Anti-lock Braking System

Anti-lock Braking System (ABS)

Prepared by:

- Eng.Haitham Shehata Hussein

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Anti-lock Braking System

What is (ABS)?

Anti-lock braking system (ABS) is an automobile safety system prevent the wheels of a vehicle locking as brake pedal pressure is applied - often suddenly in an emergency or short stopping distance. This enables the driver to have steering control, preventing skidding and loss of traction.

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History of ABS

- **1929 :-** ABS was first developed for aircraft by the French automobile and aircraft pioneer Gabriel Voisin, as threshold braking on airplanes is nearly impossible.
- **1936:** German company Bosch is awarded a patent an "Apparatus for preventing lock-braking of wheels in a motor vehicle".
- **1936-:** Bosch and Mercedes-Benz partner - R&D into ABS.
- **1972:** WABCO partners with Mercedes-Benz developing first ABS for trucks.
- **1978:** First production-line installation of ABS into Mercedes and BMW vehicles.
- **1981:** 100,000 Bosch ABS installed.
- **1985:** First ABS installed on US vehicles.

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History of ABS

- **1986:** 1M Bosch ABS installed.
- **1987:** Traction control - in conjunction with ABS – used on passenger vehicles.
- **1989:** ABS hydraulic unit combined with standard hydraulic brake unit
- **1992:** 10M Bosch ABS installed.
- **1995:** Electronic Stability - in conjunction with ABS and TCS - for passenger cars.
- **1999:** 50M Bosch ABS installed.
- **2000:** 6 of 10 new cars on the road are ABS equipped.
- **2003:** 100M Bosch ABS installed.
- **Nowadays:-** Almost all new cars have ABS.

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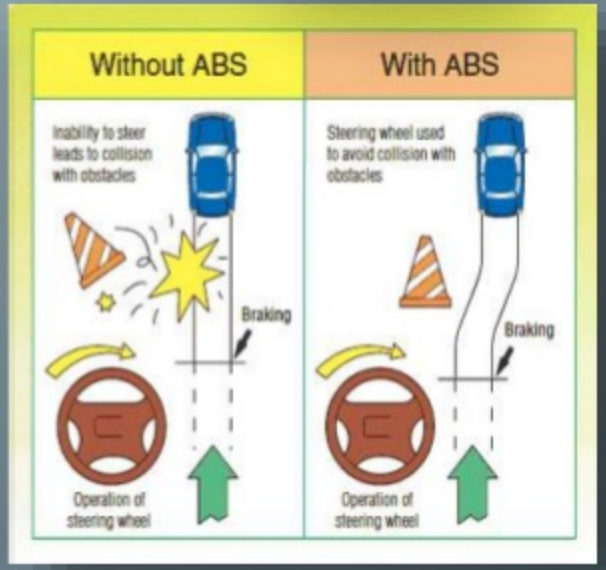
Motivation for ABS Development

- **Under hard braking, an *ideal* braking system should:**

➢ Provide the shortest stopping distances on all surfaces

➢ Maintain vehicle stability and steer ability.



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Overview

Many different control methods for ABS systems have been developed. These methods differ in their theoretical basis and performance under the changes of road conditions.

