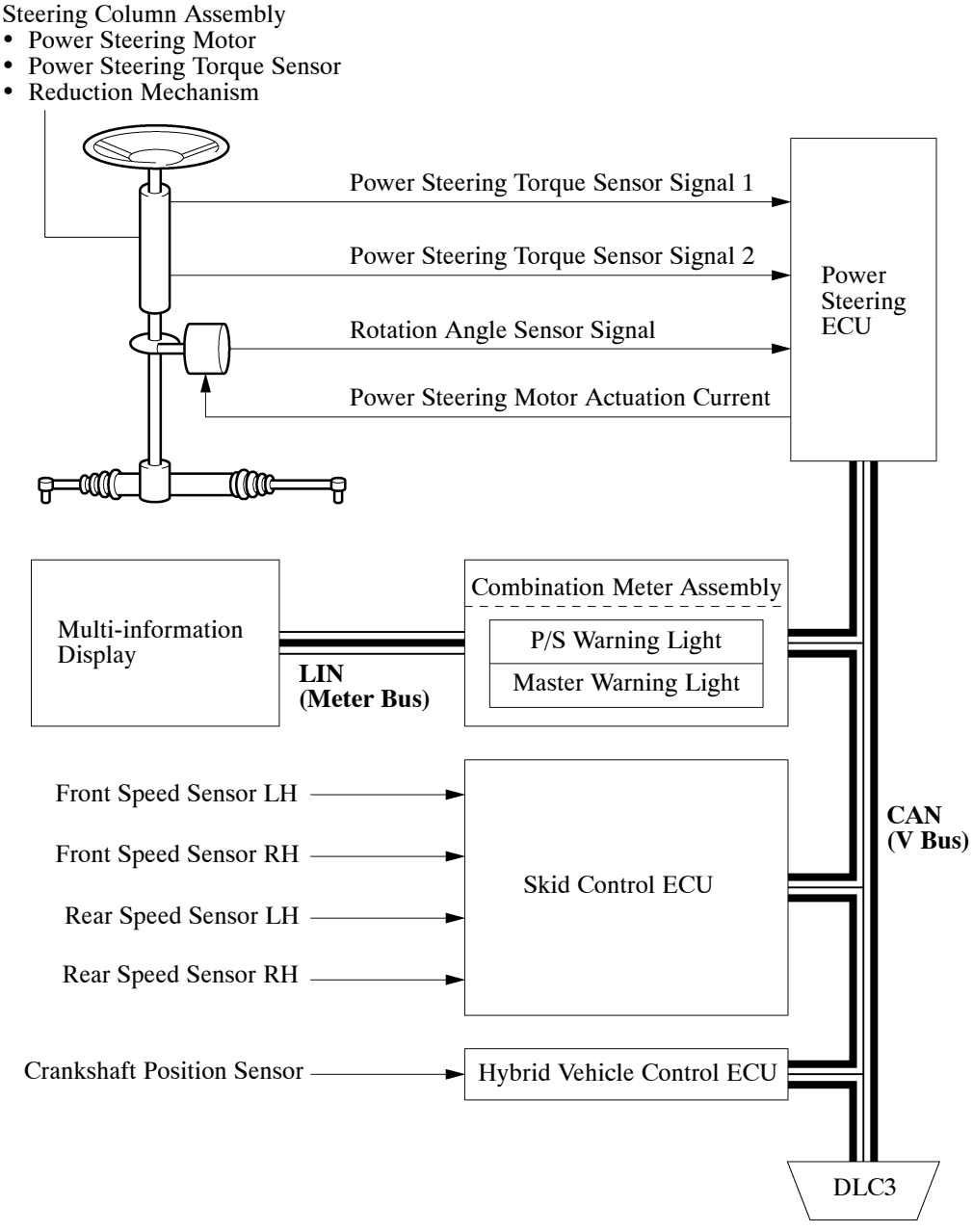
■EPS SYSTEM

1. General

The［EPS］(Electric［Power］Steering) system uses a power steering motor, a power steering torque sensor and a reduction mechanism that are built into the steering column assembly to generate assist torque, in order to assist the driver's steering effort.

- This system activates the power steering motor only when the driver turns the steering wheel. As a result, no energy is consumed when the vehicle is going straight, enhancing fuel economy.
- VDIM［(Vehicle］Dynamics［Integrated］Management) performs integrated control of the brake system and the［EPS］system.［The power steering］ECU controls the assist torque for the power steering motor based on the assist torque request sent from the skid control ECU.［For details, see page CH-42.

