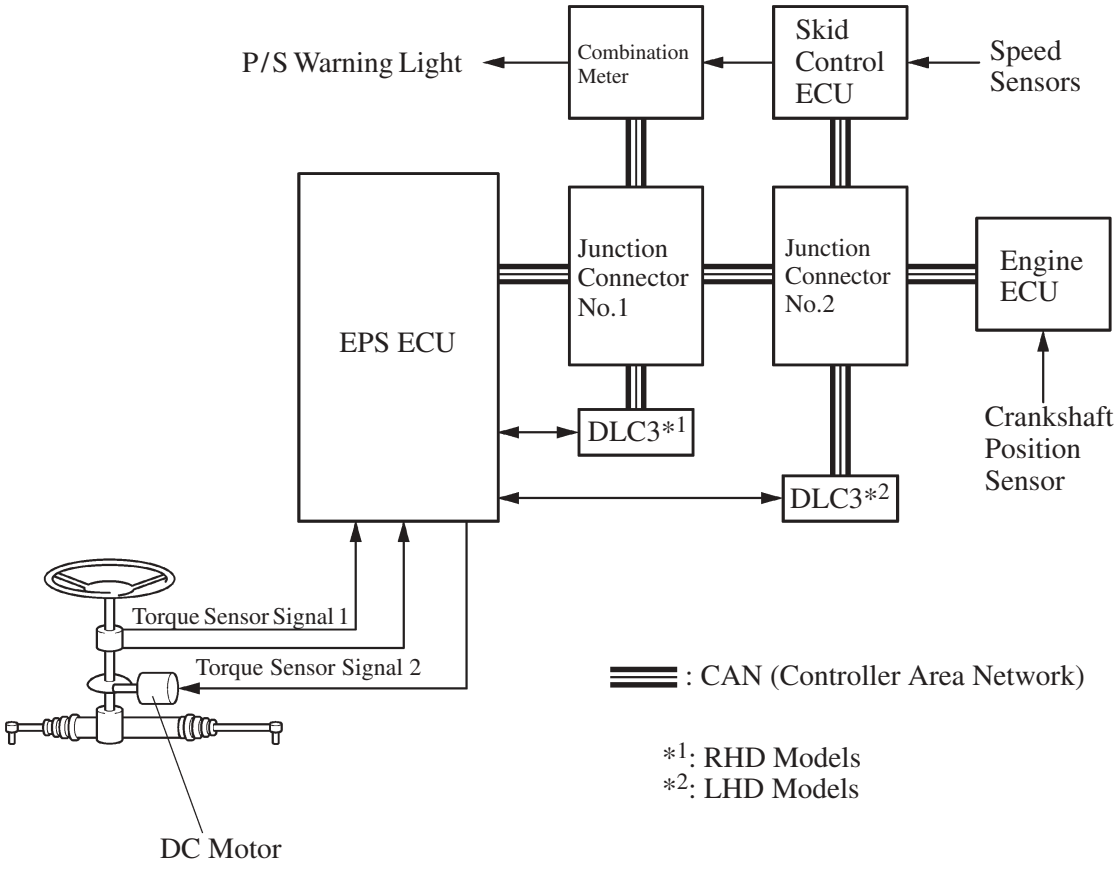
■EPS (ELECTRIC POWER STEERING)

