

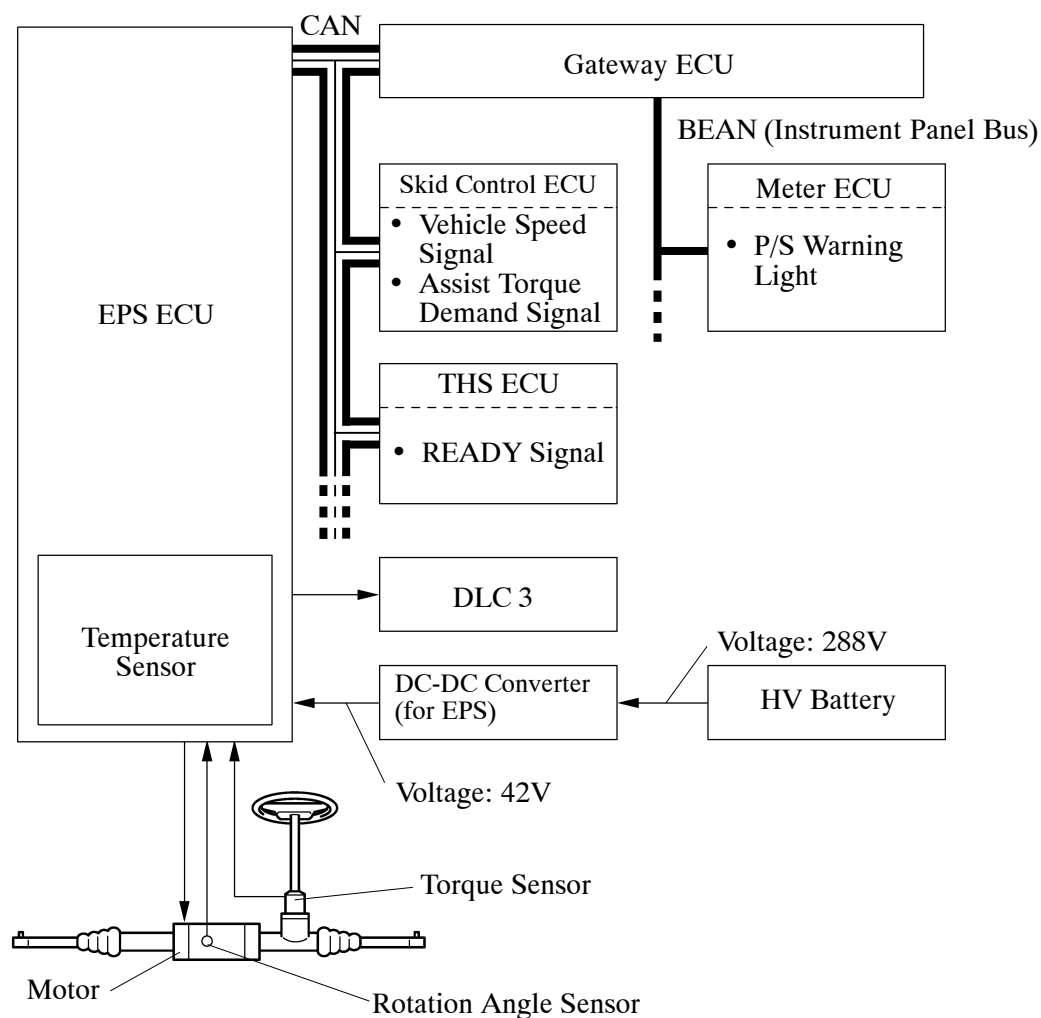
■ EPS (Electric Power Steering)