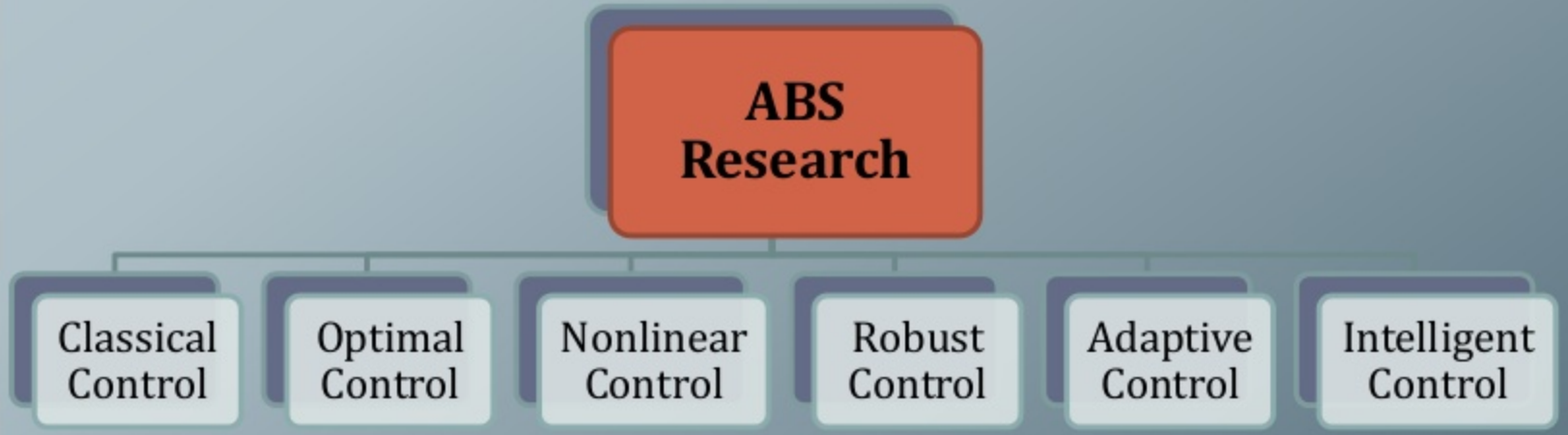

Figure 1. Sampling of ABS control

Principles for ABS Operation

When the brake pedal is depressed during driving, the wheel speed decreases and the vehicle speed does as well. The decrease in the vehicle speed, however, is not always proportional to the decrease in the wheel speed. The non-correspondence between the wheel speed and vehicle speed is called “slip” and the magnitude of the slip is expressed by the “slip ratio” which is defined as follows:

Slip ratio = (Vehicle speed – Wheel speed)/Vehicle speed × 100%

When the slip ratio is 0%, the vehicle speed corresponds exactly to the wheel speed. When it is 100%, the wheels are completely locking (rotating at a zero speed) while the vehicle is moving.

See Fig 2.