1. General

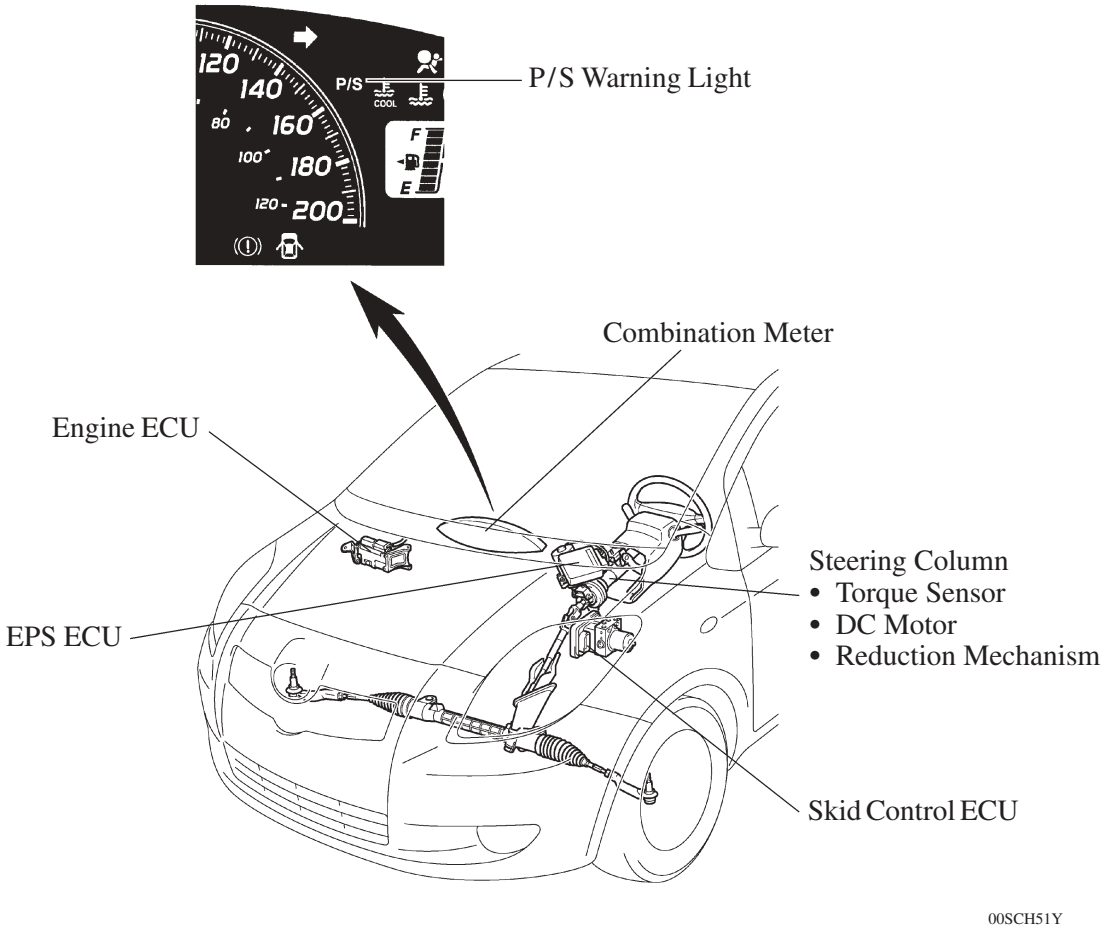
- This system generates torque using a DC motor and a reduction mechanism that are mounted on the steering column to assist the driver's steering. The amount of power assist is calculated by the EPS ECU.
- This system offers excellent fuel economy characteristics because the DC motor that is mounted on the steering column provides power assist, and this motor consumes energy only when power assist is required.
- 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.

2. System Diagram



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3. Layout of Main Components



Hatchback LHD Model

4. Function of Main Components

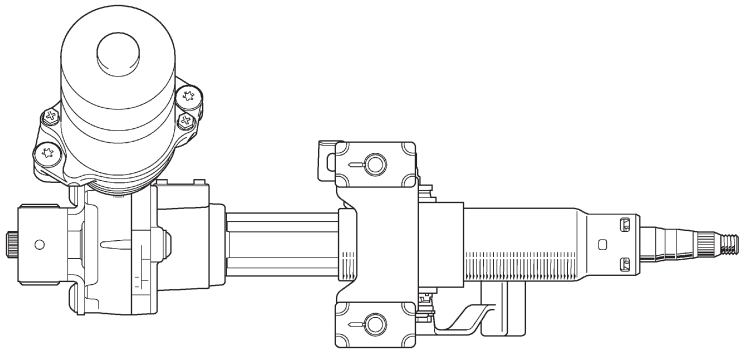
Component		Function
Steering Column	Torque Sensor	Detects the twist of the torsion bar, calculates the torque that is applied to the torsion bar by changing it into an electrical signal, and outputs this signal to the EPS ECU.
	DC Motor	Generates power assist in accordance with a signal received from the EPS ECU.
	Reduction Mechanism	Reduces the speed of the DC motor through the use of a worm gear and a wheel gear and transmits it to the column shaft.
EPS ECU		Actuates the DC motor mounted on the steering column to provide power assist, based on the signals received from various sensors and vehicle speed.
Engine ECU		Outputs the engine speed signal to EPS ECU.
Combination Meter		In case of a malfunction in the system, turns ON the P/S warning light.
Skid Control ECU		Outputs the vehicle speed signal to EPS ECU.

