# Electric Power Steering

Overview Electric Power Steering (EPS) provides power assist even when the engine is stopped. It also improves fuel economy because it is lightweight and the DC motor consumes energy only when power assist is required. The EPS is powered by a 12V motor and is not dependent on the engine for its power source so steering feel is not affected when the engine is shut OFF.

The EPS ECU uses the torque sensor output and information from the Skid Control ECU about vehicle speed and torque assist demand to determine the direction and force of the power assist. It then actuates the DC motor accordingly.

EPS Parts Location
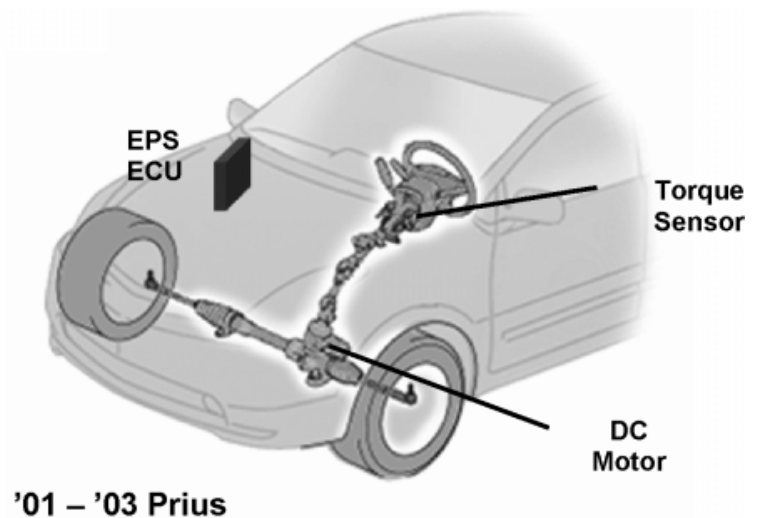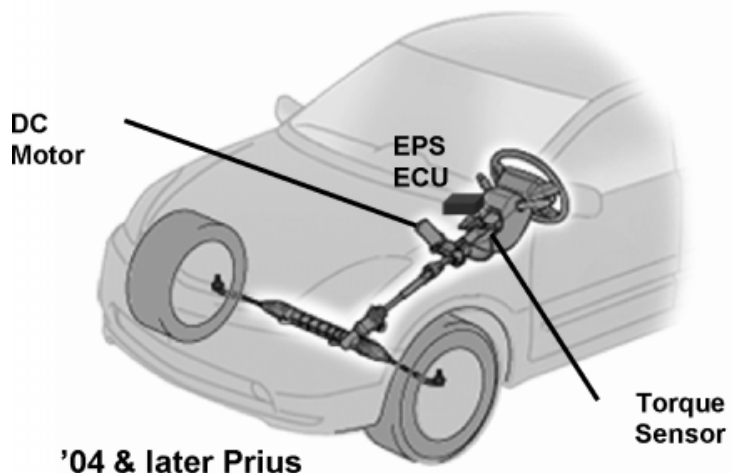
Figure 7.1   T072f701c

Steering Gear   When the steering wheel is turned, torque is transmitted to the pinion causing the input shaft to rotate. The torsion bar that links the input shaft and the pinion twists until the torque and the reaction force equalize. The torque sensor detects the twist of the torsion bar and converts the torque applied to the torsion bar into an electrical signal.

