STEERING

06
SECTION

06–00 OUTLINE

STEERING ABBREVIATIONS

DPE060000000T01

ATF	Automatic Transaxle Fluid
CAN	Controller Area Network
EHPAS	Electro Hydraulic Power Assist Steering
OFF	Switch Off
ON	Switch On
WDS	Worldwide Diagnostic System

STEERING FEATURES

DPE060000000T02

Improved handling	• Electro hydraulic power assist steering (EHPAS) adopted ~~(L8, LF)~~ • ~~Engine-speed-sensing power steering adopted (MZR-CD (RF Turbo))~~
Improved fuel economy Improved marketability	• Electro hydraulic power assist steering (EHPAS) adopted ~~(L8, LF)~~
Improved operability	• Steering shaft with a tilt/telescope mechanism adopted
Improved safety	• Steering shaft with an energy absorbing mechanism adopted
Improved serviceability	• Enhanced malfunction diagnosis function for use with WDS or equivalent

STEERING SPECIFICATIONS

DPE060000000T03

Item			Specifications
Steering wheel	Outer diameter (mm {in})		372 {14.6}
	Lock to lock (turns)		2.9
Steering shaft	Shaft type		Collapsible design
	Coupling type		Cross-shaped joint design
	Tilt amount (mm {in})		40 {1.6}
	Telescope amount (mm {in})		50 {2.0}
Steering gear and linkage	Type		Rack and pinion design
	Rack stroke (mm {in})		81.0 {3.19} × 2
Power steering	Power assist system		Vehicle speed sensing ~~(L8, LF)~~ ~~Engine speed sensing (MZR-CD (RF Turbo))~~
	Fluid specification	Type	ATF M-**III** or equivalent (e.g. Dexron®**II**)
		Capacity* (approx. quantity) (L {US qt, Imp qt})	0.80 {0.84, 0.70} ~~(L8, LF)~~ ~~0.97 {1.03, 0.85) (MZR-CD (RF Turbo))~~

* : When fluid reservoir tank is at maximum volume.

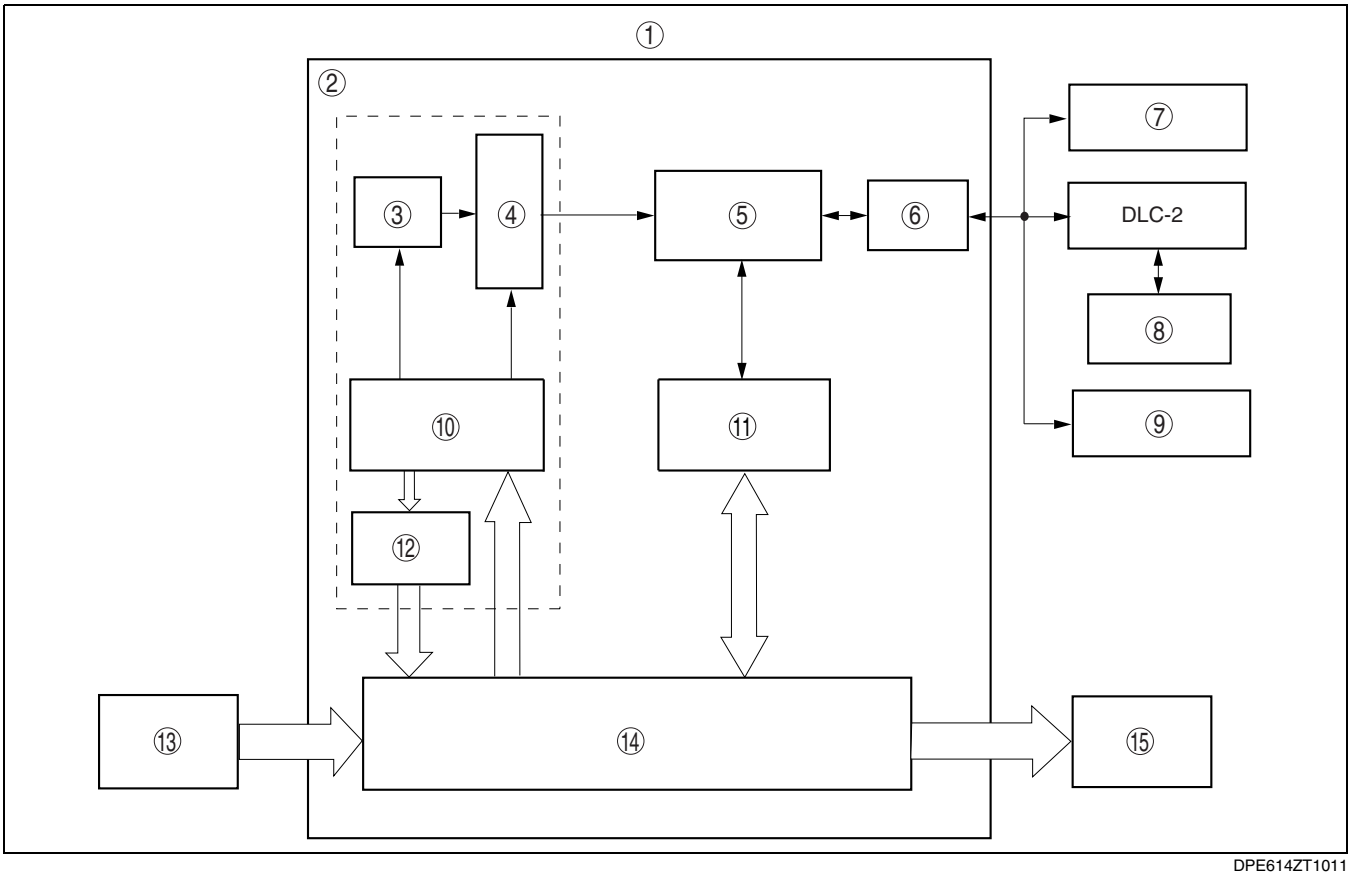
06–02 ON-BOARD DIAGNOSTIC

ON-BOARD DIAGNOSTIC SYSTEM OUTLINE [ELECTRO HYDRAULIC POWER ASSIST STEERING (EHPAS)]

DPE060200000T01

- 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 and a PID/data monitor function that reads out specified input/output signals.
- The Data Link Connector 2 (DLC-2), which groups together all the connectors used for malfunction diagnosis into a single place, 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, providing enhanced malfunction diagnosis and improved serviceability.

Block Diagram



DPE614ZT1011

1	EHPAS control module
2	On-board diagnostic function
3	Memory function
4	Malfunction Display Function
5	External tester communication function
6	CAN driver

7	EHPAS warning light
8	WDS or equivalent
9	Other modules
10	Malfunction detection function
11	PID/DATA monitor function
12	Fail-safe function

