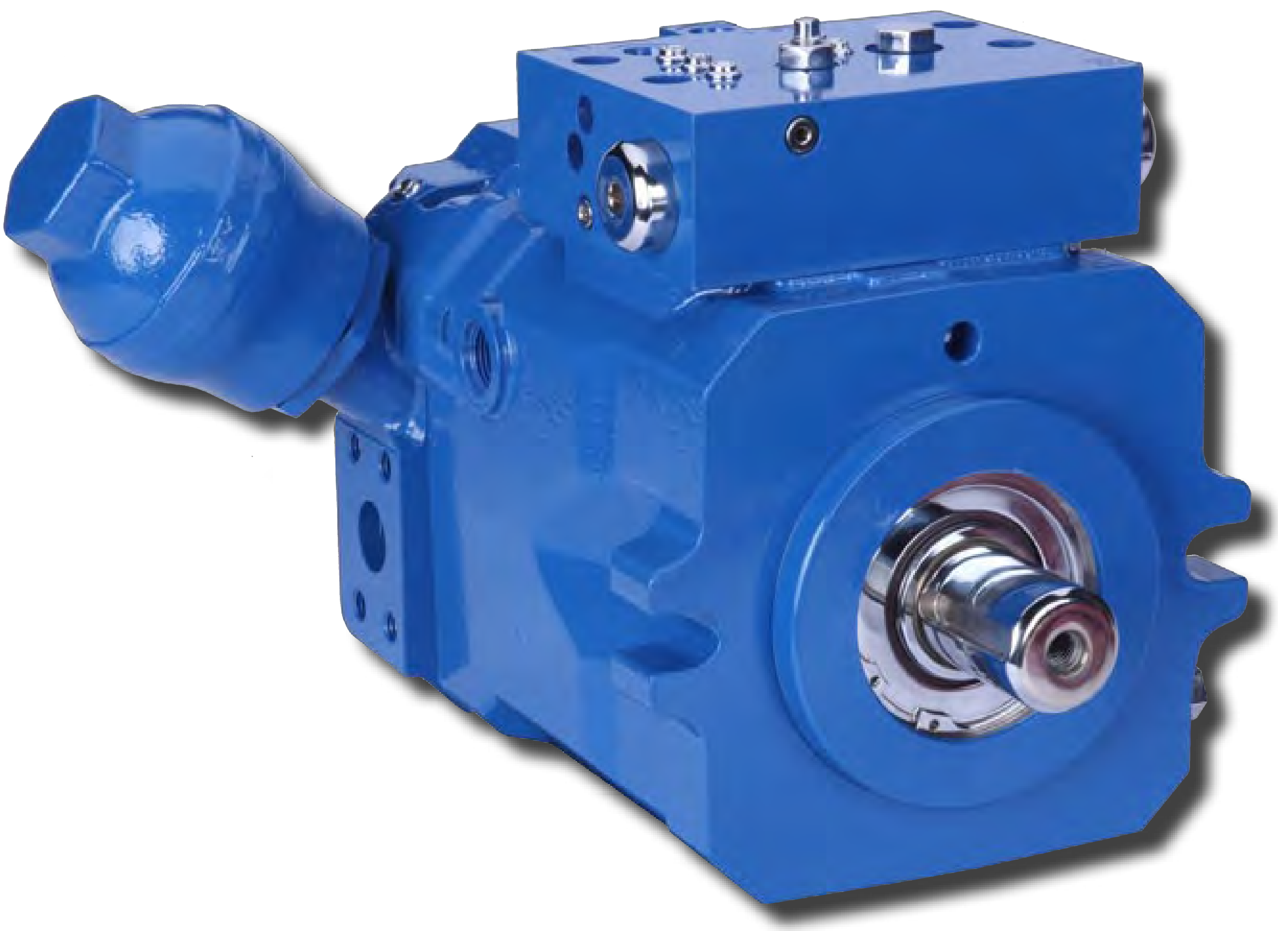
Danfoss DuraForce HPR Series Open-Circuit Piston Pumps Service Manual



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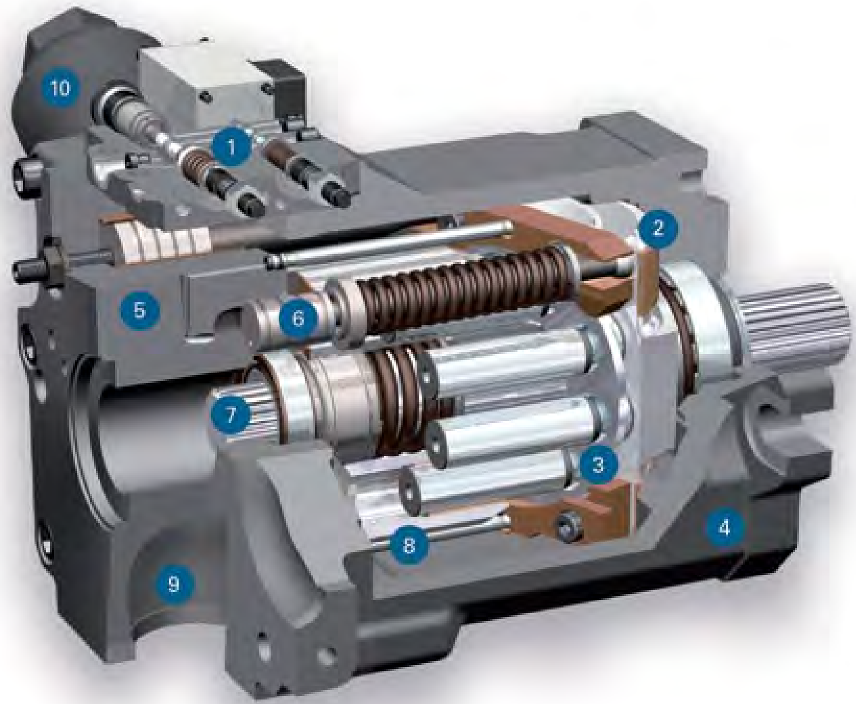


1. **LS-Regulator**
   Optimum utilisation of power
2. **Swash Plate**
   Hydrostatic bearing
3. **Piston-Slipper Assembly**
   21° swash angle
4. **Housing**
   Monoshell for high rigidity
5. **Valve Plate Housing**
   Highly integrated
6. **Actuator Piston**
   Long-lived and precise
7. **Through Shaft**
   For additional pumps
8. **Cylinder Barrel**
   Compact due to 21° technology
9. **Suction Port**
   Good suction capacity also without tank pressurization
10. **SPU**
    Reduction of pressure pulsation over the entire range of operation, maintenance-free

