A. General

The ABS anti-lock braking system (or electronic braking slip control) is one of the active safety elements of a vehicle which can decisively reduce the risk of becoming involved in an accident.

For this reason, the ABS is expected to meet the following demands:

1. The driving stability of the vehicle should be assured while braking, both when the braking force is slowly increased up to the locking limit and when suddenly increasing the braking force in the event of a panic stop.

2. As long as the vehicle speed is adequately below the critical cornering speed, braking on a bend should be possible without impairing driving stability while maintaining full steerability (the critical cornering speed is the speed at which a vehicle can be driven around a bend without engine power and just fast enough that it will not leave the road under the influence of centrifugal force).

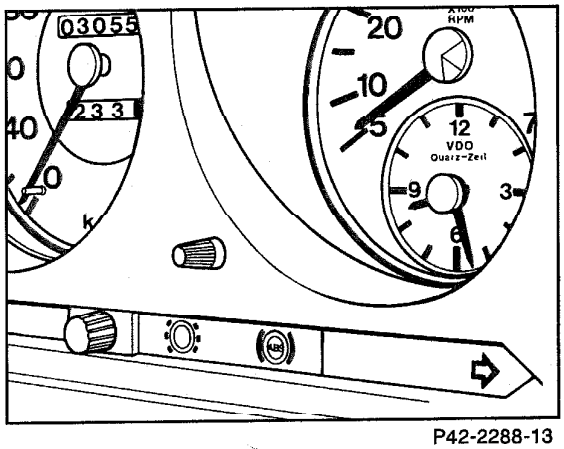
3. When the brake pedal is excessively operated to the extent that an uncontrolled braking system will result in the wheels locking, the ABS will modify the braking pressure in the wheel brakes so that the wheels do not lock and, instead, the adhesion between the wheels and the road is optimally exploited.

Consequently, vehicles with ABS as compared with uncontrolled brake systems provide the following advantages when the brakes are fully applied:

- Higher driving stability
- Better steerability

B. Driving with ABS

When the ignition is switched on, the yellow indicator lamp in the instrument cluster with the symbol ABS will come on and will go out when the engine is running (just like the charge indicator lamp). If the lamp does not go out, undervoltage in the electrical system may be responsible or the current feed to the electronic control module may be interrupted. Upon starting off, at approx. 5 km/h, a self-checkup of ABS (bite) will be effected. If a fault is discovered, the indicator lamp will again come on.



P42-2288-13

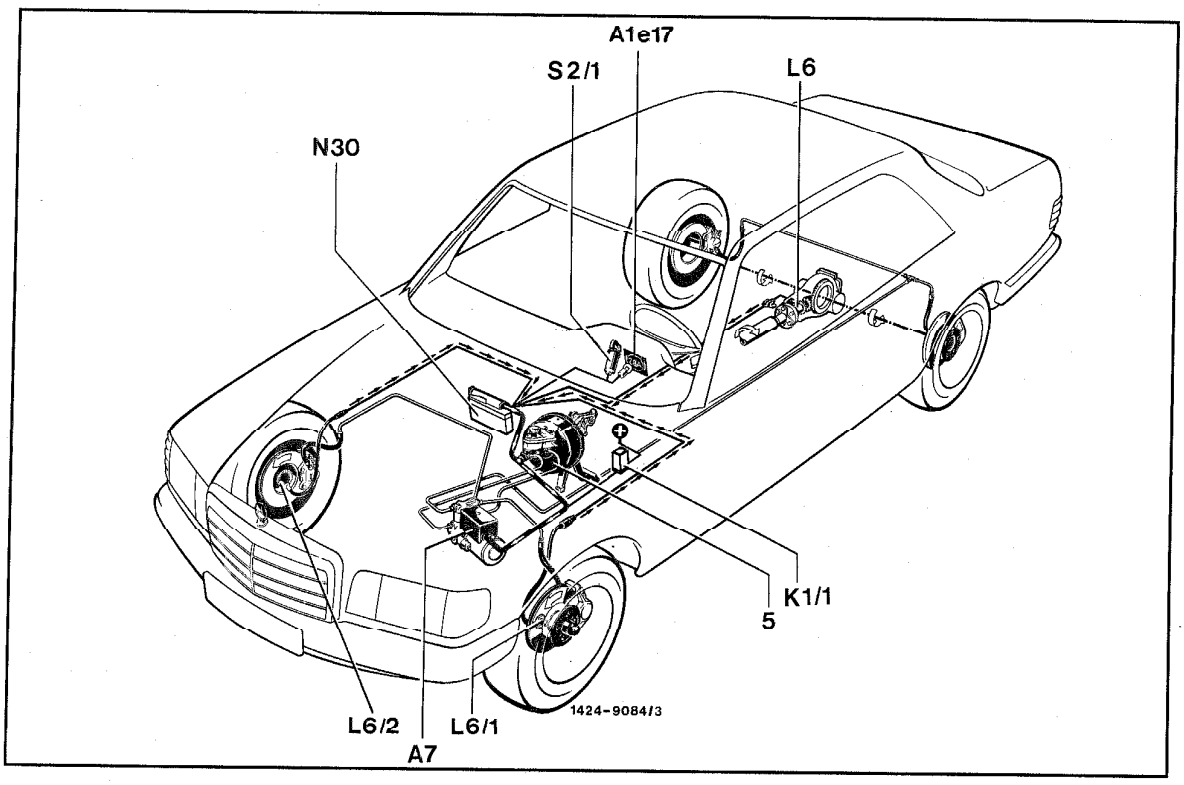
In the event of a permanent fault, e.g. a broken cable, the fault is stored in the ABS control module until the ignition is switched off. A temporary undervoltage in the electrical system is not stored. This means that if the battery voltage is below 11 volts when the ignition is switched on and the test speed is exceeded, the ABS will remain switched off until the charge from the alternator increases the voltage to above
11 volts. Only then will the indicator lamp go out.

Any braking in the locking range initiated above 8 km/h (above 12 km/h on the 1st version up to 02/84) can be governed down to a speed of 3 km/h (down to 5 km/h on the 1st version up to 02/84). This means that controlled braking will proceed only after the so-called control speed of 8 km/h (12 km/h on 1st version up to 02/84) has been exceeded.

