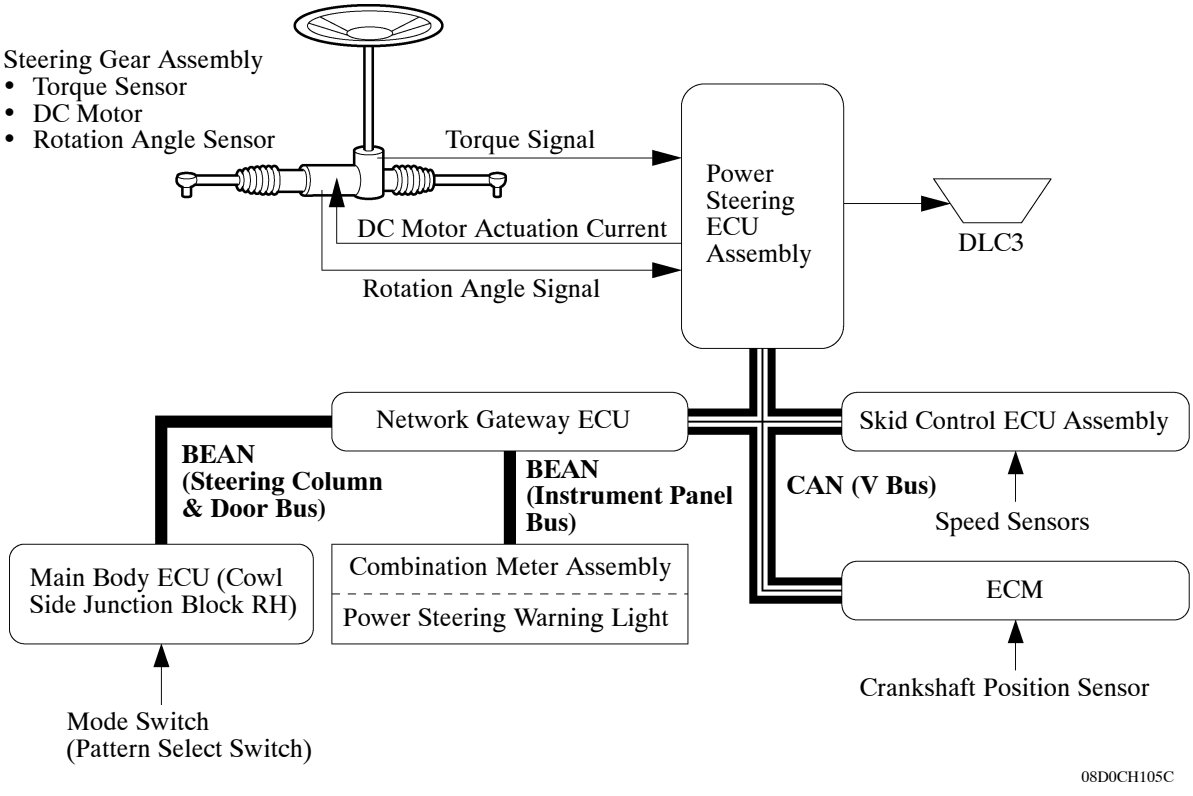
■EPS SYSTEM

1. General

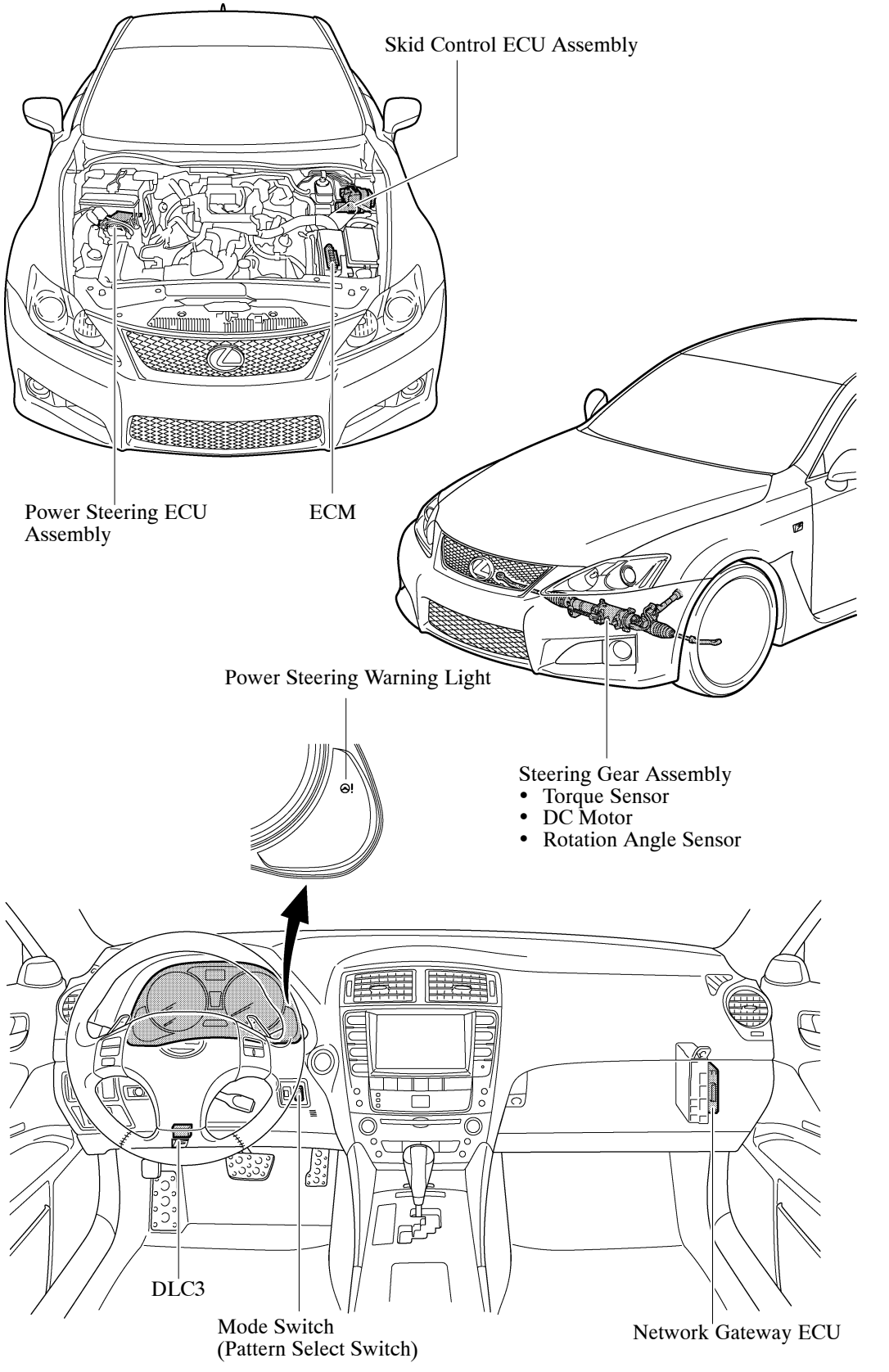
The EPS (Electric power steering) system uses a DC motor and a reduction mechanism that are built into the steering gear housing to generate assist torque, in order to assist the driver's steering effort.

- The EPS system actuates the motor only during steering when torque assist is required. As a result, the EPS system does not consume any energy during straight line driving, thus realizing fuel economy.
- The power steering ECU assembly controls this system.

▶ System Diagram ◀



2. Layout of Main Components



3. Function of Main Components

Component		Outline
Steering Gear Assembly		Reduces the speed of the motor and transmits it to the rack shaft.
	Torque Sensor	By detecting the twist of the steering torsion bar, the sensor indicates the torque that is applied to the torsion bar using an electrical signal, it sends to the power steering ECU assembly.
	DC Motor	Generates power assist in accordance with the actuation current received from the power steering ECU assembly.
	Rotation Angle Sensor	Transmits the rotation angle of the DC motor to the power steering ECU assembly.
Power Steering ECU Assembly		• Actuates the DC motor to provide power assist, based on the signals received from various sensors. • When the power steering ECU assembly detects an EPS system malfunction, it outputs a warning signal to the combination meter assembly.
Combination Meter Assembly • Power Steering Warning Light		Upon receiving a signal from the power steering ECU assembly in the event of a system malfunction, the meter ECU illuminates the power steering warning light.
Skid Control ECU Assembly		Transmits speed sensor signals to power steering ECU assembly.
ECM		Transmits the engine speed signal to power steering ECU assembly.
Mode Switch (Pattern Select Switch)		Switches modes to change the assist characteristics.