Design Characteristics

- High pressure axial piston pump in swash plate design for open loop systems
- Clockwise or counter clockwise rotation
- Self-priming at high nominal speed
- Higher rotating speed by tank pressurization or swash angle reduction
- Adaptive noise optimization SPU
- Decompression fluid is drained via pump housing for suction side stability
- Exact and rugged load sensing controls
- SAE high pressure ports
- SAE mounting flange with ANSI or SAE spline shaft
- Through shaft SAE A, B, B-B, C, D and E
- Optional tandem and multiple pumps

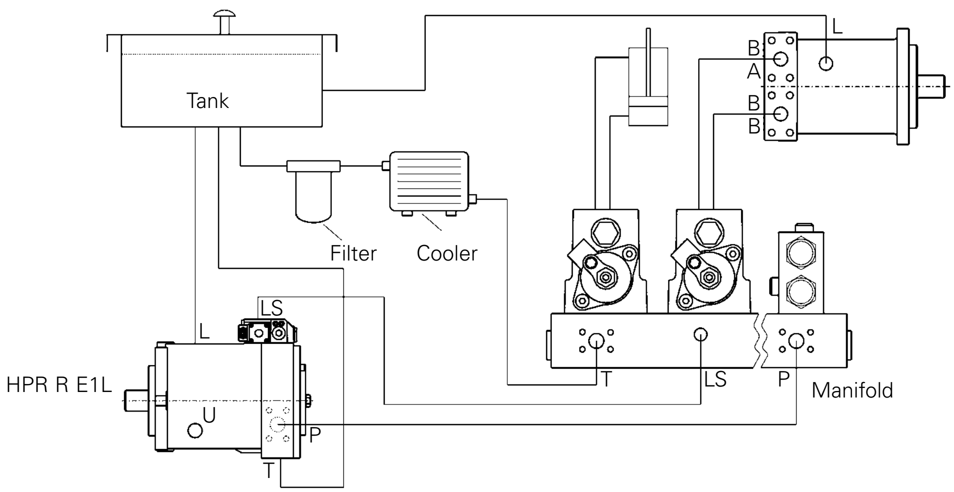
Product Advantages

- Energy saving operation by “flow on demand” control
- Dynamic response
- Excellent suction up to rated speed
- Noise optimization over the entire range of operation
- Optimum interaction with Eaton LSC-Directional Control Valves and LinTronic
- Compact design
- High power density
- High pressure rating
- High reliability
- Long working life

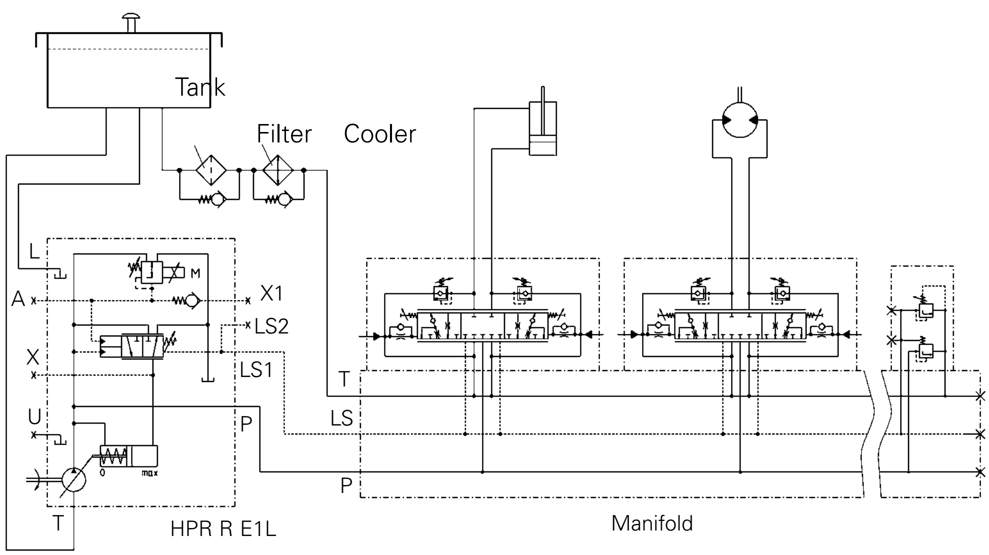
Open Loop

Representation of hydraulic components in an open loop circuit: HPR regulating pump with load sensing function for energy saving, flow on demand control and VW load sensing directional control valves for load-independent, synchronous movements of actuators without unintentional interaction. The system is complemented with proven Eaton products such as electronic controls, swing drives and hydraulic motors.

Function Diagram



Circuit Diagram



Specifications and Performance

The table shows the complete capacity range of the pumps, while the diagram below shows the recommended practical range for the different nominal sizes of the HPR pump with control limit between 200 bar Δp minimum and 280 bar Δp maximum. It enables initial selection of the required nominal pump size.

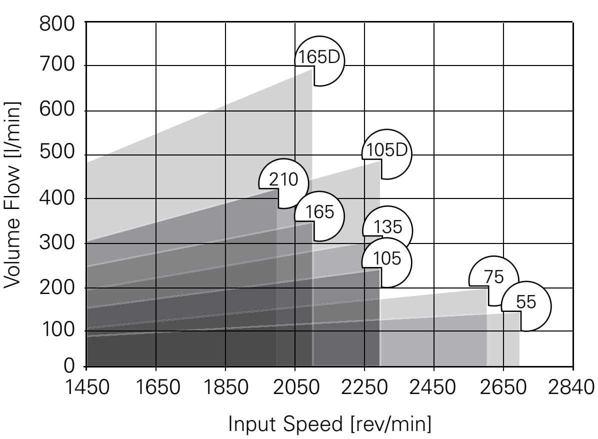
Specifications

Model		**55**	**75**	**105**	**135**	**165**	**210**	**105D**	**165D**
Rated Size									
Maximum Displacement	cm^3/rev	54.8	75.9	10.5	135.6	165.6	210	2x105	2x165.6
Speed*	min^{-1}	2700	2600	2300	2300	2100	2000	2300	2100
Volume Flow									
Max. oil flow	1/min	147.9	197.3	241.5	311.9	347.8	420	483	695.6
Pressure									
Nominal Pressure	bar	420	420	420	420	420	420	420	420
Peak Pressure	bar	500	500	500	500	500	500	500	500
Permissible Housing Pressure (absolute)	bar	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Input Torque									
Max. Input torque at max. operating pressure and Vmax	Nm	366	508	702	907	1106	1404	1090	2215
Response Times**									
Vmax -> Vmin swashing at	HP 100 bar ms	120	120	120	140	150	200	200	150
constant max. system pressure HP	HP 200 bar ms	70	70	70	70	130	170	170	130
Vmin -> Vmax swashing from stand-by	HP 100 bar ms	180	180	180	180	180	160	160	180
pressure and zero outlet flow to constant max. system pressure HP	HP 200 bar ms	160	180	160	160	160	130	130	160
Permissible Shaft Loads									
Axial	N	2000	2000	2000	2000	2000	2000	2000	2000
Radial	N	on request	on request	on request	on request	on request	on request	on request	on request
Perm. Housing Temperature									
Perm. Housing Temp. with min. perm. viscosity > 10 cST	°C	90	90	90	90	90	90	90	90
Weights									
HPR without oil (approximate)	kg	39	39	50	65	89	116	107	197
Maximum moment of inertia	kgm^2x 10^{-2}	0.79	0.79	1.44	2.15	3.41	4.68	2.88	6.88

* Max. operating speed (rated speed) without tank pressurization Operating speed with tank pressurization see chapter operational parameters.