⚠ **WARNING!**
When the indicator lamp in the instrument cluster comes on, the ABS is switched off and the vehicle can only be braked without ABS control.
The conventional brake system remains operational. The vehicle should be checked and repaired in a Mercedes-Benz service station as soon as possible.

Design
The anti-lock braking system comprises the conventional braking system known up to now and the following additional components:

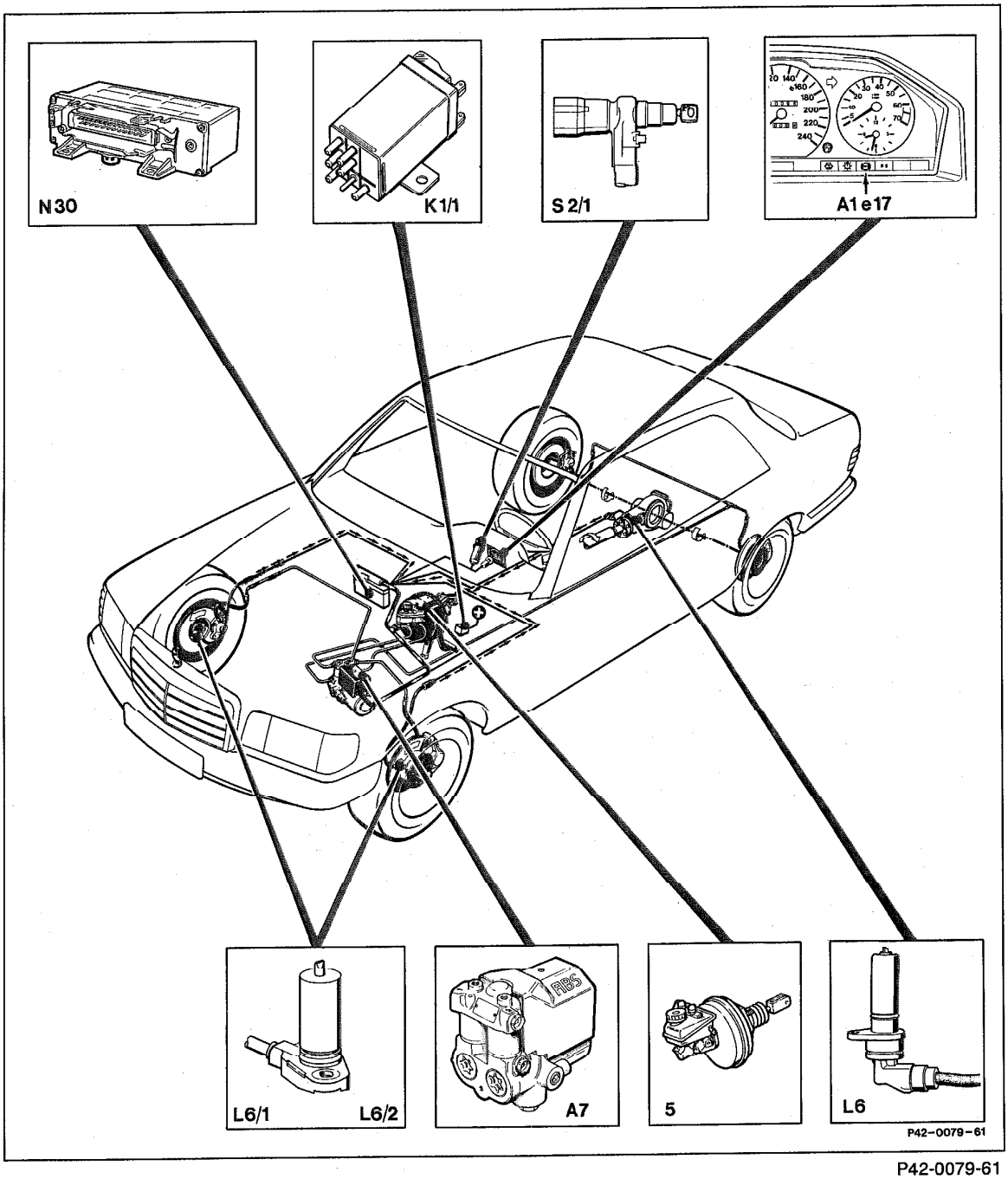
a) Hydraulic unit
b) Vehicle speed signal sensors
c) ABS control module
d) Harness with overvoltage protection relay



1424-9084/3

5	Brake booster with tandem brake master cylinder	L6/1	Left front axle VSS sensor
A1e17	ABS MIL	L6/2	Right front axle VSS sensor
A7	ABS hydraulic unit	N30	ABS control module
K1/1	Overvoltage protection relay module (87E, 7-pole)	S2/1	Ignition/starter switch
L6	Rear axle VSS sensor		

C. Location of components



P42-0079-61

5	Brake booster with tandem brake master cylinder	L6	Rear axle VSS sensor
A1e17	ABS MIL	L6/1	Left front axle VSS sensor
A7	ABS hydraulic unit	L6/2	Right front axle VSS sensor
K1/1	Overvoltage protection relay module (87E, 7-pole)	N30	ABS control module
		S2/1	Ignition/starter switch

D. Overall function

The ABS is operational when the ignition is switched on and a speed of 5-7 km/h has been attained. All braking operations in the locking range are controlled starting at the so-called control speed of 8 km/h (from 12 km/h on 1st version up to 02/84).

The following describes the control cycle on one wheel. The control sequence on the other wheels is the same. The wheel speed measured by the vehicle speed signal sensor provides the wheel deceleration and acceleration signals for the electronic control module. Linking of the individual wheel speeds provides the so-called reference speed, which is the approximate vehicle speed. A comparison of the wheel speed with the reference speed supplies the slip signals.

If, as a result of excessive brake fluid pressure in a brake caliper the wheel shows a tendency toward locking, a condition which is recognized by means of the wheel speed characteristics (wheel slip), the fluid pressure will be held constant, that is an additional pressure increase is not possible.

