

Operation

The Anti-lock Brake System (ABS) is controlled and monitored electrically.

Only the electrical operation of the system is described in this manual, whereas the mechanical and hydraulic components are discussed in the Service Manual, Group 5:2 Anti-lock braking system (ABS).

A sensor at each wheel of the car supplies the control unit with information on the speed of rotation of the corresponding wheel. If any of the wheels should tend to lock, the control unit will adjust the braking effort, i.e. the hydraulic fluid pressure in the brake lines, by means of electric control valves. The braking effort on the front wheels can be controlled individually, whereas that on the rear wheels is controlled jointly.

The brake unit, which is connected to the brake pedal, does not employ the vacuum in the engine intake manifold for the servo action. The car is equipped instead with an electrically driven hydraulic pump which provides the servo action. The hydraulic fluid pressure is maintained at the required value by means of a pressure switch which controls the hydraulic pump motor.

Two warning lamps on the fascia are connected to the brake system: the ABS warning lamp (ANTI LOCK) and the usual brake warning lamp which is also incorporated into brake systems without ABS.

On cars for the US, CA and AU markets, the lamp is marked with the text BRAKE FLUID instead of the symbol.

The components of the ABS system are supplied across the fuses on relay and fuse board 302.

Control unit 291 is protected by the 10A fuse, and main relay 292 and pump relay 293 are protected by the two 30A fuses.

In addition, warning lamps 47Q and 47F are supplied (+15) when the ignition switch is in the drive or start position.

Power supply

When the ignition switch is turned to the drive position, pin 2 of the control unit will be energised (+54). The supply from pin 8 of the control unit then energises main relay 292. The unit is thus supplied (+30) so that it can operate the control valves of the hydraulic unit.

Operation of warning lamps when the car is started

The warning lamps for the brake system light up every time the engine is started. This allows the driver to check that the bulb filaments are intact. (How the warning lamps light up to indicate defects is covered in the section entitled "Monitoring functions".)

When the ignition switch is turned to the start position, the +54 supply to main relay 292 will be interrupted, the relay will be de-energised, and ABS

warning lamp 47Q will therefore be earthed at earthing point 65/93 via diode 303A and the relay contacts. Since the relay is always de-energised for at least 2 seconds when the engine is started, the lamp will light up during this time. (However, the lamp may remain alight for up to 60 seconds, until the correct hydraulic pressure has been reached.)

When the ignition switch is turned to the drive position, brake warning lamp 47F will also light up for 1–2 seconds, since it will be earthed by a timer circuit in the combined instrument.

Hydraulic pressure

The pressure in the hydraulic unit accumulator is maintained at the correct value by a hydraulic pump, which is driven by motor 297 and is controlled by pressure switch 294.

If the pressure is less than 140 bar when the engine is started, contacts 4-1 will be closed. The coil of pump relay 293 is then earthed and motor 297 is supplied across the relay contacts.

When the hydraulic pump has raised the pressure in the accumulator to 180 bar, the contacts will open and the motor will stop. If the pressure should drop to 140 bar while the car is travelling, the contacts will again close and the pump will start. The pump requires 10–15 seconds to raise the pressure from 140 bar to 180 bar.

Brake light switch

Brake light switch 29 informs the control unit that the brake pedal has been depressed, which enables the control logic to respond more quickly.

Monitoring functions

For particulars of the functions of the lamps during starting, see under the heading "Operation of the warning lamps when the car is started".

Brake warning lamp

Brake warning lamp 47F for the foot brake will light up on the following occasions:

- if the level in the brake fluid reservoir should drop to the MIN mark on the reservoir. The lamp will then be earthed at earthing point 7 across contacts 4-3 in brake fluid level sensor 299.
- if the pressure in the brake unit accumulator should drop below 105 bar. The lamp will then be earthed at earthing point 7 across contacts 2-1 in pressure switch 294. The contacts open at 105 bar and close at 134 bar. (In this situation, the ABS warning lamp will also light up.)

Under normal operating conditions, both pairs of contacts are open.

Cars without ABS are also fitted with the brake warning lamp, but the lamp is then used only to provide a warning that the fluid level in the reservoir is low.

ABS warning lamp

The control unit monitors the performance of the ABS system and, if a fault should occur, will light up ANTI LOCK warning lamp 47Q. When the lamp is alight, the ABS function is inoperative, and the brake system will perform as a conventional brake system.