1. General

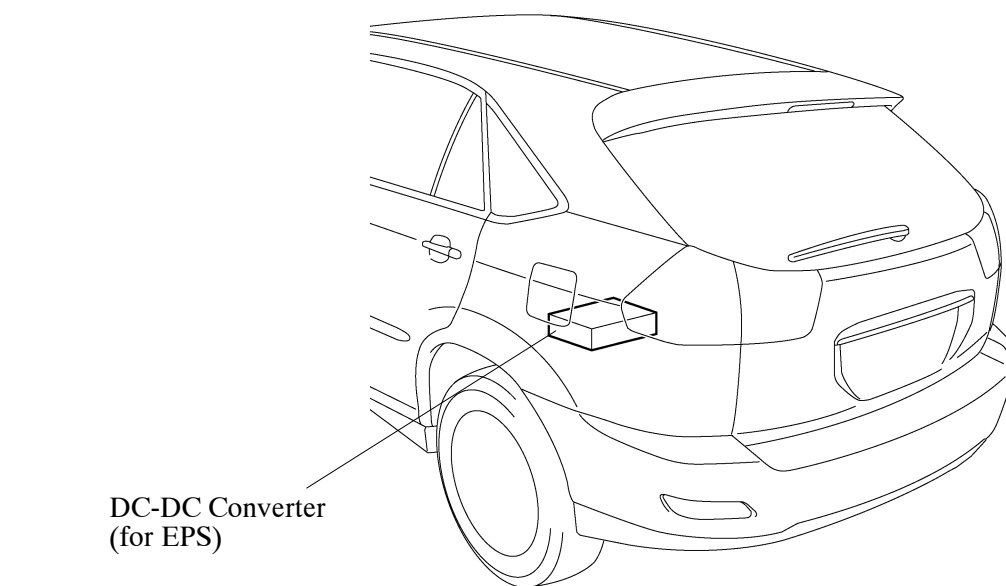
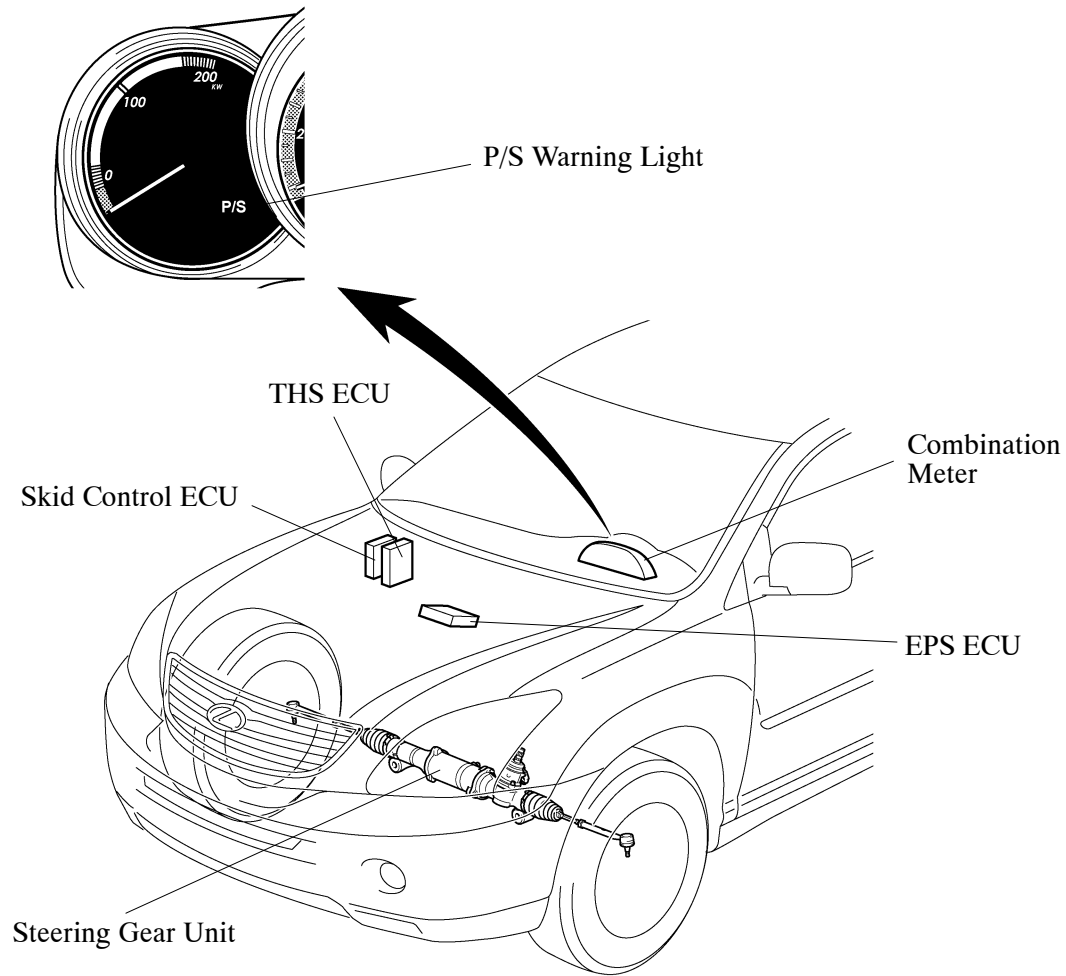
- This system uses a motor and a reduction mechanism that are built into the steering gear housing to generate assist torque, in order to assist the driver's steering effort. The EPS ECU calculates the amount of power assist in accordance with the signals provided by the sensors and the ECUs.
- This system offers excellent fuel economy characteristics because the DC motor, which is built into the steering gear housing to provide power assist, consumes energy only when power assist is required.
- The EPS is driven by a high voltage (42V). A DC-DC converter converts the power of the HV battery (288V) and supplies it to the motor.
- Unlike the conventional hydraulic power steering system, this system excels in serviceability because it does not require pipes, vane pump, pulley and power steering fluid.
- The EPS ECU maintains communication with the skid control ECU, THS ECU, and Gateway ECU via CAN. In addition, the EPS ECU maintains communication with the Meter ECU through the Gateway ECU, via BEAN. For details, refer to Multiplex Communication on page BE-4.
- The new RX400h uses a VDIM (Vehicle Dynamics Integrated Management) to effect the total control of the vehicle. As a result, the brake system and the EPS system effect cooperative control. When the VSC function of the brake control system is activated, the EPS ECU controls the assist torque of the motor upon receiving an assist torque demand signal from the skid control ECU.