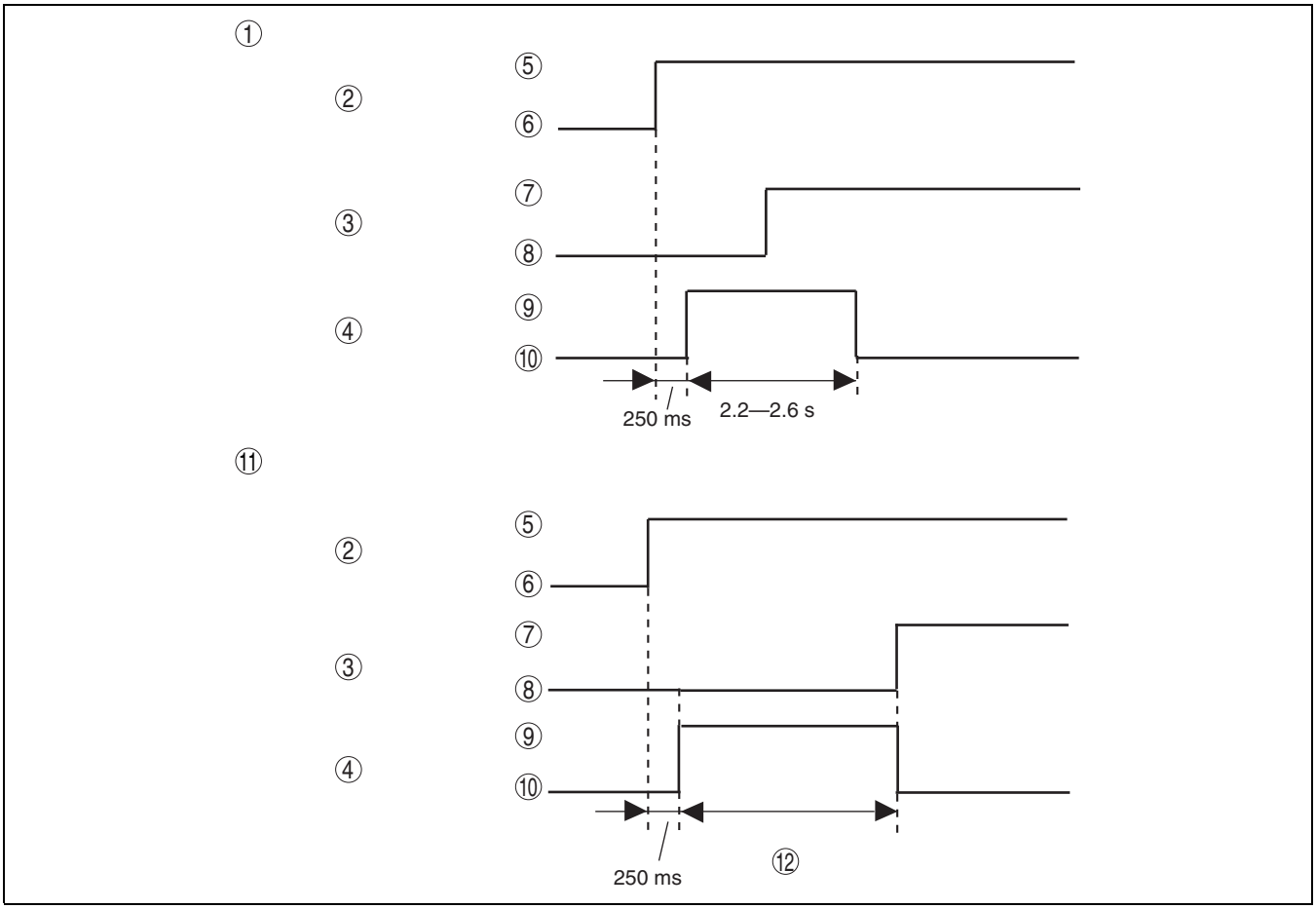
13	Input device
14	Normal control area
15	Output device

ON-BOARD DIAGNOSTIC SYSTEM FUNCTION [ELECTRO HYDRAULIC POWER ASSIST STEERING (EHPAS)]

DPE060200000T02

Malfunction Detection Function

- The malfunction detection function detects malfunctions in the input/output signal system of the EHPAS control module (built into the electric power steering oil pump) when the ignition switch is at the ON position or driving the vehicle.
- The EHPAS warning light illuminates according to the following figure when the ignition switch is turned to the ON position to inspect for open circuits in the light.



B3E0602T009

1	Period until engine rotation determined: shorter than 2.2—2.6 s
2	Ignition switch
3	Engine rotation determined
4	EHPAS warning light
5	ON
6	OFF

7	Rotating
8	Stopped
9	Illuminated
10	Not illuminated
11	Period until engine rotation determined: longer than 2.2—2.6 s
12	Period until engine rotation determined

Malfunction Display Function

- When the malfunction detection function detects a malfunction, the EHPAS warning light illuminates to advise the driver. Using the external tester communication function, DTCs can be output to the DLC-2 via the CAN line. 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 EHPAS control module has a 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, the EHPAS warning light illuminates to advise the driver. At this time, the fail-safe function disables system control or gradually reduces the assist power.

DTC Table

System malfunction location	DTC (WDS or equivalent display)	Fail-safe function	
		EHPAS warning light illumination status	Control status
Electric power steering oil pump	B1238	Illuminated	Control disabled
Battery power supply	B1317	Illuminated*1	Control disabled*2
	B1318	Illuminated*3	Control disabled*2
Electric power steering oil pump (control module)	B1342	Illuminated	Control disabled
IG power supply	B1352	Illuminated	Control continues
Module configuration	B2477	Illuminated	Control disabled
Electric power steering oil pump (motor)	C1099	Illuminated	Control disabled
Steering angle sensor	C1278	Illuminated	Control continues*4
CAN line	U0073	Illuminated	Control continues*5
	U0100	Illuminated	Control continues*5
	U2023	Illuminated	Control continues*6

*1 : Illuminates when battery voltage is more than **17 V** .
*2 : Controlled motor speed is decreased to **391 rpm per s** until it is set at **0 rpm,** and control is disabled.
*3 : Illuminates when battery voltage is less than **9 V** .
*4 : Controlled steering speed is decreased to **100 degree per s** until it is set at **0 degree,** and control continues.
*5 : Motor is stopped: Maintained at condition when stopped. Motor is rotating: Controlled vehicle speed is increased to **20 km/h {12 mph} per s** until it is set at **200 km/h {124 mph}** , engine speed is set at **1,000 rpm** , and control continues.
*6 : Motor is stopped: Engine speed and vehicle speed assimilation stops. After the motor is restarted, vehicle speed is set at **200 km/h {124 mph}** and engine speed is set at **1,000 rpm** , and control continues. Motor is rotating: Engine speed and vehicle speed assimilation stops. Engine speed is set at **1,000 rpm** and vehicle speed is set at **200 km/h {124 mph}** , and control continues.

ON-BOARD DIAGNOSTIC SYSTEM PID/DATA MONITOR FUNCTION [ELECTRO HYDRAULIC POWER ASSIST STEERING (EHPAS)]

DPE060200000T03

- The PID/data monitor function is used for optionally selecting input/output signal monitor items preset in the EHPAS control module and reading them out in real-time.

Command name (WDS or equivalent display)	Input/output part	Unit/operation (WDS or equivalent display)
CCNT	DTC (Number of continuous DTCs)	—
ENGRPM	Engine speed signal	RPM
MTR_AMP	Motor operating current signal	A
RPM_ACT	Actual motor speed signal	RPM
RPM_TGT	Target motor speed signal	RPM
STEER_RATE	Steering angle sensor	°/s
TEMP_BOARD	Circuit temperature	°C
VPWR	EHPAS control module supply voltage	V
VSS	Vehicle speed signal	KPH/MPH

ON-BOARD DIAGNOSTIC SYSTEM EXTERNAL TESTER COMMUNICATION FUNCTION [ELECTRO

HYDRAULIC POWER ASSIST STEERING (EHPAS)]

DPE060200000T04

Outline

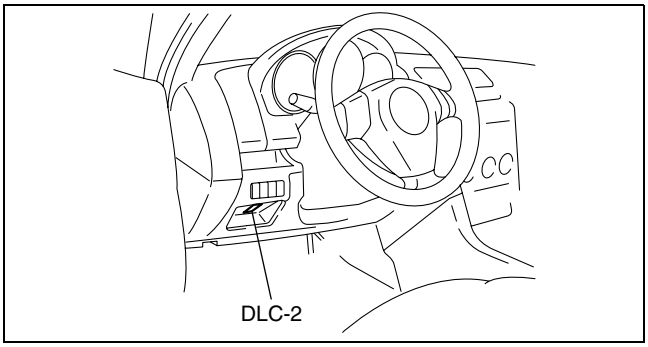
- The external tester communication function enables communication of diagnostic data (DTC read-outs, input/output signal read-outs) between the EHPAS control module and an external tester.

Connections/Communication Contents

	External tester	
	WDS	
	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

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 EHPAS control module via CAN lines.
- The EHPAS control module receives the command signals of the malfunction detection function and PID/data monitor function from the WDS or equivalent, and sends DTCs and data regarding the operating status of each input/output part to the WDS or equivalent.



