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**GROUP 35B**

# **ANTI-LOCK BRAKING SYSTEM (ABS)**

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**GENERAL INFORMATION**

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The ABS (with EBD) ensures directional stability and controllability during hard braking. The ABS is standard equipment on the all models.

This ABS uses a 4-sensor system that controls all four wheels independently of each other, and has the following features:

- EBD<sup>\*1</sup> control that can obtain ideal rear wheel brake force has been employed.
- The magnetic encoder for detecting the wheel speed has been installed instead of the rotor as the wheel speed sensor.

- For wiring harness saving and secure data communication, CAN<sup>\*2</sup> bus has been adopted as a tool of communication with other ECUs.
- The ABS and EBD are controlled by ASC-ECU, because they are functions of ASC system.

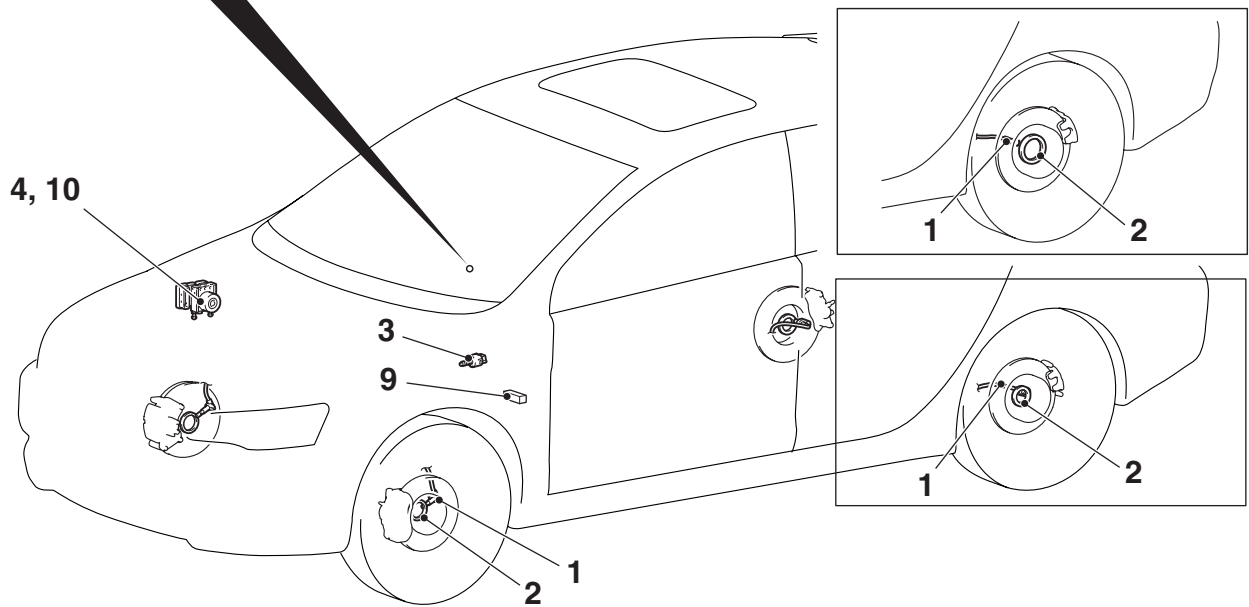
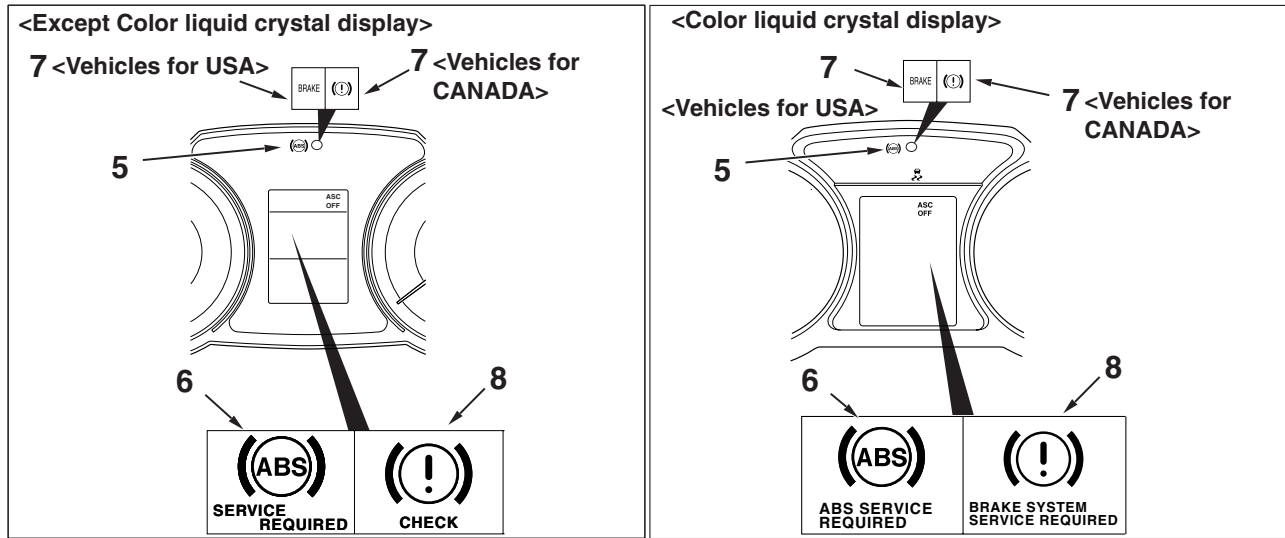
**NOTE:**