For details on the VDIM, see the Brake Control System on page CH-39.

► System Diagram ◀



2. Layout of Main Components



LHD Models

3. Function of Main Components

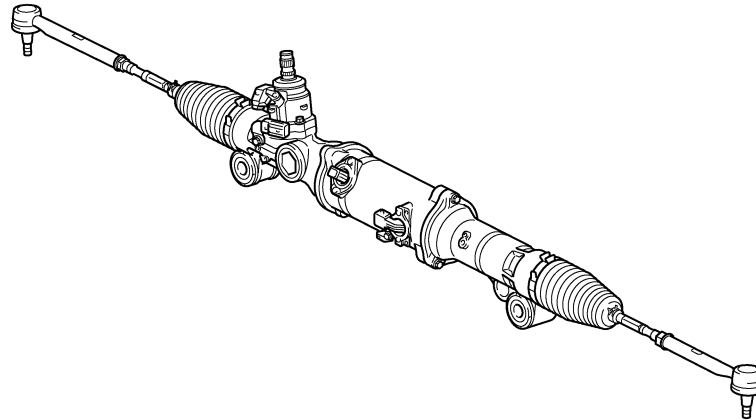
Components		Function
Steering Gear Unit	Torque Sensor	Detects the twist of the torsion bar with this, it calculates the torque that is applied to the torsion bar by changing it into an electrical signal, and outputs this signal to the EPS ECU.
	Motor	Generates power assist in accordance with a signal received from the EPS ECU.
	Reduction Mechanism	Uses a screw mechanism to reduce the speed through a ball screw reduction gear and a rack shaft gear, as well as to convert the rotational movement to a linear movement.
	Rotation Angle Sensor	Outputs the rotation angle of the motor to the EPS ECU.
DC-DC Converter (for EPS)		Converts the voltage of the HV battery from 288V to 42V and supplies this power source to the motor via the EPS ECU.
EPS ECU		In accordance with the signals received from various sensors and the skid control ECU, the EPS ECU operates the motor in the steering gear unit for the purpose of providing power assist.
THS ECU		Transmits a READY signal to the EPS ECU, in order to inform the EPS system that it is ready to generate electricity.
Skid Control ECU		- Vehicle speed signal is outputted to EPS ECU. - When VSC (Vehicle Stability Control) function is operating, the skid control ECU transmits an additional torque signal (which it has calculated in accordance with the signals from the sensors for the purpose of effecting cooperative control) to the EPS ECU.
Meter ECU		Upon receiving a signal from the EPS ECU in the event of a system malfunction, the meter ECU illuminates the P/S warning light.