5. Construction and Operation of Main Components

Steering Column

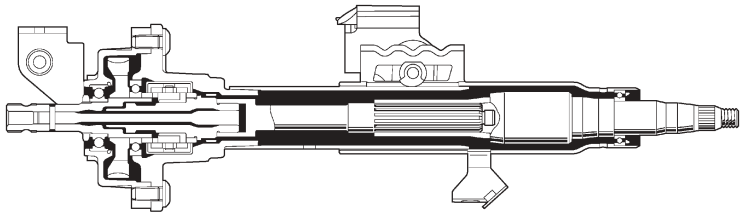
1) General

A DC motor, reduction mechanism, and torque sensor are mounted on the steering column.



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Top View

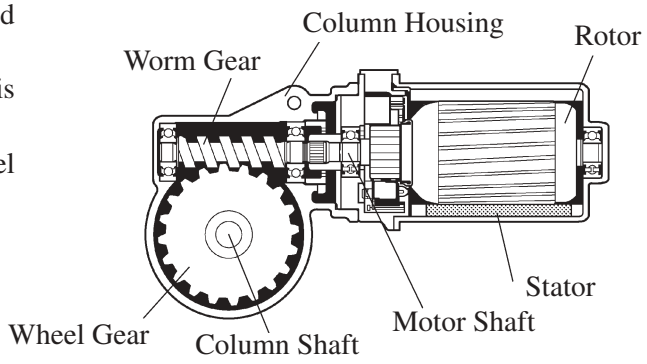


Cross Section

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2) DC Motor

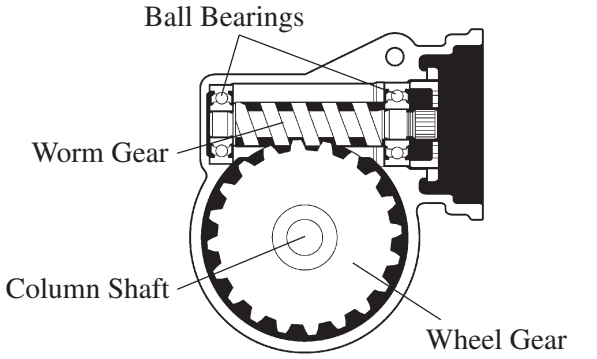
The DC motor consists of the rotor, stator, and motor shaft.
The torque that is generated by the motor is transmitted via the joint to the worm gear. Then this torque is transmitted via the wheel gear to the column shaft.



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3) Reduction Mechanism

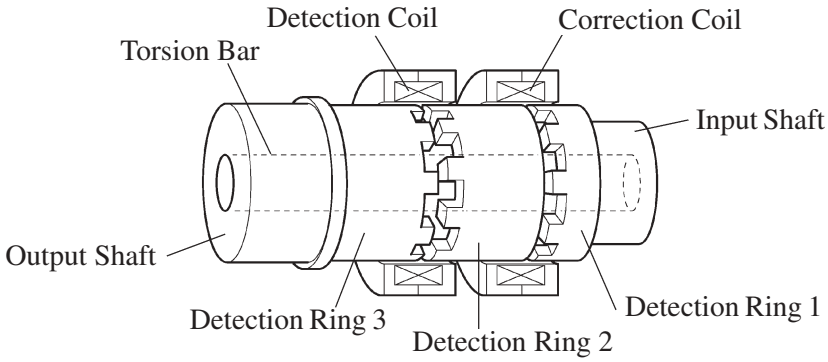
This mechanism reduces the speed of the DC motor via the worm gear and the wheel gear, and transmits it to the column shaft.
The worm gear is supported by the ball bearings in order to reduce noise and frictions.



287CH26

4) Torque Sensor

- The torque sensor detects the twist of the torsion bar, 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.
- Detection ring 1 and detection ring 2 are mounted on the input shaft, and detection ring 3 is mounted on the output shaft. The input shaft and the output shaft are joined by the torsion bar. A detection coil and a correction coil are placed on the outside of the detection rings to complete an excitation circuit without making a contact.
- The function of detection rings 1 and 2 is to correct temperature. They detect the temperature changes that occur in the correction coil and correct the deviation that is caused by the temperature changes.
- The detection coil consists of a dual circuit that outputs two signals, VT1 and VT2. The ECU controls the assist amount based on these two signals and at the same time detects a sensor malfunction.



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Service Tip

If the steering column, or steering gear is removed and reinstalled, the zero point of the torque sensor must be adjusted. For details, see the Yaris Repair Manual (Pub. No. RM00S1E).