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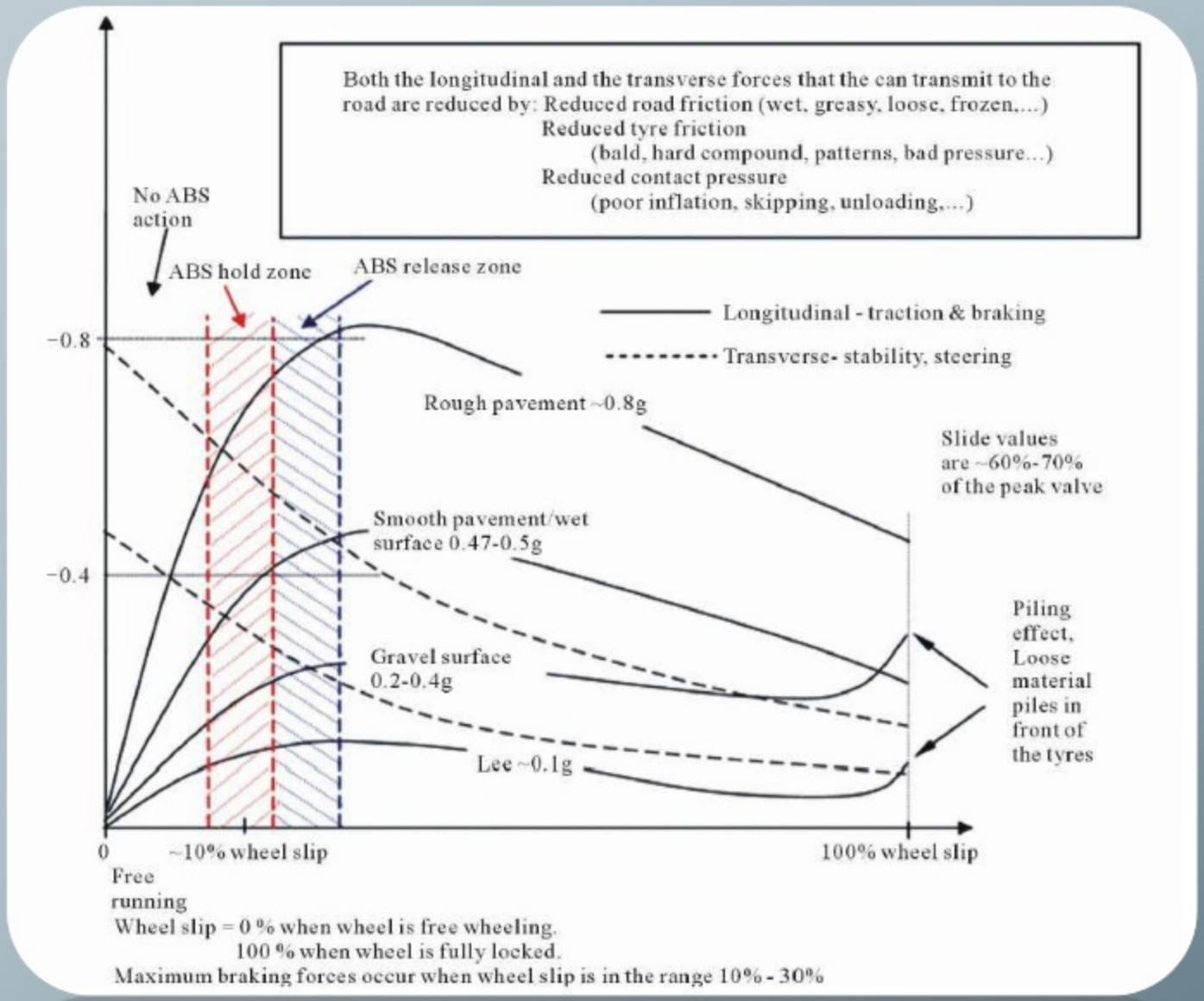
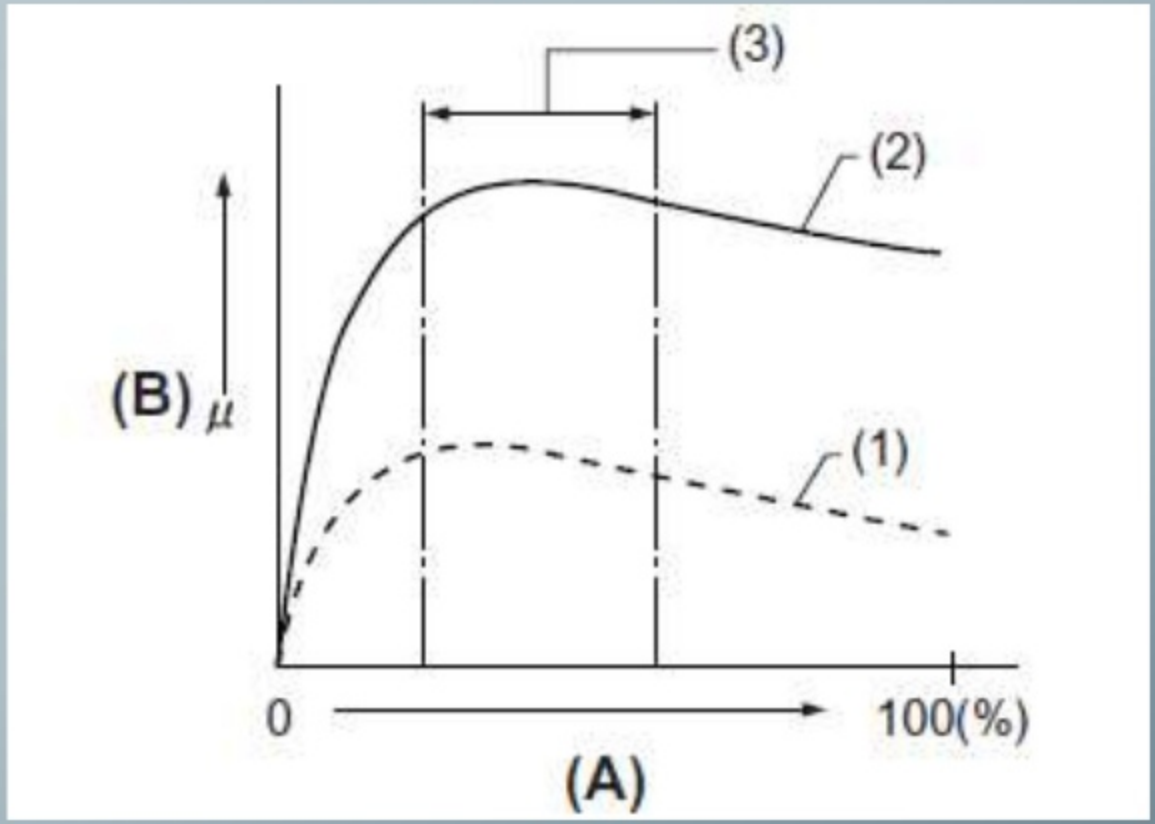


Figure 2. Illustration of the relationship between braking coefficient and wheel slip

- The best braking action occurs at between 10-20%.
- If vehicle speed and wheel speed is the same wheel slippage is 0%
- A lock-up wheel will have a wheel slippage of 100%



(A) Slip ratio
(B) Coefficient of friction between tire and road surface

(1) Icy road
(2) Asphalt-paved road
(3) Control range by ABS

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Principles for ABS Operation

- Figure 2 shows the relationship between braking co-efficient and wheel slip. It is shown that the slide values for stopping/traction force are proportionately higher than the slide values for cornering/steering force. A locked-up wheel provides low road handling force and minimal steering force.