** Measured at fluid viscosity 20 cST and input speed 1500 rpm.

Performance Data



Model Code

HPR – Self-regulating Pump for Open Loop Operation

HPR	105	R	0	S1	M	A	AC	AC	000	0	0	0	0	AA	00	0	0	000	A	00	A	A	A
1 2 3	4 5 6	7	8	9 10	11	12	13 14	15 16	17 18 19	20	21	22	23	24 25	26 27	28	29	30 31 32	33	34 35	36	37	38

	55	75	105	135	165	210	280
1 2 3 Product							
HPR – Open Loop Variable Displacement Pump	●	●	●	●	●	●	●
4 5 6 Displacement							
055 – 55 cc/r	●						
075 – 75 cc/r		●					
105 – 105 cc/r			●				
135 – 135 cc/r				●			
165 – 165 cc/r					●		
210 – 210 cc/r						●	
280 – 280 cc/r							●
7 Rotation							
R – CW	●	●	●	●	●	●	●
L – CCW	•	•	•	•	•	•	
8 Mounting Flange							
0 – SAE J744 standard (size 105: LP;H1L;E1L only)	●	●	●	●		●	●
1 – SAE J744 standard / additional threads (sizes 105; 135; (*u))			●	●			
2 – SAE J744 standard / additional holes					●		
3 – ISO 30119-2 metric (TL2;ETP;LEP only)(*m)			●				●
4 – plug-in (LP;H1L;E1L only)/ (size 105; (*d))			•	•			
5 – Bell housing SAE 3 (LP;H1l;E1l only)/(sizes 105; (*d))			•	•			
6 – Bell housing SAE 4 (LP;H1l;E1l only)/(sizes 105; (*d))			•	•			
9 10 Input Driveshaft							
S1 – splined ANSI B92.1 12/24 - 14t (SAE C)/(size 105:(*w))	●	●	●				
S2 – splined ANSI B92.1 12/24 - 17t (SAE C-C)			●	●			
S3 – splined ANSI B92.1 8/16 - 13t (SAE D&E)				●	●		
S4 – splined ANSI B92.1 8/16 - 15t (SAE F)/(sizes 210; 280: (*t))						●	●
T1 – splined ANSI B92.1 16/32 - 21t (*t)		●					
T2 – splined ANSI B92.1 16/32 - 23t (*t)			●				
T3 – splined ANSI B92.1 16/32 - 27t (*t)				●	●	●	
K1 keyed ISO3019-2 / 40 mm (metric flange only (pos. 8))			●				
K2 – keyed ISO3019-2 / 60 mm							●
11 Porting							
M – ISO 6149 metric	●	●	●	●	●	●	●
D – DIN 3852	•	•	•	•			

	55	75	105	135	165	210	280
12 Pump Control							
A – LP:LS/pressure cut-off	●	●	●	●	●	●	●
B – H1L:LS/hydraulic override (*m)	●	●	●	●	●	●	●
C – E1L:LS/electric override (*m)	●	●	●	●	●	●	●
D – TL2:LS/power limiter (*m)/ (*r)			●	●		●	●
E – ETP:electro-proportional/ power limiter/PCO (*m)/ (*r)			●	●		●	●
F – LEP:LS/electric stroke limiter/PCO (*m)/(*r)			●	●		●	●
13 14 Pressure Compensator Setting							
00 – Not applicable (H1L; E1L; TL2)	•	•	•	•	•	•	•
AA – 250 bar	●	●	●	●	●	●	●
AB – 350 bar	●	●	●	●	●	●	●
AC – 420 bar	●	●	●	●	●	●	●
15 16 Load Sensing Differential Pressure							
00 – Not applicable (ETP)	•	•	•	•	•	•	•
AC – 20 bar	●	●	●	●	●	●	●
17 18 19 Power Limiter Setting							
000 – not applicable (LP; H1L; E1L; LEP)	●	●	●	●	●	●	●
value – 009 - 106 kW (numeric 3 digits)			●				
value – 012 - 136 kW (numeric 3 digits)				●			
value – 019 - 184 kW (numeric 3 digits)						●	
value – 032 - 221 kW (numeric 3 digits)							●
20 Pressure Limiter Remote Control							
0 – not applicable (LP; H1L; E1L;TL2)	●	●	●	●	●	●	●
D – disabled (ETP; LEP only)			●	●		●	●
R – enabled (ETP; LEP only)			●	●		●	●
21 Power Limiter Remote Control							
0 – not applicable (LP; H1L; E1L;LEP only)	●	●	●	●	●	●	●
1 – remote power uprating (default for TL2; ETP)			●	●		●	●
2 – remote power up- & downrating (TL2; ETP only)			●	●		●	●

• Available Option ● Preferred Option

♦ Separate Specification Required

(*d) DIN porting only (see position 11)
(*e) Availability depends on controller type (see position 12)
(*m) ISO metric porting only (see position 11)
(*r) CW rotation only (see position 7)
(*s) Second HPV/R unit has to be specified separately
(*t) Recommended if HPV/R unit is attached to PTO (see position 26,27)
(*u) Required for PTO flange size C (see position 26,27)
(*w) Not for tandem units (see position 26,27)

Model Code

HPR – Self-regulating Pump for Open Loop Operation

HPR	105	R	0	S1	M	A	AC	AC	000	0	0	0	0	AA	00	0	0	000	A	00	A	A	A
1 2 3	4 5 6	7	8	9 10	11	12	13 14	15 16	17 18 19	20	21	22	23	24 25	26 27	28	29	30 31 32	33	34 35	36	37	38

