

ABS**4891-01****OVERVIEW AND OPERATING PROCESS****1. SYSTEM OVERVIEW**

When braking suddenly or braking on slippery roads, the vehicle keeps moving forward but the wheels are locking and not rotating. If these happen, the vehicle may lose stability or rotate resulting in an accident. ABS helps to maintain directional stability and control of the vehicle. ABS is designed to secure more safety and increase the control of steering wheel during emergency braking situation. But, ABS does not guarantee perfect safety beyond its physical limit. ABS in this vehicle contains EBD function. In normal driving conditions, the brake system operates without ABS function.

1) Basic Theory of ABS Function

To give you a better understanding of the tasks and functions of ABS, we will first look at the physics principles.

► Stopping distance

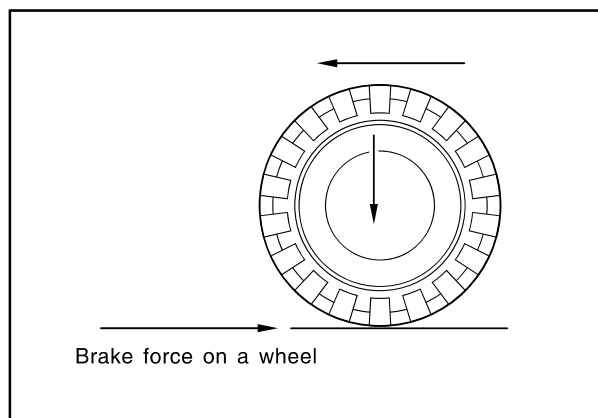
The stopping distance depends on the vehicle weight and initial speed when braking starts. This also applies for vehicle with ABS, where ABS always tries to set an optimum brake force on each wheel. As great forces are exerted between the tires and the carriageway when braking, even with ABS the wheels may scream and rubber is left on the road. With an ABS skid mark one may be able to clearly recognize the tire profile. The skid mark of an ABS vehicle does not however leave any hint of the speed of the vehicle in the case of an accident, as it can only be clearly drawn at the start of braking.

► Brake force on a wheel

The maximum possible brake force on a wheel depends on the wheel load and the adhesion coefficient between tire and carriageway. With a low adhesion coefficient the brake force, which can be obtained is very low. You are bound to know the result already from driving on winter roads. With a high adhesion coefficient on a dry road, the brake force, which can be obtained, is considerably higher. The brake force, which can be obtained, can be calculated from below formula:

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2) Maximum Brake Force



$$F_{Bmax} = \text{wheel load } F_R \times \text{coefficient of friction } (\mu_h)$$

The braking process cannot be described sufficiently accurately with the brake forces calculated. The values calculated only apply if the wheel is not locked. In the case of a locking wheel, the static friction turns into lower sliding friction, with the result that the stopping distance is increased. This loss of friction is termed "slip" in specialist literature.

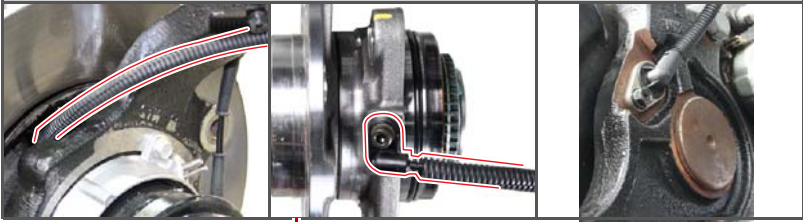
2. COMPONENTS AND LAYOUT

The basic functions of ABS system are same with previous version. However, the wheel speed sensing type is different from previous version.