4. Constructions and Operation

Steering Gear Unit

1) General

A motor, reduction mechanism, and the torque sensor are enclosed in the steering gear unit.



LHD Model

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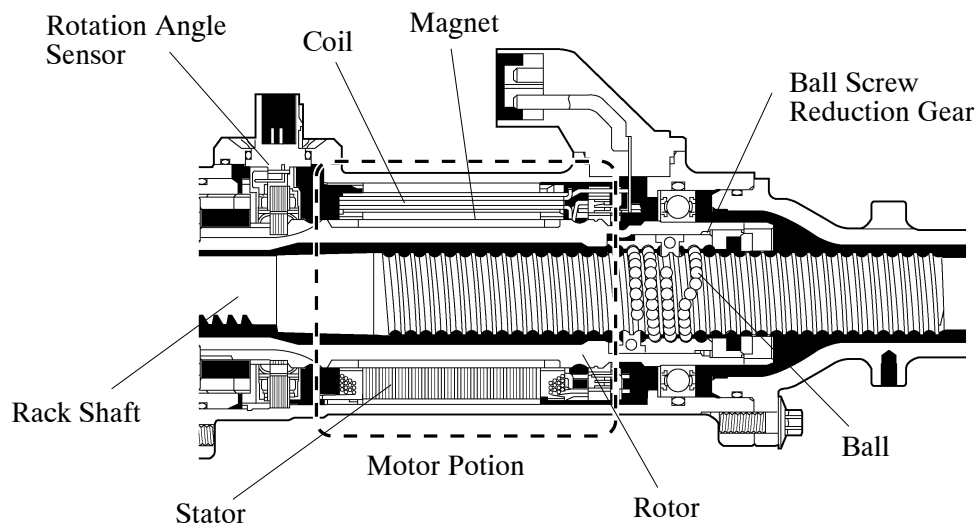
2) Motor

- The motor is a high power output, brushless type motor that is driven by a voltage of 42V.
- The motor, which is mounted coaxially to the rack shaft, consists of a rotation angle sensor, stator, and rotor.

A ball screw reduction gear, which consists of a reduction mechanism, is installed on the rotor.

The balls transmit the rotational torque of the motor to the rack shaft in the form of axial force.

- The rotation angle sensor consists of resolver sensors, which excel in reliability and durability. The rotation angle sensor detects the rotation angle of the motor and outputs it to the EPS ECU. As a result, it ensures efficient EPS control.

