

Specifications

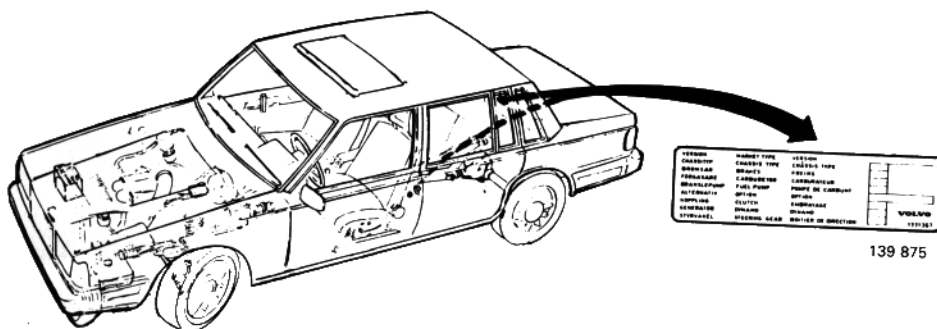
Service plate

Earlier location: On upper front member in luggage compartment.

Later location: On left-hand rear doorpost.

The plate provides the following information:

Part	Manufacturer	Code
Brakes	Girling, front and rear	1
	Girling, front; ATE, rear	2
	Bendix (DBA), front; ATE, rear	3



Brake fluid

Grade DOT 4+

Front brakes

Type Disc

Brake disc

Version 1	Solid	o.d./new thickness/min. thickness	
Version 2	Ventilated	o.d./new thickness/min. thickness	280/14/11.5 mm
Version 3	Ventilated	o.d./new thickness/min. thickness	262.4/22/20 mm
Version 4	Ventilated	o.d./new thickness/min. thickness	287/22/20 mm
			280/26/23 mm

Lateral runout with disc mounted on hub (see page 53) max. 0.06 mm

Brake caliper

..... Sliding

Versions 1, 2 and 3 as above: No. of pistons per caliper/diameter 2/40 mm

Version 4 as above: No. of pistons per caliper/diameter 1/57 mm

Brake pads

Versions 1, 2 and 3 as above: area/thickness 44 cm²/11 mm

Version 4 as above: area/thickness 52 cm²/12 mm

Min. permissible pad thickness 3 mm

Car brakes

Disc

Brake disc

Version 1 Live rear axle	o.d./new thickness/min. thickness	281/9.6/8.4 mm
Version 2 Multilink	o.d./new thickness/min. thickness	265/10/8 mm

Lateral runout

Version 1: disc mounted on car	max. 0.08 mm
Version 2: disc mounted on car	max. 0.06 mm

Brake caliper, type

Version 1 as above	Fixed
Version 2 as above	Sliding
Number of pistons per caliper/diameter (version 1)	2/36, 38, 40 mm
(version 2)	1/38, 40 mm

Brake pads

Version 1 as above: area/thickness	25 cm ² /10 mm
Version 2 as above: area/thickness	26 cm ² /8 mm
Min. permissible lining thickness	2 mm

Master cylinder

Type, cars without ABS	Tandem (Twintax)
Type, cars with ABS	Tandem

Brake servo

Type	DBA 2×8" or 10"
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	Earlier version	Later version
Ratio	1:3.5	1:4.0
Pedal travel with engine switched off (depress pedal 3–4 times before measuring)	max. 55 mm	

Reducing valve

5-door, 4-cyl. models	3.5 MPa
Other models	2.5 MPa

Parking brake

Brake drum, diameter	160 mm
radial out-of-truth	max. 0.15 mm
ovality	max. 0.2 mm
Brake linings, effective area	168 cm ²
Full power should be reached when brake lever is	tightened by 4–7 notches

Wheels should be rotatable by hand when brake lever is tightened by two notches.

Wheels should be locked when brake is tightened by four notches.

Reassembly of bolted joints

General remarks

- Clean all joint mating surfaces, first physically and then with a degreasing agent.
- Always replace bolts, or bolts and nuts, in angle-torqued joints.
- Torques specified below must be applied to an accuracy of better than 5%.

- Replace bolts and nuts as required in normally torqued joints. Clean and oil bolts prior to reassembly (applies to joints to which thread locking compound is not applied).
- Use the recommended angle gauge for measuring torque angles.

Note: 1 Nm = 0.7376 ft lb

Normally torqued joints

Page	Description	Nm	(ft lb)
42, 46, 57, 60, 125, 129	Front brake caliper (mounting bolt)	100	(74)
31, 42, 57, 61	Lower guide sleeve bolt, Bendix (DBA)	34	(25)
40	Guide pin for Bendix (DBA) caliper retainer	25	(18.5)
31, 46, 57, 61	Guide pin screws (upper and lower), Girling 2-piston caliper	34	(25)
33, 46, 61	Guide pin screws (upper and lower), Girling single-piston caliper	27	(20)
49, 52, 62, 63, 86, 88, 91, 94, 97	Rear brake caliper (mounting bolt)	58	(43)
38, 52	Guide pin screws (upper and lower), Girling (multilink)	34	(25)
72, 136	Master cylinder (mounting nuts)	max. 23	(17)
79	Brake servo (mounting nuts)	14	(10)
52	Bleeding nipple (small, M8)	4.5	(3.5)
	Bleeding nipple (large, M10)	10	(7.5)
	Brake hoses to nipple	18	(13)
56, 60, 62, 63 88, 94, 128	Brake disc locating pins	max. 8	(6)
26, 31, 33, 36, 38, 42, 46 49, 52, 57, 61, 62, 63, 86 88, 91, 94, 97, 125, 129	Wheel nuts	85	(63)
133	ABS sensor (rear wheels)	8-12	(6-9)

Angle-torqued joints

Page	Description	Nm	(ft lb)	Degrees
128	Front wheel hub to spindle (nut)	100	(74)	45
134	Rear axle member (front) to body (bolt)	70	(52)	60
134	Rear axle member (rear) to body (bolt)	70	(52)	60

Brakes General

Cleaning of components

The components of the hydraulic braking system must be cleaned in clean brake fluid or denatured alcohol which does not contain benzene (benzole).

Although brake fluid is an excellent cleaning agent, it is also expensive. **Denatured** alcohol is, therefore, the most suitable cleaning agent.

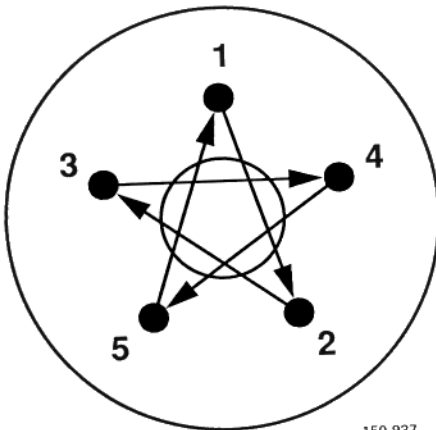
Petrol, naphtha, trichloroethylene or alcohol containing benzene must not be used for cleaning purposes since the slightest trace of mineral oil in the system will attack the rubber seals and cause them to swell.

It is extremely important that no cleaning agent remains in the system when filling with brake fluid. Traces of substances such as alcohol will lower the boiling point of the fluid, causing vaporization and impairing operation.

After cleaning, the components should be wetted with brake fluid and assembled. The complete system should then be filled with fluid.

Brake fluid

Only top-quality brake fluid complying with the **DOT 4+** standard should be used in the system. Use only genuine Volvo brake fluid. Never re-use brake fluid. **Always** store the brake fluid in the original container and seal tightly.



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Do not mix brake fluids

Maximum cleanliness is essential to prevent the entry of dirt into the system when topping up the master cylinder and carrying out similar operations. Use only fresh, new fluid. Fluid drained from the system, for example when bleeding the brakes, must not be re-used.

Even top-quality brake fluid will deteriorate gradually due to absorption of moisture and minor impurities after a long period of use.

Compared with new fluid, a brake fluid which has deteriorated is recognizable by its darker or altered color, relative lack of odor and watery appearance. The fluid should be replaced if any of these signs are present.

The recommended brake fluid replacement interval is every second year.

Brake fluid, replacement

The recommended brake fluid replacement interval is 40,000 km (30,000 miles = 48,000 km in USA/Canada) or every second year. The fluid should be replaced more often in climates of high humidity.

Tightening of wheel nuts

The following applies to fitting and tightening of the wheel nuts:

Ensure that the brake disc and wheel mating surfaces are clean. Lubricate the wheel locating pins on the hub with rust inhibitor, P/N 11 61 038-3.

Finger-tighten the nuts and then tighten diagonally to **85 Nm** (63 ft lb) using a torque wrench or torque socket **981 4031-2**. The torque socket is designed for tightening wheel nuts with a standard, pneumatic, impact-type nut runner delivering a torque of **250–350 Nm** (184–258 ft lb).

Diagonal tightening/torquing is important to prevent stressing of the brake disc.

Brake discs

General

The condition of the brake discs is critical to braking performance. Factors such as runout, corrosion and variations in thickness will cause vibrations and pulling.

For this reason, the discs should always be inspected when replacing the pads. See specifications on page 3 regarding thickness and maximum runout.

Machining of brake discs

Inspect the discs for signs of damage. The disc must be replaced if it is cracked or worn to the extent that there is no margin for machining. In the case of radial scoring, uneven wear, corrosion deposits etc., tests have shown that ma-

chining the disc on the car with a special machining unit can be an alternative to replacement in terms of tolerances and surface finish. Refer to current market warranty procedures.



If machining a disc:

If the disc must be removed to clean the ABS sensor and sensor wheel, or for any other reason, this should be carried out prior to machining (see below).

Mark the position of the disc with respect to the hub. Remove the disc and clean the sensor and sensor wheel with a **soft brush** (a steel brush must not be used). Clean the mating surfaces on the disc and hub thoroughly. Mount the disc on the hub in accordance with the marking.



Machining

The machining procedure is described in the instructions supplied with the machining unit.

Note: The disc must **not** be removed from the hub following machining. However, if removal is unavoidable, the disc **must without exception** be reinstalled in the same position.

Fault tracing

Brakes – general

CAUSE	ACTION
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Excessive brake travel, spongy feel

Air in hydraulic system.	Bleed system.
Too little brake fluid in system.	Check for leakage. Bleed system.
Leakage from hydraulic system.	Locate and repair leakage. Bleed system.
Faulty master cylinder.	Recondition cylinder. Replace as required.

Poor braking action

Moisture on brake pads and discs.	Brake repeatedly to correct fault.
Grease or oil on brake pads.	Replace pads. Check adjoining seals.
Faulty or leaking brake servo.	Check servo. Replace as required.
Leakage from brake servo vacuum hose connections.	Check and replace components as required.

Car pulls to one side when braking

Grease or oil on a brake pad.	Replace pad. Check seals.
Faulty brake caliper.	Recondition or replace caliper.
Excessive play in wheel bearings or incorrect wheel alignment.	Check suspension and steering.
Uneven tire pressure.	Adjust pressure.
Uneven tire wear.	Replace tyres; check front wheel alignment.
Faulty suspension and steering adjustment.	Adjust suspension and steering.
New brake pads.	Drive until pads are bedded in.

CAUSE**ACTION****Brakes grab**

Moisture on brake pads and discs.	Brake repeatedly to correct fault.
Excessive wheel bearing play.	Adjust bearings.
Worn brake pads.	Replace pads.
Pulsation in pedal due to excessive variation in disc thickness.	Recondition or replace disc.
Loose brake caliper.	Tighten loose component.

Brake squeal

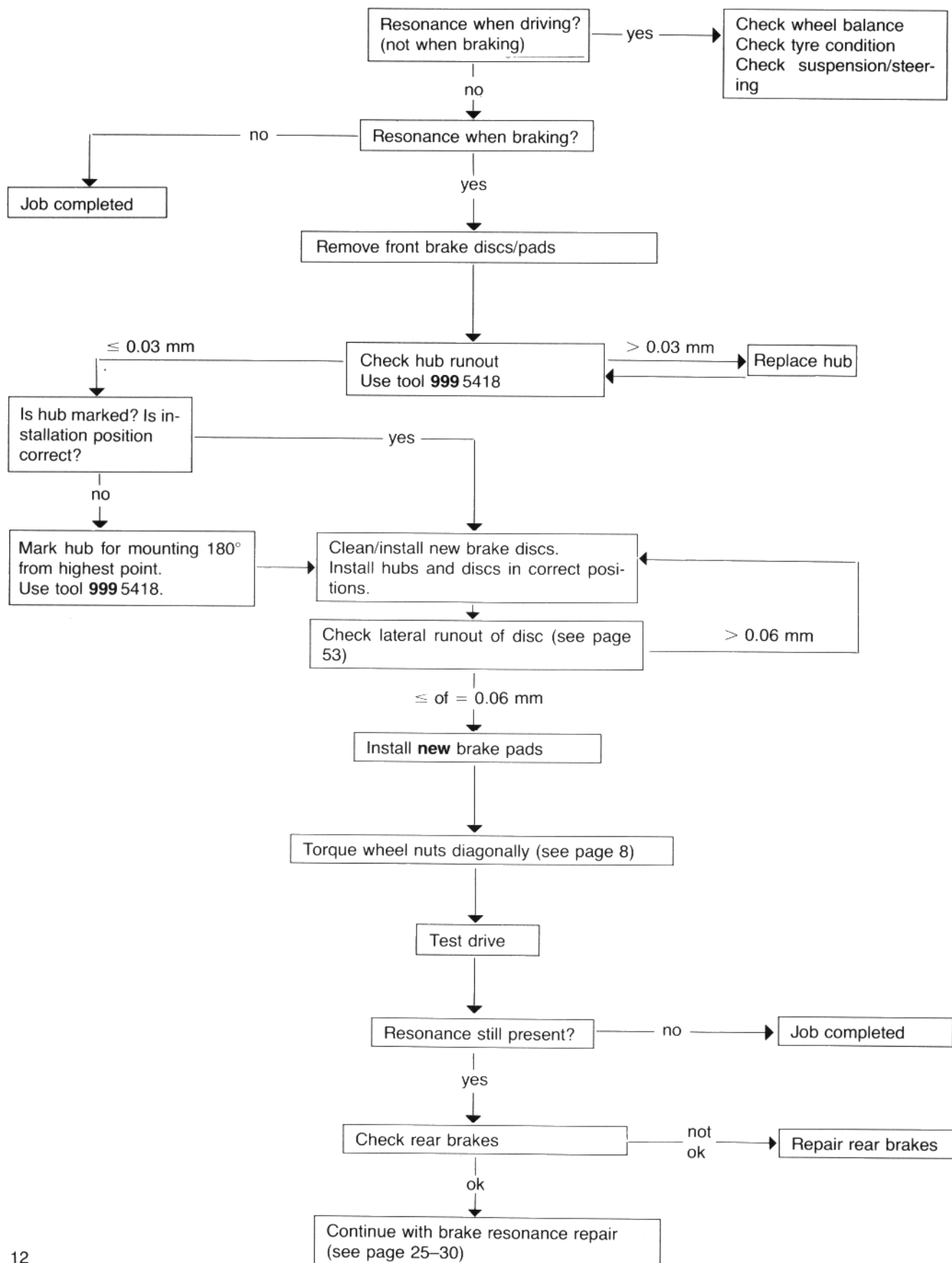
Atmospheric influence.	Brake repeatedly to eliminate squeal.
'Glazed' pad surface.	Brake hard several times.
Worn brake pads.	Replace pads.
Pads vibrating in brake caliper.	Install shim if available as spare part.
Anti-squeal shim missing or not lubricated.	Lubricate pad backing plate and shim with grease, P/N 11 61 325-4.

Brakes bind

Brake piston seizing in caliper.	Recondition or replace caliper.
Brake pads sticking in brake caliper.	Clean caliper and replace pads.
Guide pin seizing in brake caliper.	Clean or replace caliper.
Brake cylinder pushrod incorrectly adjusted.	Adjust pushrod.
Equalizing port in master cylinder blocked.	Recondition master cylinder.
Deformed brake pipe.	Replace pipe.
Brake hose blocked.	Replace hose.
Worn fluid seal in caliper.	Recondition or replace caliper.
Parking brake incorrectly adjusted.	Adjust brake.
Cable sticking.	Replace cable.

Fault tracing, brake resonance

Vibrations in steering wheel/brake pedal when braking



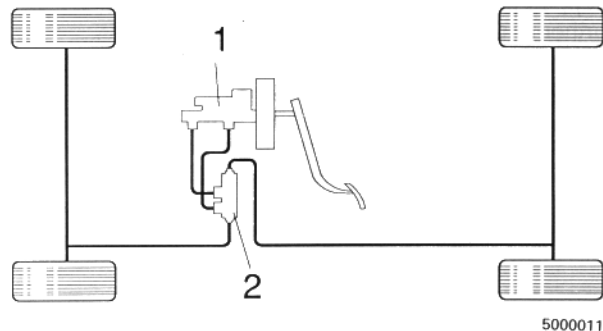
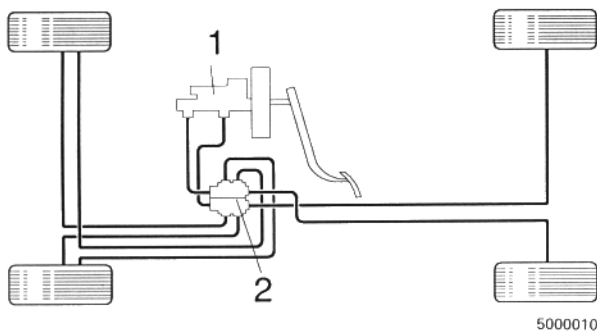
Group 50 Brakes, general

Design and function

General

The car is equipped with two independent braking systems, one of which – the wheel brakes – is operated by the brake pedal and acts on all four wheels through an hydraulic system supplying two independent circuits from a tandem-type master cylinder.

The second system – the parking brake – is lever-operated and acts mechanically on both rear wheels. See page 83 for a more detailed description.



Triangular-split braking system

1. Master cylinder
2. Brake pipe manifold and pressure differential warning valve*

On cars with a **triangular-split** braking system, each front brake is equipped with two completely independent cylinders. One circuit supplies the lower cylinders in the front brakes and the right rear wheel brake, while the second serves the upper cylinders at the front and the left rear wheel. This ensures that braking power is available at all times even if a brake pipe is ruptured. Approximately 80% of the normal braking power is available under these conditions.

A warning valve in the brake manifold warns the driver of any abnormal pressure difference between the two circuits.

The brake servo is operated directly by the brake pedal. Employing the vacuum in the engine intake manifold, the function of the servo is to reduce the pedal force required for braking.

A more detailed description of the brake servo is given on page 67.

* On 1989 models, the warning valve was replaced by a level switch in the brake fluid reservoir to warn the driver of low fluid level e.g. due to leakage from the system.

Axle-split braking system

1. Master cylinder
2. Brake manifold and reducing valve*

Cars with ABS and models without ABS from 1992 on are equipped with an axle-split braking system. In this case, the rear circuit supplies the front brakes and the front circuit the rear brakes. The purpose of the reducing valve (which was added to the rear brakes on 1992 models) is to reduce the pressure in the rear circuit under severe braking conditions to prevent wheel lock.

The reducing valve incorporates a safety function which is associated with the front brakes. In the event of an hydraulic fault in the front brakes, the pressure to the rear brakes is maintained at its full, unreduced value.

See each group as appropriate for further details of the wheel brake and parking brake components.

The hydraulic braking system is of the dual-circuit type, consisting either of a triangular-split (earlier version) or axle-split configuration (models from 1992 on).

Note: All cars with ABS have an axle-split system.

Circuit arrangement in cars with triangular-split braking system

1. Supplied by the rear section of the master cylinder, the primary circuit serves:

- the lower cylinders in the front calipers;
- the right rear caliper.

The master cylinder is of a special tandem type with stepped pistons. The principle of operation is described in further detail under Group 52, pages 64 and 65.

Earlier version, pre-1989 models:

The brake manifold incorporates a warning valve, which operates a warning lamp on the instrument panel in the event of leakage in any of the circuits.

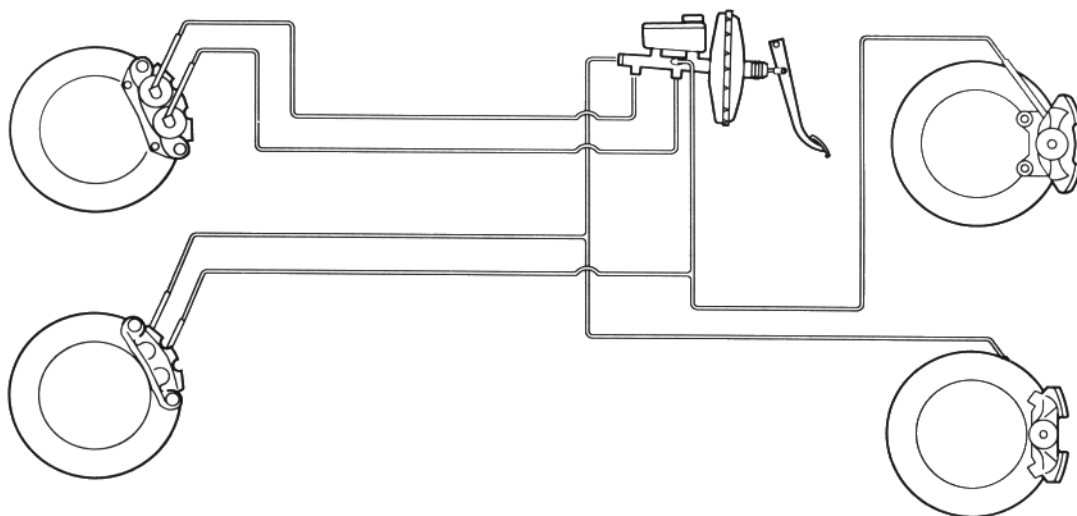
2. Supplied by the front section of the master cylinder, the secondary circuit serves:

- the upper cylinders in the front calipers;
- the left rear caliper.

The master cylinder is connected to the brake manifold by two pipes. See under 'Earlier version' and 'Later version' below. The brake pipes are run to the wheels from the manifold.

Later version, models from 1989 on:

The warning valve in the manifold has been superseded by a level switch in the brake fluid reservoir.



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Circuit arrangement on cars with axle-split braking system, with or without ABS

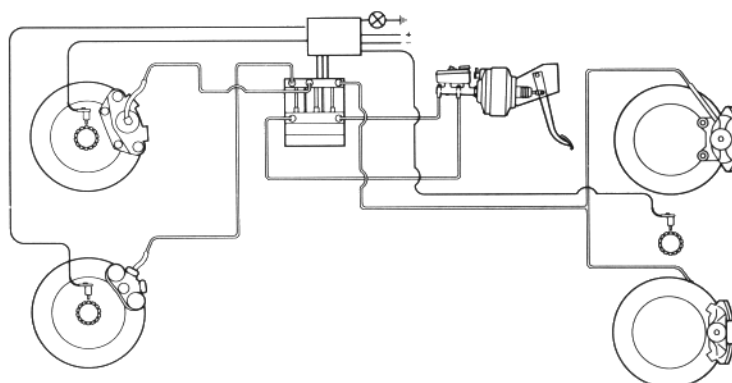
1. Supplied by the rear section of the master cylinder, the primary circuit serves the front calipers.

On pre-1992 models **with ABS**, two brake pipes connect the master cylinder directly to the ABS hydraulic modulator, from there the brake pipes run to the wheels. A level warning switch is installed in the brake fluid reservoir.

