BRAKES

04 SECTION

OUTLINE 04-00
ON-BOARD DIAGNOSTIC. . . . 04-02
CONVENTIONAL BRAKE SYSTEM. 04-11
PARKING BRAKE SYSTEM . . . 04-12
ANTILOCK BRAKE SYSTEM . . 04-13
DYNAMIC STABILITY CONTROL. 04-15

04–00 OUTLINE

BRAKE ABBREVIATIONS 04–00–1
BRAKE FEATURES 04–00–1
BRAKE SPECIFICATIONS. 04–00–2

BRAKE ABBREVIATIONS

DPE040000000T01

ABS	Antilock Brake System
ATX	Automatic Transaxle
CAN	Controller Area Network
CM	Control Module
CPU	Central Processing Unit
~~DSC~~	~~Dynamic Stability Control~~
EBD	Electronic Brakeforce Distribution
HU	Hydraulic Unit
IG	Ignition
LF	Left Front
LR	Left Rear
~~MTX~~	~~Manual Transaxle~~
OFF	Switch Off
ON	Switch On
PID	Parameter Identification
RF	Right Front
RR	Right Rear
SW	Switch
~~TCS~~	~~Traction Control System~~
WDS	Worldwide Diagnostic System

BRAKE FEATURES

DPE040000000T02

Improved safety	• Intrusion minimizing brake pedal adopted • Large power brake unit (10 inch) with attached mechanical brake assist mechanism adopted • Electronic brakeforce distribution (EBD) control adopted • ABS adopted • ~~Dynamic stability control (DSC) adopted~~
Improved braking force	• Large diameter front disc brakes adopted • Large diameter rear disc brakes adopted • ~~Vacuum pump adopted (MZR-CD (RF Turbo))~~
Improved serviceability	• ~~Combined sensor integrating yaw rate and lateral G sensors adopted~~ • Enhanced malfunction diagnosis system for use with WDS or equivalent
Improved operability	• Center lever type parking brake, adjustable from vehicle interior, adopted
Size and weight reduction	• Integrated construction of the hydraulic unit (HU) and control module (CM) adopted for the ABS HU/CM ~~and DSC HU/CM~~ • Semi-conductor element type ABS wheel-speed sensor adopted • Magnetic encoder type ABS sensor rotor adopted
Improved brake pedal operability	• A master cylinder with smaller diameter long-stroke type has been adopted

Improved reliability	• Specialized CAN communication adopted for communications between the combined sensor and the DSC HU/CM • DSC HU/CM with built-in brake fluid pressure sensor

BRAKE SPECIFICATIONS

DPE040000000T03

Item		Specification
Brake pedal	Type	Suspended design
	Pedal lever ratio	2.8
	Max. stroke (mm {in})	117 {4.61}
Master cylinder	Type	Tandem
	Cylinder bore (mm {in})	22.2 {0.874}
Front brake (disc)	Type	Ventilated disc
	Cylinder bore (mm {in})	57 {2.2}
	Pad dimensions (area x thickness) (mm^2 x mm {in^2 x in})	5,140 × 12.0 {7.967 × 0.47}
	Disc plate dimensions (mm {in})	With 15 inch brake: 278 × 25 {10.9 × 0.98} With 16 inch brake: 300 × 25 {11.8 × 0.98}
Rear brake (disc)	Type	Solid disc
	Cylinder bore (mm {in})	38 {1.5}
	Pad dimensions (area x thickness) (mm^2 x mm {in^2 x in})	2,700 × 10.8 {4.185 × 0.43}
	Disc plate dimensions (mm {in})	With 15 inch brake: 280 × 11 {11.0 × 0.43} With 16 inch brake: 302 × 11 {11.9 × 0.43}
Power brake unit	Type	Vacuum multiplier, single diaphragm
	Outer diameter (mm {in})	272.1 {10.71}
Rear wheel braking force control device	Type	Electronic brakeforce distribution (EBD)
Brake piping	Piping layout	X pattern
Parking brake	Type	Mechanical design, rear two-wheel braking
	Operating method (application/release)	Manually operated lever design
	Play adjustment method	Auto-adjusting
Brake fluid	Type	European (L.H.D. U.K.) specs.: SAE J1703, FMVSS 116 DOT-3 or DOT-4 General (L.H.D. R.H.D.) specs.: SAE J1703, FMVSS 116 DOT-3

04–02 ON-BOARD DIAGNOSTIC

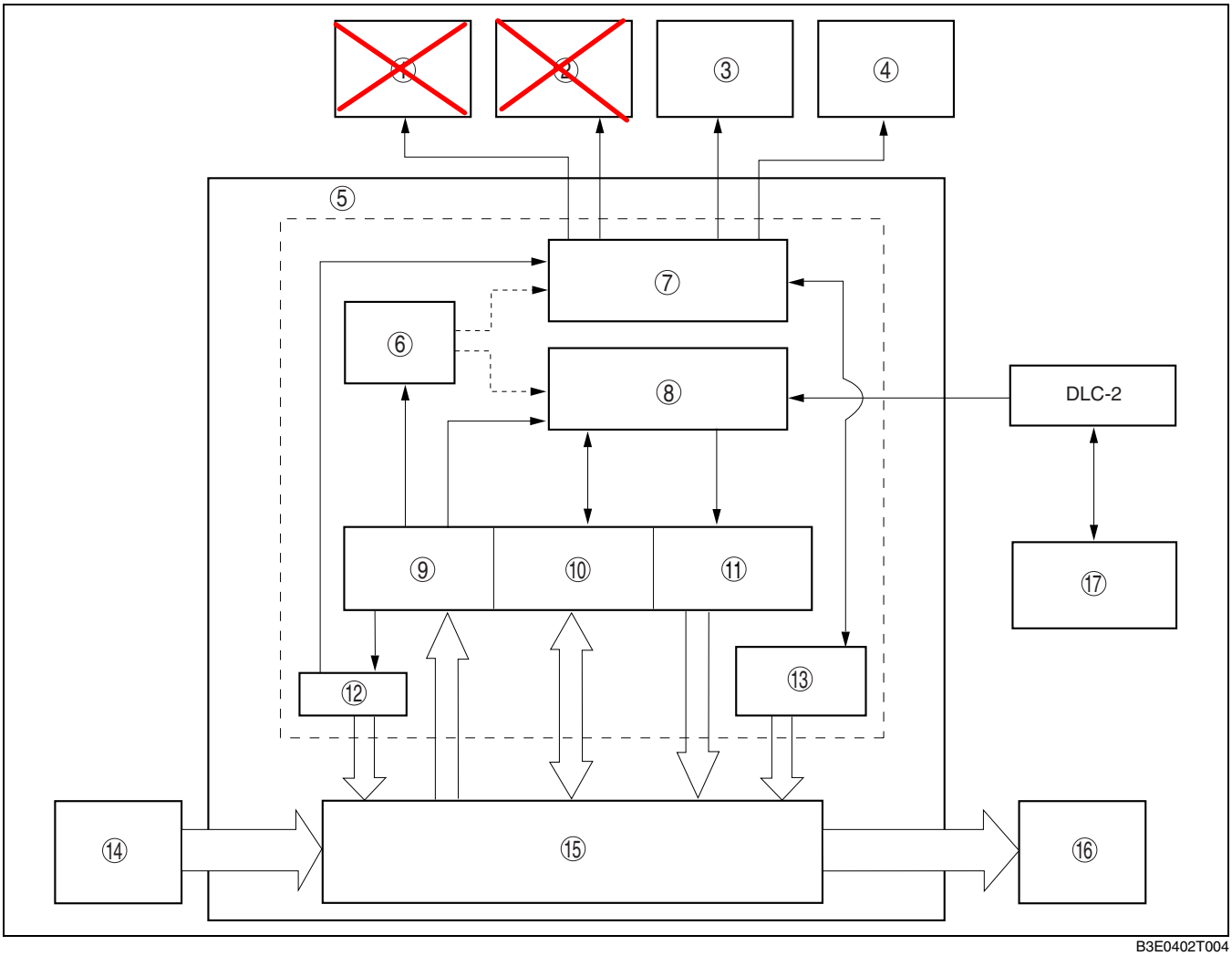
ON-BOARD DIAGNOSTIC SYSTEM OUTLINE [ABS, ~~DYNAMIC STABILITY CONTROL (DSC)~~] 04–02–1
ON-BOARD DIAGNOSTIC SYSTEM FUNCTION [ABS, ~~DYNAMIC STABILITY CONTROL (DSC)~~] 04–02–2
ON-BOARD DIAGNOSTIC SYSTEM PID/DATA MONITOR FUNCTION [ABS, ~~DYNAMIC STABILITY CONTROL (DSC)~~] 04–02–5
ON-BOARD DIAGNOSTIC SYSTEM ACTIVE COMMAND MODES FUNCTION [ABS, ~~DYNAMIC STABILITY CONTROL (DSC)~~] 04–02–6
ON-BOARD DIAGNOSTIC SYSTEM EXTERNAL TESTER COMMUNICATION FUNCTION [ABS, ~~DYNAMIC STABILITY CONTROL (DSC)~~] 04–02–7
DLC-2 CONSTRUCTION [ABS, ~~DYNAMIC STABILITY CONTROL (DSC)~~] 04–02–7

ON-BOARD DIAGNOSTIC SYSTEM OUTLINE [ABS, ~~DYNAMIC STABILITY CONTROL (DSC)~~]

DPE040243750T01

- The on-board diagnostic system consists of a malfunction detection system that detects abnormalities in input/output signals when the ignition switch is at the ON position, a data monitor function that reads out specified input/output signals and a active command modes function that allows for override operation of output parts (such as solenoid valves).
- The data link connector 2 (DLC-2), which groups together all the connectors used for malfunction diagnosis and detecting/repair into a single location, has been adopted, thereby improving serviceability. Diagnosis is performed by connecting the WDS or equivalent to the DLC-2.
- In addition to DTC read-out, the WDS or equivalent is used to clear DTCs using the display screen of the diagnostic tester, and to access the PID/data monitor and active command modes functions, providing enhanced malfunction diagnosis and improved serviceability.

Block Diagram



B3E0402T004

1	~~DSC indicator light (with DSC)~~	2	~~DSC OFF light (with DSC)~~

3	ABS warning light
4	Brake system warning light
5	On-board diagnostic function
6	Memory function
7	Malfunction display function
8	Serial communication
9	Malfunction detection function
10	PID/DATA monitor function
11	Active command modes function
12	Fail-safe function
13	HU inspection function
14	Input device
15	Normal control area
16	Output device
17	WDS or equivalent

ON-BOARD DIAGNOSTIC SYSTEM FUNCTION [ABS, ~~DYNAMIC STABILITY CONTROL (DSC)~~]

DPE040243750T02

Malfunction detection function

- The malfunction detection function detects malfunctions in the input/output signal system of the ABS HU/CM (vehicles with ABS) ~~or DSC HU/CM (vehicles with DSC~~) when the ignition switch is at the ON position.
- When the ABS HU/CM ~~and DSC HU/CM~~ are started up, the following malfunction detections are performed.
  ABS HU/CM
  — The ABS and brake system warning lights illuminate for **approx. 3.0 s** when the ignition switch is turned to the ON position to inspect for open circuits in the lights. At the same time, the fail-safe relay is operated, and the input/output signals of each part is monitored for malfunction diagnosis. After starting to drive, the first time the vehicle speed is **approx. 10 km/h {6.2 mph} or more** the pump motor is operated and malfunction diagnosis is performed again. Input/output signals are monitored for malfunction determination when the ignition switch is at the ON position.
  ~~**DSC HU/CM**~~
  — The ABS and brake system warning lights, and DSC indicator lights illuminate for **approx. 3.0 s** and the DSC OFF light illuminates for **approx. 1.8 s** when the ignition switch is turned to the ON position to inspect for open circuits in the lights. At the same time, the fail-safe relay is operated, and the input/output signals of each part is monitored for malfunction diagnosis. After starting to drive, the first time the vehicle speed is **approx. 10 km/h {6.2 mph} or more** the pump motor is operated and malfunction diagnosis is performed again. Input/output signals are monitored for malfunction determination when the ignition switch is at the ON position.
- When malfunctions are detected, the corresponding lights are illuminated to alert the driver. Using the external tester communication function, DTCs can be output through the CAN_H and CAN_L of the DLC-2. At the same time, malfunction detection results are sent to the memory and fail-safe functions.

Memory function

- The memory function stores DTCs of malfunctions in input/output signal systems. With this function, once a DTC is stored it is not cleared after the ignition switch has been turned off (LOCK position), even if the malfunctioning signal system has returned to normal.
- Since the ABS ~~and DSC~~ control modules have built-in non-volatile memory, DTCs are not cleared even if the battery is removed. Therefore, it is necessary to clear the memory after performing repairs. Refer to the Workshop Manual for the DTC clearing procedure.

Fail-safe function

- When the malfunction detection function determines a malfunction, each light illuminates to advise the driver. At this time, the fail-safe function controls the ABS, EBD, ~~TCS* and DSC*~~ as shown in the fail-safe function malfunction contents table.

~~*. Only vehicles with DSC~~

Warning

- **If EBD control is suspended the rear wheels could lock-up before the front wheels. If this occurs, the vehicle could swerve and become unstable. Therefore always inspect the system immediately if EBD control is suspended.**

Fail-safe Function Malfunction Contents ~~(Vehicles With ABS)~~

Malfunction location	DTC	Fail-safe function			
		Warning light illumination status		Control status	
	WDS or equivalent display	ABS warning light	Brake system warning light (when parking brake is released)	ABS control	EBD control
Power supply system	B1317	Illuminated	Illuminated	Control disabled	Control disabled
	B1318*1		Illuminated *2		Control disabled*2
			Not illuminated *3		Control enabled*3
ABS HU/CM (internal malfunction)	B1342	Illuminated	Illuminated	Control disabled	Control disabled
	C1267				
Pump motor, motor relay	C1095	Illuminated	Not illuminated	Control disabled	Control enabled
ABS sensor rotor	C1141	Illuminated	Not illuminated *4	Control disabled	Control enabled*5
	C1142				
	C1143				
	C1144				
ABS wheel-speed sensor	C1145	Illuminated	Not illuminated *4	Control disabled	Control enabled*5
	C1146				
	C1147				
	C1148				
ABS wheel-speed sensor/ABS sensor rotor	C1233	Illuminated	Not illuminated *4	Control disabled	Control enabled*5
	C1234				
	C1235				
	C1236				
Brake switch	C1446	Not illuminated	Not illuminated	Control enabled	Control enabled
CAN line	U1900	Not illuminated *6	Not illuminated *6	Control enabled	Control enabled
	U2012				

*1 : Detected if vehicle speed is **20 km/h {12.4 mph} or more** .
*2 : Detected regardless of time if at **approx. 8 V** .
*3 : Detected if condition of **approx. 9.7 V or less** continues for **210 ms or more** .
*4 : Illuminates when two wheels or more have a malfunction.
*5 : Control disabled when two wheels or more have a malfunction.
*6 : Illuminates depending on malfunction contents.