- <sup>\*1</sup>: EBD (Electronic Brake-force Distribution)
- <sup>\*2</sup>: For more information about CAN (Controller Area Network), refer to GROUP 54C P.54C-2.

**SPECIFICATIONS**

Item			Specifications
ABS control type			4 sensors
Wheel speed sensor	Magnetic encoder	Front	86 (N pole: 43, S pole: 43)
		Rear	86 (N pole: 43, S pole: 43)
	Type		Semiconductor

**CONSTRUCTION DIAGRAM**



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**MAIN COMPONENTS AND FUNCTIONS**

Parts name		No.	Functional description
Sensor	Wheel speed sensor	1	Outputs the frequency signal in proportion to the rotation speed of each wheel to ASC-ECU.
	Magnetic encoder for wheel speed detection	2	The wheel speed sensor is a pulse generator. When the magnetic encoder for wheel speed detection (a plate on which north and south pole sides of the magnets are arranged alternately) rotates, it outputs frequency pulse signal in proportion to each wheel speed.
	Stop light switch	3	Outputs the signal indicating whether the brake pedal is depressed or not through ETACS-ECU to ASC-ECU via the CAN line.

Parts name		No.	Functional description
Actuator	Hydraulic unit	4	Drives the solenoid valve using the signal from ASC-ECU, and controls the brake fluid pressure for each wheel.
	ABS warning light	5	Informs the driver of the system status by illuminating, flashing, or turning off the warning light according to the signal from ASC-ECU.
	ABS warning display	6	Informs the driver of the system status by illuminating or turning off the warning display according to the signal from ASC-ECU.
	Brake warning light	7	Used as the warning light for the parking brake, brake fluid level, and EBD control. Informs the driver of the system status by illuminating or turning off the warning light according to the signal from ASC-ECU.
	Brake warning display	8	Used as the warning lamp for the brake fluid level, and EBD control. Informs the driver of the system status by illuminating or turning off the warning display according to the signal from ASC-ECU.
Data link connector		9	Establishes the communication with scan tool.
ASC control unit (ASC-ECU)		10	Controls the actuators (described above) based on the signals coming from each sensors.
			Controls the self-diagnostic functions and fail-safe functions.
			Controls diagnostic function (Compatible with scan tool).

## SYSTEM CONFIGURATION

Refer to GROUP 35C –General Description [P.35C-2](#).

## ABS ELECTRICAL DIAGRAM

Refer to GROUP 35C –General Description [P.35C-2](#).