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Principles for ABS Operation

The main benefit from ABS operation is to maintain directional control of the vehicle during heavy braking in rare circumstances

ABS Components Overview

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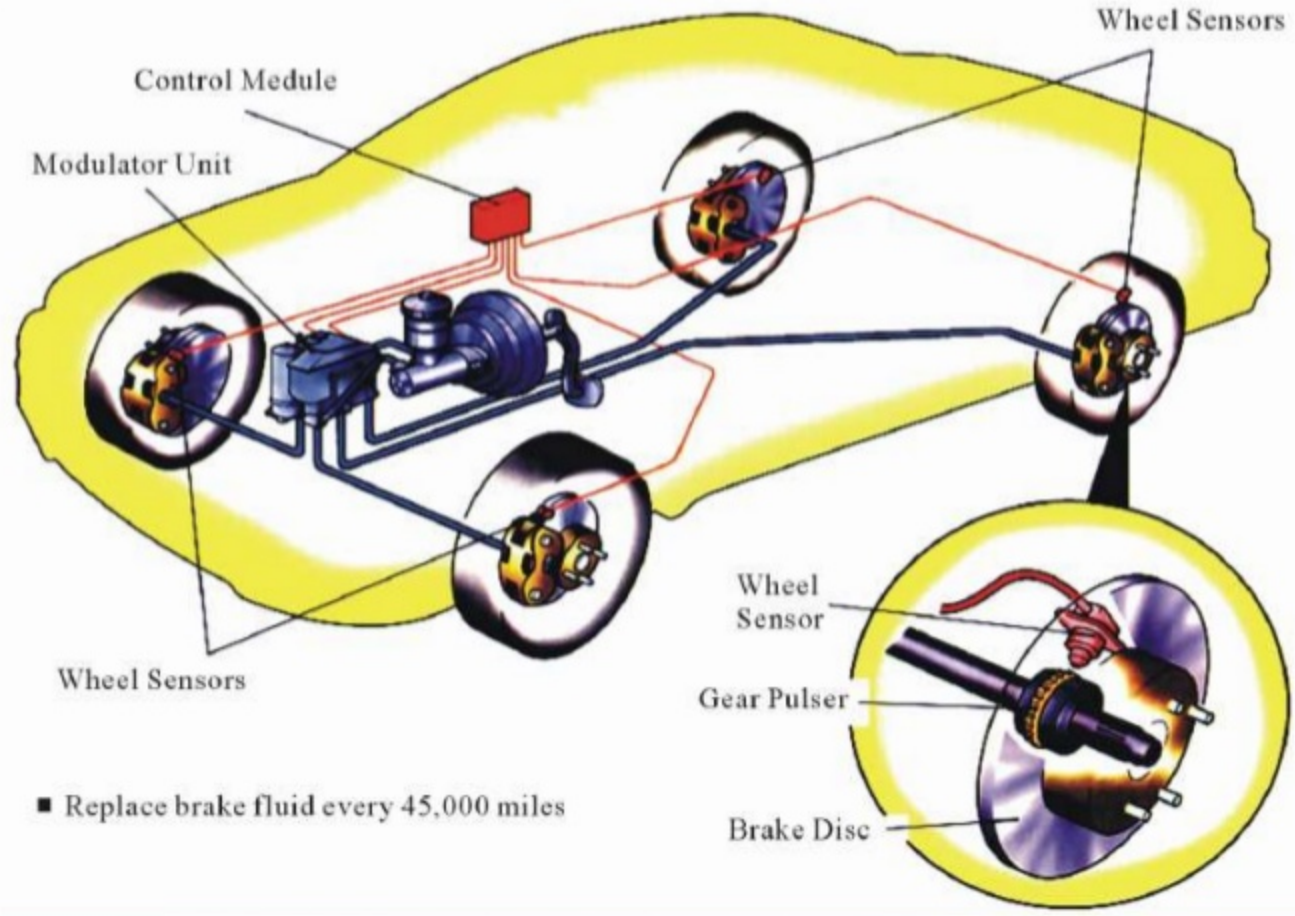


- ❑Hydraulic unit.
- ❑ Electronic brake control module (EBCM).
- ❑Two system fuses.
- ❑Four wheel speed sensors.
- ❑Interconnecting wiring
- ❑The ABS indicator
- ❑The rear drum brake.

