

Light and safe steering

- with steering components from Sauer-Danfoss



**SAUER
DANFOSS**

What really matters is inside



There are many good reasons for choosing Sauer-Danfoss for vehicle steering

The prime objective of Sauer-Danfoss is to be a good partner and an effective task-solver for its customers. This means, among other things, close and loyal cooperation: you have the steering application – we have the know-how. It's really that simple. The rest is down to mutual trust and confidence, openness and fresh approach that characterises our cooperation, for here, too, we stand by what we say.

Total quality

Quality has long been a byword at Sauer-Danfoss. The aim with our steering products is to provide components that will operate for many years with a minimum of service. Quality is unconditional and applies to every facet of our production. The company uses the latest quality assurance methods and equipment, and in our quality development work we make sure that we are always ahead of the demands and wishes of the market.

Service throughout the world

Where development, production and service are concerned, Sauer-Danfoss has been active on the mobile hydraulics market for many years. This has given us a wealth of experience in solving problems rapidly and efficiently. Our ability to think creatively on the spot has been put to the test many many times.

Our experience over the years has taught us much and has resulted in a worldwide service network. Today, Sauer-Danfoss is represented by specialist Service Shops on five continents. All of the shops are manned by qualified personnel and all of them are equipped with the latest tools and test equipment.

This is the best assurance of fast and competent service we can give you.

A wide range of components

Sauer-Danfoss offers steering solutions for off-road vehicles, both at component and system levels. We cover all requirements – right from the smallest garden tractor to the largest specialpurpose vehicle.

Steering components from Sauer-Danfoss are used in vehicles where the operator must be able to control small and large steering forces and where operator comfort and safety demands are high.

The product range makes it possible to cover applications of all types, right from ordinary 2-wheel steering (Ackermann steering) to articulated steering, complicated 4-wheel steering, automatic steering (e.g. sensor steering) and remote steering via satellite.

Above all – the starting point of product and system design at Sauer-Danfoss is always the customer's need!



Articulated steering



One wheel steering



Ackermann steering



Four wheel steering

Page 12 gives a comprehensive overview of all steering components

Light vehicles



OSPM
steering unit



OSPM
steering unit with
steering wheel



OSPM
steering unit with
steering column
and steering wheel

For light vehicles such as garden tractors, municipal vehicles, lawnmowers, small forklift trucks, etc., Sauer-Danfoss offers OSPM hydrostatic steering units.

OSPM units are compact and light, and thus easy to install. An integrated steering column and end port connections give a simple and economic system.

The mini steering unit consists of a rotary valve and a metering pump, as can be seen in all Sauer-Danfoss steering units.

This principle gives safe and stable steering in all conditions, whether in straight-line driving or when manoeuvring.



Principal OSPM characteristics:

- Compact design and small dimensions
- Optional integrated steering column
- One or more built-in valve functions: pressure relief, shock, and/or non-return in pump connection
- Integrated fittings in end ports
- Low steering torque
- Low flow loss
- Low system price.

OSPM is designed for hydraulic systems where oil is supplied by a fixed-displacement pump: the OSPM steering unit is available in "Open Center" and "Power Beyond" versions.

With the Open Center type, in neutral position there is an open connection through the unit from pump to tank.

With the Power Beyond type, in the neutral

position oil is led from the steering unit pump connection to the E-connection, which can be used for working hydraulics.

When steering, the steering has first priority, the remaining oil is available for working hydraulics.

OSPM is available with displacements from 32 to 100 cm³/rev.

A TAD torque amplifier is offered for use on the same type of vehicles, but where a mechanical connection is required between steering column and steering wheel.

TAD is a hydromechanical unit and operates in the same way as servo steering in a car.

The torque applied to the steering wheel can be amplified up to 40 times. TAD is available with integrated pressure relief valve.

TAD
Torque
amplifier



Small and medium-sized vehicles



We offer hydrostatic steering systems for small and medium-sized vehicles, typically tractors, harvesters, forklift trucks, and smaller contractors' machines.



OSPC
Steering unit



OSPR
Steering unit

OSPC ON/OR for hydraulic systems where oil is supplied by a fixed-displacement pump. The range is wide and flexible, characterised by:

- Low steering torque, 0.5 Nm to 1.8 Nm in normal steering situations
- Low noise level and wide control range
- One or several built-in valve functions: pressure relief, shock, suction, and/or non-return in pump connection
- Port threads as required, to DIN, ISO, SAE or JIS standards.

OSPC is available in versions "Open Center Reaction" or "Open Center Non Reaction" (OR or ON) and with displacements from 40 to 500 cm³/rev.

OSPC is also available in a "Closed Center Non Reaction" (CN) type. CN steering units are for constant-pressure systems with variable pump flow. In neutral position, the CN unit shuts off oil flow between pump and tank.