2. Supplied by the front section of the master cylinder, the secondary circuit serves the rear calipers.

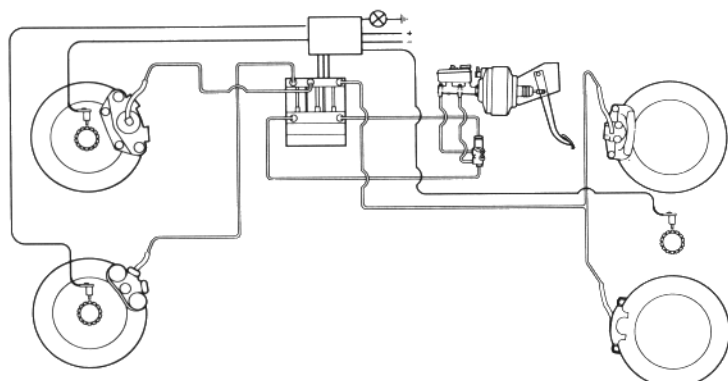
On models from 1992 on, **with or without ABS**, two brake pipes are run to a pressure-reducing valve, from there the pipes run to the ABS hydraulic modulator or, on cars without ABS, directly to the wheels. These variants are also equipped with a level warning switch in the brake fluid reservoir.

Cars with ABS, pre-1992 models

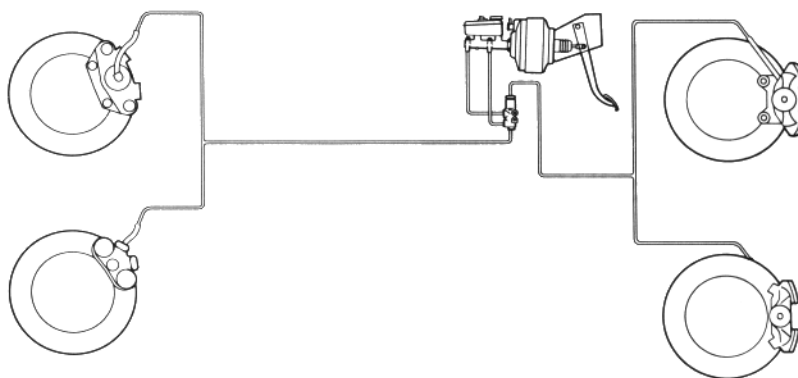


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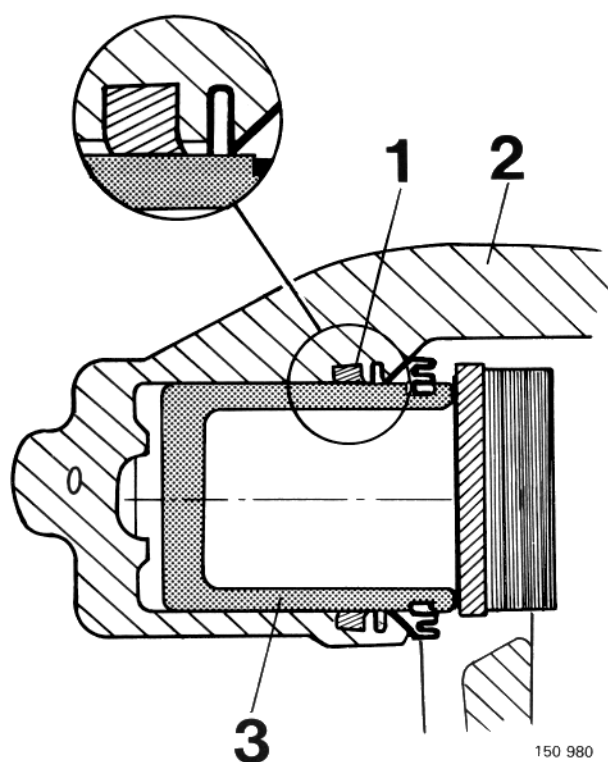
Cars with and without ABS, models from 1992 on



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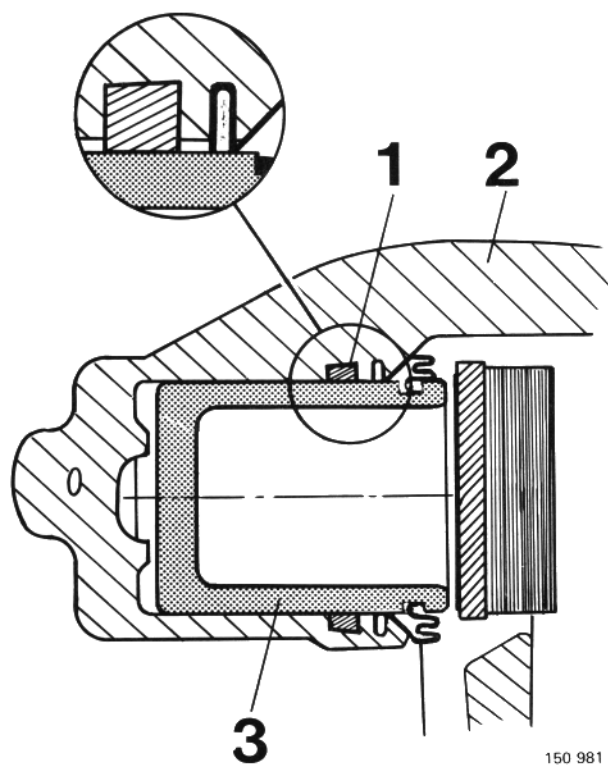
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Brakes applied

The caliper pistons are forced outward, pressing the brake pads against the discs, when the brakes are applied and the pressure in the master cylinder increases. The braking power varies in proportion to the pedal pressure. Outward movement of the pistons produces a lateral stress on the seals, which remains present while the brakes are on.

1. Seal
2. Piston housing
3. Brake piston



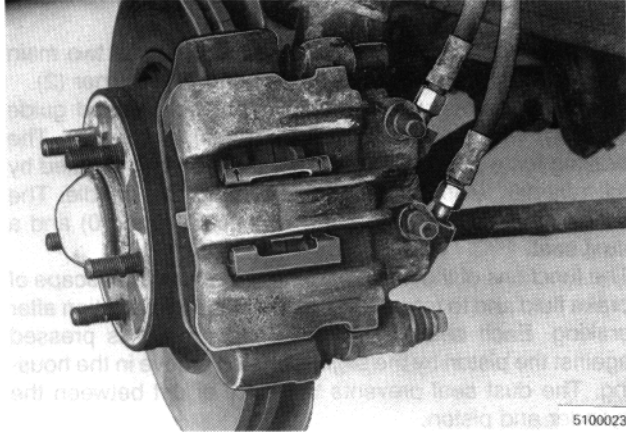
Brakes released

The hydraulic pressure on the pistons is relieved when the pedal is released. In this system, in which there is no residual hydraulic pressure in the brake pipes, the stress in the seal is sufficient to return each piston by a certain amount, creating a clearance between pad and disc. Thus, the pads remain in a 'neutral' position at a certain distance from the disc, regardless of wear, and the brakes are self-adjusting.

Group 51 Wheel brakes

Design and function

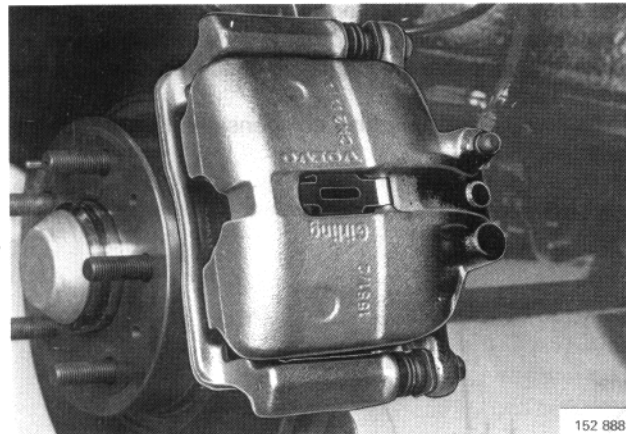
General



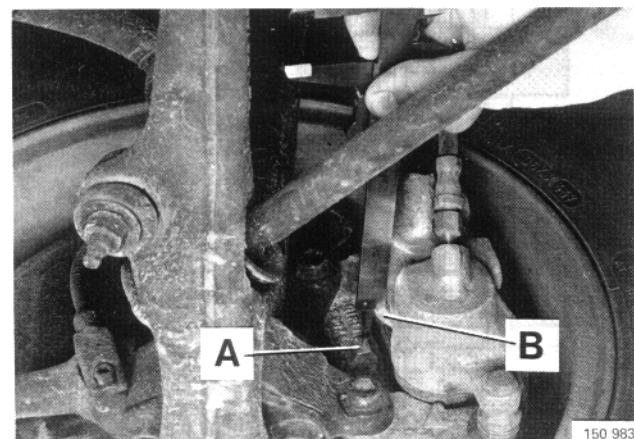
Front brakes

Each brake disc is made of cast iron. The disc is integral with the hub in the earlier version, but is a separate component in the later version. A splash shield is used to help keep the disc clean. The brake caliper is mounted on the wheel spindle.

Two-piston caliper

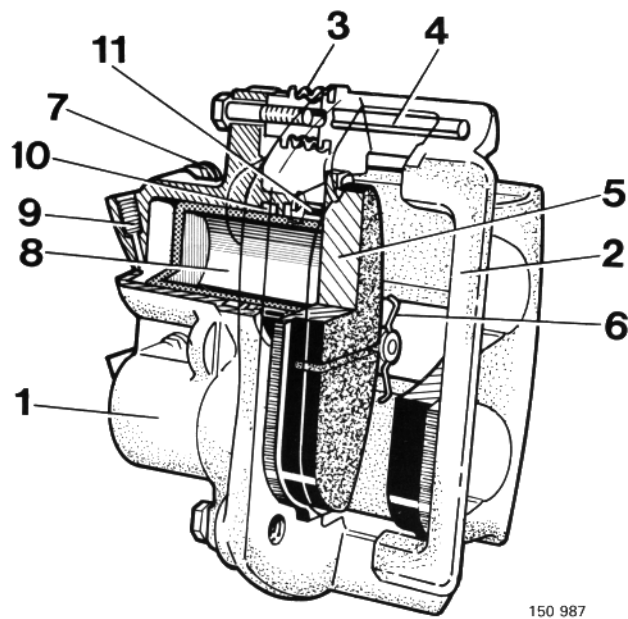


Single-piston caliper



The pad thickness can be measured in the case of the single-piston caliper, using a sliding callipers to measure the distance between points **A** and **B**. This measurement must not exceed 35 mm (1.38 in) in the case of a normally worn disc.

The pad thickness can also be measured on Girling two-piston calipers, on cars produced after 1 January 1988.



- | | |
|------------------|----------------------|
| 1. Caliper | 7. Bleeding nipple |
| 2. Retainer | 8. Piston |
| 3. Rubber gaiter | 9. Brake fluid inlet |
| 4. Guide pin | 10. Fluid seal |
| 5. Brake pad | 11. Dust seal |
| 6. Spring | |

The brake caliper is available in three main versions:

- two-piston caliper for solid brake disc (aluminium housing)
- two-piston caliper for ventilated brake disc
- single-piston caliper for ventilated brake disc

Although the calipers differ in **external** appearance, the principle of operation is the same in all cases.

The illustration shows a two-piston caliper for a ventilated brake disc.

The caliper is of the sliding type and consists of two main components, the caliper proper (1) and the retainer (2).

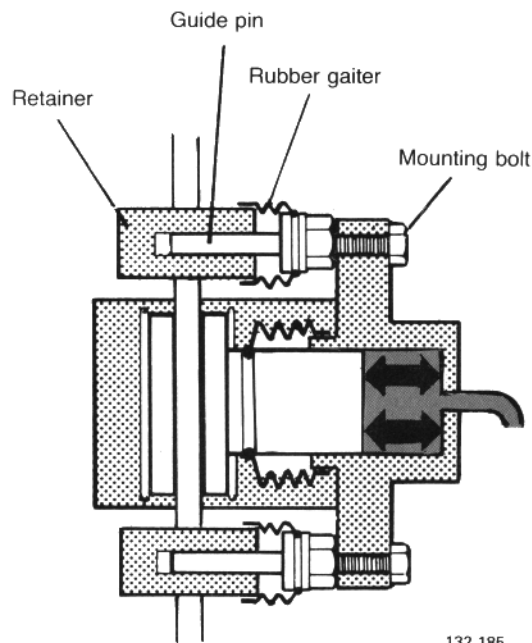
The caliper moves in the retainer on two greased guide pins (4), which are protected by rubber gaiters (3). The braking force exerted by the pads (5) is accommodated by the retainer, which transfers the force to the spindle. The caliper houses two pistons (8) with fluid seals (10) and a dust seal.

The functions of the fluid seals are to prevent the escape of brake fluid and to return the pistons to the idle position after braking. Each seal is square in section and is pressed against the piston by the slightly angled groove in the housing. The dust seal prevents the entry of dirt between the cylinder and piston.

The piston force is exerted directly on the adjoining pad and through the retainer to the opposite pad.

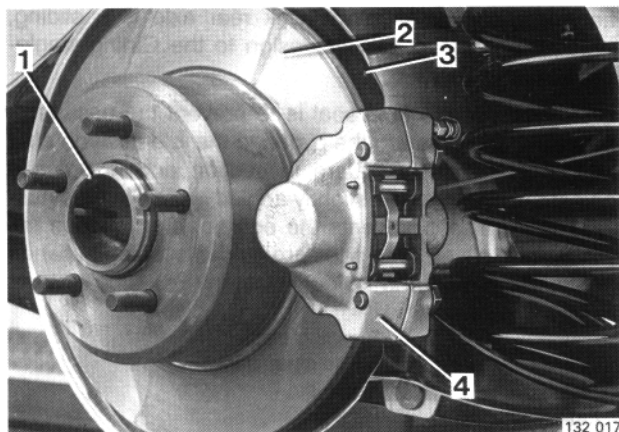
This causes the caliper and guide pins to slide in the retainer, ensuring that the forces are equalised on both sides of the disc.

This sliding movement also compensates for wear of the outer pad.



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Principle of operation of sliding caliper



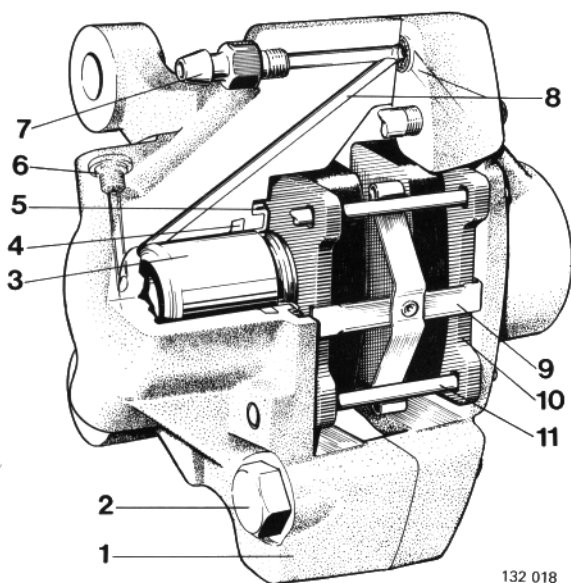
Rear brakes

Each rear brake disc is made of cast iron and is mounted on the axle shaft. The brake shield helps keep the disc clean. The disc hub also serves as a drum for the parking brake.

Brake caliper for live rear axle

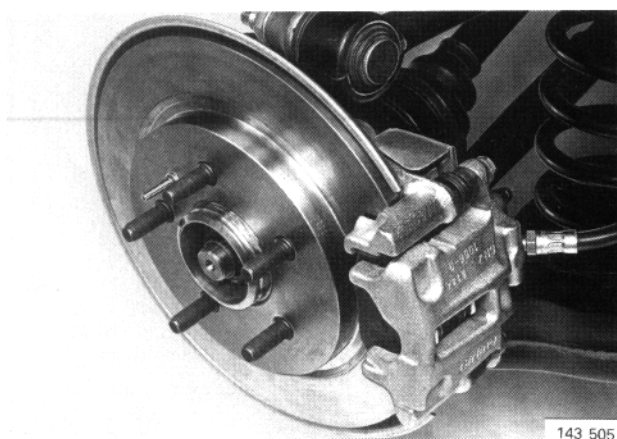
The caliper is mounted on the outer section of the rear axle tube.

- | | |
|----------------|------------------|
| 1. Drive shaft | 3. Brake shield |
| 2. Brake disc | 4. Brake caliper |



The brake caliper for a live rear axle consists of two halves bolted together and enclosing the brake disc. Each half houses a cylinder and piston. The cylinders are interconnected through a passage in the housing. The fluid seals, which are square in section and are pressed against the piston by the slightly angled groove in the housing, serve to prevent the escape of brake fluid and to return the pistons to the idle position after braking. The dust seals prevent the entry of dirt between the cylinders and pistons. The brake pads are held in position in the housing by guide pins.

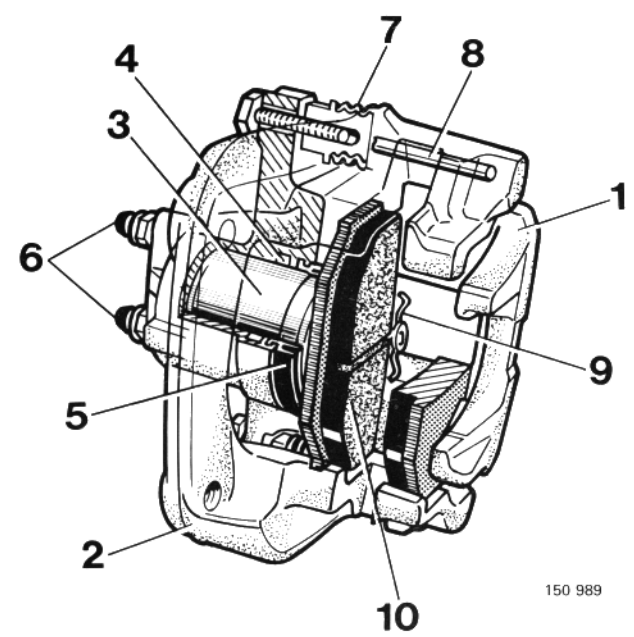
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|----------------------|--------------------|
| 1. Housing | 7. Bleeding nipple |
| 2. Bolt | 8. Passage |
| 3. Piston | 9. Damping spring |
| 4. Fluid seal | 10. Brake pad |
| 5. Dust seal | 11. Guide pin |
| 6. Brake fluid inlet | |



Brake caliper for multilink rear axle

The caliper is mounted on the bearing housing.

Design and function

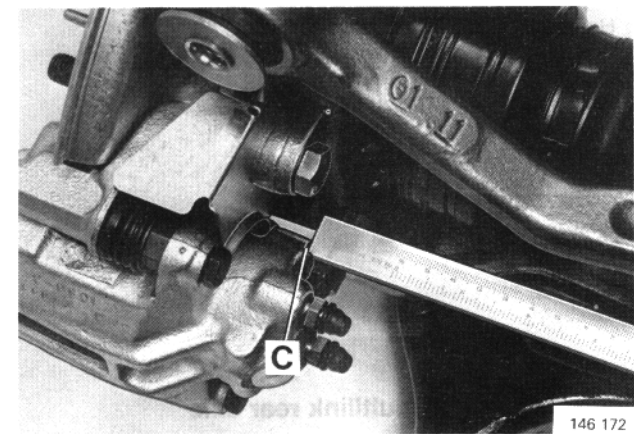


The brake caliper for a multilink rear axle is a sliding, single-piston type of similar design to the Girling single-piston front caliper.

The function of the fluid seal is to prevent the escape of brake fluid and to return the piston to the idle position after braking. The seal is square in section and is pressed against the piston by the slightly angled groove in the housing. The dust seal prevents the entry of dirt between the cylinder and piston. The pads are held in position between the piston housing and caliper retainer.

- | | |
|---------------------|---------------------|
| 1. Piston housing | 6. Bleeding nipples |
| 2. Caliper retainer | 7. Guide pin gaiter |
| 3. Piston | 8. Guide pin |
| 4. Fluid seal | 9. Spring |
| 5. Dust seal | 10. Brake pad |

Since the left and right-hand calipers are identical, the caliper is provided with two bleeding nipples. The **upper** nipple should be used for bleeding purposes.



Measurement of pad thickness (multilink rear axle only)

The brake pad thickness can be measured on the multilink rear axle caliper. This is carried out by measuring the distance between point C and the face of the shield between the bearing housing mounting lugs and caliper retainer. The measurement must not exceed **25 mm (0.98 in)**.

Repair and maintenance

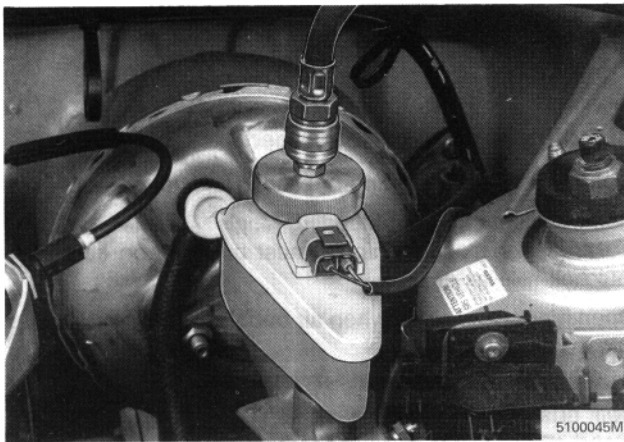
Bleeding of brakes

Normal mechanical bleeding is usually sufficient when reconditioning or replacing a brake caliper. In this case, the brake pedal must be depressed throughout the operation to ensure that the system is not drained of fluid. A bleeding unit must be used if the system has been drained either wholly or partially.

In other bleeding operations and when changing the fluid, a bleeding unit which pressurises the system to 2–3 bar (29–44 lb/in²) must be used.

Use only genuine Volvo brake fluid with the designation DOT 4+. **Never** re-use drained fluid. **Always** store fluid in the original container, tightly sealed.

Note: ABS systems take longer to bleed than conventional systems.



A1

Switch off ignition.
Jack up and support car.
Clean brake fluid reservoir and cap before removing cap.

A2

Connect bleeding unit to brake fluid reservoir

Follow supplier's instructions regarding connection and operation of unit.

A3

Operate brake pedal

Operate pedal several times to expel any air bubbles in master cylinder.

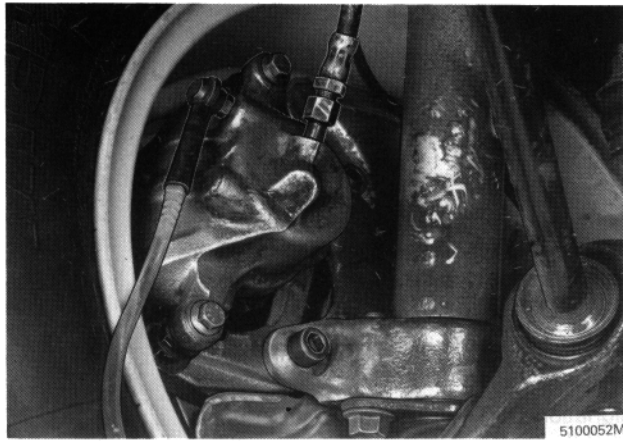
Note: This should be carried out between each bleeding operation on the particular caliper.

A4

Bleed calipers in following order:

Cars with ABS, models to 1987 inclusive:
 Bleed one front wheel, second front wheel and rear wheels in that order.

Cars without ABS, and 1988 or later models with ABS:
 Bleed one rear wheel, second rear wheel and front wheels in that order.



A5

Bleeding of front brake calipers

Illustration shows bleeding of single-piston caliper.

Remove dust cap(s) from bleeding nipple(s).

Connect fluid collector tube to nipple.

Open nipple and close when air bubbles are no longer present in escaping fluid.