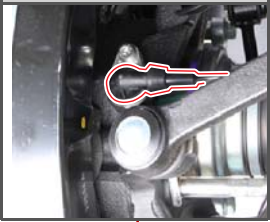
Front Active Wheel Speed Sensor

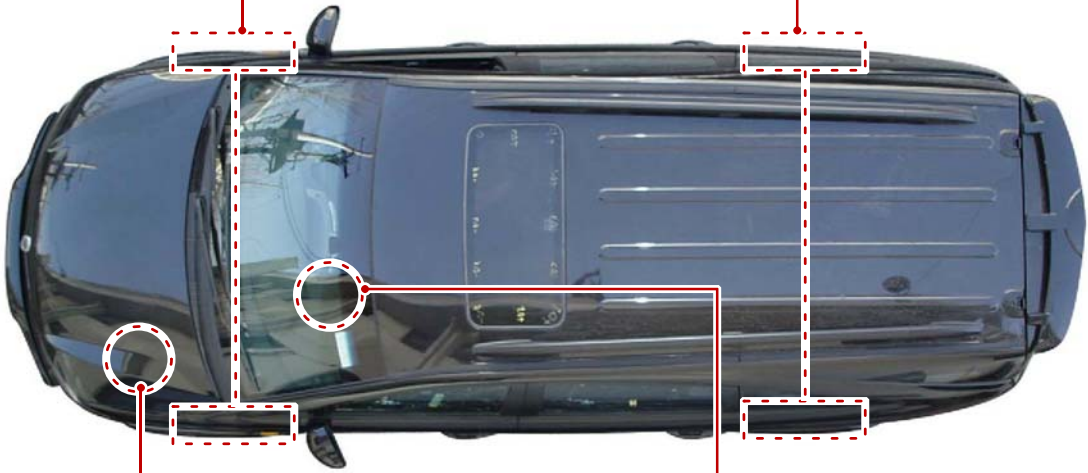
4WD

2WD



Rear Active Wheel Speed Sensor





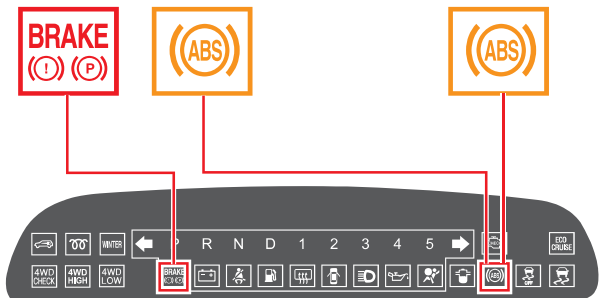
ABS HECU



Warning Lamps

EBD warning lamp

ABS warning lamp



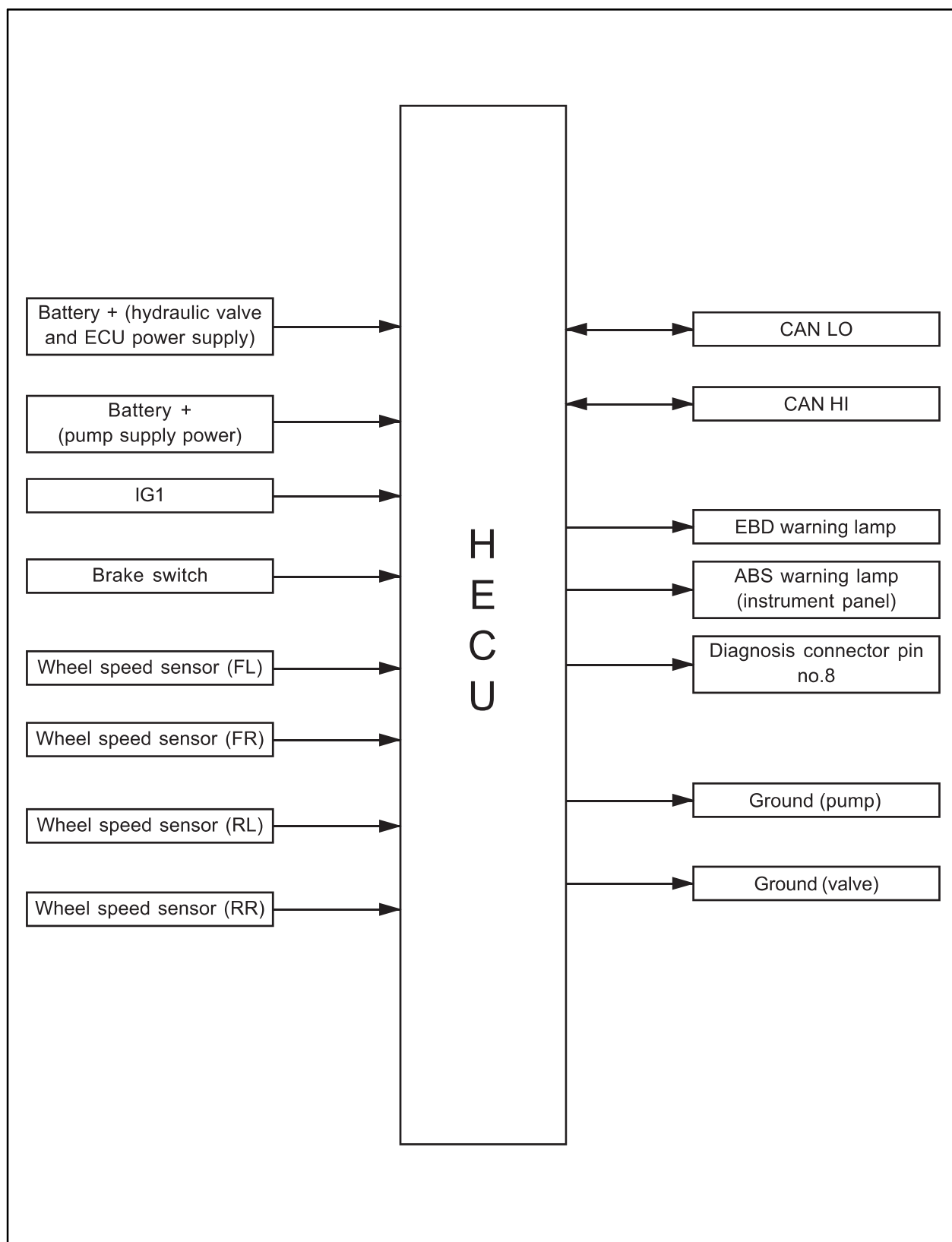
 **NOTE**

For details about the components, refer to Chapter "ESP".

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3. ABS SYSTEM OPERATION

1) Block Diagram



2) EBD (Electronic Brake Force Distribution) System

► System description

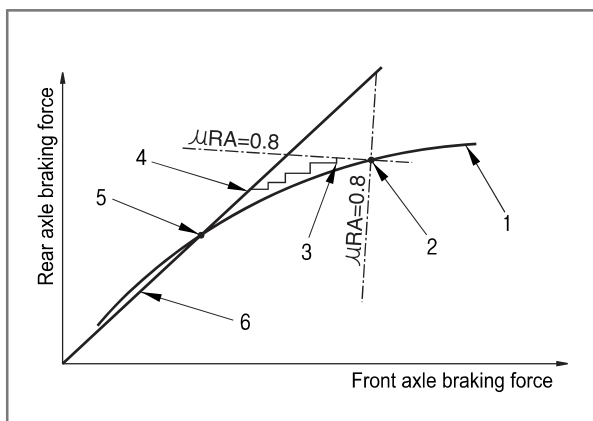
As an add-on logic to the ABS base algorithm, EBD works in a range in which the intervention thresholds for ABS control are not reached yet.

EBD ensures that the rear wheels are sensitively monitored for slip with respect to the front axle. If slip is detected, the inlet valves for the rear wheels are switched to pressure hold to prevent a further increase in pressure at the rear-wheel breaks, thus electronically reproducing a pressure-reduction function at the rear-wheel brakes.

ABS features an enhanced algorithm which includes control of the brake force distribution between the front and rear axles. This is called Electronic Brake Distribution. In an unloading car condition the brake efficiency is comparable to the conventional system but for a fully loaded vehicle the efficiency of the EBD system is higher due to the better use of rear axle braking capability.