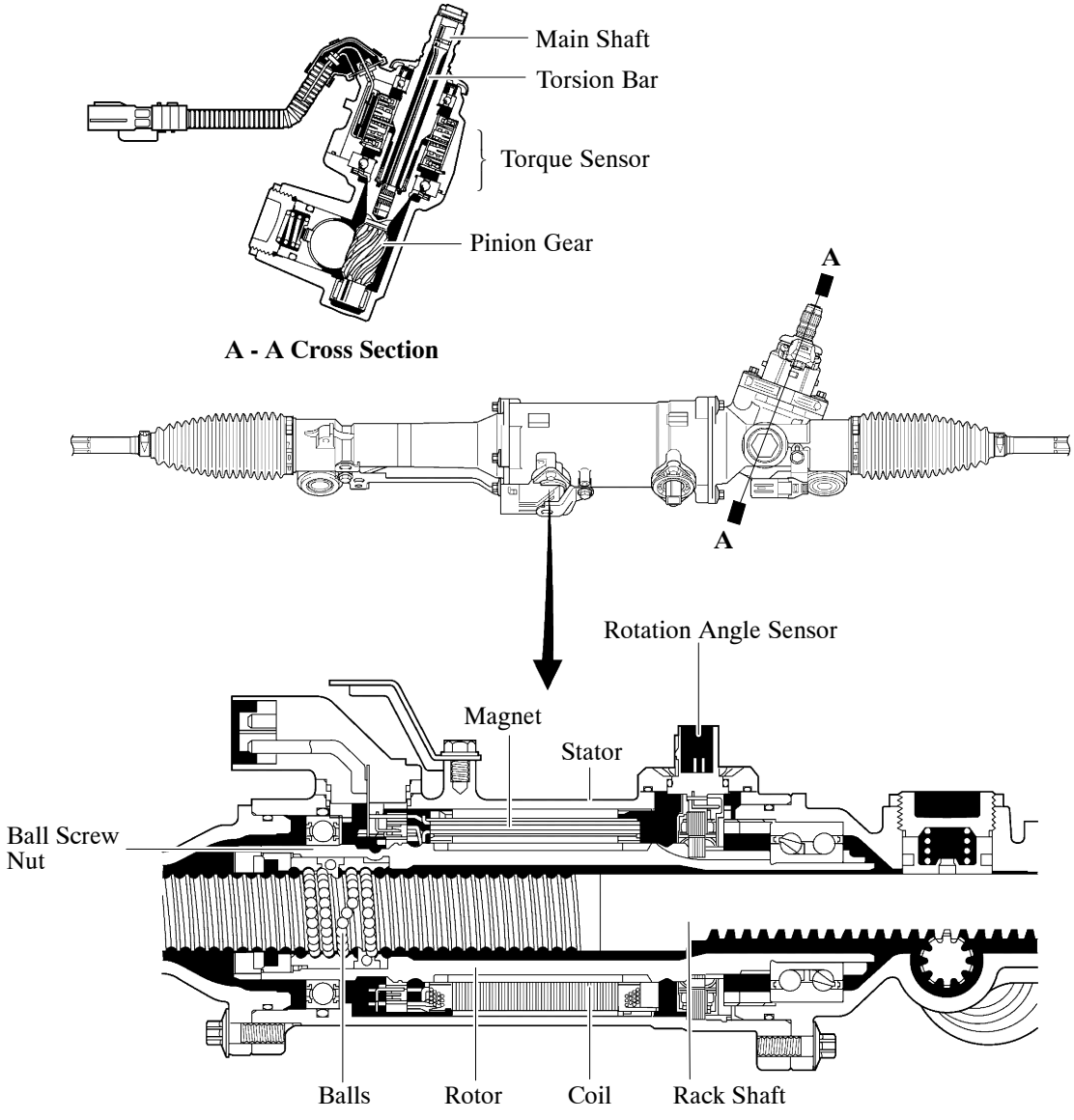
4. Construction and Operation

Steering Gear Assembly

1) General

The steering gear assembly consists of the rack shaft, reduction mechanism, pinion gear, torsion bar, DC motor, rotation angle sensor and torque sensor.

