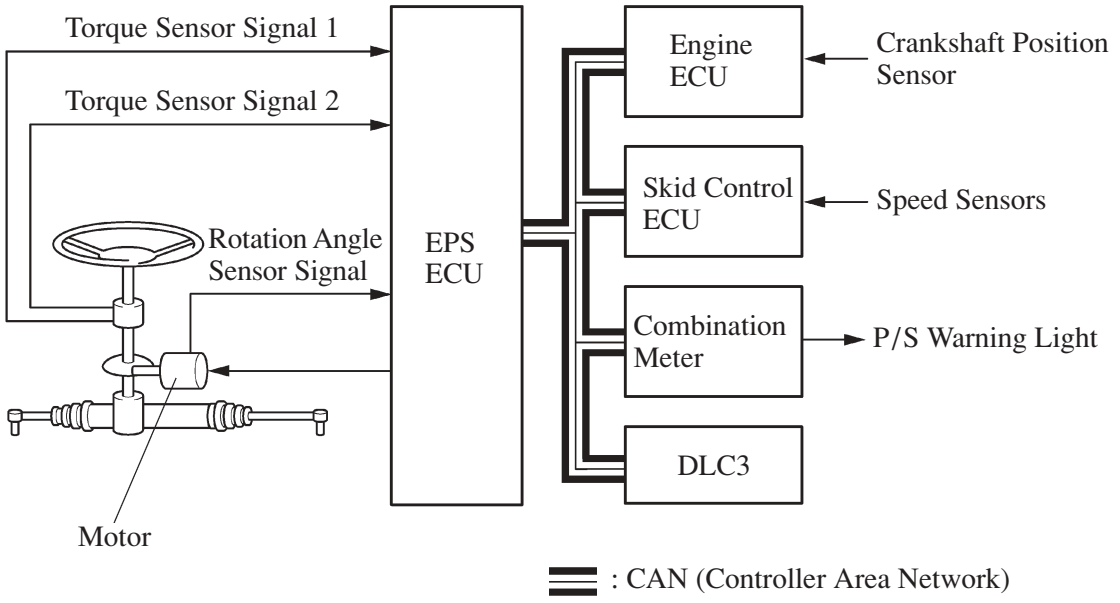
■EPS (ELECTRIC POWER STEERING)

1. General

- This system generates torque using a 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 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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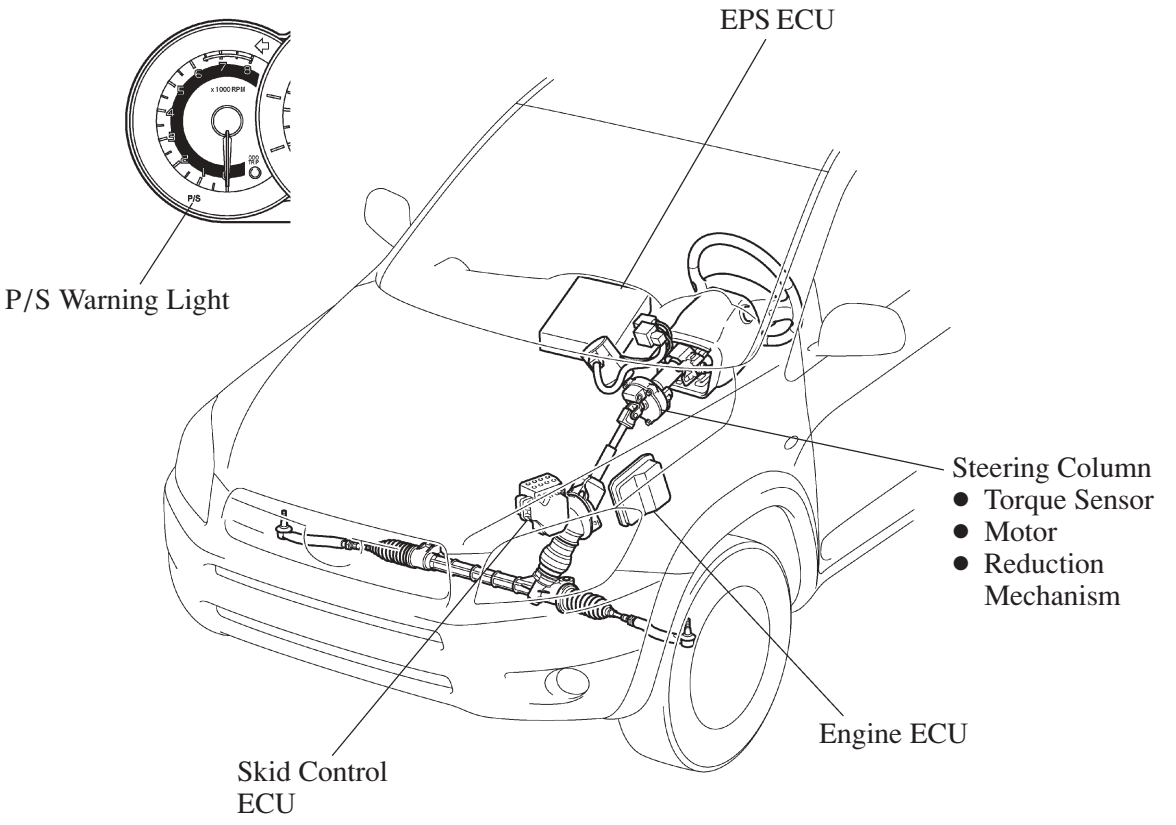
3. Layout of Main Components