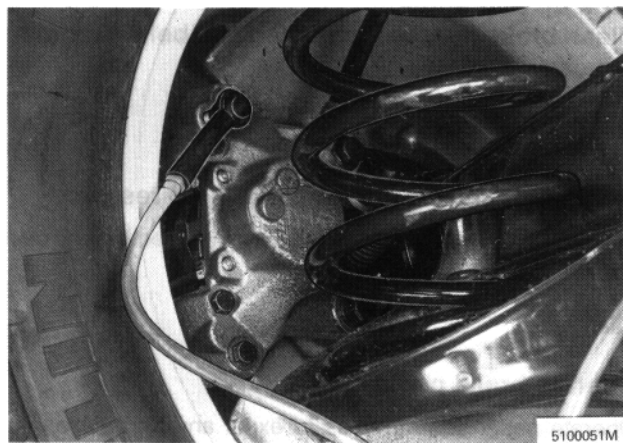
Tighten nipple to **10 Nm** (7.5 ft lb).

Cars with two-piston calipers:

Connect tube to upper nipple and carry out above procedure.

Refit dust cap(s) on bleeding nipple(s).

Bleed other caliper as described above.



A6

Bleeding of rear brake calipers

Picture illustrates bleeding of caliper for live rear axle.

Remove dust cap from bleeding nipple.

Note: Upper bleeding nipple must be used on cars with multilink rear axles.

Open nipple and close when air bubbles are no longer visible in escaping fluid.

Tighten nipple to **4.5 Nm** (3.3 ft lb).

Refit dust cap on bleeding nipple.

Bleed other caliper as described above.

A7

Depressurize system

Check system. Check for air in system by operating brake pedal at force equivalent to hard braking.

Pedal travel must not exceed **55 mm** (2.2 in) when engine is switched off and brake pedal is operated at least 3–4 times prior to measurement.

If pedal travel exceeds **55 mm** (2.2 in), bleed system again and recheck travel.

Disconnect bleeding unit from brake fluid reservoir.

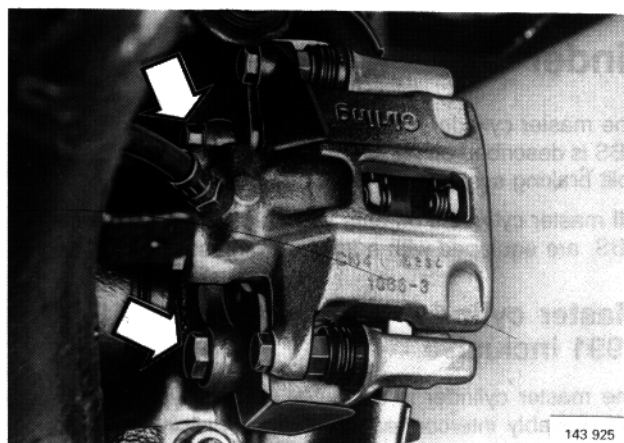
Check level in reservoir.

Check that vent hole in reservoir cap is free of dirt. Fit cap.

Wash off fluid spillage, if any, with lukewarm water and car shampoo.

Lower car.

Rear brake disc, replacement (multilink)



O1

Slacken parking brake adjuster (see page 84).
Jack up and support rear of car. Remove wheel
Mark wheel position if locating stud is not fitted.

O2

Remove:

- brake pads (see page 37)
- brake caliper. Tie up caliper with steel wire to ensure that hose is not damaged.

O3

Remove brake disc

Remove locating pin and brake disc. If disc is stuck, tap lightly with plastic mallet to loosen.

O4

Ensure that all mating surfaces are clean

O5

Install brake disc and locating stud

Tighten stud to **8 Nm** (6 ft lb).

O6

Install:

- brake caliper. Use new bolts. Tighten to **58 Nm** (43 ft lb).
- brake pads (see page 38)

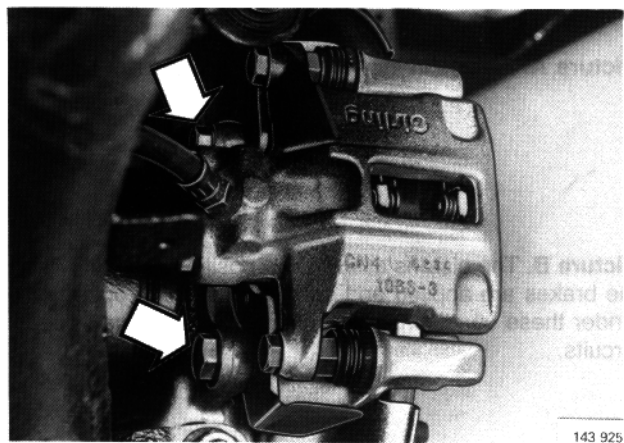
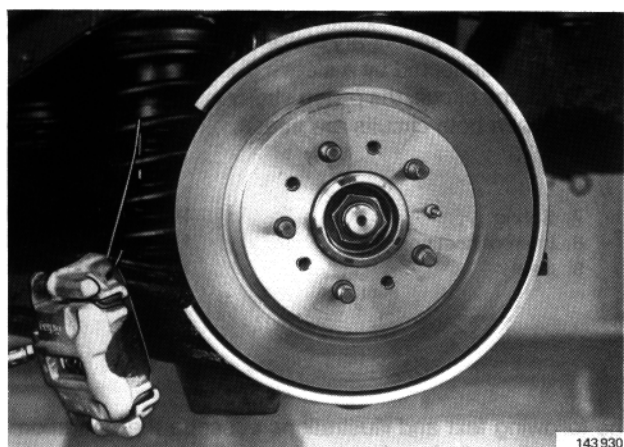
O7

Refit wheels as per markings

Finger-tighten nuts, then torque diagonally to **85 Nm** (63 ft lb).

Note: See page 8 for further information on tightening of wheel nuts.

Readjust parking brake (see page 84).

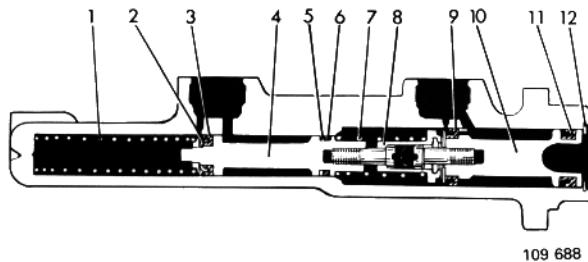


Group 52 Hydraulic braking system

Design and function

Master cylinder

The first description of the master cylinder applies to cars **without ABS** to 1991 inclusive. These have a triangular-split braking system.



The master cylinder for cars from 1992 on, with or without ABS is described on page 65. These models have an axle-split braking system.

All master cylinders on cars from 1989 on, with or without ABS, are equipped with a level warning switch.

Master cylinder on cars without ABS to 1991 inclusive

The master cylinder is a special tandem type employing two movably interconnected, stepped pistons of different diameters in a stepped cylinder. The cross-sectional area of the secondary circuit cylinder is only half that of the primary cylinder. The secondary piston (4) and primary piston (10) are interconnected by a sleeve (8). Thus, in the event of failure of one circuit, the piston stroke is greater than normal (i.e. when both circuits are intact).

1. Spring
2. Spring seat
3. Seal

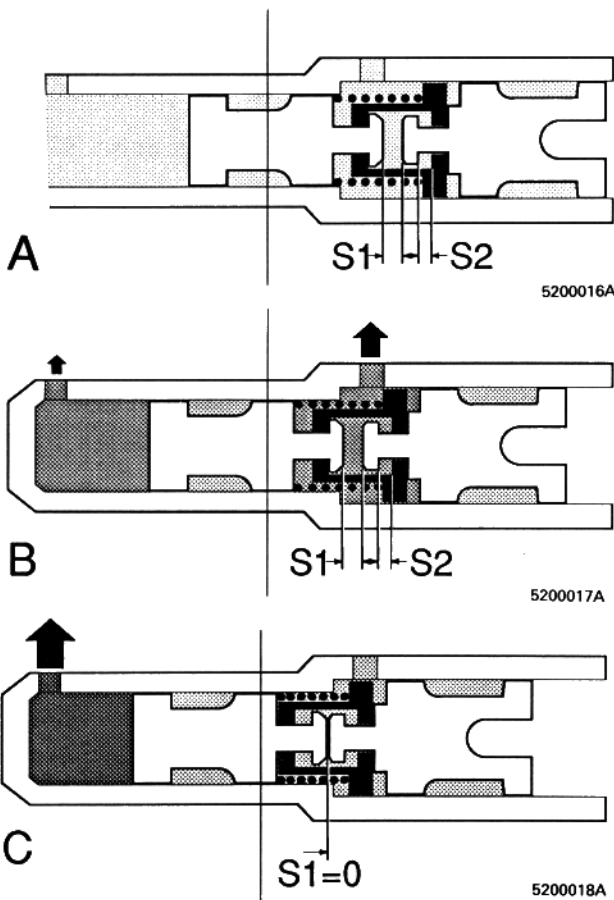
4. Secondary piston
5. Seal
6. Seal

7. Spring
8. Interconnecting sleeve
9. Seal

10. Primary piston
11. Seal
12. Locking ring

Secondary circuit

Primary circuit

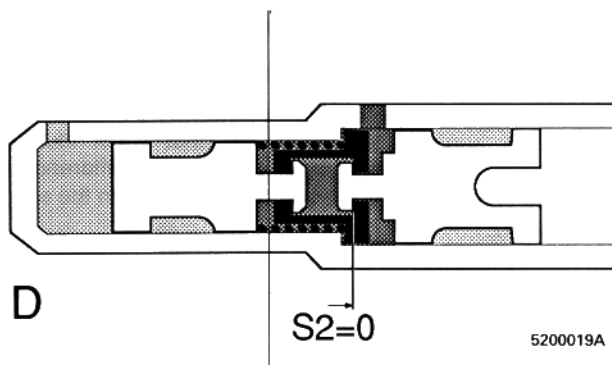


The following text and illustrations describe the operation of the master cylinder, showing the pistons in different positions.

Picture A. Pistons in idle position (with brakes off).

Picture B. The pistons assume the positions shown when the brakes are applied and both circuits are in operation. Under these conditions, the pressure is the same in both circuits.

Picture C. If a leakage occurs in the **primary circuit**, no pressure will be developed ahead of the primary piston. Initially, the primary piston will be pushed forward until the interconnecting sleeve meets the secondary piston ($S1 = 0$). The latter will then be displaced mechanically and pressure will be developed in the secondary circuit. Since the cross-sectional area of the secondary piston is only half that of the primary piston, the secondary circuit pressure will be twice that delivered when both circuits are in operation (for the same pedal pressure).



Picture D. If a leakage occurs in the **secondary circuit**, the secondary piston will be displaced by pressure from the primary piston. The interconnecting sleeve will limit the displacement to a value equivalent to $S_2 = 0$, following which the pistons will move together under the action of the sleeve. In this case also, the braking pressure will be twice the normal value, since the actual pressure area is only half of the normal value (the difference between the primary and secondary piston areas).

Secondary circuit
Zero pressure

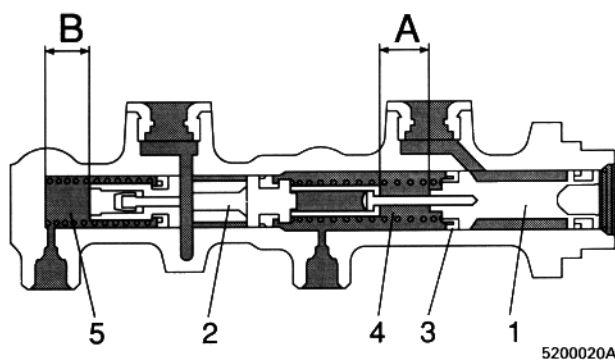
Primary circuit
Zero pressure

Normal pressure

Normal pressure

Twice normal pressure

Twice normal pressure



Master cylinder on cars from 1992 on, with or without ABS

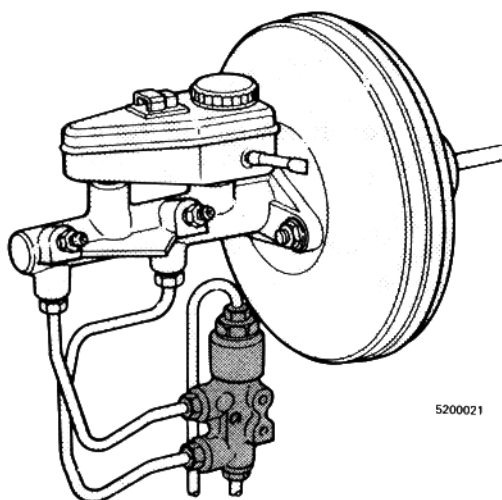
The master cylinder is of the tandem type. When the brakes are applied, the primary piston (1) is displaced towards the secondary piston (2). Fluid pressure is developed in the primary circuit (4) when the primary seal (3) passes the equalising port, causing the secondary piston (2) to increase the pressure in the secondary circuit (5).

In the event of failure of the **primary circuit** (4), the secondary piston (2) will not be subjected to pressure until the pushrod (1) has traversed the distance (A). This will cause a loss in pedal travel corresponding to distance (A) times the pedal ratio.

In the event of failure of the **secondary circuit** (5), both the primary (1) and the secondary pistons (2) will travel distance (B) before pressure can be developed in the primary circuit (4). This will cause a loss in pedal travel corresponding to distance (B) times the pedal ratio.

1. Primary piston
2. Secondary piston
3. Primary seal

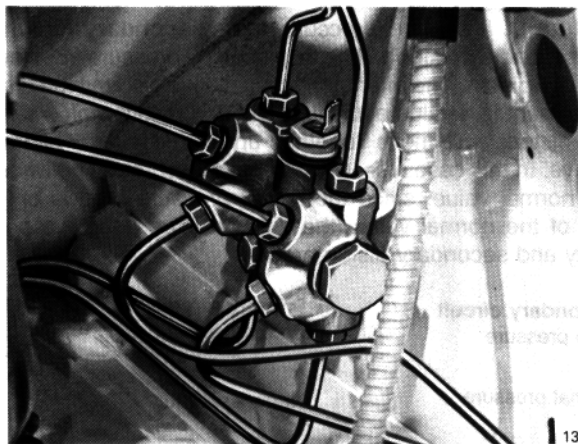
4. Primary circuit
5. Secondary circuit



Reducing valve

A reducing valve was introduced on the rear brakes of models from 1992 on. The valve is installed in all variants. The feature improves the braking power on the rear wheels while eliminating the risk of wheel lock.

The reducing valve is independent of the ABS system, its sole function being to reduce the pressure to the rear wheel circuit under severe braking conditions, to prevent wheel lock. A built-in safety function connects the valve to the front wheel circuit. In the event of hydraulic failure in the latter, this ensures that full, unreduced braking pressure is delivered to the rear wheel circuit.



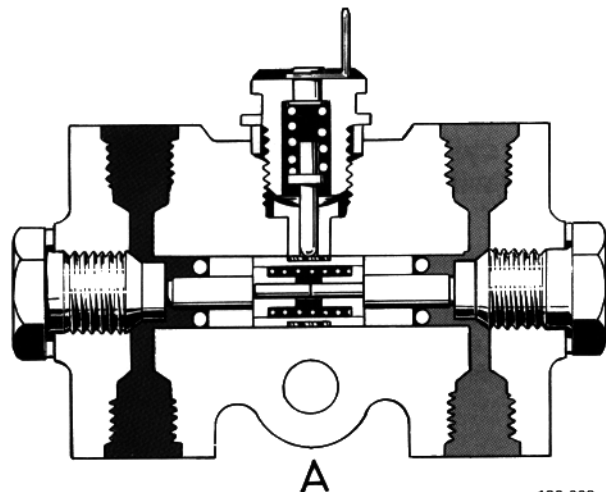
132 019

Pressure differential warning valve

The warning valve is installed only in cars **without** ABS.

Made of aluminium alloy, the valve is incorporated in the brake pipe manifold mounted on the inner wheel housing. Its function is to warn the driver of excessive difference in pressure between the two braking circuits (e.g. in the event of leakage).

On models from 1989 on, the warning valve was replaced by a level switch in the brake fluid reservoir, a feature already installed on cars with ABS.

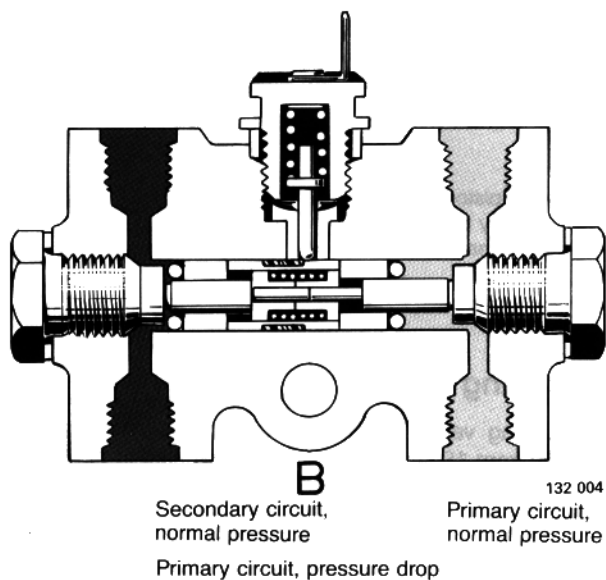


132 003

The warning valve actuating pin rests on the mid-section of a movable piston in the chamber between the primary and secondary circuits of the manifold.

When the brakes are applied normally i.e. when the pressure in both circuits is approximately equal, the piston is in the position shown in figure **A**.

A. Equal pressure in both circuits



132 004

If an excessive drop in pressure (due to leakage or air in the system) occurs in one of the circuits, the piston will be displaced laterally by the higher pressure in the other circuit (figure **B**).

The valve actuating pin will then ground the warning lamp on the instrument panel and the lamp will light.

The piston must be returned to the idle position when the fault has been corrected. This is achieved by exerting moderate pressure on the brake pedal.

B. Pressure drop in one circuit (right-hand)

Secondary circuit,
normal pressure

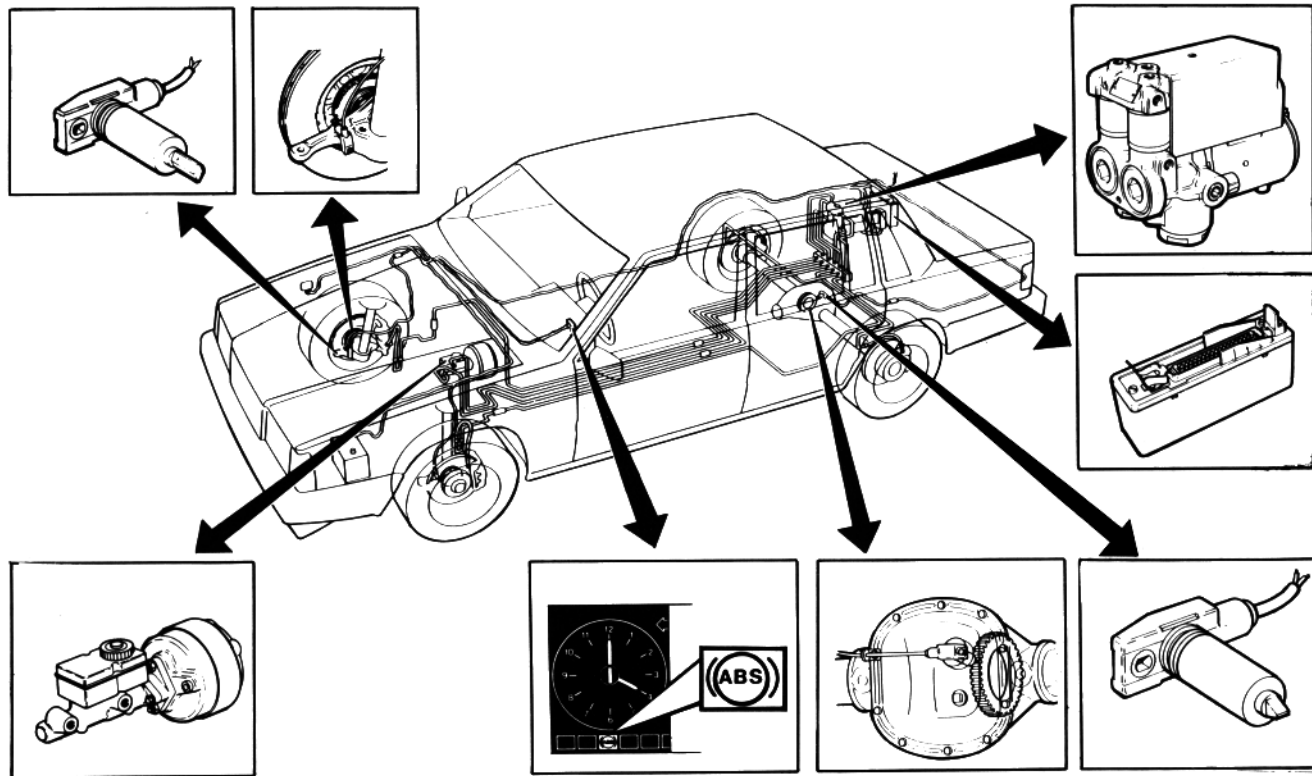
Primary circuit,
normal pressure

Primary circuit, pressure drop

Group 59 Anti-lock brakes (ABS)

Design and function

General



139 766

Location of main components in car

The illustration shows an earlier configuration with the hydraulic modulator and control module mounted at the rear. The hydraulic modulator is installed in the engine compartment and the control module in the passenger compartment on models from 1988 on.

The ABS system consists of the following main components: hydraulic modulator, sensors, control module, wiring and a warning lamp on the combined instrument which lights if the system becomes inoperative.

Vehicles equipped with ABS have an axle-split braking system. The rear piston in the master cylinder serves the front axle and the front cylinder the rear axle.

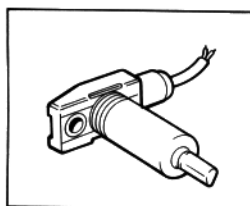
ABS ensures that directional stability and steering control are maintained, and the braking distance minimised, when the brakes are applied. This is achieved by a combination of precision hydraulics and digital technology.

The system is designed to sense the degree of friction between the road surface and each of the tyres, and the control module automatically operates the hydraulic system so as to maintain the correct pressure in the braking circuits at all times. If a wheel is about to lock, the supply pressure to that caliper is reduced temporarily.

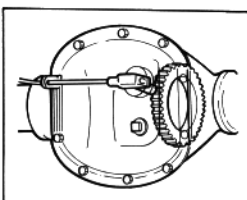
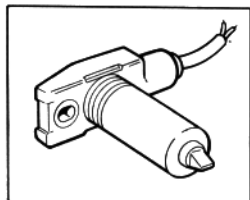
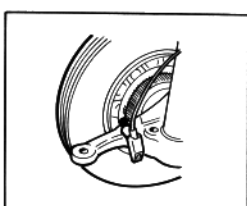
A warning lamp on the combined instrument lights if the ABS system is inoperative. **Note:** The normal braking function is available at all times.

Description of components and function

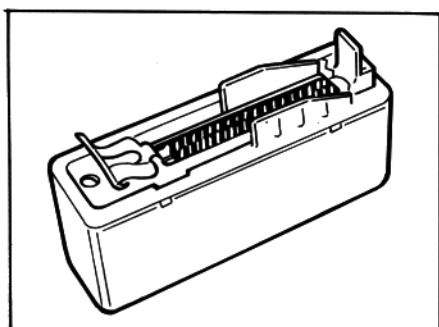
Sensor



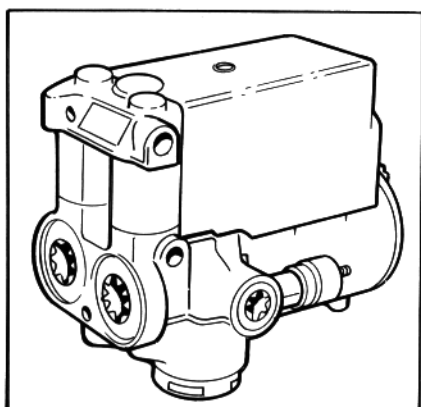
Sensor wheel



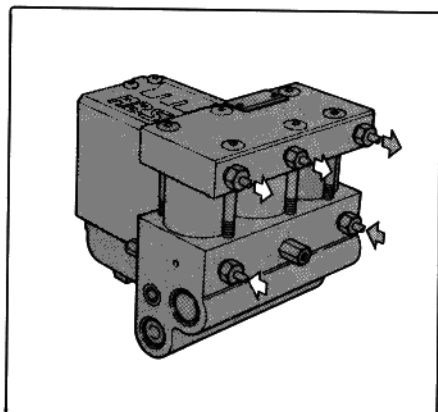
150 079



150 071



150 072



152 886

Sensors/sensor wheels

Each ABS sensor measures the speed of the road wheel by detecting the rate of passage of the teeth on the sensor wheel.