Fail-safe Function Malfunction Contents (Vehicles With DSC)

Malfunction location	DTC	Fail-safe function							
		Warning light illumination status				Control status			
	WDS or equivalent display	ABS warning light	Brake system warning light (when parking brake is released)	DSC indicator light	DSC OFF light	ABS control	EBD Control	TCS Control	DSC Control
Power supply system	B1317	Illuminated	Illuminated	Illuminated	Not illuminated	Control disabled	Control disabled	Control disabled	Control disabled
	B1318*1		Illuminated *2				Control disabled *2		
			Not illuminated *3				Control enabled *3		
DSC HU/CM (internal malfunction)	B1342	Illuminated	Illuminated	Illuminated	Not illuminated	Control disabled	Control disabled	Control disabled	Control disabled
	C1267								
Vehicle data not recorded	B2141*4	Not illuminated	Not illuminated	Illuminated *5	Not illuminated	Control enabled	Control enabled	Control disabled *6	Control disabled *6
Combined sensor system (internal malfunction)	B2741	Not illuminated	Not illuminated	Illuminated	Not illuminated	Control enabled	Control enabled	Control disabled	Control disabled
DSC OFF switch	C1093	Not illuminated	Not illuminated	Not illuminated	Not illuminated	Control enabled	Control enabled	Control enabled	Control enabled
Pump motor, motor relay	C1095	Illuminated	Not illuminated	Illuminated	Not illuminated	Control disabled	Control enabled	Control disabled	Control disabled
ABS sensor rotor	C1141	Illuminated	Not illuminated *7	Illuminated	Not illuminated	Control disabled	Control enabled *8	Control disabled	Control disabled
	C1142								
	C1143								
	C1144								
ABS wheel-speed sensor	C1145	Illuminated	Not illuminated *7	Illuminated	Not illuminated	Control disabled	Control enabled *8	Control disabled	Control disabled
	C1155								
	C1165								
	C1175								
ABS wheel-speed sensor/ ABS sensor rotor	C1233	Illuminated	Not illuminated *7	Illuminated	Not illuminated	Control disabled	Control enabled *8	Control disabled	Control disabled
	C1234								
	C1235								
	C1236								
Steering angle sensor	C1277	Not illuminated	Not illuminated	Illuminated	Not illuminated	Control enabled	Control enabled	Control disabled	Control disabled
	C1278								
	C1306								
	C1307								
Combined sensor system	C1279	Not illuminated	Not illuminated	Illuminated	Not illuminated	Control enabled	Control enabled	Control disabled	Control disabled
	C1280								
	C1281								
	C1282								
	C2778								
Brake fluid pressure sensor	C1288	Not illuminated	Not illuminated	Illuminated	Not illuminated	Control enabled	Control enabled	Control disabled	Control disabled
	C1440								
Brake switch	C1446	Not illuminated	Not illuminated	Not illuminated	Not illuminated	Control enabled	Control enabled	Control enabled	Control enabled
TCS control system	C1470	Not illuminated	Not illuminated	Not illuminated	Not illuminated	Control enabled	Control enabled	Control enabled	Control enabled

Malfunction location	DTC	Fail-safe function							
		Warning light illumination status				Control status			
	WDS or equivalent display	ABS warning light	Brake system warning light (when parking brake is released)	DSC indicator light	DSC OFF light	ABS control	EBD Control	TCS Control	DSC Control
Brake fluid pressure sensor power supply	C1730	Not illuminated	Not illuminated	Illuminated	Not illuminated	Control enabled	Control enabled	Control disabled	Control disabled
TCS/DSC control system	C1994	Not illuminated	Not illuminated	Illuminated	Not illuminated	Control enabled	Control enabled	Control disabled	Control disabled
Combined sensor (initialization procedure not performed)	C2785	Not illuminated	Not illuminated	Illuminated	Not illuminated	Control enabled	Control enabled	Control disabled	Control disabled
CAN line	U1900 U2012 U2023 U2202	Not illuminated *9	Not illuminated *9	Illuminated	Not illuminated	Control enabled	Control enabled	Control disabled	Control disabled
Combined sensor (CAN 2 line malfunction)	U1901 U2527	Not illuminated	Not illuminated	Illuminated	Not illuminated	Control enabled	Control enabled	Control disabled	Control disabled

*1 : Detected if vehicle speed is **20 km/h {12.4 mph} or more** .
*2 : Detected regardless of time if at **approx. 8 V** .
*3 : Detected if condition of **approx. 9.7 V or less** continues for **210 ms or more** .
*4 : DTC B2141 (vehicle data not recorded) is stored in the memory only when the ignition switch is turned to the ON position for the first time after DSC HU/CM replacement. Since the vehicle data is downloaded from the PCM via a CAN line when the ignition switch is turned to the ON position, it is only stored as a past malfunction when the ignition switch is turned off and then turned to the ON position.
*5 : Illuminates only when the ignition switch is turned to the ON position for the first time after DSC HU/CM replacement.
*6 : Disabled only when the ignition switch is turned to the ON position for the first time after DSC HU/CM replacement.
*7 : Illuminates when two wheels or more have a malfunction.
*8 : Control disabled when two wheels or more have a malfunction.
*9 : Illuminates depending on malfunction contents.

04

ON-BOARD DIAGNOSTIC SYSTEM PID/DATA MONITOR FUNCTION [ABS, ~~DYNAMIC STABILITY CONTROL (DSC)~~]

DPE040243750T03

- The PID/data monitor function is used for optionally selecting input/output signal monitor items preset in the ABS HU/CM or DSC HU/CM and reading them out in real-time.

PID/DATA Monitor Table ~~(Vehicles with ABS)~~

WDS or equivalent display	Input/output part name	Unit/Operation (WDS display)
BOO_ABS	Brake switch	On/Off
CCNTABS	DTC (amount detected)	—
LF_WSPD	ABS wheel-speed sensor (LF)	KPH/MPH
LR_WSPD	ABS wheel-speed sensor (LR)	KPH/MPH
RF_WSPD	ABS wheel-speed sensor (RF)	KPH/MPH
RR_WSPD	ABS wheel-speed sensor (RR)	KPH/MPH

PID/DATA Monitor Table (Vehicles with DSC)

WDS or equivalent display	Input/output part name	Unit/Operation (WDS display)
BOO_ABS	Brake switch	On/Off
CCNTABS	DTC (amount detected)	—
ESP_VOLT	IVD/DSC sensor supply voltage	V
LAT_ACCL	Combined sensor (lateral-G sensor)	G
LF_WSPD	ABS wheel-speed sensor (LF)	KPH/MPH
LR_WSPD	ABS wheel-speed sensor (LR)	KPH/MPH
MPRETDR	Brake fluid pressure sensor	Pa
RF_WSPD	ABS wheel-speed sensor (RF)	KPH/MPH
RR_WSPD	ABS wheel-speed sensor (RR)	KPH/MPH
SWA POS	Steering angle sensor	°
TCYC_FS	DSC HU/CM	On/Off
TCYC_SW	DSC OFF switch	Depressed/Not Depressed
YAW_RATE	Combined sensor (yaw rate value)	°/s

ON-BOARD DIAGNOSTIC SYSTEM ACTIVE COMMAND MODES FUNCTION [ABS, DYNAMIC STABILITY CONTROL (DSC)]

DPE040243750T04

- The active command modes function is used for optionally selecting simulation items of input/output parts preset in the ABS HU/CM or DSC HU/CM, and to operate them regardless of CM control.
- To protect the hydraulic unit interior, operate output related parts for only **2 s or less** when using the active command modes function.

Active Command Modes Function Table (Vehicles with ABS)

Command name	Output part name	Operation	Operating condition
LF_INLET	LF inlet solenoid valve	On/Off	Ignition switch at ON
LF_OUTLET	LF outlet solenoid valve		
LR_INLET	LR inlet solenoid valve		
LR_OUTLET	LR outlet solenoid valve		
PMP_MOTOR	Pump motor		
RF_INLET	RF inlet solenoid valve		
RF_OUTLET	RF outlet solenoid valve		
RR_INLET	RR inlet solenoid valve		
RR_OUTLET	RR outlet solenoid valve		

Active Command Modes Function Table (Vehicles with DSC)

Command name	Output part name	Operation	Operating condition
LATACCEL	Combined sensor (lateral acceleration) initialization	True/False	Ignition switch at ON
LF_INLET	LF inlet solenoid valve	On/Off	
LF_OUTLET	LF outlet solenoid valve		
LF_TC_PRV	LF stability control solenoid valve		
LF_TC_SWV	LF traction control solenoid valve		
LR_INLET	LR inlet solenoid valve		
LR_OUTLET	LR outlet solenoid valve		
MCYL_S_CAL	Brake fluid pressure sensor initialization	True/False	
PMP_MOTOR	Pump motor	On/Off	
RF_INLET	RF inlet solenoid valve		
RF_OUTLET	RF outlet solenoid valve		
RF_TC_PRV	RF stability control solenoid valve		
RF_TC_SWV	RF traction control solenoid valve		
RR_INLET	RR inlet solenoid valve		
RR_OUTLET	RR outlet solenoid valve		
YAWRATE	Combined sensor (yaw rate) initialization		

ON-BOARD DIAGNOSTIC SYSTEM EXTERNAL TESTER COMMUNICATION FUNCTION [ABS, ~~DYNAMIC STABILITY CONTROL (DSC)~~]

DPE040243750T05

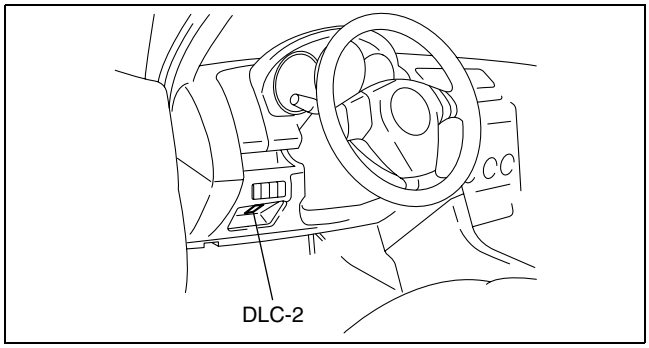
- The external tester communication function enables communication of diagnostic data (DTC read-outs, input/output signal read-outs, and operation of input/output parts) between the ABS HU/CM ~~or the DSC HU/CM~~ and an external tester.

Connections/Communication Contents

	External tester	
	WDS or equivalent	
	Connection	Communication method
On-board diagnostic (malfunction detection) function	Input/output: CAN_H (HS), CAN_L (HS)	Serial communication
PID/DATA monitor function	Input/output: CAN_H (HS), CAN_L (HS)	Serial communication
Active command modes function	Input/output: CAN_H (HS), CAN_L (HS)	Serial communication

Serial communication

- Serial communication (two-way communication) allows for multiple data to be sent and received instantly along the same line.
- By connecting the WDS or equivalent to the DLC-2, diagnostic data can be sent and received between the WDS or equivalent and the ABS HU/CM ~~or DSC HU/CM~~ using the CAN_H and CAN_L terminals (within the DLC-2).
- The ABS HU/CM ~~or DSC HU/CM~~ receives the command signals of the malfunction detection function, PID/data monitor function, and the active command modes function from the WDS or equivalent, and sends DTCs and data regarding the operating condition and status of each input/output part to the WDS or equivalent.



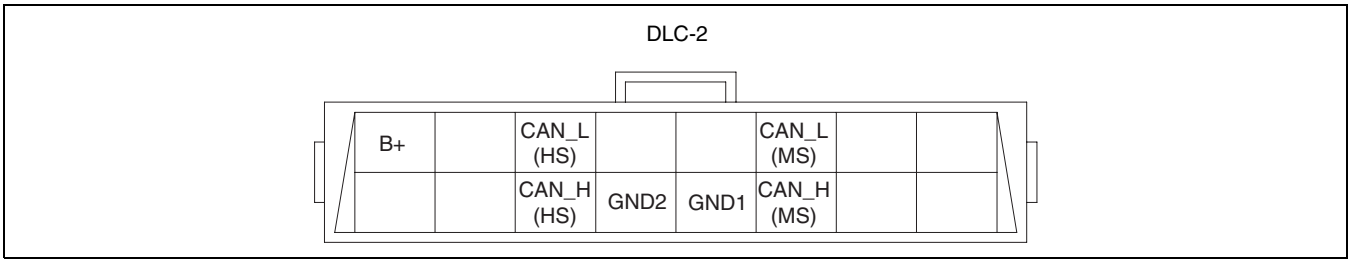
DPE402AW1005

Diagnostic function name	Signal received	Signal sent
Malfunction detection function	DTC verification signal	Diagnostic trouble code
PID/DATA monitor function	Command signal to read selected monitor item	Monitored data for requested monitor item
Active command modes function	Operation command signal for selected active command modes item	Output part drive signal

DLC-2 CONSTRUCTION [ABS, ~~DYNAMIC STABILITY CONTROL (DSC)~~]

DPE040243750T06

- A connector (DLC-2) conforming to International Organization for Standardization (ISO) standards has been adopted.
- Shape and terminal arrangement as stipulated by the ISO 15031-3 (SAE J1962) international standard has been adopted for this connector. The connector has a 16-pin construction that includes the CAN_H (HS), CAN_L (HS), CAN_H (MS), CAN_L (MS), GND1, GND2 and B+ terminals.



