

GROUP 35B

FOUR-WHEEL ANTI-LOCK BRAKE SYSTEM (4ABS)

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GENERAL INFORMATION

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The ABS that ensures directional stability and controllability during hard braking. ABS is standard equipment on the ES and GTS models but is optional.

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

- EBD *1 (Electronic Brake-force Distribution system) 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 *2 bus has been adopted as a tool of communication with other ECUs.

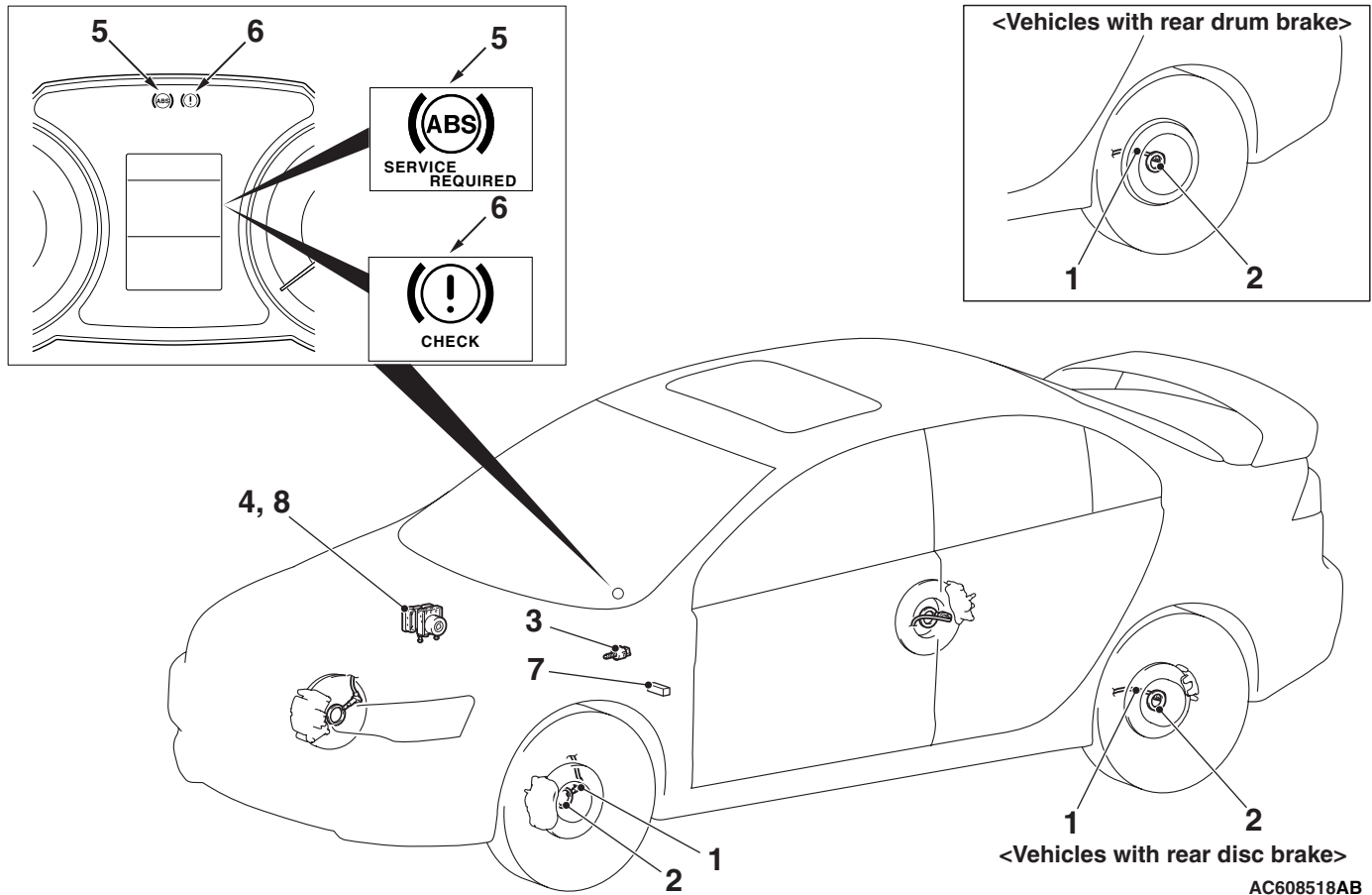
NOTE:

- *1: EBD (Electronic Brake-force Distribution)
- *2: 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