In the case of the rear wheels, the value recorded is an average since only one sensor and sensor wheel is installed.

Control module

The control module computes the speed, acceleration and deceleration of the wheels in response to the sensor signals.

The module features an inbuilt monitoring circuit which can detect internal module faults, as well as electrical faults in the sensors, hydraulic modulator, signal circuits etc.

A new control module with a function known as **GMA** is installed in models from 1990 on. Operating on the front wheels, GMA is active only when braking under ABS control. The function is engaged if a yawing movement occurs between the left and right-hand wheel pairs when running on different types of road surface (such as ice and bare earth).

Hydraulic modulator

The hydraulic modulator receives and processes the control module signals so as to maintain the correct pressure in the wheel cylinders. In the event of wheel lock, the pressure in the brake cylinder of the locked wheel is reduced and the integral electrical control pump returns brake fluid from the wheel cylinder to the master cylinder.

A later version of the hydraulic modulator is provided with new pipe connections at two points. The outlets in question are marked 'h' (rear circuit outlet) and 'i' (left front outlet). Since the size of the new outlets is M12 compared with M10 previously, the brake pipes must also be replaced when replacing an earlier modulator with the new type.

A completely new type of modulator was introduced on models from 1992 on (see illustration).

The piping and connector arrangement is completely different on the new version which, as a result, cannot be installed in earlier models.

Fault tracing of ABS system

The following procedure applies to cars to 1987 inclusive and should be carried out if the ABS lamp lights while driving.

Note: First see the ABS fault-tracing charts on pages 118–120.

Special tools: Multimeter, P/N 999 6525–3, or voltmeter, P/N 999 6450–4, and ohmmeter, P/N 999 9724–9.

General

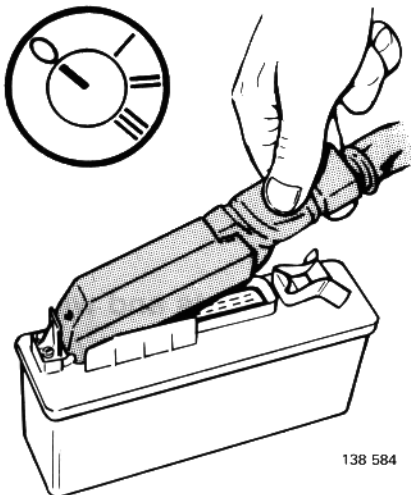
These fault-tracing instructions assume that the braking system as a whole is operational.

Important

The instructions on this and the following pages must be observed at all times, otherwise the control module may be damaged.

Control module monitoring circuit

The control module incorporates a fault-monitoring circuit designed to detect faults in the module itself, and in the sensor circuitry, hydraulic modulator, signal circuits etc. On detecting a fault, the circuit disengages the ABS system and operates the warning lamp on the combined instrument. The following checks should be carried out if the lamp lights:



Note: All checks must be carried out.

AH1

Battery:

- do not disconnect battery while engine is running
- disconnect battery leads when booster charging
- do not use booster charger or voltage source higher than 16 V for jump starting

AH2

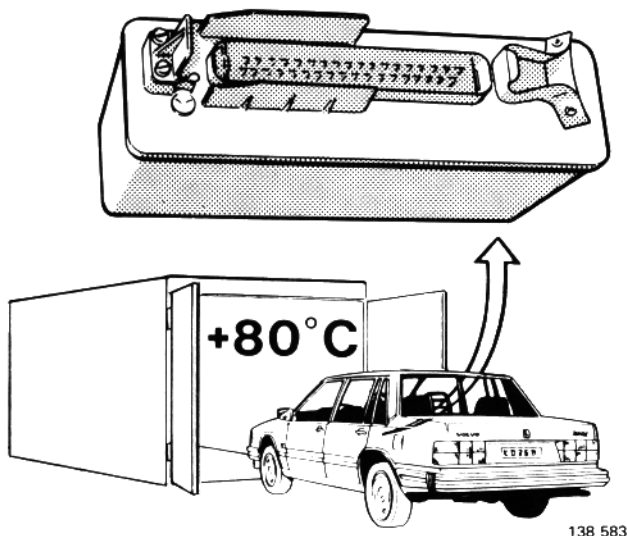
Ignition

Switch off ignition when disconnecting or connecting control module connector.

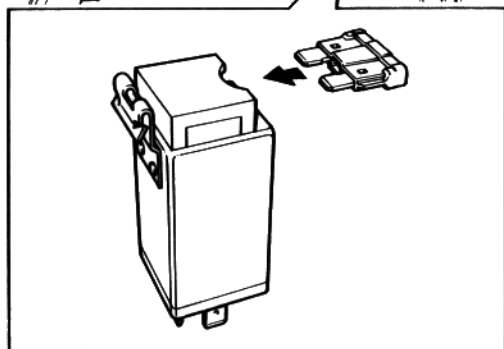
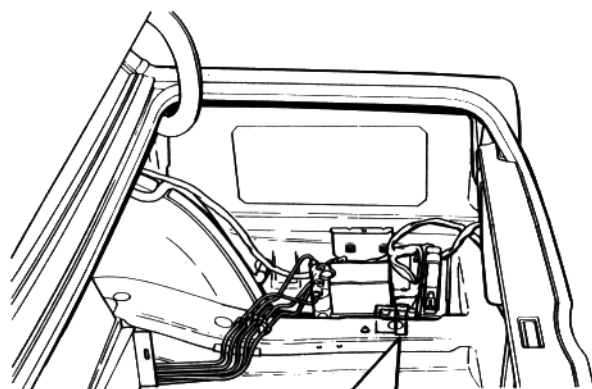
AH3

Control module

- Remove control module, for example when stoving paintwork. The module must not be exposed to temperatures above +80°C (176°F).
- Disconnect control module connector when carrying out arc welding on the car.
- Do not replace the module without checking the associated wiring and components, otherwise the new module may be damaged in the same manner as the original.



Checking fuses, connectors and ground terminals



138 599

AH4

Models to 1984 inclusive:

Check fuses 2 and 10 in electrical distribution unit.
Check fuse at right-hand wheel housing (80 A).

AH5

Models from 1985 to 1987 inclusive:

Check fuses 2 and 12 in electrical distribution unit.

AH6

Check transient surge protector fuse (10 A)

Remove cover over right-hand well in luggage compartment. Fold back carpet.

AH7

Check all ABS system connectors, wiring and ground terminals

Ensure that components are correctly and securely connected.

Poor contacts can cause fault symptoms.

Checking components and wiring

See appropriate wiring diagram at rear of manual.

AH8

Switch off ignition

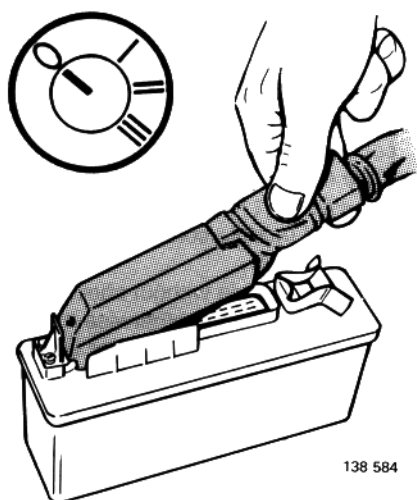
AH9

Disconnect control module connector

Depress catch and lift off connector.

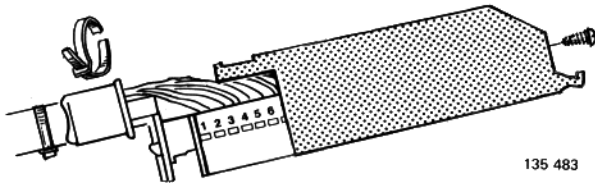
AH10

Remove protective cover from hydraulic modulator



138 584

AH11



135 483

Remove protective cover from connector**Important!**

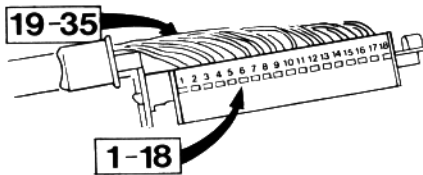
Never insert test instrument probes into terminal sockets.

Experience has shown that this may damage terminals and further aggravate fault(s).

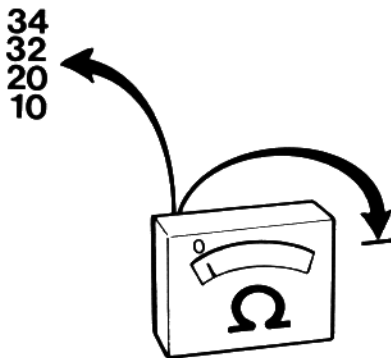
Check terminals through holes in connector sides. Do not exert greater force than necessary to make contact.

Terminal numbers are punched in connector sides.

AH12

**Check ground terminals in connector**

AH13



141 123

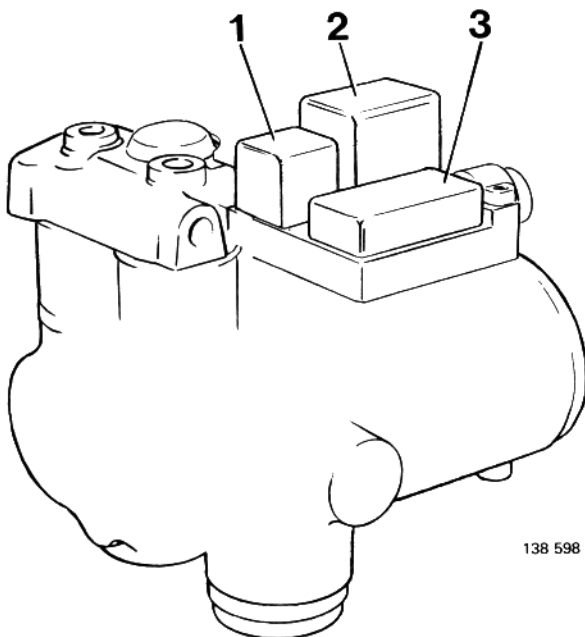
Connect ohmmeter between ground and

- terminal 10
- terminal 20
- terminal 32
- terminal 34

Resistance should be 0 ohm in all cases.

If reading is incorrect: Check integrity and connection of leads.

Leads are grounded at right-hand rear light.



138 598

If test of terminal 32 indicates fault, repeat test with new valve relay. Relay is mounted on hydraulic modulator.

1. Valve relay
2. Motor relay
3. Connector

AH14

Switch on ignition

AH15

Check supply to transient surge protector

Protector is mounted on bracket beside control module.

Measure voltage at connector terminals 2, 4 and 3. Instrument should indicate 12 V in all cases. If no supply is present at terminal 3, check that leads are intact. If so, replace surge protector.

AH16

Check supply to converter unit (mounted beside surge protector)

Measure voltage at all terminals. Instrument should indicate 12 V in all cases.

If not: replace converter unit.

AH17

Check that wiring is intact

AH18

Check supply to control module connector

AH19

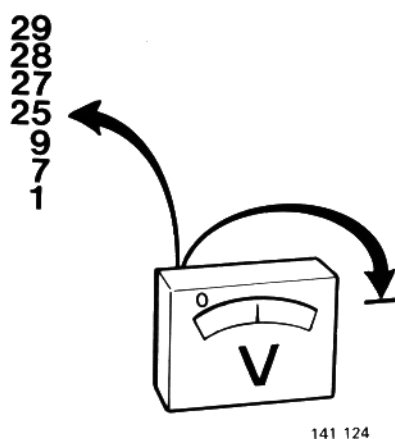
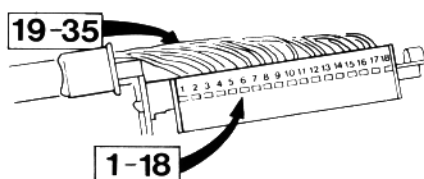
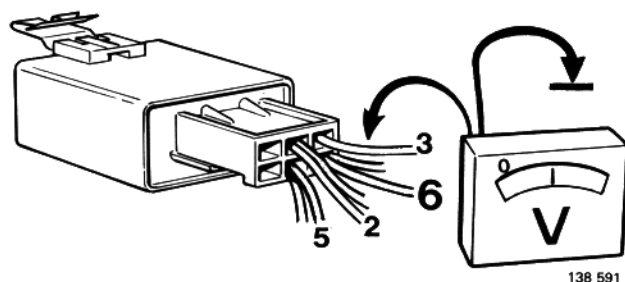
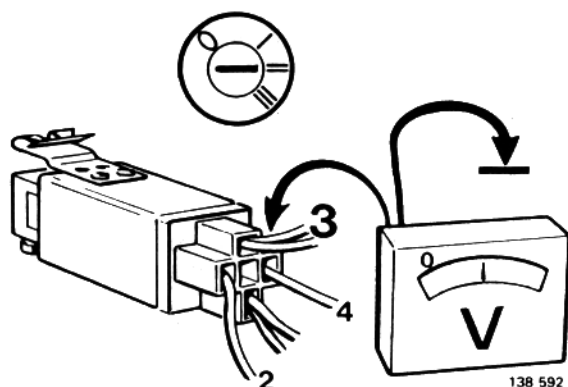
Connect voltmeter between ground and

- terminal 1
 - terminal 7
 - terminal 9
 - terminal 25, while operating brake pedal
 - terminal 27
 - terminal 28
 - terminal 29. **Note:** Instrument should indicate 0.5–1.0 V.
- The instrument should indicate battery voltage in all cases except at terminal No. 29.

AH20

If no voltage is present at

- terminal 1: Faulty surge protector
- terminal 7: Faulty converter unit
- terminal 9: Faulty converter unit
- terminal 25: Check brake light switch and replace if necessary. Also check brake light bulbs and replace if necessary.
- terminal 27: Faulty valve relay. Replace relay.
- terminal 28: Faulty motor relay. Replace relay.
- terminal 29: If correct voltage is present at terminal 27, instrument should indicate 0.5–1.0 V at terminal 29. If not, valve relay is faulty. Replace relay.





139 877

Check that wiring is intact

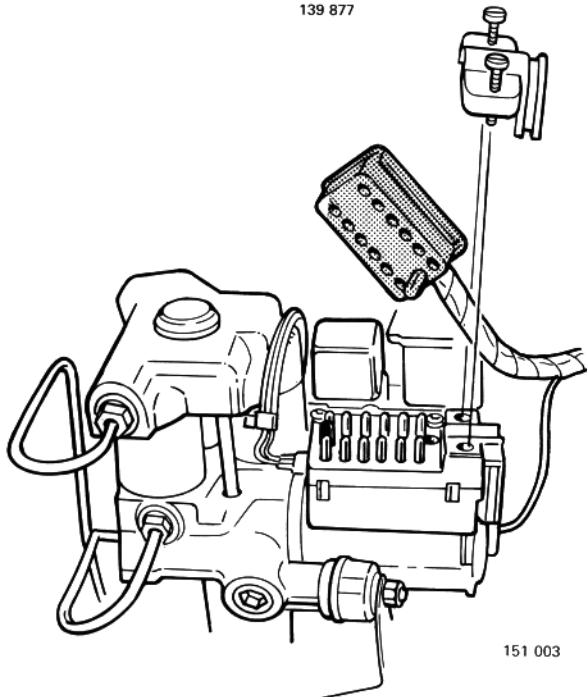
AH21

Switch off ignition

AH22

Check voltage at hydraulic modulator connector.
Disconnect connector from unit

AH23



151 003



152 889

Switch on ignition

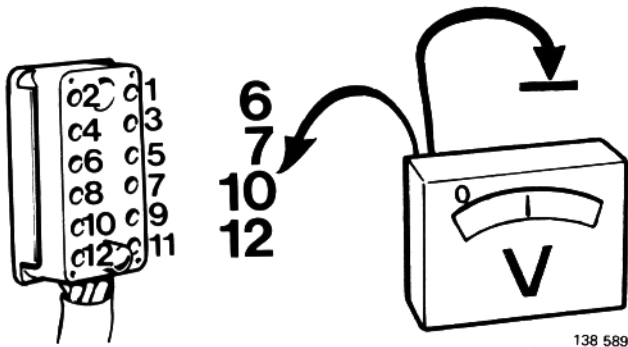
AH24

Connect voltmeter between ground and

- terminal 6
- terminal 7
- terminal 10
- terminal 12

Instrument should indicate battery voltage in all cases.

AH25



138 589

If no voltage is present at

- terminal 6: Check fuse 2 in electrical distribution unit.
- terminal 7: Reconnect connector. ABS lamp should light. If not, replace lamp.
- terminal 10: Faulty surge protector. Replace unit.
- terminal 12: Check 80 A fuse at right front wheel housing.

AH26

Check that wiring is intact

AH27

Reinstall connector

AH28



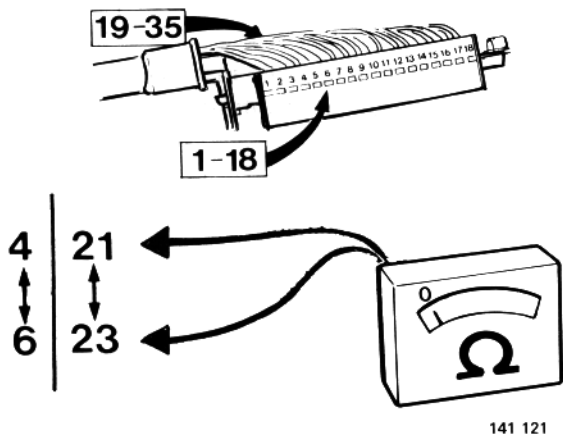
AH29

Switch off ignition

AH30

Check front wheel sensors

Connect ohmmeter to control module connector. Connect between terminals 4 and 6 for left front sensor, and between 21 and 23 for right front sensor. Instrument should indicate 0.9–2.2 kohm. If reading is incorrect: Measure at connectors at suspension strut towers in engine compartment. If wiring is intact and reading is still incorrect: Replace sensor.



141 121

AH31

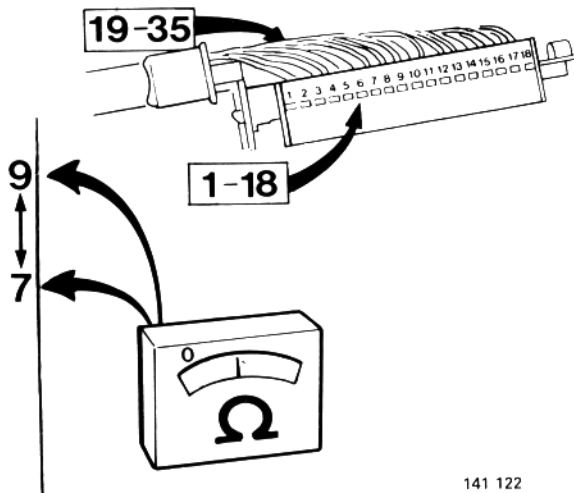
Check rear sensor

Connect ohmmeter between terminals 7 and 9. Instrument should indicate 0.6–1.6 kohm. If reading is incorrect: Measure at sensor connector located beside fuel filler pipe in luggage compartment. If reading is still incorrect, check first that wiring is intact.

If wiring is intact and reading is still incorrect: Replace sensor.

Note: If clearance between sensor and sensor wheel is incorrect, system will become inoperative and ABS lamp will light. Clearance may be adjusted as described in operations AN5–AN9 on page 130.

See pages 130–131 regarding replacement of sensor.



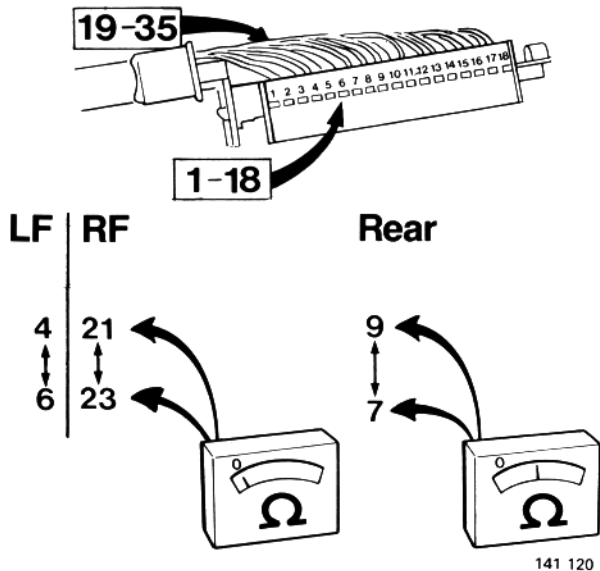
141 122

AH32

Checking sensor wiring

Check that leads from control module connector are run to correct wheels. Connect ohmmeter to terminals indicated in illustration.

Rotate left front, right front and rear wheels in turn, and connect probes to appropriate terminals. Resistance should vary as wheel rotates.



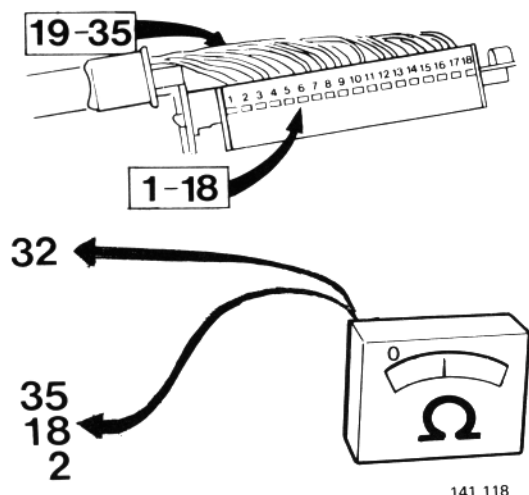
141 120

AH33

Check hydraulic modulator solenoid valves

Connect one ohmmeter probe to terminal 32 on control module connector. Use other probe to measure at terminals 2 (left front), 35 (right front) and 18 (rear).

Instrument should indicate 0.7–1.7 ohm in all cases. If reading is incorrect: Measure directly at hydraulic modulator (see wiring diagram). If reading is still incorrect: Replace modulator.



AH34

Switch on ignition

AH35

Check motor relay in hydraulic modulator

Connect lead between ground and terminal 28.

Hydraulic modulator should start.

Note: Do not connect lead for more than 2 seconds.

If modulator does not start, repeat test with new motor relay.

AH36

Check that wiring is intact

AH37

Check valve relay in hydraulic modulator

Connect voltmeter between terminal 32 and ground.

Connect lead between ground and terminal 27.

Valve relay should operate and instrument should indicate battery voltage.

If fault persists, repeat test with new relay.