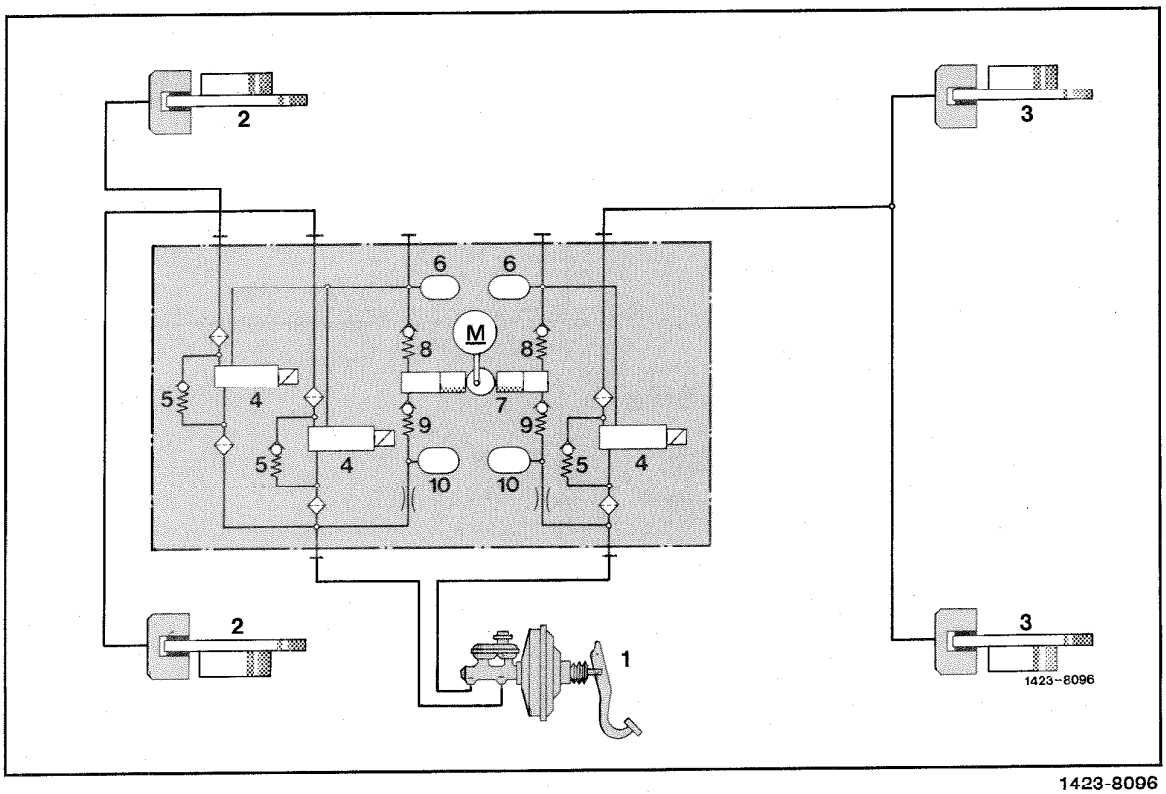
If there is still a tendency toward locking because the constant pressure is still too high, the outlet valve in the solenoid valve is opened to lower the fluid pressure. Simultaneously, the brake fluid still in storage is pumped back into the tandem brake master cylinder by the return pump. If the pressure is so low that the wheel wants to accelerate again, there will be no further pressure reduction and the fluid pressure will again be held constant.

When the acceleration of the wheel again passes a threshold value, the pressure is again increased by opening the input valve in the solenoid valve.

By means of appropriate signals from the ABS control module, the hydraulic unit can actuate the three following control stages of
pressure build-up
pressure holding and
pressure reduction.

The control sequence is continually repeated under controlled braking, until the brake pedal is released or shortly before the vehicle stops.

E. Hydraulics

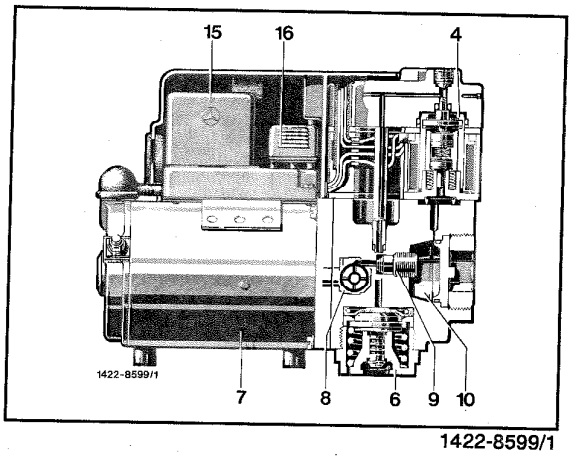


1423-8096

1	Brake booster with tandem brake master cylinder	6	Pump reservoir
2	Front wheel brake	7	Return pump
3	Rear wheel brake	8	Pump input valve
4	Solenoid valve	9	Pump output valve
5	Check valve	10	Noise damper

Irrespective of the pressure in the tandem brake master cylinder, the hydraulic unit can change the fluid pressure for the brake calipers during regulation.

However, a pressure increase as compared with pressure coming from the master cylinder is not possible.



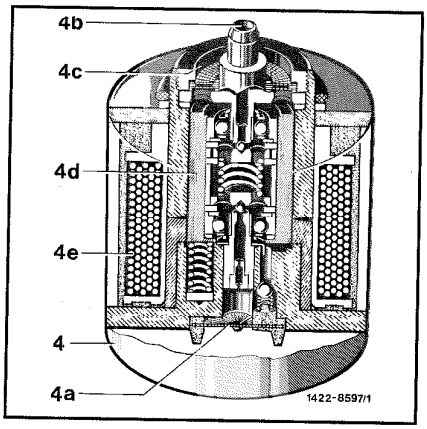
1422-8599/1

4 Solenoid valve
6 Pump slide
7 Return pump
8 Pump input valve
9 Pump output valve
10 Noise damper
15 Return pump relay
16 Solenoid valve relay

The hydraulic unit comprises three fast-switching solenoid valves. Of these valves, one each is allocated to the left-hand and right-hand front wheel brake and the third with the rear wheel brake.

By activating the valves with varying voltages, the brake fluid pressure of the individual brake calipers can be

increased = pressure build-up stage (no current)
held = pressure holding stage (half max. current)
or reduced = pressure reduction stage (max. current).