C3U0402S002

Terminal	Function
CAN_L (HS)	Serial communication Lo terminal (HS)
CAN_H (HS)	Serial communication Hi terminal (HS)
CAN_L (MS)	Serial communication Lo terminal (MS)
CAN_H (MS)	Serial communication Hi terminal (MS)
GND1	Body GND terminal
GND2	Serial communication GND terminal
B+	Battery power supply terminal

04–11 CONVENTIONAL BRAKE SYSTEM

CONVENTIONAL BRAKE SYSTEM OUTLINE 04–11–1
CONVENTIONAL BRAKE SYSTEM STRUCTURAL VIEW 04–11–2
INTRUSION-MINIMIZING BRAKE PEDAL FUNCTION 04–11–2
INTRUSION-MINIMIZING BRAKE PEDAL OPERATION 04–11–2
MASTER CYLINDER CONSTRUCTION. 04–11–3
POWER BRAKE UNIT FUNCTION 04–11–4
POWER BRAKE UNIT CONSTRUCTION/ OPERATION 04–11–5
~~VACUUM PUMP CONSTRUCTION [MZR-CD (RF Turbo)] . . . . . 04–11–8~~
FRONT BRAKE (DISC) CONSTRUCTION 04–11–8
REAR BRAKE (DISC) CONSTRUCTION 04–11–9

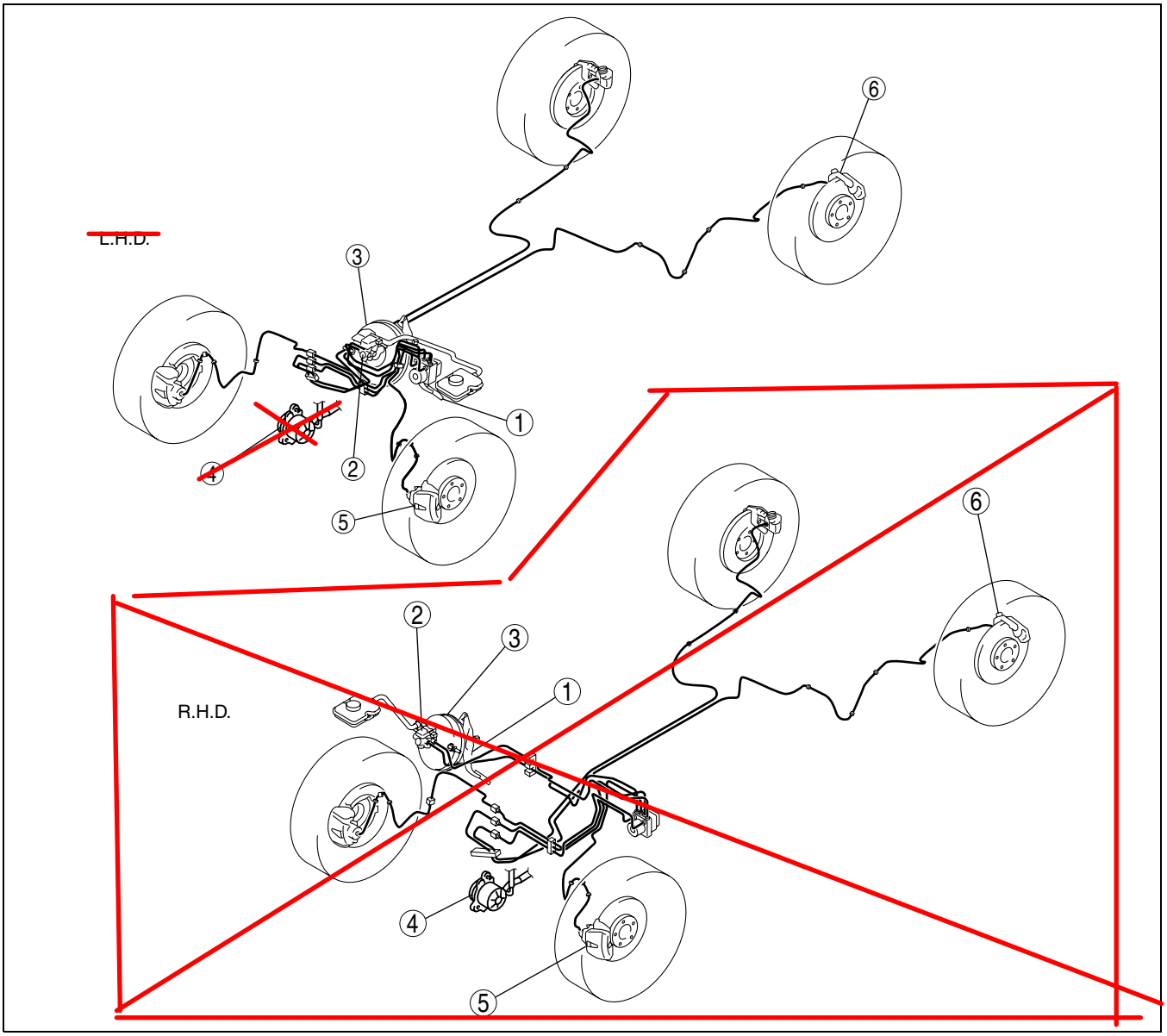
CONVENTIONAL BRAKE SYSTEM OUTLINE

DPE041100000T01

- A brake pedal with an intrusion minimizing mechanism has been adopted. As a result, driver safety has been improved.
- A small diameter long-stroke type master cylinder has been adopted, improving operability and response.
- A large diameter, single diaphragm power brake unit with a mechanical assist mechanism has been adopted, improving braking force and safety.
- ~~A vacuum pump has been adopted, improving braking force. (MZR-CD (RF Turbo))~~
- A large diameter, ventilated disc-type front brake has been adopted, improving braking force.
- A large diameter, solid disc-type rear brake has been adopted, improving braking force.

CONVENTIONAL BRAKE SYSTEM STRUCTURAL VIEW

DPE041100000T02



DPE411ZT1001

1	Brake pedal
2	Master cylinder
3	Power brake unit

4	Vacuum pump (MZR-CD (RF Turbo))
5	Front brake (disc)
6	Rear brake (disc)

INTRUSION-MINIMIZING BRAKE PEDAL FUNCTION

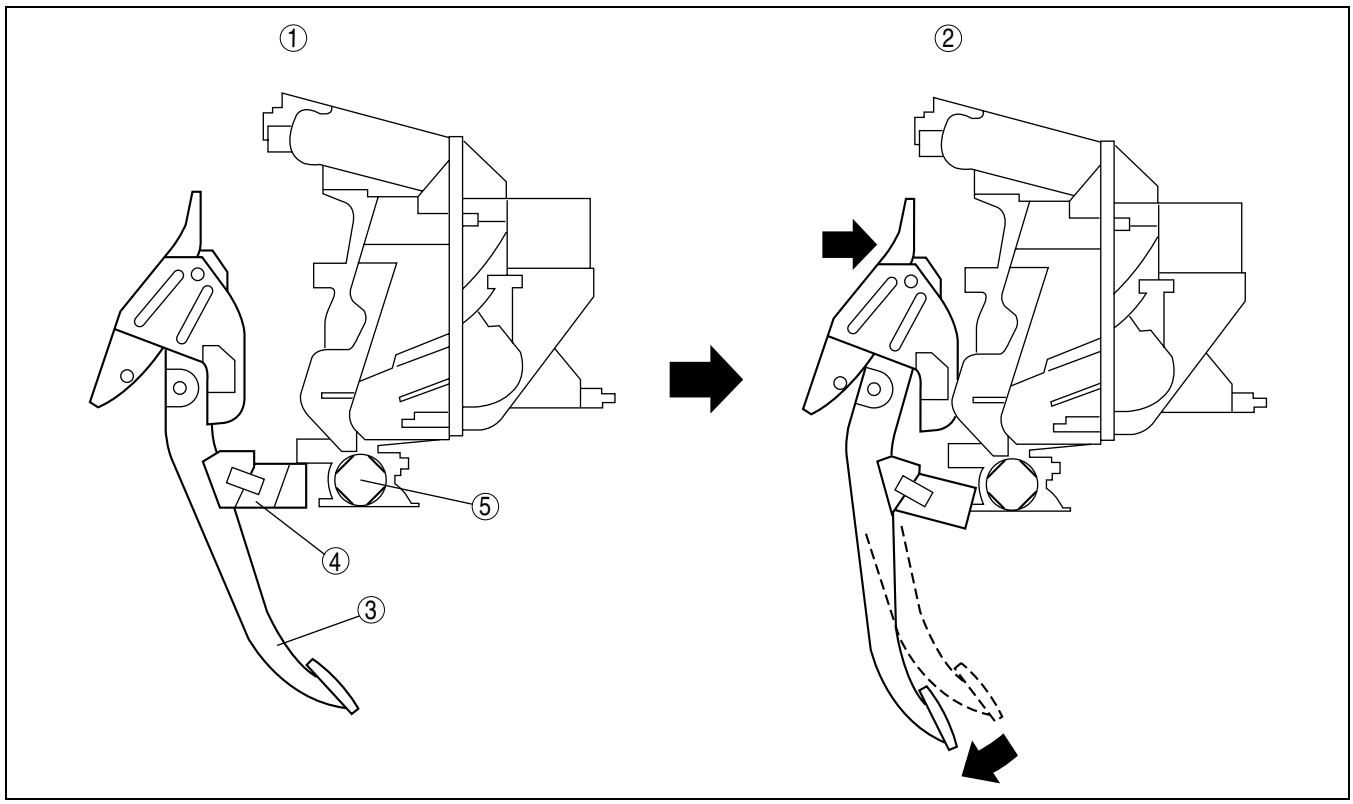
DPE041143300T01

- An intrusion-minimizing brake pedal, which minimizes the amount of rearward pedal thrust in a frontal collision, has been adopted. Due to this, impact force to the lower body of the driver is softened.

INTRUSION-MINIMIZING BRAKE PEDAL OPERATION

DPE041143300T02

- In a frontal collision, the brake pedal is forced rearward by the movement of the engine and other parts.
- Pedal arm section A of the rearward moving brake pedal contacts the cross-beam.
- Pedal arm section A rotates where it contacts the cross-beam, preventing rearward movement of the brake pedal.



B3E0411T012

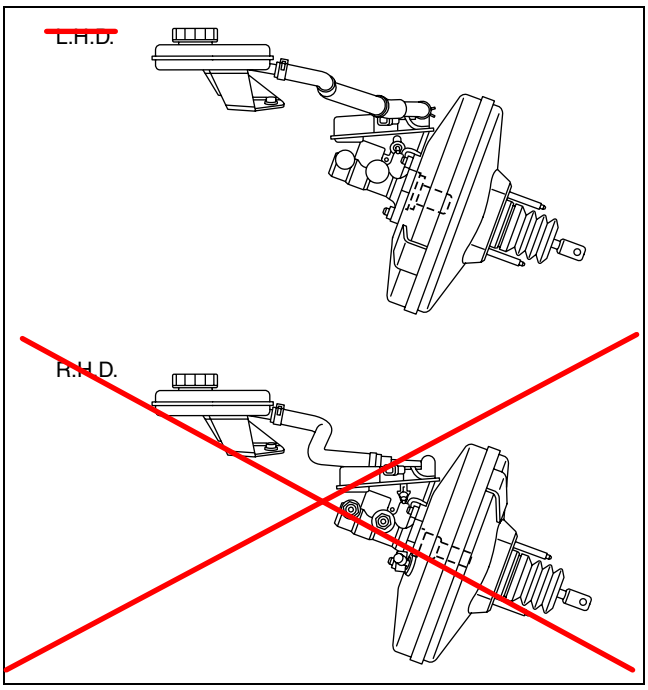
1	Normal condition
2	During collision
3	Brake pedal

4	Pedal arm section A
5	Cross-beam

MASTER CYLINDER CONSTRUCTION

DPE041143400T01

- With the adoption of the master cylinder having a long stroke and small diameter (**22.2 mm {0.874 in}**), brake pedal operability has been improved.
- ~~For vehicles with DSC, the diameter of the pipe between the master cylinder and the DSC HU/CM has been increased, improving response during DSC operation.~~
- Except for the reserve tank, the master cylinder cannot be disassembled. Therefore, if there is any malfunction in the interior of the master cylinder, replace the cylinder component without disassembling.



DPE411ZT1002

POWER BRAKE UNIT FUNCTION

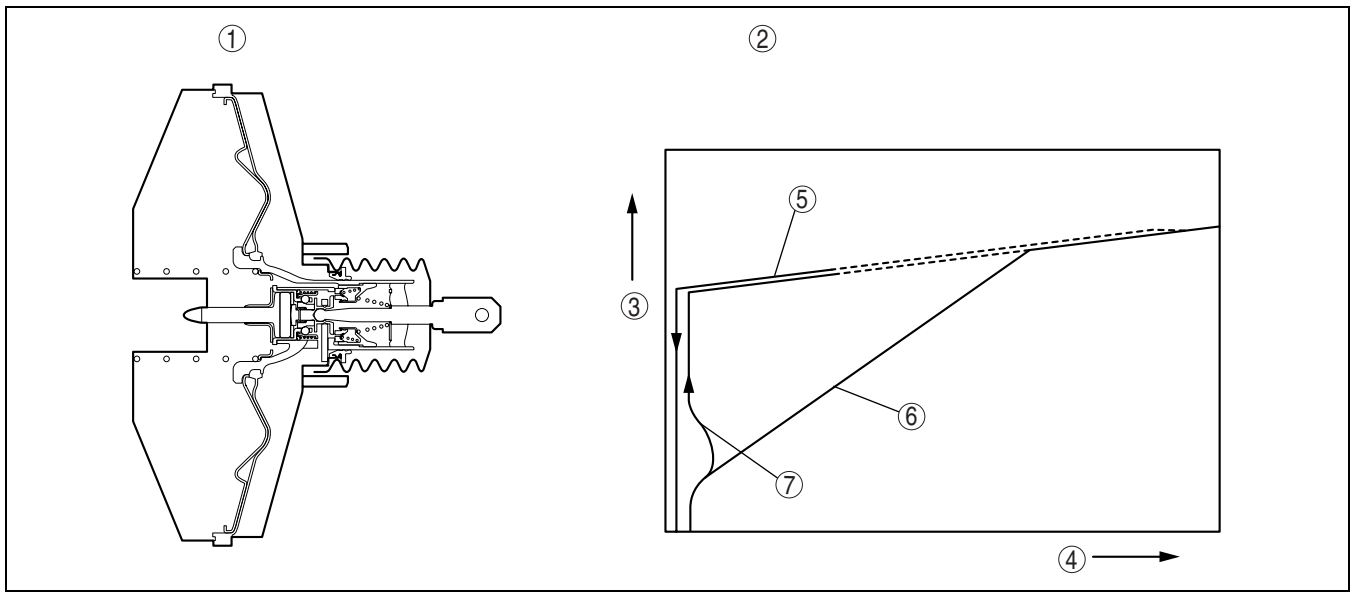
DPE041143800T01

Function

- A 10-inch, single diaphragm type power brake unit has been adopted for all models, achieving compatibility between high braking performance and excellent brake feeling.
- With the adoption of a brake assist function for ABS ~~and DSC~~ equipped vehicles, brake system (including ABS during emergency braking) effectiveness has been further improved.
  - — The brake assist function operates by aiding braking operation during emergency braking or other times when a high amount of brake power is required.
  - — Inexperienced drivers or drivers who panic during emergency braking may apply the brakes quickly but without sufficient force, or they may apply sufficient force but cannot maintain it for a continuous period. In these cases, the normal vehicle braking performance cannot exert sufficient force.
  - — The brake assist function determines, based on brake pedal depression speed and force, if emergency braking is occurring. If it occurs, the power brake unit applies maximum braking power.
- The structure of the brake assist function, built into the power brake unit, is simple and mechanical, to ensure a high level of reliability.

Note

- When the brake pedal is depressed, the following effects may be felt. These are normal effects of the brake assist operation and do not indicate an abnormality.
  - — When the brake pedal is depressed strongly or depressed at higher speeds, the pedal will feel softer but the brakes will be applied strongly.
  - — When the brake pedal is depressed strongly or depressed at higher speeds, a clicking noise from the brake booster may be heard.
- The brake assist equipment does not supersede the functionality of the main braking system.