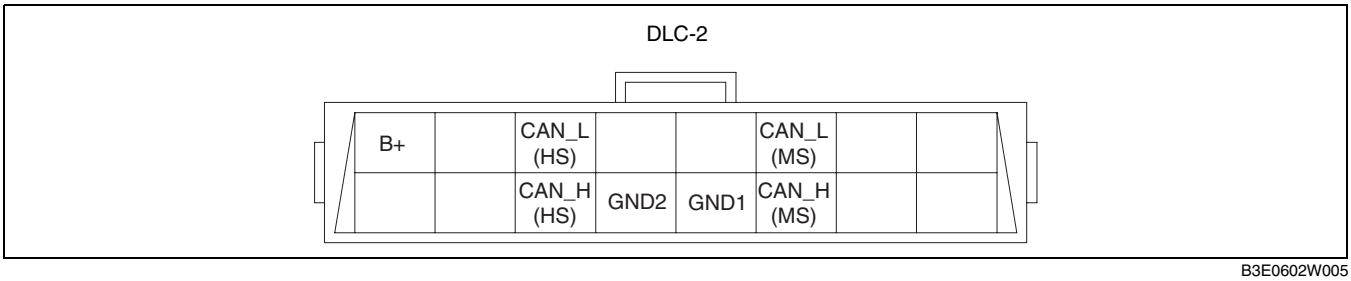
DPE402AW1005

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

DLC-2 CONSTRUCTION [ELECTRO HYDRAULIC POWER ASSIST STEERING (EHPAS)]

DPE060200000T05

- A connector (DLC-2) conforming to International Organization for Standardization (ISO) standards has been added.
- 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.



B3E0602W005

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

Terminal	Function
GND2	Serial communication GND terminal
B+	Battery power supply terminal

06-14 POWER STEERING

POWER STEERING OUTLINE

DPE061400000T01

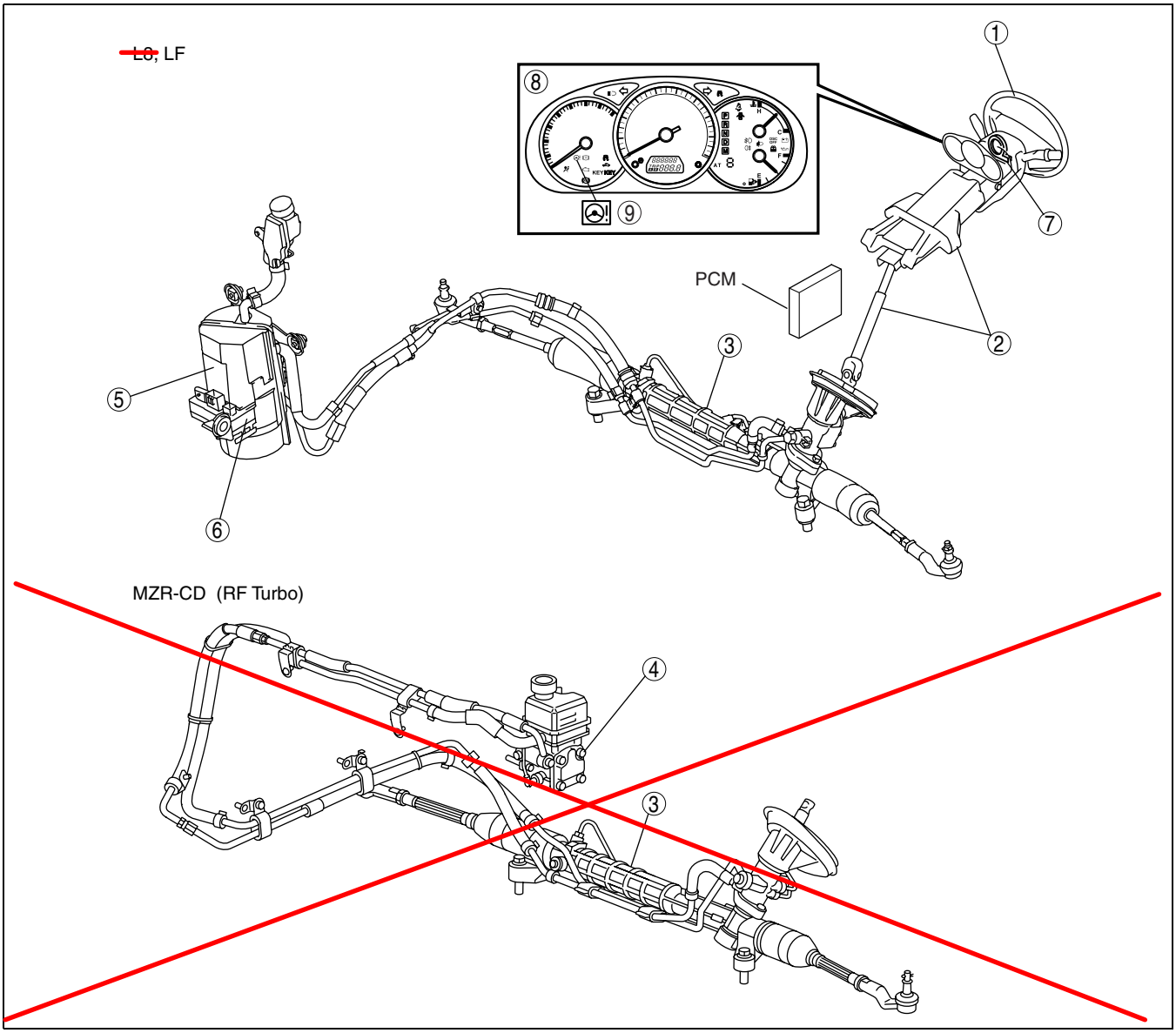
- For vehicles with the ~~L8~~, LF engine, excellent steering feel and smooth handling from low to high speeds is provided due to the adoption of electro hydraulic power assist steering (EHPAS). Engine load is reduced, improving fuel economy, due to the adoption of an electric power steering oil pump.
- ~~Engine-speed-sensing power steering has been adopted for vehicles with the MZR-CD (RF Turbo) engine.~~