CN units are available with displacements from 50 to 400 cm³/rev.

OSPR ON corresponds to OSPC ON as far as function is concerned. The difference is that OSPR has end port connections that in some applications can make installation easier. OSPR is available with the same valve functions as OSPC, with displacements from 70 to 315 cm³/rev.



OSPC LS and OSPF LS are for Load Sensing Systems where oil is supplied by a pump via a priority valve or from a pump with variable displacement. OSPC LS and OSPF LS have the same characteristics as OSPC. In addition, however, OSPF LS offers:

- Higher max. steering speed, limited only by the capacity of the pump and the pressure setting
- Wide control range which gives better steering comfort
- Steering wheel backlash eliminated.

OSPC LS is available in versions "LS Static" and "LS Dynamic", "Reaction" or "Non Reaction" (LSR and LS).

OSPF LS is offered as "Reaction" or "Non Reaction" (LSR and LS). Both types can be supplied with several valves: pilot pressure relief, shock, suction and/or non-return, and with displacements from 40 to 400 cm³/rev.

OSPB ON/OR/CN and OSPB LS are steering units corresponding to OSPC. The only difference is that OSPB has no built-in valve functions.

OSPB is available with displacements from 50 to 1000 cm³/rev. When valve functions are required in a system with OSPB, a separate valve block, type OVP, is offered for flange mounting on the steering unit.

OSPC LS/
OSPF LS
Steering unit



OSPB
Steering unit



Heavy vehicles



OSPD
Steering unit



OSPQ
Steering unit



OSPL
Steering unit

OSPC, OSPC LS and OSPF LS hydrostatic steering units (see previous page) are also ideal for large tractors, combine harvesters, excavators, loaders, and similar vehicles. Special types have also been developed especially for these types of vehicles:

OSPD LS is a load sensing steering unit with two gearwheel sets. The two sets are mechanically connected and a changeover valve determines whether one or both sets are active. During normal operating conditions both gearwheel sets operate simultaneously, but in the event of pump failure only one gearwheel is used. This gives the following advantages:

- Possibility of manual steering of the heaviest vehicles, without the need for an emergency pump. The ratio of displacement normal steering/emergency steering is optional up to a factor of 5

- Possibility of changeover between large and small displacement: large displacement for working situations and small for precise steering, on roads for example.
- Good steering characteristics, as with OSPC and OSPF load sensing steering units.

OSPD LS is available in versions "LS Static" and "LS Dynamic", "Reaction" or "Non Reaction" (LSR and LS) and with built-in valves: pilot pressure relief, shock, suction and/or non-return. OSPD is available with the following displacements:

- a: Metering pump for manual steering, 70 to 125 cm³/rev.
- b: Combined with metering pump, 70 to 315 cm³/rev. For example, a metering pump (a) 80 cm³/rev. and (b) 160 cm³/rev. give 240 m³/rev. The steering unit is thus designated OSPD 80/240 LS.



OSPQ LS is a load sensing steering unit with flow amplification. OSPQ gives a variable oil flow in relation to steering wheel speed: with steering wheel speed less than about 10 rev./min output flow corresponds to the displacement of the gearwheel set alone. With higher steering wheel speeds, oil is also led to the steering cylinder via the built-in flow amplification valve. The advantage of OSPQ is that it enables manual steering on relatively heavy vehicles without the need for an emergency pump.

OSPQ LS is available in the same versions and offers the same valve possibilities as OSPD LS. OSPQ is available with the following displacements/amplification factors:

- Displacements: 80, 100, 125 or 160 cm³/rev.
- Amplification factor: from 1.2 to 2.0.
E.g. metering pump 80 cm³/rev., amplification factor 2.0. Steering unit designation: OSPQ 80/160 LS.

OSPL LS is a load sensing steering unit specially developed for large displacements in order to

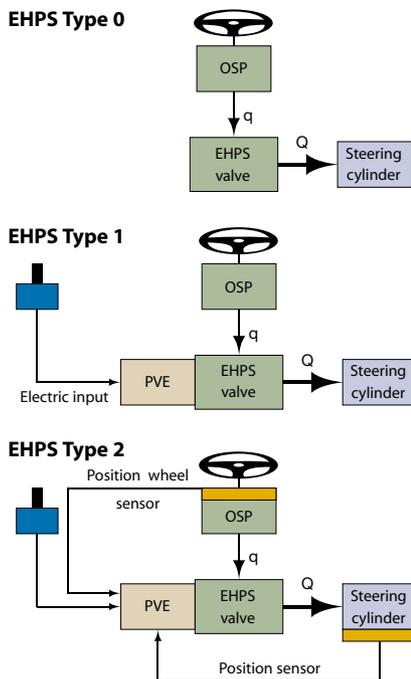
minimise flow loss. It is therefore extremely suitable for large vehicles. OSPL is available with built-in valves: pilot pressure relief, shock, suction and/or non-return.