B3E0411T002

1	Cross-sectional view
2	Output characteristics
3	Output
4	Input

5	During brake assist operation
6	During normal braking
7	Operation characteristic (change according to pedal force)

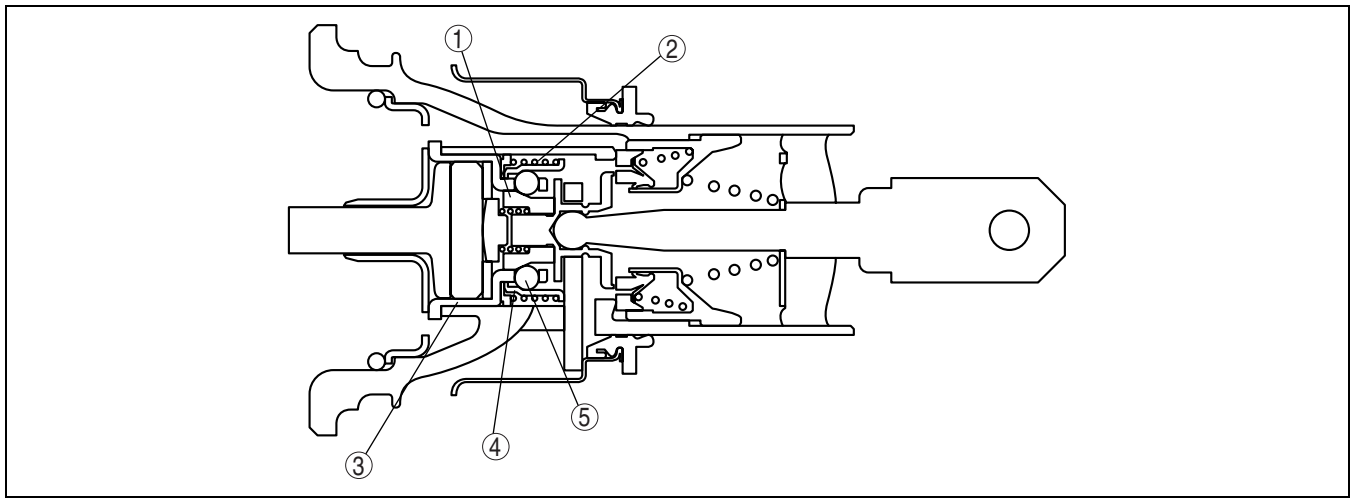
POWER BRAKE UNIT CONSTRUCTION/OPERATION

DPE041143800T02

04

Construction

- The basic construction of the power brake unit with brake assist function is the same as a conventional unit with the addition of the following parts:
  - — Ball
  - — Ball cage
  - — Ball sleeve
  - — Lock sleeve
  - — Spring



B3E0411T003

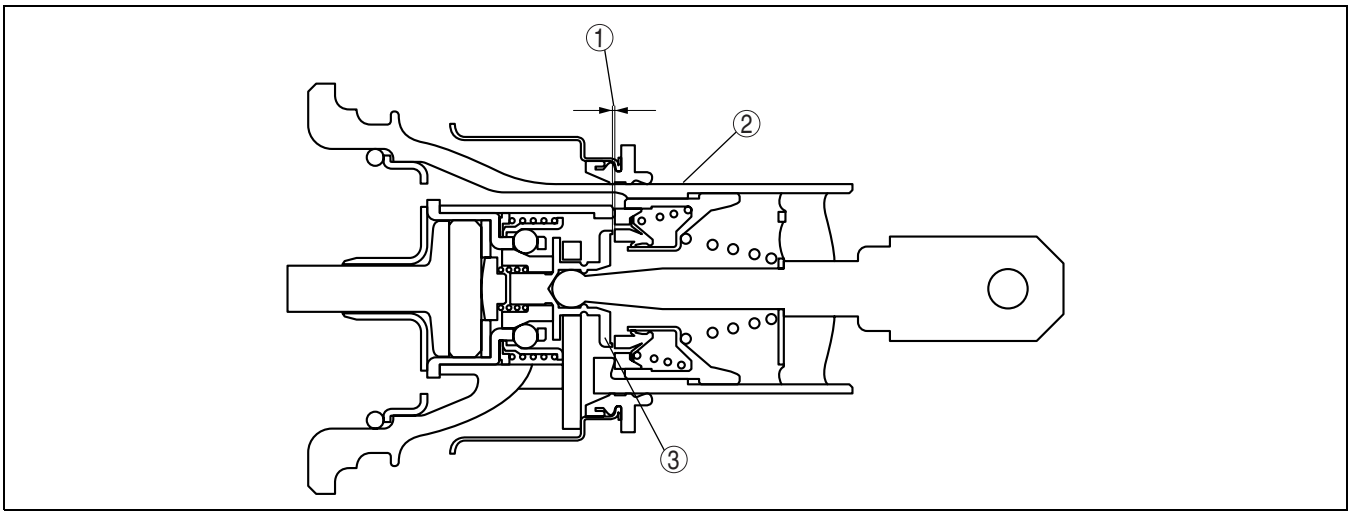
1	Ball sleeve
2	Spring
3	Ball cage

4	Lock sleeve
5	Ball

Operation

Operation outline

- When the brake pedal is depressed, the valve piston, inside the power brake unit, moves ahead of the control housing to create a relative travel distance which the brake assist function utilizes. This relative travel distance varies in relation to pedal speed depression and force in the following ways.
  - — Slow and weak pedal force applied (normal braking): Small relative travel distance
  - — Quick and strong pedal force applied (emergency braking): Large relative travel distance
- The brake assist function determines emergency braking when the relative difference exceeds the specified amount.



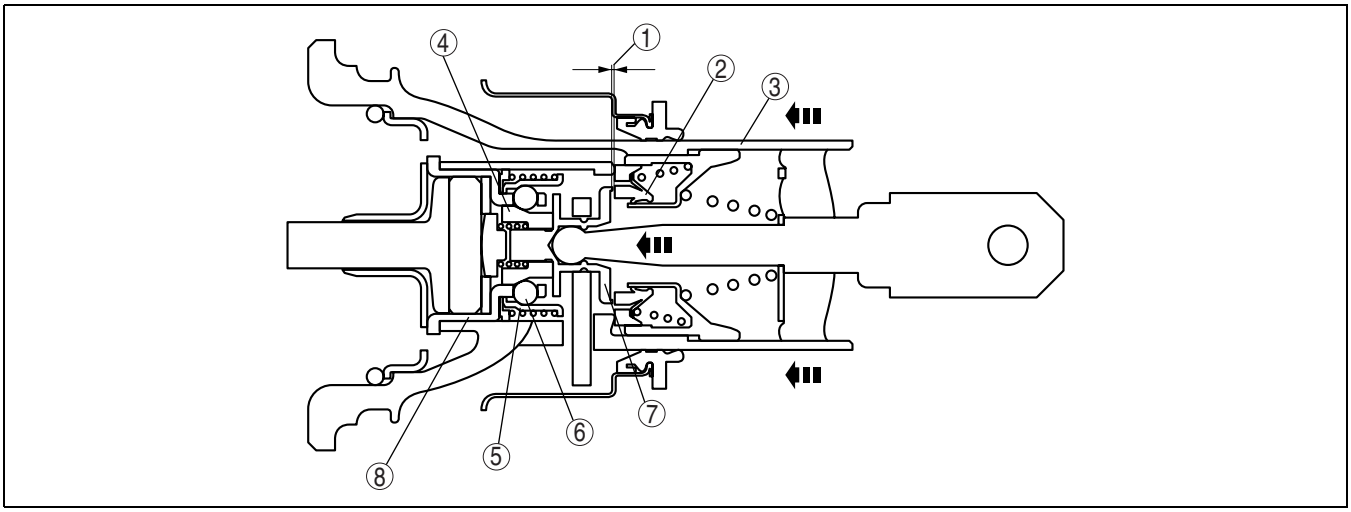
B3E0411T004

1	Valve piston and control housing relative travel distance (gap)

2	Control housing
3	Valve piston

During normal braking

- During normal braking, due to the relative travel distance of the valve piston and control housing being extremely small, the lock sleeve is held in its original position by the force applied by the spring. At the same time, the ball cage remains free to move axially and the balls remain free to move vertically.
- Therefore, the ball sleeve moves following the control housing, thereby closing the disc valve. This allows hydraulic pressure to be applied in relation to the pedal force of the driver.



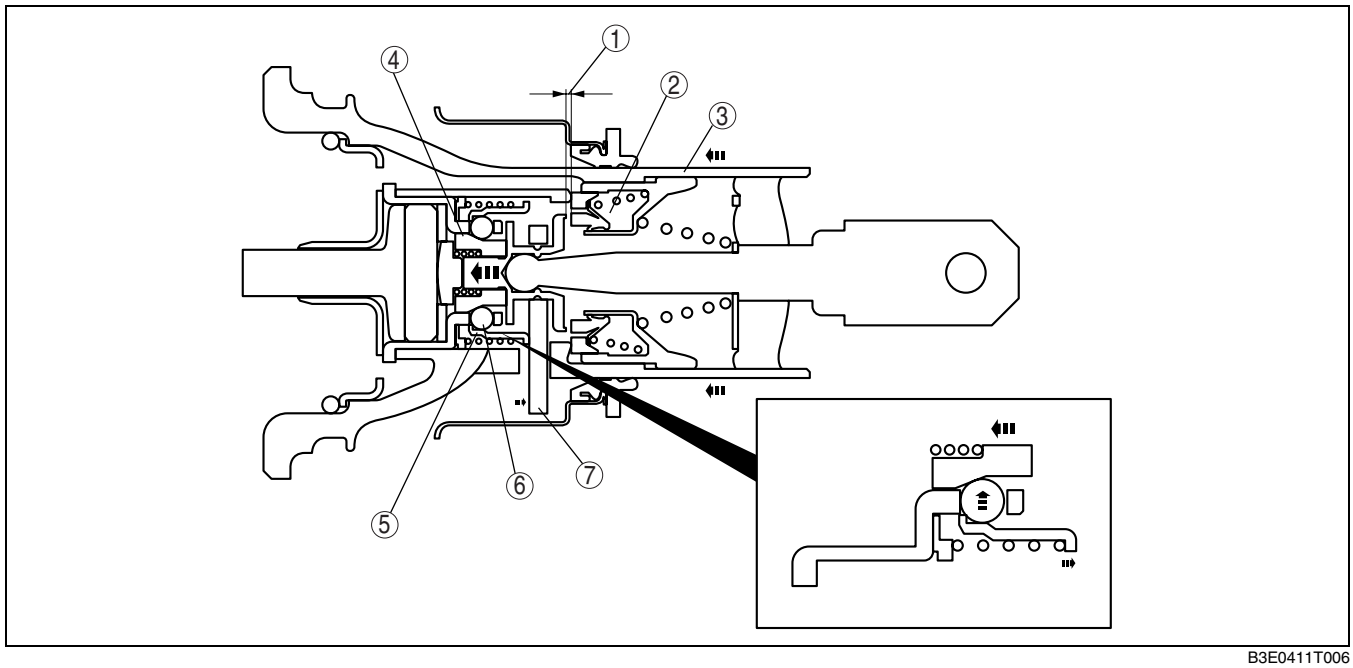
B3E0411T005

1	Valve piston and control housing relative travel distance (gap: small)
2	Disc valve
3	Control housing
4	Ball sleeve

5	Lock spring
6	Ball
7	Valve piston
8	Ball gauge

During brake assist operation

- During emergency braking, the relative travel distance of the valve piston and control housing exceeds the specified amount for brake assist. When this occurs, the balls are moved in over the slope of the ball sleeve and the lock sleeve is moved up against the key. Due to this, the balls become locked and the ball sleeve can no longer be moved in the closing direction of the disc valve.
- As a result, the brake assist functions by maintaining the increased hydraulic pressure in the power brake unit at its maximum (wheel locking limit), regardless of the pedal force applied.
- The amount of change in braking force during brake assist operation is the same as the brake pedal stroke amount (pedal force).



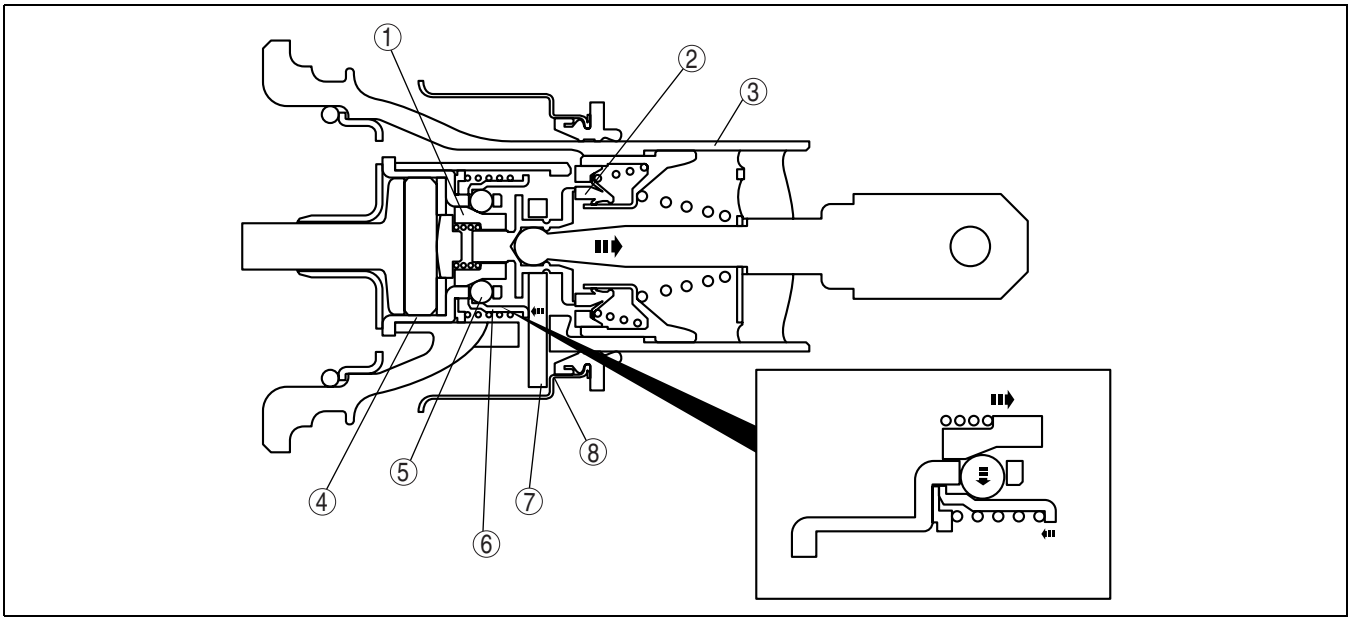
B3E0411T006

1	Valve piston and control housing relative travel distance (gap: large)
2	Disc valve
3	Control housing

4	Ball sleeve
5	Lock sleeve
6	Ball
7	Key

After brake assist release

- When the brake pedal is fully released, the control housing and valve piston return to their original position. The key is pressed against the vacuum cylinder, and the lock sleeve is slid back to its original position the same time as the balls are moved outward by the ball sleeve.
- As a result, the ball sleeve is again free to move axially and the balls are free to move vertically. Braking operation returns to normal.



B3E0411T007

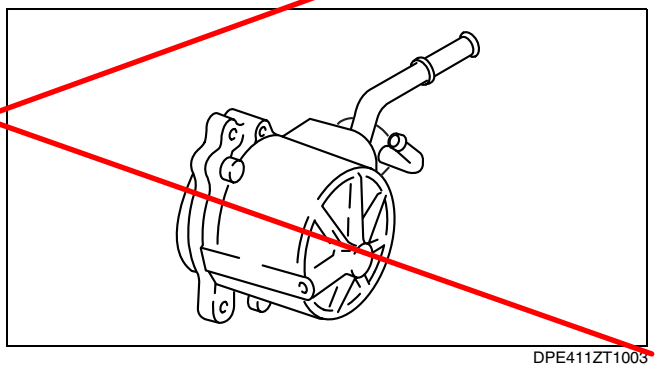
1	Ball sleeve
2	Valve piston
3	Control housing
4	Ball gauge

5	Ball
6	Lock sleeve
7	Key
8	Vacuum cylinder

VACUUM PUMP CONSTRUCTION [MZR-CD (RF TURBO)]

DPE041118777T01

- A vacuum pump with a camshaft system has been adopted for the MZR-CD (RF Turbo) engine for improved braking force.