► Advantages

- Elimination of conventional proportioning valve EBD utilizes the existing rear axle wheel speed sensor to monitor rear wheel slip.
- Based on many variables in algorithm a pressure hold, increase and/or decrease pulsetrain may be triggered at the rear wheels insuring vehicle stability.
- Vehicle approaches the ideal brake force distribution (front to rear).
- Constant brake force distribution during vehicle lifetime.
- EBD function is monitored via ABS safety logic (conventional proportioning valves are not monitorable).



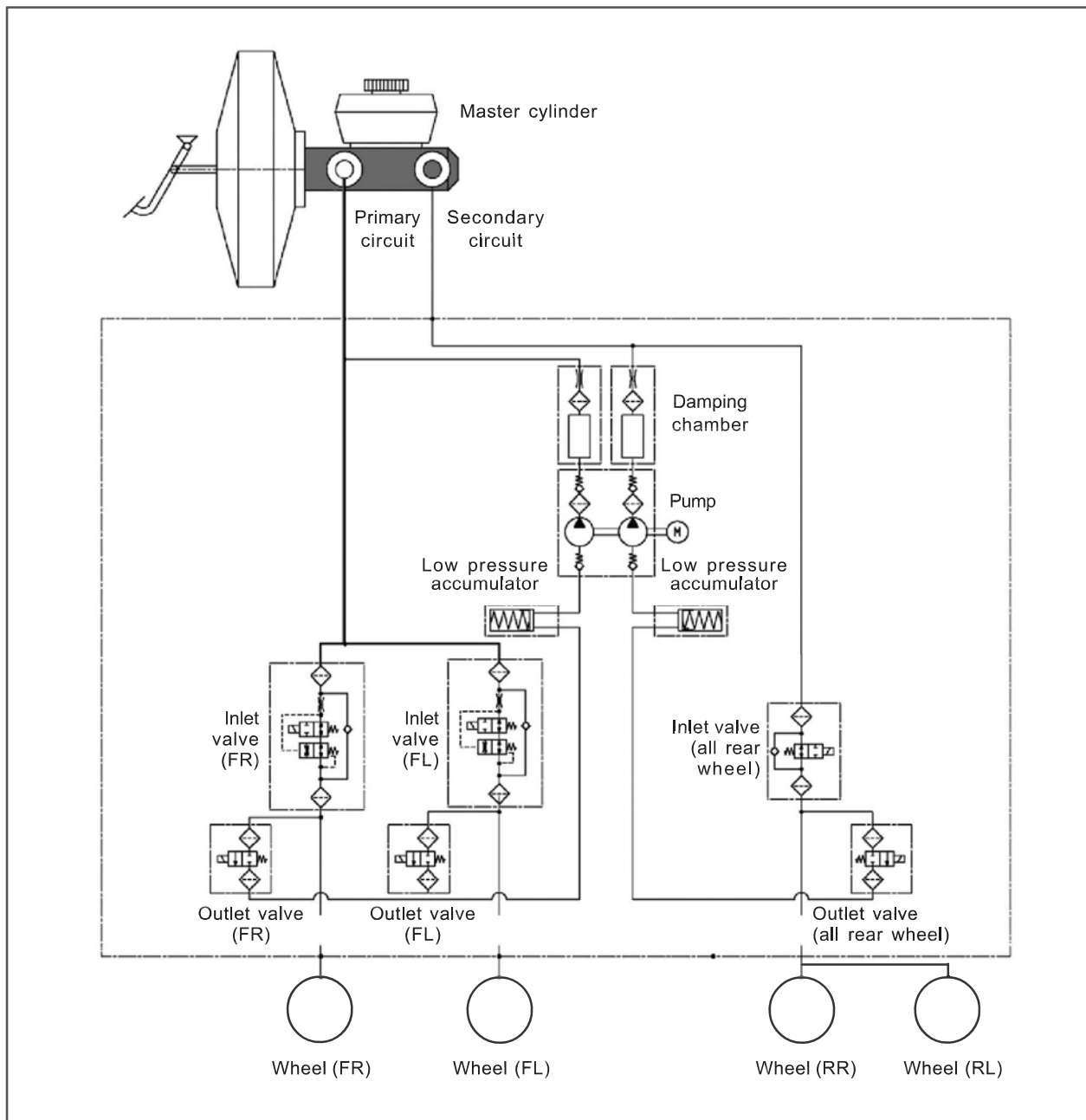
3) Important Notice

1. The modulators for production line are not filled with the brake fluid (dry type). But, for after service, they are filled with the brake fluid (wet type).
2. Make sure to keep the procedures in service manual when bleeding the air from the brake lines.