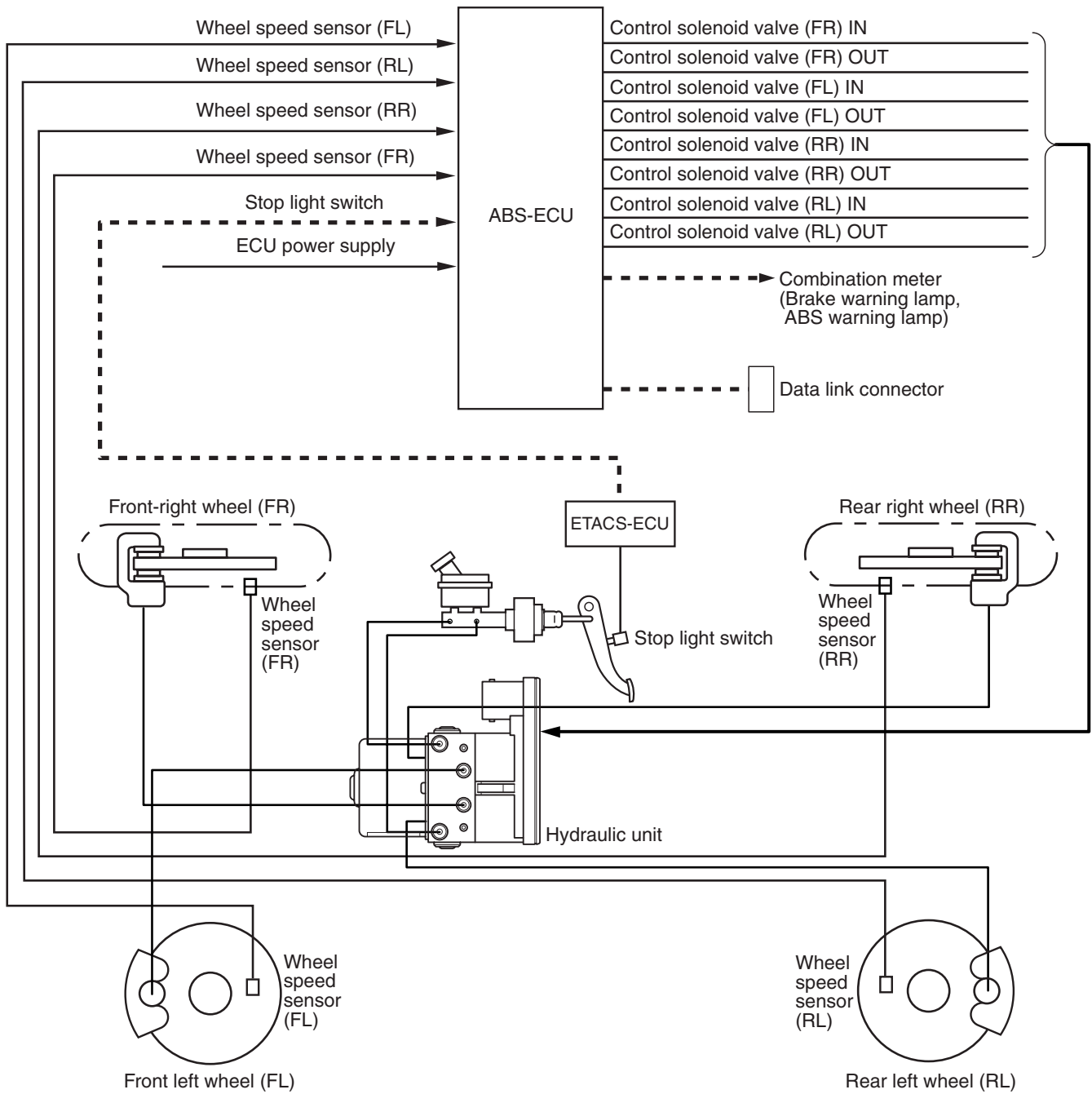
CONSTRUCTION DIAGRAM



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 ABS-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 ABS-ECU via the CAN line.
Actuator	Hydraulic unit	4	Drives the solenoid valve using the signal from ABS-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 ABS-ECU.
	Brake warning light	6	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 ABS-ECU, ETACS or combination meter.
Data link connector		7	Establishes the communication with scan tool.
ABS control unit (ABS-ECU)		8	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).