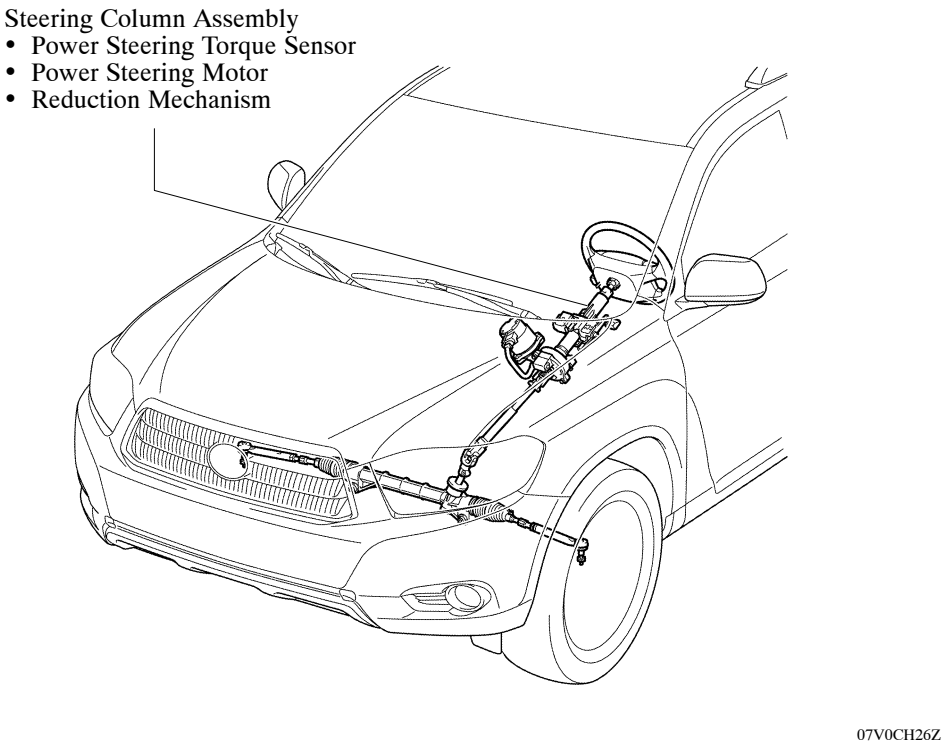
▶ System Diagram ◀



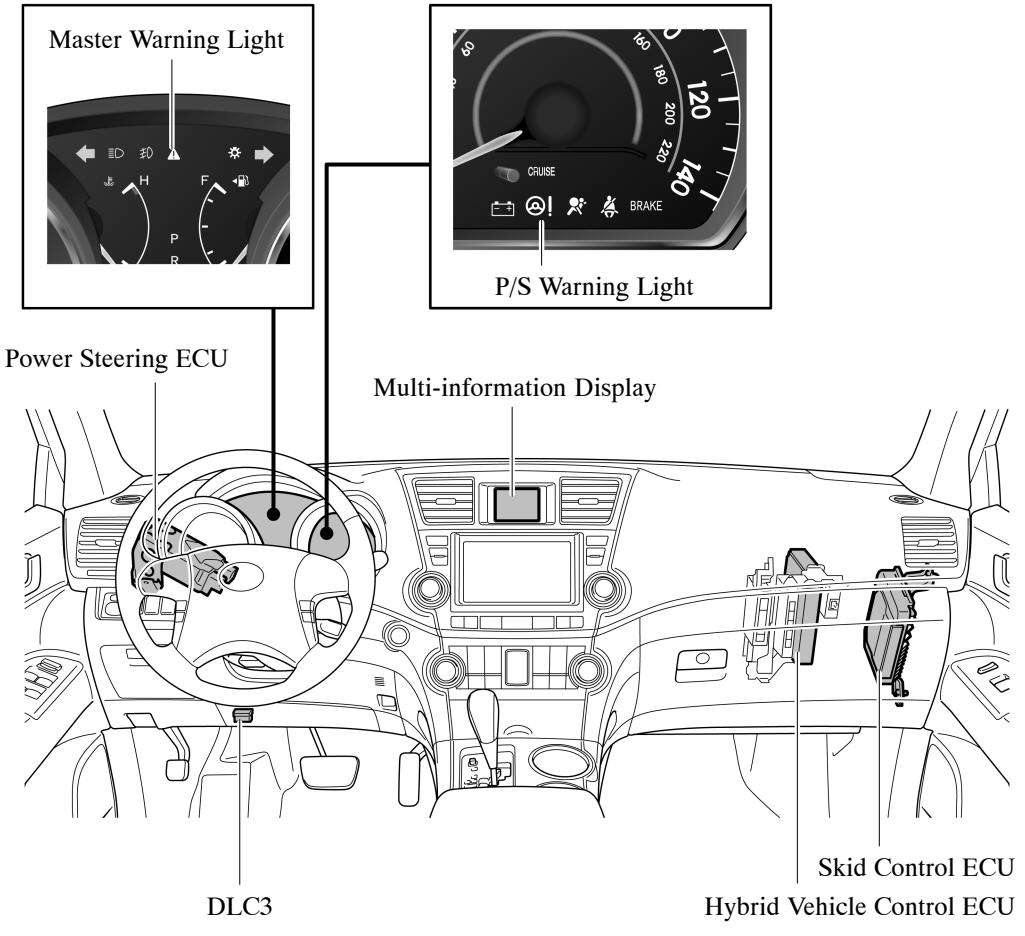
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2. Layout of Main Components