DPE411ZT1003

FRONT BRAKE (DISC) CONSTRUCTION

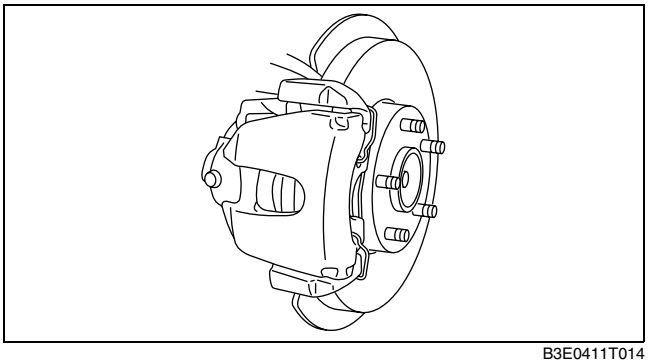
DPE041133980T01

With 15 inch brake

- Large diameter, ventilated disc type front brakes with a **278 mm {10.9 in}** diameter and **25 mm {0.98 in}** thickness have been adopted, improving braking force and fade resistance.

With 16 inch brake

- Large diameter, ventilated disc type front brakes with a **300 mm {11.8 in}** diameter and a **25 mm {0.98 in}** thickness have been adopted, improving braking force and fade resistance.



B3E0411T014

REAR BRAKE (DISC) CONSTRUCTION

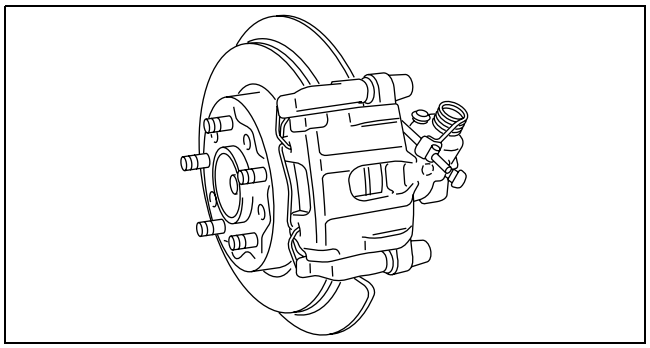
DPE041126980T01

With 15 inch brake

- Large diameter, solid-disc type rear brakes with a **280 mm {11.0 in}** diameter and **11 mm {0.43 in}** thickness have been adopted, improving braking force and fade resistance.

With 16 inch brake

- Large diameter, solid-disc type rear brakes with a **302 mm {11.9 in}** diameter and **11 mm {0.43 in}** thickness have been adopted, improving braking force and fade resistance.



B3E0411T015

04–12 PARKING BRAKE SYSTEM

PARKING BRAKE SYSTEM OUTLINE. . 04–12–1
PARKING BRAKE SYSTEM STRUCTURAL VIEW 04–12–1

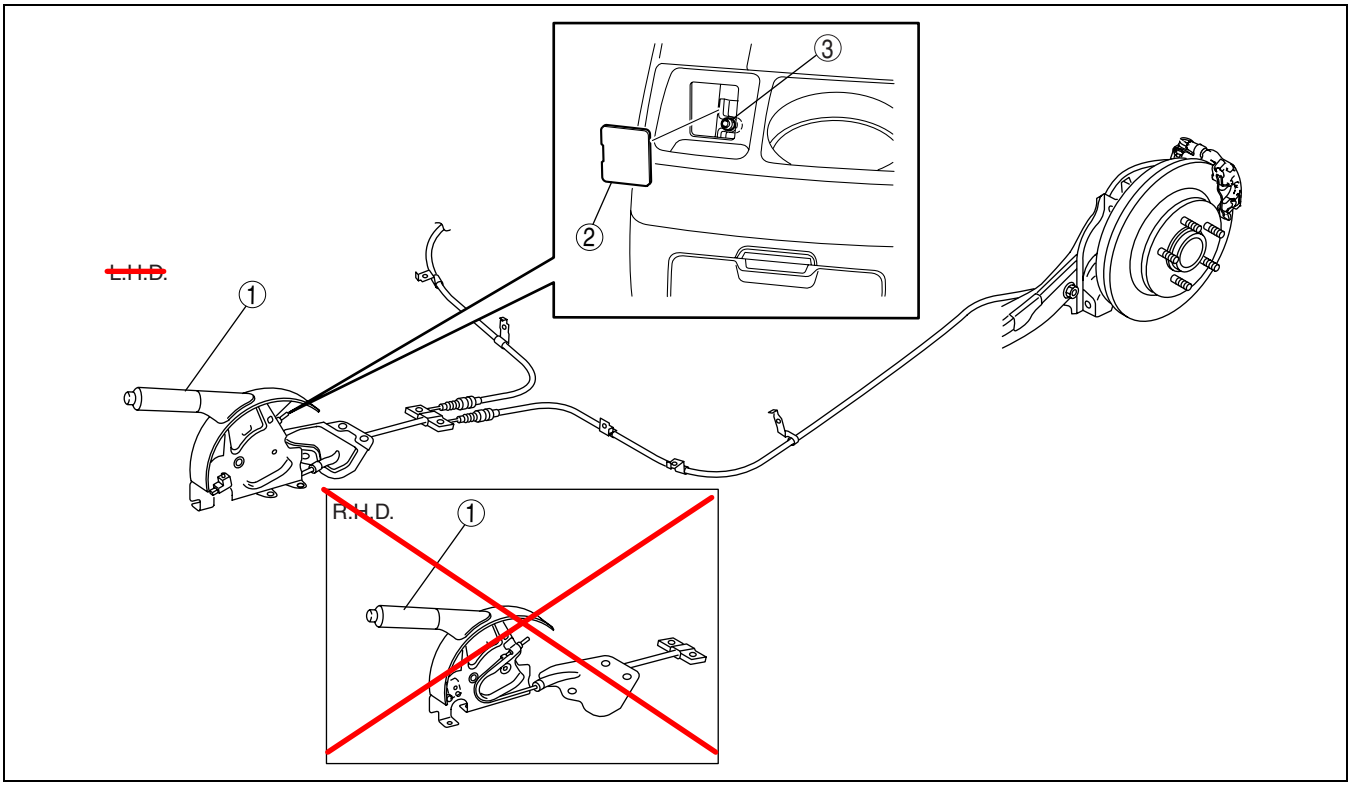
PARKING BRAKE SYSTEM OUTLINE

DPE041200000T01

- A center lever type parking brake that can be adjusted from the vehicle interior has been adopted, improving operability.
- Parking brake lever adjustment can easily be performed by removing the service hole cover in the console, improving serviceability.

PARKING BRAKE SYSTEM STRUCTURAL VIEW

DPE041200000T02



DPE412ZT1001

1	Parking brake lever
2	Service hole cover

3	Adjusting nut

04–13 ANTILOCK BRAKE SYSTEM

ABS OUTLINE 04–13–1
ABS STRUCTURAL VIEW 04–13–2
ABS SYSTEM WIRING DIAGRAM 04–13–3
ABS HU/CM CONSTRUCTION 04–13–4
ABS HU PART FUNCTION 04–13–4
ABS HU PART CONSTRUCTION/ OPERATION 04–13–4
ABS CM PART FUNCTION 04–13–8
ABS CONTROL OUTLINE 04–13–8
ABS CONTROL OPERATION 04–13–9
EBD CONTROL OUTLINE 04–13–10
EBD CONTROL OPERATION 04–13–11
CONTROLLER AREA NETWORK (CAN) OUTLINE 04–13–12
ABS WHEEL-SPEED SENSOR AND ABS SENSOR ROTOR FUNCTION 04–13–12
ABS WHEEL-SPEED SENSOR AND ABS SENSOR ROTOR CONSTRUCTION/ OPERATION 04–13–13

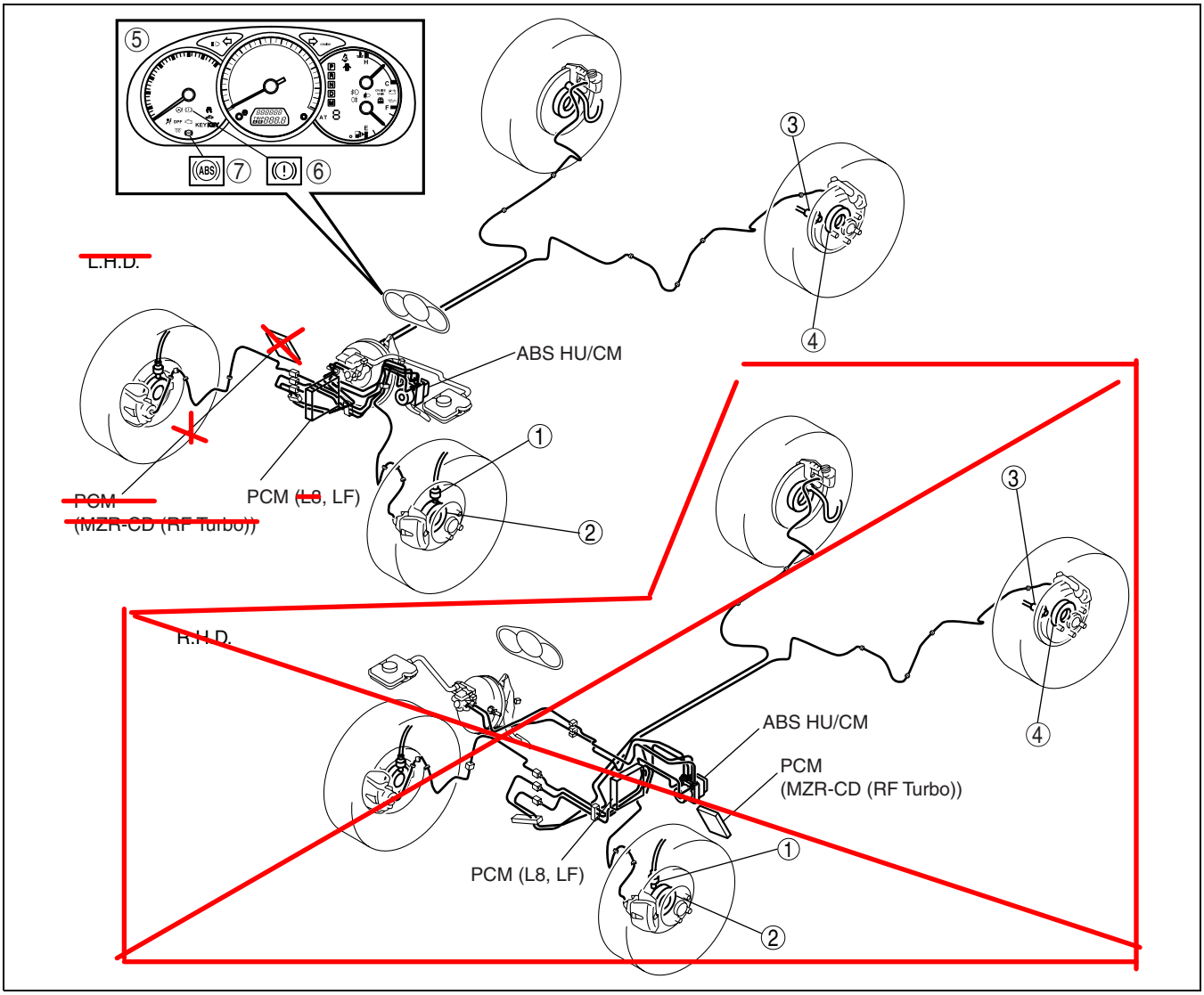
ABS OUTLINE

DPE041300000T01

- The ABS HU/CM, integrating both the hydraulic unit (HU) and control module (CM), has been adopted, resulting in size and weight reduction.
- A semi-conductor element type ABS wheel-speed sensor has been adopted, improving reliability and reducing size and weight.
- A magnetic encoder type ABS sensor rotor that is integrated with the wheel hub component has been adopted, improving reliability and reducing size and weight.
- Electronic brakeforce distribution (EBD) control has been adopted, resulting in improved safety and handling stability.

