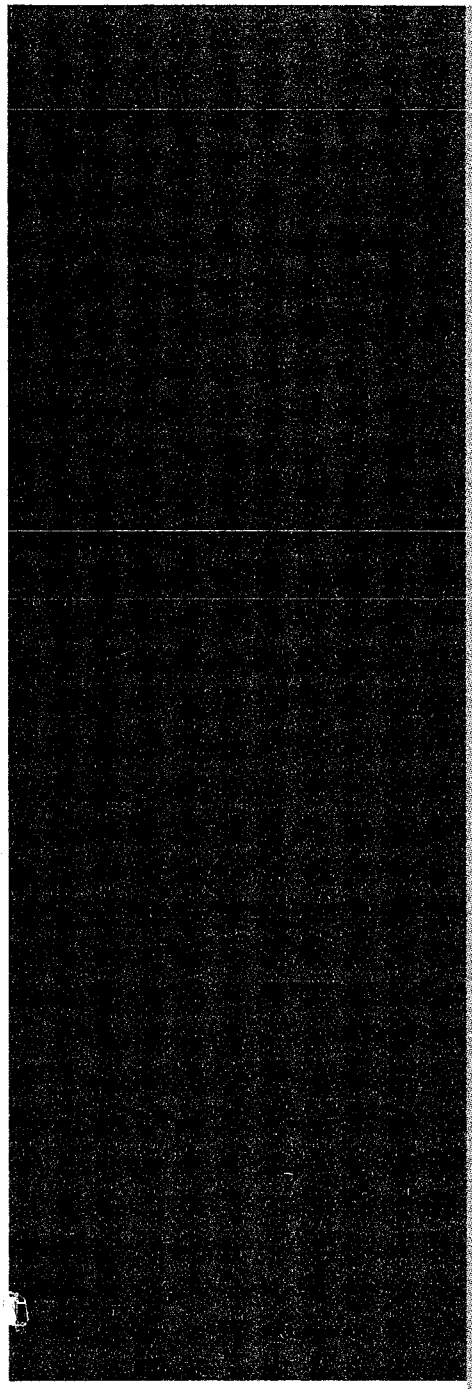

Linde

HPR Regulating Pumps

- for open loop circuits
- for load sensing regulations
- for the Linde Synchron Control system
- for mobile applications
- for industrial service

هیدرولیک موسوی
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1. Description

1.1 Design and components

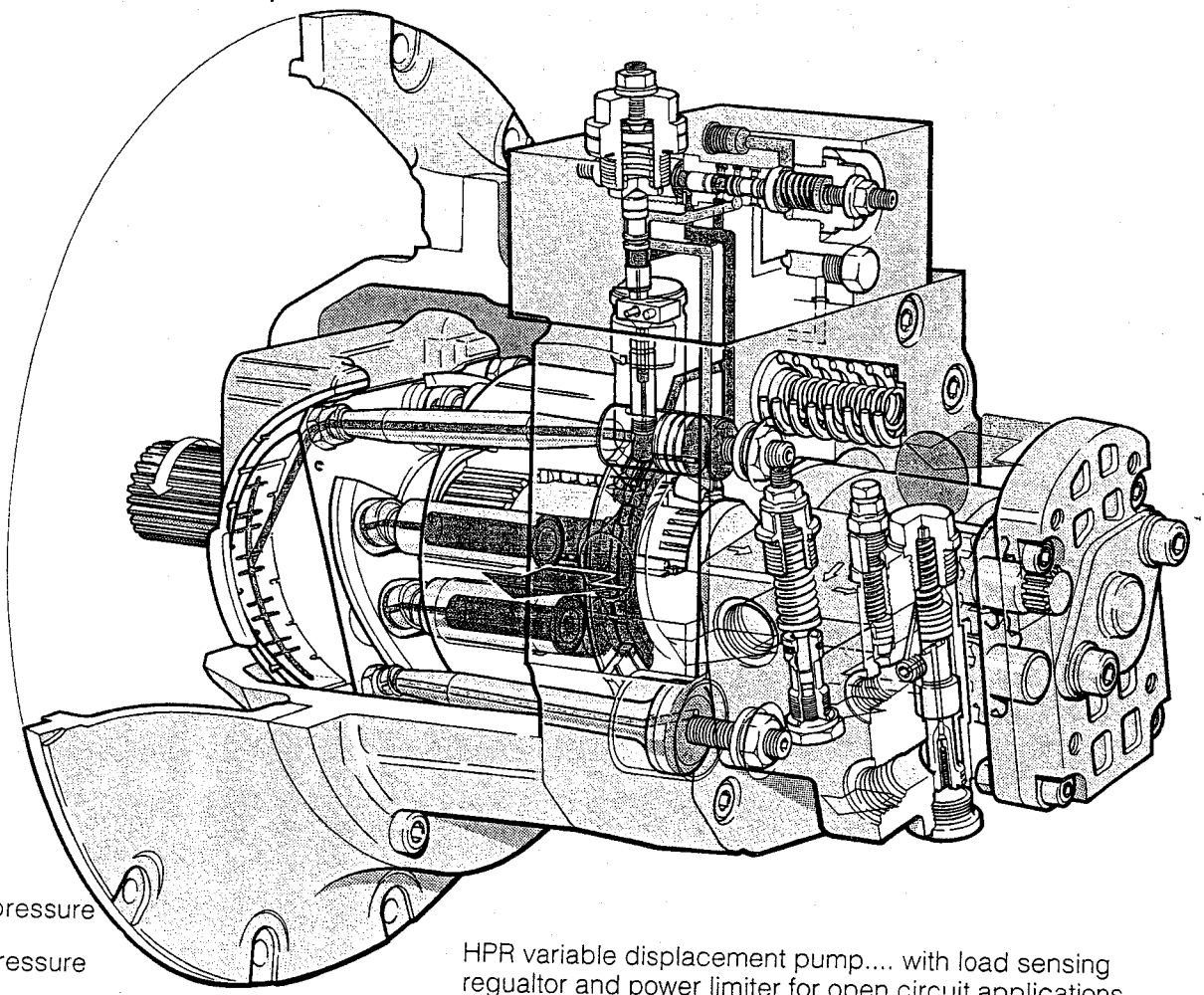
Linde HPR regulating systems comprise two main subassemblies.

The power section takes the form of our proven self-priming axial piston pump of swashplate design for variable displacement operation. Its functional components such as the pistons and the cylinder block, the swashplate, the valve plate and the bearings, have all been thoroughly tried and tested in a wide range of different applications in which controlled, transient overloading is a frequent occurrence.

The second subassembly takes the form of a number of regulators in a tailored configuration designed to meet the various demands placed on the system characteristics of a hydraulic drive. These effectively utilise the wide displacement range of the HPR regulating pumps with which they are combined.

The extensive array of control possibilities afforded by direct constructional pump/regulator combination can be further expanded by the user. The addition of system-dependent open-loop and feedback control lines for supervisory or complementary functions enhances the performance capabilities of the basic controller configuration employed, providing an ideal match to specific application requirements.

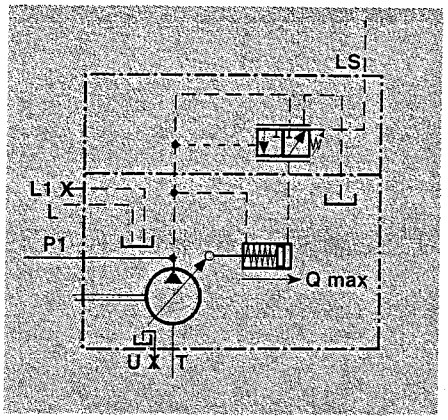
The HPR is more than just a pump for hydraulic drives. The HPR range includes a number of control systems from Linde for optimising energy consumption and maximising machine safety through overload protection. The ease of use designed into the HPR concept also means enhanced operator comfort and performance.