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.
	Motor		Generates power assist in accordance with a signal received from the EPS ECU.
		Rotation Angle Sensor	Outputs the rotation angle of the motor to the EPS ECU.
	Reduction Mechanism		Reduces the speed of the motor through the use of a worm gear and a wheel gear and transmits it to the column shaft.
EPS ECU			Actuates the 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.

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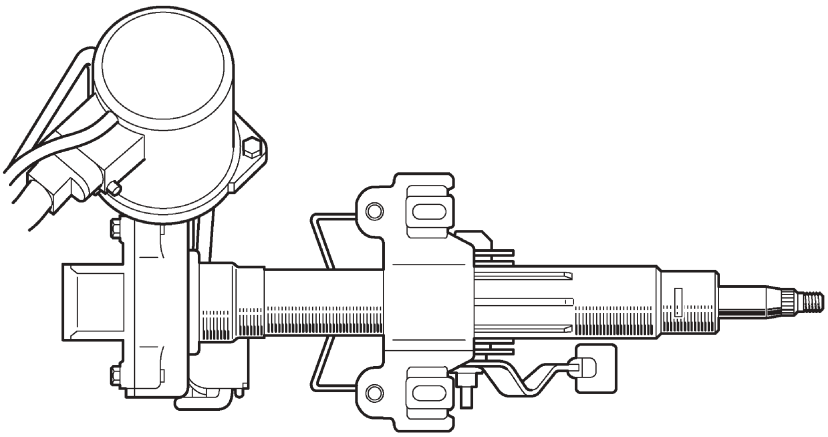
5. Construction and Operation of Main Components

Steering Column

1) General

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



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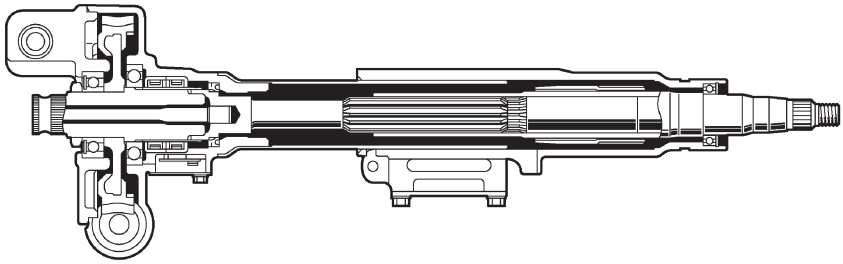
Top View