06

POWER STEERING STRUCTURAL VIEW

~~L.H.D.~~

DPE061400000T02

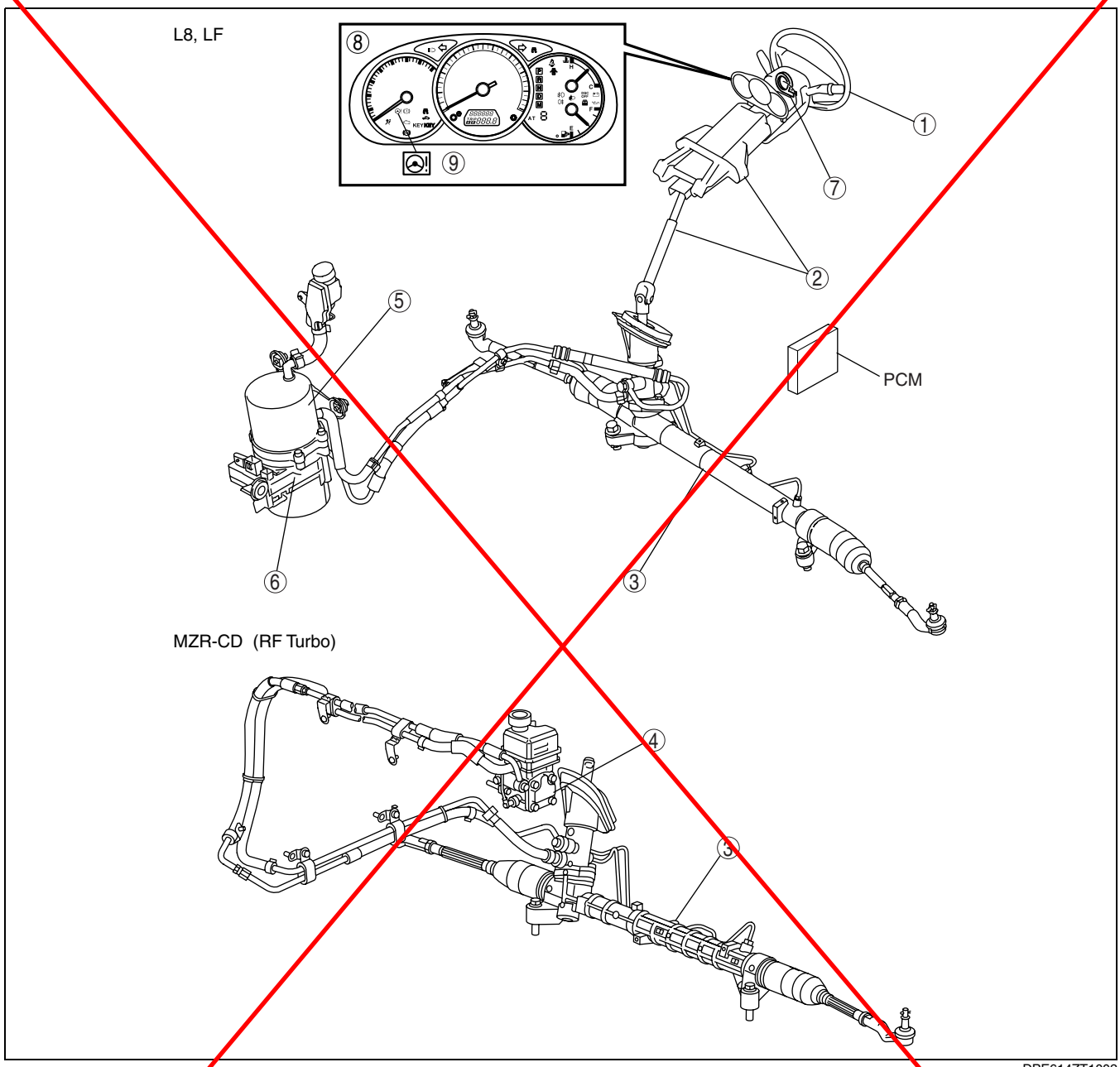


DPE614ZT1001

1	Steering wheel
2	Steering column and shaft
3	Steering gear and linkage
~~4~~	~~Power steering oil pump~~
5	Electric power steering oil pump

6	EHPAS control module (built into electric power steering oil pump)
7	steering angle sensor
8	Instrument cluster
9	EHPAS warning light

R.H.D.



DPE614ZT1002

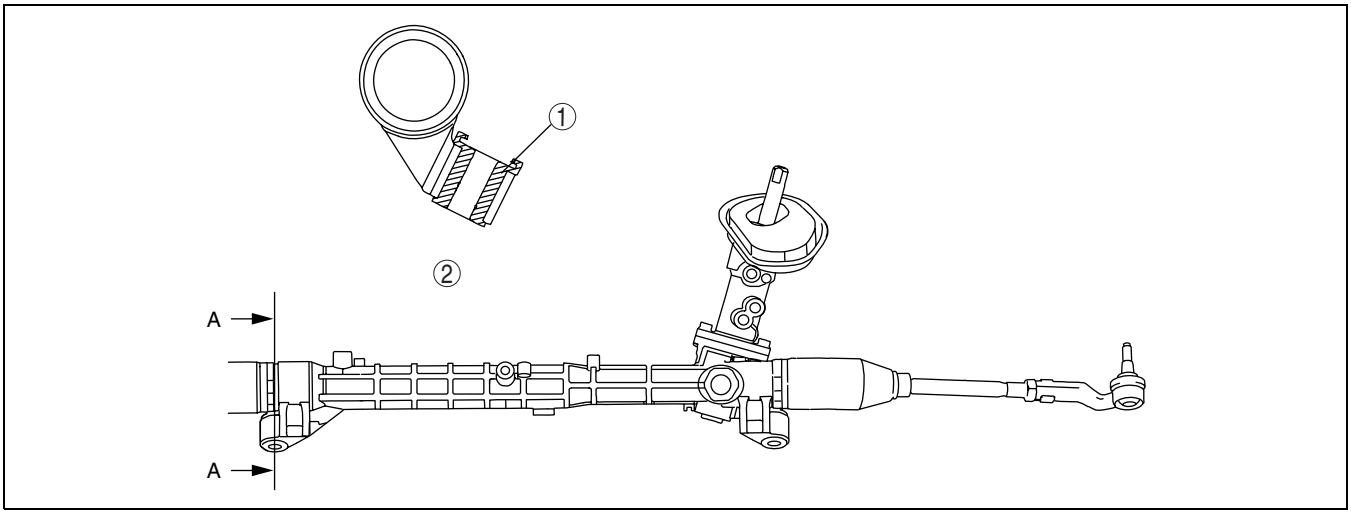
1	Steering wheel
2	Steering column and shaft
3	Steering gear and linkage
4	Power steering oil pump
5	Electric power steering oil pump

6	EHPAS control module (built into electric power steering oil pump)
7	steering angle sensor
8	Instrument cluster
9	EHPAS warning light

STEERING GEAR AND LINKAGE CONSTRUCTION

DPE061432960T01

- A size and weight reduced rack and pinion system steering gear has been adopted.
- Heightened support rigidity has been achieved due to the integration of the steering gear mounts (two locations) and gear housing, improving response and steering stability.



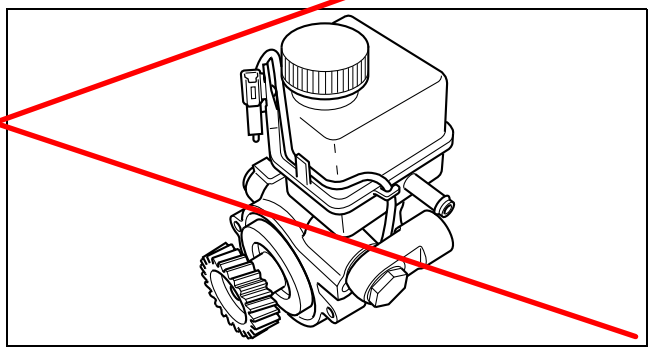
B3E0612T002

1	Mount rubber
2	Cross-section A-A

POWER STEERING OIL PUMP CONSTRUCTION

DPE061432650T01

- A size and weight-reduced vane-type oil pump with a built-in flow control valve has been adopted for vehicles with the MZR-CD (RF Turbo) engine.