High pressure
Low pressure
Control pressure
Load sensing pressure

HPR variable displacement pump.... with load sensing regualtor and power limiter for open circuit applications

2. Regulator types and their functions



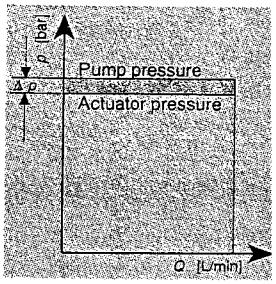
to 2.1 HPR variable displacement pump with load sensing regulator

The Linde HPR range of pumps can be equipped with various service-proven regulating devices to suit each individual application.

The functions of these regulators are described under 2.1 through 2.5

2.1 Load sensing regulator "L"

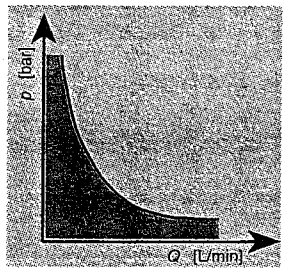
HPR pumps with load sensing control effectively regulate the volume flow with stroke reductions close to zero. If pump delivery consumption by the actuators in the system is at zero, the volume flow is reduced to the minimum required for maintaining the system-related control pressure. On operation of the actuator control valves, the load sensing regulator on the HPR unit automatically alters the stroke, and thus pump displacement, to the flow value demanded, adjusting output continuously up to maximum available pump capacity. The pump pressure is thus never any more than approx. 20 bar above the (maximum) pressure of the active actuator concerned.



The flow-on-demand capability of the load sensing regulator greatly improves energy efficiency in hydraulic drives equipped with the appropriate control valves. The advantages of a load sensing regulator can be combined with those of regulator type **T** (as described in 2.2 only) or **P**, depending on the pump model.

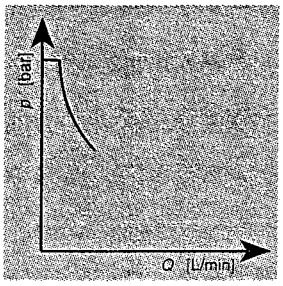
2.2 Power limiter "T"

The power limiter constitutes the ideal solution in applications in which the drive output available for the hydraulic system is limited, but in which power distribution optimisation must nevertheless be ensured. With this regulator, the mathematical product of volume flow *Q* (operating speed) and pressure *p* (force) is limited in accordance with a hyperbolic function. If the setpoint of the power limiter is exceeded, it reduces the volume flow, i.e. the stroke displacement of the HPR pump, until the *p* x *Q* error has been eliminated. The great advantage of the Linde **T** power limiter lies in the fact that it offers optimum power utilisation on the basis of a precise limiting curve.



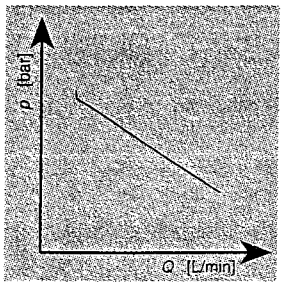
2.3 Pressure cut-off "P"

One of the major benefits of hydraulic drives lies in the ease with which they can be protected against overload. However, the use of pressure relief valves which respond in the overload range has to be regarded as inefficient owing to the uncontrolled power loss which they cause. The immediate response available with a pressure cut-off regulator on an HPR pump, on the other hand, eliminates the power losses caused by the drawn-out discharge of pressure relief valves. It immediately reduces the stroke displacement of the pump while at the same time maintaining operating pressure at a steady value.



2.4 Linear-action constant power regulator "T"

The function of this regulator corresponds to that of the power limiter described under 2.2. The difference lies in the fact that, once the actuator pressure reaches the setpoint of the constant power regulator on the HPR pump, pump displacement is reduced in accordance with a linear rather than a characteristic. Such a system cannot be combined with load sensing control.



2.5 Load limiting regulator "U"

If several hydraulic pumps are coupled to a prime mover, it is often advantageous to incorporate a load limiting (overload protection) regulator into the system. This detects decreases in engine or motor speed and reduces the pump control pressure accordingly, thus adjusting pump displacement so that the power unit continues to operate at full output (speed). This ensures that sufficient power remains available not only for the HPR drive system but also for other hydraulic circuits and actuators. The components required for load limiting control, aside from the swash actuator on the pump, are a tacho generator, a Linde CEB electronic overload protection regulator and an LS power valve.

3. Expanded regulating functions

(implemented by the user)

Multiple control functions

The need for high machine versatility, particularly in the case of construction equipment and industrial trucks, means that the hydraulic drives installed have to exhibit a range of characteristics. Excavators, cranes, loaders and drive transmissions, for example, all represent different requirements. Multi-purpose machines must be adaptable, and with HPR variable displacement regulating pumps this can be facilitated by certain easy-to-implement installation options. The range of open-circuit applications for HPR pumps can be substantially expanded - an advantage which can also be utilised in stationary drives.

3.1 HPR variable displacement pump with load sensing regulator and power limiter

3.1.1 *Additional functional capability:* Constant power control

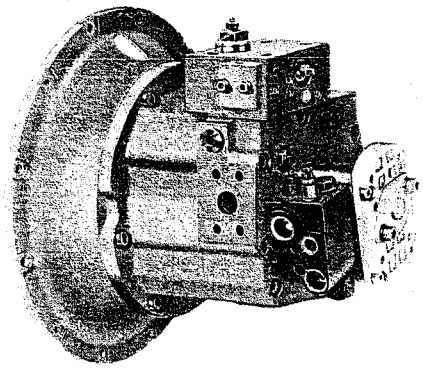
Installing an external interconnecting line between the high-pressure port P1 and the load sensing port LS disables the load sensing regulator and the pump operates under constant power control.

If, in addition, a 2/2 directional control valve is installed in this interconnecting line, the user can alternate between two functions depending on requirements:

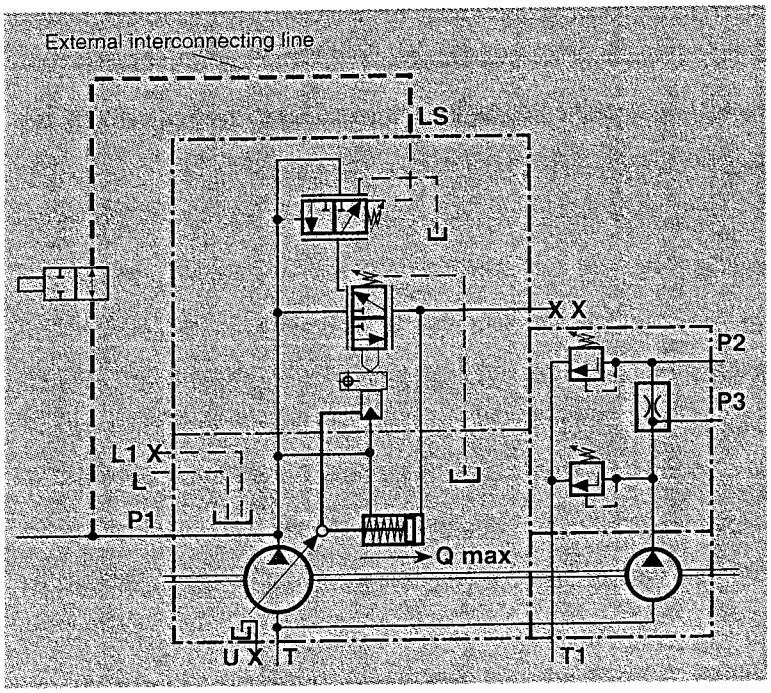
- Load sensing regulator with power limiter, subject to the actuator control valves being suitable for the load sensing mode

or

- Constant power control alone



HPR variable displacement pump equipped with load sensing regulator and power limiter.