ABS Components Overview

(1) ABS control module and hydraulic control unit (ABSCM & H/U).

(2) Two-way connector.

(3) Diagnosis connector.

(4) ABS warning light.

(5) Data link connector (for SUBARU select monitor).

(6) Transmission control module (AT models only).

(7) Tone wheels.

(8) ABS wheel speed sensor.

(9) Wheel cylinder.

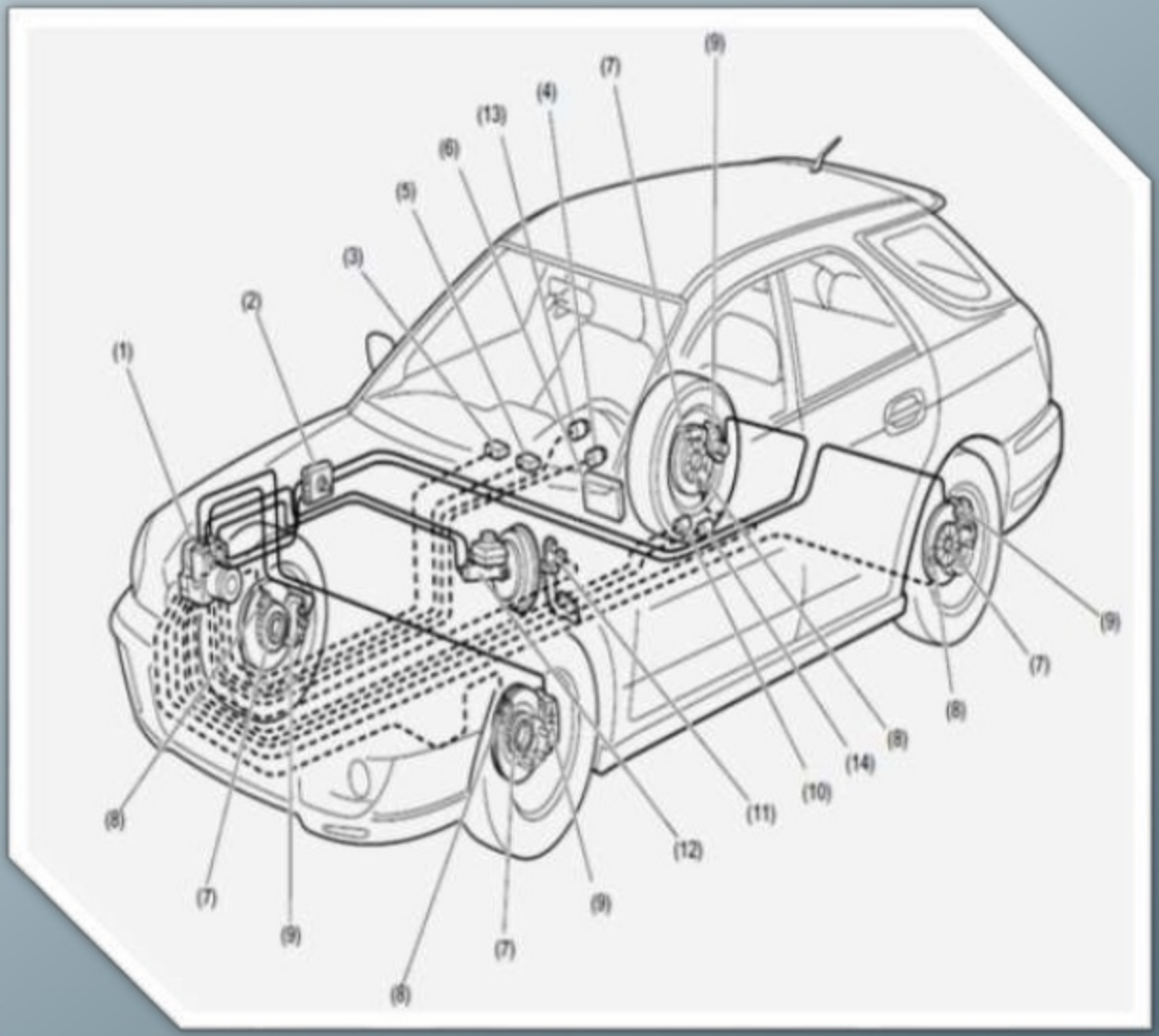
(10) G sensor.