ABS STRUCTURAL VIEW

DPE041300000T02



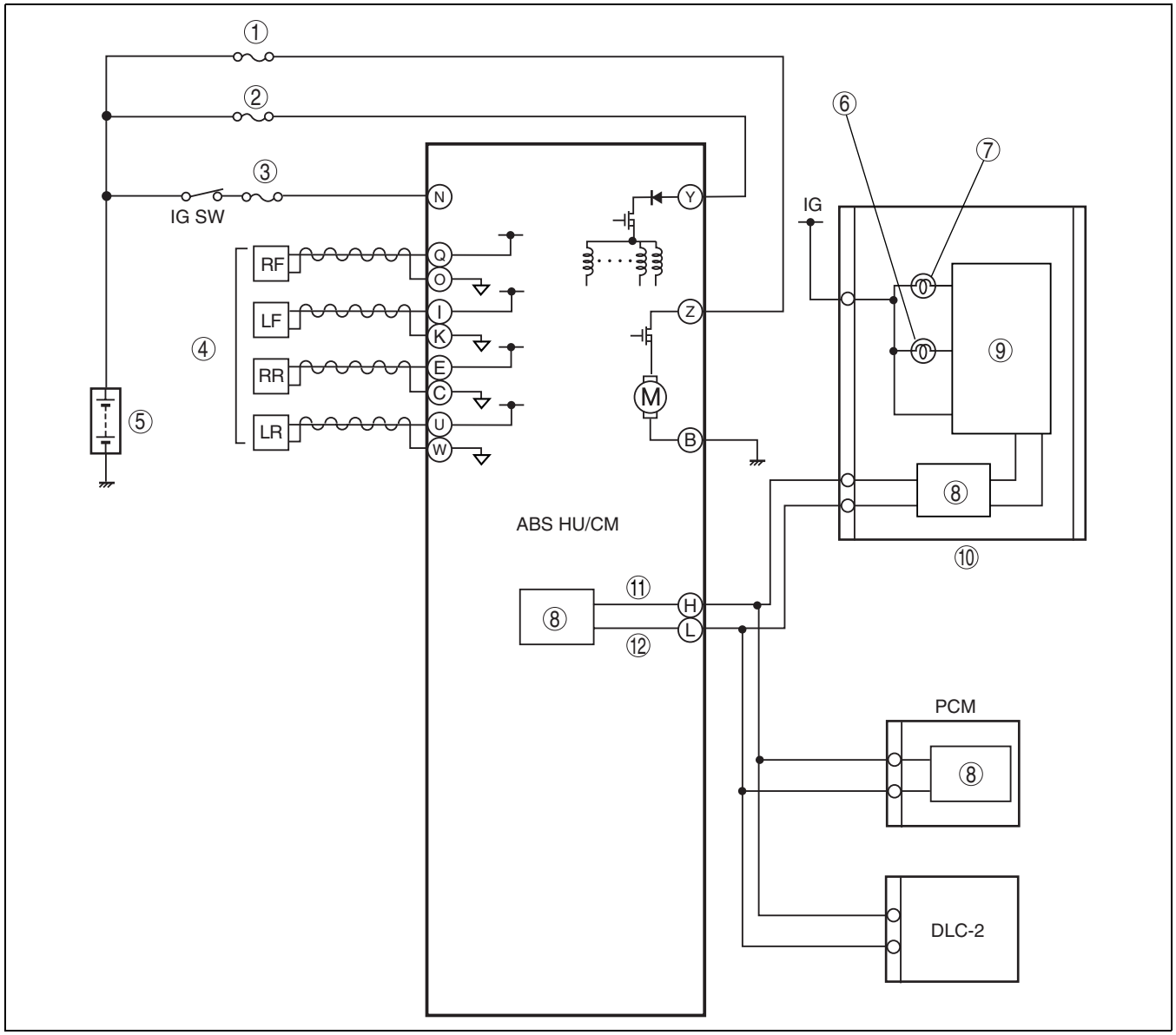
DPE413ZT1001

1	Front ABS wheel-speed sensor
2	Front ABS sensor rotor
3	Rear ABS wheel-speed sensor
4	Rear ABS sensor rotor

5	Instrument cluster
6	Brake system warning light
7	ABS warning light

ABS SYSTEM WIRING DIAGRAM

DPE041300000T03



B3E0413T101

1	ABS-P 30A fuse
2	ABS-V 20A fuse
3	ABS/DSC 5A fuse
4	ABS wheel-speed sensor
5	Battery
6	Brake system warning light

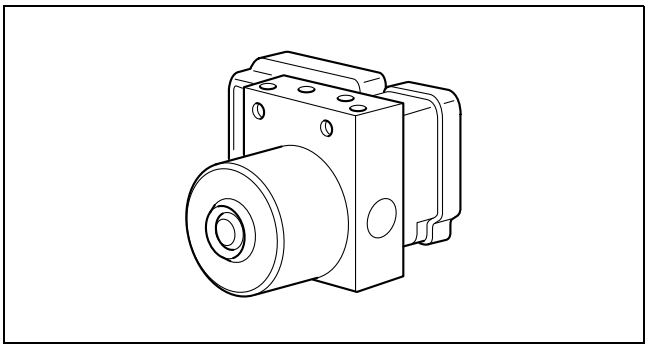
7	ABS warning light
8	CAN driver
9	Microcomputer
10	Instrument cluster
11	CAN_H
12	CAN_L

ABS HU/CM CONSTRUCTION

DPE041343750T01

Construction

- A high reliability, reduced size and weight ABS HU/CM, integrating both the ABS HU and ABS CM, has been adopted.



B3E0413T018

ABS HU PART FUNCTION

DPE041343750T02

- The ABS HU adjusts the fluid pressure to the caliper pistons by controlling (on/off) each solenoid valve and pump motor according to signals from the ABS CM.

ABS HU PART CONSTRUCTION/OPERATION

DPE041343750T03

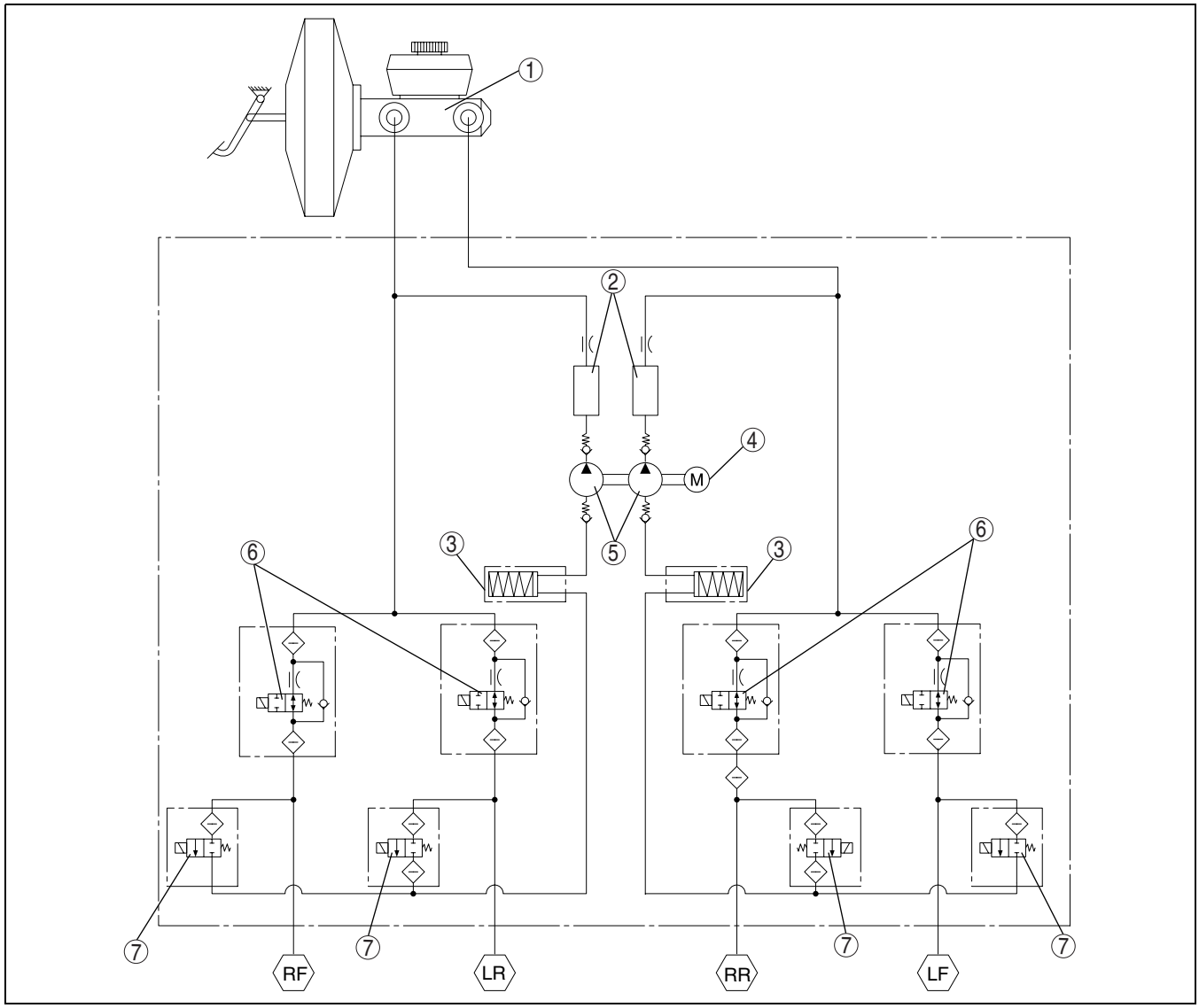
Construction

- The ABS HU mainly consists of the inlet/outlet solenoid valves, pump motor (pump) and reservoir.

Function Of Main Component Parts

Part name	Function
Inlet solenoid valve	• Adjusts the fluid pressure in each brake system according to ABS CM signals.
Outlet solenoid valve	• Adjusts the fluid pressure in each brake system according to ABS CM signals.
Reservoir	• Temporarily stores the brake fluid from the caliper piston to ensure smooth pressure reduction.
Pump	• Returns brake fluid stored in the reservoir back to the master cylinder.
Pump motor	• Operates the pump according to ABS CM signals.

Hydraulic Circuit Diagram



B3E0413T005

1	Master cylinder
2	Damper chamber
3	Reservoir
4	Pump motor

5	Pump
6	Inlet solenoid valve
7	Outlet solenoid valve

Operation

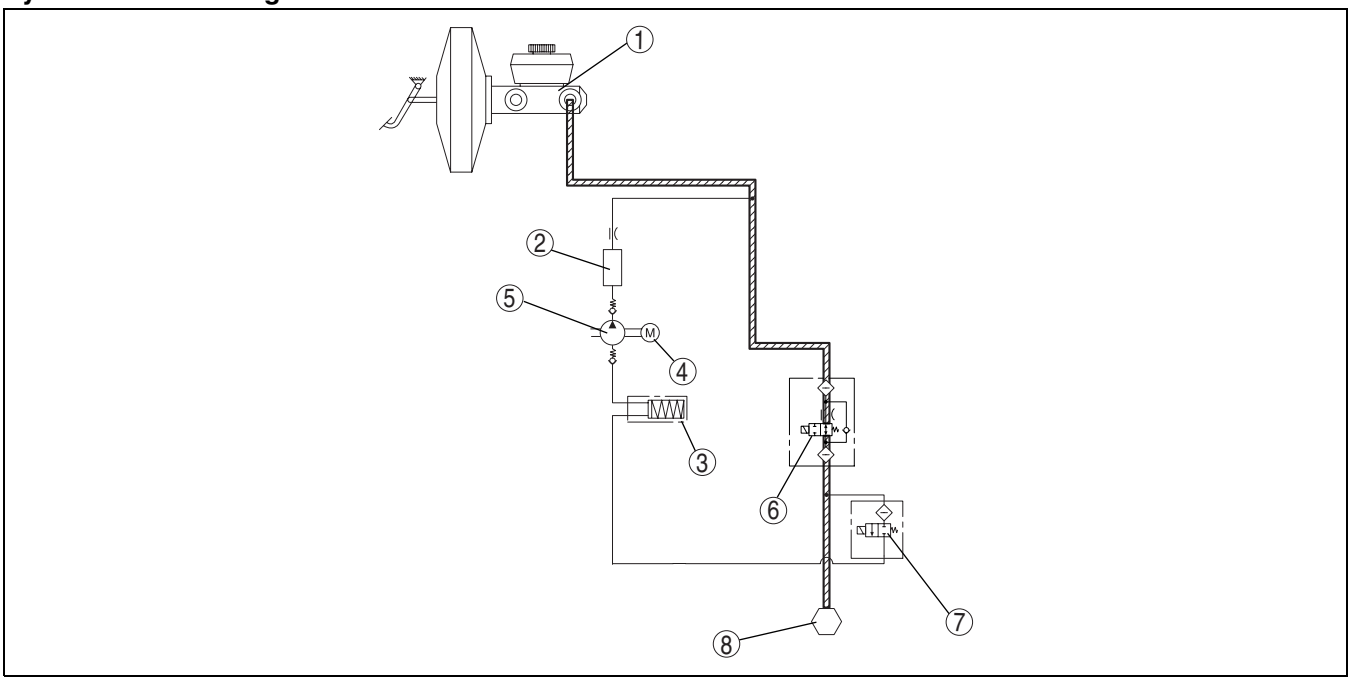
During normal braking

- During normal braking, the solenoid valves are not energized and all of them are off. When the brake pedal is depressed, brake fluid pressure is transmitted from the master cylinder, through the inlet solenoid valves, and then to the caliper piston. (The figure shows control for one front wheel only.)

Solenoid valve operation table

Inlet solenoid valve				Outlet solenoid valve				Pump motor, pump
LF	RF	LR	RR	LF	RF	LR	RR	
OFF (open)				OFF (closed)				Stopped

Hydraulic Circuit Diagram



B3E0413T102

1	Master cylinder
2	Damper chamber
3	Reservoir
4	Pump motor

5	Pump
6	Inlet solenoid valve
7	Outlet solenoid valve
8	Caliper piston

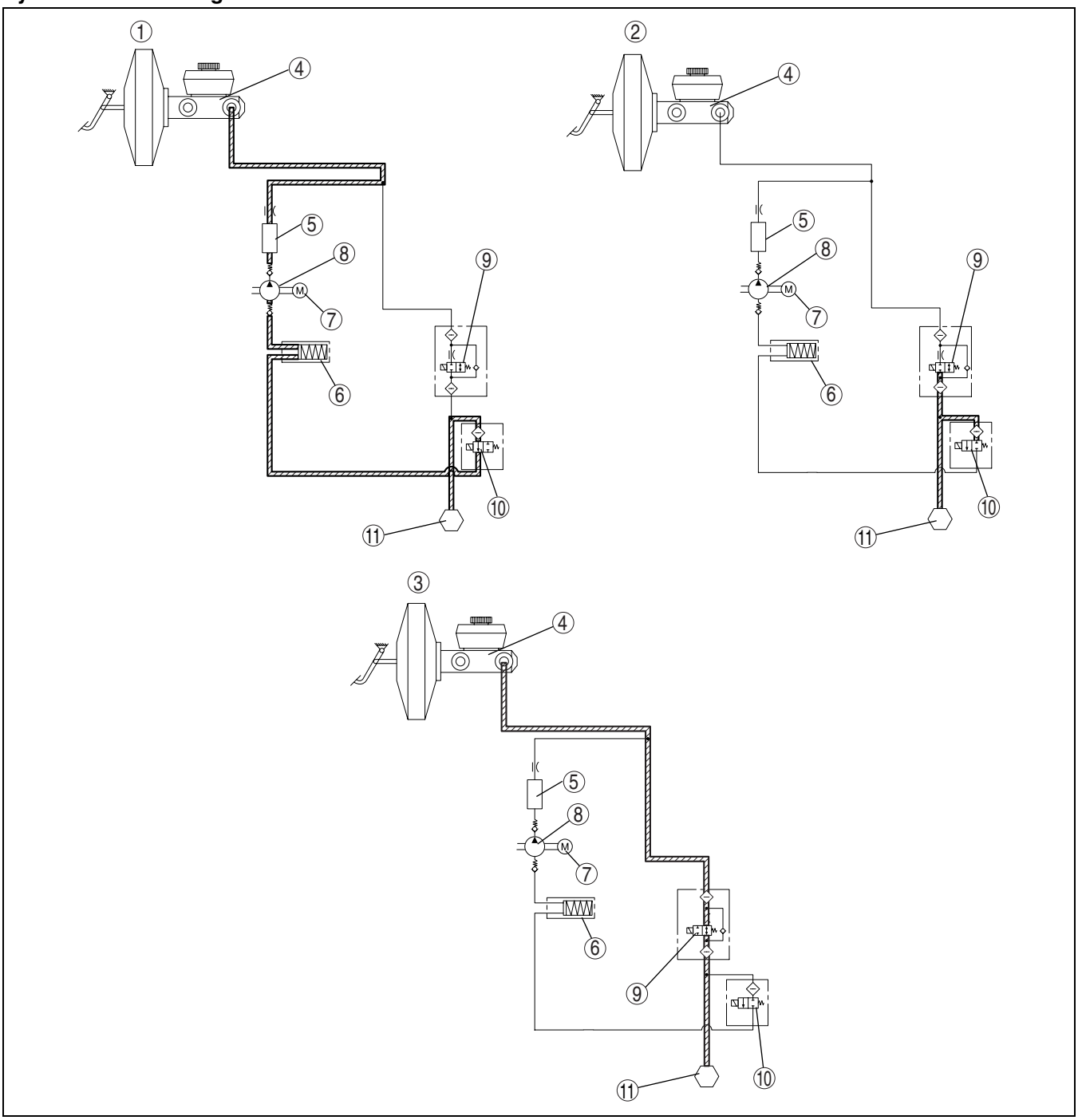
During ABS and EBD control

- When wheel lock-up is about to occur, the inlet and outlet solenoid valves are energized and controlled in three pressure modes (increase, maintain, or reduction), thereby adjusting brake fluid pressure. Brake fluid during pressure reduction is temporarily stored in the reservoir and afterwards the pump motor operates the pump to return the fluid to the master cylinder. (The figure shows control for one front wheel only.)