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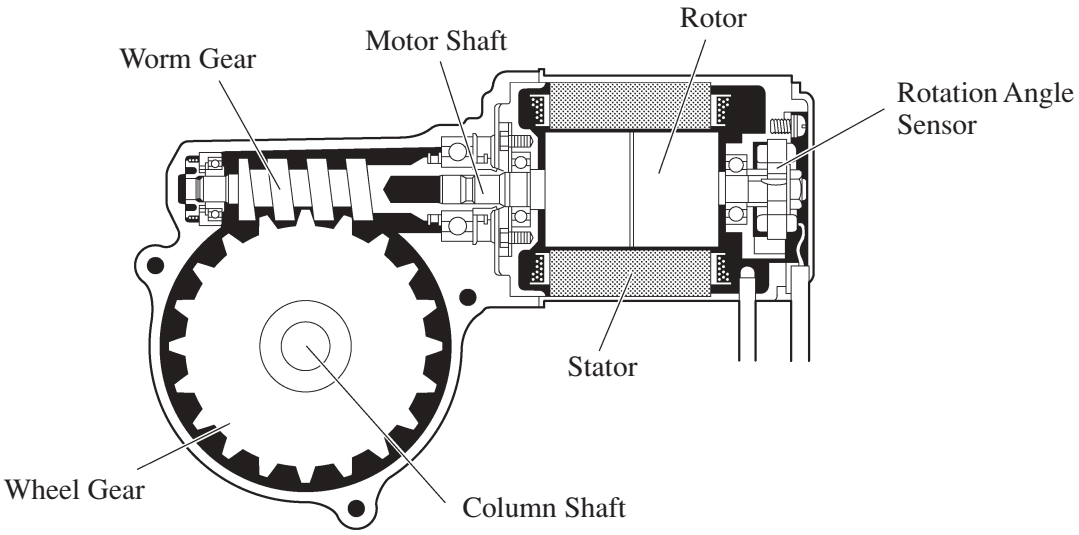
Cross Section

2) Motor

- A low inertia, low noise, and high power output motor is used.
- The 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.
- The rotation angle sensor consists of resolver sensor, which excels 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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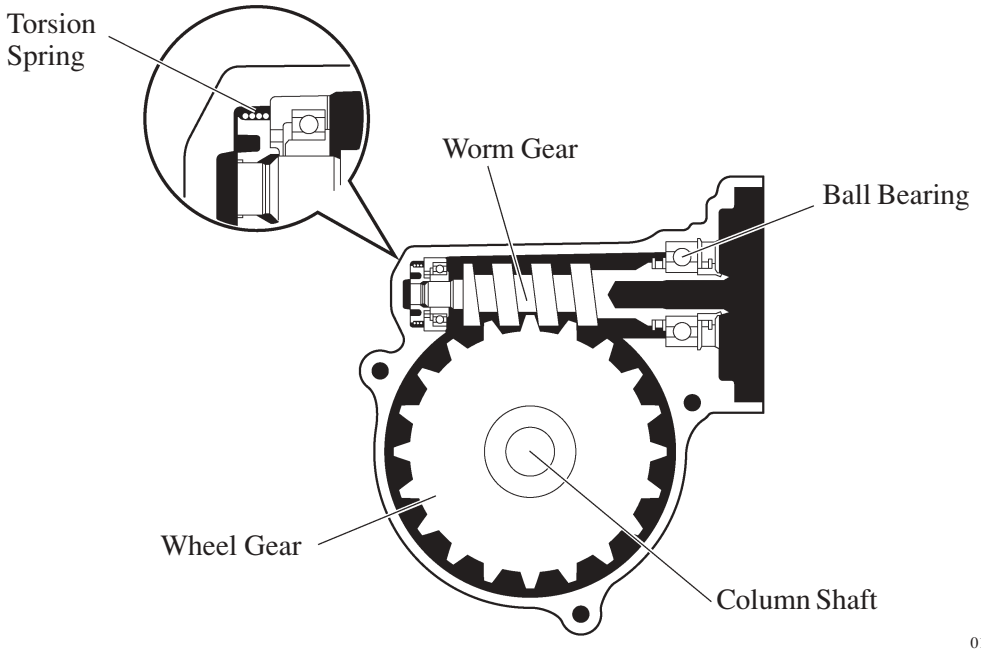
3) Reduction Mechanism