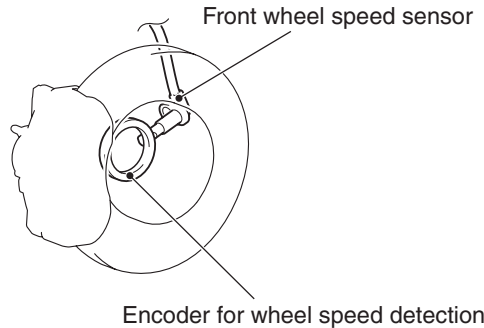
## CONSTRUCTION DESCRIPTION

### SENSOR

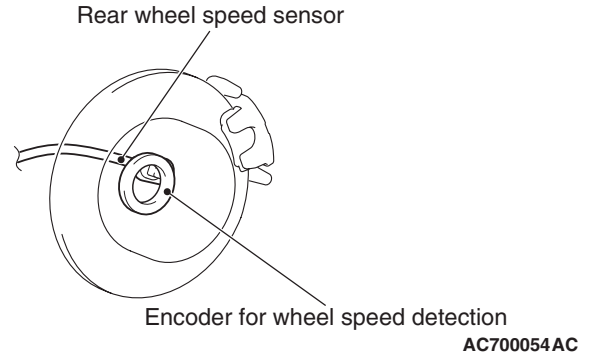
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#### Wheel speed sensor

FRONT



REAR



The wheel speed detecting section is a kind of a pulse generator. It consists of the magnetic encoder for wheel speed detection (a plate on which north and south pole sides of the magnets are arranged alternately) which rotates at the same speed of the wheel and the wheel speed sensor (semiconductor sensor). This sensor outputs frequency pulse signals in proportion to the wheel speed.

The front wheel speed detecting section consists of the front wheel speed sensor mounted on the knuckle and the magnetic encoder for wheel speed detection which is press-fitted together with the oil seal to the front wheel bearing. The rear wheel speed detecting section consists of the rear wheel speed sensor mounted on the trailing arm assembly and the magnetic encoder for wheel speed detection which is press-fitted together with the oil seal to the rear wheel bearing.

### ACTUATORS

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#### ABS warning light, Brake warning light

The ABS system informs the driver of the ABS system status by illuminating, extinguishing, or flashing the ABS warning light and brake warning light as follows.

##### ABS warning light

- Turns ON when a system malfunction occurs.

##### Brake warning light

- Turns ON when an EBD system malfunction occurs.

##### NOTE:

- Turns ON when the brake fluid level in the reservoir tank becomes the specified value or lower.
- Turns ON when the parking brake lever is pulled and the brake is activated.

#### ABS warning light and brake warning light illumination or flashing pattern

State		ABS warning light	Brake warning light
Normal	Correct	–	–
Faulty	ABS failure	Illuminates	–
	EBD failure	Illuminates	Illuminates
When scan tool is connected	Actuator not operated	–	–
	Actuator operated	Flash (2Hz)	–
	After actuator operated*	Illuminates*	Illuminates*

NOTE: \*:ABS and brake warning lights remain illuminated until the ignition is switched off.