Code	Description	55	75	105	135	165	210	280
22	**Control Solenoids**							
0	– not applicable (LP; H1L; TL2)	●	●	●	●	●	●	●
A	– AMP / 12V	●	●	●	●	●	●	●
B	– AMP / 24 V	●	●	●	●	●	●	●
C	– DIN / 12 V	•	•	•	•	•	•	•
D	– DIN / 24 V	•	•	•	•	•	•	•
E	– Deutsch / 12V	•	•	•	•	•	•	•
F	– Deutsch / 24V	•	•	•	•	•	•	•
23	**Noise Optimization Devices**							
0	– No Noise Reduction Device	●	●	●	•	•	•	
1	– With SPU primary noise reduction (sizes 55-105: (*r))	●	●	●	●	●	●	●
24 25	**Auxiliary Pad and Shaft Definition**							
0G	– to add gear pump see positions 26,27	•	•	•	•	•	•	•
AA	– SAE J744 A without shaft coupling (default)	●	●	●	●	●	●	●
AB	– SAE J744 A / ANSI B92.1 16/32-9 teeth (A)	●	●	●	●	●	●	
AC	– SAE J744 A / ANSI B92.1 16/32 - 11 teeth				•		•	
AD	– SAE J744 A / ANSI B92.1 16/32 - 13 teeth			•	•		•	•
AE	– SAE J744 B without shaft coupling	•	•	•	•	•	•	•
AF	– SAE J744 B / ANSI B92.1 16/32-13 teeth (B)	•	•	•	•	•	•	•
AG	– SAE J744 B / ANSI B92.1 16/32-15 teeth (B-B)	•	•	•	•			•
AH	– SAE J744 C without shaft coupling	•	•	•	•	•	•	•
AJ	– SAE J744 C / ANSI B92.1 12/24-14 teeth (C)	•	•	•	•	•	•	•
AK	– SAE J744 C / ANSI B92.1 16/32 - 21 teeth		•	•	•		•	
AL	– SAE J744 C / ANSI B92.1 16/32 - 23 teeth			•	•	•	•	
AM	– SAE J744 D without shaft coupling				•	•	•	•
AN	– SAE J744 D / ANSI B92.1 8/16-13 teeth (D)				•			
AP	– SAE J744 D / ANSI B92.1 12/24 - 17 teeth				•			
AQ	– SAE J744 D / ANSI B92.1 16/32 - 27 teeth				•	•	•	
AR	– SAE J744 E without shaft coupling						•	•
AS	– SAE J744 E / ANSI B92.1 16/32 - 27 teeth						•	
26 27	**Auxiliary Pump or Tandem Adapter**							
00	– without	●	●	●	●	●	●	●
BA	– internal gear pump 16cc	●	●	•	•			
BB	– internal gear pump 22,5cc	•	•	●	●			
BC	– internal gear pump tandem 16+16cc	•	•	•	•			
BD	– internal gear pump tandem 16+22,5cc	•	•	•	•			
BE	– internal gear pump tandem 22,5+16cc	•	•	•	•			
BF	– internal gear pump tandem 22,5+22,5cc	•	•	•	•			
BG	– external gear pump 31cc (*r)			•	•			
BH	– external gear pump 38cc			•	•		•	•
BJ	– external gear pump 44cc (*r)						•	•
BK	– external gear pump tandem 22,5+22,5 cc (*r)				•	•	•	•
BL	– HPV/R 55 mounting preparation (*s)	•	•	•	•	•	•	•
BM	– HPV/R 75 mounting preparation (*s)		•	•	•	•	•	•
BN	– HPV/R 105 mounting preparation (*s)			•	•	•	•	•
BP	– HPV/R 135 mounting preparation (*s)				•	•	•	
BQ	– HPV/R 210 mounting preparation (*s)						•	•
28	**Auxiliary Drive on Internal Gear Pump**							
0	– Without internal gear pump	●	●	●	●	●	●	●
A	– SAE J744 A / ANSI B92.1 16/32 - 9 teeth (A) (default)	●	●	●	●			
B	– SAE J744 B without shaft coupling	•	•	•	•			
C	– SAE J744 B/ANSI B92.1 16/32 - 13 teeth (B)	•	•	•	•			
D	– SAE J744 B/ANSI B92.1 16/32 - 15 teeth (B-B)	•	•	•	•			
E	– SAE J744 C without shaft coupling			•	•			
F	– SAE J744 C/ANSI B92.1 12/24 - 14 teeth (C)			•	•			
29	**Internal Gear Pump Supply**							
0	– Without internal gear pump	●	●	●	●	●	●	●
E	– External supply port	●	●	●	●			
30 31 32	**Maximum Displacement Setting**							
000	– Catalog Pump Rating	●	●	●	●	●	●	●
33	**Operating Speed**							
A	– Catalog Pump Rating	●	●	●	●	●	●	●
34 35	**Special Requirements**							
00	– Without special requirements (default)	●	●	●	●	●	●	●
36	**Surface Coating**							
0	– Anti rust conservation oil (default)	●	●	●	●	●	●	●
A	– Primer blue	●	●	●	●	●	●	●
37	**Unit Identification**							
A	– Eaton	●	●	●	●	●	●	●
38	**Type Code Release**							
A	– Revision Level A	●	●	●	●	●	●	●

• Available Option ● Preferred Option ♦ Separate Specification Required

Operational Parameters

Life Time Recommendations

Eaton high pressure units are designed for excellent reliability and long service life. The actual service life of a hydraulic unit is determined by numerous factors. It can be extended significantly through proper maintenance of the hydraulic system and by using high-quality hydraulic fluid.

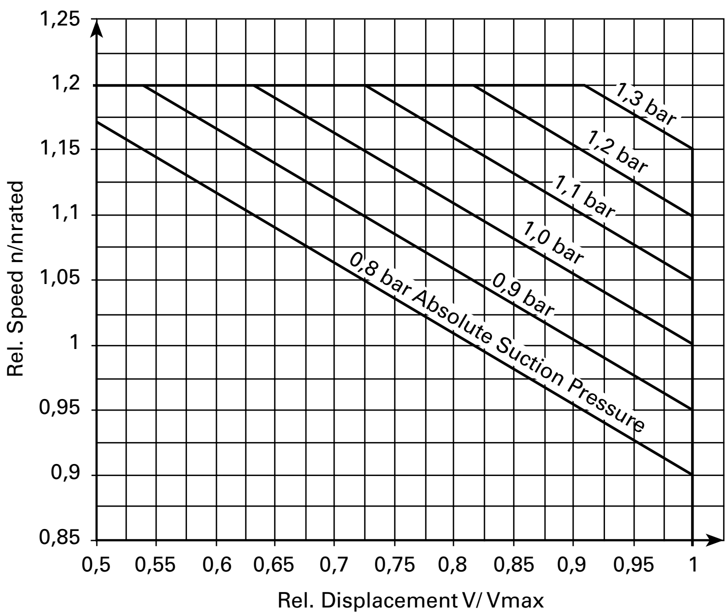
Beneficial Conditions for Long Service Life

Speed	Lower continuous maximum speed
Operating Pressure	Less tan 300 bar Δp on average
Max. Pressure	Only at reduced displacement
Viscosity	15...30 cSt
Power	Continuous power or lower
Purity of Fluid	18/16/13 in accordance with ISO 4406 or better

Adverse Factors Affecting Service Life

Speed	Between continuous maximum speed and intermittent maximum speed
Operating pressure	More than 300 bar Δp on average
Viscosity	Less than 10 cSt
Power	Continuous operation close to maximum power
Purity of fluid	Lower than 18/16/13 in accordance with ISO 4406

Operational Parameters. HPR Suction Speed



Operational Parameters

Tank connection

The leakage and decompression oil generated during pump operation is drained from the rotating group into the pump housing.