3. Be familiar with the lamp ON conditions to provide the correct information and reliability to customers.
ECU monitors the valve and motor for ABS when the vehicle speed approaches 5 km/h. At this time, you can hear the clattering noise.

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4. HYDRAULIC CIRCUIT DIAGRAM

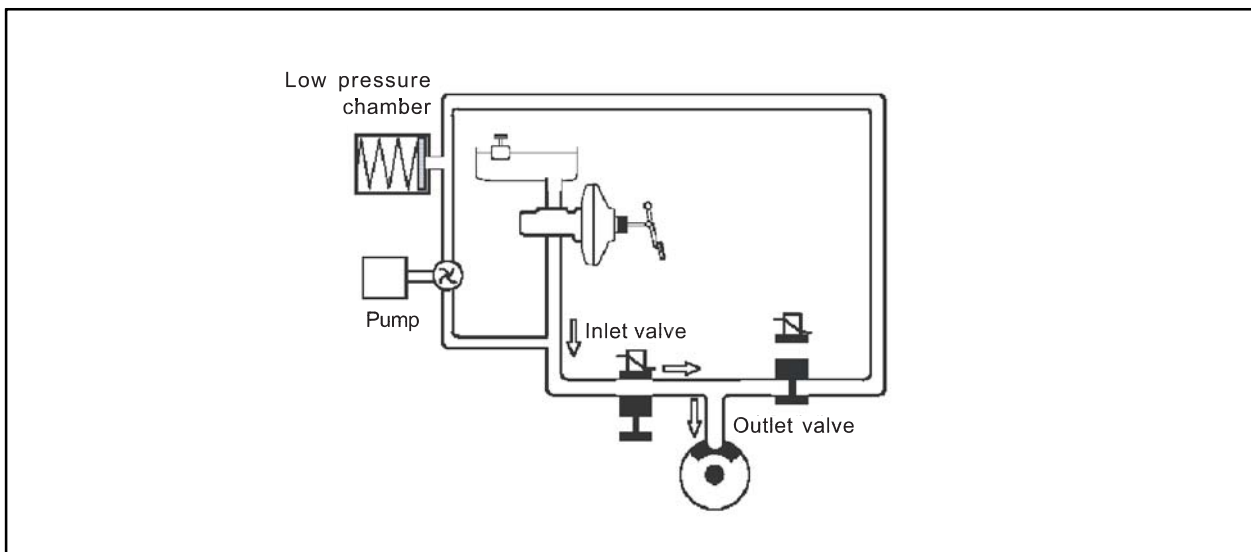
1) Hydraulic Circuit of ABS



The vehicle equipped only with the ABS controls the wheel's braking force using three 3-channel 4-sensor method. The front wheels that are the primary circuit of the brake system is composed of two wheel speed sensors and two channel valves system with two inlet valves and two outlet valves. The rear wheels that are the secondary circuit of the brake system is composed of two wheel speed sensors, one inlet valve and one outlet valve. This system is similar to the one from the previous model.