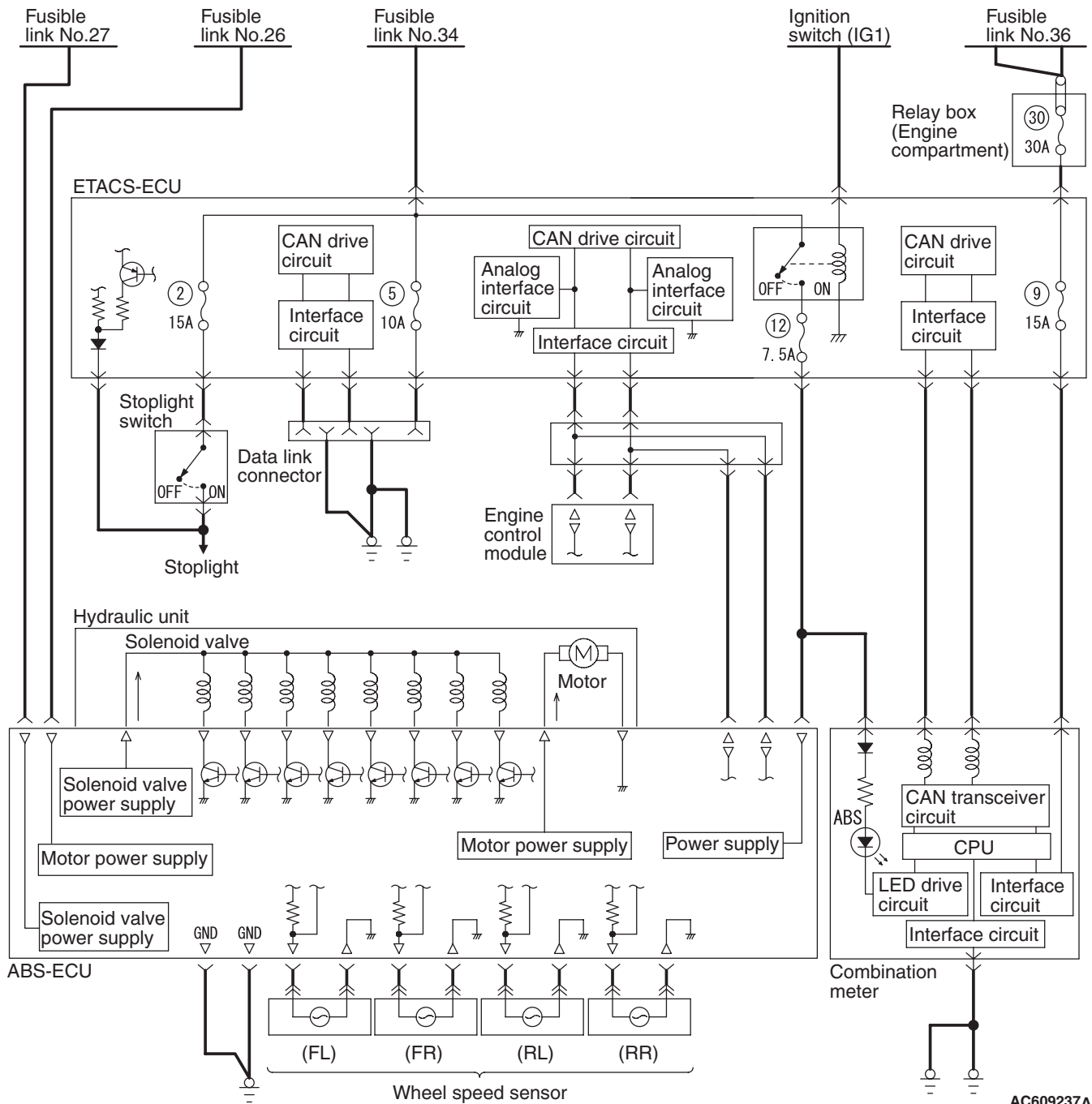
SYSTEM CONFIGURATION



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NOTE: Dashed lines indicate the CAN bus communication lines.