Excessive housing pressure must be avoided through suitably dimensioned piping between the housing and the tank.

Operational Parameters. Filtration

In order to guarantee long-term proper function and high efficiency of the hydraulic pumps the cleanliness level of the lubricant must comply with the following criteria according to Eaton Hydraulic Fluid Recommendation 03-401-2010. Maintaining the recommended cleanliness level can extend the service life of the hydraulic system significantly.

For reliable proper function and long service life

18/16/13 in accordance with ISO 4406 or better

Commissioning

The minimum cleanliness level requirement for the hydraulic oil is based on the most sensitive component. For commissioning we recommend a filtration in order to achieve the required cleanliness level.

Filling and operation of hydraulic systems

The required cleanliness level of the hydraulic oil must be ensured during filling or topping up. When drums, canisters, or large-capacity tanks are used the oil generally has to be filtered. We recommend the implementation of suitable filters to ensure that the required cleanliness level of the oil is achieved and maintained during operation.

International standard

Code Number According to ISO 4406
18/16/13

Operational Parameters

Pressure Fluids

In order to ensure the functional performance and high efficiency of the hydraulic pumps the viscosity and purity of the operating fluid should meet the different operational requirements. Eaton recommends using only hydraulic fluids which are confirmed by the manufacturer as suitable for use in high pressure hydraulic installations or approved by the original equipment manufacturer.

Permitted Pressure Fluids

- Mineral oil HLP to DIN 51 524-2
- Biodegradable fluids in accordance with ISO 15 380 on request
- Other pressure fluids on request

Eaton offers an oil testing service in accordance with VDMA 24 570 and the test apparatus required for in-house sesting. Prices available on request.

Recommended Viscosity Ranges

Pressure Fluid Temperature Range	[°C]	-20 to +90
Working viscosity range	[mm²/s] = [cSt]	10 to 80
Optimum working viscosity	[mm²/s] = [cSt]	15 to 30
Max. viscosity (short time start up)	[mm²/s] = [cSt]	1000

In order to be able to select the right hydraulic fluid it is necessary to know the working temperature in the hydraulic circuit. The hydraulic fluid should be selected such that its optimum viscosity is within the working temperature range (see tables).

The temperature should not exceed 90 °C in any part of the system. Due to pressure and speed influences the leakage fluid temperature is always higher than the circuit temperature. Please contact Eaton if the stated conditions cannot be met or in special circumstances.

Viscosity Recommendations

Working Temperature [°C]	Viscosity [mm²/s] = [cSt] at 40 °C
Approx. 30 to 40	22
Approx. 40 to 60	32
Approx. 60 to 80	46 or 68

Further information regarding installation can be found in the operating instructions.

LSC-System

The Synchron Control System (SC-System) for open loop hydraulic circuits enables demand-orientated pump volume control based on load sensing technology. A SC-System compensates the effect of varying loads, varying numbers of actuators and different load levels at different actuators. This happens automatically, thereby making machine operation more convenient since, unlike in other systems, continuous corrective action is no longer required. The SC-System enables high-efficiency hydraulic systems to be realized that are strictly orientated to the machine functions. Our application specialists will be happy to provide advice for individual machine configurations.

Functionality

- Demand-oriented pump control
- Excellent precision control characteristics without readjustment
- Exact reproducibility of machine movements through exact control of actuators
- Dynamic response characteristics
- Load-independent, synchronous movements of several actuators
- "Social" oil distribution even in the event of overload
- Automatic venting of directional control valve end caps
- Optimum movement continuity even for combined movements

Further Optional Functions Such As

- Priority control of individual actuators
- Output control
- High-pressure protection
- Regeneration function
- Combined function shuttle valve
- Load holding function

Machine Equipment

- Customized system design for optimum implementation of customer requirements
- Optimum utilization of the installed power with simultaneous improvement of energy consumption
- High flexibility through manifold plates
- Compact, integrated solutions
- Modular design of valve sections
- Add-on cylinder valves for direct and fast cylinder supply, no additional hose burst protection required
- Optimized piping

Benefits

- Perfect matching of the individual operating functions for customized machine characteristics
- Efficient and dynamic machine control for short operating cycles
- Optimized energy balance for reduced fuel consumption and enhanced handling performance
- Simple and safe machine operation for non-fatigue and efficient working
- Unsurpassed reliability even under harsh operating conditions
- Reduced installation times

Noise Reduction

SPU Silencer

In hydraulic systems pressure pulsations can lead to noise emission. These pressure pulsations are a result of the inherent non-uniformity of the volume flow in rotary piston pumps.

In open loop hydraulic circuits pressure pulsations primarily originate from within the hydraulic pump during the compression stroke, i.e. when a piston coming from the low-pressure side (suction side) enters the high-pressure side, where it is suddenly subjected to high pressure.

The higher the pump speed and the pressure difference between the low-pressure and high-pressure side, the more pulsation energy is added to the hydraulic system via the hydraulic fluid.

Pressure pulsations can cause components of the hydraulic system or the machine to oscillate, thereby generating noise that is perceivable for the human ear.

In principle noise emissions from machinery with hydraulic systems can be reduced in the following ways:

- Reduction of operating pressure and speed. This reduces the pulsation energy introduced into the hydraulic system
- Primary measures for optimizing the compression stroke in rotary piston machines with the aim of reducing pulsation
- Secondary measures such as vibration-optimized design and installation of machine components and sound-proofing for noise suppression

Noise Generation

Flow Ripple
▼
Pressure Ripple
▼
Fluid Borne Noise
▼
System Excitation
▼
Structure Borne Noise
▼
Noise Radiation

Noise Reduction.
SPU Silencer

All Eaton hydraulic pumps are optimized with respect to pulsation characteristics and therefore noise generation.