AH38

Check that wiring is intact

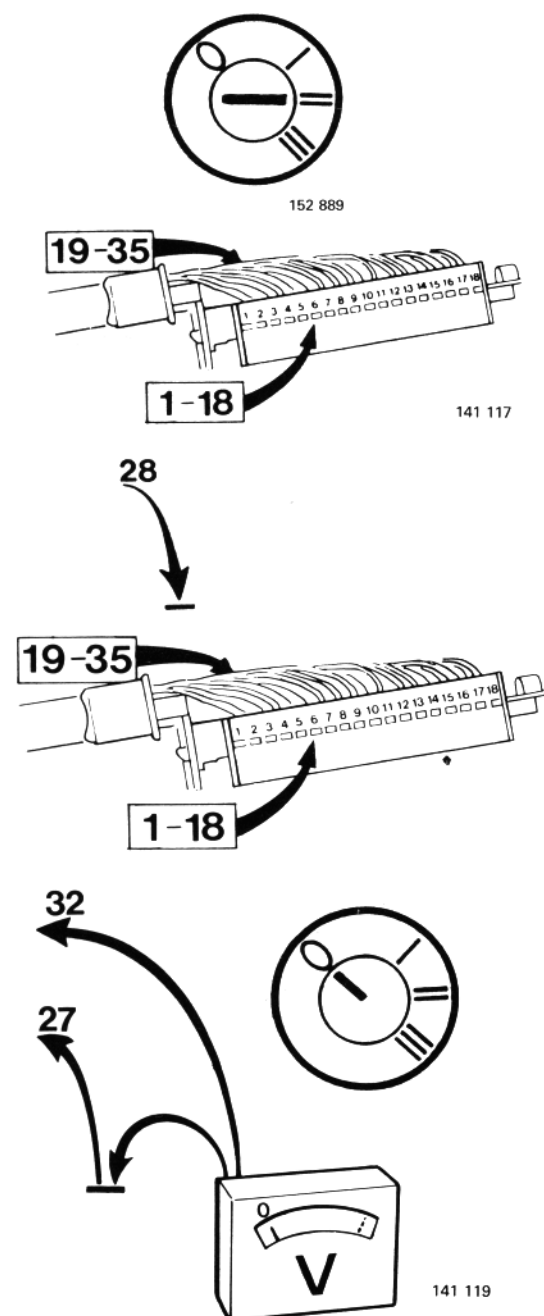
AH39

Switch off ignition and disconnect test equipment

If no fault has been detected, repeat procedure with new control module.

AH40

Reinstall panels, carpets, hydraulic modulator cover etc.



Fault tracing of ABS system

The following procedure applies to cars from 1988 on and should be carried out if the ABS lamp lights while driving.

Note: First see the ABS fault-tracing charts on pages 118–120.

Special tools: Multimeter, P/N 999 6525-3, or voltmeter, P/N 999 6450-4, and ohmmeter, P/N 999 9724-9.

Note: Cars from 1993 on: See TP 5901201.

General

These fault-tracing instructions assume that the braking system as a whole is operational.

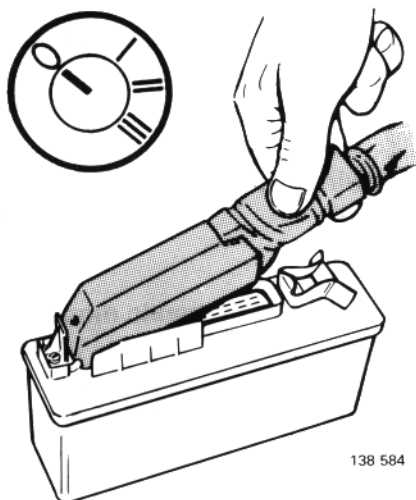
Important

The instructions on this and the following pages must be observed at all times, otherwise the control module may be damaged.

Control module monitoring circuit

The control module incorporates a fault-monitoring circuit designed to detect faults in the module itself, and in the sensor circuitry, hydraulic modulator, signal circuits etc.

On detecting a fault, the circuit disengages the ABS system and operates the warning lamp on the combined instrument. The following checks should be carried out if the lamp lights:



Note: All checks must be carried out

AJ1

Battery:

- do not disconnect battery while engine is running
- disconnect battery leads when booster charging
- do not use booster charger or voltage source higher than 16 V for jump starting

AJ2

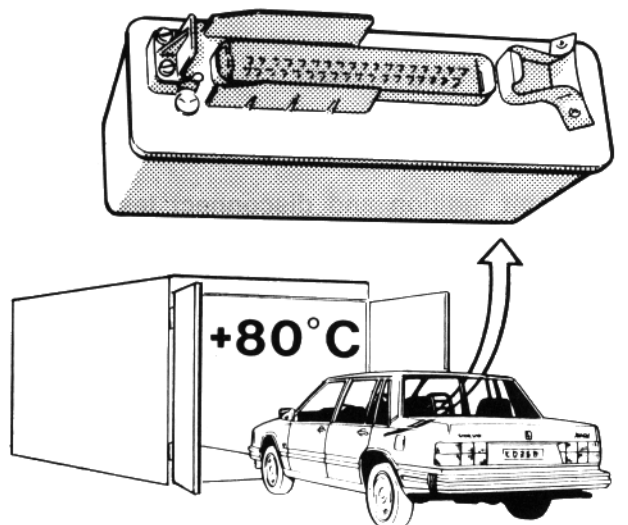
Ignition

Switch off ignition when disconnecting or connecting control module connector.

AJ3

Control module

- Remove control module, for example when stoving paintwork. The module must **not** be exposed to temperatures above +80°C (176°F).
- Disconnect control module connector when carrying out arc welding on the car.
- Do not replace module without checking associated wiring and components, otherwise new module may be damaged in same manner as original.



AJ4

Check transient surge protector fuse (10 A)

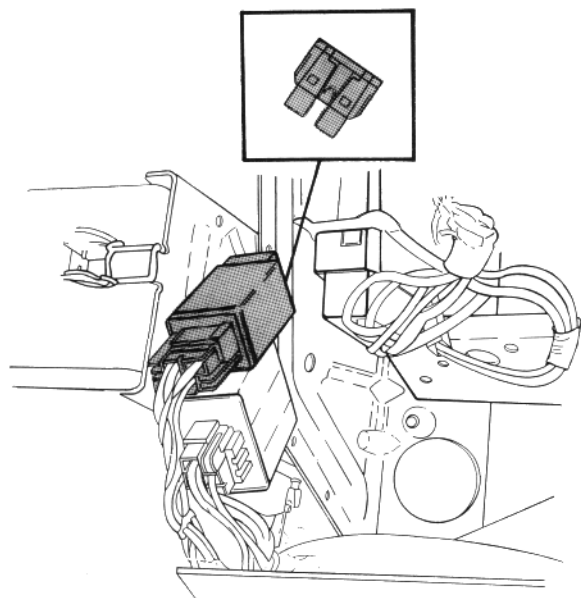
Remove soundproofing panel under dashboard on driver's side.

AJ5

Check all ABS system connectors, wiring and ground terminals

Ensure that components are correctly and securely connected.

Poor contacts can cause fault symptoms.



146 156

Checking components and wiring

See appropriate wiring diagram at rear of manual.

AJ6

Switch off ignition

AJ7

Disconnect control module connector

Depress catch and lift off connector.

AJ8

Remove protective cover from hydraulic modulator

AJ9

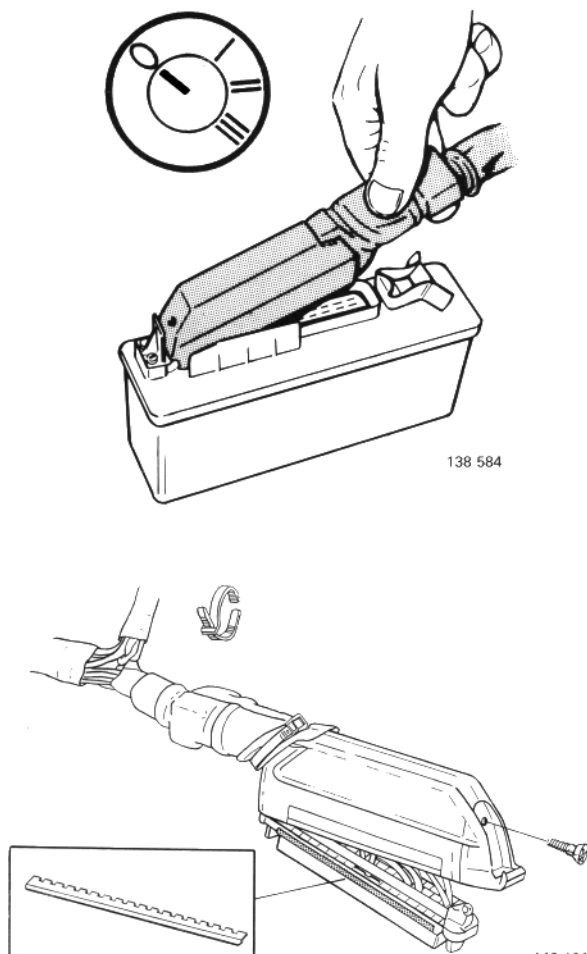
Remove protective cover from connector**Important!**

Never insert test instrument probes into terminal sockets.

Experience has shown that this may damage terminals and further aggravate fault(s).

Check terminals through holes in connector sides. Do not exert greater force than necessary to make contact.

AJ10

Remove white cover strips on connector sides

146 136

AJ11

Check ground terminals in connector

AJ12

Connect ohmmeter between ground and

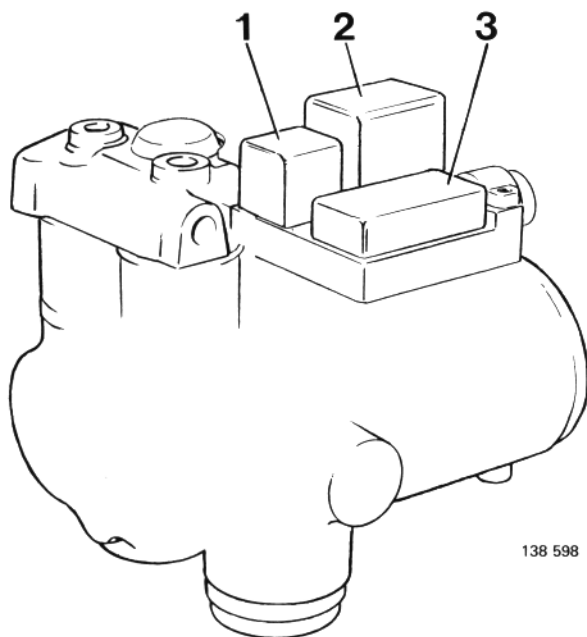
- terminal 10
- terminal 20
- terminal 32
- terminal 34

Resistance should be 0 ohm in all cases.

If reading is incorrect: Check integrity and connection of leads.

Leads are grounded at left-hand A-post.

146 147



138 598

If test of terminal 32 indicates fault, repeat test with new valve relay. Relay is mounted on hydraulic modulator.

1. Valve relay
2. Motor relay
3. Connector

AJ13

Switch on ignition

AJ14

Check supply to transient surge protector

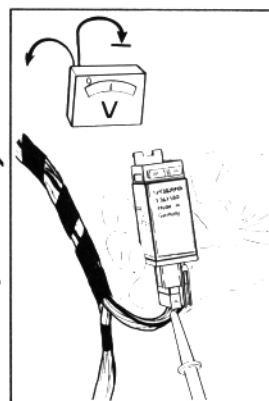
Protector is mounted on bracket beside control module.

First connect voltmeter between ground and terminal 1 on **control module connector**. Instrument should indicate battery voltage.

If no voltage is present, measure directly at surge protector connector.

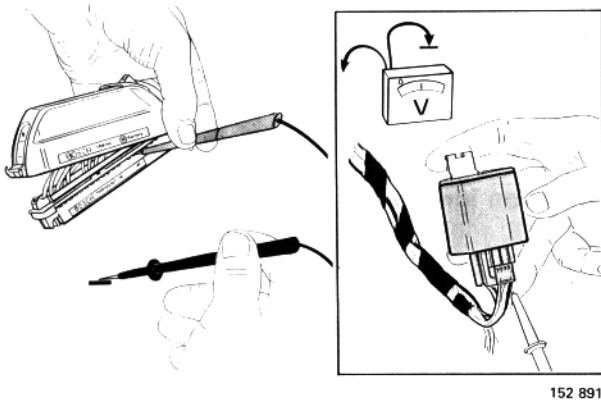
Voltage should be present at terminals 1, 2 and 4. Also check that terminal 3 is grounded. If voltage is present at terminals 1 and 4 only when terminal 3 is grounded, surge protector is faulty and must be replaced.

Note: Battery voltage should be present at surge protector terminal 1 at all times, even when ignition is switched off and control module connector is connected.



152 890

AJ15

**Check converter unit**

(Installed only on cars up to 1988.)

Unit is mounted on control module bracket.

Connect voltmeter between ground and terminals 7 and 9 on **control module connector**.

Instrument should indicate battery voltage.

If no voltage is present, measure directly at converter unit terminals 1, 2 and 4.

If no voltage is present at any of above terminals, replace converter unit.

Note: Battery voltage should be present only at converter unit terminal 3 when control module connector is connected and ignition is on.

AJ16

Check supply to control module connector

AJ17

Connect voltmeter between ground and

- terminal 25, while operating brake pedal
- terminal 27
- terminal 28
- terminal 29. **Note:** Instrument should indicate 0.5–1.0 V.

Instrument should indicate battery voltage in all cases except at terminal No. 29.

Start engine. Instrument should indicate battery voltage at terminal 15.

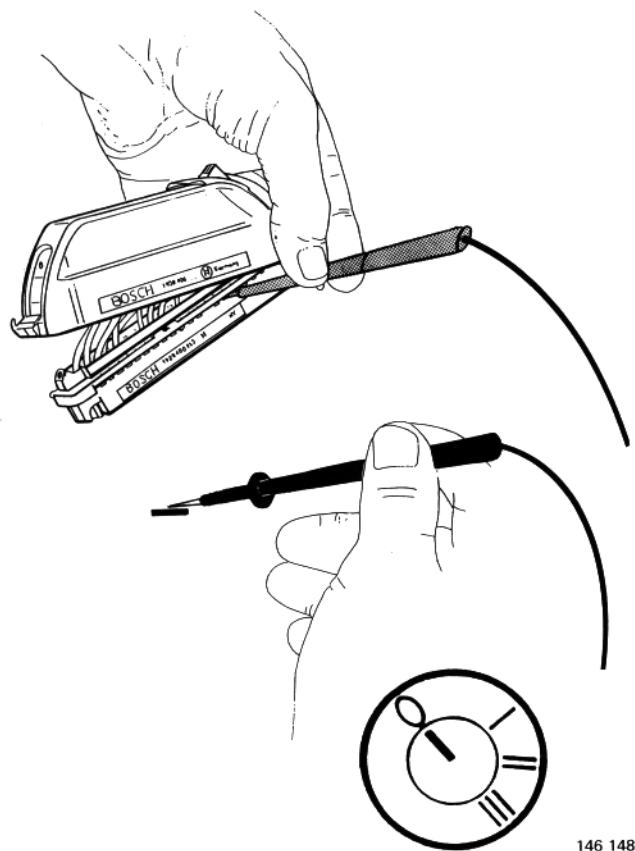
AJ18

First check that wiring is intact. If voltage is not present at

- terminal 25: Check brake light switch and replace if necessary. Also check brake light bulbs and replace if necessary.
- terminal 27: Faulty valve relay. Replace relay.
- terminal 28: Faulty motor relay. Replace relay.

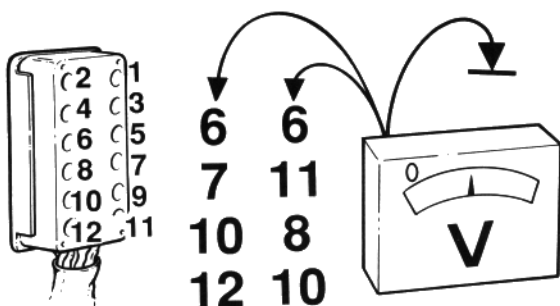
Also measure at terminal 29. If voltage is present at terminal 27 when checked, instrument should indicate 0.5–1.0 V at terminal 29. If not, valve relay is faulty. Replace relay.

AJ19

Switch off ignition



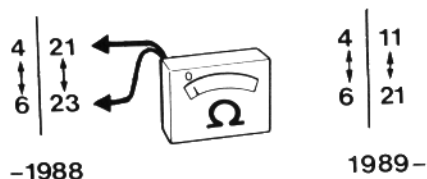
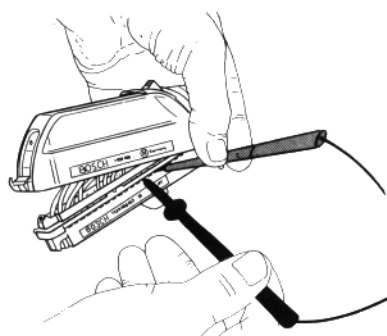
152 889



S5900171



139 877



-1988

1989-

146 143

AJ20

**Check voltage at hydraulic modulator connector.
Disconnect connector from unit**

AJ21

Switch on ignition

AJ22

Connect voltmeter between ground and

up to 1991

from 1992

- | | |
|---------------|---------------|
| - terminal 6 | - terminal 6 |
| - terminal 7 | - terminal 11 |
| - terminal 10 | - terminal 8 |
| - terminal 12 | - terminal 10 |

Instrument should indicate battery voltage in all cases.

AJ23

**If voltage is not present at above terminals,
carry out following checks and ensure that wiring
is intact:**

- terminal 6: Check leads
- terminal 7: (Terminal 11 in models from 1992 on): Re-connect leads. ABS lamp should light. If not, replace lamp.
- terminal 10: (Terminal 8 in models from 1992 on): Surge protector faulty. Replace unit.
- terminal 12: (Terminal 10 in models from 1992 on): Check leads.

AJ24

Switch off ignition

AJ25

Reconnect connector

AJ26

Check front sensors

Connect ohmmeter to control module connector. Models to 1988 inclusive: Connect between terminals 4 and 6 for left front sensor, and between terminals 21 and 23 for right front sensor.

Models from 1989 on: Connect between terminals 4 and 6 for left front sensor, and between 11 and 21 for right front sensor.

Instrument should indicate between 0.9 and 2.2 kohm. If reading is incorrect: Measure at connectors at suspension strut towers in engine compartment. If reading is still incorrect; Check first that wiring is intact.

If wiring is intact and reading is still incorrect: Replace sensor.

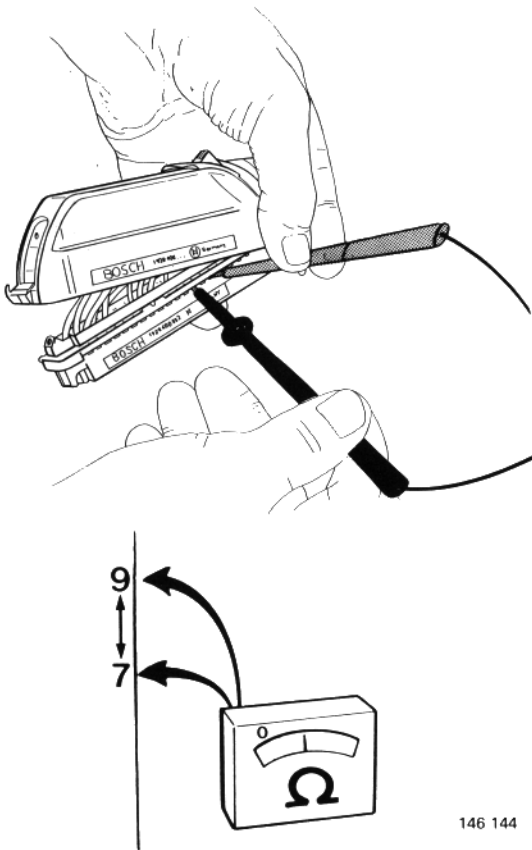
Also inspect front sensor wheels for damage. Max. permissible radial run-out = 0.15 mm (0.006 in).

Note: If replacing sensor wheel, ensure that correct type is installed:

Models to 1988 inclusive: 96 teeth

Models from 1989 on: 48 teeth.

AJ27



146 144

Check rear sensor

Connect ohmmeter between terminals 7 and 9. Instrument should indicate 0.6–1.6 kohm. If reading is incorrect: Measure at sensor connector located beside fuel filler pipe in luggage compartment.

Note: Connector seal must be replaced. If reading is still incorrect: Check first that wiring is intact.

If wiring is intact and reading is still incorrect: Replace sensor.

Note: See pages 130–131 regarding replacement of sensor on cars with **live rear axle**.

See pages 132–134 regarding replacement of sensor on cars with **multilink rear axle**.

Sensor signals will be incorrect if sensor wheel is more than 0.2 mm out of round or if any teeth are damaged. If so, replace sensor wheel as described in Service Manual, Section 4(46) Rear axle.

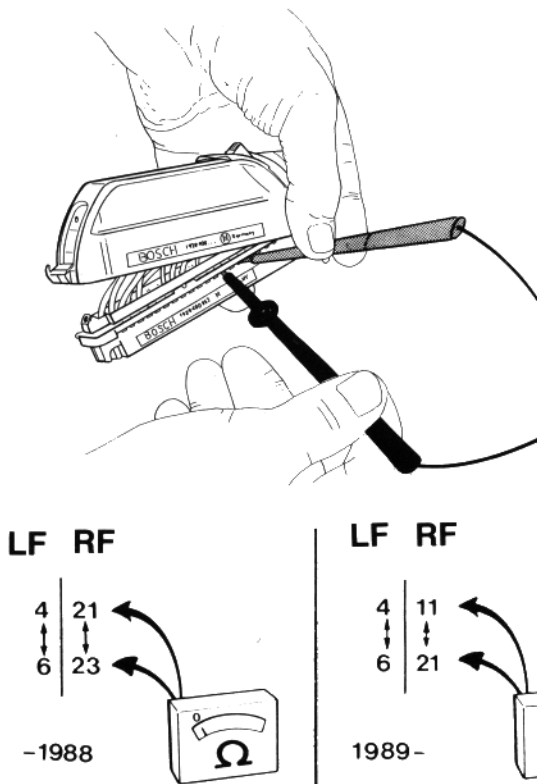
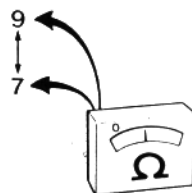
When replacing sensor wheel, remember that two different types (with **48** and **96** teeth) are available.

AJ28

Checking sensor wiring

Check that leads from control module connector are run to correct wheels. Connect ohmmeter as described in AJ26 and AJ27 'Check front/rear sensors'.

Rotate left front, right front and rear wheels in turn, and connect probes to appropriate terminals. Resistance should vary as wheel rotates.

**Rear**

146 150

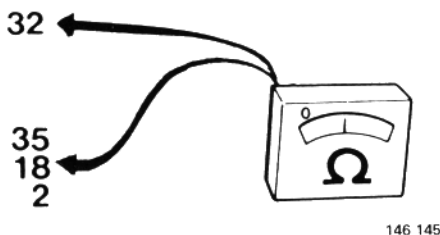
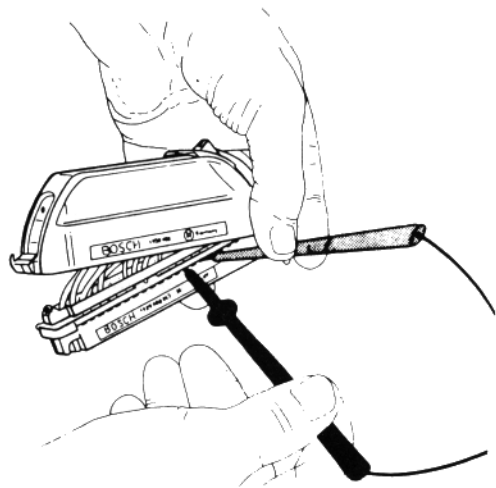
AJ29

Check hydraulic modulator solenoid valves

Connect one ohmmeter probe to terminal 32 on control module connector. Use other probe to measure at terminals 2 (left front), 35 (right front) and 18 (rear).

Instrument should indicate 0.7–1.7 ohm in all cases. If reading is incorrect: Measure directly at hydraulic modulator (see wiring diagram). If reading is still incorrect: Replace modulator.