DC Motor   The DC motor uses a worm gear to transmit the motor's torque to the column shaft.
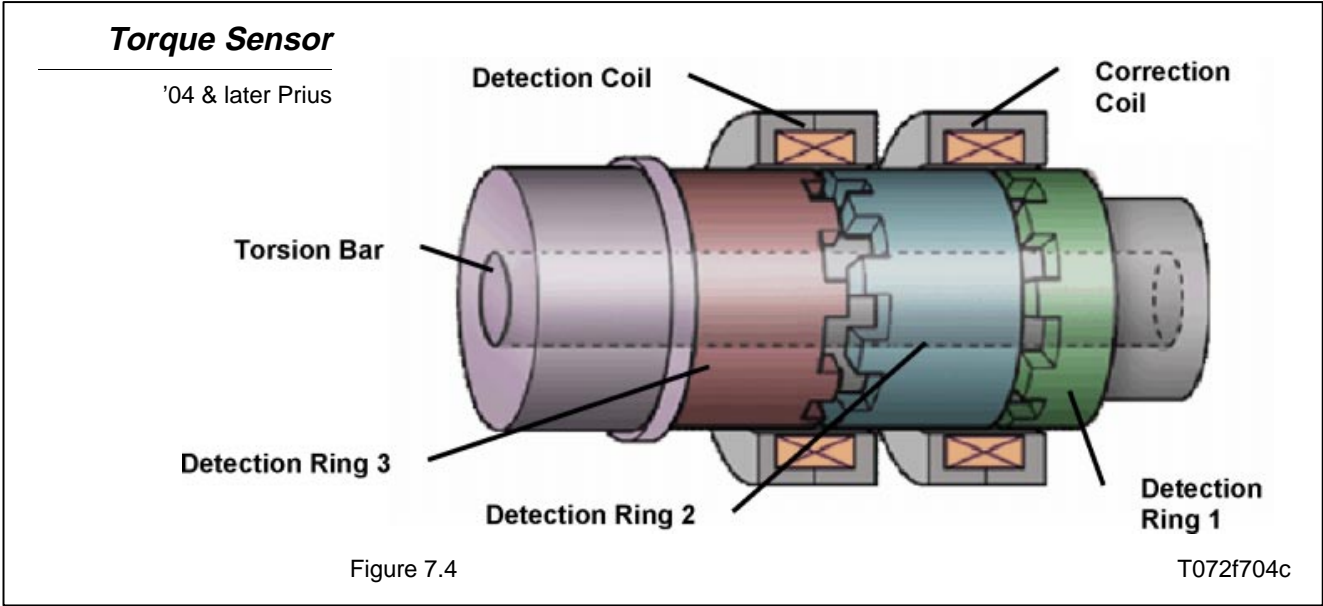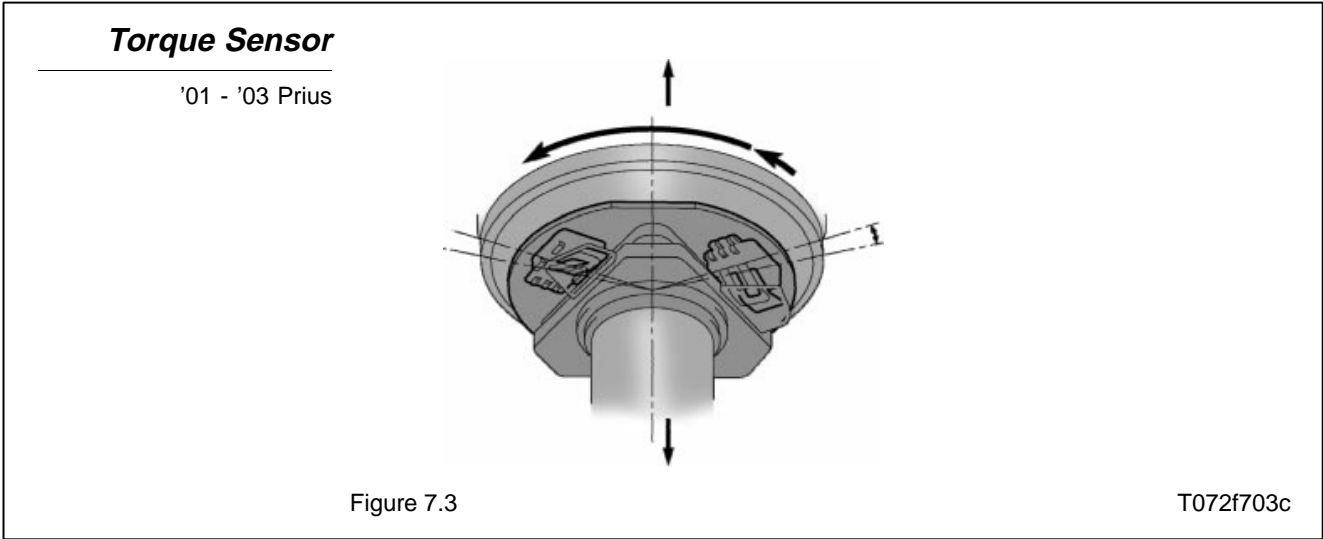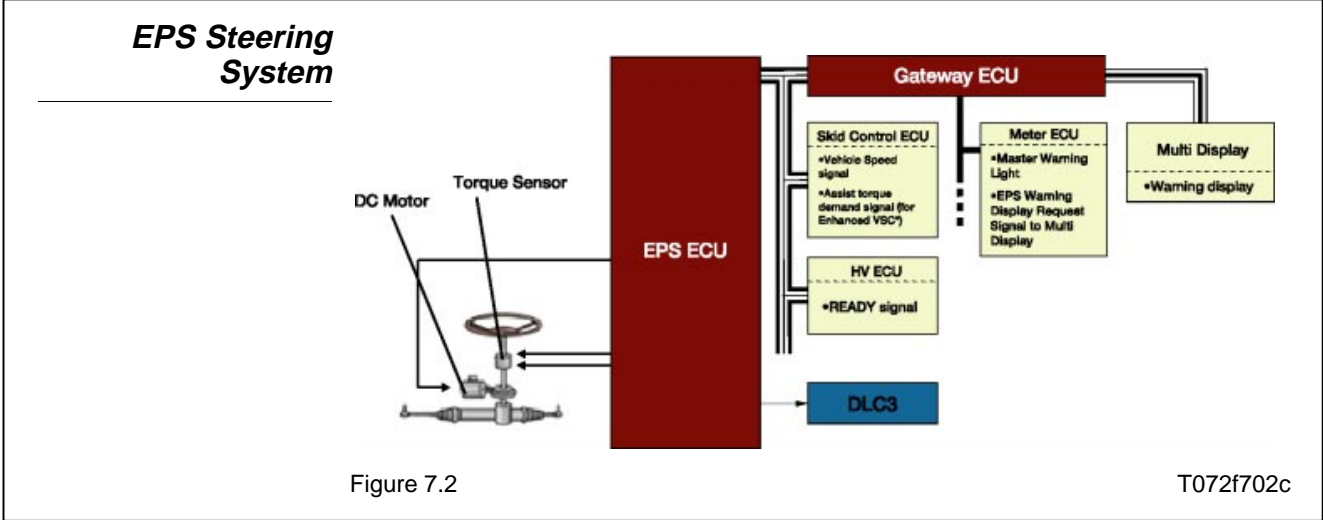
Reduction Mechanism   The reduction mechanism transmits motor power assist to the pinion shaft. The reduction mechanism consists of the ring gear that is secured to the pinion shaft and the pinion gear that is integrated with the motor shaft. The power assist of the motor is transmitted by the reduction mechanism to the pinion shaft which provides power assist to the steering effort.