- The reduction mechanism consists of balls and a ball nut. The balls and ball contact surfaces are processed with a high degree of accuracy to achieve high efficiency and low noise.
- The DC motor is a high power output and brushless type.
- The DC motor is located around the rack shaft. The motor consists of a magnet, coil, stator, and rotor.
- The ball screw nut secured to the rotor transmits rotational torque from the rotor to the balls. The balls then transmit the rotational torque to the rack shaft.



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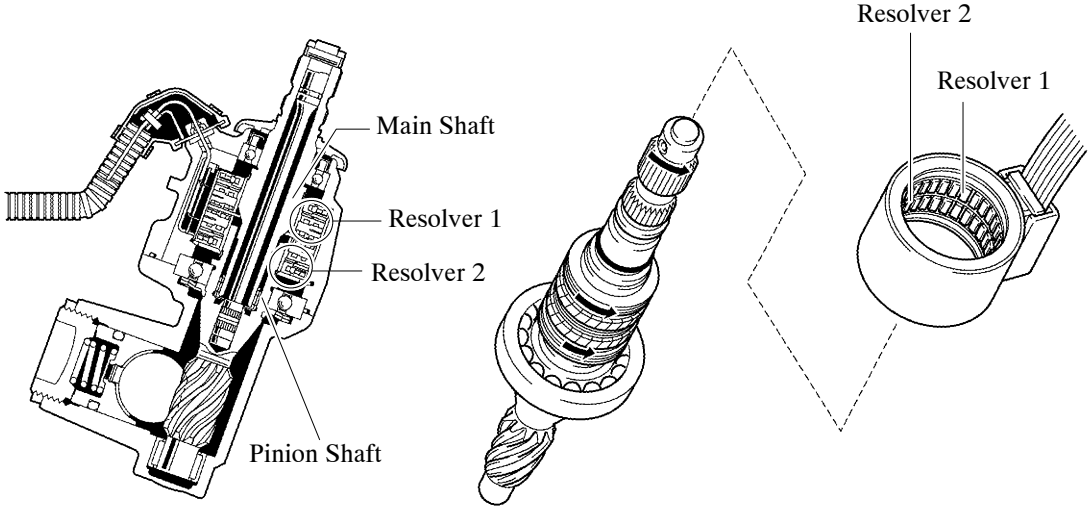
2) Torque Sensor

The torque sensor consists of resolver 1 and resolver 2.

- Resolver 1 is mounted to the main shaft on the input side. Resolver 2 is mounted to the pinion shaft on the output side.
- These resolvers convert twisting force on the input and output sides of the torsion bar into electric signals and transmit these signals to the power steering ECU assembly.
- The signals sent from the input and output sides differ depending on the amount of twisting force. The power steering ECU assembly calculates the torque value based on the differences in these signals.



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5. System Control

General

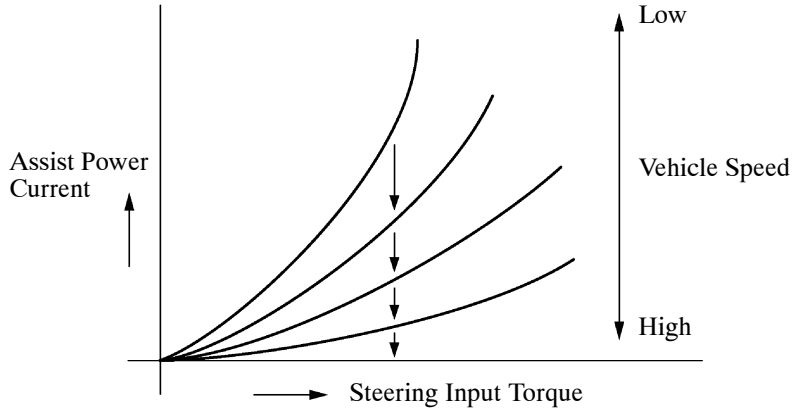
The EPS system has the following controls:

Control	Outline
Basic Control	Calculates the assist current required based on the steering torque value and the vehicle speed, and actuates the DC motor.
Inertia Compensation	Improves the starting movement of the DC motor when the driver starts to turn the steering wheel.
Returnability Control	Improves returnability during steering wheel operation.
Damper 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.
Voltage Boost Control	Boosts the battery voltage in the power steering ECU assembly. It is maintained at 27 volts when the driver is not turning the steering wheel or when the vehicle is being driven straight. It effects variable control between 27 to 34 volts in accordance with the load, when the driver is turning the steering wheel.
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.
Fail-safe	When the power steering ECU assembly detects a malfunction in the EPS system, the ECU changes the control mode to a fail-safe mode, thus enabling the vehicle to be driven.
Diagnosis	If the power steering ECU assembly detects a malfunction in the system, the power steering ECU assembly makes the power steering warning light flash to warn the driver and stores DTCs (Diagnostic Trouble Codes) in memory.

Basic Control

The power steering ECU assembly receives the vehicle speed signal and signals from various sensors. Based on these signals, the power steering ECU assembly judges the current vehicle condition, and determines the assist current to be applied to the motor.

- The diagram below describes the relationship between the steering torque and the assist power current.



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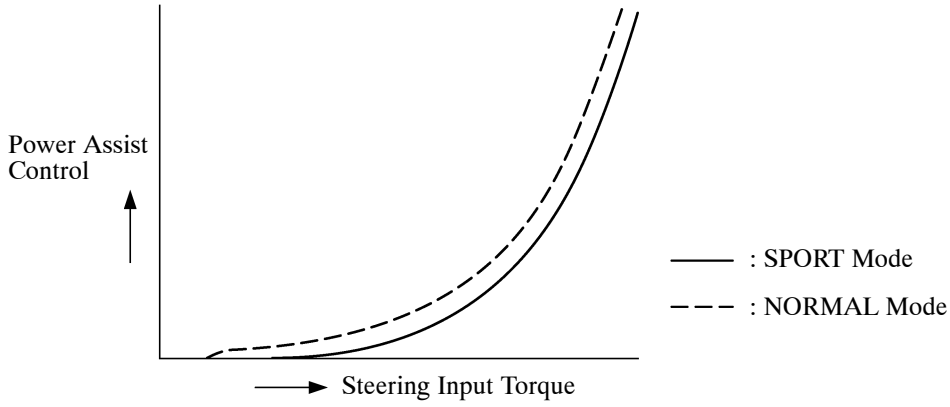
Mode Switch (Pattern Select Switch)

The mode switch (pattern select switch) allows the power steering assist characteristics to be changed, offering a choice between SPORT mode and NORMAL mode. In addition to changing the control characteristics for the EPS system, operating the mode switch (pattern select switch) also changes control characteristics for the engine, automatic transmission and VDIM.

- The chart below shows comparison of the assist torque between NORMAL mode and SPORT mode.



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Fail-safe

Fail-safe operation modes are as follows:

Item	Control
Torque Sensor System Malfunction	Disables the assist.
Rotation Angle Sensor Malfunction	Disables the assist.
DC Motor Overheating	Limits the assist force.
DC Motor Short (including drive system malfunction)	Disables the assist.
DC Motor Over-current	Disables the assist.
Power Steering ECU Assembly Overheating	Limits the assist force.
Power Steering ECU Assembly Internal Temperature Sensor System Malfunction	Limits the assist force.
Power Steering ECU Assembly System Malfunction (including boost circuit system malfunction)	Disables the assist.
Vehicle Speed Signal Malfunction	Limits the assist force.
Power Supply Voltage Malfunction	Pauses the assist. (Provides normal assist after the voltage recovers.)

Diagnosis

If the power steering ECU assembly detects a malfunction in the EPS system, the power steering ECU assembly flashes the power steering warning light in order to alert the driver. At this time, by either cutting off or decreasing the voltage gradually, the power steering ECU assembly causes the steering to revert to a manual state as a result of restricting the output voltage. In addition, if the source voltage supplied to the system decreases, the power steering ECU assembly may limit the output current or illuminate the power steering warning light to inform the driver that the steering force may increase. At the same time, DTCs (Diagnostic Trouble Codes) are stored in memory. DTCs can be read by the use of the intelligent tester. For details, see the LEXUS IS F Repair Manual (Pub. No. RM08E0E).