Note: Buzzer setting should be used when measuring low resistances with multimeter. Remember that resistance of instrument leads is included in reading.



146 145



152 889

AJ30

Switch on ignition

AJ31

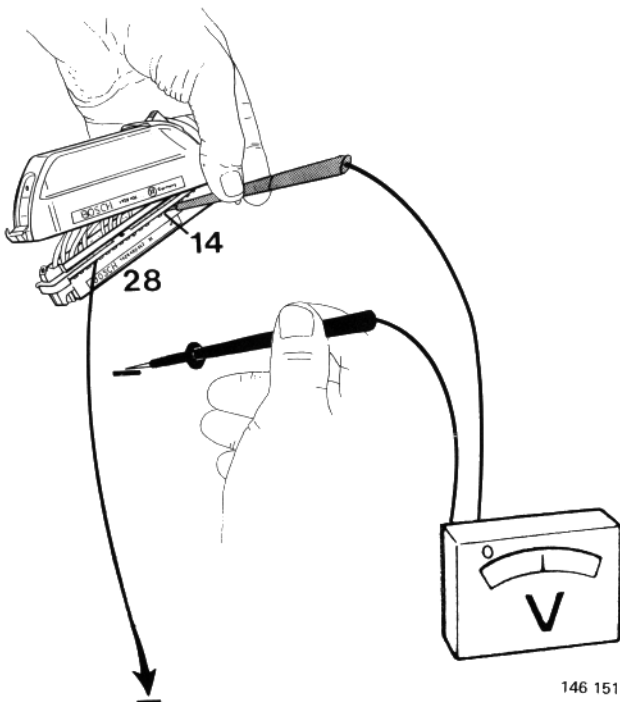
Check motor relay in hydraulic modulator

Connect jumper lead between ground and terminal 28. Hydraulic modulator should start.

Note: Do not connect lead for more than 2 seconds.

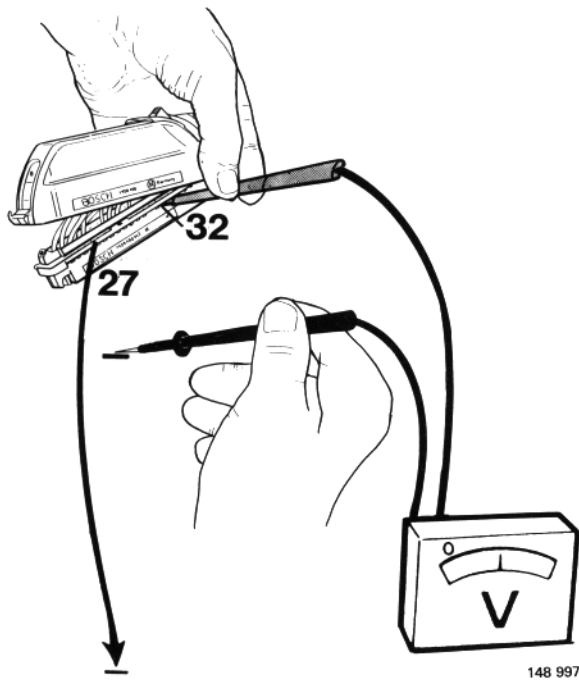
Measure voltage between terminal 14 and ground while jumper lead is connected. Instrument should indicate battery voltage.

If modulator does not start, check that wiring is intact. If fault persists, repeat test with new motor relay.



146 151

AJ32

**Check valve relay in hydraulic modulator**

Connect voltmeter between terminal 32 and ground. Connect jumper lead between ground and terminal 27. Valve relay should operate and instrument should indicate battery voltage.

If relay does not operate, check that wiring is intact. If fault persists, repeat test with new relay.



AJ33

Switch off ignition

AJ34

Disconnect test equipment

If no fault has been detected, repeat procedure with new control module.

AJ35

Reinstall panels, carpets, hydraulic modulator cover etc

Fault tracing charts

The following charts have been prepared to facilitate fault tracing if the ABS warning lamp lights. The ABS function ceases to operate when the control unit detects a fault; however, the ordinary braking system continues to operate as normal.

When the ABS function ceases to operate, the warning lamp will continue to light until the ignition is switched off,

even if the fault clears. The lamp should not light when the engine is restarted after the fault has cleared and the ignition has been switched off in the interim.

Note: See also Fault tracing of ABS system on pages 103 and 110.

Note: Cars from 1993 on: See TP 5901201.

Fault indication occurs	Warning lamp status	Function faulty or normal	Fault type, see pp. 119–120
When ignition is switched on	<ul style="list-style-type: none"> – Lamp lights – Lamp goes out after 2 s – Lamp does not light – Lamp lights/goes out alternately 	Normal Faulty Faulty Faulty	8 1 3
When engine starts Speed = 0 km/h	<ul style="list-style-type: none"> – Lamp goes out after engine starts – Lamp does not go out after engine starts 	Normal Faulty	2
When speed reaches 6 km/h (4 mph) for first time after ignition has been switched on (i.e. when car begins to roll)	<ul style="list-style-type: none"> – Lamp lights at 6 km/h (4 mph) and remains lit until ignition is switched off 	Faulty	4
Sporadically while driving	<ul style="list-style-type: none"> – Lamp lights while driving and remains lit until ignition is switched off 	Faulty	5
When braking while ABS system is controlling	<ul style="list-style-type: none"> – Lamp lights when system is controlling and remains lit until ignition is switched off 	Faulty	6
	<ul style="list-style-type: none"> – Lamp goes out before ignition is switched off (also applies while driving) 	Faulty	7

Fault type	Probable cause(s)
1a. ABS function present	<ul style="list-style-type: none"> – Lamp faulty – Fault in supply to lamp in combined instrument – Open-circuit in wiring between lamp in combined instrument, control module and hydraulic modulator
1b. ABS function absent	<ul style="list-style-type: none"> – 6-pin connector between instrument panel wiring and ABS wiring at pedal mounting not installed
1c. ABS function present even when ignition is switched off	<ul style="list-style-type: none"> – Surge protector relay activated continuously, even when ignition is switched off (applies therefore to complete ABS system)
2a. ABS function present although lamp is lit	<ul style="list-style-type: none"> – Lead to lamp in combined instrument short-circuited to ground – Low generator charge, D+ signal absent or grounded
2b. ABS function absent	<ul style="list-style-type: none"> – Control module, surge protector, hydraulic modulator connectors not installed – SUPPLY-RELATED FAULT involving: <ul style="list-style-type: none"> – poor battery condition, deficient voltage in busbar 30 and/or 15 supply – wiring; busbar 30/15 supply controller, busbar 31 ground, ground connection – fuse in surge protector relay, fusebox or electrical distribution unit – surge protector relay – Fault detected during INITIAL TEST: <ul style="list-style-type: none"> – VALVE-RELATED FAULT involving: <ul style="list-style-type: none"> – valve relay – wiring, connectors between control module, valves and valve relay – valve coils – internal control unit fault
3. Oscillatory (continuous) on/off operation of warning lamp	<ul style="list-style-type: none"> – Special case: Open-circuit/poor contact in lead between control module and surge protector relay – Poor battery condition and/or alternator function
4. ABS function absent	<ul style="list-style-type: none"> – Fault detected during special FUNCTION TEST: <ul style="list-style-type: none"> – PUMP-RELATED FAULT involving: <ul style="list-style-type: none"> – pump motor relay – wiring and connector between control module, pump and pump relay – SENSOR-RELATED FAULT: open-circuit, short-circuit, (low signal strength) involving: <ul style="list-style-type: none"> – sensor – wiring and connector between sensor and control module – internal control module fault

Fault type	Probable cause(s)
5. ABS function absent	Sporadic fault which occurs when speed exceeds 6 km/h (4 mph) and is not, therefore, detected by function test as per item 4: – intermittent SENSOR-RELATED FAULT (see item 4 for details)
6. ABS function absent	Sporadic fault which occurs when speed exceeds 6 km/h (4 mph) and is not, therefore, detected by either initial test or function test as per item 2b or 4: – intermittent SENSOR-RELATED FAULT (see item 4 for details) – intermittent PUMP-RELATED FAULT (see item 4 for details) – intermittent VALVE-RELATED FAULT (see item 2b for details)
7a. Lamp lights and ABS function is present. Lamp goes out before ignition is switched off.	– Poor alternator charge, D+ signal grounded while lamp is lit
7b. ABS function absent while lamp is lit. Lamp goes out before ignition is switched off	– Intermittent SUPPLY-RELATED FAULT (see item 2b for details)
8. Lamp lights for approx. 2 s and then goes out	– Open-circuit in D+ signal – Fault in wiring and connector between alternator and control module

Repair and maintenance

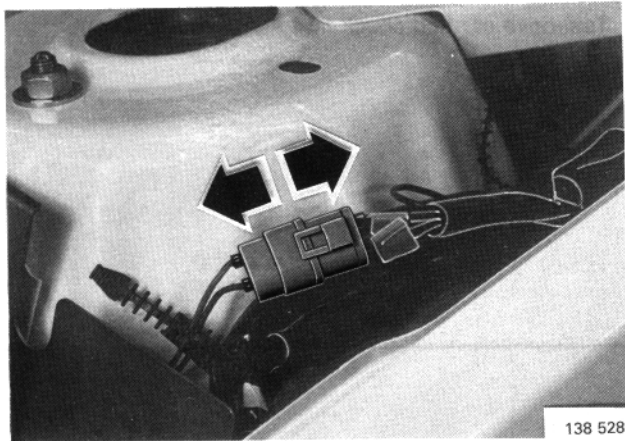
Front wheel sensor, replacement

AK1

Remove sensor

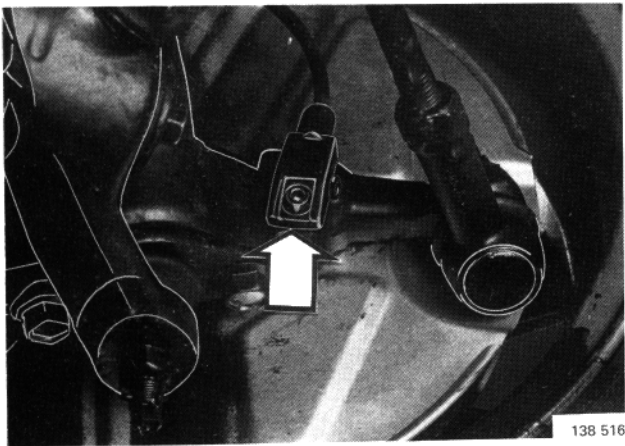
Identify sensor cable and follow cable to suspension strut tower. Disconnect connector.

Withdraw leads through wheel housing. Free leads from clips.



AK2

Remove sensor from suspension strut

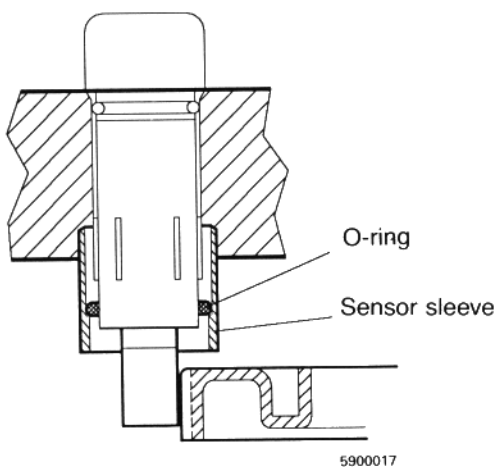


Installation

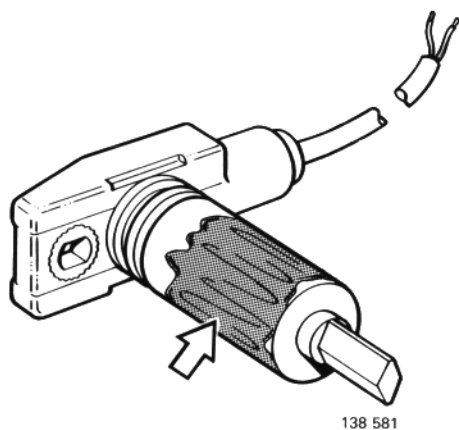
AK3

Inspect O-ring in sensor sleeve

Ensure that O-ring is correctly seated when installing sensor. If not, clearance between sensor and sensor wheel will be incorrect, causing disturbance to function of ABS system.



AK4



Install sensor

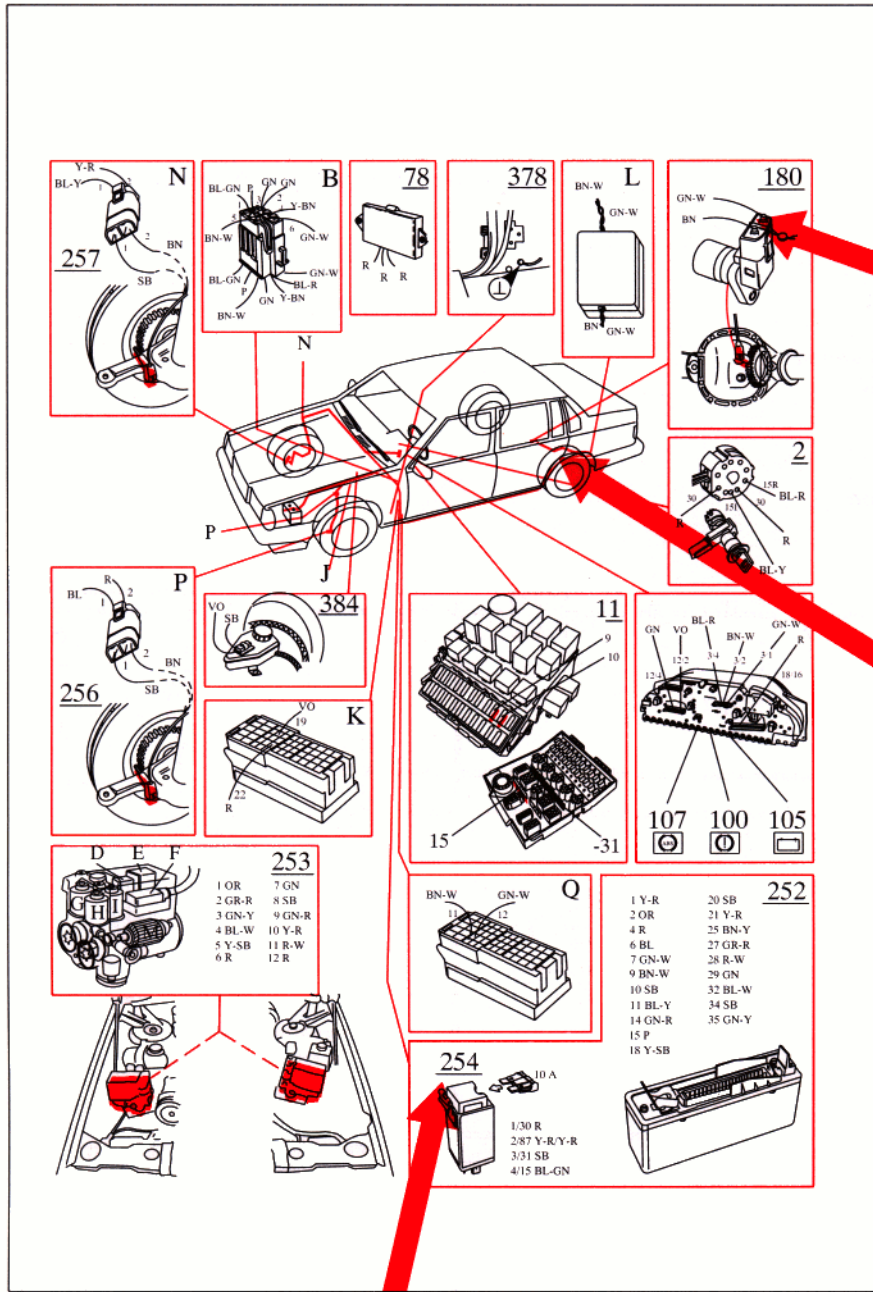
Lubricate sensor with small quantity of wheel bearing grease and mount on suspension strut.

Note: Ensure that sensor tip is free of grease and dirt.

Secure sensor cable in clips. Run cable into engine compartment. Reconnect connector.

Test-drive car and check that ABS lamp goes out.

How to use component location diagrams



The illustration show the wiring connections to the various components.

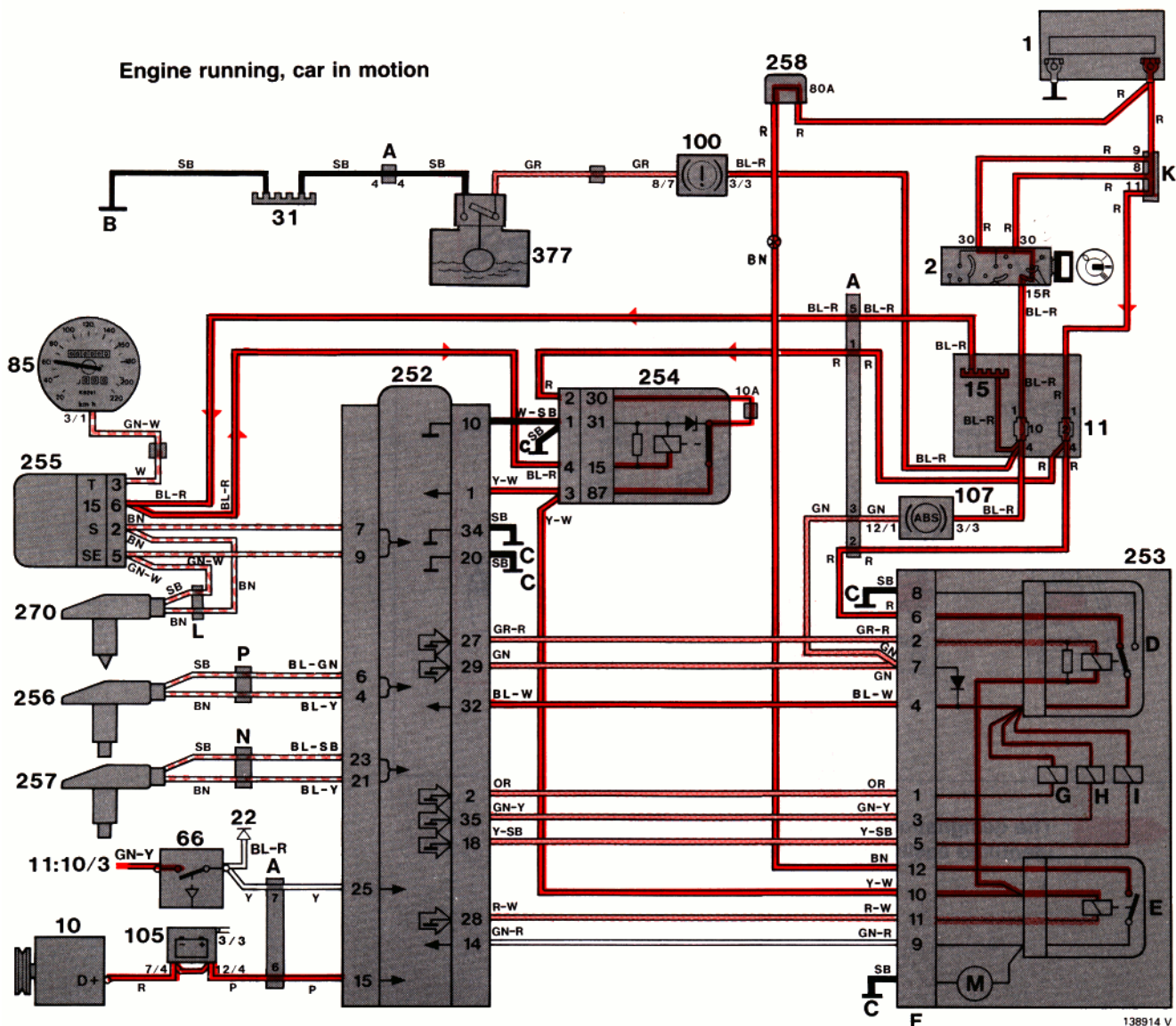
The component locations and wiring runs are also shown.

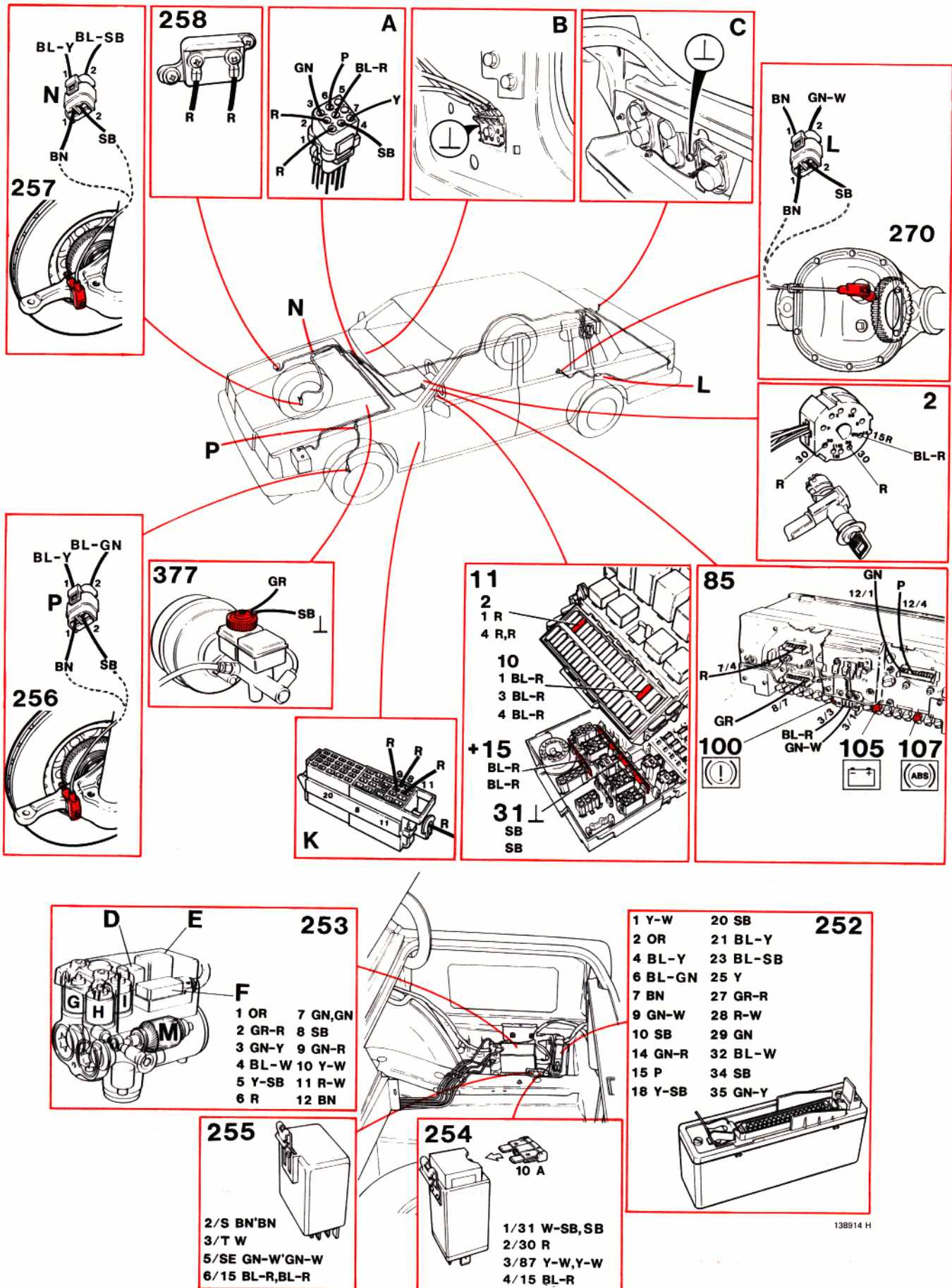
The designations enable the components to be identified easily on the wiring diagram.