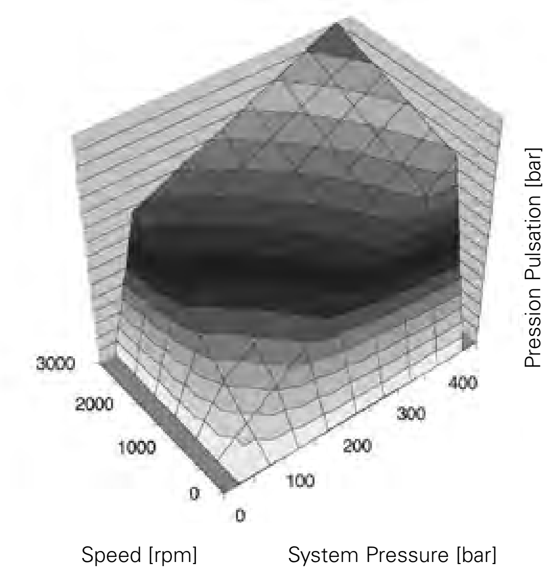
In addition to common primary measures such as exclusive use of pulsation-optimized port plates, Eaton offers the SPU silencer for HPR open loop pumps.

Without affecting the functionality and efficiency of the pump, this system reduces pressure pulsations by up to 70%, irrespective of pressure, speed or temperature.

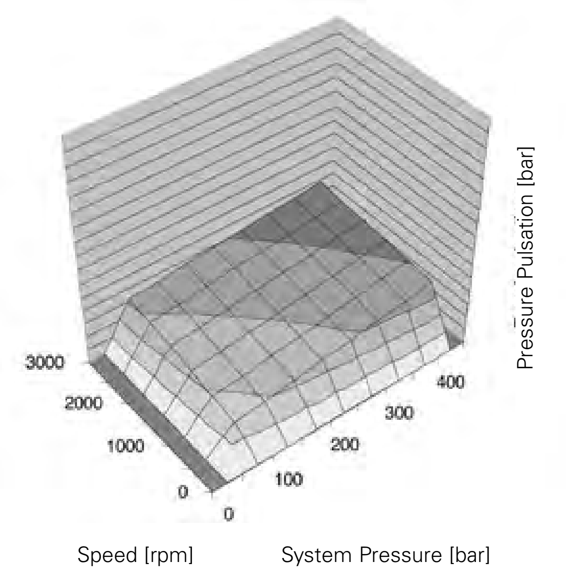
The SPU system is adaptive over the entire operating range. No setting up or maintenance is required.

Pressure Pulsations
With and Without SPU

Conventional Commutation



SPU Commutation



Noise Reduction

SPU Silencer

SPU Silencer Function

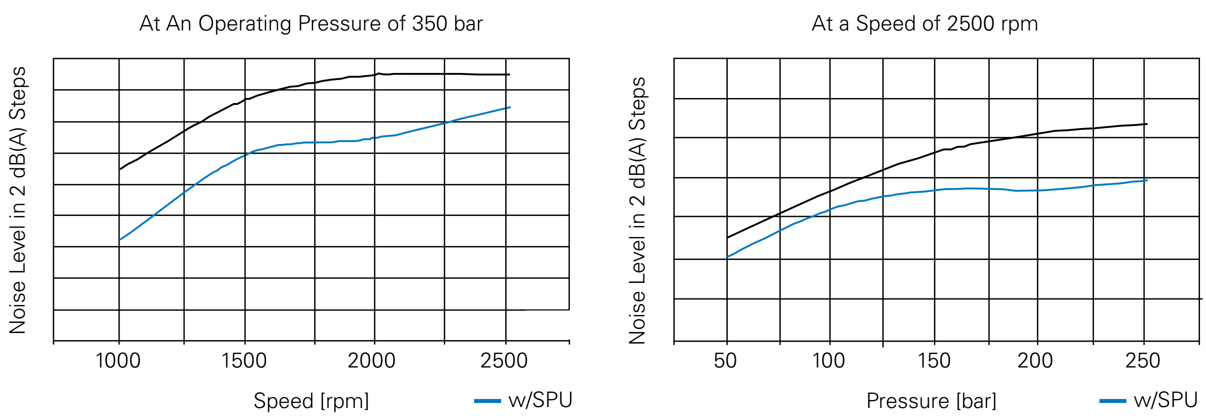
- Reduction of pressure pulsations over the entire operating range
- Reduction of volume flow fluctuations
- No impairment of efficiency
- Ready for use immediately, no maintenance required
- Simple and rugged design
- Minimum increase in weight and volume

HPR with SPU

Noise Reduction SPU Silencer

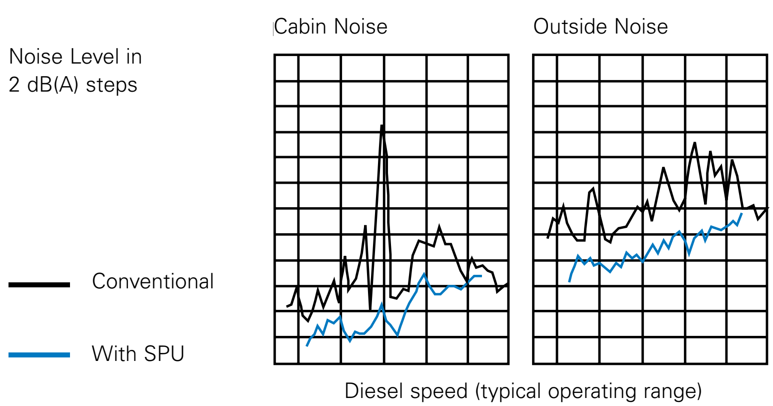
The following diagrams illustrate the immediate effect of pulsation level reduction via SPU on the sound pressure level and therefore the perceived noise emission.

Comparison of Sound Pressure Levels for a HPR 75-02 Pump With and Without SPU



Comparison of Resulting Noise Emission

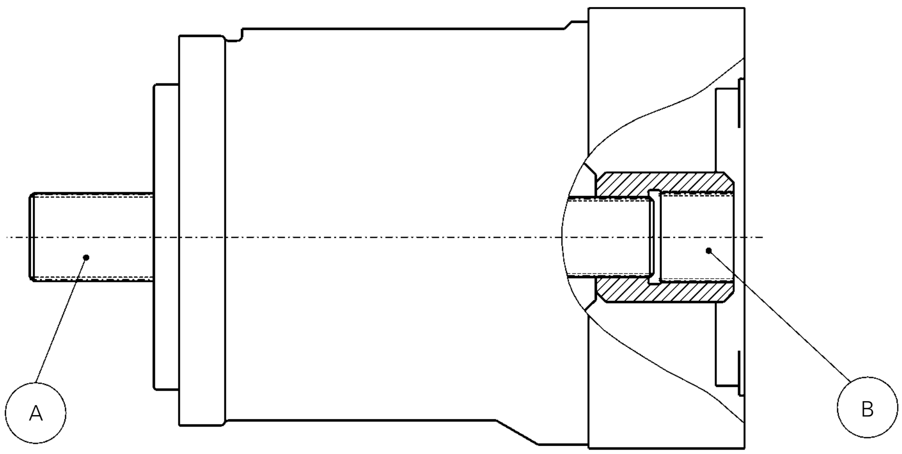
Shown in 2 dB(A) steps over a typical diesel engine operating speed range.