## ASC-ECU

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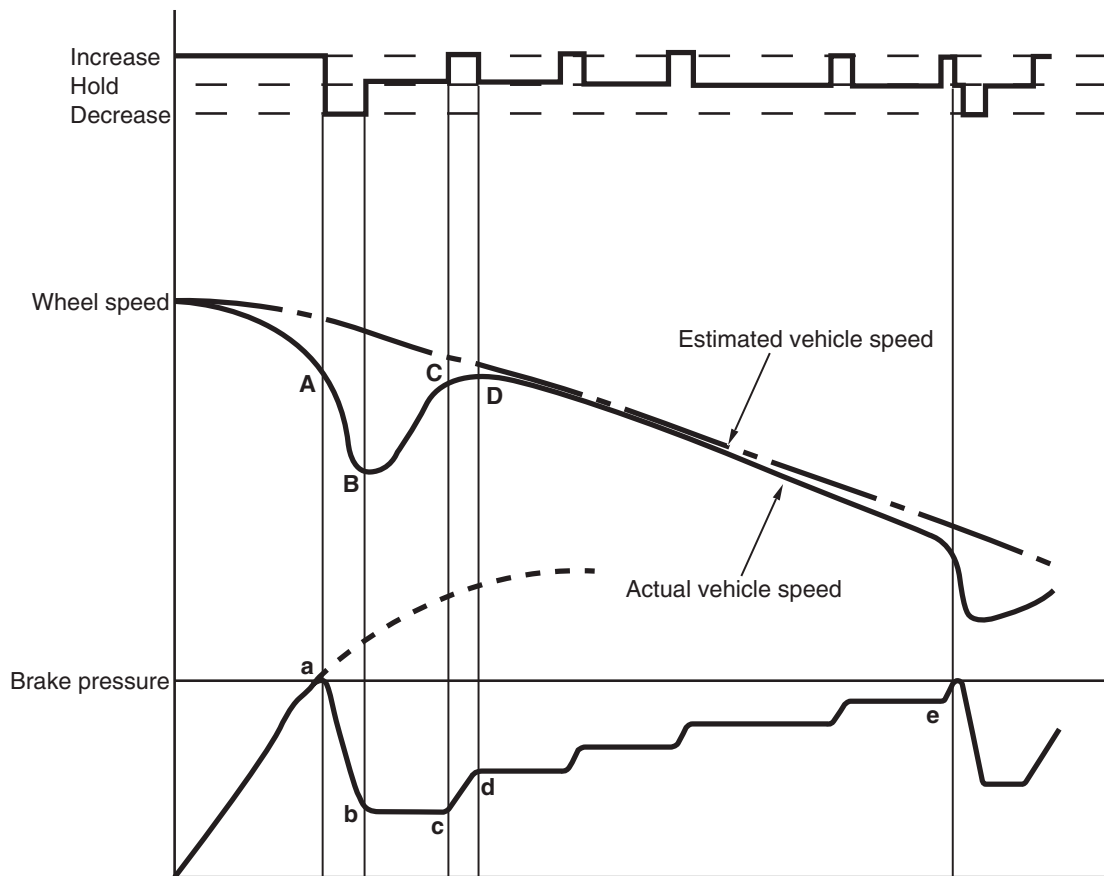
- By integrating ASC-ECU into the hydraulic unit, no wiring harness for sending drive signal of the solenoid valve and pump motor is required, assuring higher reliability.
- Self-diagnostic and memory functions are integrated into ASC-ECU. If any malfunction is detected by the self-diagnostic function, ASC-ECU activates a fail-safe function and illuminates the ABS warning light and brake warning light\*.

*NOTE: \*: The brake warning light is used as the EBD control warning light.*

- ASC-ECU detects vehicle speed from the signals of the wheel speed sensor, recognizes the wheel rotation status, estimates the wheel slip condition based on the preprogrammed algorithm, and then controls the solenoid valve in the hydraulic unit so that the wheels do not lock.

## ABS fluid pressure control

## ABS control cycle



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1. The ASC-ECU calculates the speed and deceleration of each wheel based on the signals from the four wheel speed sensors, and estimates the vehicle speed at that time.
2. When the brake pedal is depressed, the brake fluid pressure applied to the wheel cylinder increases, and the wheel speed decreases. When the difference between the wheel speed and vehicle speed increases, and the vehicle deceleration goes below the specified value (Point A), ECU determines that the wheels are about to be locked. At this time, ECU reduces the brake fluid pressure by outputting the pressure decrease signal to the solenoid valves (IN, OUT). (between a and b)
3. When the vehicle deceleration and wheel speed begin recovery, and the vehicle speed reaches the point B, ECU outputs the pressure hold signal to maintain the wheel cylinder fluid pressure. (between b and c)

4. When the wheel speed deceleration is further recovered and overpasses the point C, ECU determines that the wheel lock possibility has been eliminated and increases the brake fluid pressure by outputting the pressure increase signal again. (between c and d)