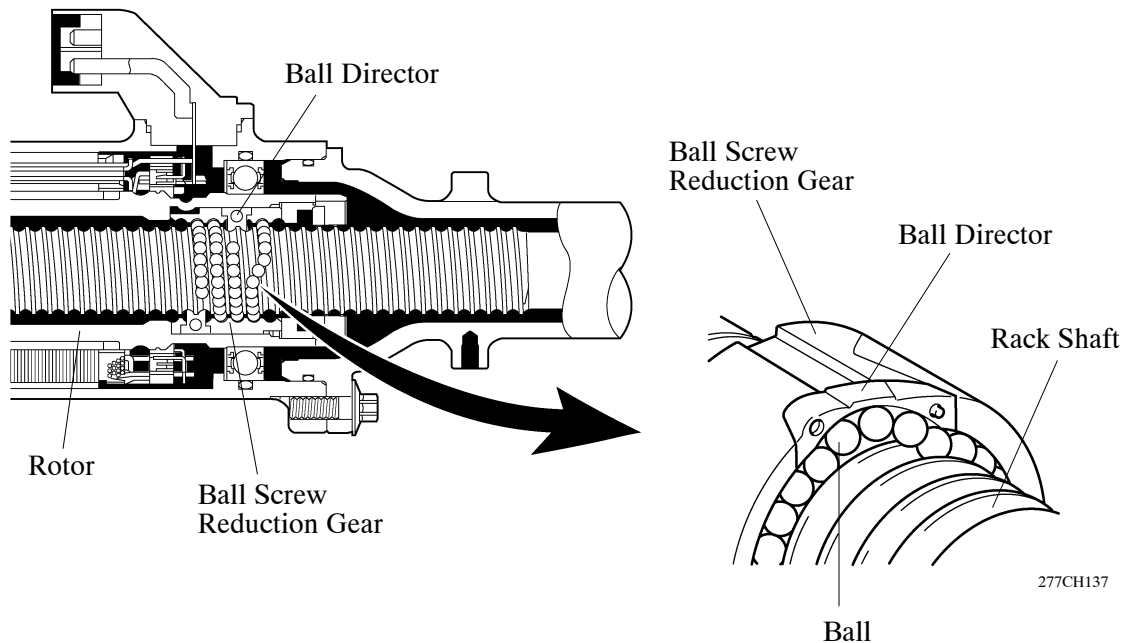


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3) Reduction Mechanism

- The reduction mechanism consists of a high-precision rolled ball thread with a smooth surface, which realizes high efficiency and low noise.
- The ball screw reduction gear has four ball directors, and is fixed to the rotor.
- By the ball director, the ball is circulated endlessly the inside of the ball screw reduction gear.
- The motor operates to rotate the rotor. Then, the rotational torque of the motor travels from the ball screw reduction gear via the balls, thus transmitting a direct axial force to the rack shaft.

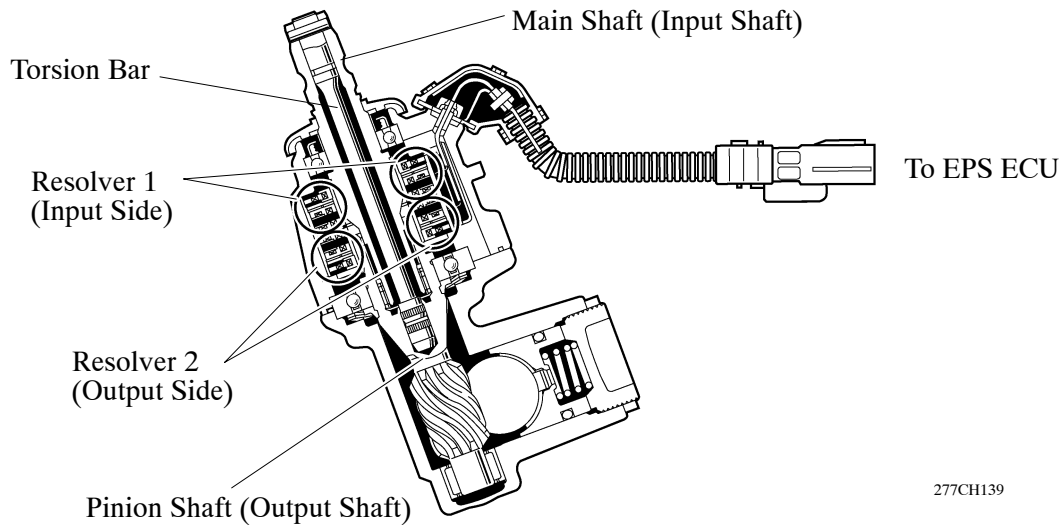


4) Torque Sensor

a. General

The torque sensor consists of two resolvers, a torsion bar, main shaft (input shaft), and pinion shaft (output shaft).

