Antilock braking system (ABS)

In hazardous driving conditions, it is possible for the wheels of a vehicle to lock up under braking. The possible causes include wet or slippery road surfaces, and abrupt reaction on the part of the driver (unexpected hazard). The vehicle can become uncontrollable as a result, and may go into a slip and/or leave the road. The antilock braking system (ABS) detects if one or more wheels are about to lock up under braking and if so makes sure that the brake pressure remains constant or is reduced. By so doing, it prevents the wheels from locking up and the vehicle remains steerable. As a consequence the vehicle can be braked or stopped quickly and safely.

System overview

The ABS braking system is based on the components of the conventional system. Those are
- the brake pedal (Fig. 1, 1),
- the brake booster (2),
- the master cylinder (3),
- the reservoir (4),
- the brake lines (5) and hoses (6), and
- the brakes and wheel-brake cylinders (7).

In addition there are also the following components:
- the wheel-speed sensors (8),
- the hydraulic modulator (9), and
- the ABS control unit (10).

The warning lamp (11) lights up if the ABS is switched off.
**Wheel-speed sensors**
The speed of rotation of the wheels is an important input variable for the ABS control system. Wheel-speed sensors detect the speed of rotation of the wheels and pass the electrical signals to the control unit.

A car may have three or four wheel-speed sensors depending on which version of the ABS system is fitted (ABS system versions). The speed signals are used to calculate the degree of slip between the wheels and the road surface and therefore detect whether any of the wheels is about to lock up.

**Electronic control unit (ECU)**
The ECU processes the information received from the sensors according to defined mathematical procedures (control algorithms). The results of those calculations form the basis for the control signals sent to the hydraulic modulator.

**Hydraulic modulator**
The hydraulic modulator incorporates a series of solenoid valves that can open or close the hydraulic circuits between the master cylinder (Fig. 2, 1) and the brakes (4). In addition, it can connect the brakes to the return pump (6). Solenoid valves with two hydraulic connections and two valve positions are used (2/2 solenoid valves). The inlet valve (7) between the master cylinder and the brake controls pressure application, while the outlet valve (8) between the brake and the return pump controls pressure release. There is one such pair of solenoid valves for each brake.

Under normal conditions, the solenoid valves in the hydraulic modulator are at the “pressure application” setting. That means the inlet valve is open. The hydraulic modulator then forms a straight-through connection between the master cylinder and the brakes. Consequently, the brake pressure generated in the master cylinder when the brakes are applied is transmitted directly to the brakes at each wheel.

As the degree of brake slip increases due to braking on a slippery surface or heavy braking, the risk of the wheels locking up also increases. The solenoid valves are then switched to the “maintain pressure” setting. The connection between the master cylinder and the brakes is shut off (inlet valve is closed) so that any increase of pressure in the master cylinder does not lead to a pressure increase at the brakes.

If the degree of slip of any of the wheels increases further despite this action, the pressure in the brake(s) concerned must be reduced. To achieve this, the solenoid valves are switched to the “pressure release” setting. The inlet valve is still closed, and in addition, the outlet valve opens to allow the return pump integrated in the hydraulic modulator to draw brake fluid from the brake(s) concerned in a controlled manner. The pressure in the relevant brake(s) is thus reduced so that wheel lock-up does not occur.