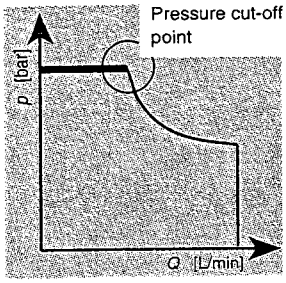


These control functions can be expanded or modified to enable implementation of the following:

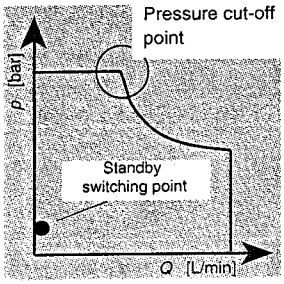
1. Constant power control
2. Constant power control with pressure cut-off
3. Constant power control with pressure cut-off and external standby switching

3. Expanded regulating functions

(continued)



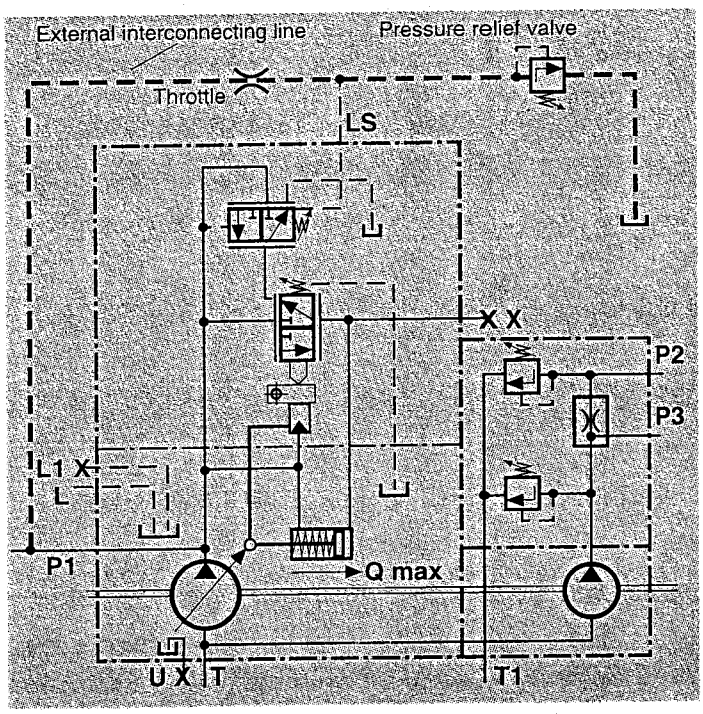
to 3.1.2
Characteristic of the expanded regulating system



to 3.1.3
Characteristic of the expanded regulating system

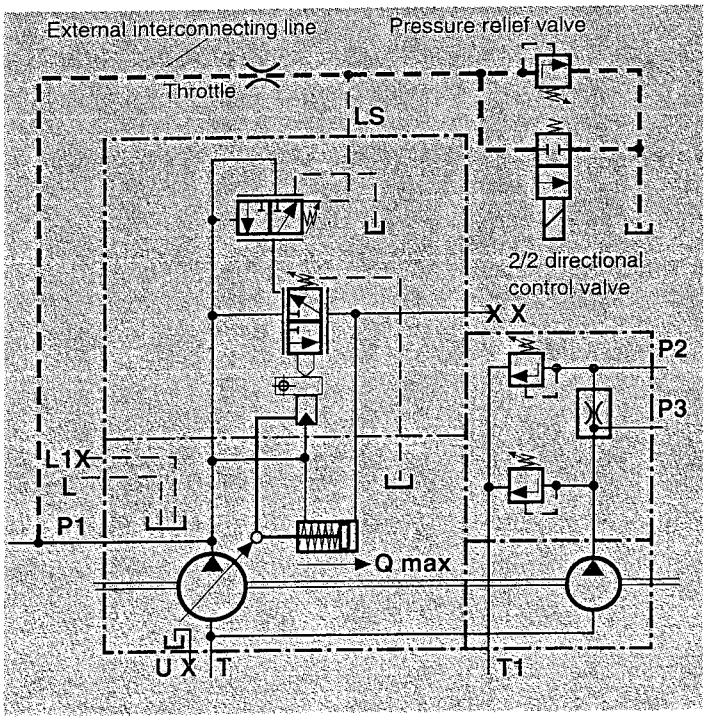
3.1.2 *Additional functional capability:* Constant power regulation with pressure cut-off

A pressure cut-off function can be incorporated by integrating a throttle element (orifice) in the external interconnecting line described under 3.1.1 and adding a pressure relief valve.



3.1.3 *Additional functional capability:* Standby switching combined with constant power regulation and pressure cut-off as per 3.1.2.

A 2/2 directional control valve connected in parallel with the pressure cut-off arrangement described under 3.1.2 enables the system featuring constant power regulation and pressure cut-off to be further expanded for standby switching with the P1 port closed.

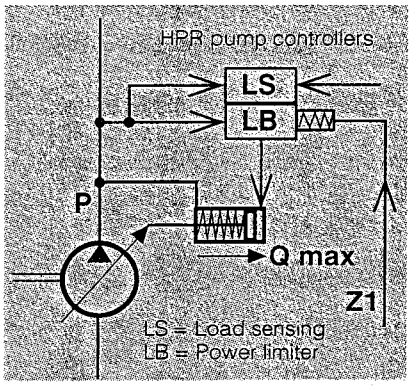


3. Expanded regulating functions

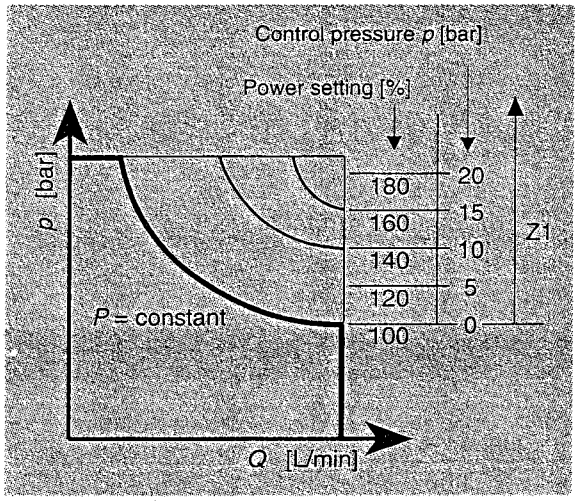
(continued)

3.2 HPR variable displacement pump with mode selection "M"

The various requirements placed on a system featuring constant power regulation can be met by incorporation of a mode selection feature. With a "single-stage" or "two-stage" power setting device, the basic power setpoint can be changed in response to one or two additional pressure signals. Such a system can be implemented both in conjunction with a power limiter (standard solution) and the modified system featuring a constant power regulator (see 3.1).

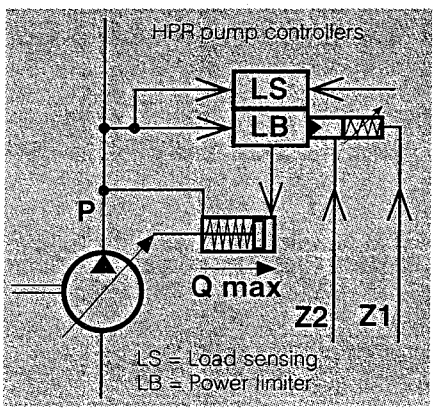


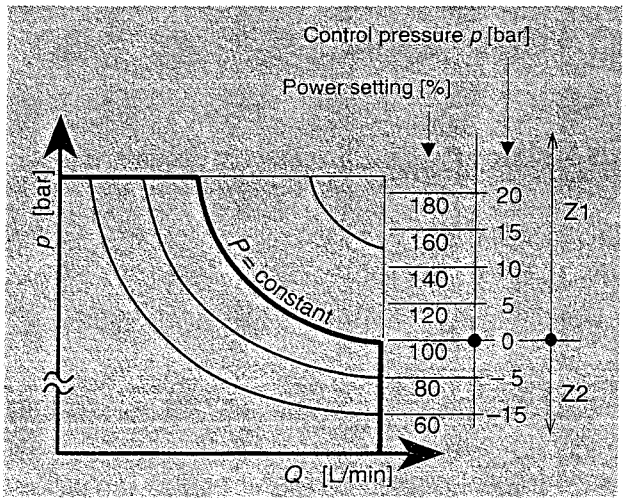
Single-stage setting adjuster



Two-stage setting adjuster

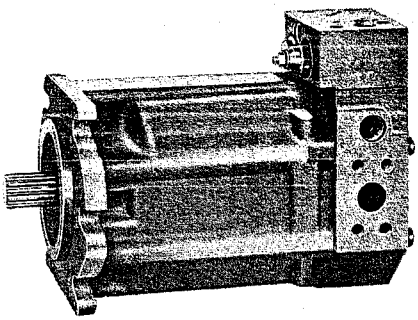
With this mode selection control in an HPR pump, a second pressure signal, Z2, opposes the spring force (= basic setting), thus adjusting the power setting to values below the initial 100% reference point.