The two resolvers for the torque sensor are mounted to the main shaft (input shaft) and the pinion shaft (output shaft) respectively, which are coupled with the torsion bar. This construction generates a relative angle difference that is equivalent to the twisting of the torsion bar. When the driver turns the steering wheel, this difference is created between the angle that the main shaft (input shaft) transmits to the resolver 1 and the angle that the pinion shaft (output shaft) transmits to the resolver 2.



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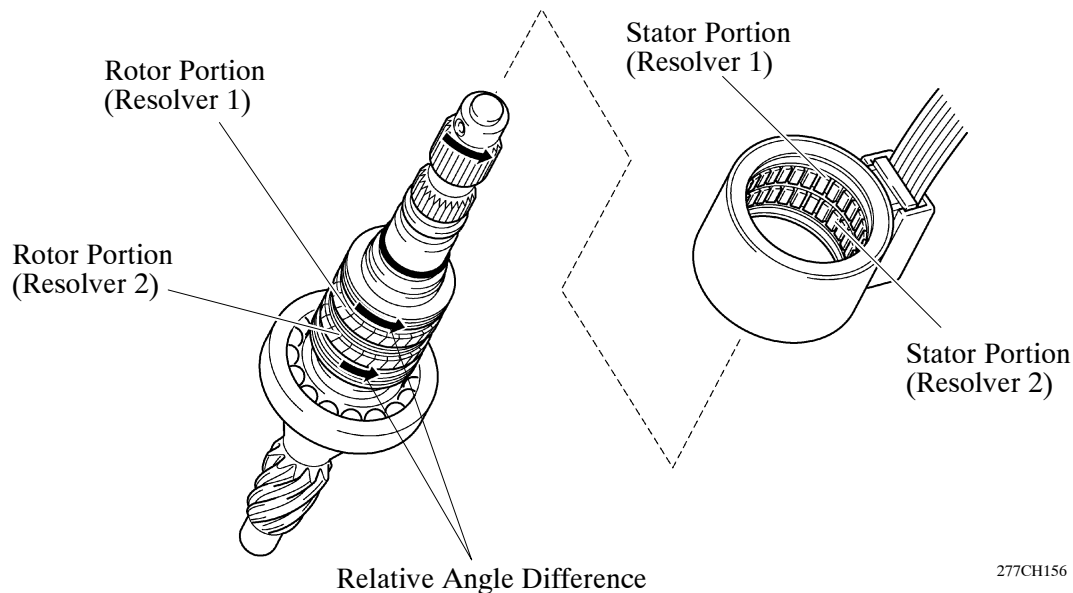
b. Torque Sensor Operation

i) Straight-line Driving

If the vehicle is driven straight and the driver does not turn the steering wheel, the specified voltage that is output at this time is determined by the ECU to indicate the neutral position of the steering. Therefore, it does not apply current to the motor.