740/760 1984

- | | | | |
|---------|---|---|--|
| 2 | Ignition switch | A | Connector at RH A-post |
| 10 | Alternator and voltage regulator | B | Ground terminal at RH A-post |
| 11 | Fusebox | C | Ground terminal at RH rear light |
| 11:10/3 | Fuse No. 10, terminal 3 | D | Solenoid valve relay |
| 15 | Busbar 15 in electrical distribution unit | E | Pump motor relay |
| 22 | Brake light | F | Connector on hydraulic modulator |
| 31 | Ground busbar in electrical distribution unit | G | Solenoid valve, left front |
| 66 | Brake light switch | H | Solenoid valve, right front |
| 85 | Speedometer | I | Solenoid valve, rear |
| 100 | Brake system warning light | K | Connector at LH A-post |
| 105 | Ignition lamp | L | Connector in luggage compartment |
| 107 | ABS warning lamp | M | Pump motor |
| 252 | ABS control module | N | Connector at RH suspension strut tower |
| 253 | ABS hydraulic modulator | P | Connector at LH suspension strut tower |
| 254 | ABS transient surge protector | | |
| 255 | ABS converter unit | | |
| 256 | ABS sensor, left front | | |
| 257 | ABS sensor, right front | | |
| 258 | ABS fusebox, 80 A | | |
| 270 | Speedometer and ABS sensor | | |
| 377 | Brake fluid level switch | | |

Engine running, car in motion





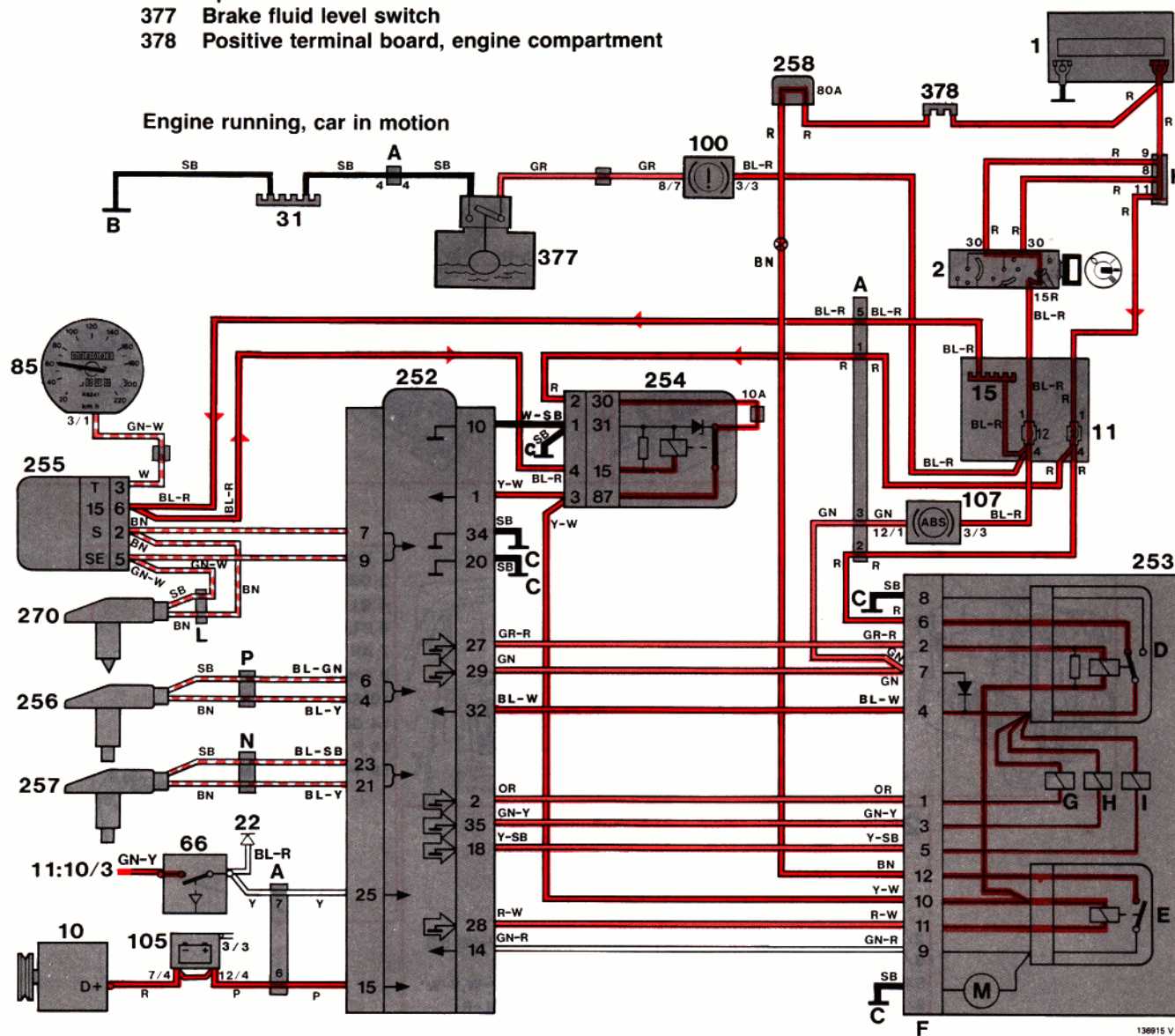
138914 H

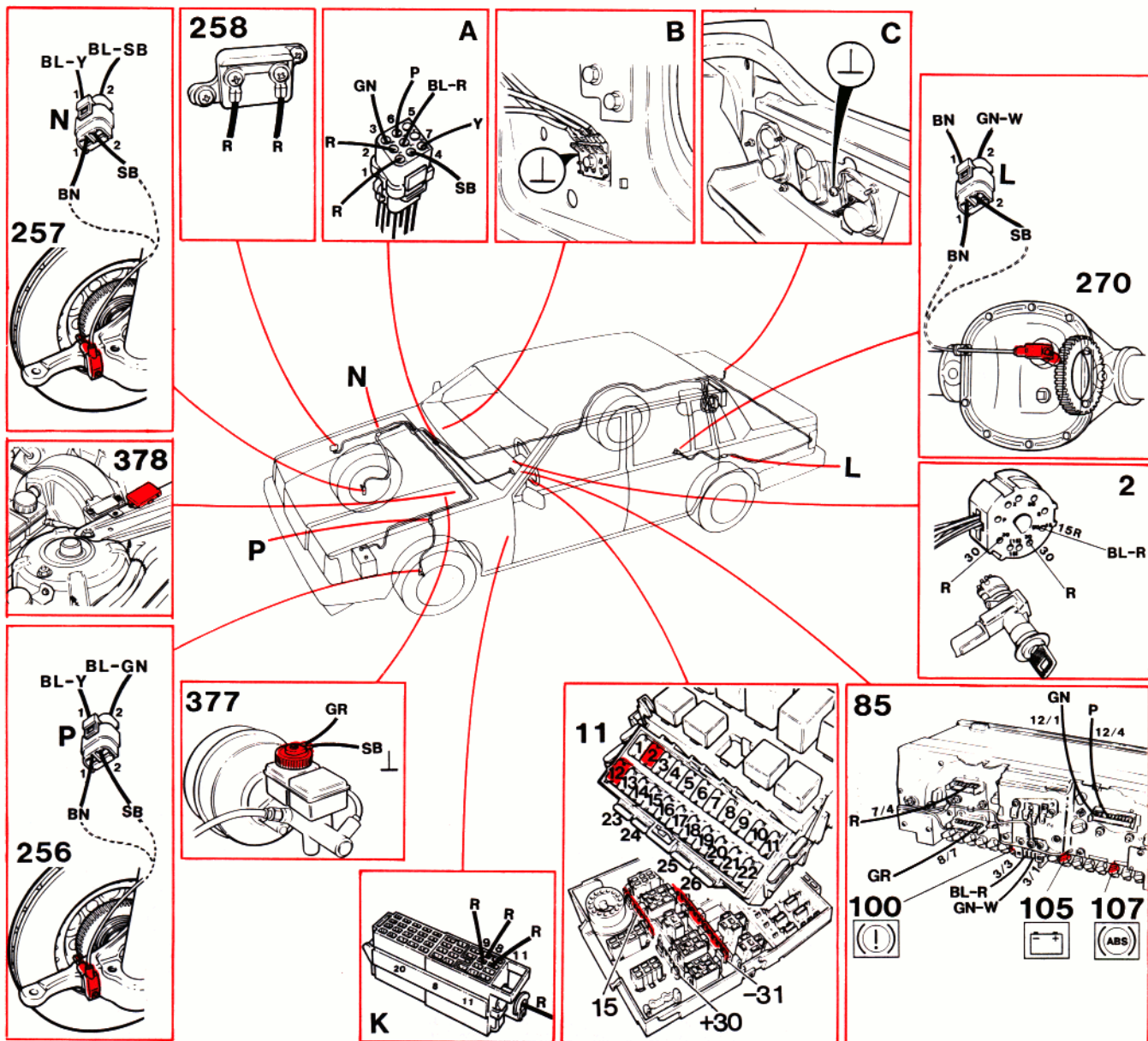
Wiring diagram, ABS braking system

740/760 1985

- | | | | |
|---------|---|---|--|
| 2 | Ignition switch | A | Connector at RH A-post |
| 10 | Alternator and voltage regulator | B | Ground terminal at RH A-post |
| 11 | Fusebox | C | Ground terminal at RH rear light |
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| 22 | Brake light | F | Connector on hydraulic modulator |
| 31 | Ground busbar in electrical distribution unit | G | Solenoid valve, left front |
| 66 | Brake light switch | H | Solenoid valve, right front |
| 85 | Speedometer | I | Solenoid valve, rear |
| 100 | Brake system warning lamp | K | Connector at LH A-post |
| 105 | Ignition lamp | L | Connector in luggage compartment |
| 107 | ABS warning lamp | M | Pump motor |
| 252 | ABS control module | N | Connector at RH suspension strut tower |
| 253 | ABS hydraulic modulator | P | Connector at LH suspension strut tower |
| 254 | ABS transient surge protector | | |
| 255 | ABS converter unit | | |
| 256 | ABS sensor, left front | | |
| 257 | ABS sensor, right front | | |
| 258 | ABS fusebox, 80 A | | |
| 270 | Speedometer and ABS sensor | | |
| 377 | Brake fluid level switch | | |
| 378 | Positive terminal board, engine compartment | | |

Engine running, car in motion



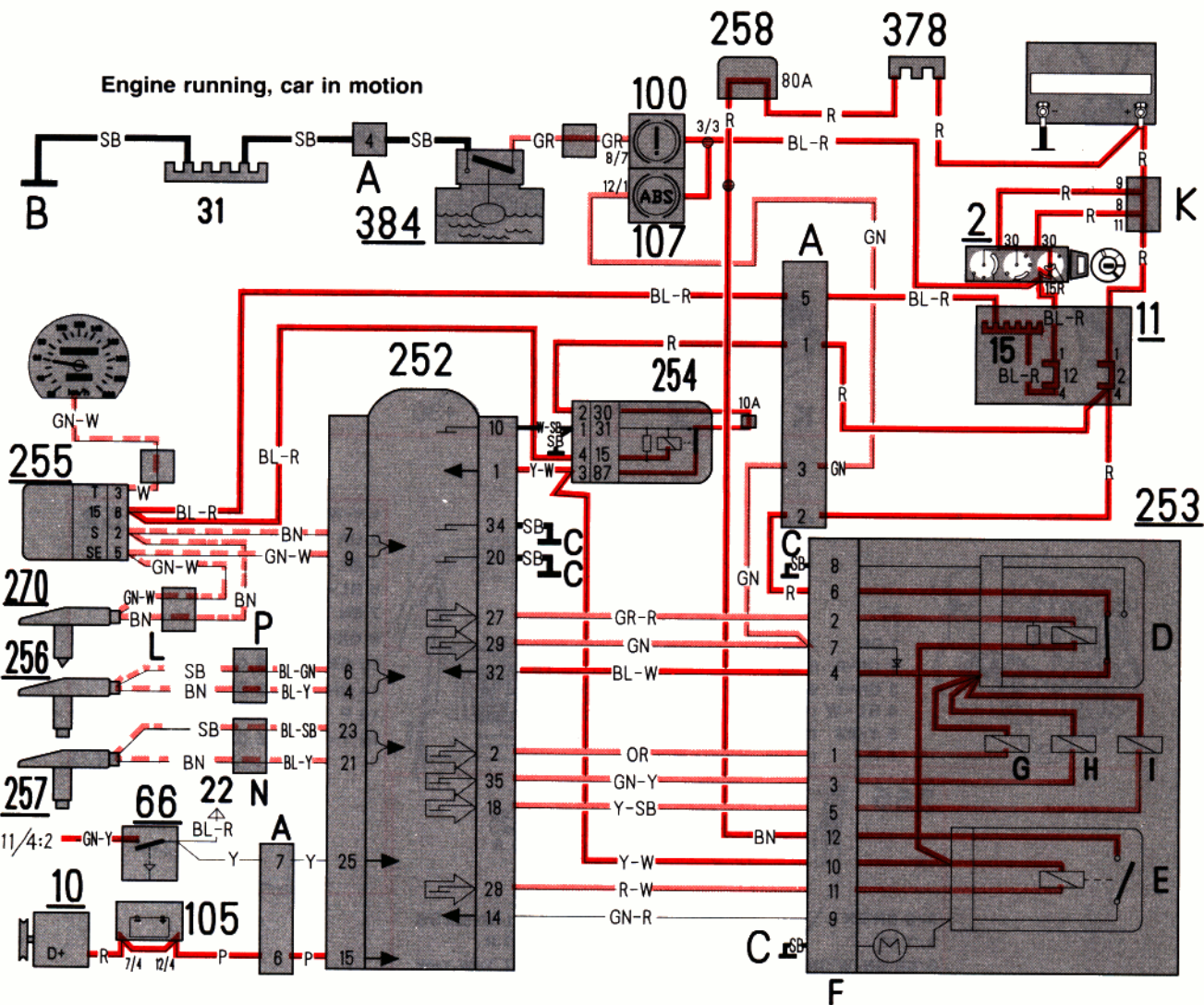


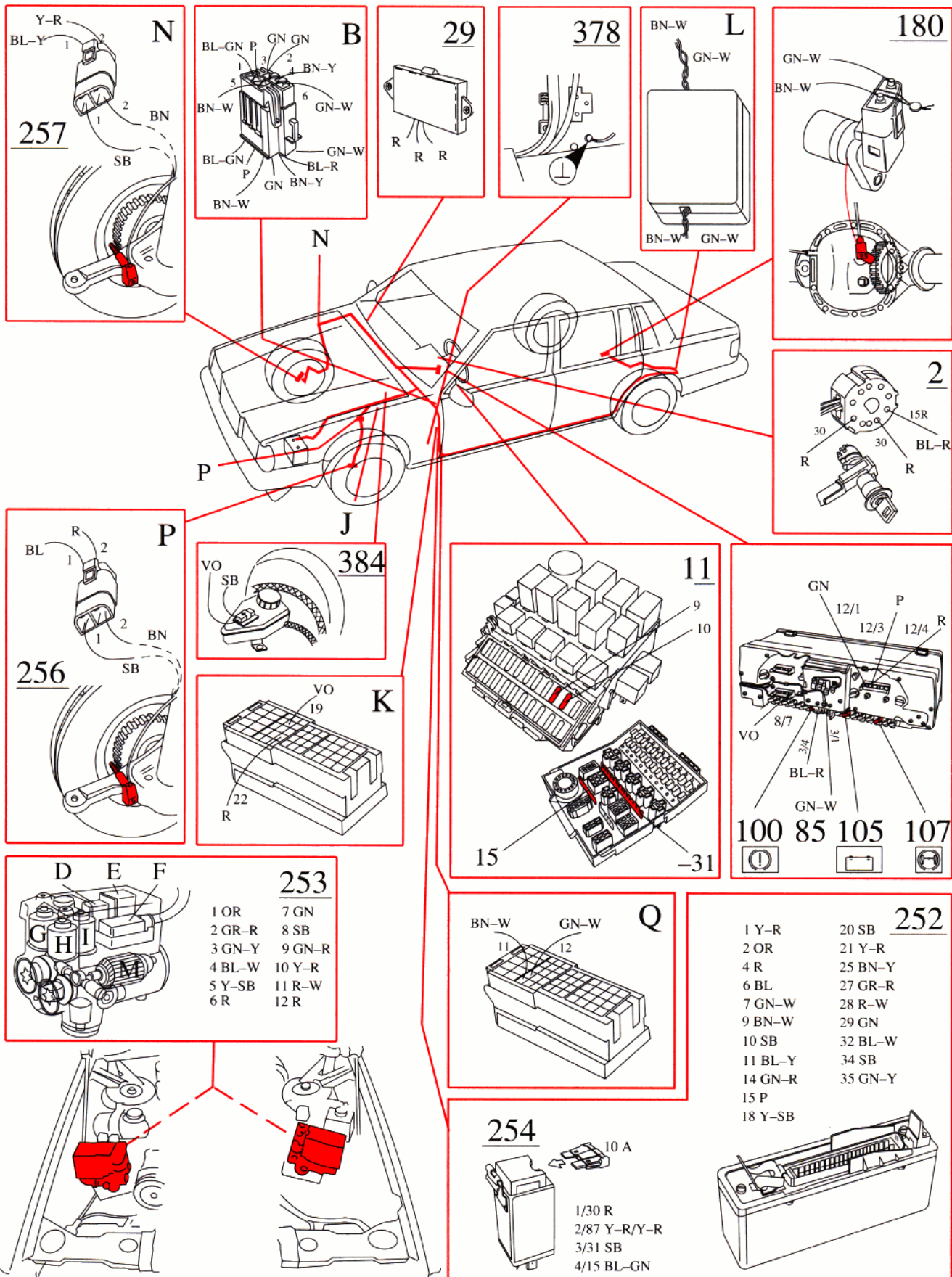
Wiring diagram, ABS braking system

740/760 1986

- 2 Ignition switch
- 10 Alternator and voltage regulator
- 11 Fusebox
- 15 Busbar 15 in electrical distribution unit
- 22 Brake light
- 31 Ground busbar in electrical distribution unit
- 66 Brake light switch
- 85 Speedometer
- 100 Brake system warning lamp
- 105 Ignition lamp
- 107 ABS warning lamp
- 252 ABS control module
- 253 ABS hydraulic modulator
- 254 ABS transient surge protector
- 255 ABS converter unit
- 256 ABS/ETC, left front
- 257 ABS/ETC, right front
- 258 ABS fusebox, 80 A
- 270 Speedometer and ABS sensor
- 378 Positive terminal board, engine compartment
- 384 Brake fluid level switch

- A Connector at RH A-post
- B Ground terminal at RH A-post
- C Ground terminal at RH rear light
- D Solenoid valve relay
- E Pump motor relay
- F Connector on hydraulic modulator
- G Solenoid valve, left front
- H Solenoid valve, right front
- I Solenoid valve, rear
- K Connector at LH A-post
- L Connector in luggage compartment
- M Pump motor
- N Connector at RH suspension strut tower
- P Connector at LH suspension strut tower





Wiring diagram, ABS braking system

760, 1989

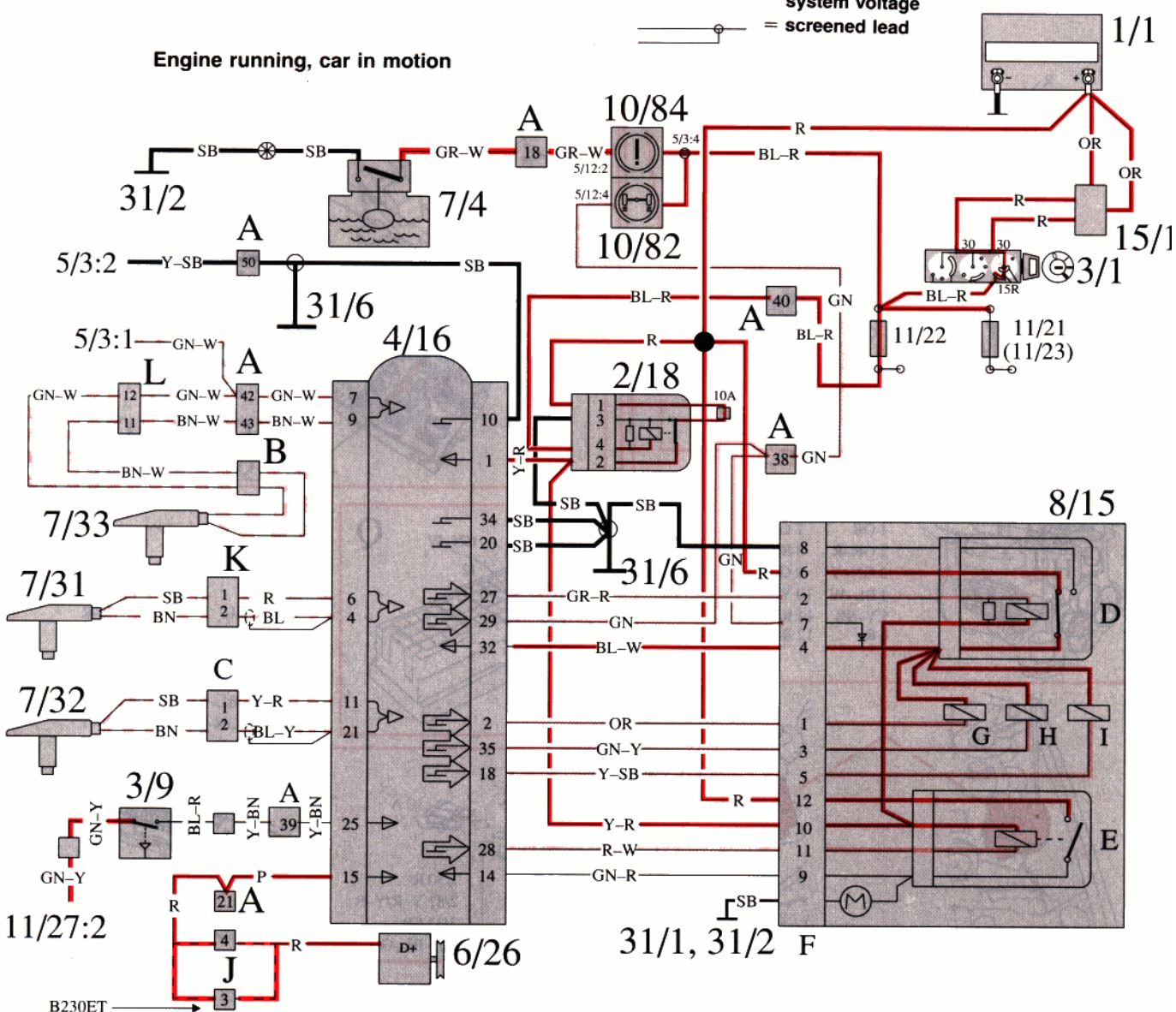
- 1/1 Battery
 2/18 ABS transient surge protector
 3/1 Ignition switch
 3/9 Brake light switch
 4/16 ABS control module
 5/ Combined instrument
 6/26 Alternator
 7/4 Brake fluid level switch
 7/31 ABS sensor, left front
 7/32 ABS sensor, right front
 7/33 ABS and speedometer sensor
 8/15 ABS hydraulic modulator
 10/82 ABS warning lamp
 10/84 Brake warning lamp
 11/1-35 Fuses
 15/1 Positive terminal board
 31/1 Ground terminal, right front wing
 31/2 Ground terminal, left front wing
 31/6 Ground terminal, LH A-post

- A Connector at LH A-post
 B Connector in luggage compartment
 C Connector at RH suspension strut tower
 D Solenoid valve relay
 E Pump motor relay
 F Hydraulic modulator connector
 G Solenoid valve, left front
 H Solenoid valve, right front
 I Solenoid valve, rear
 J Connector at LH suspension strut tower
 K Connector at LH suspension strut tower
 L Connector at LH A-post