3. Expanded regulating functions

(continued)



HPR variable displacement pump equipped with load sensing regulator and pressure cut-off.

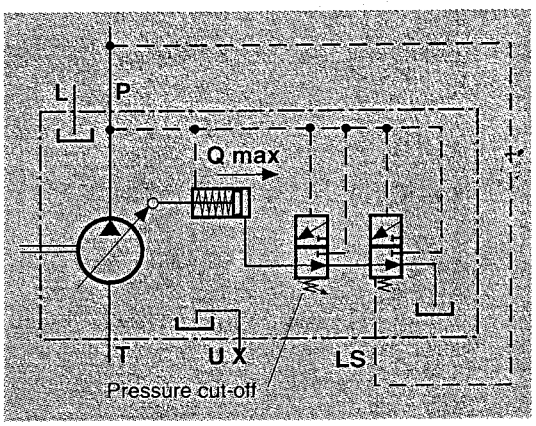
These control functions can be modified to enable implementation of the following:

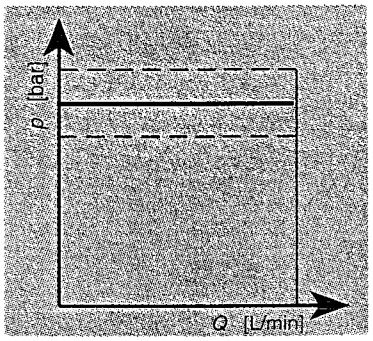
1. Constant pressure regulation
2. Constant flow regulation with pressure cut-off override under conditions of constant or variable drive speed

3.3 HPR variable displacement pump with load sensing regulator and pressure cut-off for other regulating modes

3.3.1 *Additional functional capability:* Constant pressure regulation

Incorporation of an interconnecting line between the high-pressure port P1 and the load sensing port LS disables the load sensing regulator and the pump operates under constant pressure control. The pressure cut-off in this case acts as the actual constant pressure regulator, the setting of which can be adjusted as required.

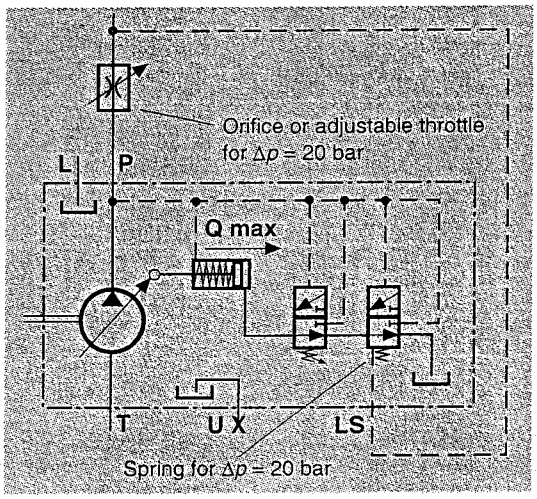


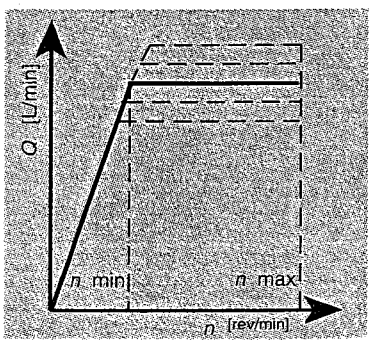


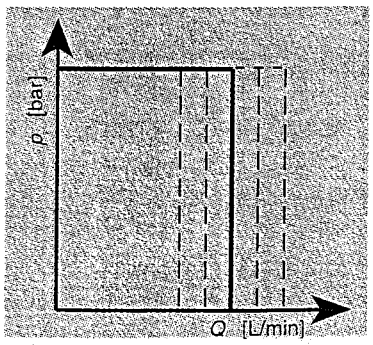
The pressure cut-off setting determines the constant pressure value

3.3.2 *Additional functional capability:* Constant flow regulation with pressure cut-off override under conditions of constant or variable pump drive speed:

Installation of an orifice or adjustable throttle between the high-pressure port P1 and the interconnecting line leading to the load sensing regulator enables the pump to deliver a predetermined, constant flow even under conditions of variable drive speed. The pressure cut-off maintains its subordinate role as the override control. The delivery flow rate is determined by the orifice diameter or throttle valve setting and the pressure differential spring Δp (usually set at 20 bar) at the load sensing regulator.







to 3.3.2
Regulating characteristics

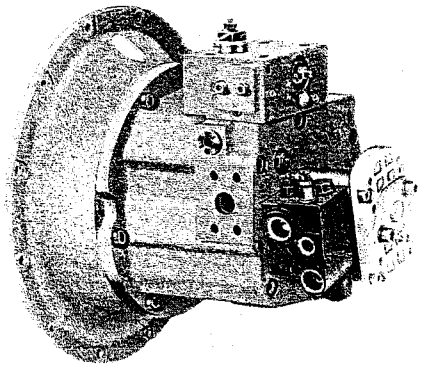
4. Range of pump models and type destignation key

4.1 Range of HPR variable displacement pump models

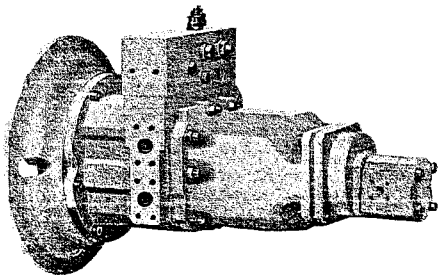
Design variants	Page	Type 100	130	160	100D	130D	160D
Volumetric displacement [cm³]		100	130	160	2x 100	2x 130	2x 160
Variable displacement pump with flywheel case mating flange							
Flange size SAE 4	12	■					
Flange size SAE 3	12/13	■	■	■	■	■	■
Flange size SAE 2	13					■	
Load sensing regulator (LS) **L**	3	■	■	■	■	■	■
Power limiter (LB) **T**	3						
Equipped for load limiting control **U**	3				■	■	
Mode selection option **M**	6	■	■	■			
Direction of rotation: CW*)		■	■	■	■	■	■
Auxiliary pump 19 cm³					■		
Auxiliary pump 22 cm³		■			■	■	
Auxiliary pump 31.2 cm³			■	■			
Auxiliary pump, internally primed		■	■	■			
Auxiliary pump, externally primed					■	■	■
Through-shaft for PTO at auxiliary pump		■	■	■			
Variable displacement pump with 4/2 hole mating flange							
Flange size SAE C	15	■					
Flange size SAE D	15		■	■			
Load sensing regulator (LS) **L**	12	■	■	■			
Pressure cut-off (DA) **P**	3						
Const. power regulator (linear) **T**	3	■					
Equipped for load limiting regulation **U**	3		■	■			
Dir. of rotation: CW (**R**) or CCW(**L**)		R	R / L	L			
Auxiliary pump 16 cm³		■					
Auxiliary pump 22 cm³			■				
Auxiliary pump 31.2 cm³			■	■			
Auxiliary pump, externally primed		■	■	■			
Through-shaft for PTO at main pump		■	■	■			

*) CCW on application

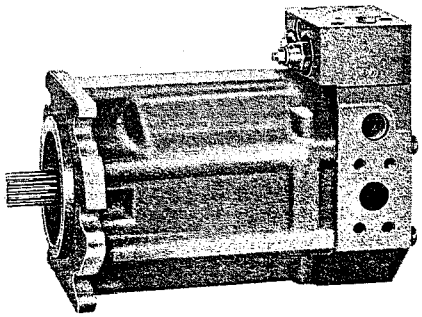
The identification letters in brackets correspond to the previous type designations. When referring to the various models, please use the modified identification letters shown in emboldened print.



