

G2 POWER STEERING

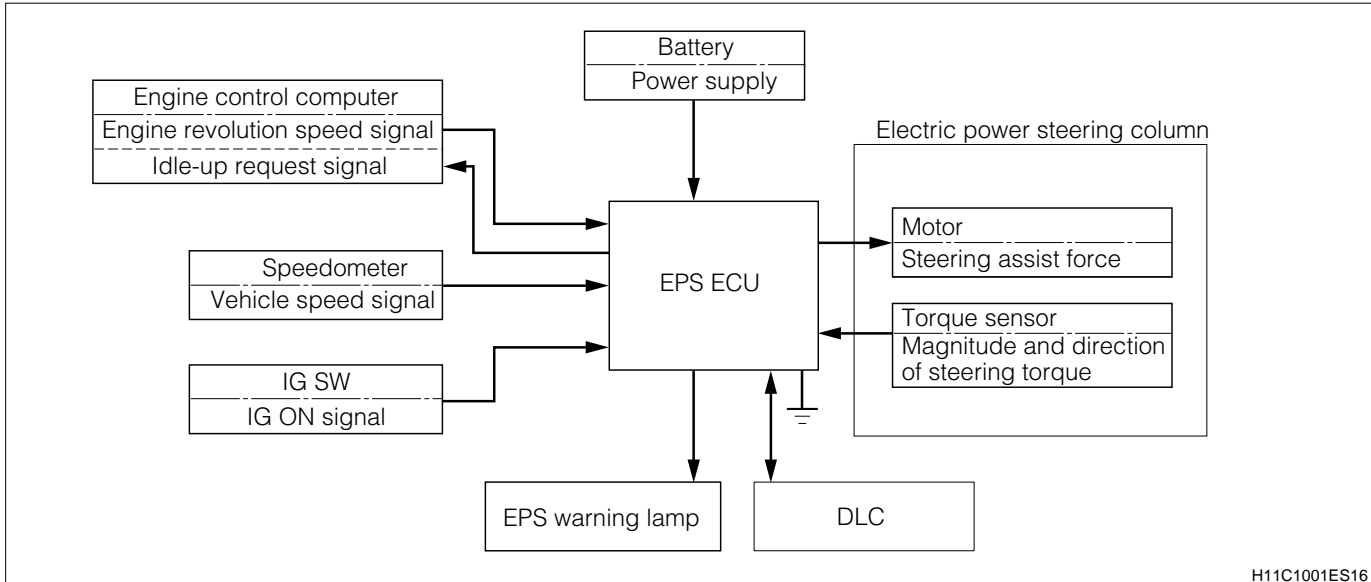
ELECTRIC POWER STEERING -----	G2 - 1
OUTLINE-----	G2 - 1
SYSTEM DRAWING -----	G2 - 1
SYSTEM WIRING DIAGRAM -----	G2 - 1
LOCATION OF COMPONENTS -----	G2 - 2
CONTROL -----	G2 - 3
BASIC THEORY -----	G2 - 3
ASSIST CONTROL-----	G2 - 3
DIAGNOSIS -----	G2 - 3
TEST MODE FUNCTION(SENSOR CHECK FUNCTION)-----	G2 - 4
FAIL-SAFE FUNCTION -----	G2 - 5
COMPONENTS -----	G2 - 6
ELECTRIC POWER STEERING	
COLUMN ASSEMBLY -----	G2 - 6
SPEEDOMETER -----	G2 - 9
EFI ECU -----	G2 - 9
EPS WARNING LAMP -----	G2 - 9