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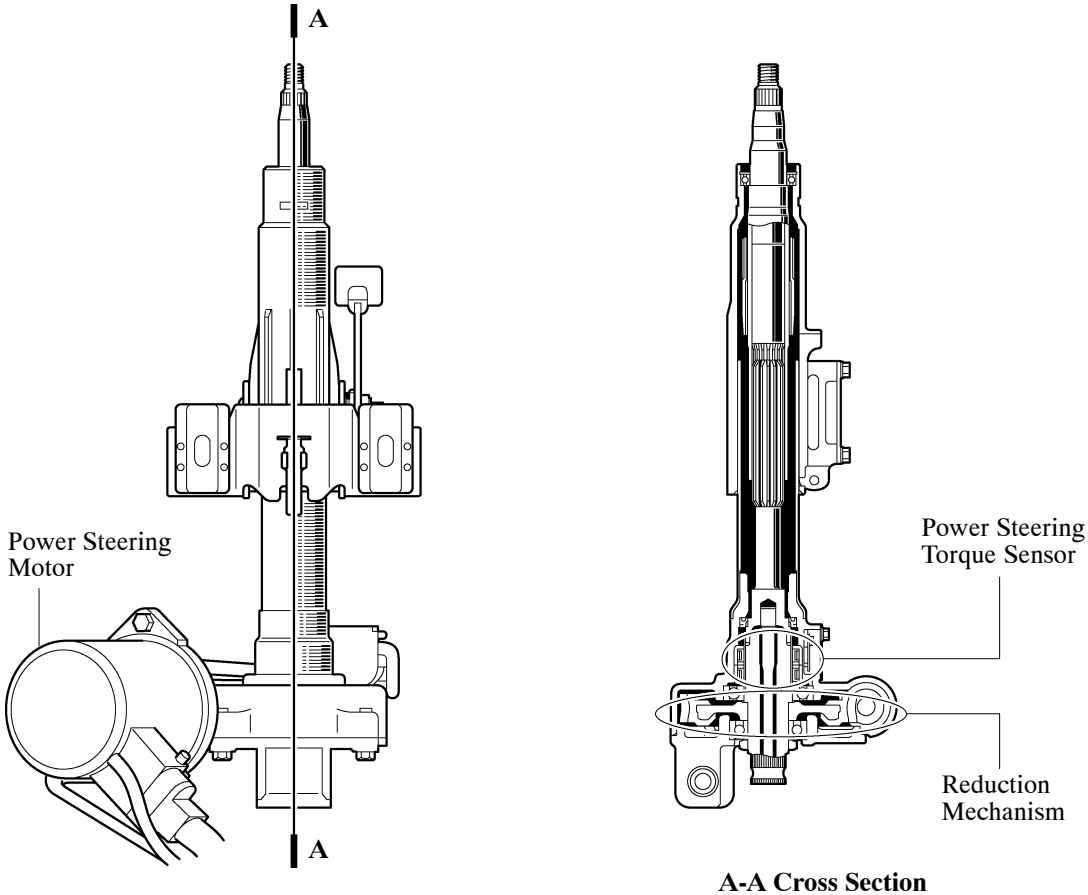
3. Function of Main Components

