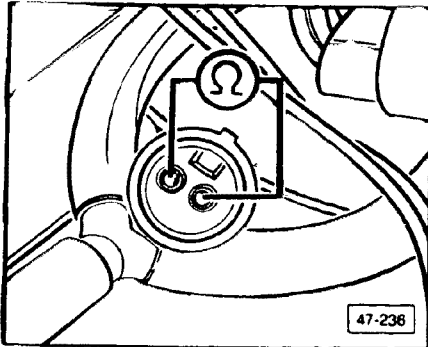
- connector ohmmeter to female terminals
measure resistance of speed sensor
 - 0.8K ohms to 1.8K ohms

If **NOT OK**

- replace wheel speed sensor

If **OK,**

- check for continuity between wheel speed sensor and ABS control unit connector



- bridge the male terminals of the wheel speed sensor connector
- remove ABS control unit connector
- check for continuity between wheel speed sensor you bridged and corresponding terminals of ABS control unit connector

If **NOT OK,**

- repair wiring as necessary