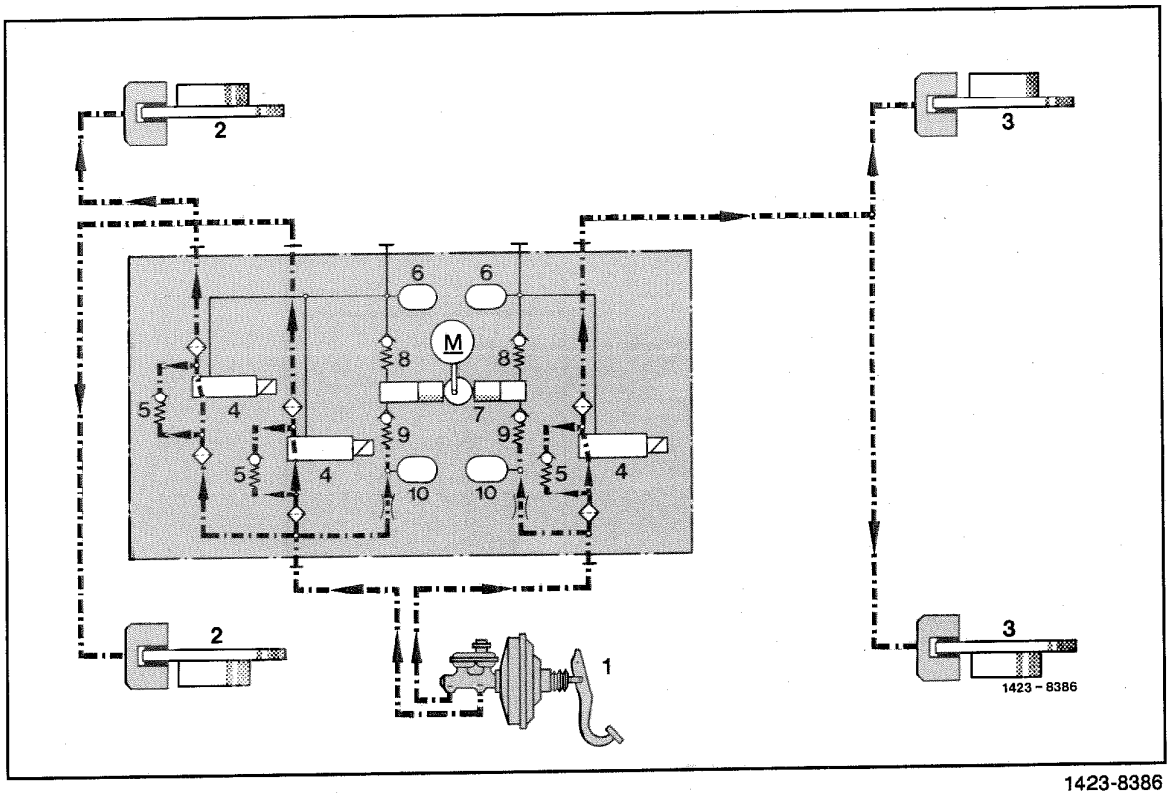


1422-8597/1

4 Solenoid valve
4a Connection - brake line from brake master cylinder
4b Output - return pump
4c Connection - brake line to wheel brake
4d Armature
4e Coil

Pressure build-up stage

In the pressure build-up stage the pressure can be increased via the open input valve in the solenoid valve up to the pressure activated by the tandem brake master cylinder.

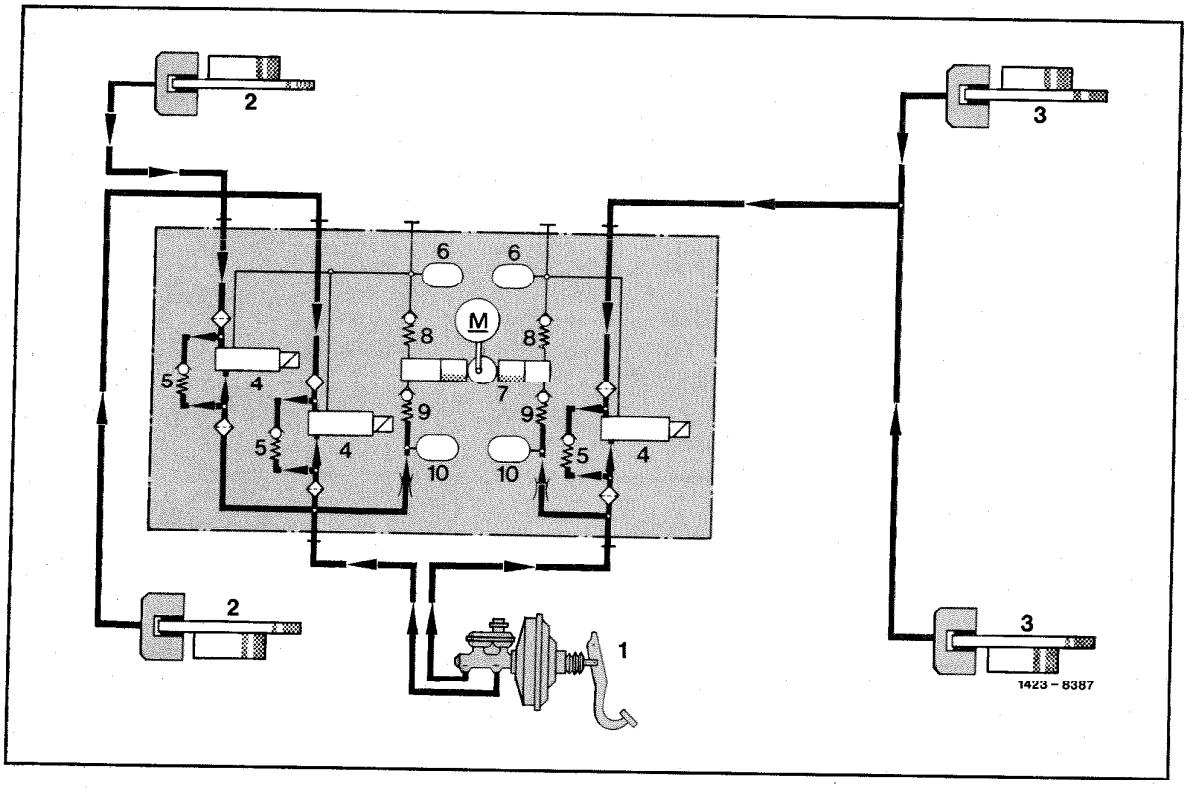


1423-8386

1	Brake booster with tandem brake master cylinder	6	Pump reservoir
2	Front wheel brake	7	Return pump
3	Rear wheel brake	8	Pump input valve
4	Solenoid valve	9	Pump output valve
5	Check valve	10	Noise damper

Pressure holding stage

In the pressure holding stage which precedes each pressure reduction stage, the fluid pressure from the hydraulic unit to the wheel brakes is held constant because the output and input in the solenoid valve are closed.

