

Key term

In series – incorporated as part of the circuit.

To diagnose hydraulic system pressure faults, you must fit a power-assisted steering pressure gauge **in series** with the pump, then run the engine at different speeds and under different operating conditions. The gauge is similar in operation to an engine oil pressure gauge, but it has a manually operated valve that is able to control the flow of fluid in the system. In this way, you can check flow and pressure and compare them with the manufacturer's specifications.

- By connecting the gauge with the valve in the open position, you can check supply pressure when the steering is at full lock.
- By connecting the gauge with the valve in the open position, you can check supply pressure when the engine is operating in its normal rev range (1000 to 3000 rpm) with the steering in the straight ahead position.
- By connecting the gauge with the valve in the closed position, you can check the maximum supply pressure available from the pump.

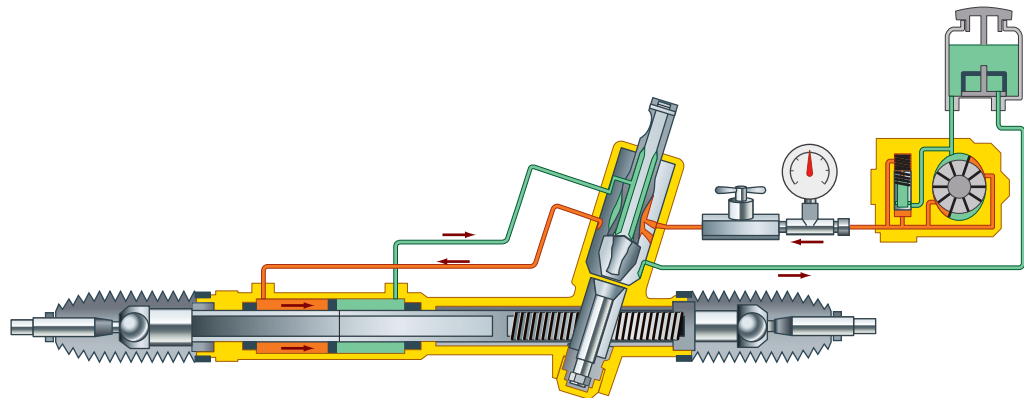


Figure 2.43 Using a gauge to check steering hydraulic pressures



NEW TECH

Steer by wire

Some manufacturers are experimenting with a system of steer by wire. In this set up, the steering wheel is replaced with a joystick that can control not only steering but also acceleration and braking. The main drawbacks of this system are the difficulty in making it failsafe and the reluctance of drivers to give up control of the steering wheel.

Action

Examine a vehicle in your workshop and identify the main component parts of a hydraulic power-assisted steering system.



Safe working

Do not run the hydraulic pump for more than five seconds with the valve on the pressure gauge in the closed position, as this may cause the pump to overheat and can cause damage.

Power-assisted hydraulic fluid pressures can reach around 80 bar (1160psi) so you must take care when working on these systems.

Table 2.7 Typical operating pressures that may be found during hydraulic testing

Pressure gauge valve open			Pressure gauge valve closed	Symptom and possible fault
Engine speed 1000 rpm	Engine speed 3000 rpm	Engine speed 1000 rpm, steering turned to full lock	Engine run (maximum 5 seconds)	
40 bar	35 bar	80 bar	80 bar	Correct operation
25 bar	25 bar	80 bar	80 bar	Power assistance too low Flow control valve stuck open/faulty
40 bar	35 bar	60 bar	80 bar	Power assistance too low Faulty control valve or hydraulic piston
40 bar	35 bar	60 bar	60 bar	Power assistance too low Worn pump
65 bar	65 bar	80 bar	80 bar	Power assistance too high Flow control valve stuck closed/faulty

Noise and bleeding

Noise from a hydraulic power-assisted steering system may be caused by:

- loose drive belt
- air in the hydraulic system, known as **cavitation**
- pump bearing wear.

If air has entered the system, it can be bled by topping up the fluid reservoir with the correct grade of power steering fluid and turning the steering from lock to lock with the engine running. This will help fluid to fully circulate through the steering system and air to escape once it has reached the reservoir.