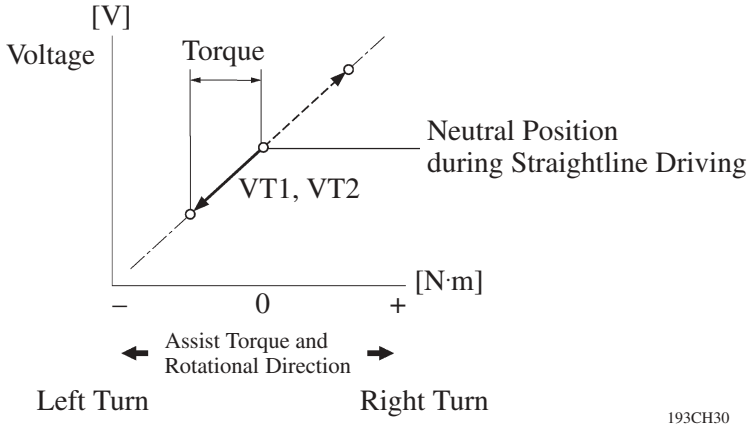
	Initialization	Calibration
Steering Wheel, Cloumn and Gear	○	○
EPS ECU	—	○

a. Straightline 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 EPS ECU to indicate the neutral position of the steering wheel. Therefore, it does not apply current to the DC motor.

b. When Steering

When a driver turns the steering wheel to the right or left, the twist that is created in the torsion bar creates a relative displacement between detection ring 2 and detection ring 3.
This change is then converted into two electrical signals, VT1 and VT2, and sent to the EPS ECU. When the steering wheel is turned to the left, a voltage that is lower than the neutral is output as shown in the diagram below.
The direction of the turn is thus detected according to these outputs. Furthermore, the turn amount of steering assist is determined by the magnitude of the output value.



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 DC motor accordingly.
- In case a malfunction occurs in the system, the fail-safe function stops the output current and reverts the control to manual steering. At this time, a P/S warning light illuminates to alert the driver of the malfunction.
- The EPS ECU of new Yaris has following functions:

Item	Function
Basic Control	Calculates the assist current from the steering torque value and the vehicle speed, and actuates the motor.
Inertia Compensation Control	Ensures the starting movement of the 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 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.

2) Fail-safe

If the EPS ECU detects a malfunction in the EPS system, it turns ON the 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 way as manual steering.

▶ Fail-safe Chart ◀

Item	Function
Torque Sensor System Malfunction	Disables the assist.
Motor Overheating	Limits the assist force.
Motor Short (Including drive system malfunction)	Disables the assist.
Motor Overcurrent	Disables the assist.
EPS ECU Internal Temperature Sensor Malfunction	Limits the assist force.
EPS ECU System Malfunction	Disables the assist.
Vehicle Speed and Engine Speed Signals Malfunction	Temporarily limits the assist, returning to normal control when normal conditions are reestablished.
Power Supply Voltage Malfunction	Temporarily limits the assist, returning to normal control when normal conditions are reestablished.

3) Self-diagnosis

- If the EPS ECU detects a problem in the EPS system, the warning light that corresponds to the function in which the malfunction has been detected lights 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 read by connecting an intelligent tester II, or by connecting the SST (09843 -18040) to the TC and CG terminals of the DLC3 and observing the blinking of the power steering warning light.

For details of the DTCs that are stored in EPS ECU memory, see the Yaris Repair Manual (Pub. No. RM00S1E).

▶ DTC Chart (Blinking Power Steering Warning) ◀

DTC No.		Detection Item
5-digit	2-digit	
C1511	11	Torque sensor circuit malfunction
C1512	12	
C1513	13	
C1514	14	Torque sensor power source circuit malfunction
C1515	15	Torque sensor zero point adjustment undone
C1516	16	Torque sensor zero point adjustment incomplete
C1517	17	Torque sensor hold malfunction
C1524	24	Motor circuit malfunction
C1531	31	EPS ECU malfunction
C1532	32	
C1533	33	
C1534	34	
C1551	51	IG power source voltage malfunction
C1552	52	Motor power source voltage malfunction
C1554	54	Power supply relay malfunction
C1555	55	EPS motor relay malfunction
C1581	81	Assist map number un-written
U0073	91	Control module communication bus OFF
U0105	92	Lost communication with powertrain ECU
U0121	93	Lost communication with Anti-lock Brake System (ABS) control module