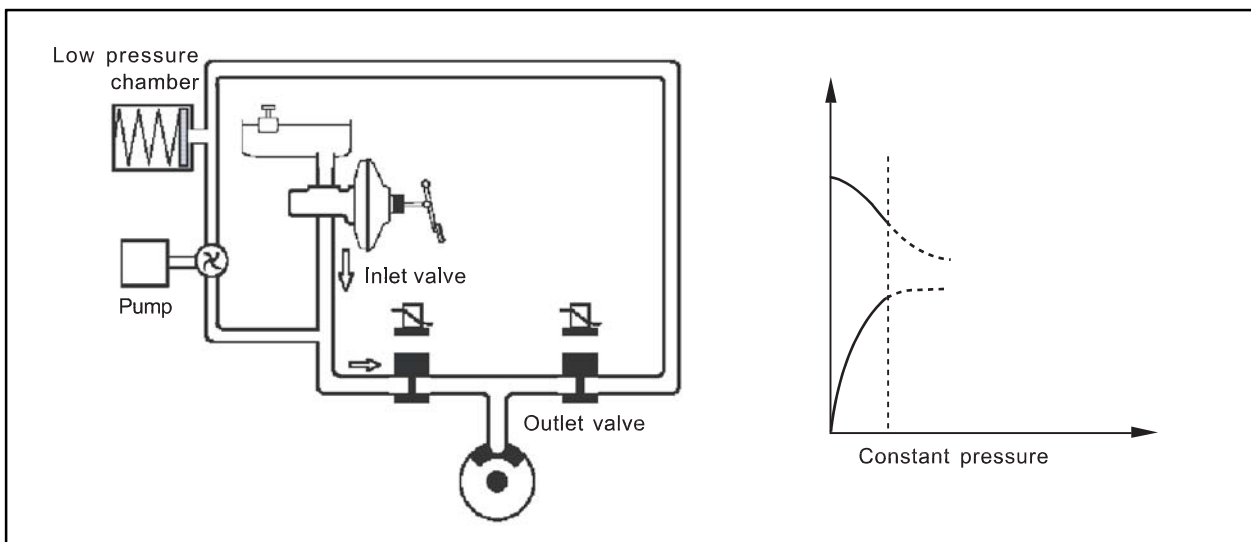
2) ABS Circuit Per ABS Operation Range

► Hydraulic Pressure Circuit when ABS is Not Operating



The hydraulic pressure in the master cylinder increases through the vacuum booster and it is delivered to the wheel via the normal open inlet valve. At this moment, the normally-closed outlet valve is closed. The speed of the wheel that hydraulic pressure is delivered reduces gradually.

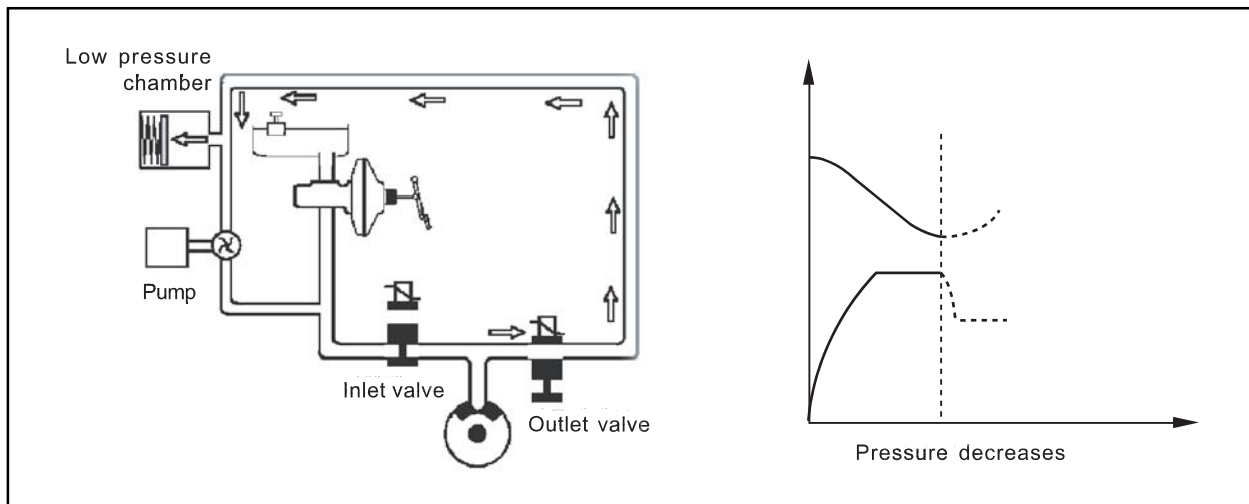
► No Hydraulic Pressure Circuit when ABS is Operating