(11) Stop light switch.

(12) Master cylinder.

(13) Brake & EBD warning light.

(14) Lateral G sensor (STi).



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ABS Components

- ABS brake system are
  - **Integrated**
- An integrated system has the master cylinder and control valve assembly made together.
  - **Nonintegrated**
- A nonintegrated has the master cylinder and control valve assembly made separate.

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ABS Components

- ABS systems consist of 4 primary components:

1- ABS Controller; the brains of the system. ABS Controllers are a computer that reads the inputs and then controls the system to keep the wheels from locking up and skidding.

2- ABS Speed Sensors; there are generally one on each wheel (sometimes they are located on the differential).
It detects a change in acceleration in the longitudinal direction of the vehicle and outputs it to the ABSCM as a voltage signal.

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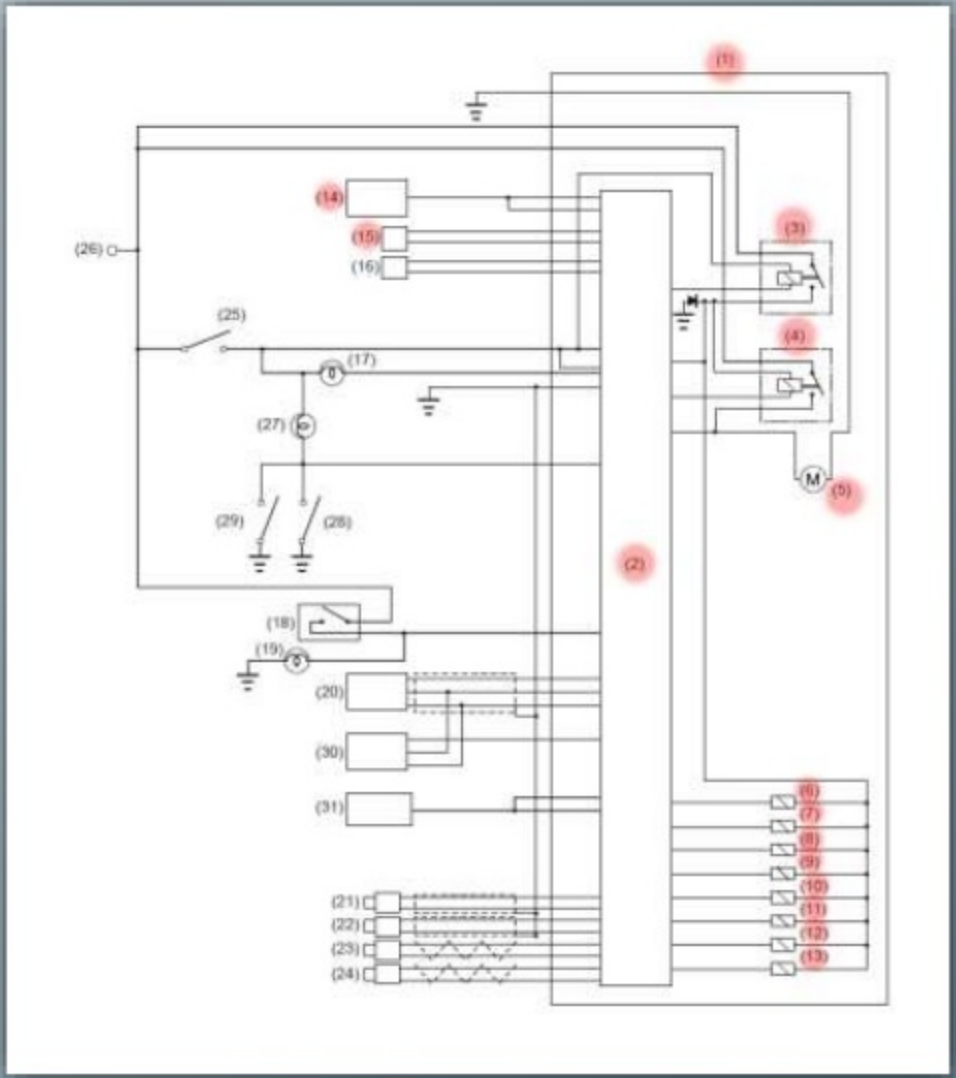
ABS Components

3- ABS Modulator/Valves; some system have separate valves for each wheel with a modulator to control them. Other systems they are combined. In either case they work with the controller and the pump to add or release pressure from the individual wheels brakes to control the braking.