Component			Function
Steering Column Assembly	Power Steering Torque Sensor		Detects the amount of twist of the torsion bar. Based on the torque that is applied to the torsion bar, the sensor creates an electrical signal, and outputs this signal to the power steering ECU.
	Power Steering Motor		Generates power assist in accordance with a signal received from the power steering ECU.
		Motor Rotation Angle Sensor	Outputs the rotation angle of the power steering motor to the power steering ECU.
	Reduction Mechanism		Reduces the speed of the power steering motor through the use of a worm gear and a wheel gear and transmits it to the column shaft.
Combination Meter Assembly	P/S Warning Light		Lights up to alert the driver when the power steering ECU detects a malfunction in the EPS system.
	Master Warning Light		Lights up to alert the driver when the power steering ECU detects a malfunction in the EPS system.
Power Steering ECU			Actuates the power steering motor mounted on the steering column assembly to provide power assist, based on the signals received from various sensors and ECUs.
Multi-information Display			Shows a warning message to alert the driver when the power steering ECU detects a malfunction in the EPS system.
Hybrid Vehicle Control ECU			Outputs the engine speed signal to the power steering ECU.
Skid Control ECU			• Outputs the vehicle speed signal to the power steering ECU. • Requests steering torque assist during steering cooperative control.

4. Steering Column Assembly

General

The steering column assembly includes a power steering torque sensor, power steering motor, and reduction mechanism.



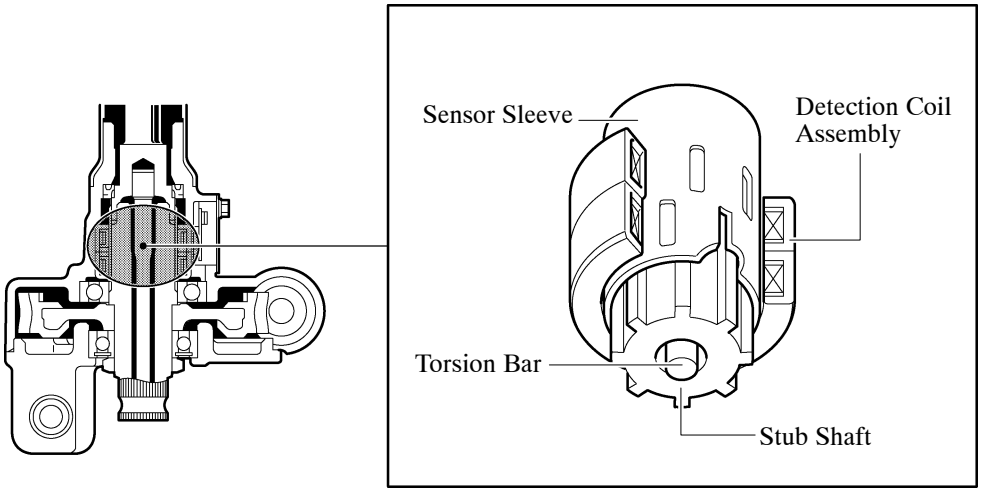
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Power Steering Torque Sensor

1) General

The power steering torque sensor consists of the sensor sleeve, stub shaft and detection coil assembly. This sensor outputs two types of signals to the power steering ECU.

- The sensor sleeve is mounted on the input shaft, and the stub shaft is mounted on the output shaft. The input shaft and the output shaft are joined by the torsion bar.
- The detection coil assembly is placed on the outside of the sensor sleeve to complete an excitation circuit without making contact.



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2) Steering Torque and Steering Direction Detection

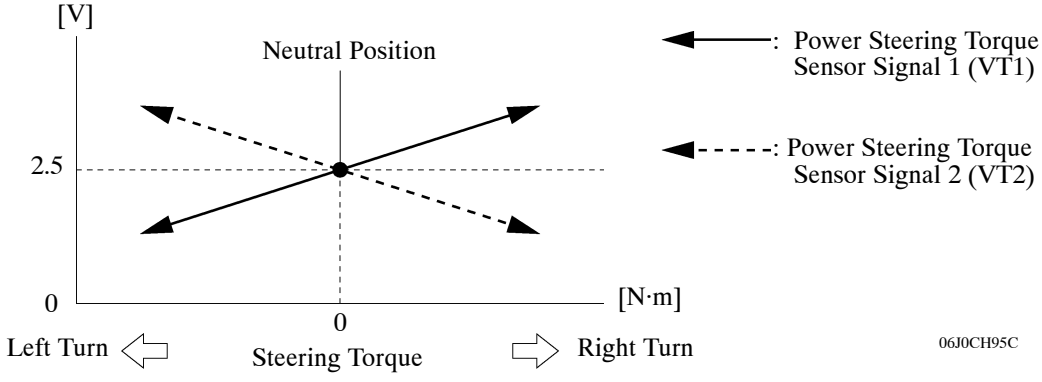
a. When the steering wheel is not turned