As hydraulic pressure on each wheel increases, the wheel tends to lock. In order to prevent the wheel from locking, the hydraulic valve modulator operates the inlet valve control solenoid to close the inlet valve and stop the hydraulic pressure increases. At this moment, the outlet valve is closed. This procedure helps the wheel to maintain a stable hydraulic pressure.

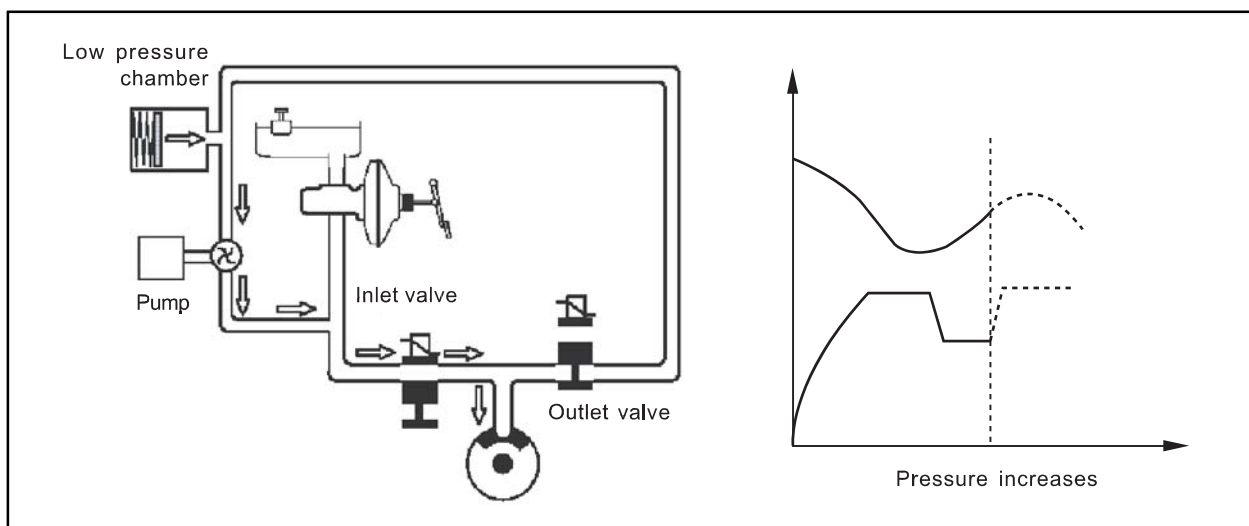
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► Pressure Decreases in the Circuit when ABS is Operating