ELECTRIC POWER STEERING

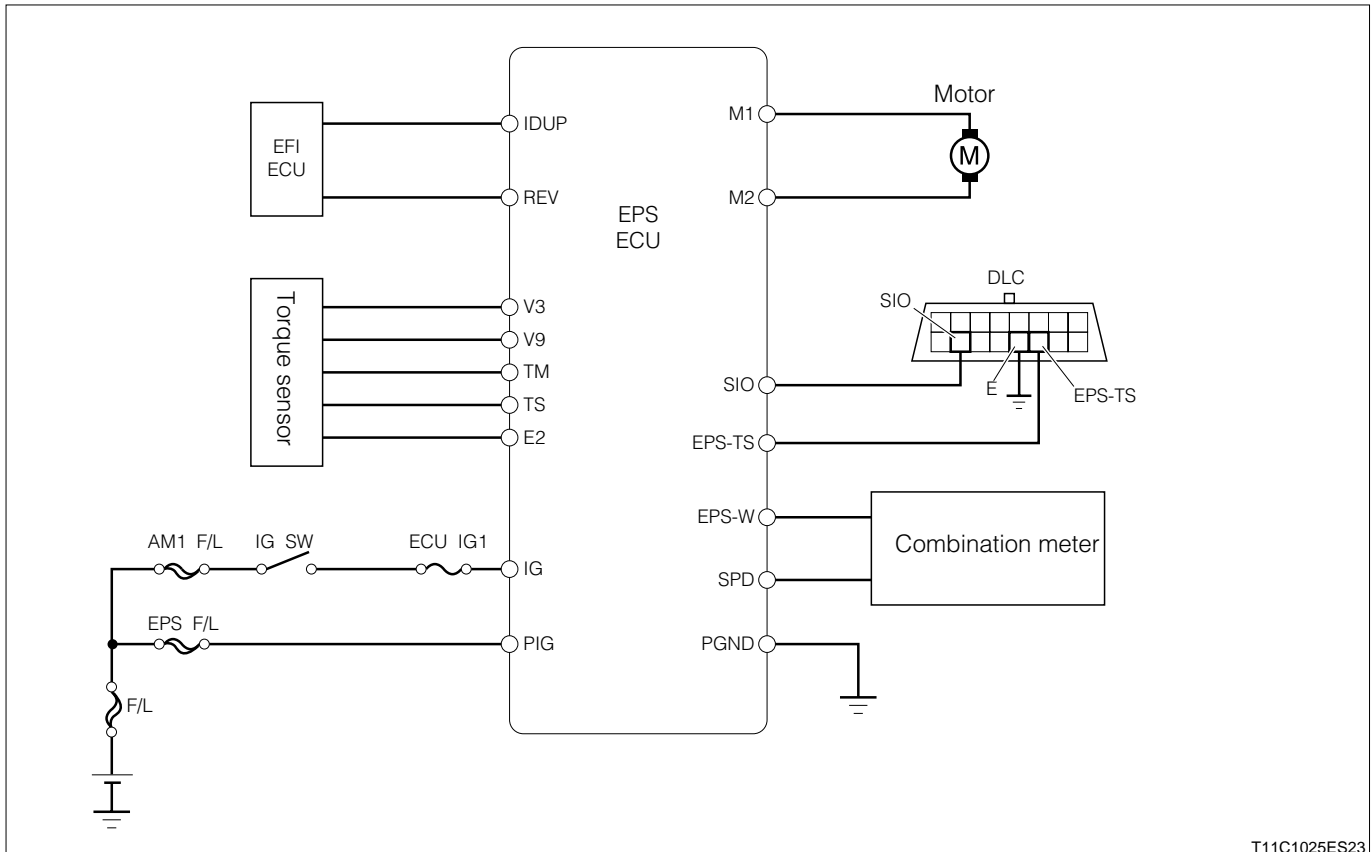
1 OUTLINE

1. A vehicle speed-responsive type electric power steering (EPS), featuring a good response and straight-line vehicle stability, has been employed in all vehicles. This power steering can provide a lighter steering effort while the steering wheel is turned when the vehicle is stationary or is running at low speeds, and an appropriately heavy steering effort when the vehicle is running at medium or high speeds.