When the driver does not turn the steering wheel, the power steering torque sensor outputs a specified voltage (2.5 V) to the power steering ECU. As long as the specified voltage is output, the power steering ECU determines that the steering wheel is in the neutral position.

b. When the steering wheel is turned

When the driver turns the steering wheel to the right or left, twist that is created in the torsion bar creates a relative displacement between the sensor sleeve and the stub shaft. At this time, the voltage output from the power steering torque sensor to the power steering ECU changes. Based on the changes, the power steering ECU determines the steering torque and steering direction input by the driver.

▶ Power Steering Torque Sensor Output Characteristics ◀

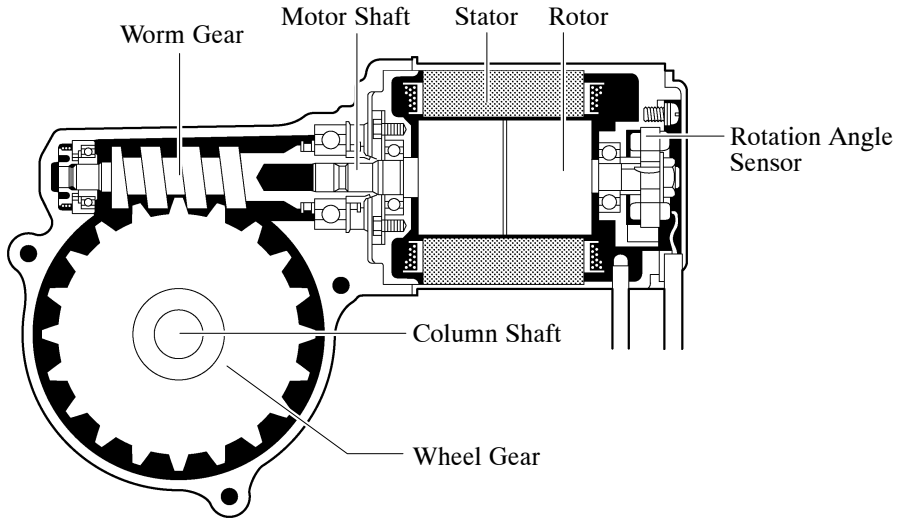


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Power Steering Motor

- A low inertia, low noise, and high power output power steering motor is used.
- The operating range of the power steering motor is 8 to 16 V.
- The motor consists of the rotor, stator, motor shaft and rotation angle sensor.
- The torque that is generated by the motor is transmitted via the joint to the worm gear. Then this torque is transmitted via the wheel gear to the column shaft.
- The rotation angle sensor consists of the resolver sensor, which excels in reliability and durability. The rotation angle sensor detects the rotation angle of the motor and outputs it to the power steering ECU. As a result, it ensures efficient EPS control.