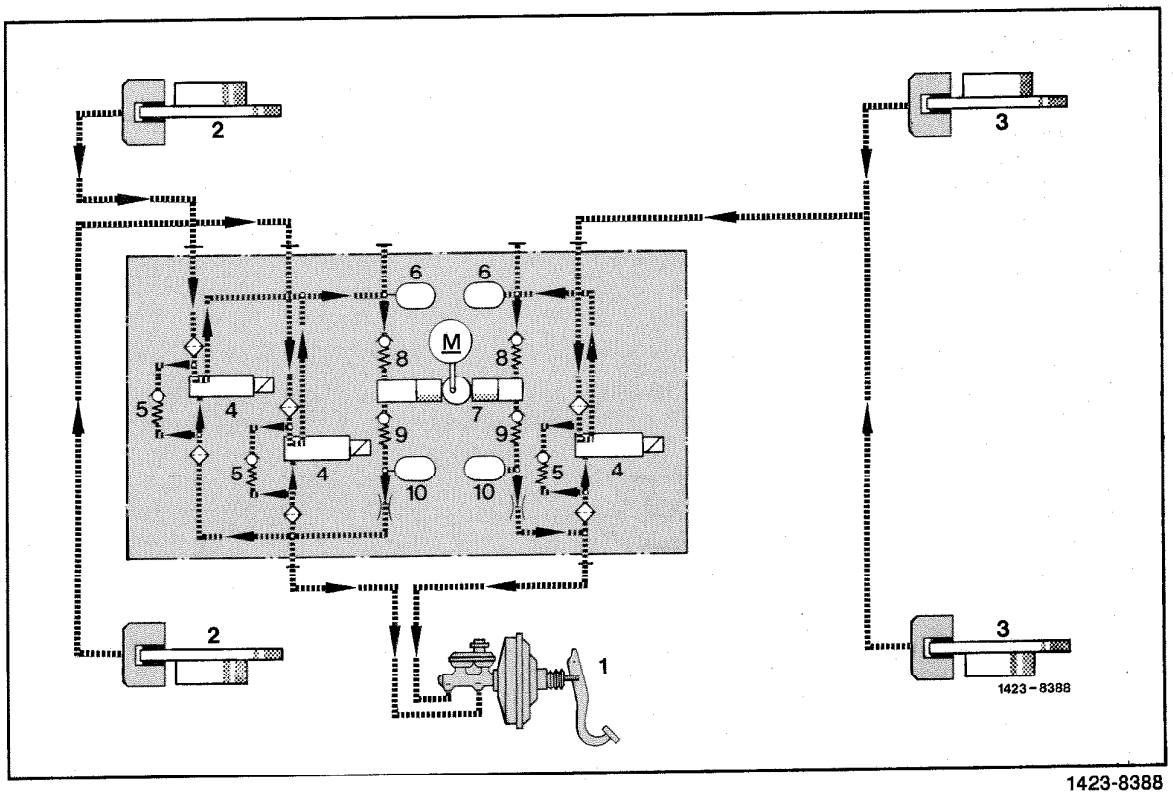


1423-8387

1	Brake booster with tandem brake master cylinder	6	Pump reservoir
2	Front wheel brake	7	Return pump
3	Rear wheel brake	8	Pump input valve
4	Solenoid valve	9	Pump output valve
5	Check valve	10	Noise damper

Pressure reduction stage

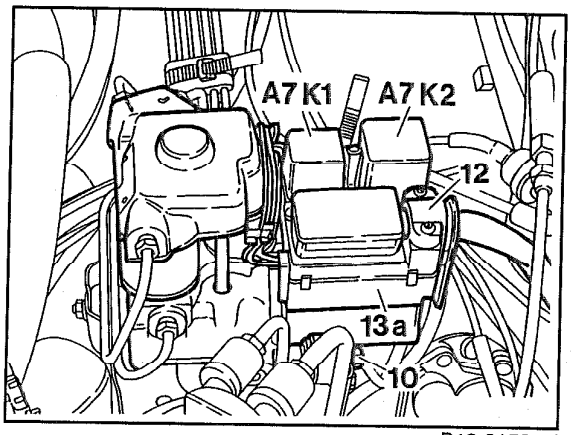
During the pressure reduction stage the brake fluid flows via a reservoir (6) into return pump (7). To maintain the fluid volume of the master cylinder, the return pump returns the brake fluid into the master cylinder against the prevailing pressure. To dampen the delivery noise, each circuit is provided with a noise damper (10).



1423-8388

1	Brake booster with tandem brake master cylinder	6	Pump reservoir
2	Front wheel brake	7	Return pump
3	Rear wheel brake	8	Pump input valve
4	Solenoid valve	9	Pump output valve
5	Check valve	10	Noise damper

On plug socket (13a) of the hydraulic unit there is a relay (A7K1) for solenoid valves and relay (A7K2) for the return pump. The hydraulic unit is connected to the vehicle ground at the hexagon nut (10) via a grounding strap.