HPR regulating pump with flywheel case mating flange and gear pump



Regulating pump type HPR XXX**D** equipped with flywheel case mating flange and gear pump



HPR regulating pump with SAE 4/2 hole mating flange

4.2 Type designation key

HPR | | | | | | |

Variable displacement regulating pump (H series)

Type **100**, **130**, **160**, **100D**, **130D**, **160D**

Direction of drive rotation (as viewed facing the drive shaft end)
- Clockwise = **R**
- Counterclockwise = **L**

Control system
- Load sensing = **L** (LS)
- Power limiter (input) = **T** (LB)
- Load limiting regulator = **U**
- Pressure cut-off (pressure regulator) = **P** (DA)
- Mode selection = **M**

Pressure setting [bar] (e.g. of the pressure cut-off)

Add-on components (where required)
- with PTO, without auxiliary pump = **P**
- with PTO, with auxiliary pump, externally primed = **E**
- with PTO, with auxiliary pump, internally primed = **I**

The identification letters in brackets correspond to the previous type designations. When referring to the various models, please use the modified identification letters shown in emboldened print.

4.2.1 Ordering examples

Regulating pump type **HPR 130 R LT M I** conforms to the following specifications:

Pump model **HPR 130**
suitable for clockwise rotation = **R**
with load sensing regulator and power limiter = **LT**
with mode selection = **M**
with built-on internally primed auxiliary pump = **I**

Regulating pump type **HPR 100 R LP 350 E** conforms to the following specifications:

Pump model **HPR 100**
suitable for clockwise rotation = **R**
with load sensing regulator and pressure cut-off = **LP**
pressure cut-off set to 350 bar = **350**
with built-on externally primed auxiliary pump = **E**

5. Technical data

5.1 Main pump

5.1.1 Pressure

Maximum pressure [1]	500 bar
Rated pressure (= maximum operating pressure)	420 bar
Continuous pressure rating [2]	250 bar
Permissible internal casing pressure	1.5 bar

[1] Transient increase above the nominal pressure (= maximum rated operating pressure) at which the pump remains operable.
[2] Pressure at which all pump components operate below the fatigue limit.

Type		100	130	160	100D	130D	160D
5.1.2	max. displacement [cm^3]	100	130	160	2x100[3]	2x130[3]	2x160[3]
5.1.3	max. speeds [rev/min]						
	without pressurisation	2300	2300	2000	2300	2300	2000
	with pressurisat. 0.6...0.8 bar	2500	2500	2200	2500	2500	2200

[3] Both delivery flows from the constructionally separated high pressure ports of this pump type must be connected to a single discharge line for fluid power supply to a hydraulic system.

6. Drive

6.1 Couplings

Drive transmission must be performed by means of suitable coupling elements (please consult us if you have any specific requirements).

We recommend couplings exhibiting high torsional stiffness combined with effective vibration damping, engineered for subcritical performance and resistant to oil and high temperatures.

As the pumps exhibit a relatively small flywheel mass, a rigid-shaft rotor arrangement ensures that critical speeds are assigned to values above the motor speed range. The drive thus remains within the subcritical operating range and dangerous torsional vibration is effectively avoided.

6.2 Maximum permissible angular acceleration

on application

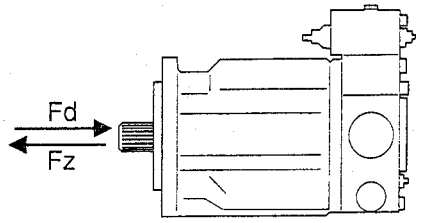
6.3 Rotary group mass moment of inertia

(without gear pump)

Type	100	130	160	100D	130D	160D
Rotary group mass moment of inertia without gear pump [kgm^2]	0.022	0.044	0.044	0.045	0.088	0.088

6.4 Max. permissible thrust acting on the drive shaft

Type		100	130	160	100D	130D	160D
Force vector Fz	[N]	5500	6500	6500	5500	6500	6500
Force vector Fd	[N]	3500	4300	4300	3500	4300	4300



7. General specifications

7.1 Weight

see Unit Dimensions (Section 8)

7.2 Hydraulic fluid

Mineral oil HL or HLP to DIN 51524, other fluids on application

7.2.1 Hydraulic fluid temperature range	–20° ... + 90° C
7.2.2 Operating viscosity range	10 ... 80 mm^2/s
7.2.3 Optimum operating viscosity range	15 ... 20 mm^2/s
7.2.4 Maximum viscosity (transient start-up conditions)	1000 mm^2/s

Recommendations:

approx. operating temperature range	Viscosity class (mm^2/s = cSt) HL or HLP
30° ... 40° C	22 mm^2/s at 40° C
60° ... 70° C	68 mm^2/s at 40° C
80° ... 90° C	100 mm^2/s at 40° C

Aside from the minimum requirements specified in DIN 51524, any branc hydraulic fluid used must also meet all the requirements inherent in a high pressure hydraulic system. This applies in particular to so-called HLPD (detergent) oils.

Linde recommends that only those hydraulic fluids be used, the suitability of which for high pressure hydraulic systems can be guaranteed by the manufacturer.

In order to select the correct hydraulic fluid, the operating temperature in the circuit (closed loop) must be known.

The hydraulic fluid should be selected such that, in the operating temperature range, the operating viscosity lies in the optimum range (see 7.2.3).

Note ! As a result of the influence of pressure and rotational speed, the leakage oil temperature is always above the circuit temperature. At no point in the system should the temperature be higher than 90 °C.

If the conditions indicated cannot be complied with in specific applications, please consult us.