1-1 SYSTEM DRAWING

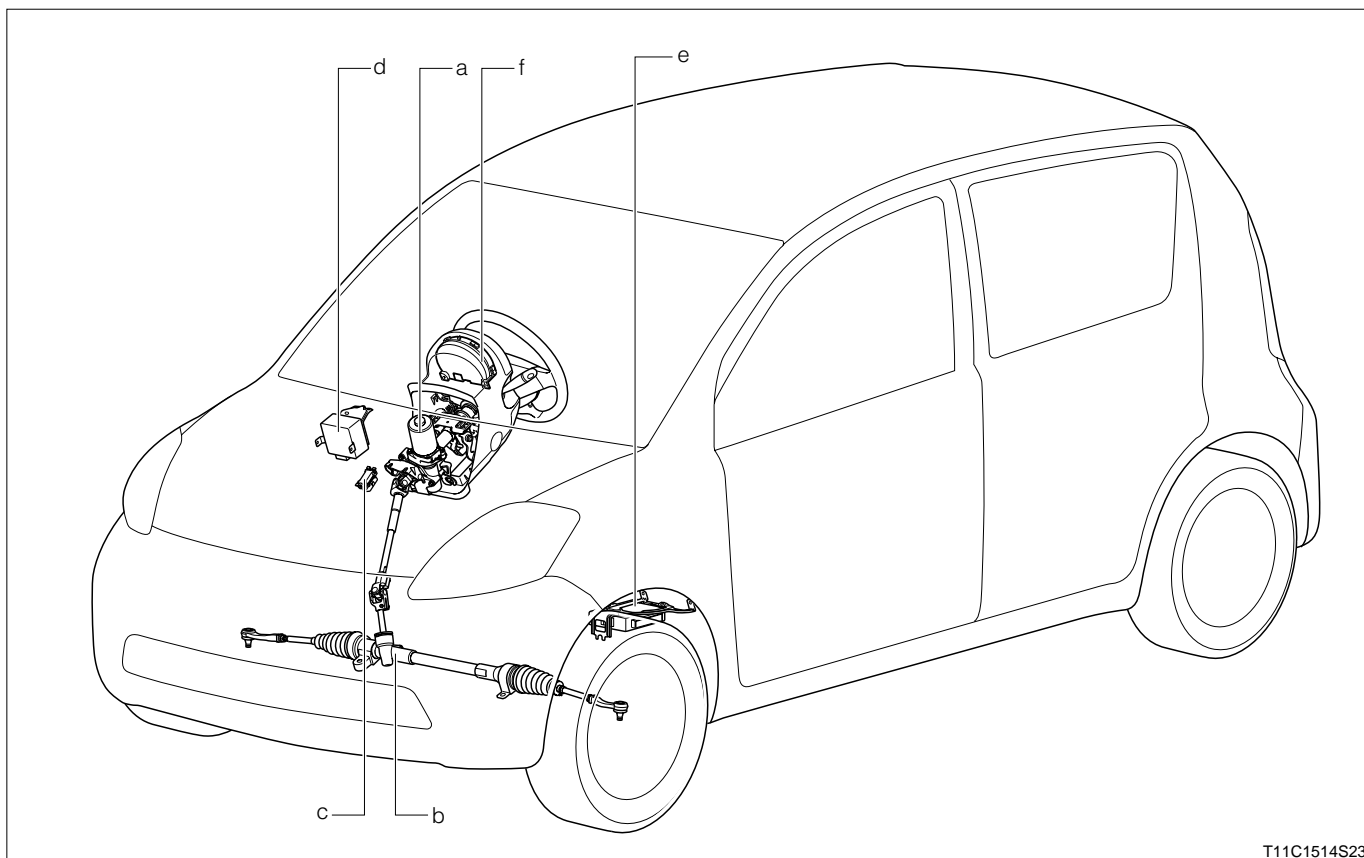


1-2 SYSTEM WIRING DIAGRAM

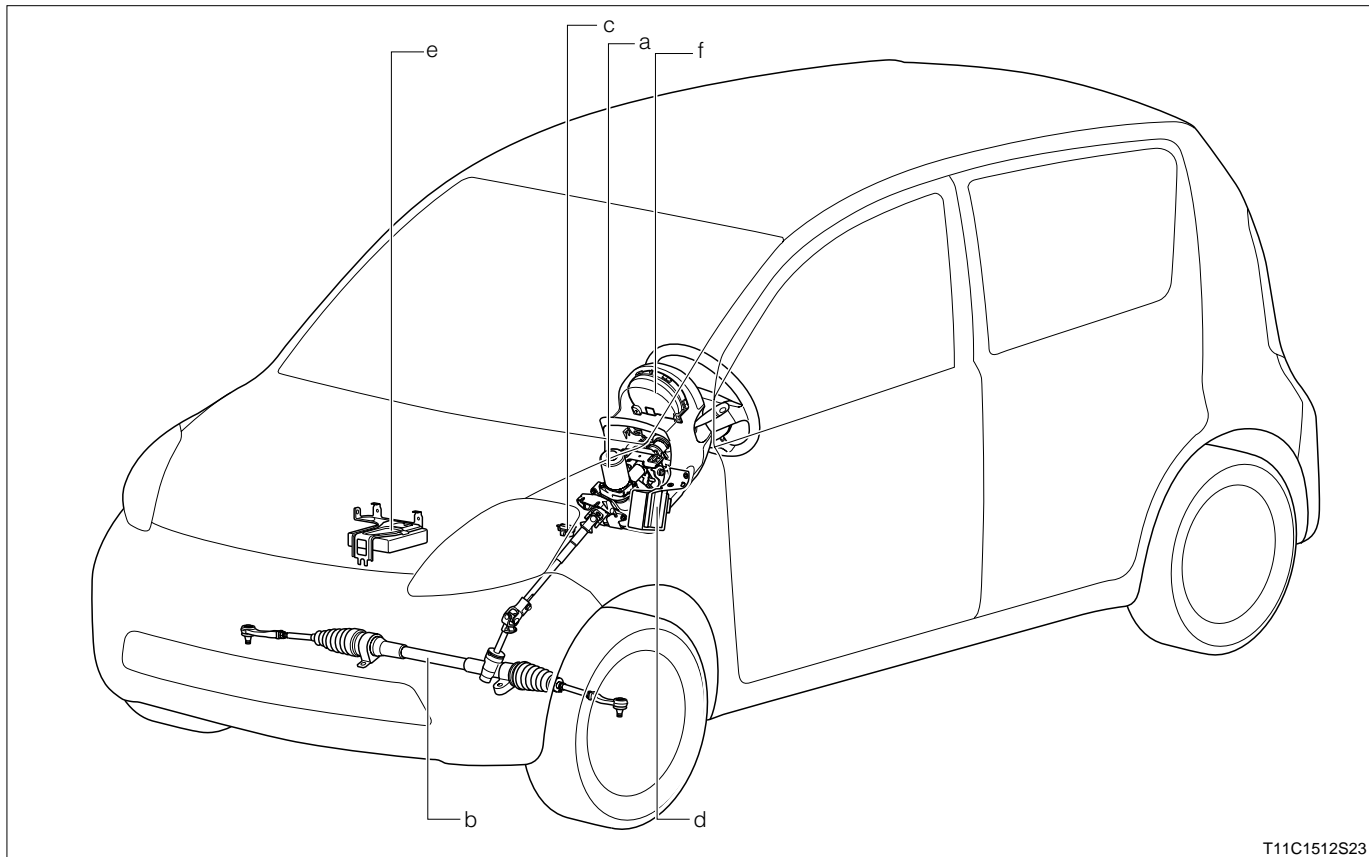


1-3 LOCATION OF COMPONENTS

RHD vehicles



T11C1514S23



T11C1512S23

a	Steering column
b	Steering gear
c	DLC
d	EPS ECU
e	EFI ECU
f	Combination meter (warning lamp, speedometer)