Torque Sensor   The torque sensor detects the twist of the torsion bar and converts the applied torque into an electrical signal. The EPS ECU uses that signal to calculate the amount of power assist the DC motor should provide.

('04 & later Prius)   The '04 & later Prius uses an induction-type torque sensor. Detection Ring 1 and 2 are mounted on the input shaft and Detection Ring 3 is mounted on the output shaft. When torque is applied to the torsion bar the detection rings move in relationship to each other. The detection coil senses a change in inductance that is proportional to the amount of torque applied.

EPS CPU   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.

Fail Safe   If the EPS ECU detects a malfunction in the EPS system a warning light illuminates to alert the driver. The EPS ECU will store the DTC(s) and the system will power down, however, the system still provides the ability to steer manually.

EPS Steering System

Figure 7.2   T072f702c

Torque Sensor

'01 - '03 Prius

Figure 7.3   T072f703c

Torque Sensor

'04 & later Prius

Figure 7.4   T072f704c

Calibration of Torque Sensor Zero Point

The Torque Sensor Zero Point should be calibrated whenever you remove and replace the:

- Steering column assembly (containing the torque sensor)
- Power steering ECU assembly
- Steering wheel
- Steering gear assembly
- Or if there is a difference in steering effort between right and left

DTC C1515/15 Torque Sensor Zero Point Calibration Not Performed

DTC C1515 does not indicate a problem. This DTC is set when the Torque Sensor Zero Point calibration is not performed. Calibrate the Torque Sensor Zero Point and then delete the DTC.