ABS ELECTRICAL DIAGRAM



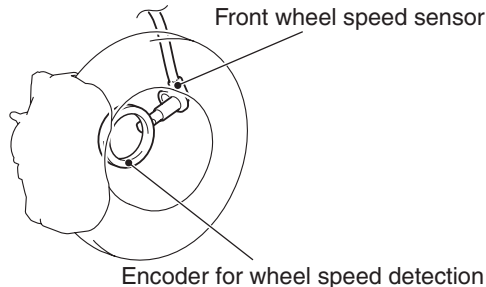
CONSTRUCTION DESCRIPTION

SENSOR

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Wheel speed sensor

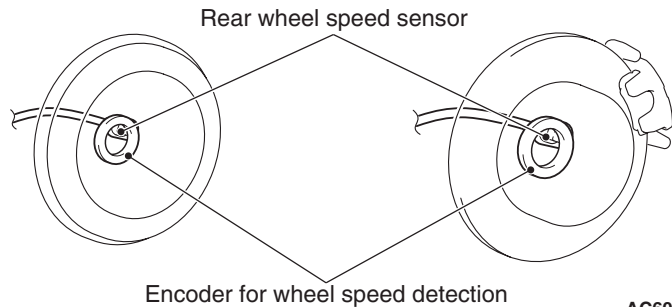
FRONT



REAR

<Vehicles with rear drum brake>

<Vehicles with rear disc brake>



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The wheel speed sensor 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 sensor 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 sensor 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.

ABS-ECU

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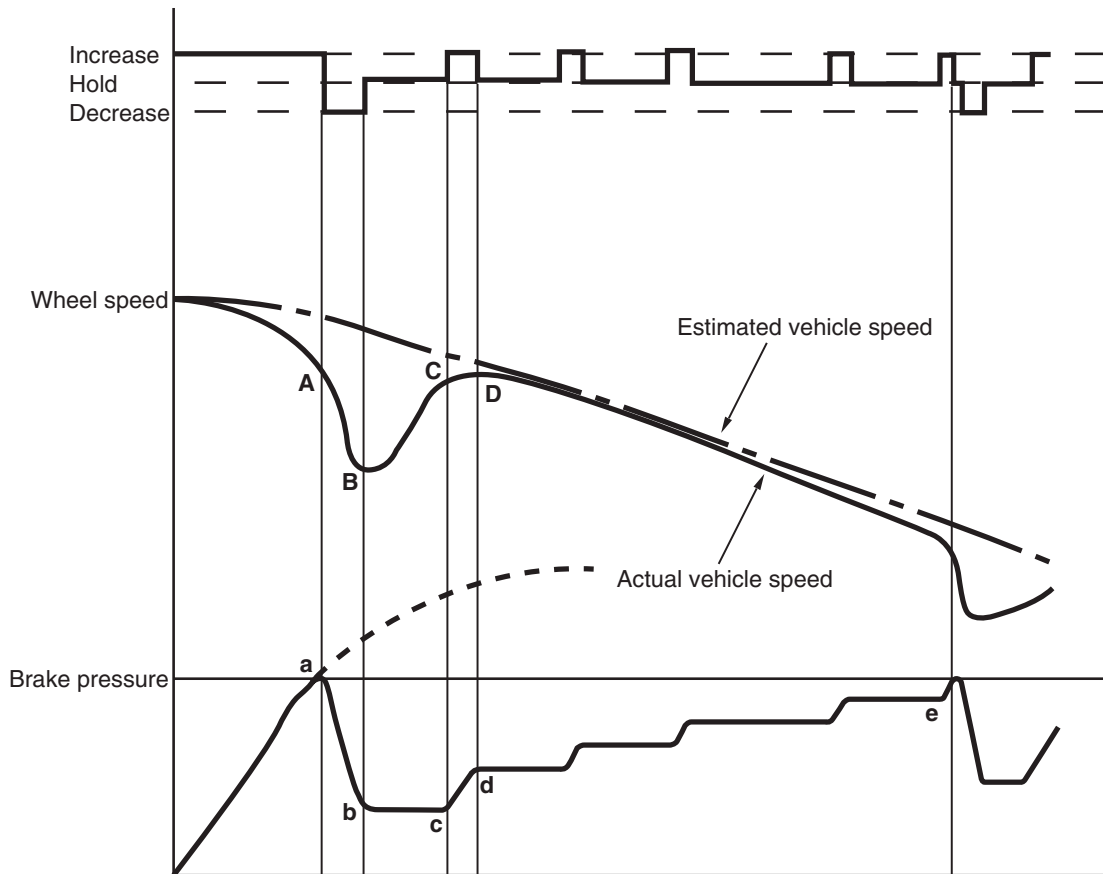
- By integrating ABS-ECU into the hydraulic unit, no wiring harness for sending drive signal of the solenoid valve and pump motor is required, assuring higher reliability.
- Self-diagnostic and memory functions are integrated into ABS-ECU. If any malfunction is detected by the self-diagnostic function,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

- ABS-ECU detects vehicle speed from the signals of the wheel speed sensor and its 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 hydraulic pressure control

ABS control cycle



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1. The ABS-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)