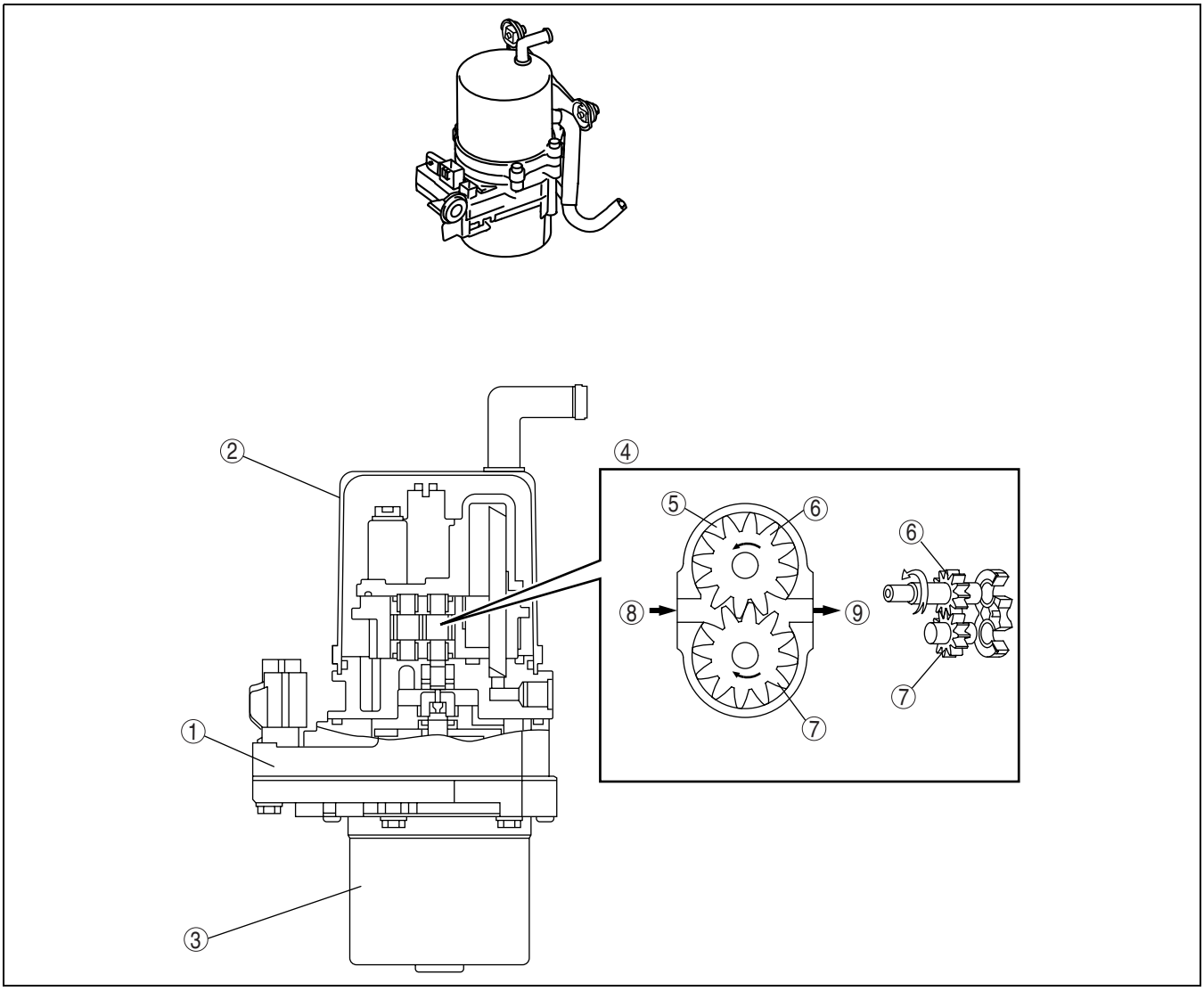


DPE614ZT1003

ELECTRIC POWER STEERING OIL PUMP CONSTRUCTION

DPE061432650T02

- Electric power steering oil pump has been adopted for vehicles with the L8, LF engine to reduce engine load. This allows for an improvement in fuel economy while conserving the performance and feeling of conventional hydraulic power steering.
- Size and weight reduction is achieved due to the integration of the electric power steering oil pump, motor, reserve tank, and electro hydraulic power assist steering (EHPAS) control module.



DPE614ZT1009

1	EHPAS control module
2	Reserve tank
3	Motor
4	Gear pump
5	Hydraulic chamber

6	Drive pinion
7	Driven pinion
8	Intake
9	Outlet

ELECTRO HYDRAULIC POWER ASSIST STEERING (EHPAS) OUTLINE

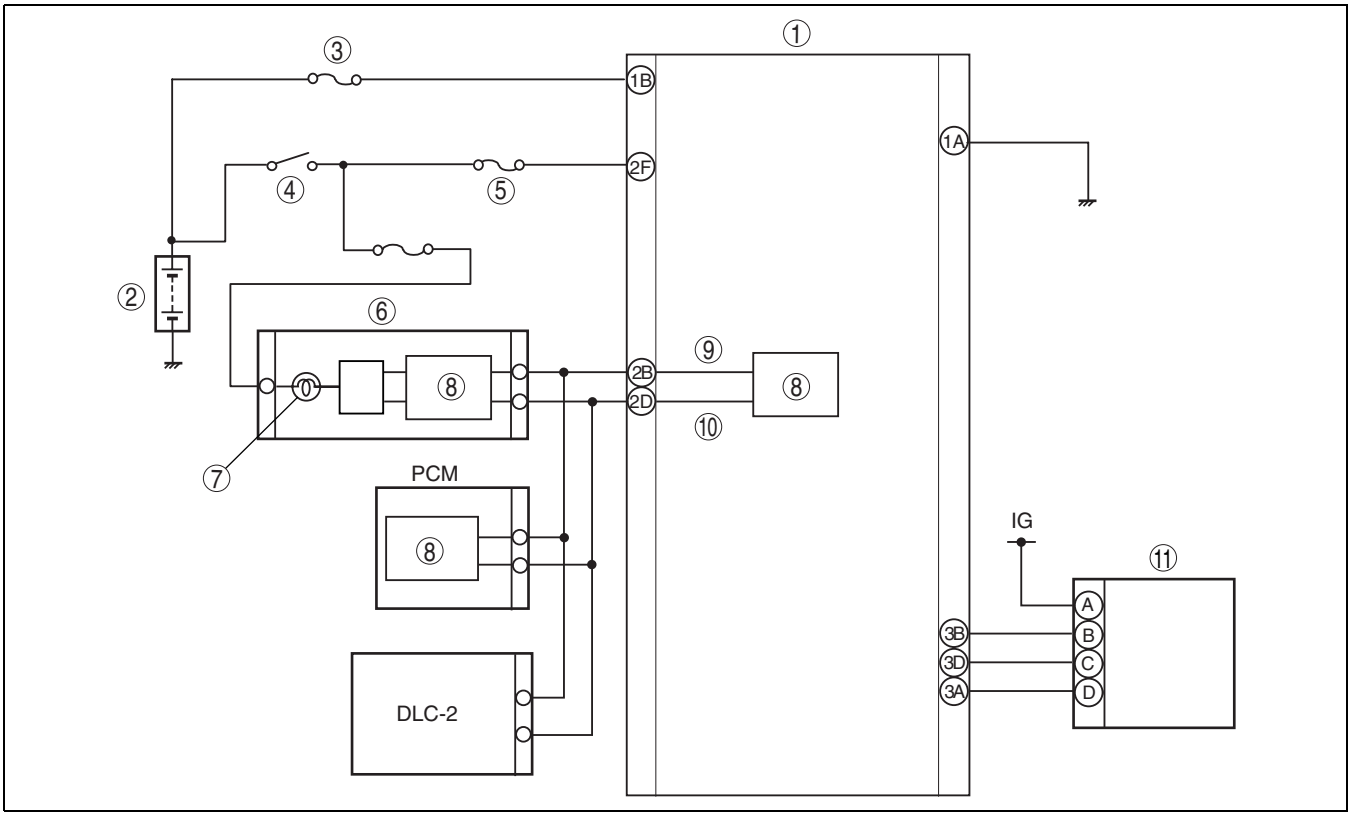
DPE061400000T03

- EHPAS has been adopted for vehicles with the ~~L8,~~ LF engine. Engine load is reduced due to the electric power steering oil pump operating independently of the engine. This allows for an improvement in fuel economy while conserving the performance and feeling of conventional hydraulic power steering.
- When replacing the electric power steering oil pump, configuration procedure must be done to match the vehicle information with a new EHPAS control module.