2 CONTROL

2-1 BASIC THEORY

The power steering is assisted by the following method. The motor, provided at the center of the steering column, drives the steering shaft. The steering effort is assisted by transmitting this driving force to the steering rack. Furthermore, the EPS ECU controls the assisting direction and assisting force to optimum values, based on the signals sent from the vehicle speed sensors, torque sensors, and EFI ECU.

2-2 ASSIST CONTROL

The EPS ECU calculates an optimum assisting force each time, based on the vehicle speed signal from the vehicle speed sensors, steering force and steering direction from the torque sensors. In this way, the output signal to the motor is controlled.

2-3 DIAGNOSIS

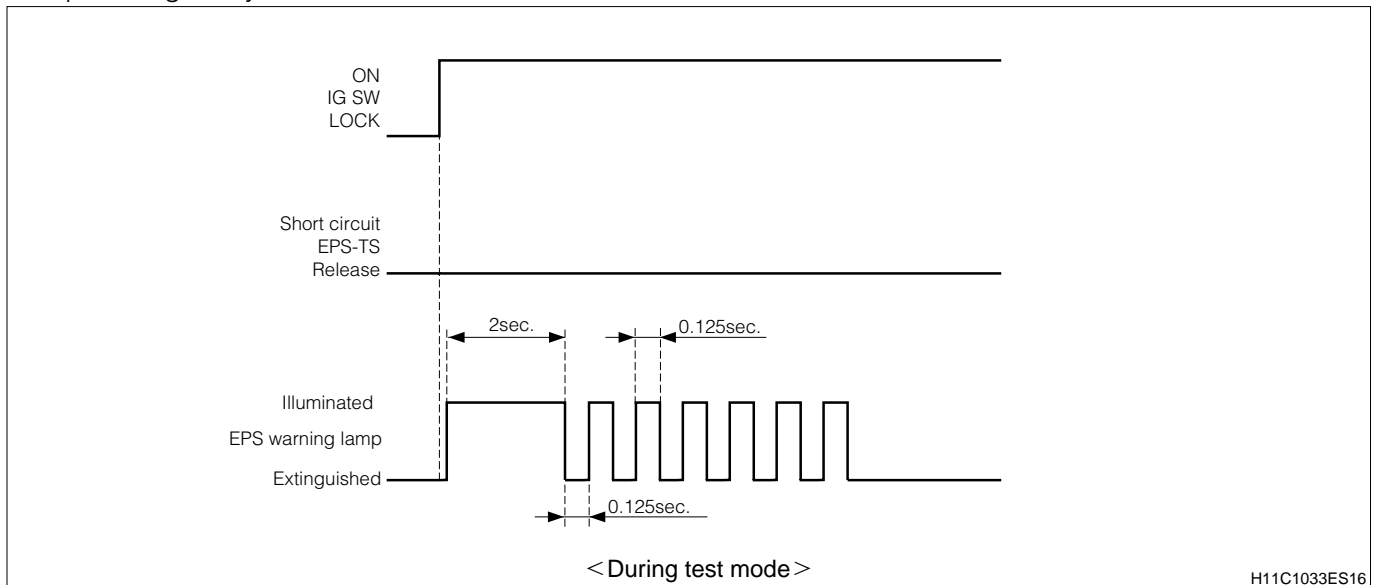
2-3-1 DESCRIPTION

Diagnosis means is a function in which the ECU informs the inspector of abnormal items if any abnormality exists in the input/output system. When an abnormality takes place, the ECU memorizes the abnormal item. Moreover, this memory function is written into a non-volatile ROM(EEPROM) so that the diagnosis results will remain in the memory even if the power is switched off.

Please refer to the repair manual for more detail of the diagnosis.

2-4 TEST MODE FUNCTION(SENSOR CHECK FUNCTION)

- 1.The test mode function (sensor check function) evaluates whether the sensor and signal systems are functioning normally or not by checking the output of the vehicle speed sensor signal and engine revolution speed signal. Thus, this function informs the inspection worker of the results by making the EPS warning lamp flash.
- 2.The test mode is performed when an elimination operation by the DLC is performed. The test mode code is memorized.
- 3.When the test mode is set, the EPS ECU causes a warning lamp to flash, thus indicating that the test mode is set. Next, the engine is started. The EPS warning lamp goes out and the test mode codes are automatically erased when each signal output has been judged to be “normal” after the vehicle has run at a speed of 20 km/h or more for at least 2 seconds. When the check results reveal an abnormality or no test can be carried out because the check conditions were not satisfied, the EPS warning lamp will continue to flash. In this case, the test mode code will not be erased. Return the IG SW to the "LOCK" position once and check/repair the vehicle speed sensor signal system and the engine speed signal system.