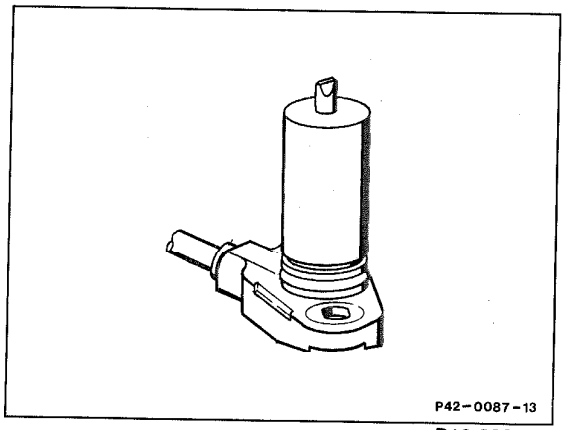
P42-2150-13

10	Hexagon nut
12	Harness stress relief
13a	Plug socket
A7K1	Solenoid valve relay
A7K2	Return pump relay

F. Electronics

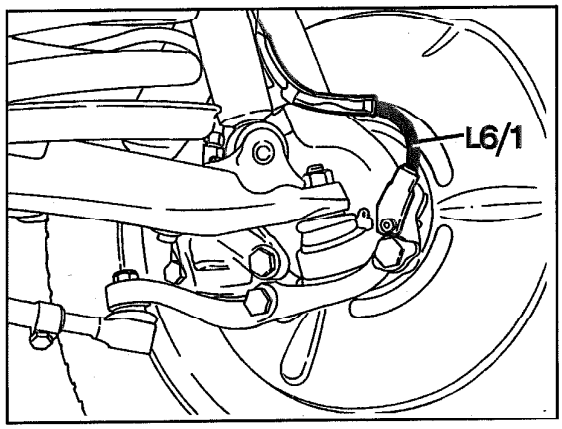
Vehicle speed signal sensors

Rod-shaped vehicle speed signal sensors or impulse sensors are used for measuring wheel speeds. In the three-channel system with three vehicle speed signal sensors installed in our vehicles (excluding vehicles with ASR), the wheel speed of each front wheel is measured separately.



P42-0087-13

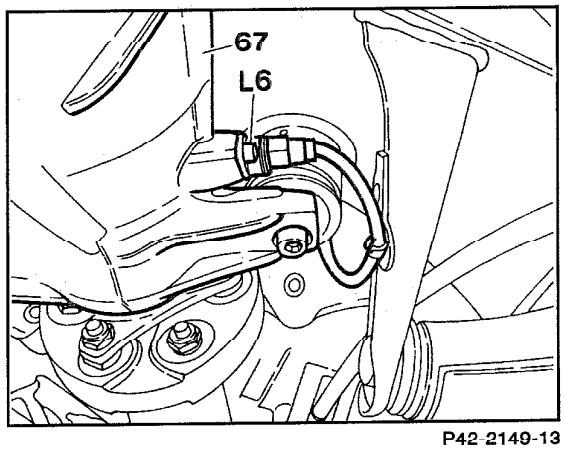
The vehicle speed signal sensors (L6/1 or L6/2) for the front axle are installed in the steering knuckles.



P42-2119-13

L6/1 Left front axle VSS sensor

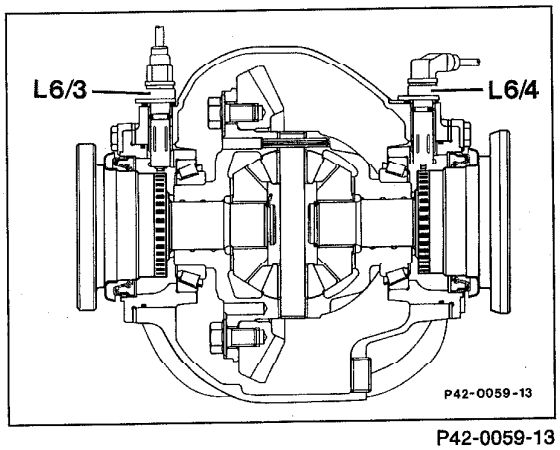
The vehicle speed signal sensor (L6) is located on the rear axle casing (67). The drive pinion serves to measure the mean speed of both rear wheels.



P42-2149-13

Note

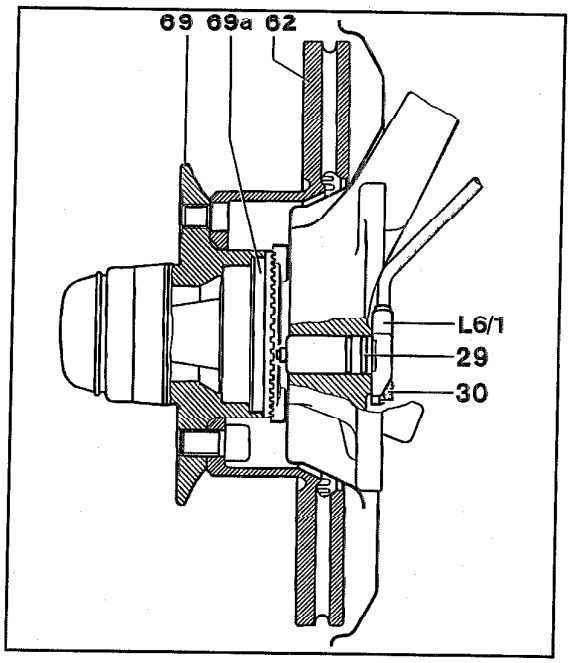
The four-channel system is used on vehicles with ASR I. In this system, the wheel speed of each rear wheel is measured separately. The vehicle speed signal sensors (L6/3 and L6/4) are located in the rear axle casing above the rear axle shaft flange.



P42-0059-13

The vehicle speed signal sensors sense wheel speeds by way of the rotor teeth. On the front axle, the rotor teeth (69a) are machined into the front wheel hub (69).

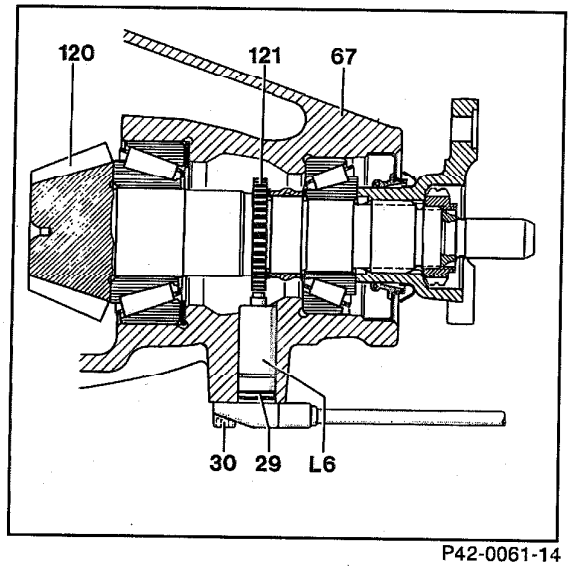
The vehicle speed signal sensors (L6/1, L6/2) on the front axle have a diameter of 18 mm.