4- ABS Pumps; since the ABS modulator/valves can release pressure from the individual wheels brakes there needs to be a way to restore the pressure when required. That is what the ABS pumps job is. When the pump is cycling, the driver may experience a slight pedal vibration. This cycling is happening many times per second and this slight vibration is natural.

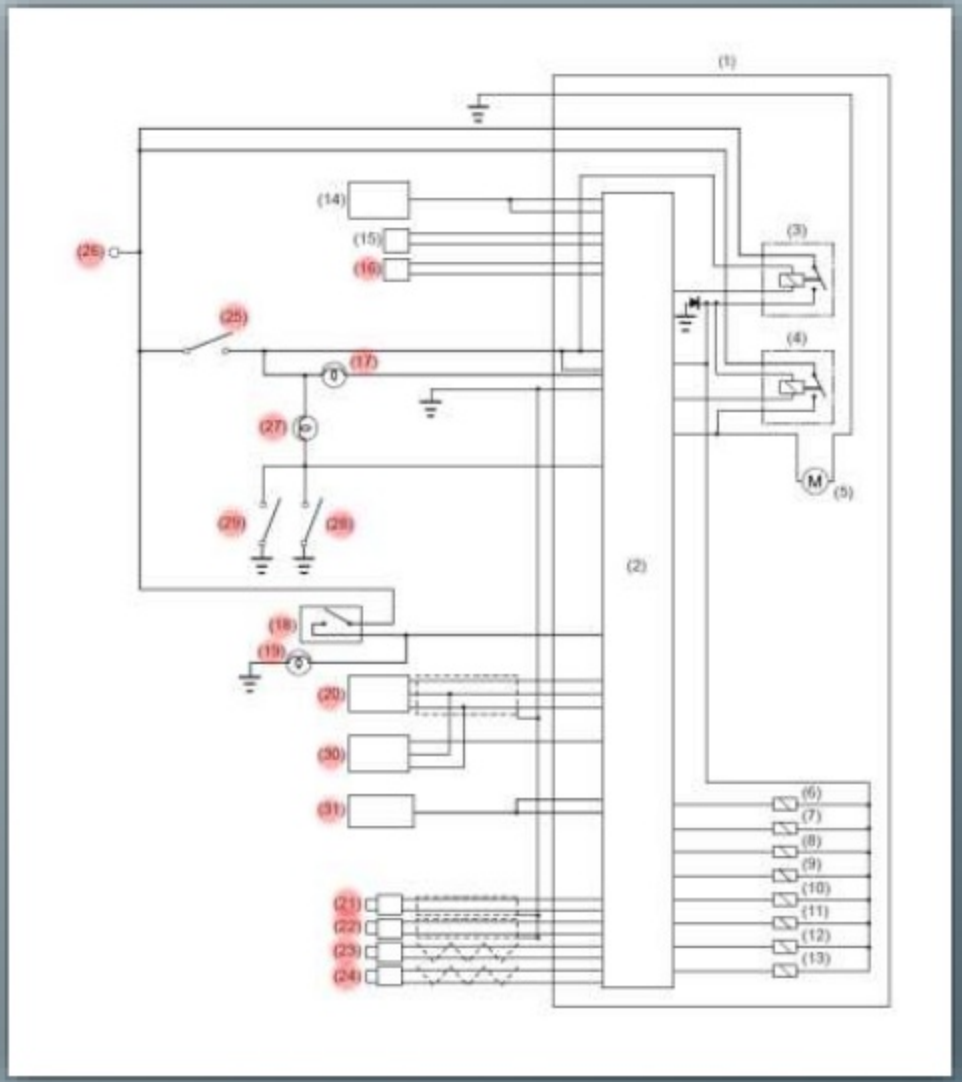
Subaru Impreza ABS Application.

(1) ABS control module and hydraulic control unit
(2) ABS control module section
(3) Valve relay
(4) Motor relay
(5) Motor
(6) Front left inlet solenoid valve
(7) Front left outlet solenoid valve
(8) Front right inlet solenoid valve
(9) Front right outlet solenoid valve
(10) Rear left inlet solenoid valve
(11) Rear left outlet solenoid valve
(12) Rear right inlet solenoid valve
(13) Rear right outlet solenoid valve
(14) Automatic transmission control Module
(15) Diagnosis connector



Subaru Impreza ABS Application.