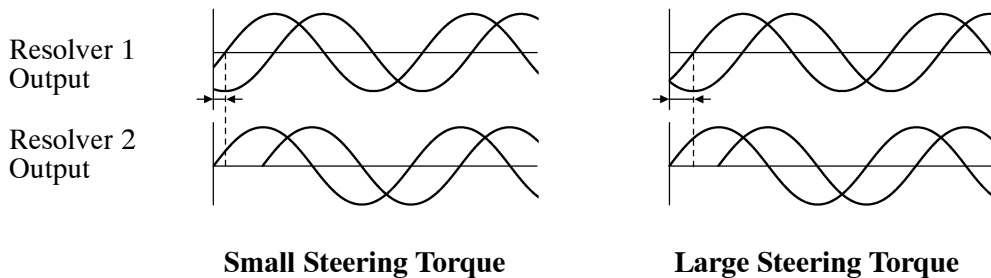
ii) When Steering

When the driver turns the steering wheel, a relative angle difference is created between the rotor portions of the resolvers 1 and 2, only in the amount that is equivalent to the twisting of the torsion bar. The stator portions of the resolvers 1 and 2 receive the angles of the rotors in the form of electric signals and output them to the EPS ECU. Based on these input signals, the EPS ECU calculates the relative angle difference between the angles detected by the two resolvers. The EPS ECU calculates the torque value based on that difference. Then, the EPS ECU calculates the assist current based on the calculated torque value and vehicle speed. Based on the information obtained from the rotation angle sensor, the EPS ECU actuates the motor at a predetermined current.



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► Torque Sensor Output Image Diagram ◀

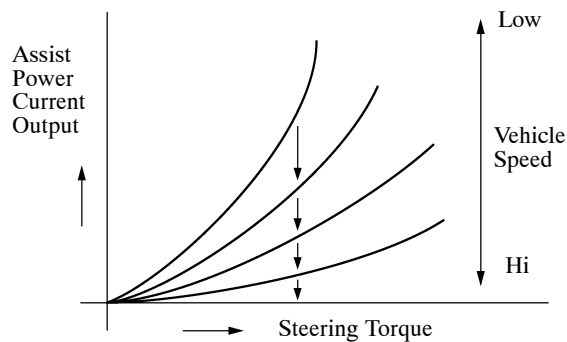


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5. EPS ECU

1) General

- The EPS ECU receives signals from various sensors, judges the current vehicle condition, and determines the assist current to be applied to the motor accordingly.
- The diagram on the right describes the relationship between the steering torque and the assist power current output.



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- The EPS ECU of new RX400h has a following function:

Item	Function
Basic Control	Calculates the assist current from the steering torque value and the vehicle speed, and actuates the motor.
Inertia Compensation Control	Improves the starting movement of the motor when the driver starts to turn the steering wheel.
Return Force Compensation Control	During the short interval between the time the driver fully turns the steering wheel and the wheels try to return, this control assists the returning force.
Damping Compensation Control	Regulates the amount of assist when the driver turns the steering wheel while driving at high speeds, thus damping the changes in the yaw rate of the vehicle body.
System Overheat Protection Control	Estimates the motor temperature based on the amperage and the current duration. If the temperature exceeds the standard, it limits the amperage to prevent the motor from overheating.

- The EPS ECU effects cooperative control with the skid control ECU, in order to control the steering assist torque in accordance with information received from the skid control ECU. This facilitates the steering operation of the driver, thus realizing a high level of vehicle stability.

For an outline of Power Steering Cooperative Control Function, refer to CH-44.

2) Diagnosis

- If the EPS ECU detects a problem in the EPS system, the master warning light that corresponds to the function in which the malfunction has been detected light up to alert the driver of the malfunction.
- At the same time, the DTCs (Diagnosis Trouble Codes) are stored in memory. The DTCs can be accessed by using the intelligent tester II.

For details of the DTCs that are stored in EPS ECU memory, see the LEXUS RX400h Repair Manual (Pub. No. RM1139E).

3) Fail-Safe

- If the EPS ECU detects a malfunction in the EPS system, it turns on the P/S warning light in the combination meter to inform the driver and stops the assist control. As a result, the EPS system operates in the same manner as manual steering.
- In case of a malfunction, the fail-safe function activates and the ECU effects various controls. For details refer to the LEXUS RX400h Repair Manual (Pub. No. RM1139E).