OSPL is available with displacements 520, 630, 800 or 1000 cm³/rev. An OVPL valve block can be flange mounted to OSPL units that have no built-in valves (see page 13).

Flow amplifier OSQ is offered for very heavy vehicles to amplify the oil flow from the steering unit.
(See page 13 for explanation).

Steering and electronics

EHPS
Valve block
and OSPCX



On loaders, large forklift trucks, dumpers, large tractors, combine harvesters, forestry machines and other heavy vehicles there is often need for electrically actuated steering in the form of a joystick or automatic steering. Electrically actuated steering acts as a supplement to hydraulic steering wheel control and facilitates optimised steering characteristics in different driving situations. In other words, it increases vehicle productivity and improves driving comfort.

Sauer-Danfoss offers electrohydraulic steering systems for such applications. A basic system consists of a pilot-controlled unit as the signal source and an EHPS type 0 valve block which proportionally to the pilot flow controls oil to the steering cylinders.

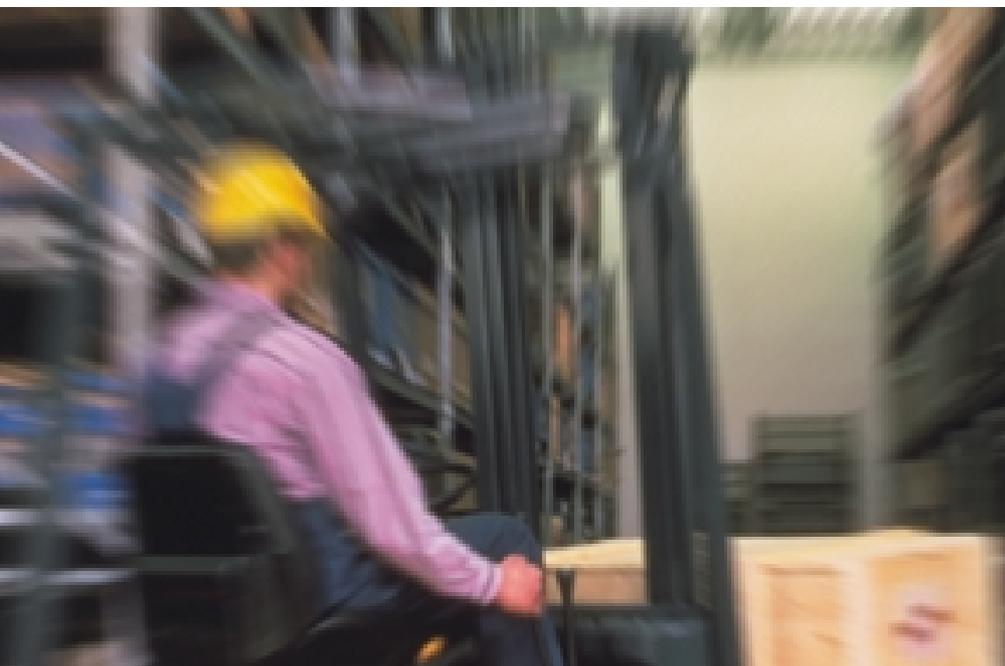
The system can be extended to include an electric actuator so that it becomes possible to select alternative steering with, for example, a joystick (EHPS type 1).

In addition, the valve block can be supplied with built-in microcontroller and control software (EHPS type 2). The electrohydraulic steering system from Sauer-Danfoss is characterised by:

- High steering pressure requiring smaller cylinders and oil flow
- Low pilot pressure (max. 30 bar) giving an extremely low noise level in the cab
- The possibility of manual steering in the event of pump failure – even on very heavy vehicles.

- Minimal side acceleration on vehicles with articulated steering
- The microcontroller means no steering wheel drift and the possibility of variable gear ratio between steering wheel and steered wheel, and the possibility of “interfacing” with automatic steering
- Facility for CAN bus interface
- EHPS can be built together with Sauer-Danfoss PVG 32 proportional valves.

Steering systems with EHPS and electrical steering can gain approval for road use. EHPS is available with built-in valve functions: priority, pilot pressure relief, shock, suction and/or non-return.



Sauer-Danfoss now supply fully electrical steering systems consisting of a steering actuator and steering reference sensor for small and medium-sized warehouse forklift trucks.

The steering reference sensor can be a generator type EPSR or a potentiometer, on which a mini steering wheel or a tiller arm can be mounted. The steering actuator turns the steered wheel by chain or pinion. The actuator consists of a brushless a.c. motor and a cycloidal reduction gear. All necessary control and power electronics, and sensors are already built onto the actuator, therefore installation is very simple and economic.