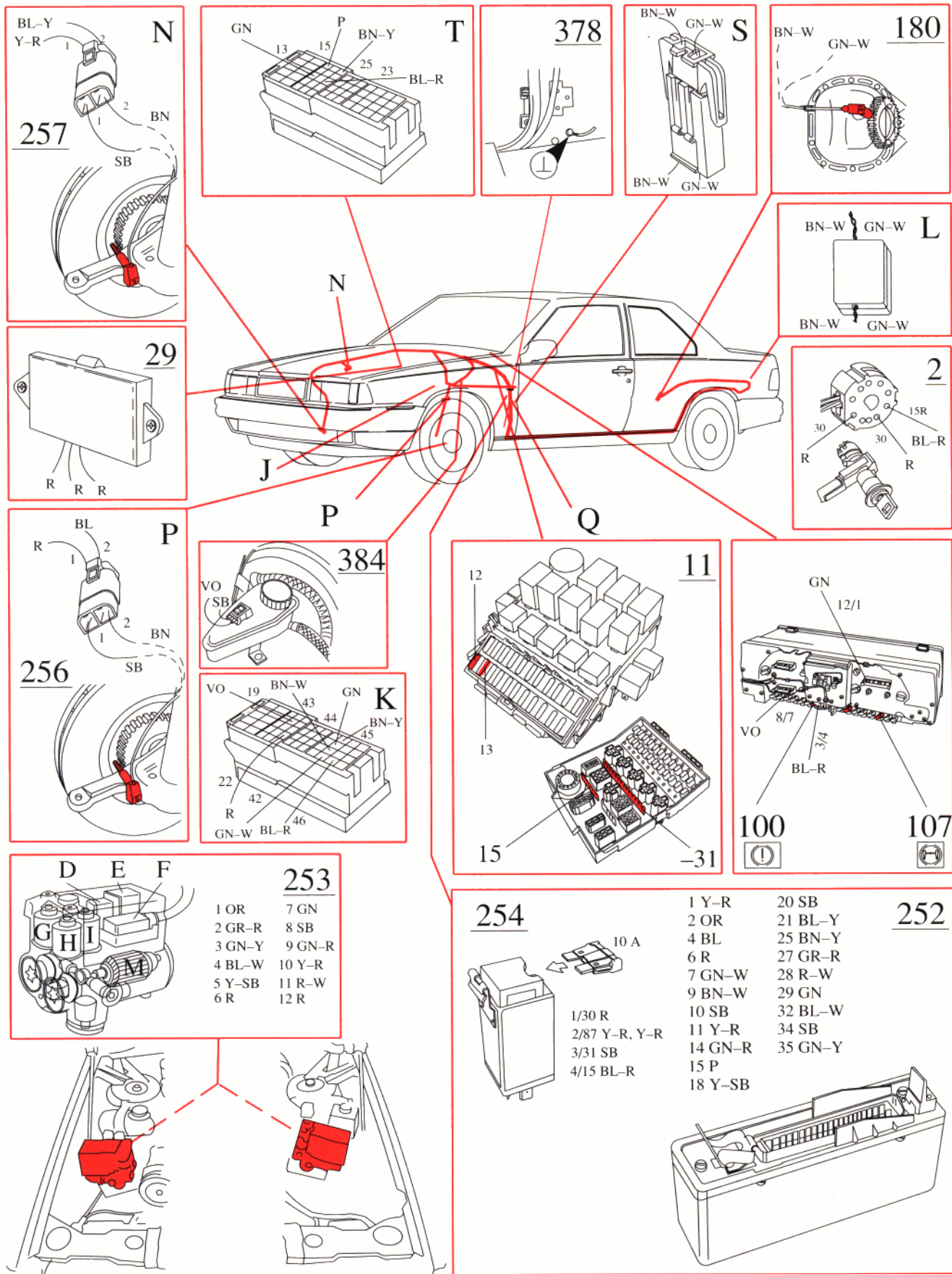
Wiring diagram code:

- = neutral
 — = ground terminal
 — = system voltage
 — = voltage below system voltage
 — = screened lead

Engine running, car in motion







Wiring diagram, ABS braking system

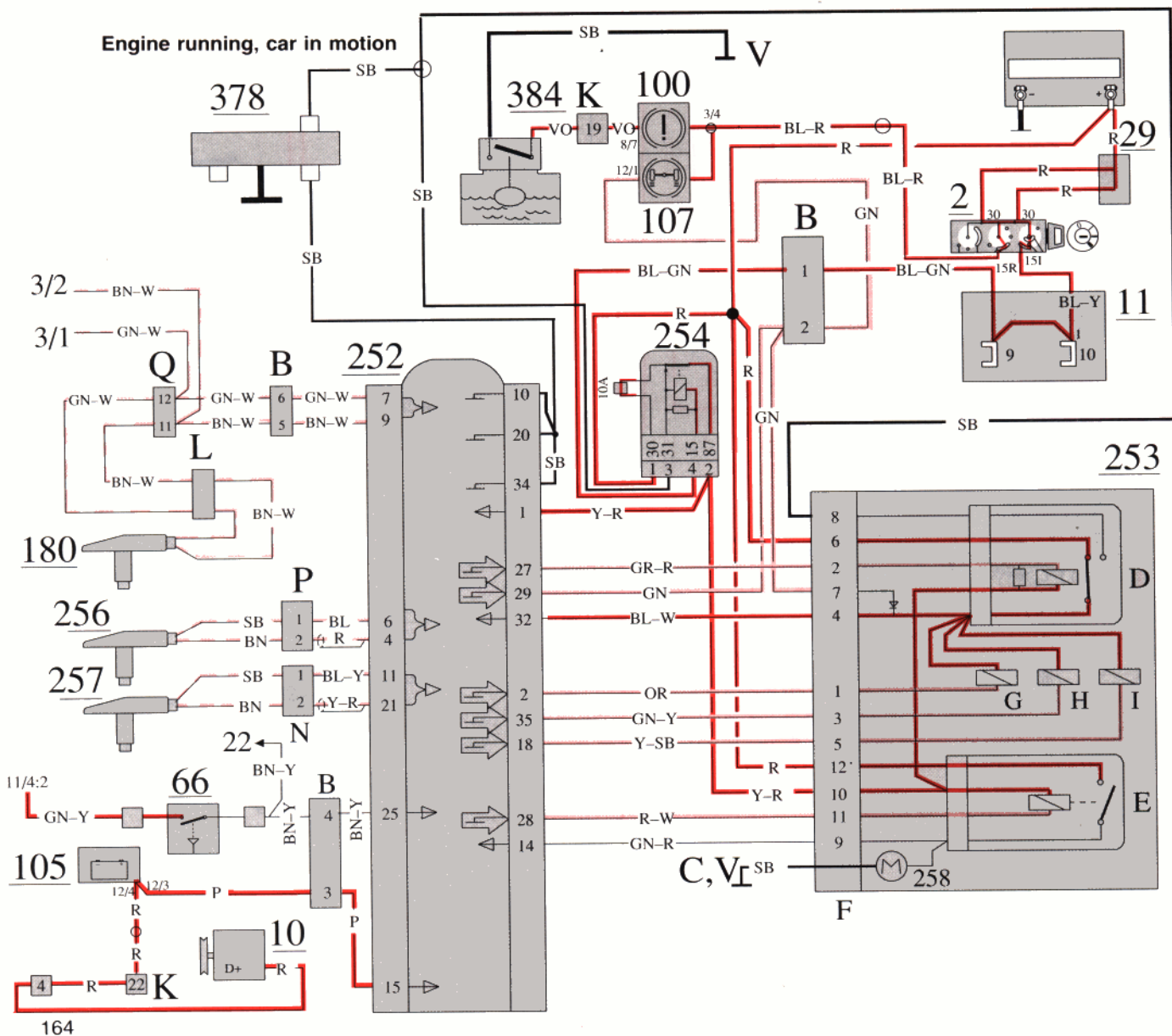
740, 1990

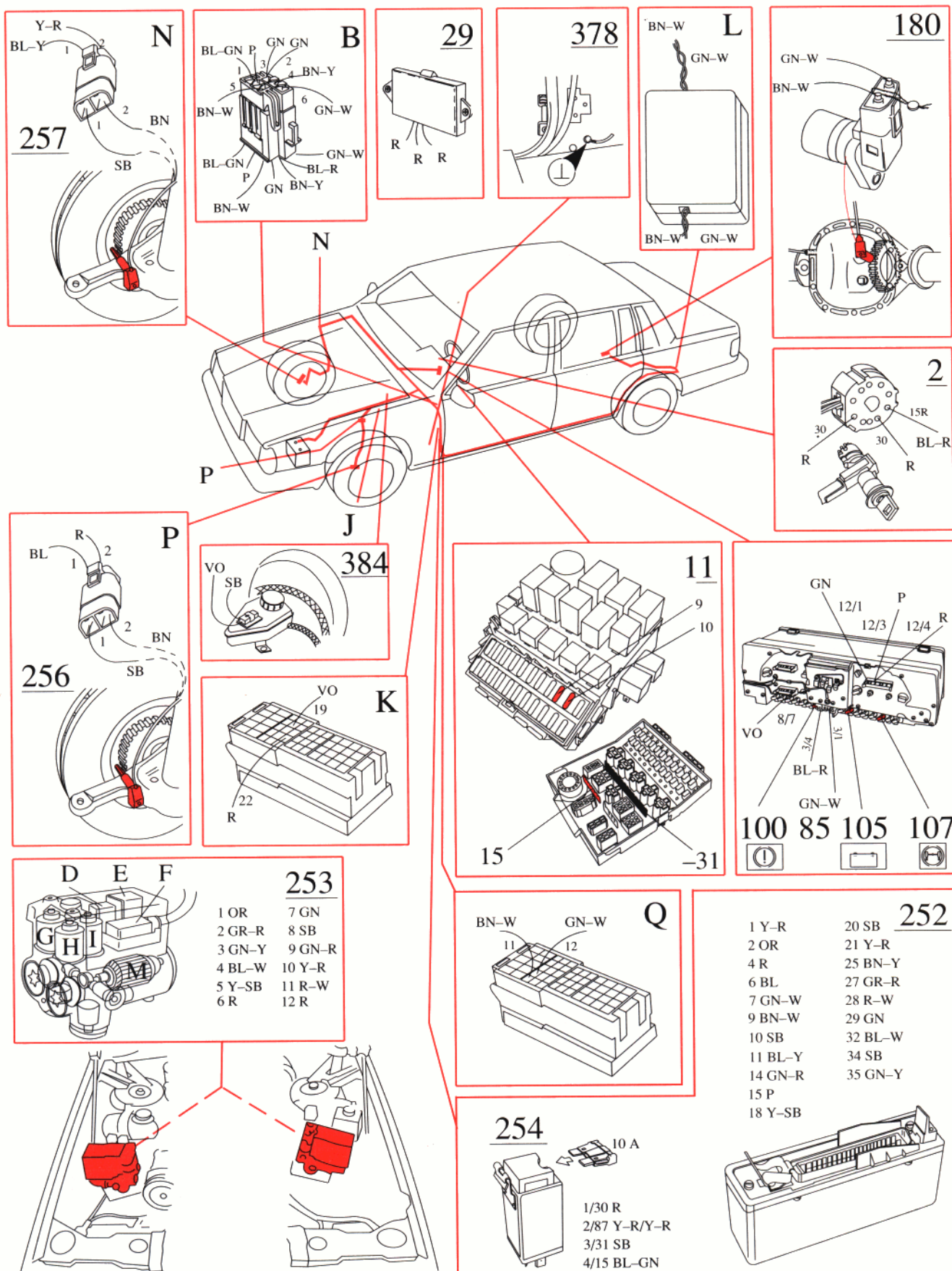
- 2 Ignition switch
- 3 4-pin connector on combined instrument
- 10 Alternator and voltage regulator
- 11 Fusebox
- 22 Brake light
- 29 Positive terminal board
- 66 Brake light switch
- 85 Speedometer
- 100 Brake system warning lamp
- 105 Ignition lamp
- 107 ABS warning lamp
- 180 ABS and speedometer sensor
- 252 ABS control module
- 253 ABS hydraulic modulator
- 254 ABS transient surge protector
- 256 ABS sensor, left front
- 257 ABS sensor, right front
- 258 Motor in hydraulic modulator
- 378 Ground terminal, A-post
- 384 Brake fluid level switch

- B Ground terminal at LH A-post, 6-pin
- C Ground terminal on hydraulic modulator
- D Solenoid valve relay
- E Pump motor relay
- F Hydraulic modulator connector
- G Solenoid valve, left front
- H Solenoid valve, right front
- I Solenoid valve, rear
- J Connector at LH suspension strut tower
- K Connector at LH A-post
- L Connector in luggage compartment
- M Pump motor
- N Connector at RH suspension strut tower
- P Connector at LH suspension strut tower
- Q Connector at LH A-post
- V Ground terminal, left front wing
- Soldered joint

Wiring diagram code:

- = neutral
- = ground terminal
- = system voltage
- = voltage below system voltage
- = screened lead





Wiring diagram, ABS braking system

760, 1990

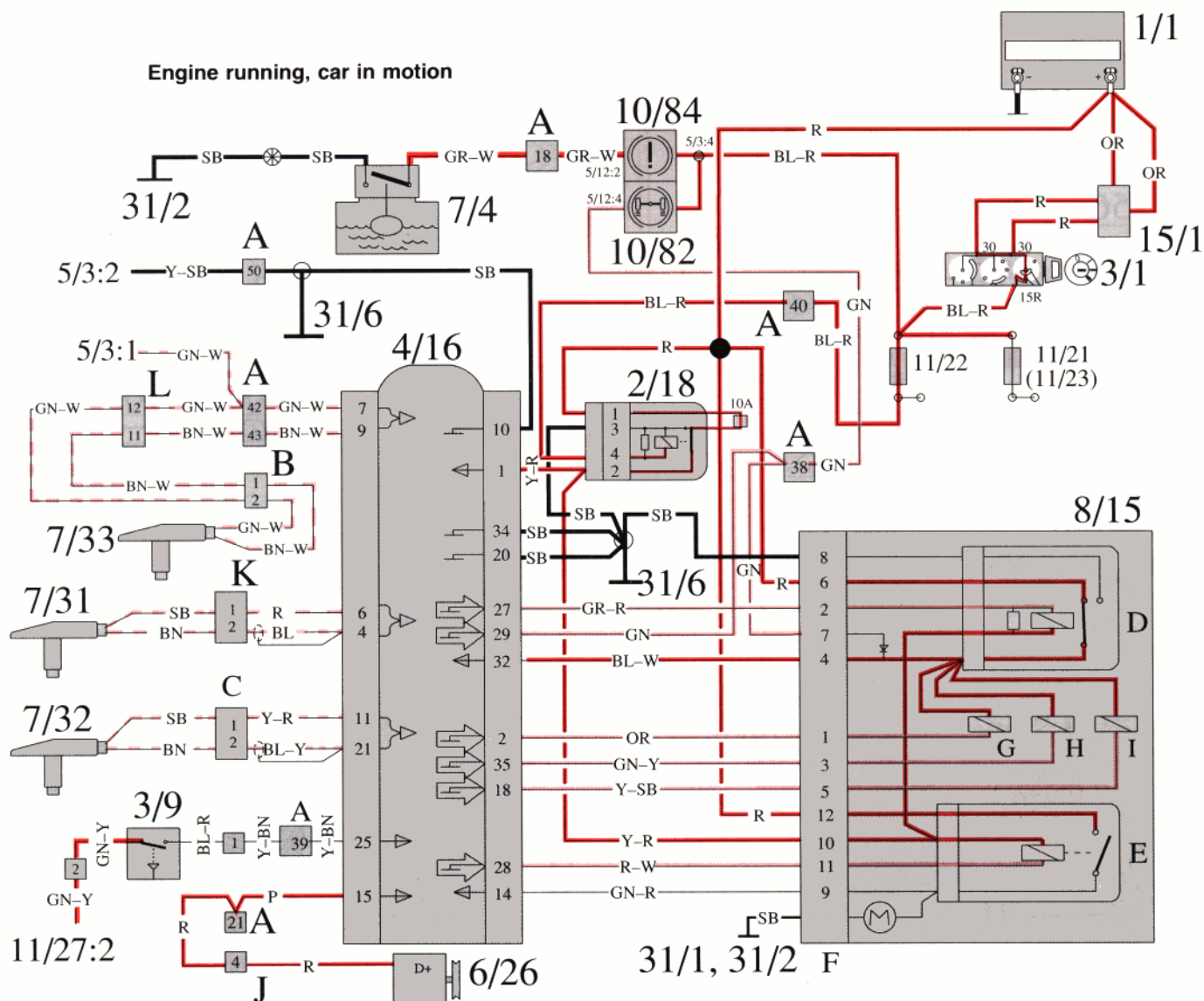
- 1/1 Battery (1)
- 2/18 ABS transient surge protector (254)
- 3/1 Ignition switch (2)
- 3/9 Brake light switch (66)
- 4/16 ABS control module (252)
- 5/ Combined instrument
- 6/26 Alternator (10)
- 7/4 Brake fluid level switch (384)
- 7/31 ABS sensor, left front (256)
- 7/32 ABS sensor, right front (257)
- 7/33 ABS and speedometer sensor (270)
- 8/15 ABS hydraulic modulator (253)
- 10/82 ABS warning lamp (107)
- 10/84 Brake warning lamp (100)
- 11/1-35 Fuses
- 15/1 Positive terminal board (78)
- 31/1 Ground terminal, right front wing
- 31/2 Ground terminal, left front wing
- 31/6 Ground terminal, LH A-post

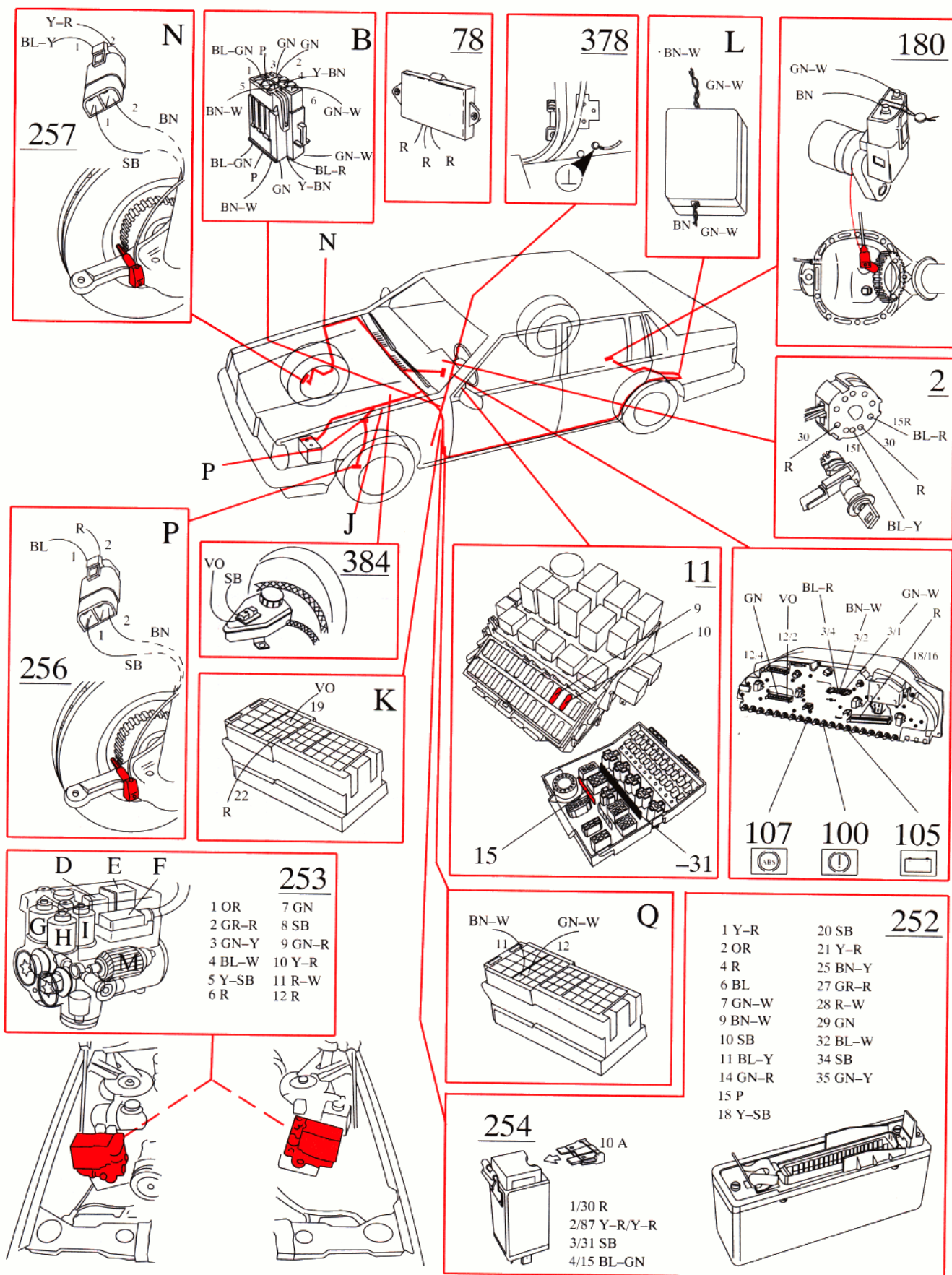
- A Connector at LH A-post
- B Connector in luggage compartment
- C Connector at RH suspension strut tower
- D Solenoid valve relay
- E Pump motor relay
- F Hydraulic modulator connector
- G Solenoid valve, left front
- H Solenoid valve, right front
- I Solenoid valve, rear
- J Connector at LH suspension strut tower
- K Connector at LH suspension strut tower
- L Connector at LH A-post

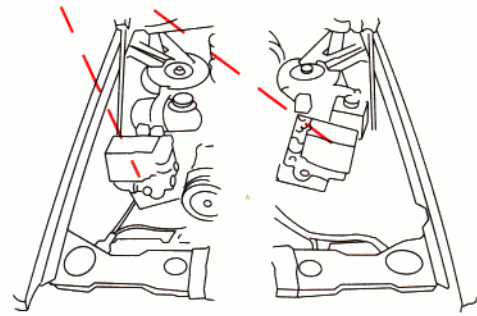
Wiring diagram code:

- = neutral
- = ground terminal
- = system voltage
- = voltage below system voltage
- = screened lead

Engine running, car in motion







Wiring diagram, ABS braking system

960, 1992 (B 230 FT/FT and D 24 TIC)

- 1/1 Battery
- 2/18 ABS transient surge protector
- 3/1 Ignition switch
- 3/9 Brake light switch
- 4/16 ABS control module
- 5/1 Combined instrument
- 6/26 Alternator
- 7/4 Brake fluid level switch
- 7/31 ABS sensor, left front
- 7/32 ABS sensor, right front
- 7/33 ABS and speedometer sensor
- 8/15 ABS hydraulic modulator
- 10/82 ABS warning lamp
- 10/84 Brake warning lamp
- 11/1-35 Fuses
- 15/1 Positive terminal board
- 17/11 Test terminal (self-diagnostics)
- 19/3 Speedometer
- 31/1 Ground terminal, right front wing
- 31/2 Ground terminal, left front wing
- 31/6 Ground terminal, LH A-post

- A Connector at LH A-post
- B Connector at LH A-post
- E Connector at LH suspension strut tower
- Y Connector in footwell
- C/CC Connector at RH suspension strut tower
- C/CD Connector at LH suspension strut tower
- C/CE Connector in luggage compartment

- 1 Solenoid valve relay
- 2 Pump motor relay
- 3 Hydraulic modulator connector

Engine running, car in motion