Torque Transmission

Depending on the selected components, different torques may be transferred. Please ensure that the load transfer components such as mounting flange, PTO-through shaft and additional pumps are designed adequately. Our sales engineers will be pleased to provide design advice.

Torque Transmission of HPR



This shows the input side (A) and PTO- / output side (B) of a HPR pump.

The information on the following pages refers to

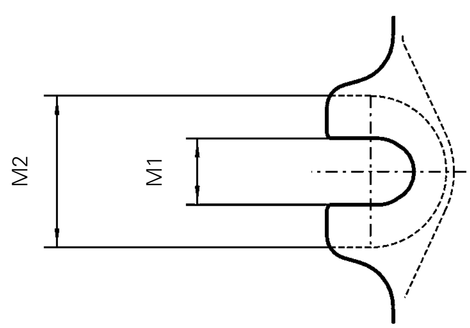
- Mounting flange and drive shaft (A)
- PTO flange and through shaft (B)

A) Flange Profile

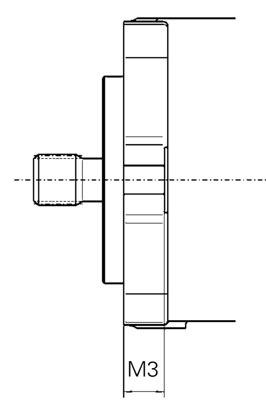
Rated Size HPR

Bolt Holt	Dimensions	55	75	105	135	165	210	105D 2-hole	105D Plug-in	105D SAE 3
M1 Inside Diameter	mm	17.5	17.5	17.5	21.5	21.5	22	17.5	14	11
M2 Outside Diameter	mm	34	34	34	40	40	42	40	20	22
M3 Bolt Hole Length	mm	20	20	20	20	25	26	20	20	12

Bolt Hole Diameter



Bolt Hole Length



Torque Transmission

Mounting Flange

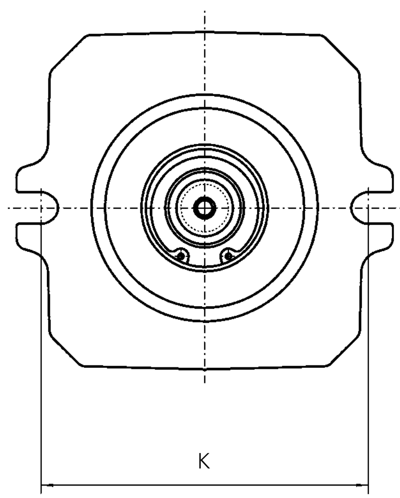
A) Mounting Flange Dimensions

Rated Size HPR

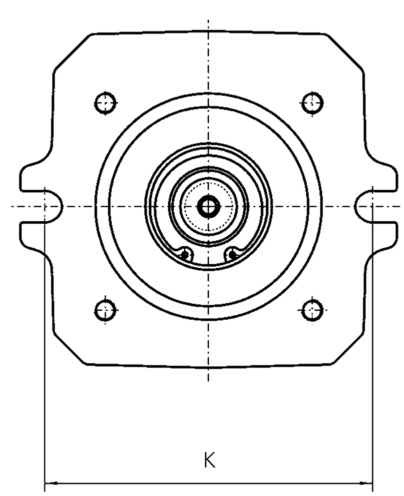
Mounting Flange Dimensions in Accordance with SAE J744	Dimensions K (mm)	55	75	105	135	165	210	105D
SAE C, C-C 2-hole	181.0	X	X	X				
SAE C, C-C 2-hole with additional thread holes	181.0			X				
SAE C, C-C 2 hole with additional bolt holes	181.0							X
SAE D 2-hole	228.6				X	X		
SAE E 4-hole	224.5						X	
Plug-in flange	251.8							X
SAE 3 bell-housing	428.6							X

A) Fixing Hole Distance K

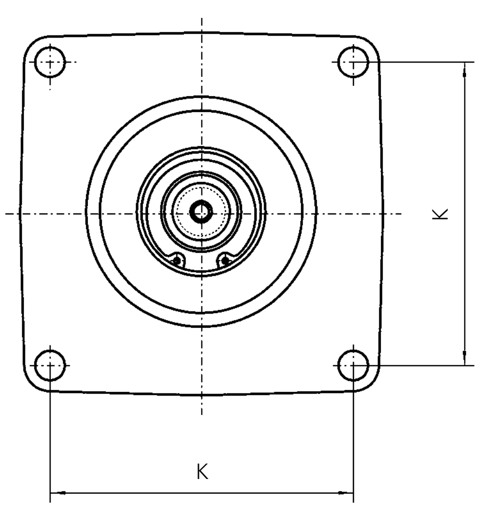
2-hole Flange



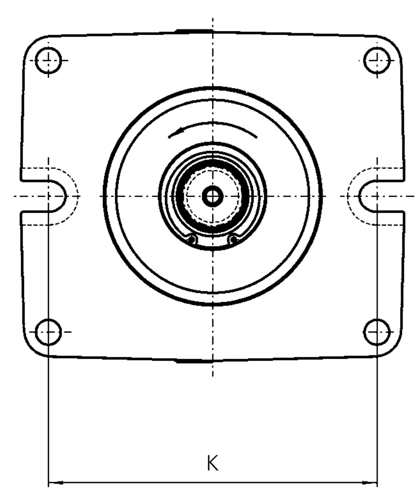
2-hole Flange with 4 Additional Threaded Holes



4-hole Flange



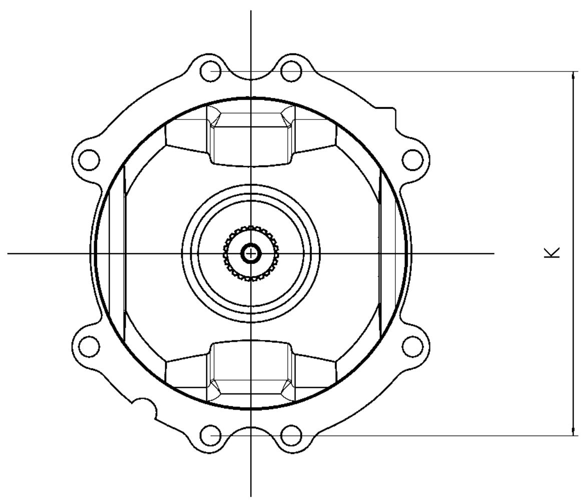
2-hole Flange with 4 Additional Bolt Holes