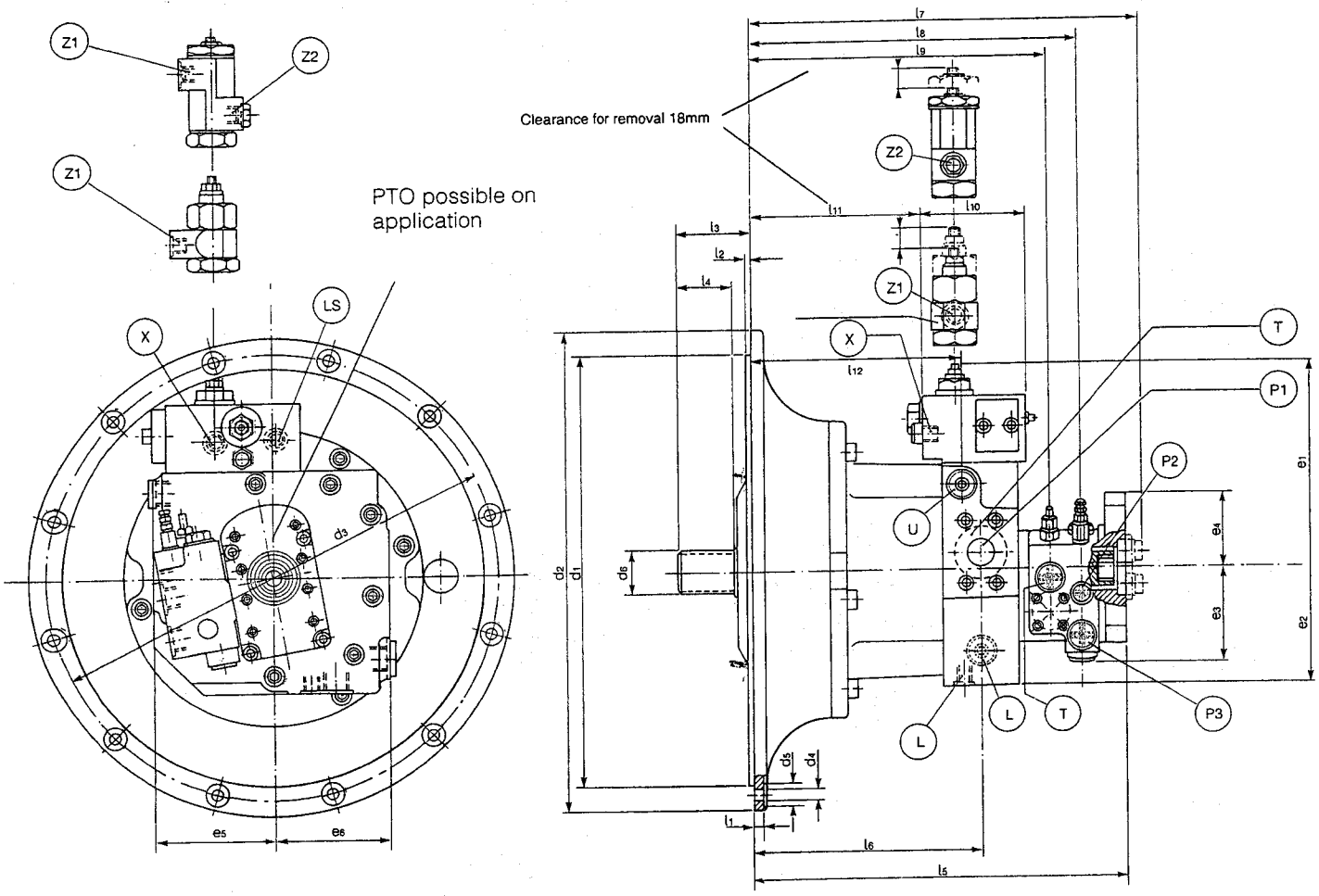
7.3 Filtration

Filtration of the hydraulic circuit is necessary.

Recommended filtration: 10 microns (filters with 25 ... 40 microns may also be used).

Linde uses and recommends 10 micron filters. These correspond to the current state of the art and can be obtained from the usual commercial sources at no additional expense. Moreover, the finer degree of filtration substantially increases the useful service life of the hydraulic equipment (less wear).

8.1 Unit dimensions of HPR regulating pumps with flywheel case mating flange Types 100, 130 and 160 with load sensing regulator and power limiter



LS = Load sensing port = M 14 x 1.5; 13 mm deep

X = Control pressure gauging port = M 14 x 1.5; 13 mm deep

L; U = Connections for leakage oil, venting, oil inlet and oil drainage = M 22 x 1.5; 15 mm deep
The functions of ports L and U depend on the position of installation. If port "U" is the highest venting outlet (installation position: "Regulator at the top"), an additional line has to be installed from port "L" to the hydraulic oil tank.

Z1; Z2 = Control pressure ports for mode selection = 9/16 - 18 UNF; 13 mm deep

Dimensions (in mm)

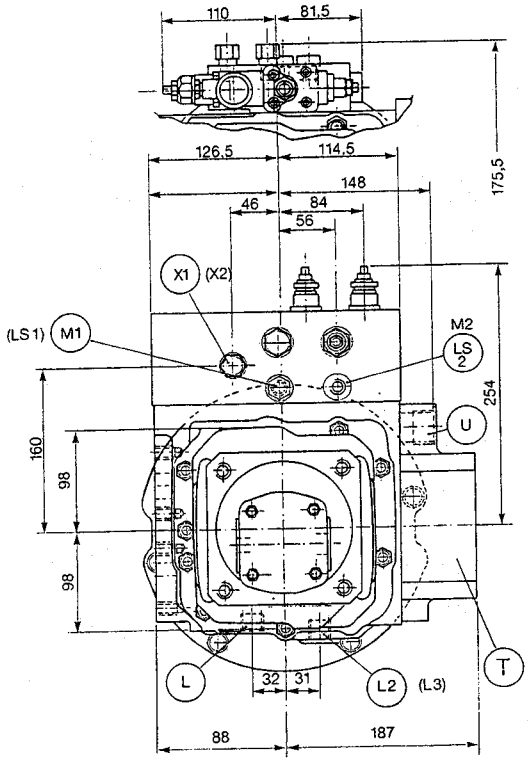
Type	Flywheel case mating flange SAE	d_1 f7	d_2	d_3	d_4	d_5	l_1	l_2	Drive shaft DIN 5482 d_6	l_3	l_4	Main connections Main pump P1	Main pump T	Auxiliary pump P2	Auxiliary pump P3 u. T
100	4	361.95	404	381	11	22	9.5	5	W 40 x 2 x 18 x 9_g	72.5	55	SAE 1"	SAE 2"	M14 x 1.5 13 deep	M22 x 1.5 15 deep
	3	409.6	456	428.6	11	22	12	6	W 40 x 2 x 18 x 9_g	56.5	55	SAE 1"	SAE 2"	M14 x 1.5 13 deep	M22 x 1.5 15 deep
130 160	3	409.6	456	428.6	11	22	12	6	W 45 x 2 x 21 x 9_g	72.5	55	SAE 1 1/4"	SAE 2 1/2"	M14 x 1.5 13 deep	M22 x 1.5 15 deep

Type	SAE	l_5	l_6	l_7	l_8	l_9	l_{10}	l_{11}	l_{12}	e_1	e_2	e_3	e_4	e_5	e_6	Weight
100	4	351	218.5	367.5	312	282	98	164.5	195.5	205	110	90	69	109	111	82
	3	367	234.5	383.5	328	298	98	211.5	211.5	205	110	90	69	109	111	83
130	3	419	272	436	372	342	98	215	272	213	113	90	69	111	123	98

t indicated here, please consult the installation drawings. In the interests of technical progress, all data subject to change without notice.

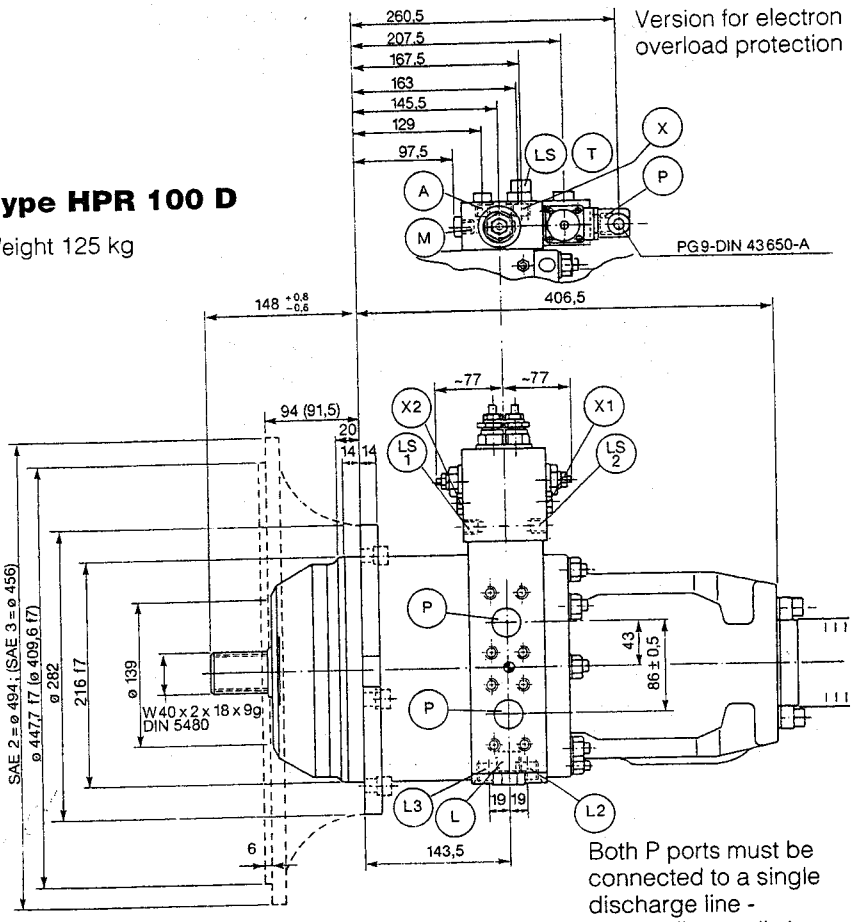
8.2 Unit dimensions of HPR regulating pumps with flywheel case mating flange Types 100D, 130D, 160D, with load sensing regulator and power limiter