Test mode code table

Code No.		Test mode	
2-digit	4-digit	Check system	Releasing conditions
71	C1571	Vehicle speed signal	The meter vehicle speed signal is above 20 km/h for over 2 seconds.
73	C1573	Engine revolution speed signal	The engine revolution speed signal continues above 360rpm for over 2 seconds

2-5 FAIL-SAFE FUNCTION

1. This is a function to perform the control so that the steer ability may not be lost even when an abnormality is encountered in the input/output signal system.
2. During the fail-safe operation, the EPS warning lamp inside the combination meter goes on, thus informing the driver of the abnormality. At the same time, the following control takes place.
3. When an abnormality was detected once, the diagnosis code for it remains memorized even if the system returns to the normal condition, the fail-safe function is released and the normal assisting condition has been restored.

List of fail-safe control functions

System diagnosed	Contents of diagnosis	Fail-safe	
		Contents of control	Control Release Conditions
Main torque sensor	Open wire, short circuit, poor sensor characteristics	Stopping of assistance	Released if IG SW is switched once from LOCK to ON after resuming the normal operation.
Sub torque sensor	Open wire, short circuit, poor sensor characteristics		
Torque sensor	Excessive difference between output value of main sensor and output value of sub-sensor		
Torque sensor	Abnormality of 9V power supply voltage of sensor		
Motor	Overcurrent		
Motor	Open wire between both terminals of the motor		
Motor	Short circuit, low voltage or overvoltage across both terminals of the motor		
EPS ECU	Malfunctioning of CPU in ECU		
EPS ECU	Abnormality of ECU inner circuit		
EPS ECU	Abnormality of temperature sensor inside ECU		
EPS ECU	Abnormality of non-volatile ROM inside ECU	Released if IG SW is switched once from LOCK to ON after resuming the normal operation.	
Vehicle speed signal (When stopped)	· Open wire or short circuit · Vehicle speed sensor malfunctioning	The fail-safe function is released when the system returns to the normal condition.	
Engine revolution speed signal	· Engine revolution (REV) signal missing · Open wire, short circuit		
Power supply	Abnormal rise in battery voltage		
Power supply	· Battery voltage abnormally dropped · PIG power supply voltage abnormally dropped		
Power supply	Malfunctioning of power supply relay in ECU	Stopping of assistance	Released if IG SW is switched once from LOCK to ON after resuming the normal operation.
EPS ECU	Malfunctioning of motor relay in ECU		