Speed sensitive solenoid diagnosis

To diagnose the correct operation of the speed sensitive system, you need to connect an oscilloscope to the speed sensor input at the power steering ECU. (You can find out how to connect and use an oscilloscope in Chapter 4, pages 184–185.).

With the vehicle in motion, you should see a wave form with a frequency proportional to vehicle speed on the screen of the oscilloscope. This signal may be analogue (see Figure 2.44) or digital (see Figure 2.45). If you don't see this wave form, check the sensor and wiring.

If the input to the ECU is correct, you should then connect the oscilloscope to the output for the power steering solenoid. At slow speed, you should see a duty cycle or pulse width modulation (PWM) on the screen of the oscilloscope that reduces as vehicle speed increases.

Key term

Cavitation – the creation of bubbles in a hydraulic fluid.

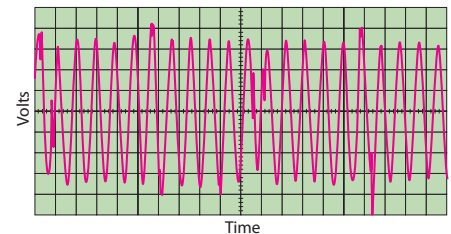


Figure 2.44 Analogue speed signal

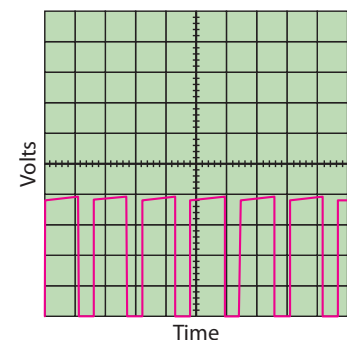


Figure 2.45 Digital speed signal

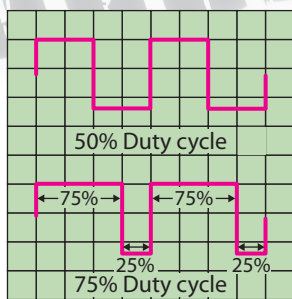


Figure 2.46 Duty cycle wave form

If the output signal is correct, then you should check the wiring and solenoid for correct function and operation.

If the input to the electronic control unit is correct but the output is missing or incorrect, you should suspect a fault with the ECU.

Electro-hydraulic power-assisted steering

An alternative to the engine-driven hydraulic pump used in power-assisted steering is for the pump to be driven using an electric motor. The electric motor, pump and fluid reservoir can then be mounted in a position away from the engine and activated when required. Sensors mounted on the steering column are able to measure the amount of turning effort applied to the steering system by the driver and send this information along with a signal from the vehicle's speed sensor to the steering electronic control unit (ECU). The ECU is then able to operate the electric motor to turn the pump and supply a pressure to the piston in the steering rack which is proportional to vehicle speed and the steering effort applied.

The advantages of this type of system are:

- Fewer loads are placed on the engine during operation, so fuel economy and engine emissions are improved.
- The pump and reservoir can now be mounted anywhere away from the engine, which increases the scope for vehicle design.
- If the engine stalls/cuts out, power assistance can be maintained.
- The pump can be controlled by a switch to provide even greater assistance when parking.