Solenoid valve operation table

	Inlet solenoid valve				Outlet solenoid valve				Pump motor, pump
	LF	RF	LR	RR	LF	RF	LR	RR	
During pressure increase mode	OFF (open)				OFF (closed)				Stopped
During pressure maintain mode	ON (closed)				OFF (closed)				Stopped
During pressure reduction mode	ON (closed)				ON (open)				Operation

Hydraulic Circuit Diagram



B3E0413T103

1	During pressure reduction mode
2	During pressure maintain mode
3	During pressure increase mode
4	Master cylinder

5	Damper chamber
6	Reservoir
7	Pump motor
8	Pump

9	Inlet solenoid valve
10	Outlet solenoid valve
11	Caliper piston

ABS CM PART FUNCTION

DPE041343750T04

Function

- The ABS CM detects the vehicle wheel speeds based on the signals from the four ABS wheel- speed sensors. The CM calculates the rotation condition of each wheel from the relation between the detected vehicle wheel speed and the estimated (based on the detected speed) vehicle speed from there on. It then accordingly controls brake fluid pressure to each wheel to prevent lock-up.

Function Table

Function name	Contents
ABS control function	• Controls brake fluid pressure when braking to maintain directional stability, ensure steerability and reduce stopping distance.
Electronic brakeforce distribution (EBD) control function	• Constantly controls proper distribution of brake fluid pressure to the front and rear wheels according to vehicle load, road surface and vehicle speed conditions to prevent early lock-up of the rear wheels.
CAN signal function	• Outputs the wheel speed signal and ABS system warning control data via CAN lines.
On-board diagnostic system	• Main components of the ABS control system have a self-diagnosis function. In case a malfunction occurs, warning lights illuminate to alert the driver, and at the same time a DTC is stored in the ABS HU/CM. • When a malfunction is determined as a result of the on-board diagnostic test, system control is suspended or limited to prevent any dangerous situation while driving.

ABS CONTROL OUTLINE

DPE041343750T05

Feature

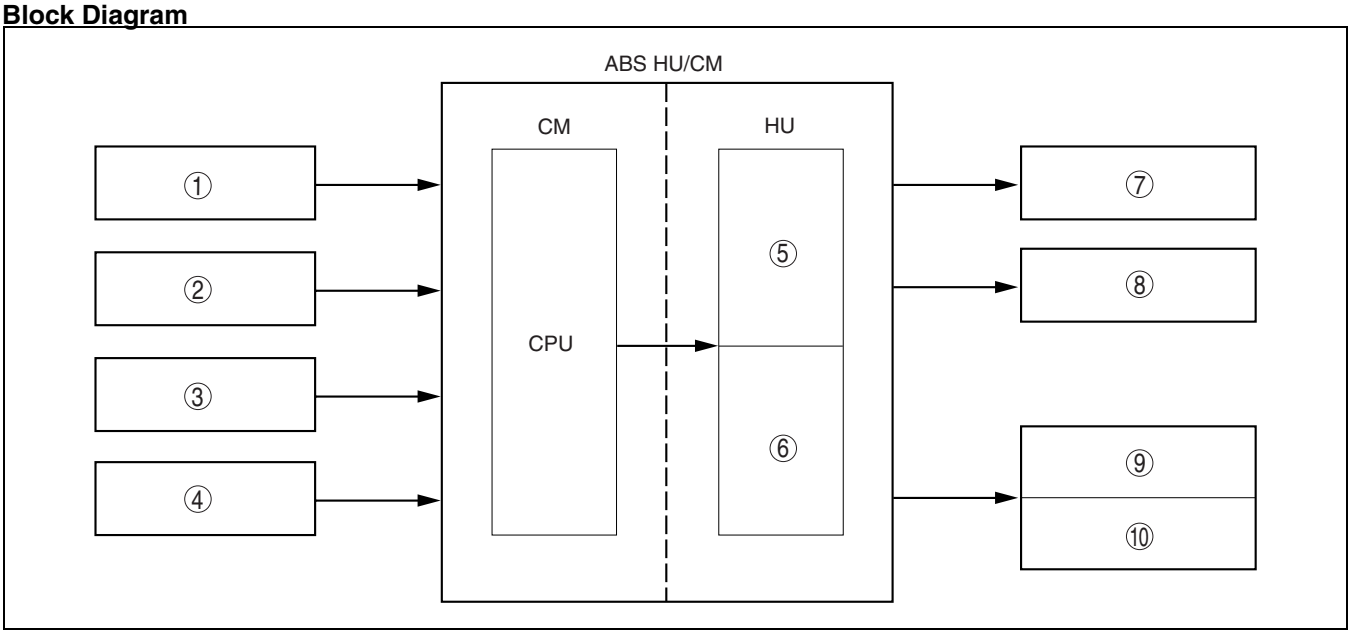
- ABS control occurs when wheel slip is determined by the ABS CM (based on the four ABS wheel-speed sensors). Then, the ABS HU inlet and outlet solenoid valves are operated and brake fluid pressure is controlled accordingly to prevent wheel lock-up.
- Use of ABS control during emergency braking or on slippery road surfaces allows directional stability to be maintained, steerability ensured and stopping distance to be reduced.
- The ABS control system has independent front wheel control and unified control (select low) for the rear wheels.

Note

- Select low control: A control system in which the left and right vehicle wheel speeds are compared and brake fluid pressure is controlled according to the wheel most likely to lock-up.

STRUCTURE

Block Diagram



B3E0413T008

1	ABS wheel-speed sensor (LF)
2	ABS wheel-speed sensor (RF)
3	ABS wheel-speed sensor (LR)
4	ABS wheel-speed sensor (RR)
5	Solenoid valve

6	Pump motor
7	Caliper piston (LF)
8	Caliper piston (RF)
9	Caliper piston (LR)
10	Caliper piston (RR)

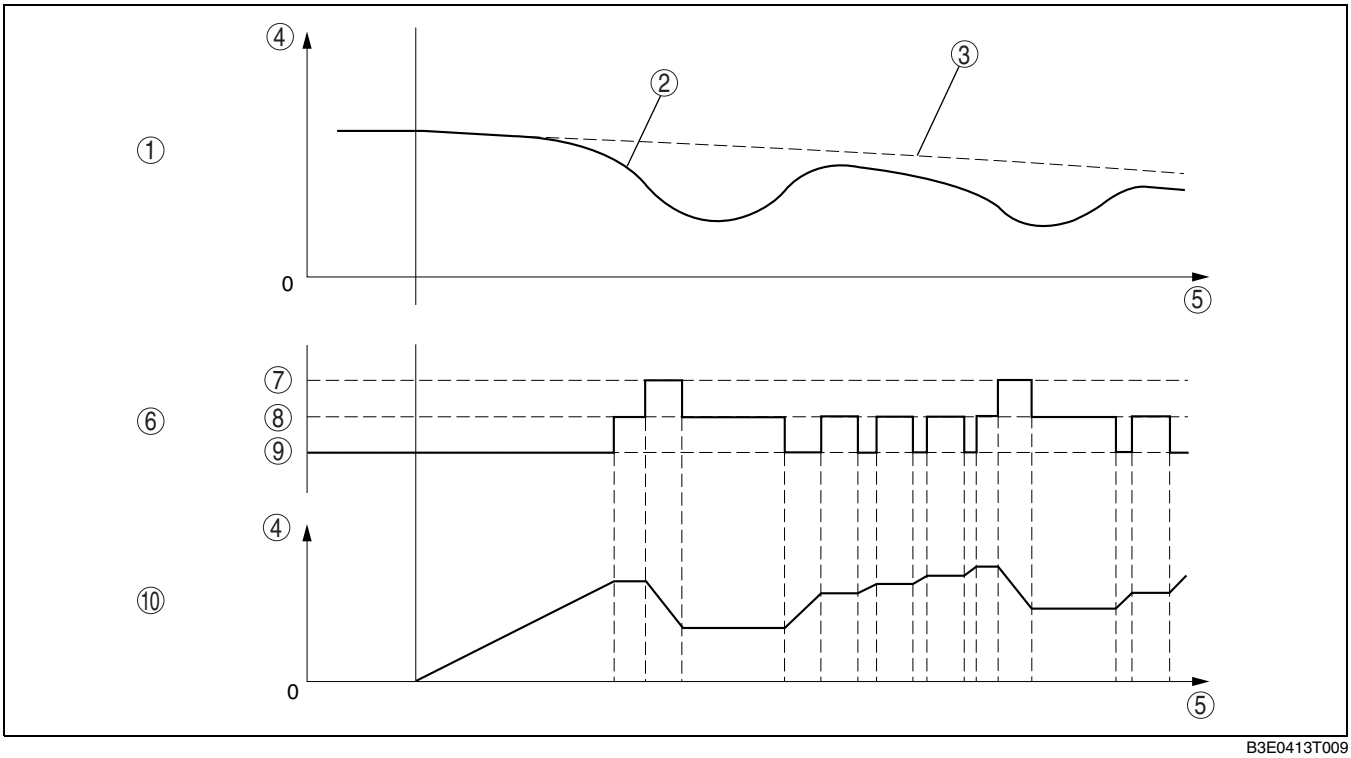
04

ABS CONTROL OPERATION

DPE041343750T06

- When the ABS CM determines wheel slip conditions based on the signals from the ABS wheel-speed sensors during braking, the ABS CM operates the ABS HU inlet and outlet solenoid valves, reducing and maintaining brake fluid pressure in accordance with the wheel slip factors. Then, when the wheel slip condition has passed, brake fluid pressure is increased and maintained, ensuring braking with a constantly stable brake force.

Operating Condition Transition Diagram



B3E0413T009

1	Speed
2	Wheel speed
3	Estimated vehicle speed
4	High
5	Time

6	Solenoid valve control
7	Pressure reduction
8	Pressure maintained
9	Pressure increase
10	Brake fluid pressure

EBD CONTROL OUTLINE

DPE041343750T07

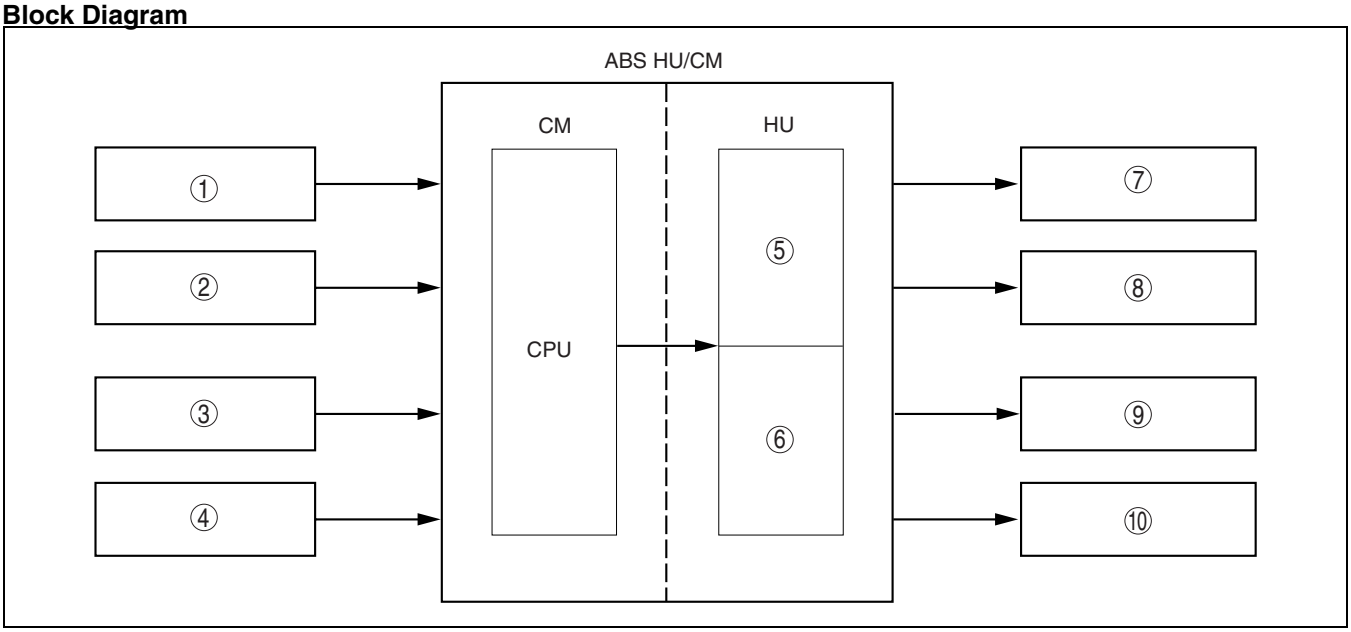
- EBD control uses the ABS system to control brake fluid pressure distribution to the rear wheels so that they do not lock-up prior to the front wheels during braking, thereby preventing the loss of handling stability.

Features

- EBD control has independent control systems for both the front and rear wheels.
- EBD control constantly and properly distributes brake fluid pressure regardless of vehicle weight.