P33-0053-15

L6/1	Left front axle VSS sensor
29	O-ring
30	Hexagon socket screw
62	Brake disc
69	Front wheel hub
69a	Teeth (rotor)

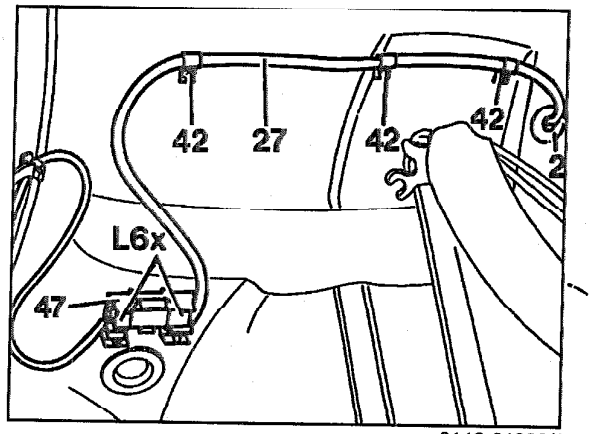
On the rear axle, the rotor is a toothed wheel (121) and pressed onto the differential pinion (120). For each rear axle ratio there is a corresponding gear wheel with a different number of teeth. Refer to "42-714 Removal and installation of vehicle speed signal sensor on rear axle" for assignment of rotor to rear axle. The vehicle speed signal sensor for the rear axle has a diameter of 15 mm.



P42-0061-14

L6	Vehicle speed signal sensor
29	O-ring - vehicle speed signal sensor
30	Hexagon socket screw
67	Rear axle casing
120	Differential pinion
121	Toothed wheel (rotor)

The vehicle speed signal sensor on the rear axle is connected to the cable harness under the rear seat via the plug connection (L6x).



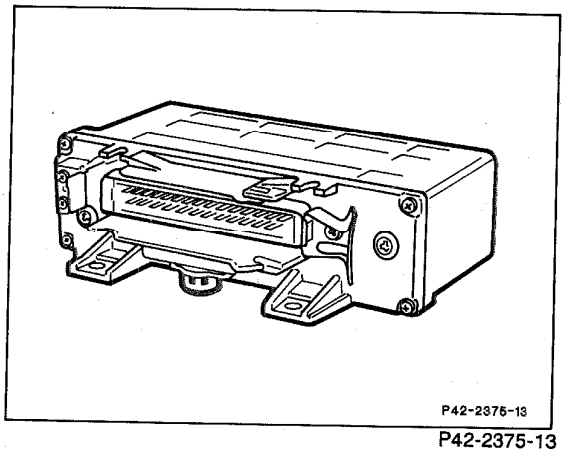
0142-24339/2

Location - rear axle

L6x	Plug connection
27	Cable - vehicle speed signal sensor
42	Clip

ABS control module

The ABS control module is designed as a circuit board version. The circuit boards are provided with printed circuits on both sides and fitted on one side with components such as resistors, diodes, transistors and so-called large-scale integrated circuits. The circuit boards are inside the control module enclosed in a light alloy housing or in a plastic housing phased in as of 04/86. The control modules with aluminum and plastic housings are interchangeable.
Different control modules are installed on vehicles with ASR, 4MATIC and ASD.



P42-2375-13

The control module processes the signals from the vehicle speed signal sensors and controls the valves in the hydraulic unit.

The entire signal conditioning and signal processing is digital.

The control module is connected to the ABS main cable harness via a 35-pin plug connection.

The electronic control module is functionally divided into:

- the signal conditioning section
- the logic section and
- the safety circuit.

Signal conditioning section

In the signal conditioning section the signals supplied by the vehicle speed signal sensors are converted into a form suitable for use by the logic section.

To prevent problems while measuring the wheel speed, which may be caused by production tolerances and by movements in the steering knuckle, the input signals are filtered prior to use. Deceleration and acceleration signals obtained from the wheel speed signals are processed in the logic section.

Logic section

The logic section of the ABS control module employs the following input signals for each controlled wheel or the controlled rear wheels:
wheel slip
wheel speed acceleration
wheel deceleration

Output signals from the logic section control the solenoid valves of the hydraulic unit. As a result, the following hydraulic functions can be generated in the brake calipers of the wheel brakes:

pressure holding
pressure reduction
pressure build-up

Safety circuit

The safety circuit has the job of recognizing faulty signals in the ABS control module and faults outside the ABS control module in the electrical installation. In addition, the safety circuit intervenes in the control sequence during extreme driving conditions such as aquaplaning. When a fault is recognized, the system should be switched off, a condition which is indicated to the driver by the indicator lamp coming on.

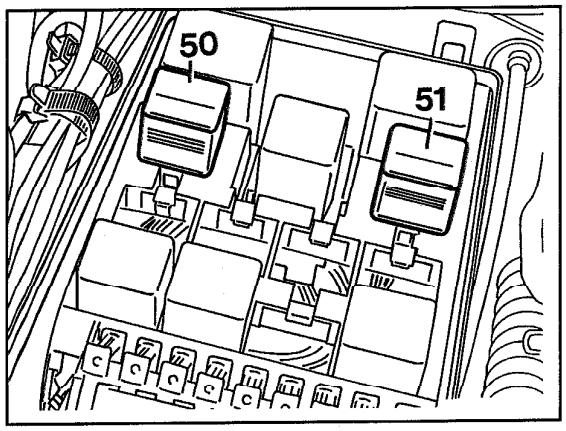
The safety circuit continuously monitors the battery voltage. If the voltage is below specific requirements (11 V), the system is also switched off until the voltage returns to the specified range.

In addition to this monitoring function, the safety circuit also includes an active section, the test cycle or bite (built-in test equipment).

The test cycle begins as soon as the wheel speed in all three speed channels is higher than 5-7 km/h. The cycle is activated by the vehicle speed signal sensor voltage, which is monitored automatically at the same time. The test cycle itself checks parts of the monitoring circuit as well as the logic section. For this purpose, the electronic control module is fed with the specific test sample signals to check whether the correct output signals are available.