Dimensions (in mm)



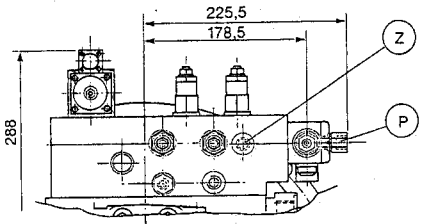
Type HPR 100 D

Weight 125 kg



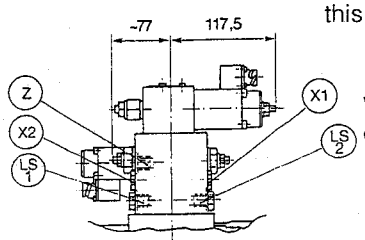
Version for electron overload protection

Both P ports must be connected to a single discharge line - this applies to all sizes

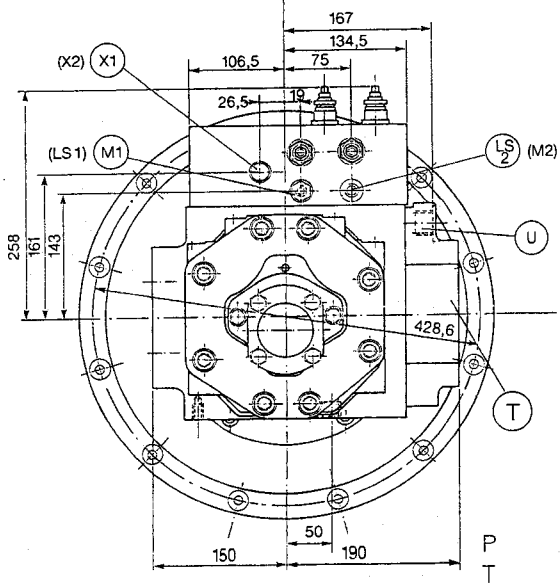


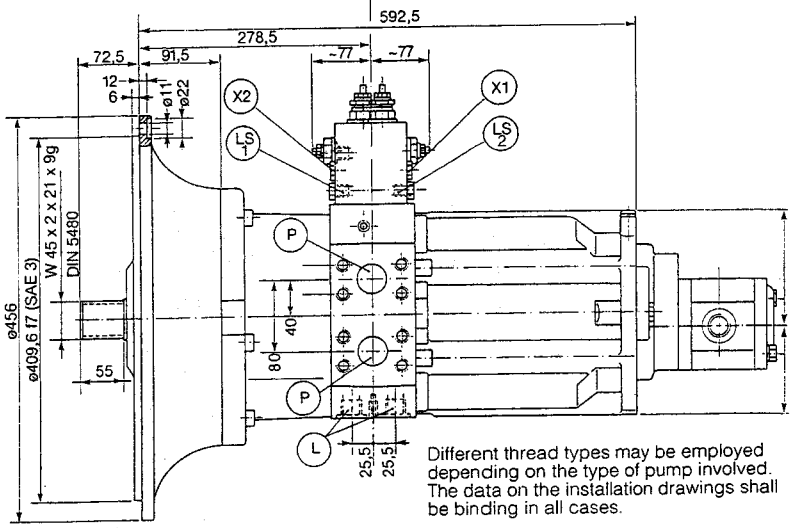
Types
HPR 130 D
HPR 160 D

Weight 171 kg



Version for electronic overload protection





Different thread types may be employed depending on the type of pump involved. The data on the installation drawings shall be binding in all cases.

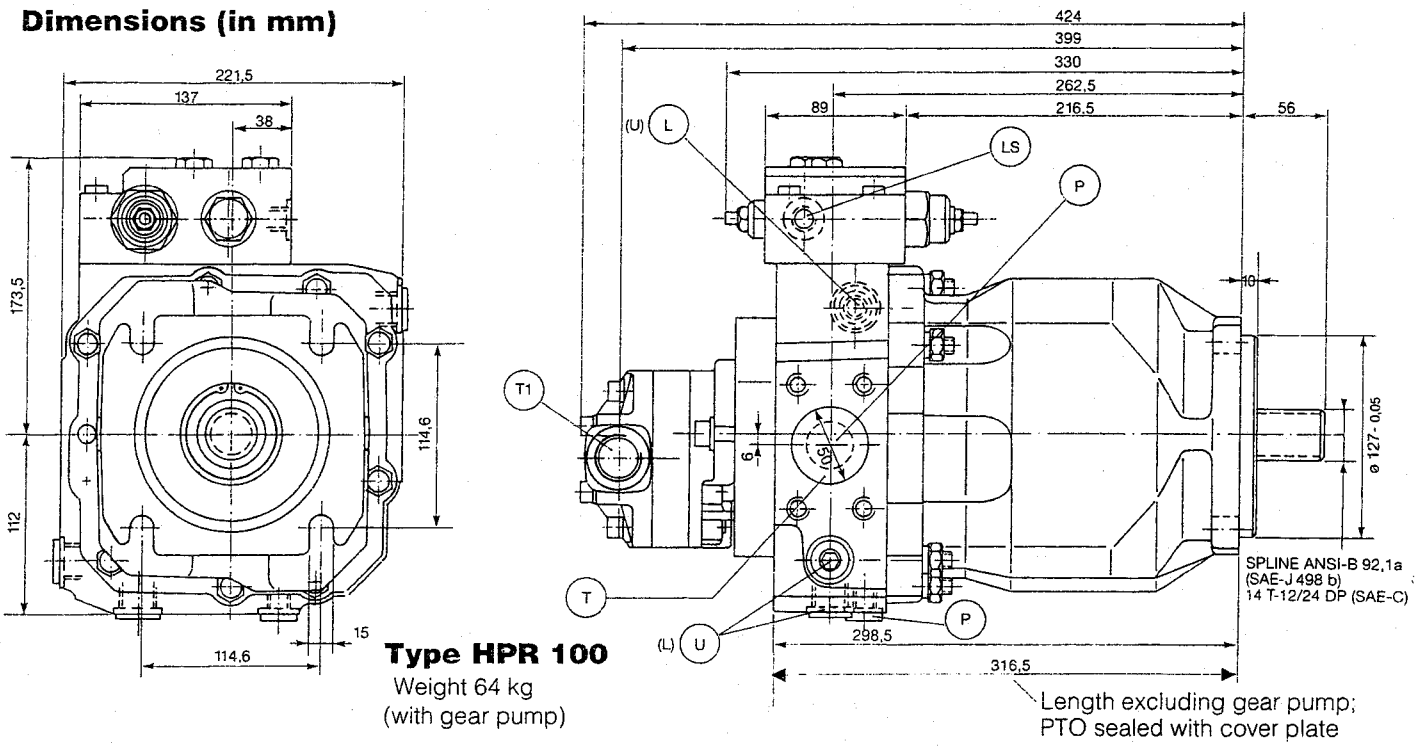
* For port functions, see notes on pages 12 and 14

P	=	High pressure port, HPR 100 D = SAE 1"; HPR 130/160 D = SAE 1 1/4
T	=	Tank port, 100 D = SAE 3"; HPR 130/160 D = SAE 4"
LS, LS1, LS2	=	Load sensing ports 9/16 - 18 - UNF - 2B, 13 mm deep
M; M1; M2	=	Load sensing gauge ports 9/16 - 18 - UNF - 2B, 13 mm deep
X ; X1; X2	=	Control pressure gauging ports 9/16 - 18 - UNF - 2B, 13 mm deep
L; L1; L2; L3	=	*Leakage oil and venting ports 7/8 - 14 - UNF - 2B, 14 mm deep
U	=	*Venting connection 1 1/16 - 12 - UN - 2B, 19 mm deep