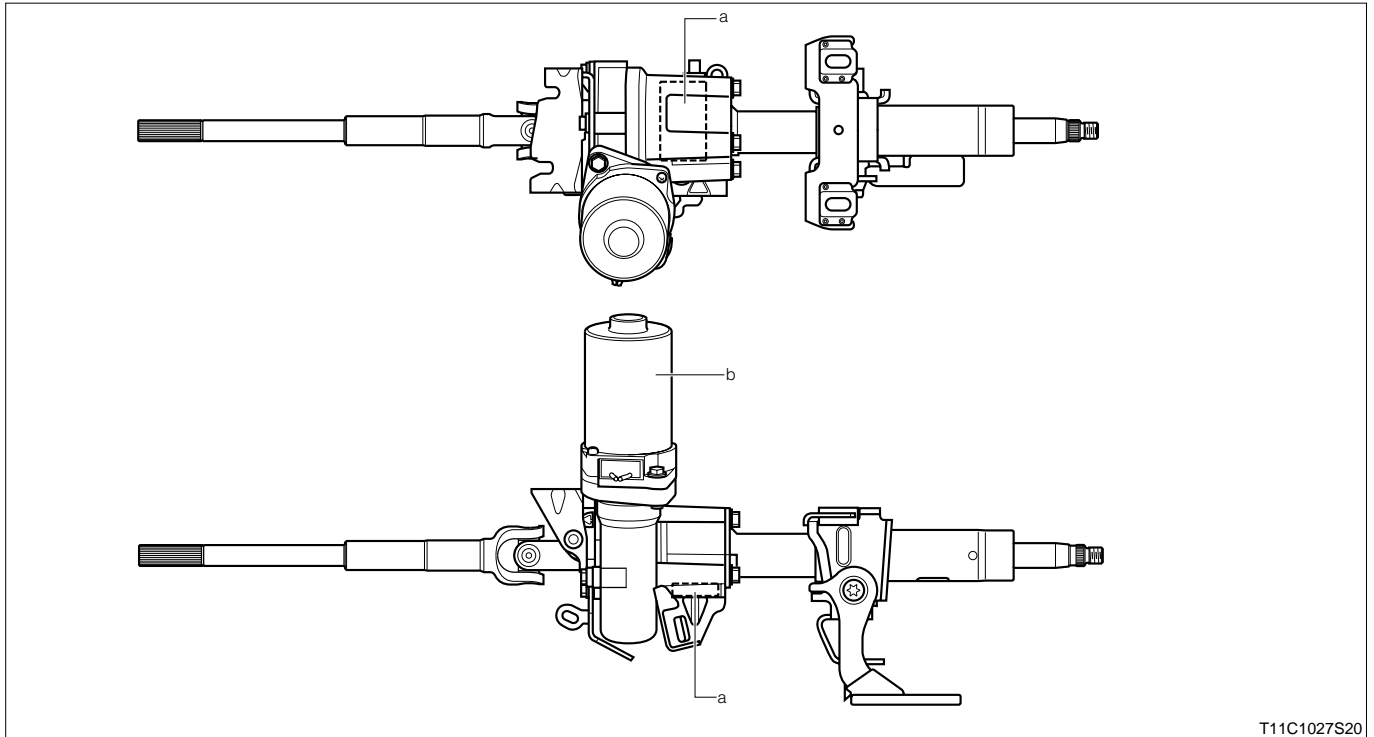
3 COMPONENTS

3-1 ELECTRIC POWER STEERING COLUMN ASSEMBLY

3-1-1 DESCRIPTION

1.The electric power steering column Ay has the following functions in addition to the functions of a normal steering column.

- (1) Torque sensor for measuring rotating torque of steering shaft
- (2) Motor for assisting the steering effort by moving the steering shaft, etc.



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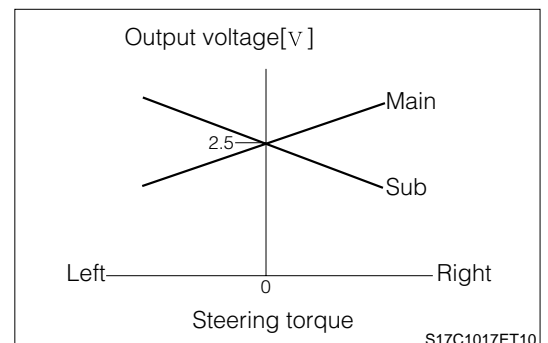
a	Torque sensor
b	Motor

3-1-2 CONSTRUCTION AND OPERATION

(1) Torque sensor

① Output characteristics

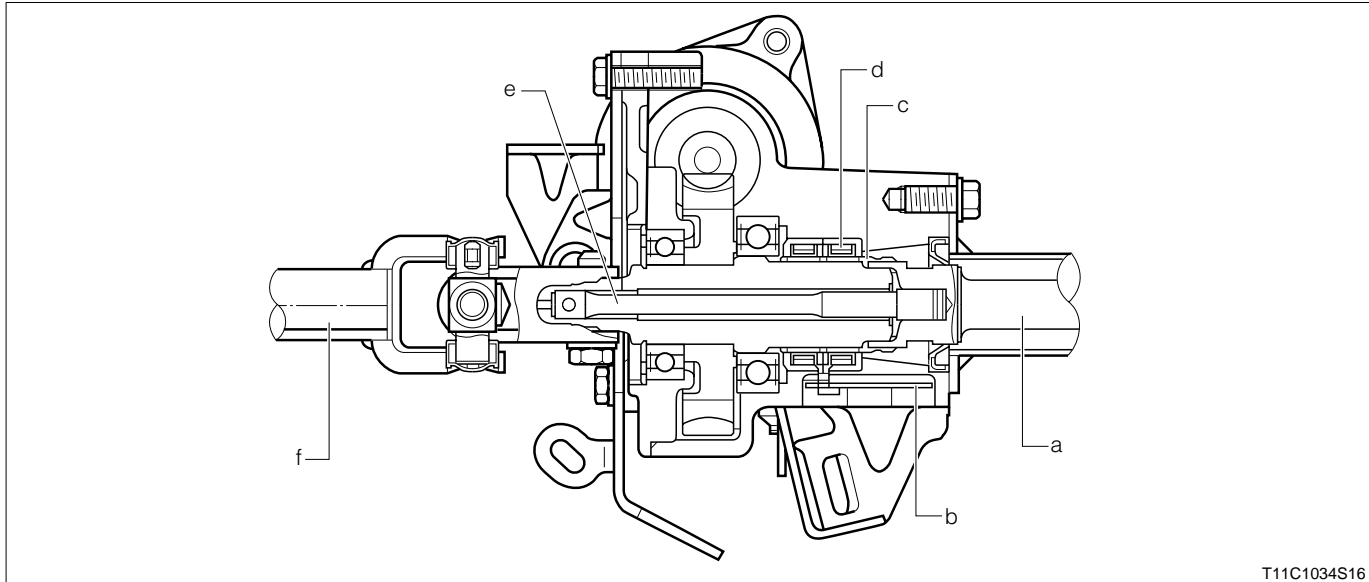
- 1.The output signals of the torque sensor consist of two torque signals, i.e. those from double circuits of a main circuit and a sub circuit.
- 2.When there is no rotating torque applied to the steering (neutral position), the output values of the main and sub are 2.5V, respectively.
- 3.The torque signal changes when a rotating torque is generated due to the steering operation. When the steering wheel is turned to the right, the main output voltage increases from 2.5V and the sub output voltage decreases from 2.5V.
- 4.The voltage change is outputted to the EPS ECU as a steering signal.