Relay with overvoltage protection

To guarantee the function of the ABS system under all operating conditions, the power supply is switched via a relay, which is actuated by terminal 15 (ignition lock).

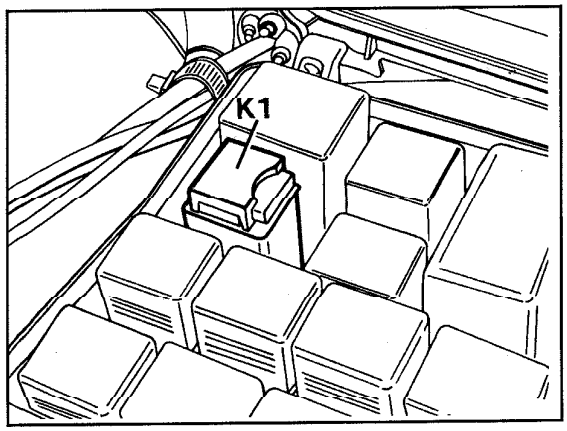


P42-2132-13

1st version up to 08/81
Separate relay for power supply and overvoltage protection

The overvoltage protection, which protects the electronic control modules against overvoltages is connected in series between the battery and the relay (ABS, CIS-E, ASD or ASR).

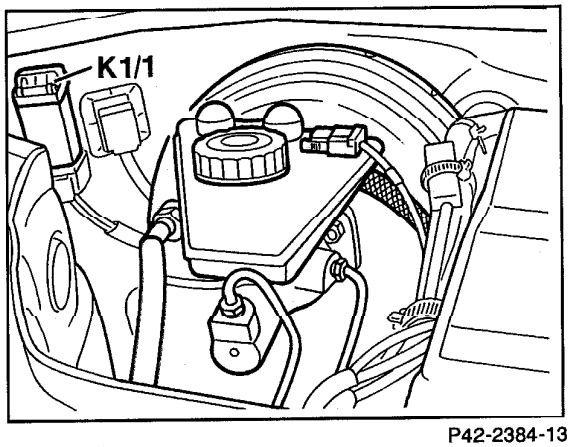
The relay and the overvoltage protection form one unit. The overvoltage protection has a replaceable fuse.



P42-2134-13

2nd version as of 08/81
Relay and overvoltage protection in one unit

5-pin relay with additional pin 87 for the CIS-E injection system.

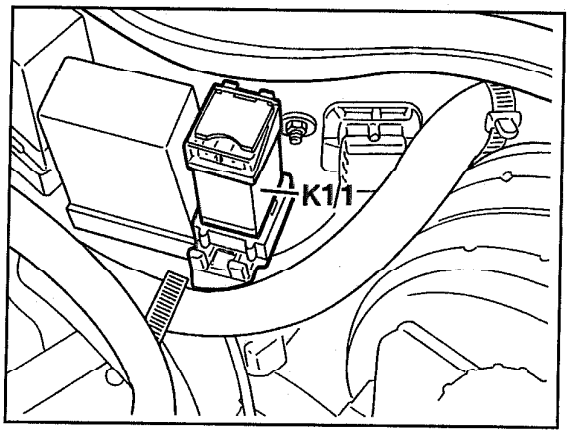


P42-2384-13

K1/1 = 3rd version as of 09/85

On vehicles as of from 05/87, depending on the vehicle model and special equipment, a 5-, 7- or 9-pin overvoltage protection relay can be installed.

5-pin K1
7-pin K1/1
9-pin K1/2



P42-2102-13

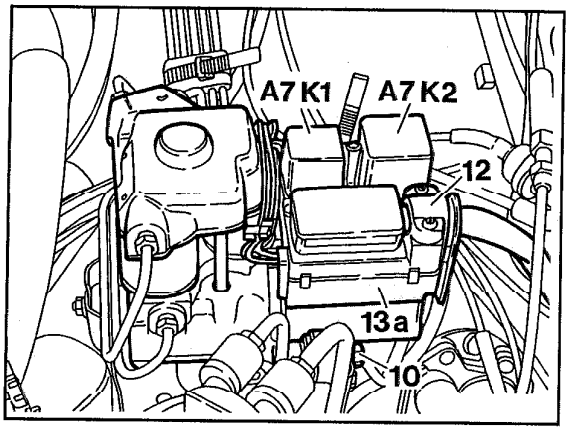
4th version as of 05/87
K1/1 or K1/2, 7- or 9-pin overvoltage protection

ABS (A7) hydraulic unit

Two relays are located under the cover of the hydraulic unit. Relay (A7K2) activates the return pump and current flows to the solenoid valves via relay (A7K1).

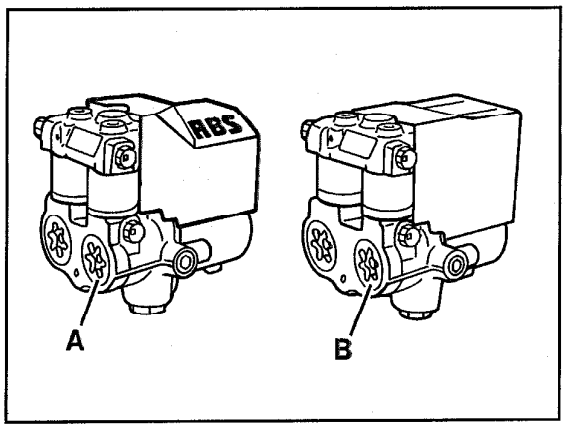
The plug socket (13a) has a soldered-in diode by means of which, with the multiple plug on the electronic control module pulled out, the indicator lamp in the instrument cluster is activated.

Phased in as of the beginning of 1986, the diode is no longer located in the plug socket but in the solenoid valve relay. The new relay has six contact pins (previously five).



P42-2150-13

In conjunction with the appropriate relay and fixing clamps the modified hydraulic unit can also be installed in vehicles produced earlier. It can be recognized on the outside by the inclined cover with the letters ABS (item A).



P42-2097-13

Electric wiring diagrams

For electric wiring diagrams, locations of the cable and plug connections as well as the location of the relays and the control module, refer to "Electric wiring diagrams" volumes 1 and 2.