- This mechanism reduces the speed of the 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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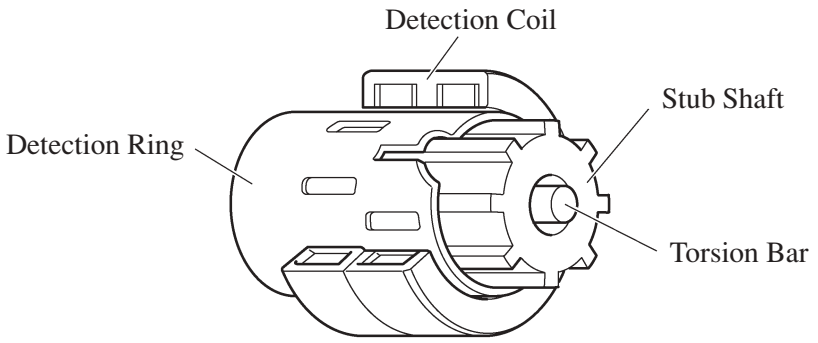
4) Torque Sensor

- 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 is mounted on the input shaft, and stub shaft is mounted on the output shaft. The input shaft and the output shaft are joined by the torsion bar. A detection coil is placed on the outside of the detection ring to complete an excitation circuit without making a contact.
- 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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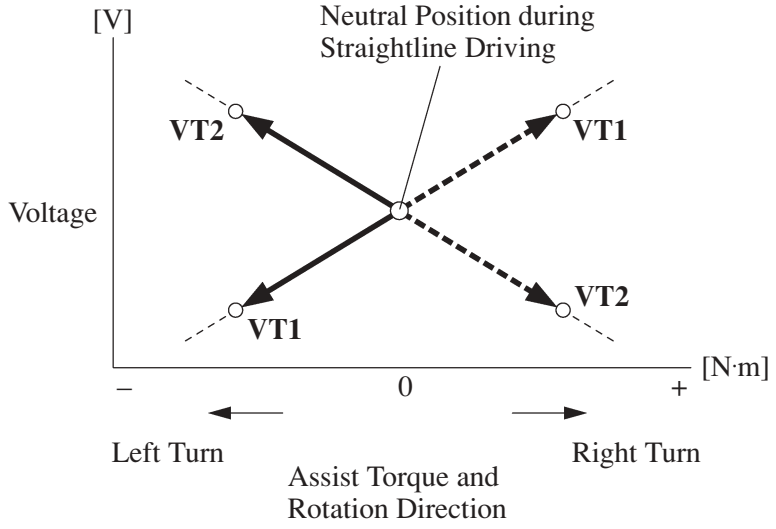
a. Straightline Driving

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 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 and the stub shaft.
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 right, VT1 outputs a voltage that is higher than that of the neutral position.
Conversely, VT2 outputs a voltage that is lower than that of the neutral position. The direction of the turn is thus detected according to these outputs. Furthermore, the amount of steering assist is determined by the magnitude of the output value.



218CH39

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.
- 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 model has following functions:

Item	Function
Basic Control	Calculates the assist current from the steering torque valve 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.

- 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 Cooperative Control with EPS and 4WD System, refer to CH-112.

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.
- In case of a malfunction, the fail-safe function activates and the EPS ECU effects various controls.

For details refer to the RAV4 Repair Manual (Pub No. RM01N0E).

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 RAV4 Repair Manual (Pub. No. RM01N0E).