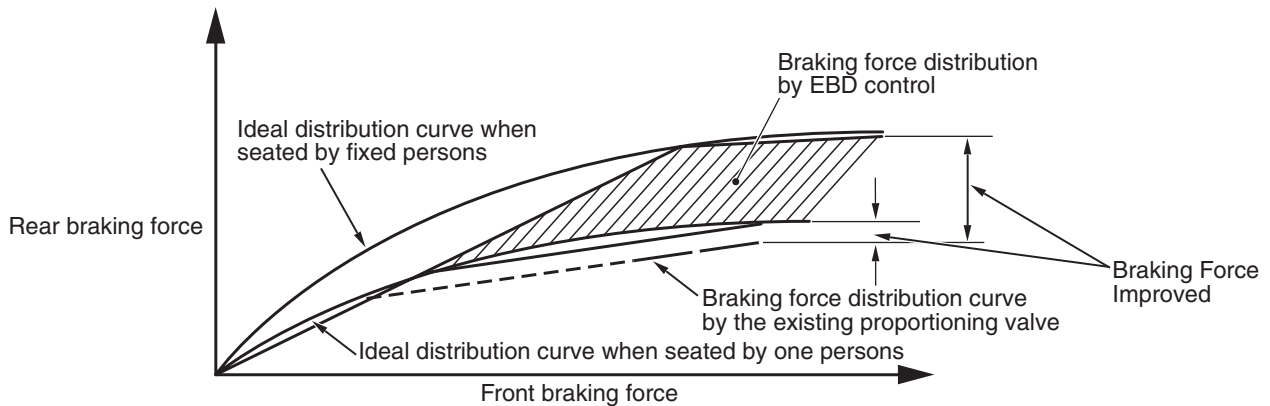
5. Brake fluid pressure is controlled by repeating the increase and hold of the pressure. (between d and e)  
6. When the wheel deceleration goes below the threshold again, ASC-ECU controls the brake fluid pressure by repeating the cycle (Step 2 to 5).

**EBD fluid pressure control**

EBD control is activated in a range with lower slip ratio where ABS is disabled. EBD calculates vehicle deceleration and slip amount of the four wheels based on the wheel speed sensor signal. If the rear wheel speed differs from the vehicle speed by a cer-

tain level or more, EBD increases, holds, and decreases the pressure at the rear wheel control solenoid valve in the hydraulic unit, and then adjusts rear wheel brake fluid pressure fairly close to an ideal distribution curve.

**EBD operating conceptual design**



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**INITIAL CHECK**

ASC-ECU performs the following initial checks using the diagnostic functions. ASC-ECU illuminates the ABS warning light for 3 seconds (including the initial check) \* after the ignition switch is turned ON. If any malfunction is detected, ASC-ECU continues illuminating the ABS warning light and disables ABS control.

*NOTE: \*: The ABS warning light may stay on after the ignition switch is turned ON until the startup vehicle speed reaches approximately 6.2 mph (10 km/h). As far as ASC-ECU memorizes any diagnostic trouble code related to the wheel speed sensor malfunction recorded during the previous ignition ON status, ASC-ECU continues illuminating the ABS warning light until it verifies that the malfunction for that code is resolved (startup check).*

**STARTUP CHECK**

When the startup vehicle speed reaches approximately 6.2 mph (10 km/h), ASC-ECU performs the following checks.

1. Motor, solenoid valve check (Initial startup\* only)
 

Turns ON the motor relay in ECU, and checks the pump motor operation. At the same time, ABS-ECU sequentially energizes each solenoid valve in a very short period and checks the valve operation.

*NOTE: \*: Initial startup indicates a first startup after the system has started.*
2. Wheel speed sensor check
 

ASC-ECU checks for any wheels that have not received wheel speed sensor signal from the startup.

**CONSTANT CHECK**

ABS-ECU constantly checks the following items.

1. ASC-ECU
 

Performs self-diagnostic in ECU.

## 2. ECU power supply

Checks if ECU power supply voltage stays within the operational range.

## 3. Wheel speed sensor

(1) Monitors the output voltage of the sensor signal wiring harness and checks for abnormal output voltage (open/short circuit).

(2) Checks for any wheels that do not send pulse signal while the vehicle is in motion.

(3) Checks if wheel speed which is abnormally higher or lower than the vehicle speed is input.

## 4. Pump motor, solenoid valve

Checks that the ASC-ECU output signal and the operating conditions of the pump motor and solenoid valve agree with each other.

**FAIL-SAFE AND DIAGNOSTIC FUNCTION**

If any malfunction is detected by the self-diagnostic function, ASC-ECU illuminates the ABS warning light and brake warning light\*, and it disables ABS and EBD control.

*NOTE: \*: The brake warning light is used as EBD control warning light.*

ASC-ECU has the following functions for easier system checks. The following items can be diagnosed using scan tool.

- Diagnostic trouble code set
- Service data output
- Actuator test
- Freeze frame data output