The following faults will cause pin 27 of control unit 291 to earth the lamp, thus lighting it up:

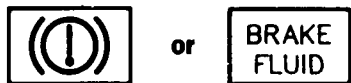
- if the level in the brake fluid reservoir should drop below the MIN marking on the reservoir. Contacts 1-2 of level sensor 299 will then open, thus opening the circuit between pins 9 and 10 of the control unit. Under normal operating conditions, contacts 3-5 of pressure switch 294 are closed. (In this case, the brake warning lamp will also light up.)
- if the pressure in the accumulator of the hydraulic unit should drop below 105 bar. Contacts 3-5 of pressure switch 294 will then open. Contacts 1-2 of level sensor 299 are closed if the level in the brake fluid reservoir is correct. (The brake warning lamp will also light up.)
- if the signal level from one of the wheel sensors 298 is too low.

The following faults will cause pin 8 of the control unit to be de-energised. ABS system relay 292 will then trip and the lamp will be earthed at earthing point 300 across the relay contacts and diode 303A.

- open-circuit in the wiring (or in the connector) to valve block 296, wheel sensors 298 or master valve 295.
- fault in the control unit.

Summary of indications provided by the warning lamps:

Brake fluid warning lamp lights up



Only the brake fluid level warning lamp will light up if the brake fluid level has dropped slightly.

Normal braking and ABS control remain unaffected.

ABS warning lamp lights up



Only the ABS warning lamp will light up if the electronic control unit should detect a fault in the ABS system.

The ordinary brakes operate normally but the ABS system is disconnected.

Brake fluid level warning and ABS warning lamps light up simultaneously



If both lamps are alight, this indicates either that the brake fluid in the reservoir has dropped further or that the hydraulic pressure has dropped to below 105 bar (1523 psi). This means that ABS control is inoperative and only reduced braking effort is available.

Joint activation due to low brake fluid level indicates that brake fluid is leaking out of the brake system. Stop immediately and don't drive the car until repairs have been carried out.

Joint activation due to low hydraulic pressure indicates that the servo action and the brake pressure at the rear wheels are not proportional to the pedal pressure. Finally, when the hydraulic pressure is 0 bar, there will be no servo action and no brake pressure to the rear wheels. The front-wheel brakes will operate normally, although without power assistance.

Locations of components

1	Battery on the right-hand side of the engine compartment	299	ABS brake fluid level sensor in the engine compartment, on the brake fluid reservoir of the hydraulic unit
20	Ignition switch on the centre console between the front seats	302	ABS electrical distribution box in the engine compartment, behind the right-hand wheel housing
21A	Ignition switch relay in the electrical distribution box under the back seat, relay position F	302A	ABS fuse holder in the engine compartment, behind the right-hand wheel housing, in the ABS electrical distribution box
22A	Fuse holder in the electrical distribution box, in the engine compartment, on the left-hand wheel housing	303A	ABS diode
29	Brake light switch at the brake pedal	303B	ABS diode in the engine compartment, behind the right-hand wheel housing, in the ABS electrical distribution box
47F	Brake warning lamp in the combined instrument	397	Diagnostic test socket, ABS
47Q	ABS warning lamp in the combined instrument	(H2-6)	under the back seat, at the ABS electronic unit
75	Distribution block in the engine compartment, on the right-hand side	G1	Earthing point on the radiator cross-member
291	ABS control unit under the right-hand side of the back seat	G5	Earthing point under the back seat
292	ABS system relay in the engine compartment, behind the right-hand wheel housing, in the ABS electrical distribution box	G8	Earthing point on the fascia
293	ABS pump relay in the engine compartment, behind the right-hand wheel housing, in the ABS electrical distribution box	G12	Earthing point for the amplifier, on the left-hand wheel housing
294	ABS pressure switch in the engine compartment, on the hydraulic unit	G16	Earthing point, hydraulic unit in the engine compartment, on the front of the hydraulic unit
295	ABS master valve in the engine compartment, on the hydraulic unit	G25	Earthing point on the gearbox 2-pole connectors
296	ABS valve block in the engine compartment, forward of the left-hand wheel housing	H2-12	under the left-hand side of the back seat
297	ABS hydraulic pump motor in the engine compartment, on the hydraulic unit	H2-22	in the engine compartment, at the hydraulic unit
298A	Wheel sensor, left-hand front on the left-hand steering swivel member	H2-23	in the engine compartment, on the right-hand side of the partition
298B	Wheel sensor, right-hand front on the right-hand steering swivel member	H2-24	under the left-hand side of the back seat
298C	Wheel sensor, left-hand rear on the left-hand rear wheel hub	H2-25	under the right-hand side of the back seat
298D	Wheel sensor, right-hand rear on the right-hand rear wheel hub	H2-27	at the electrical distribution box in the engine compartment, at the left-hand wheel housing
			3-pole connector
		H3-4	at the electrical distribution box in the engine compartment, at the left-hand wheel housing
		H29-1	29-pole white connector
		H29-3	29-pole black connector
		H33-1	33-pole black connector
		H33-3	33-pole blue connector in the electrical distribution box in the engine compartment, on the left-hand wheel housing. The connectors are accessible from the interior

Components