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② Construction

1. The input from the steering wheel is inputted to the input shaft. The input shaft and output shaft are connected by means of the torsion bar. When the output shaft is difficult to turn because the reaction force of the road surface is great, a difference in rotation occurs between the input shaft and the output shaft. Consequently, the torsion bar is twisted.
2. The sensor sleeve provided with a slit is secured on the input shaft. Also, a spline groove is provided on the output shaft.
3. The change in torque is detected from the twisted about of the torsion bar by this and by the two coils fitted to the column tube and also by the detection circuit.

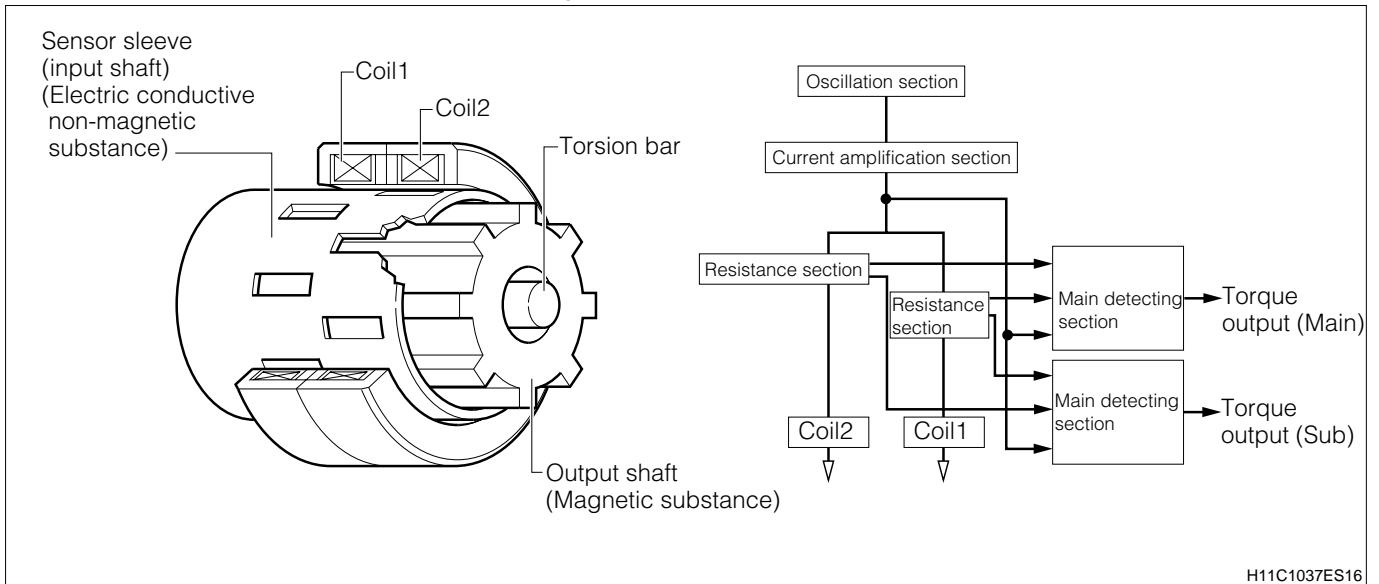


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a	Input shaft
b	Torque sensor
c	Sensor sleeve
d	Coil
e	Torsion bar
f	Output shaft

③ Operation

1. When the torsion bar is twisted by the input from the steering wheel, a difference in rotation occurs between the input shaft and the output shaft.
2. The change in facing area is caused by the difference in rotation between the slit of the sensor sleeve secured on the input shaft and the groove on the output shaft.
3. The change of the facing area becomes the change in magnetic flux density between the slit and the groove. As a result, the inductance of the energized coil (self-induced voltage) changes and this change is taken out as a voltage signal.
4. The voltage signal that has been obtained is input into the detection circuit. Thus, the twisted amount of the torsion bar is output as the change in torque.