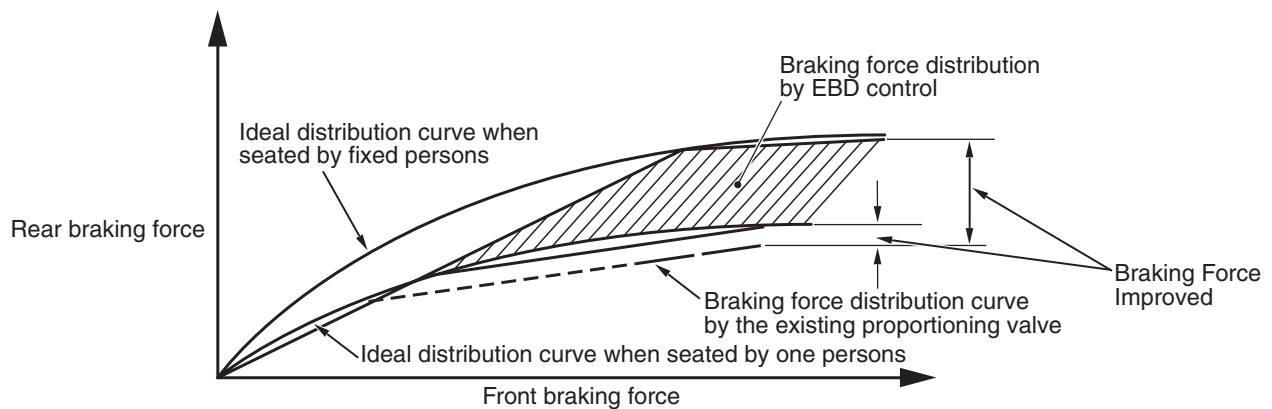
4. When the wheel speed deceleration is further recovered and overpasses the point C, ECU determines that the wheel lock possibility has been eliminated and increases the brake fluid pressure by outputting the pressure increase signal again. (between c and d)
5. Brake fluid pressure is controlled by repeating the increase and hold of the pressure. (between d and e)
6. When the wheel deceleration goes below the threshold again, ABS-ECU controls the brake fluid pressure by repeating the cycle (Step 2 to 5).

Four-wheel control

ABS fluid pressure is controlled independently for four wheels.

EBD fluid pressure control

EBD operating conceptual design



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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 certain 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.

INITIAL CHECK

ABS-ECU performs the following initial checks using the diagnostic functions. ABS-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, ABS-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 10 km/h (6 mph). As the ABS-ECU memorizes any diagnostic trouble code related to the wheel speed sensor malfunction recorded during the previous ignition ON status, ABS-ECU continues illuminating the ABS warning light until it verifies that the malfunction for that code is resolved (startup check).*

INITIAL CHECK

Performs self-diagnosis in ABS-ECU.

STARTUP CHECK

When the startup vehicle speed reaches approximately 10 km/h (6 mph), ABS-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
ABS-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. ABS-ECU
Performs self-diagnosis in ECU.

FAIL-SAFE FUNCTION

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

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

CAN COMMUNICATION

ABS-ECU outputs the ABS warning light and the EBD warning light* illumination request signals to the combination meter through CAN communication.

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

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DTC No.	Item	Countermeasures for failure			
		EBD control	ABS control	Brake warning light	ABS warning light
C100A	Abnormality in FL wheel speed sensor circuit	Executed (Prohibited when two or more wheels are faulty.)	Prohibited	Extinguished* ²	Illuminated* ³
C1015	Abnormality in FR wheel speed sensor circuit				
C1020	Abnormality in RL wheel speed sensor circuit				
C102B	Abnormality in RR wheel speed sensor circuit				
C1011	Abnormality in FL wheel speed sensor signal	Executed (Prohibited when two or more wheels are faulty.)	Prohibited	Extinguished* ²	Illuminated* ³
C101C	Abnormality in FR wheel speed sensor signal				
C1027	Abnormality in RL wheel speed sensor signal				
C1032	Abnormality in RR wheel speed sensor signal				