ELECTRO HYDRAULIC POWER ASSIST STEERING (EHPAS) WIRING DIAGRAM

DPE061400000T04

~~With ABS~~

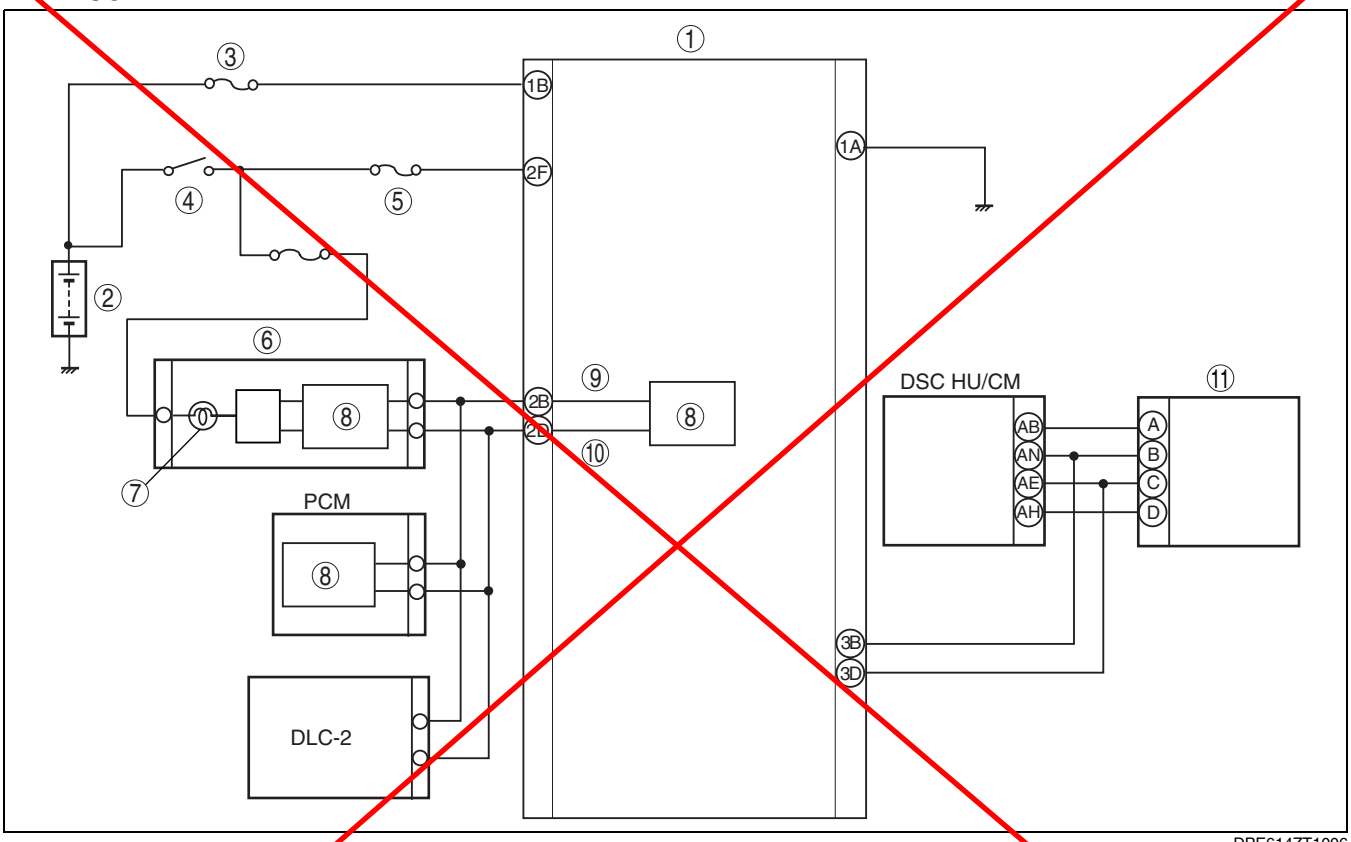


DPE614ZT1007

1	EHPAS control module
2	Battery
3	EHPAS 80 A fuse
4	Ignition switch
5	EHPAS 5 A fuse
6	Instrument cluster

7	EHPAS warning light
8	CAN driver
9	CAN_L
10	CAN_H
11	Steering angle sensor

With DSC



DPE614ZT1006

1	EHPAS control module
2	Battery
3	EHPAS 80 A fuse
4	Ignition switch
5	EHPAS 5 A fuse
6	Instrument cluster

7	EHPAS warning light
8	CAN driver
9	CAN_L
10	CAN_H
11	Steering angle sensor

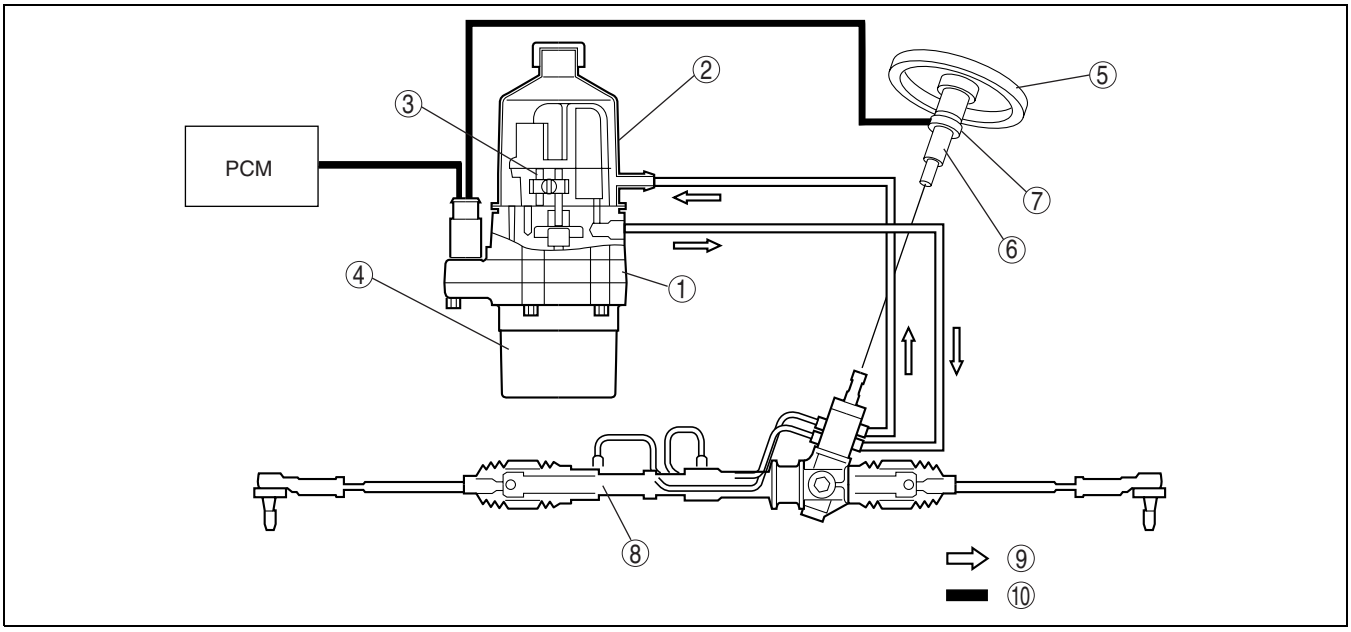
06

ELECTRO HYDRAULIC POWER ASSIST STEERING (EHPAS) CONSTRUCTION/OPERATION

DPE061400000T05

Construction

- The EHPAS system consists of the following parts:
  - — Manual steering mechanism:
    Consists of the steering wheel, steering shaft, steering gear and linkage
  - — Assist mechanism:
    Consists of the motor and gear pump that are incorporated into the electric power steering oil pump.
  - — Control system:
    Consists of the EHPAS control module incorporated into the electric power steering oil pump, the steering angle sensor installed on the combination switch, and the vehicle and engine speed signals input from the PCM.



DPE614ZT1004

1	EHPAS control module
2	Reserve tank
3	Pump
4	Motor
5	Steering wheel

6	Steering shaft
7	Steering angle sensor
8	Steering gear and linkage
9	Hydraulic pressure
10	Electric signal

Operation

Power Assist Mechanism Operation

- According to the steering action of the driver, the steering angle sensor detects the steering speed, and then outputs a steering speed signal to the EHPAS control module. The EHPAS control module uses the steering speed signal, vehicle speed signal, and other vehicle conditions, to determine the proper motor speed.
- Based on the motor seed determined by the EHPAS control module, the current from the motor drive circuit to the EHPAS motor is controlled to within the target current amount and the oil pump operates accordingly.
- The hydraulic pressure created by the oil pump is used to assist the shaft to turn axially. Due to this, the steering operation load on the driver is reduced.

Component Parts/Function

- The EHPAS system consists of the following parts. While each part has a regular function in other systems, only the function during EHPAS control is listed.