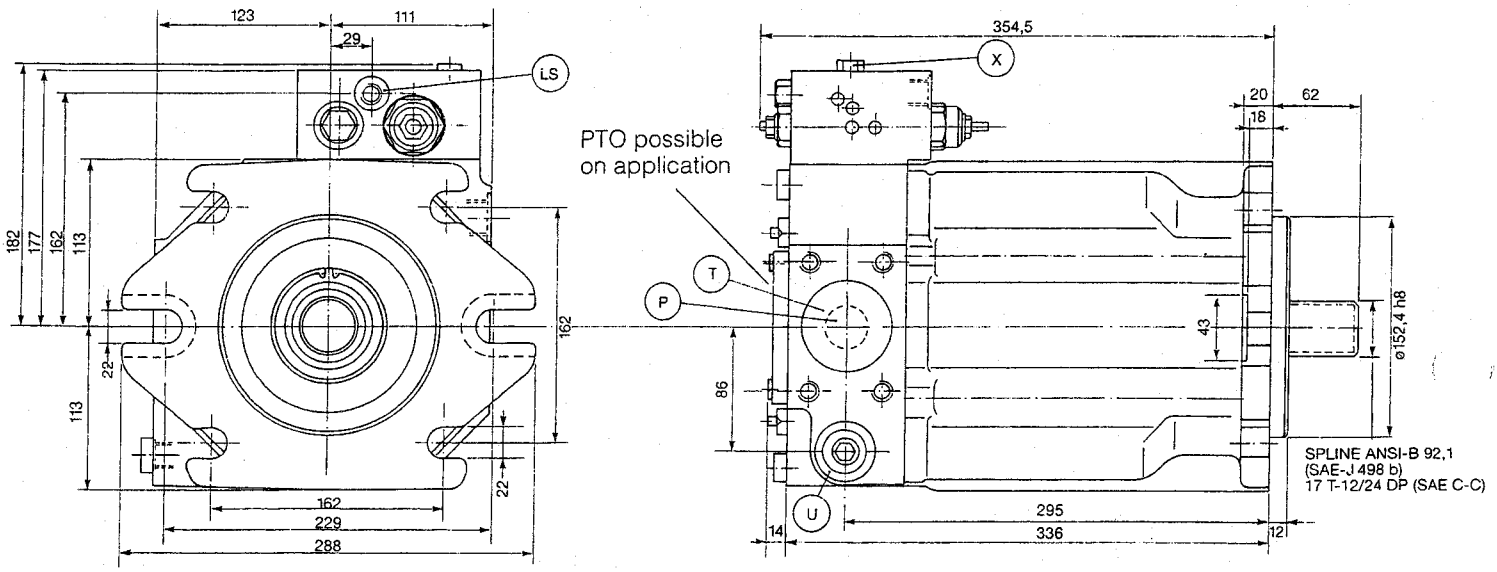
I for dimensions not indi-
ne installation drawings.
progress, all data subject

8.3 Unit dimensions of HPR regulating pumps with 4/2 hole mating flange Types 100, 130, 160 with load sensing regulator and pressure cut-off

Dimensions (in mm)



Type HPR 100
Weight 64 kg
(with gear pump)



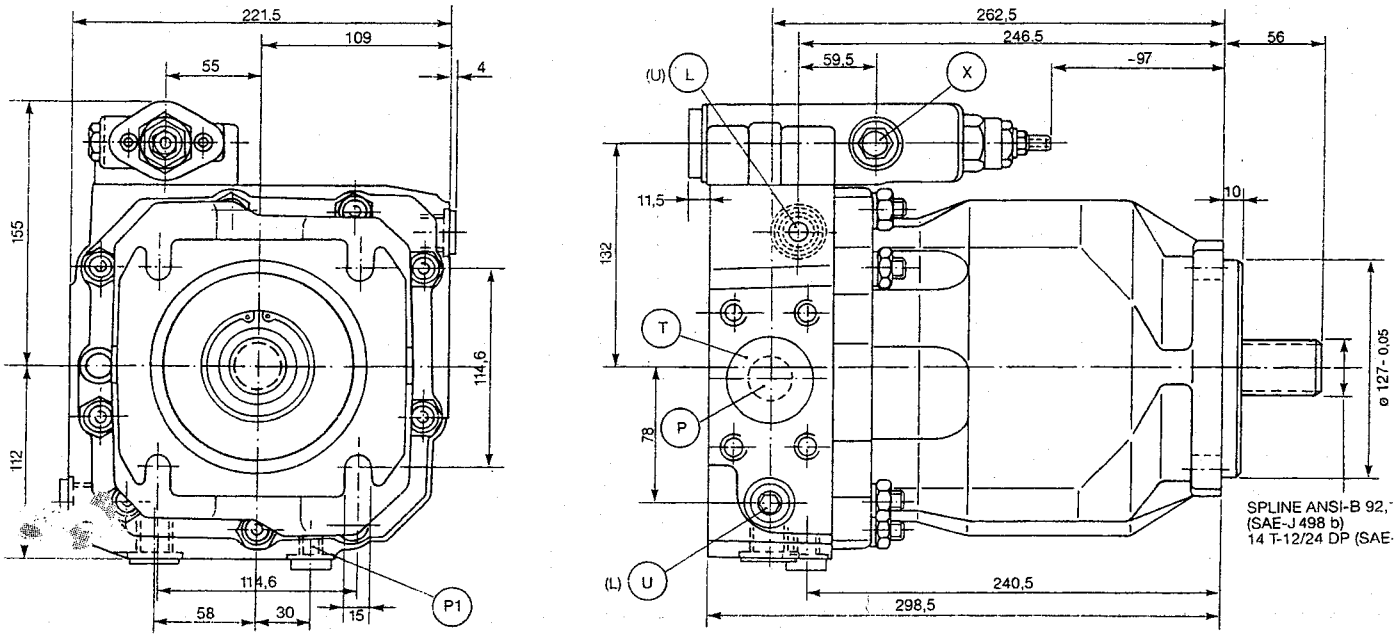
Types HPR 130 and HPR 160 Weight 73 kg (without gear pump)

P	=	High pressure port, HPR 100 = SAE 1" (6000 psi); HPR 130/160 = SAE 1 1/4" (6000 psi)
T	=	Tank port, HPR 100 = SAE 2" (standard); HPR 130/160 = SAE 2 1/2" (standard)
LS	=	Load sensing port 9/16 - 18 - UNF- 2B, 13 mm deep
X	=	Control pressure gauging port 9/16 - 18 - UNF - 2B, 13 mm deep
T1	=	Intake port, auxiliary pump, 1 1/16 - 12 - UN - 2B, 19 mm deep
L; U	=	Connections for leakage oil, venting, oil inlet, oil drainage = 7/8 - UNF for HPR 100; 1 1/16 - UNF for HPR 130/160

The functions of ports L and U depend on the position of installation. If port "U" is the highest venting outlet (installation position: "Regulator at the top"), an additional line has to be installed from port "L" to the hydraulic oil tank.

8.3 Unit dimensions of HPR regulating pumps with 4 hole mating flange Type 100 with constant power regulator (linear)

Dimensions (in mm)



Type HPR 100 Weight 58 kg

P = High pressure port SAE 1"
T = Tank port SAE 2"
X = Control pressure gauging port 9/16 - 18 - UNF - 2B
P1 = High pressure gauging port 9/16 - 18 - UNF - 2B
L; U = Connections for leakage oil, venting, oil inlet, oil drainage = 7/8 - 14 - UNF - 2B
The functions of ports L and U depend on the position of installation. If port "U" is the highest venting outlet (installation position: "Regulator at the top"), an additional line has to be installed from port "L" to the hydraulic oil tank.

for dimensions not indicated here, please consult the installation drawings. - In the interests of technical progress, all data subject to change without notice.