

Electric Power Steering (EPS)

The main difference between hydraulic and electric power steering systems is in the method of generating the power assistance force that reduces the amount of force that the driver has to apply to the steering wheel.

Hydraulic power steering systems feature a pump that is driven either by a belt running off the engine or by an electric motor. The pump is part of a hydraulic system which generates the fluid pressure/flow that is used to produce the power assistance for steering.

Electric power steering systems produce the power assistance force directly by means of an electric motor that transmits its torque either to the steering column or the steering gear. Therefore, such systems generally require extra gearing to connect the electric motor to the existing steering system components.

Otherwise, the basic design of the steering system is the same (e.g. rack-and-pinion steering gear for both hydraulic and electric power steering systems).

The steering characteristics, e.g. amount of steering force required, progression of steering force, feedback from the roadwheels, are subject to strict development specifications that have resulted in continual optimization of the hydraulic power steering systems so far used. The new electric power steering systems have to match up to the outstanding steering characteristics of BMW vehicles BMW owners have come to experience.

Versions of Electric Power Steering

The table below categorizes EPS systems on the basis of the mounting position of the servo unit consisting of electric motor and reduction gearing. With the advent of EPS, the method of generating the power assistance for steering changes from hydraulic to electrical means.

Index	EPS with APA	C-EPS
Vehicles	Z4 (E89)	Z4 (E85, E86)
Manufacturer	ZF	ZF
Type of Motor	Brushless Motor	Brushless Asynchronous Motor
Location of Motor and Reduction Mechanism	Parallel to Steering Rack	Upper Part of Steering Column Inside Passenger Compartment
Design of Reduction Mechanism	Belt and Ball Screw Drive	Worm Shaft and Gear

Distinction from Active Steering

The electric motor of an EPS system is capable of superimposing additional force in addition to the force applied by the driver. The EPS is able to determine the level and timing of that force independently of such factors as the engine speed.

The rigid link between the steering wheel and the front wheels remains unchanged with electric power steering. The gear ratio of the rack is fixed, so the position of the steering wheel is always directly related to the position of the front wheels.

The electric motor in an active steering system, by contrast, is capable of superimposing a steering angle (which changes the ratio between steering wheel and front wheels) but not a steering force.

The steering train of an active steering system is split by a double planetary gear. This enables the active steering to alter the steering angle of the roadwheels without it being felt by the driver through the steering wheel.

In order for the wheels to adopt the total steering angle produced by the steering wheel position plus the superimposed adjustment, a bracing force is required: the driver has to hold the steering wheel firmly. A pump unit is also required. This can only be of the hydraulic type on active steering systems. Only hydraulic pump units are currently capable of providing the combination of high positioning force and positioning speed.

Features

The use of electric power steering provides many advantages for the BMW customer, the environment and the BMW Group.

Interacting with the well-proven suspension concepts, a unique combination of driving comfort and dynamics is achieved. The steering properties (e.g. the level of steering torque assistance and damping) can be finely tuned by correspondingly programming the electrical system while ensuring optimum adaptation to the different vehicle philosophies.

Thus, despite the use of identical mechanical components, the system will be capable of perfect adaptation to future BMW models.

Where more precise steering and better handling characteristics are desired for a more sports-style model, it can be achieved by reducing the amount of power assistance.

Although the driver then has to apply slightly more force to the steering wheel, the feedback from the roadwheels gives the more "direct" feel desired.

By contrast, a greater degree of power assistance can be programmed for models whose steering characteristics are to be more comfort-orientated.

With the disappearance of the hydraulic system (consisting of pump, hoses, cooler, fluid, etc.), assembly of the steering on the production line is more efficient for the manufacturer. The EPS steering system is supplied as a pre-assembled unit and fitted to the vehicle as such. In addition, the EPS also eliminates the environmental hazard of hydraulic fluid leakage.

Because the electric motor is activated only when required (when steering but not when driving straight ahead) fuel consumption is reduced and the effective power output of the combustion engine increased when compared to a conventional hydraulic power steering system.

The example figures below illustrate the difference in power consumption between the two steering systems.

Power Consumption	Electric Power Steering	Hydraulic Power Steering
Minimum Demand	10 Watts	300 - 400
Maximum Demand	1,000 Watts	2,000

Features of Electric Power Steering

Improved Handling Dynamics

- Steering characteristics perfectly adapted to vehicle model
- Active return to center
- Linear dynamics benefits of up to 2 kW

Greater Driving Comfort

- Steering train isolated from suspension vibration while still transmitting the important road feedback (different road surface conditions) to the driver
- Improved isolation of interference from the road surface (less steering judder)
- Electronically controlled, speed-dependent power-assistance (e.g. greater when parking)

Greater Driving Safety

- Servotronic function: EPS assists the driver to hold the correct line, particularly at high speeds, by providing a lower level of power assistance than at low speeds.
- Steering wheel backlash is reduced by active speed-dependent damping. This function also reduces the vehicle's tendency to slew in response to abrupt steering wheel movements made by the driver.

Better Environmental Credentials

- Fuel saving of approx. 0.2 l per 100 km
- No possibility of leakage from the hydraulic system

Simplifications for the Vehicle Manufacturer

- Reduced assembly and inspection complexity at the production plant as the system is supplied as a complete unit
- Reduced range of variants compared to hydraulic systems (pumps, hoses, steering wheels)
- Easier tuning of power steering assistance by programming
- High future potential: integration between vehicle systems (dynamic driving systems, driver assistance systems)