DTC C1515/15 Torque Sensor Zero Point Incomplete

DTC C1516 also does not indicate a problem. It is set when the Torque Sensor Zero Point calibration is not completed normally. Try the procedure again and delete the DTC when finished.

DTC C1524/24 Motor Circuit Malfunction

DTC C1524/24 is set when there is a short-circuited motor terminal or abnormal voltage or current in the motor circuit. The most common fault is caused by circuit corrosion. Trouble areas include the power steering gear assembly and the EPS ECU.

DTC U0073 and DTC U0121 CAN Communiction

DTC U0073 and U0121 set when there is a problem in the CAN communication circuit. DTC U0121 indicates a communication fault with the skid control ECU, while U0073 indicates a general malfunction of the CAN communication system.

Intermittent EPS Malfunctions

Intermittent EPS malfunctions can be recorded in the Diagnostic Tester with no DTCs set. In the Diagnostic Menu for EPS, select **RECORDS CLEAR** to view recorded information relating to **MTR OVERHEAT** and **MTR LOW POWER**. Typically no codes will set when the values are recorded. This is only available for intermittent EPS problems.

Intermittent EPS Records

```
        OBD / MOBD MENU   ↓

    1: CODES (All)
    2: CAN BUS CHECK
    3: ENGINE AND ETC
    4: T/M CONTROL
    5: ABS / VSC
    6: EMPS
    7: CCS
    8: AIR CONDITIONER
    9: IMMOBILISER
```

↓

```
       DIAGNOSTIC MENU
            EMPS

    1: DATA LIST
    2: DTC INFO

    4: SNAPSHOT
    5: TRQ SENSORS ADJ
    6: RECORDS CLEAR
    7: SIGNAL CHECK
```

↓

```
     RECORDS CLEARANCE
       <  NOTICE  >

      THESE RECORDS CAN
      BE CLEARED:

    MTR OVERHEAT...UNREC
    MTR LOW POWER...UNREC


     CLEAR THE RECORDS?
     PRESS (YES) OR (NO)
```
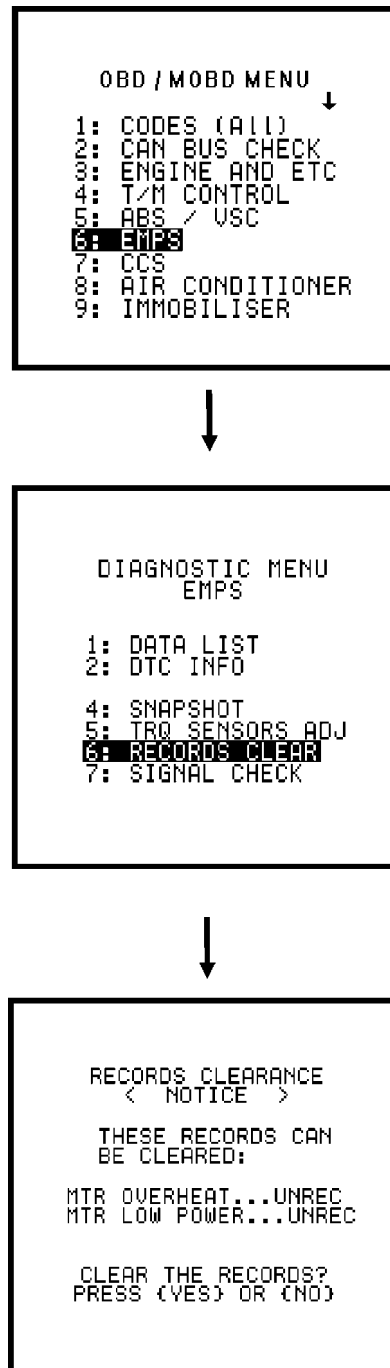
Figure 7.5   T072f705c