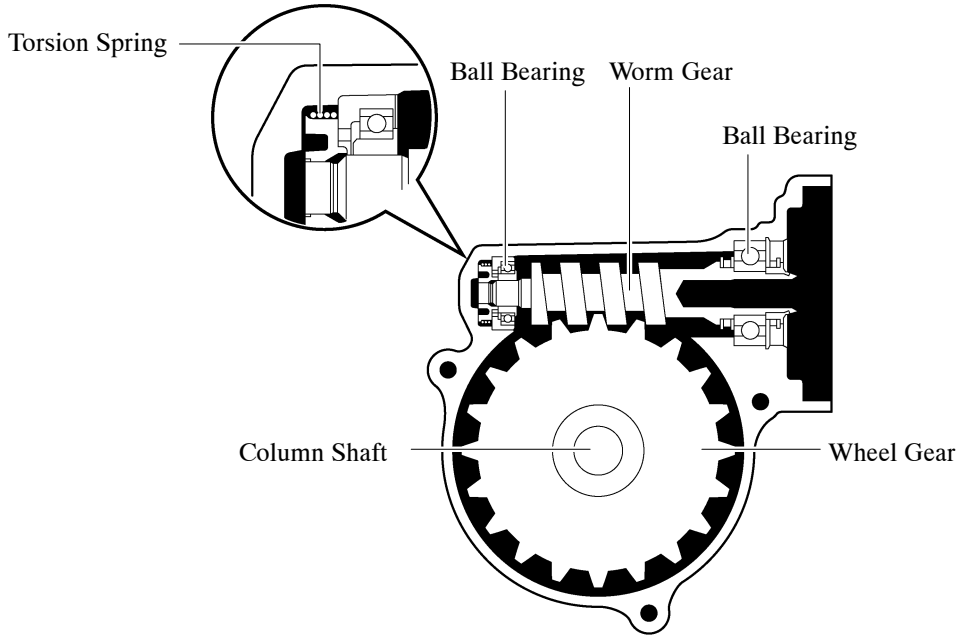


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Reduction Mechanism

This mechanism reduces the speed of the power steering motor via the worm gear and the wheel gear, and transmits it to the column shaft.

- The wheel gear is made of a high strength, low friction, and low wear plastic material, to realize low noise and a lightweight construction.
- A worm gear supported by ball bearings is used. Also, a torsion spring is provided to ensure the optimal meshing of the gears at all times.



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5. Multi-information Display

The multi-information display shows a warning message to inform the driver that there is a malfunction in the EPS system.



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6. System Control

General

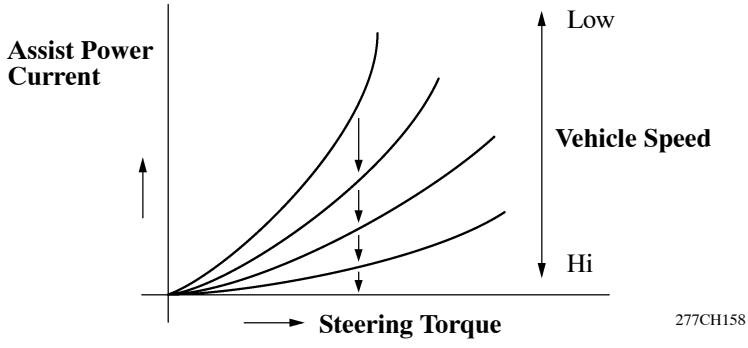
The EPS system has the following controls:

Control	Outline
Basic Control	Calculates the assist current from the steering torque value and the vehicle speed, and actuates the power steering motor.
Inertia Compensation Control	Ensures the starting movement of the power steering motor when the driver starts to turn the steering wheel.
Recovery Control	During the short interval between the time the driver fully turns the steering wheel and the wheels try to recover, this control assists the recovery force.
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.
System Overheat Protection Control	Estimates the power steering motor temperature based on the amperage and the current duration. If the temperature exceeds the standard, it limits the amperage to prevent the power steering motor from overheating.
Diagnosis (See Page CH-117)	If the power steering ECU detects a malfunction in the EPS system, the power steering ECU lights up the P/S warning light to warn the driver and stores the DTCs (Diagnostic Trouble Codes) in memory.
Fail-safe (See Page CH-117)	If the power steering ECU detects a malfunction in the EPS system, the power steering ECU changes the control mode to a fail-safe mode, thus enabling the vehicle to be driven.

Basic Control

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

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



Diagnosis

If the power steering ECU detects a malfunction in the EPS system, the power steering ECU lights up the P/S warning light in order to alert the driver. At the same time, DTCs (Diagnostic Trouble Codes) are stored in memory.

- These DTCs can be read by connecting SST (09843-18040) between the TC and CG terminals of DLC3 and observing the blinks of the P/S warning light, or by connecting Techstream to DLC3. For details, see the 2008 HIGHLANDER HYBRID VEHICLE Repair Manual (Pub. No. RM07V0U).

Fail-safe

Fail-safe operation modes are as follows:

Item	Control
Power Steering Torque Sensor Malfunction	Disables the assist.
Power Steering Motor Overcurrent	Disables the assist.
Power Steering Motor Short (Including drive system malfunction)	Disables the assist.
Power Steering Motor Rotation Angle Sensor Malfunction	Disables the assist.
Power Steering ECU Internal Temperature Sensor Malfunction	Limits the assist force.
Power Steering ECU System Malfunction	Disables the assist.
Vehicle Speed and Engine Speed Signal Malfunction	Limits the assist force.
Power Supply Voltage Malfunction	Pauses the assist. (Provides normal assist after the voltage recovers.)