(16) Data link connector
(17) ABS warning light
(18) Stop light switch
(19) Stop light
(20) G sensor
(21) Front left ABS wheel speed sensor
(22) Front right ABS wheel speed sensor
(23) Rear left ABS wheel speed sensor
(24) Rear right ABS wheel speed sensor
(25) IGN
(26) Battery
(27) Brake warning light
(28) Parking brake warning light
(29) Brake fluid level switch
(30) Lateral G sensor (STi)
(31) Driver-controllable center differential control unit



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How does ABS work?

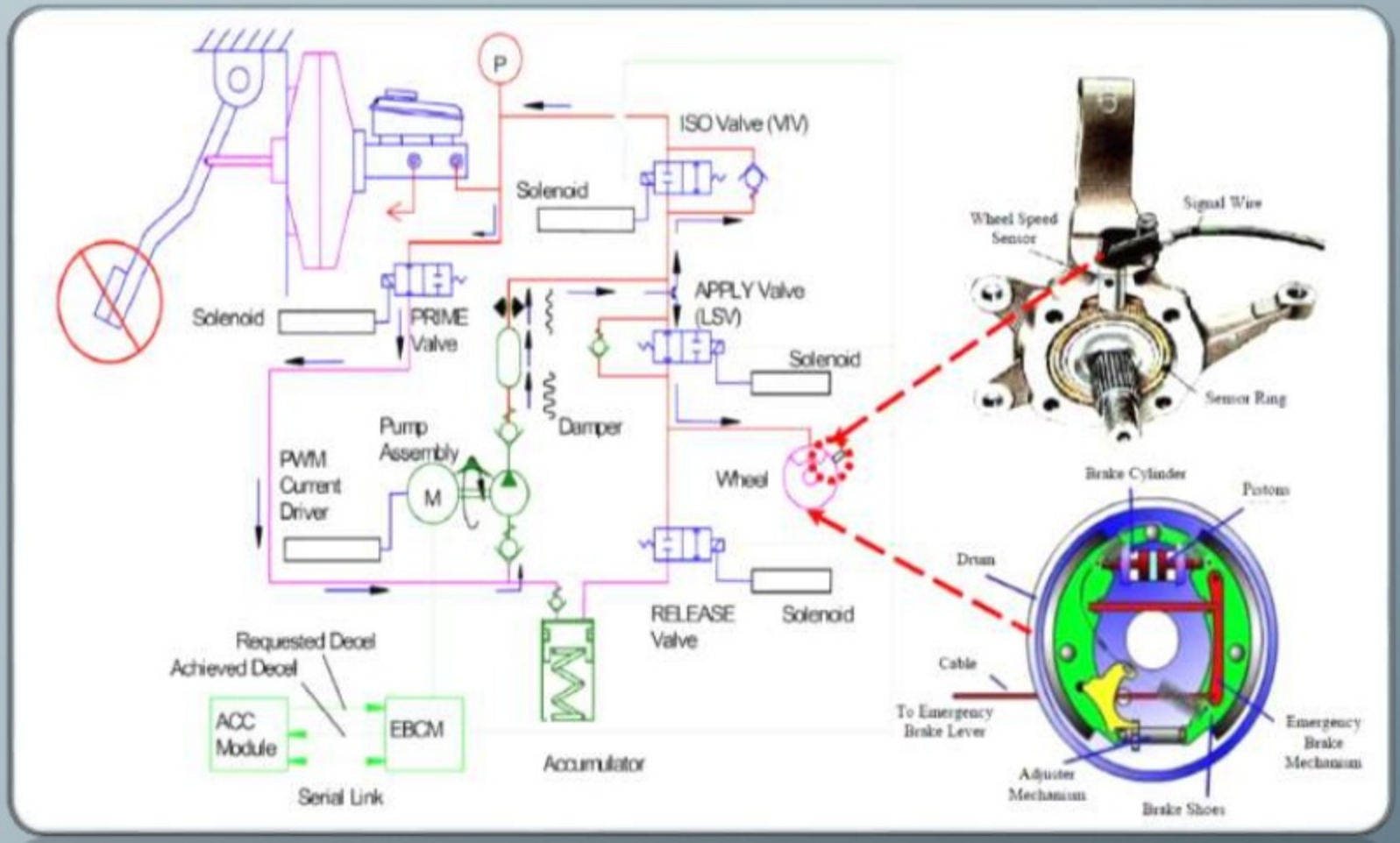

Figure 3. ABS Operating Diagram