EPS Data List

This screen print from the Diagnostic Tester represents normal condition for the EPS system.

```
TRQ1.................. 2.53V
TRQ2 ................. 2.51V
TRQ3 ................. 2.34V
SPD .................. 0MPH
MOTOR ACTUAL ........... 0A
COMMAND VALUE .......... 0A
THERMISTOR TEMP ...... 21°C
PIG SUPPLY .......... 12.1V
IG SUPPLY ........... 11.9V
TRQ1 ZERO VAL ....... 2.51V
TRQ2 ZERO VAL ....... 2.49V
TRQ3 ZERO VAL ....... 2.37V
MTR TERMINAL (+) ..... 5.8V
MTR TERMINAL (-) ..... 5.8V
MTR OVERHEAT ........ Unrec
MTR LOW POWER ....... Unrec
CONTROL MODE ....... $010E
IG ON/OFF TIMES .. 255times
#CODES ................. 0
ASSIT MAP ............. 02
ECU I.D. .............. 01
TEST MODE STAT...... NORMAL
READY STATUS ......... OFF
```

Figure 7.6   T072f706

There may be cases where customers complain that the steering is too sensitive. This is usually a normal condition. To check the EPS system using the Diagnostic Tester, go to the **EPS Data List**. Always check the Motor Actual amperage and the Torque voltage. Refer to the EPS section of the Repair Manual specifications. The screen print above shows normal conditions with the vehicle ON, and the steering wheel in the center position.

WORKSHEET 7-1
Electrical Power Steering

Worksheet Objectives

In this worksheet you will view the EPS Data List and will determine if EPS voltage and amperage values are normal. You will also become familiar with where to find intermittent problem data and how to perform a Torque Sensor Adjustment.

Tools and Equipment

- Vehicle
- Diagnostic Tester
- Repair Manual or TIS
- SST 09843-18040

Section 1 - Electric Power Steering Data List

1. Connect the Diagnostic Tester to DLC3 and start the vehicle (READY ON). Go to the EPMS, DATA LIST.

2. In the chart below, fill in the voltages for TRQ1 and TRQ2 while the steering wheel is at center, right and left.

Steering Position	TRQ1	TRQ2
Center		
Right		
Left		

Note: TRQ 3 Is the calculated value of the ECU and is for engineering purposes only. For diagnostic purposes use TRQ 1 & 2.

3. Are the readings normal? Where did you find the normal readings?

_____

_____

4. What does the MOTOR ACTUAL amperage value represent?

_____

_____

5. Turn the steering wheel to the left lock and then to the right lock. Record the amperage of MOTOR ACTUAL while turning the steering wheel in each direction.

    Turning Left:

    Turning Right:

6. Raise the vehicle so that the tires are off the ground.

7. Again turn the steering wheel to left lock and then to right lock. Again record the amperage of MOTOR ACTUAL while turning the steering wheel in each direction.

    Turning Left:

    Turning Right:

8. Compare these values with the values you obtained with the wheels on the ground.

9. How can reading the voltage and amperage values help to diagnose the EPS system?

10. Lower vehicle so that wheels are on the ground.

Section 2 - Torque Sensor Zero Point Adjustment (Diagnostic Tester)

1. Using the Diagnostic Tester, select OBD/MOBD, EMPS, TRQ SENSOR ADJ.

2. Select and execute ZERO POINT INIT.

3. What display on the vehicle now indicates that ZERO POINT ADJUST is required?

   _____

4. Using the Diagnostic Tester, follow the procedures to complete the ZERO POINT ADJUST.

5. What display on the vehicle now indicates that ZERO POINT ADJUST is complete?

   _____

Section 2a - Torque Sensor Zero Point Adjustment (Manual)

1. Perform the Zero Point Initialization and the ZERO POINT ADJUST using the Repair Manual procedures.

2. What pages in the Repair Manual are these procedures located?

   _____

3. When is the Zero Point Adjustment procedure necessary? Return vehicle to normal condition.

   _____

   _____

Return vehicle to normal condition.

Notes