Part name	Function
Electric power steering oil pump (with built-in motor, reserve tank, and EHPAS control module)	• Calculates the proper assist current based on the signal input from the steering angle sensor and the vehicle and engine speed signals input from the PCM via CAN lines, controls the motor and performs power assist. • Controls the on-board diagnostic system and fail-safe function when there is a malfunction in the EHPAS system.
steering angle sensor	• Transmits the steering speed to the EHPAS control module.
PCM	• Outputs the vehicle and engine speed signals to the EHPAS control module via CAN lines.
Instrument cluster	• The EHPAS warning light illuminates to advise the driver when a system malfunction is detected.

ELECTRO HYDRAULIC POWER ASSIST STEERING (EHPAS) CONTROL MODULE CONSTRUCTION/ OPERATION

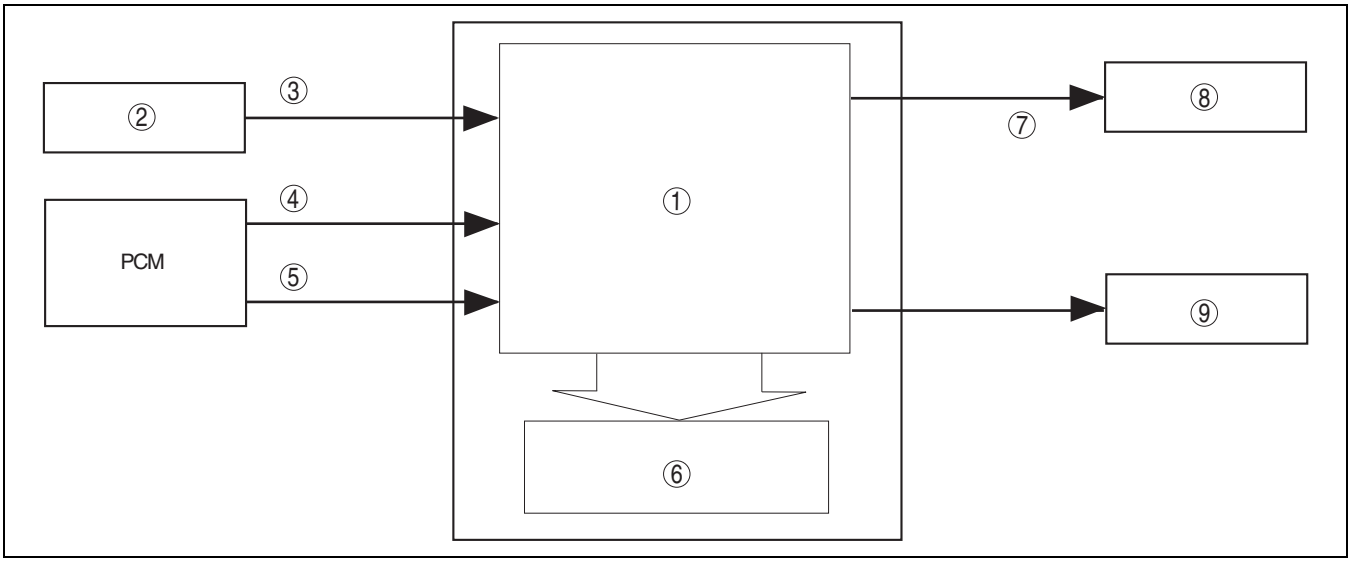
DPE061400000T06

Construction

- The EHPAS control module is built into the electric power steering oil pump.
- The module calculates the proper assist current based on the steering speed signal from the steering angle sensor installed on the steering gear and linkage, and the vehicle and engine speed signals from the PCM via CAN communication, and then outputs the control current to the motor.

Function Table

Control item	Function
Motor current control	• Calculates the proper assist current based on the steering speed, and vehicle and engine speeds, and outputs a control current to the motor.
On-board diagnostic function	• A function that allows important parts of the control system to perform self-diagnosis. In case a malfunction occurs, the EHPAS warning light illuminates to advise the driver, and at the same time a DTC is stored in the EHPAS control module. • When a malfunction is determined as a result of the on-board diagnosis, system control is suspended or limited to prevent any dangerous occurrence while driving.



DPE614ZT1010

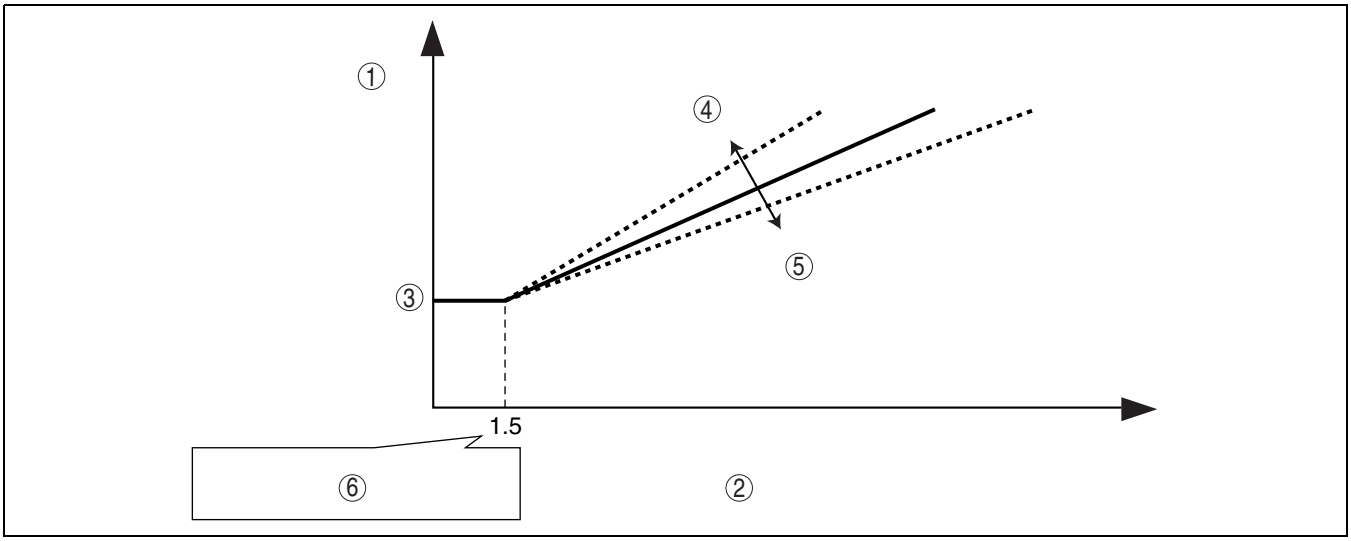
1	EHPAS control module
2	Steering angle sensor
3	Steering speed signal
4	Vehicle speed signal (CAN)
5	Engine speed signal (CAN)

6	On-board diagnostic function
7	Control current
8	Motor
9	EHPAS warning light

Operation

Motor current control

- The proper assist current is calculated based on the steering speed from the steering angle sensor, and the vehicle and engine speed signals from the PCM, and then the current output to the motor is controlled so that the motor speed is as specified according to the following table.



DPE614ZT1005

1	Motor speed (rpm)

2	Steering wheel rotation speed (deg/s)

3	Stand-by
4	Vehicle speed (low)
5	Vehicle speed (high)
6	Smallest detected angle of steering angle sensor

CONTROLLER AREA NETWORK (CAN) OUTLINE

DPE061400000T07

- The EHPAS control module sends and receives data to and from other modules via the CAN. Refer to Section 09 for a detailed explanation of the CAN.