DTC No.	Item	Countermeasures for failure			
		EBD control	ABS control	Brake warning light	ABS warning light
C1014	Mutual monitoring of FL wheel speed sensor	Executed (Prohibited when two or more wheels are faulty.)	Prohibited	Extinguished ^{*2}	Illuminated ^{*3}
C101F	Mutual monitoring of FR wheel speed sensor				
C102A	Mutual monitoring of RL wheel speed sensor				
C1035	Mutual monitoring of RR wheel speed sensor				
C1041	Abnormality in periodical signal for FL wheel speed sensor	Executed (Prohibited when two or more wheels are faulty.)	Prohibited	Extinguished ^{*2}	Illuminated ^{*3}
C1042	Abnormality in periodical signal for FR wheel speed sensor				
C1043	Abnormality in periodical signal for RL wheel speed sensor				
C1044	Abnormality in periodical signal for RR wheel speed sensor				
C1046	FL wheel speed sensor control phase time exceeded	Executed (Prohibited when two or more wheels are faulty.)	Prohibited	Extinguished ^{*2}	Illuminated ^{*3}
C1047	FR wheel speed sensor control phase time exceeded				
C1048	RL wheel speed sensor control phase time exceeded				
C1049	RR wheel speed sensor control phase time exceeded				
C104B	Abnormality in FL wheel inlet valve system	Prohibited	Prohibited	Illuminates	Illuminates
C104F	Abnormality in FR wheel inlet valve system				
C1053	Abnormality in RL wheel inlet valve system				
C1057	Abnormality in RR wheel inlet valve system				
C105F	Abnormality in FL wheel outlet valve system	Prohibited	Prohibited	Illuminates	Illuminates
C1063	Abnormality in FR wheel outlet valve system				
C1067	Abnormality in RL wheel outlet valve system				
C105B	Abnormality in RR wheel outlet valve system				
C2104	Malfunction of valve power supply circuit	Prohibited	Prohibited	Illuminates	Illuminates
C1073	Malfunction of motor drive circuit	Executed	Prohibited	Extinguished	Illuminated ^{*3}

DTC No.	Item		Countermeasures for failure			
			EBD control	ABS control	Brake warning light	ABS warning light
C2116	Abnormality in pump motor power supply voltage		Executed	Prohibited	Extinguished	Illuminated* ³
C1000	Abnormality in stop light switch circuit		Executed	Executed	Extinguished	Extinguished
C2200	Abnormality in ABS-ECU		Prohibited	Prohibited	Illuminates	Illuminates
C2100	Battery voltage problem (low voltage)	9.7 ± 0.3 V or less* ¹	Executed	Prohibited	Extinguished	Illuminates
		8.0 ± 0.5 V or less* ¹	Prohibited	Prohibited	Illuminates	Illuminates
C2101	Battery voltage problem (high voltage)	18.0 ± 1.0 V or more	Prohibited	Prohibited	Illuminates	Illuminates
C1395	Brake fluid filling not completed		Executed	Executed	Extinguished	Flashes (1 Hz)
C2203	VIN not written		Executed	Executed	Extinguished	Illuminates
C1608	Implausible diagnosis data		Executed	Executed	Extinguished	Extinguished
U0001	Bus off		Executed	Executed	Extinguished	Extinguished
U0100	Engine time-out error		Executed	Executed	Extinguished	Extinguished
U0141	ETACS time-out error		Executed	Executed	Extinguished	Extinguished
U1415	Variant coding not implemented		Executed	Prohibited	Extinguished	Illuminates
U1417	Invalid variant coding value (including wrong assembly)		Executed	Prohibited	Extinguished	Illuminates

NOTE:

- *¹ This diagnostic trouble code is not set within the vehicle speed of 20 km/h (12 mph) or less.
- *² Turns ON when two or more wheels are faulty.
- *³ Stays ON until the vehicle speed reaches 10 km/h (6 mph) when the ignition switch is turned to ON next time.

DIAGNOSTIC FUNCTION

ABS-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

DIAGNOSTIC TROUBLE CODE SET

There are 43 diagnosis items. Since all the diagnostic results are recorded in volatile memory (EEPROM*), they are stored in the memory even though the battery terminals are disconnected.

NOTE:

- *EEPROM (Electrical Erasable & Programmable ROM): Special type of memory that can be programmed or erased electrically
- For each diagnosis item, refer to Service Manual.

SERVICE DATA OUTPUT

Using scan tool, the input data sent from the sensors and switches can be read.

NOTE: For service data items, refer to Service Manual.

ACTUATOR TEST

Using scan tool, the actuators can be forcibly operated.

NOTE:

- When ABS-ECU is disabled, the actuator test cannot be performed.
- The actuator test can be performed only when the vehicle is stationary. When the vehicle speed reaches 10 km/h (6 mph), the forcible actuator operation is disabled.
- During actuator test, the ABS warning light flashes in 2Hz, and ABS control is prohibited.
- For the actuator test specification, refer to Service Manual.