STRUCTURE

Block Diagram



B3E0413T010

1	ABS wheel-speed sensor (LF)
2	ABS wheel-speed sensor (RF)
3	ABS wheel-speed sensor (LR)
4	ABS wheel-speed sensor (RR)
5	Solenoid valve

6	Pump motor
7	Caliper piston (LF)
8	Caliper piston (RF)
9	Caliper piston (LR)
10	Caliper piston (RR)

04

EBD CONTROL OPERATION

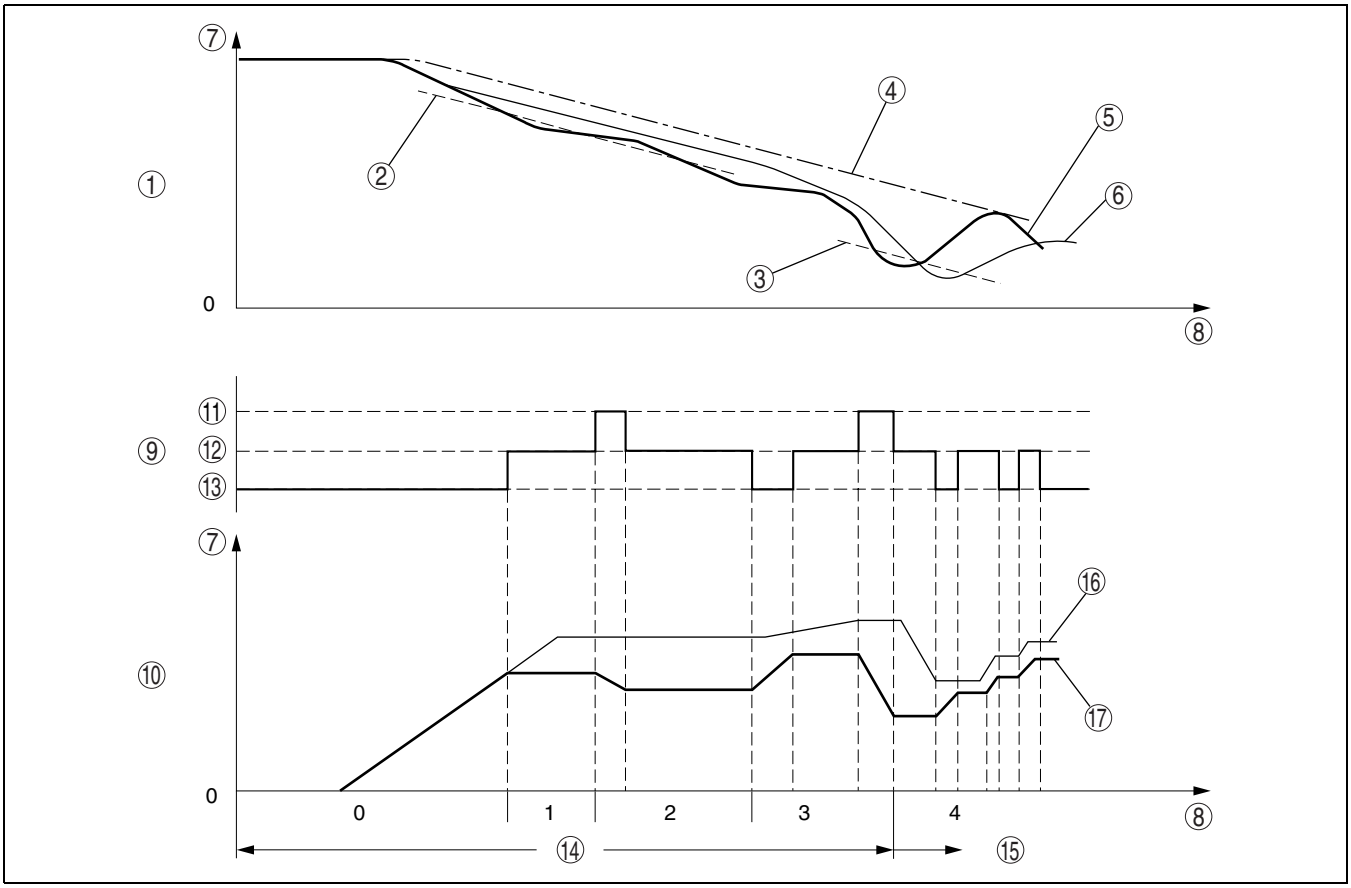
DPE041343750T08

- EBD control detects the slip ratio between the front and rear wheels from the ABS wheel-speed sensor signals. If the slip ratio of the rear wheels as compared to the front wheels is larger than the fixed limit, the ABS HU/CM reduces brake pressure being distributed to the rear wheels. Due to this, brake pressure distribution is constantly controlled in the proper proportion and in relation to vehicle load, road surface conditions and vehicle speed.
- Determination of the rear wheel slip ratio, based on a comparison of the lowest front wheel speed and the estimated vehicle speed with the rear wheel speeds, is divided into conditions 0-4 shown in the table below.
- The ABS HU outlet and inlet solenoid valves are operated and the brake fluid pressure controlled according to these conditions.
- If ABS control conditions are met during EBD control, EBD control is stopped and ABS control is given priority.

Status	Rear wheel slip ratio determination	EBD control	Solenoid valve	Comment
0	No slip	No control	Pressure increase	—
1	α%—β%	Control	Pressure maintained	—
2	β% or more	Control	Reduction/maintained	—
3	After EBD control, slip ratio is γ%	Control	Increase/maintain	—
4	Front wheel slip ratio is δ% or more	Control	Pressure reduction/ maintained/ increase	ABS control operates

$\alpha\nabla\delta$:Specified value

Operating Condition Transition Diagram



B3E0413T011

1	Speed
2	EBD initial control value
3	ABS initial control value
4	Vehicle speed
5	Rear wheel speed
6	Front wheel speed
7	High
8	Time
9	Rear solenoid valve control

10	Brake fluid pressure
11	Pressure reduction
12	Pressure maintained
13	Pressure increase
14	EBD control area
15	ABS control area
16	Front brake fluid pressure
17	Rear brake fluid pressure

CONTROLLER AREA NETWORK (CAN) OUTLINE

DPE041343750T09

- The ABS HU/CM sends and receives data to and from other modules via the CAN system. Refer to Section 09 for a detailed explanation of the CAN. (See 09–40–9 CONTROLLER AREA NETWORK (CAN) SYSTEM OUTLINE.)

Data sent

- Brake system condition
- Wheel speeds of all four wheels
- Brake system warning light illumination request
- ABS warning light illumination request

Data received

- Brake pedal position
- Tire size

ABS WHEEL-SPEED SENSOR AND ABS SENSOR ROTOR FUNCTION

DPE041343720T01

Function

- The ABS wheel-speed sensor and ABS sensor rotor detect the rotation condition of each wheel and transmit

this information to the ABS HU/CM.
- The signal from the ABS wheel speed sensor is the primary signal that the ABS HU/CM uses when carrying out control.

ABS WHEEL-SPEED SENSOR AND ABS SENSOR ROTOR CONSTRUCTION/OPERATION

DPE041343720T02

Construction

- The ABS wheel speed sensor utilizes a semi-conductor element that contains an active drive circuit (MR element*). The front sensor is installed on the steering knuckle and the rear sensor is installed on the rear wheel hub component.
- The ABS sensor rotor utilizes a magnetic encoder system that functions with magnetic rubber, and is integrated into the wheel hub component. Therefore, if there is any malfunction of the ABS sensor rotor, replace the wheel hub component.

*: A magneto-resistive force means that an exterior magnetic field acts on the element, changing the resistance of the element.

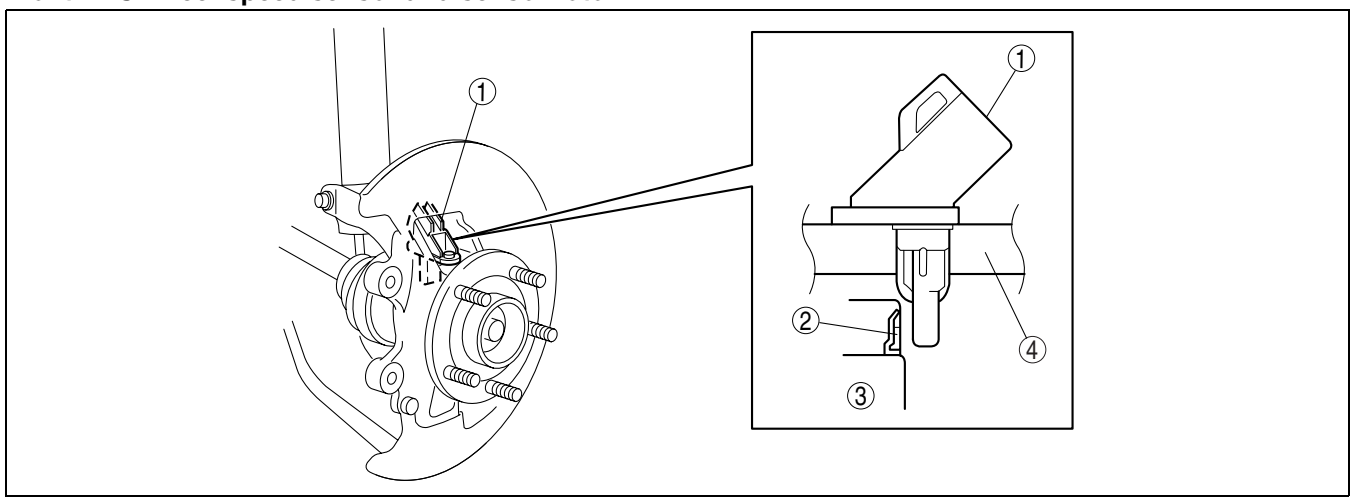
Caution

- **When inspecting the ABS wheel speed sensor, do not use a tester to inspect resistance. It is possible that the voltage from the tester could damage the semiconductor inside the ABS wheel speed sensor. Inspect using the PID data monitor of the WDS or equivalent.**

Note

- Magnetic encoder: A plate that has positive and negative poles (marked out) in a continuous, alternating line.

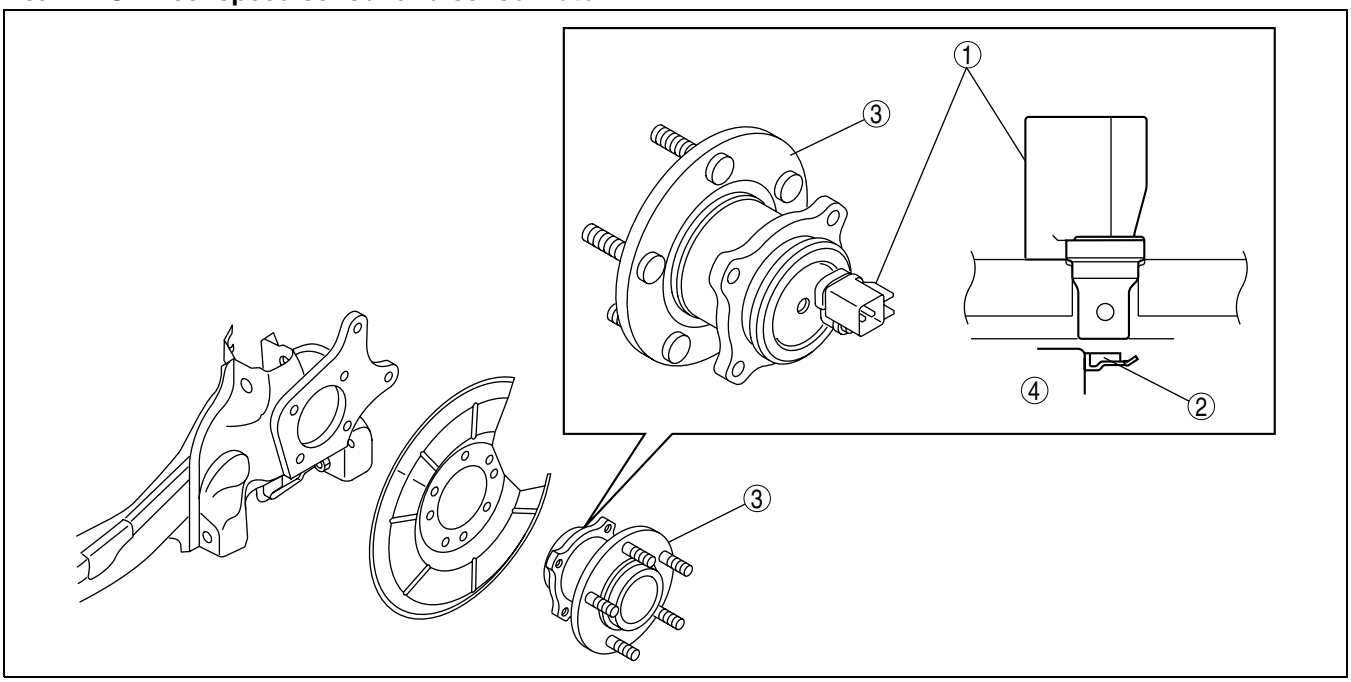
Front ABS wheel-speed sensor and sensor rotor



B3E0413T019

1	Front ABS wheel-speed sensor	3	Wheel bearing (vehicle inner side)
2	Front ABS sensor rotor	4	Steering knuckle

Rear ABS wheel-speed sensor and sensor rotor

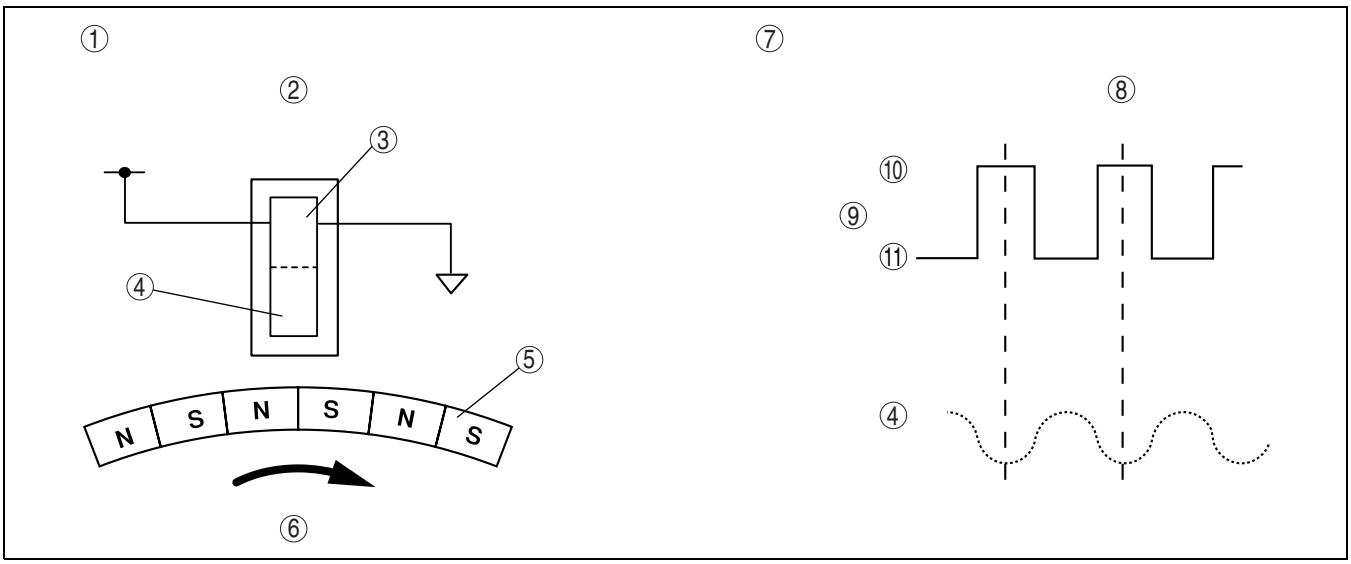


B3E0413T020

1	Rear ABS wheel-speed sensor	3	Wheel hub component
2	Rear ABS sensor rotor	4	Wheel bearing

Operation

- As the ABS sensor rotor rotates, the magnetic flux between the ABS wheel speed sensor and the ABS sensor rotor change periodically. This periodic change is in proportion to the rotation speed.
- The semiconductor element in the wheel speed sensor detects the change in magnetic flux, and the active drive circuit converts it to a rectangular wave signal for the current, which is transmitted to the ABS HU/CM.
- For every single rotation of the ABS sensor rotor, 44 rectangular wave pulse signals are output. The CM in the ABS HU/CM calculates the wheel speed from the periodicity of these pulses.



B3E0413T012

1	Detection principle	7	Output wave pattern
2	ABS wheel-speed sensor	8	Active drive circuit
3	Active drive circuit	9	Rectangular wave signal
4	Semiconductor element	10	Hi
5	Magnetic rubber (magnetic encoder)	11	Lo
6	ABS sensor rotor		