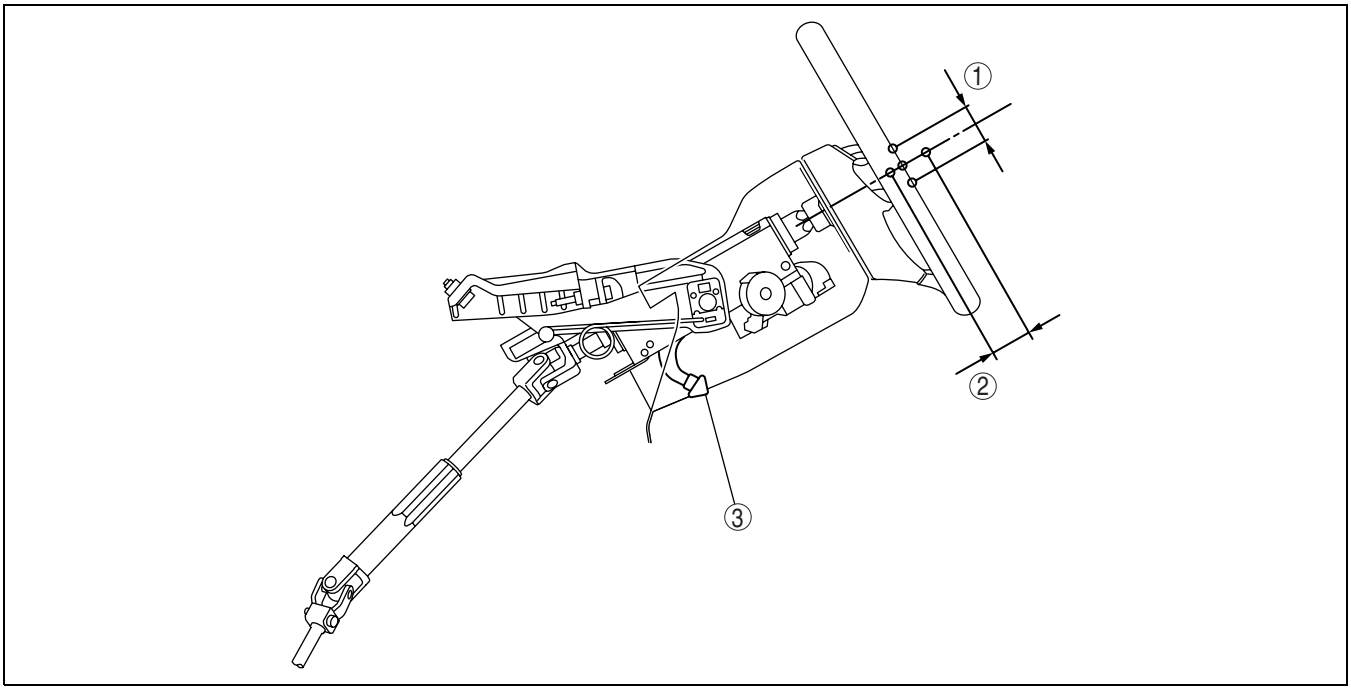
Data sent
- EHPAS warning light illumination request
- Steering angle

Data received
- Vehicle speed
- Engine speed

STEERING COLUMN CONSTRUCTION

DPE061432010T02

- A steering column equipped with a tilt / telescoping system has been adopted for all models for improved operability.
- The tilt system is adjustable by **40 mm** in the up / down direction, the telescoping system is adjustable by **50 mm** in the forward / backward direction.



DPE614ZT1008

1	Tilt amount 40 mm
2	Telescope amount 50 mm

3	Tilt/telescope amount lever

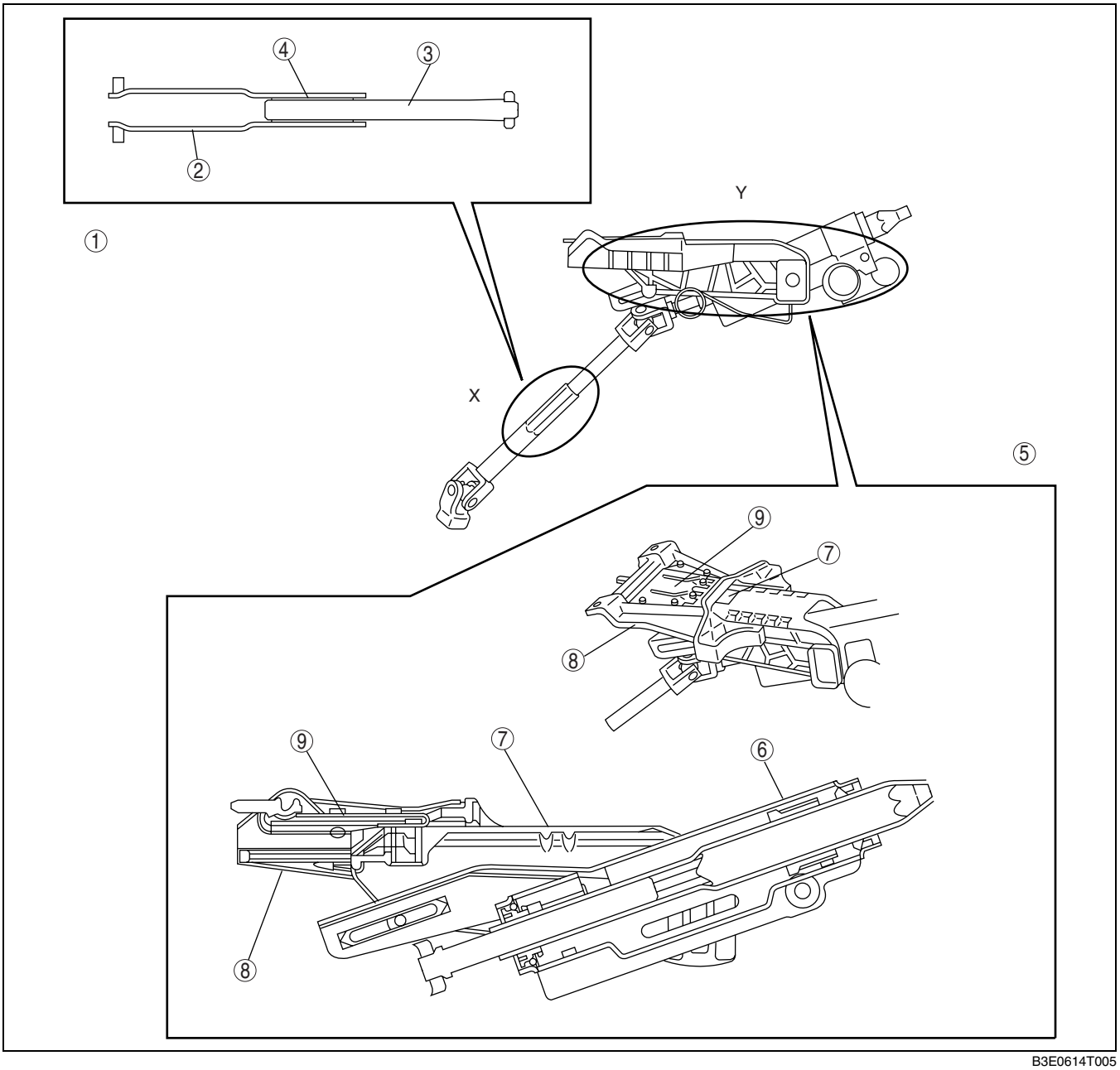
ENERGY ABSORBING SYSTEM CONSTRUCTION/OPERATION

DPE061432010T01

Construction
- Due to impact absorbing mechanisms at two points on the steering shaft, when a collision occurs, the steering shaft effectively absorbs the impact energy that would be transmitted to the driver, thereby reducing injury.

Operation
- At the moment of a collision, the rearward collapse of the steering gear and linkage (first stage impact) due to the impact energy from the front causes the intermediate shaft to contract. At this time, the sliding sleeve between the outer and inner tubes of the intermediate shaft slides and the impact energy is absorbed through this friction. (Section X in the figure)

- Then, as the steering wheel contacts the body of the driver (second stage impact), the column jacket and inner bracket slide together as a single unit along the guide. The impact energy is then absorbed due to force that deforms the bending sheet connected between the inner and outer brackets. (Section Y in the figure)



B3E0614T005

1	Section X
2	Outer tube
3	Inner tube
4	Sliding sleeve
5	Section Y

6	Column jacket
7	Inner bracket
8	Outer bracket
9	Bending sheet