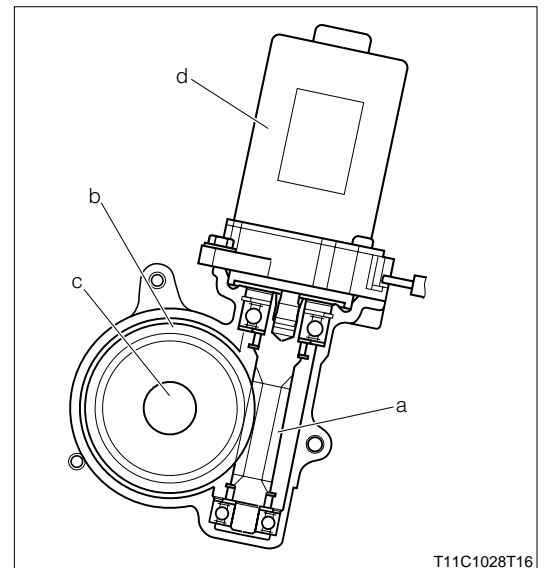


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(2) Motor

The torque due to the motor rotation is generated by a signal from the EPS ECU. Its speed is slowed by the worm gear and is transmitted to the output shaft.

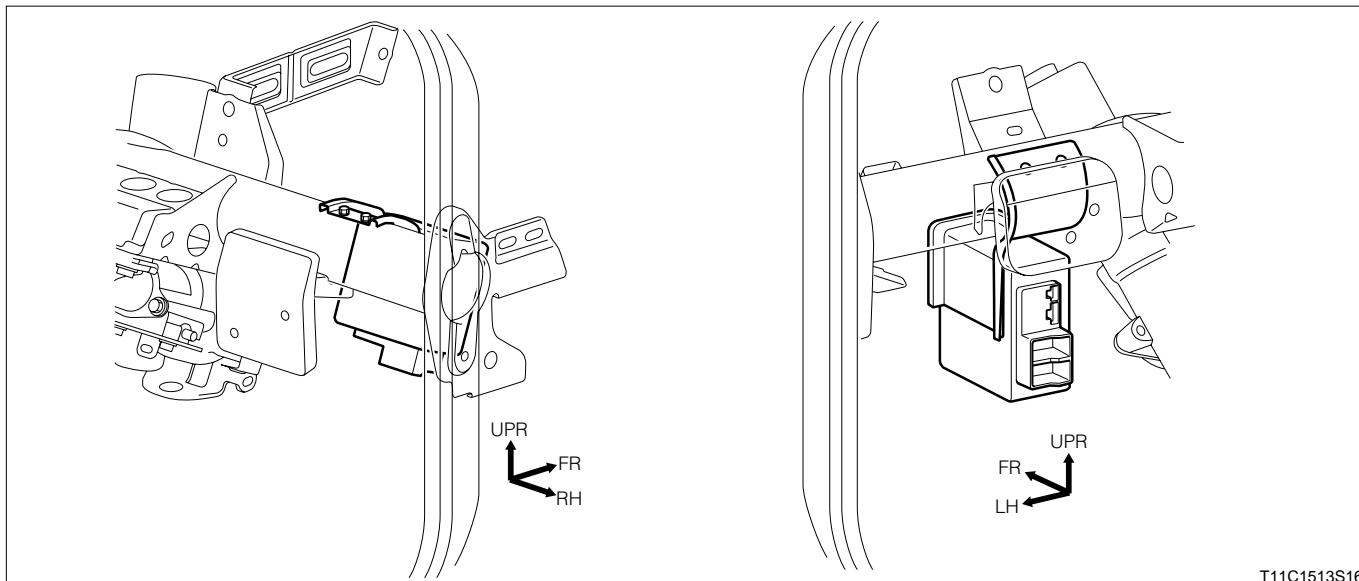
a	Worm gear
b	Worm wheel gear
c	Worm wheel shaft
d	Motor



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(3) EPS ECU

1. It is installed on the pillar-to-pillar member on the driver's seat side.



Left figure: RHD vehicle; Right figure: LHD vehicle

2. The assisting force is determined from the output values from the vehicle speed sensor and torque sensor. In this way, the direction and amount of the current sent to the motor is regulated.

3. The system is always monitored. If any abnormality is detected, the EPS warning lamp goes on and the fail-safe function is executed.

3-2 SPEEDOMETER

The speedometer receives a vehicle speed signal from the ABS ECU and calculates the vehicle speed. The vehicle speed signal outputted from the speedometer is inputted into the EPS ECU.

3-3 EFI ECU

3-3-1 ENGINE REVOLUTION SPEED SIGNAL

The signal (pulse signal) from the EFI ECU is inputted into the EPS ECU.

3-3-2 IDLE-UP REQUEST SIGNAL

In order to prevent the engine revolution speed from fluctuating (especially prevent the idle speed from dropping) due to excessive consuming power of the EPS system, an ON/OFF signal is outputted to the EFI ECU when the motor current exceeds a certain value.

3-4 EPS WARNING LAMP

1. The EPS warning lamp is provided in the combination meter. The following functions are provided:
(1) When the system is running normally, the lamp goes on when the IG SW is turned on and, after a lapse of two seconds, it will go out.

NOTE

- Even if the engine starts immediately after the IG SW has been turned on, the lamp goes on for about 2 seconds for an initial check.

(2) When the system is encountered with an abnormality, the lamp remains illuminated at all time or the lamp will not go on even if the IG SW is turned on.

(3) Output of diagnosis code

Refer to Page J3-12.