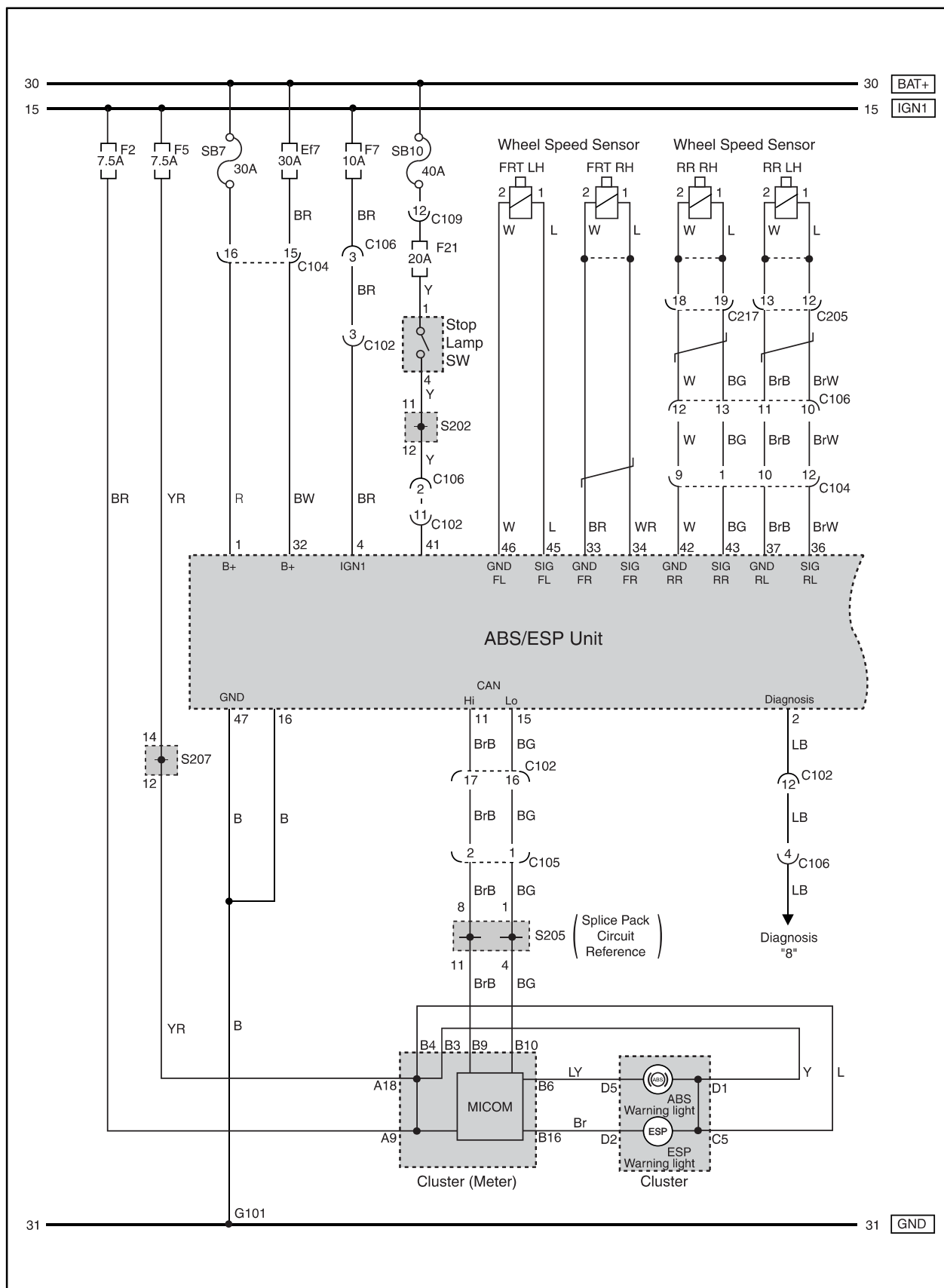
Even when the hydraulic pressure on each circuit is stable, the wheel can be locked as the wheel speed decreases. This is when the ABS ECU detects the wheel speed and the vehicle speed and gives the optimized braking without locking the wheels. In order to prevent from hydraulic pressure increases, the inlet valve is closed and the outlet valve is opened. Also, the oil is sent to the low pressure changer and the wheel speed increases again. The ABS ECU operates the pump to circulate the oil in the low pressure chamber to the master cylinder. This may make the driver to feel the brake pedal vibration and some noises.

► Pressure Increases in the Circuit when ABS is Operating



As the wheel speed increases, the inlet valve opens and the wheel's pressure increases due to the master cylinder pressure. The oil in the low pressure chamber circulates to the wheel by the pump and the wheel speed decreases as the hydraulic pressure at wheel increases. This operation continues repetitively until there are no signs that the ECU is locking the wheels. When the ABS hydraulic pressure control takes place, there may be some vibration and noises at the brake pedal.

3) Circuit Diagram



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