The fully electrical steering system from Sauer-Danfoss is characterised by the following:

- It is an integrated and compact system – the first on the market with built-in sensors
- AC technology makes the unit maintenance-free
- Low installation costs
- High level of safety (category 3, EN 954-1)
- Good steering comfort
- Low noise level
- Robust concept withstands shock loads up to 5x the nominal torque applied to the steering wheel
- Based on many years of experience within a.c. motor control technology in connection with Sauer-Danfoss VLT® frequency converters.

Three types of electrical steering systems are available:

- Type 1 is for “open loop” systems
- Type 2 corresponds to type 1 but has built-in end stop sensors and CAN-bus interface
- Type 3 is for “closed loop” systems. Type 3 has built-in end stop and position feedback sensors, and CAN-bus interface.



Product overview

Concept	Types	Components	Recommended oil flow l/min	Max. steering pressure bar	Displacement cm ³ /rev.	Accessories
Hydromechanical steering	TAD	TAD	10 - 16	70	100, 160	Steering columns: OTPB and OTP-TT.
Hydrostatic steering	OSP	OSPM	3 - 20	125	32 - 100	Steering column: OTPM.
		OSPB	5 - 80	210*	50 - 1000	Steering column: OTPB and OTP-TT. Valve blocks: OVR.
		OSPR	7 - 32	175	70 - 315	Steering column: OTPB and OTP-TT.
		OSPC	4 - 80	210*	40 - 500	Steering column: OTPB and OTP-TT.
		OSPC LS	4 - 40	210*	40 - 400	Steering column: OTPB and OTP-TT. Priority valve: OLS and OLSA.
		OSPF LS	4 - 40	210*	40 - 400	
		OSPD LS	7 - 44	210*	70 - 440	
		OSPQ LS	8 - 32	210*	80 - 320	Steering column: OTPB and OTP-TT. Priority valve: OLS. Valve block: OVPL.
	OSPL LS	52 - 100	210	520 - 1000		
	OSQ	OSQ + OSPBX	64 - 400	210	640 - 4000	Steering column: OTPB and OTP-TT for OSPBX.
EHPS type 0	EHPSV + OSPCX	up to 100	250		Steering column: OTPB and OTP-TT for OSPCX.	
Electrohydraulic steering	EHPS type 1	EHPSV + OSPCX + PVEB	up to 100	250		Steering column: OTPB and OTP-TT for OSPCX. Joystick. Wheel and steering wheel.
	EHPS type 2	EHPSV + OSPCX + PVED	up to 100	250		
				Voltage		
Fully electrical steering	EPSA + EPSR			24/48/80		

*Steering pressure >175 bar with special spool/sleeve set only.

Accessories

Steering columns

OTPM and OTPB steering columns can be supplied in many variants:

- Individual lengths from 45 mm and up to 1200 mm
- With and without sensor for starting electrically driven hydraulic pump
- With and without horn connection
- Can be supplied complete with installation brackets
- Different options for noise and vibration suppressions available

OTP-TT steering columns can be tilted and/or are telescopic. The angle of tilt is from -25° to $+25^{\circ}$ and lengths are from 280 mm to 850 mm. Typically, these steering columns are supplied by Danfoss Fluid Power to suit customer requirements exactly.

Valve blocks

OVP is a valve block for flange mounting on OSPB steering units that have no built-in valves. OVP is supplied with a pressure relief, shock, suction and/or non-return valve in the pump connection.

OVPL is for flange mounting on OSPL steering units. OVPL is supplied with shock, suction, non-return in the pump connection and/or back pressure valve in the tank connection.

Priority valves

Priority valves are used for systems where the steering system and working hydraulics are supplied with oil from just one pump, and where the steering system has the highest priority.

The priority valves are available in an OLSA version for flange mounting on the steering unit and an OLS version for in-line installation between pump and steering unit.

Flow: 40, 80, 120 or 160 l/min, pressure: up to 250 bar.

Flow amplifier

Flow amplifier OSQ is for use with a steering unit to amplify the oil flow. This produces a system able to steer vehicles weighing up to several hundred tons.

The steering unit sends a pilot flow to the flow amplifier. The pilot flow is amplified depending on the amplification spool selected. This avoids a large steering flow through the steering unit and thus optimises system efficiency and operator comfort.

The OSQ flow amplifier can be supplied with built-in valves: priority, pilot pressure relief, shock, suction and/or back-pressure valve in the tank line.

The flow amplifier is available with different amplification factors: 4, 5, 8 or more.

OTP-T
Steering columns



OVP
Valve block



OVPL
Valve block



OLSA 40/80
Priority valve



OLS 40/80
Priority valve



OLS 160
Priority valve



OSQ
Flow amplifier



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