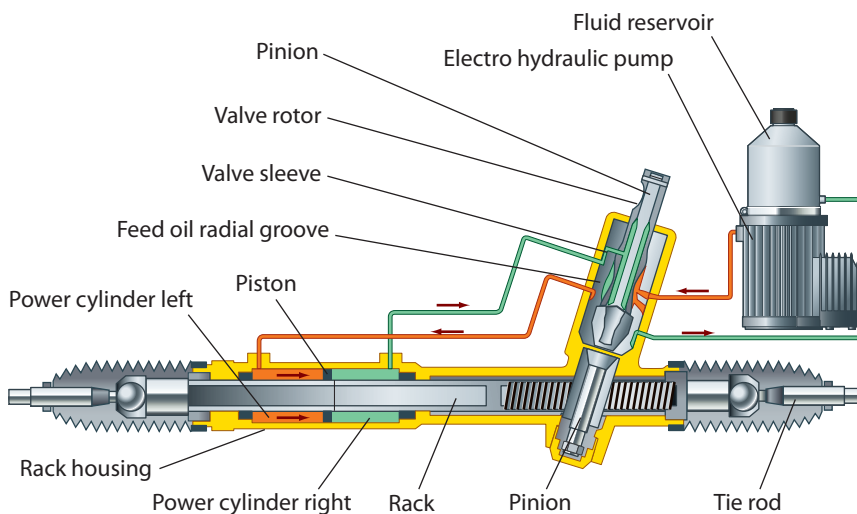


Figure 2.47 Electro-hydraulic power steering

Electronic power-assisted steering (EPS)

Many modern vehicles use electric motors to drive steering mechanisms and provide power assistance instead of hydraulics. A reversible direct current electric motor can be connected to the steering rack or column

depending on manufacturer design. As the driver applies effort at the steering wheel, movement and turning effort are registered by a torque sensor mounted on the steering column. The information provided by this sensor, as well as other inputs such as vehicle speed are then sent to the steering electronic control unit (ECU). The ECU is then able to operate the electric motor in the desired direction with a force controlled by duty cycle with a force that is proportional to vehicle speed and steering effort applied.

The advantages of this system are:

- The motor is only operated when the steering is turned – this reduces loads, improves fuel economy and reduces engine emissions.
- The motor and control system is very compact and can be used unobtrusively, even on small cars.
- Assistance can be easily varied to provide greater help when parking.
- Less maintenance is needed as there is no fluid system or leaks.
- If combined with a vehicle radar system, it can be used to provide a self-parking function.

To diagnose faults with electronic power-assisted steering systems, you can often use a scan tool to retrieve diagnostic trouble codes (DTCs),

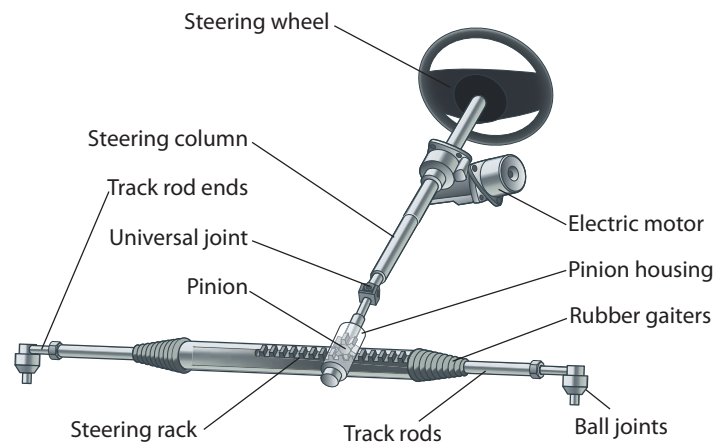


Figure 2.48 Electronic power-assisted steering

NEW TECH

Self-parking cars

Parallel parking is a slow speed manoeuvre that many drivers find difficult. As a response to consumer demand, car manufacturers are starting to design and sell self-parking cars. Advantages of self-parking cars include:

- Choosing a parking space is not restricted by the driver's skill at parallel parking.
- A self-parking car can often fit into smaller spaces than most drivers can manage on their own, which allows the same number of cars to take up fewer spaces.
- Parking takes less time, which helps to keep traffic moving.
- Minor damage created by parking is reduced.

Many systems operate with the driver controlling vehicle speed and direction with the normal driving controls. They have sensors distributed around the front and rear bumpers of the car, which act as both transmitters and receivers. These sensors send out signals, which bounce off objects around the car and reflect back to them. The car's ECU then uses the amount of time that it takes those signals to return to calculate the location of the objects. The electronic power-assisted steering then manoeuvres the car into the parking space.

Manufacturers are now designing vehicles that are completely autonomous and will control the drive as well as the steering. This means that the driver simply has to select an appropriate parking spot and position the vehicle close to the space. Having pressed a button, the car can then park completely by itself.

Action

Investigate vehicles in your workshop and state if they use:

- hydraulic power-assisted steering
- electro-hydraulic power-assisted steering
- electronic power-assisted steering.