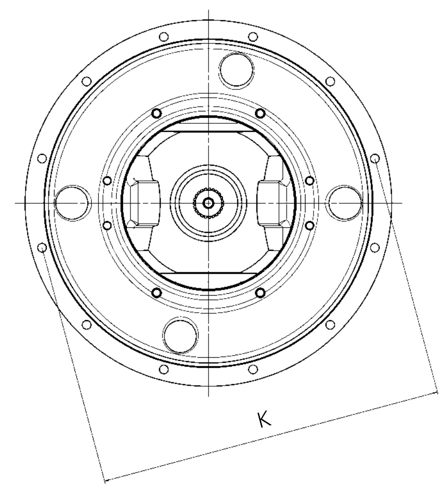
Torque Transmission

Mounting Flange

Plug-in Flange



SAE 3 Bell Housing



Torque Transmission

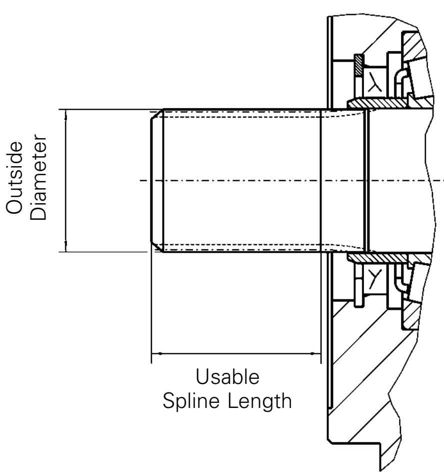
Drive Shaft

A) Dimensions Drive Shafts

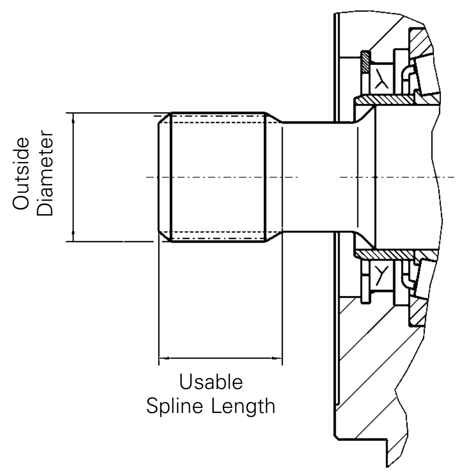
Shaft Spline in Accordance with ANSI B92.1	SAE J744 Code for Centring Shaft	Outside Diameter (mm)	Useable Spline Length (mm)	Shaft Length up to Bearing (mm)	Shaft Type	Available for Rated Size HPR						
						55	75	105	135	165	210	105D
16/32, 23Z		37.68	38.5	47.6	1			X				X
16/32, 27 Z		44.05	62	66.7	1				X	X	X	
12/24, 14 Z	C	31.22	30	47.5	2	X	X	X				
12/24, 17 Z	C-C	37.57	38	53.8	2			X	X			X
8/16, 13 Z	D	43.71	50	66.7	2				X	X		
8/16, 15 Z	F	50.06	58	66.7	1						X	

A) Hydraulics Shaft Types

Type 1. Without Undercut



Type 2. With Undercut



Torque Transmission

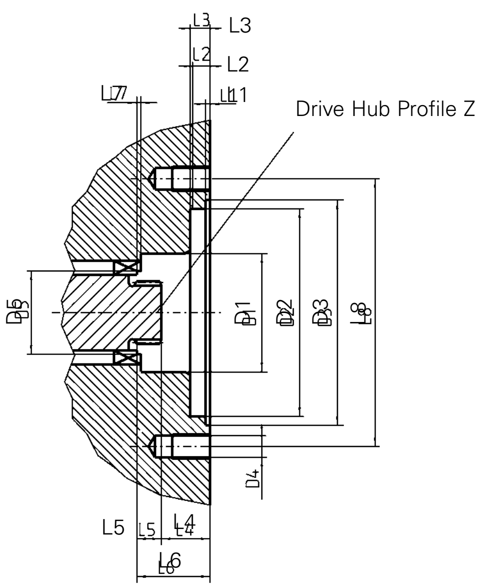
PTO through drive

Eaton pumps can be combined into tandem and multiple pumps. The combination options are determined by the permitted transfer torque. The following data refers to the PTO (pump output side, without further attachments).

B) Dimensions PTO

Rated Size	Dimensions (mm)	55	75	105	135	165	210
Z Drive Hub Profile in Accordance with ANSI B92.1		**16/32, 18 t**	**16/32, 18 t**	**16/32, 19 t**	**16/32, 21 t**	**16/32, 23 t**	**16/32, 24 t**
D1	mm	47	47	48	54	55	63
D2 Spigot Pilot Diameter	mm	82.55	82.55	82.55	82.55	82.55	82.55
D3	mm	89.5	89.5	89.5	89.5	89.5	89.5
D4		M10	M10	M10	M10	M10	M10
D5 Max. Bearing Clearance	mm	30	35	38	43	42	46
L1	mm	1.5	1.5	1.5	1.5	1.9	1.9
L2 Adapter Length	mm	7	7	7	7	8	8
L3	mm	9	9	9	9	9	9
L4 Minimum Distance	mm	35	39	33	35	57.8	46
L5 Usable Spline Length	mm	18	18	24	15.8	24.4	29.5
L6 Distance to Bearing	mm	48	48	52.7	5.2	83.3	46
L7 Min. Bearing Clearance	mm	3	3	3	3	5	5
L8 Hole Distance 2-hole	mm	106.4	106.4	106.4	106.4	106.4	106.4

B) Dimensions PTO



Torque Transmission

Output Shaft

B) Output Shaft Transfer Torque

Rated Size		55	75	105	135	165	210
Continuous Transfer Torque	Nm	220	305	420	540	540	840
Max. Transfer Torque	Nm	350	485	670	870	870	1340

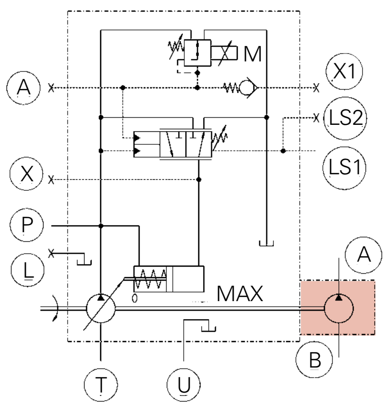
Gear Pumps

Two types of gear pumps are available: internal gear pump IGP and external gear pump EGP. The possible combinations of and with IGP and EGP are determined by the PTO option and the permitted shaft torque. Both types can be used for the control circuit and the cooling circuit. The suction limit of 0.8 bar min. (absolute) must be adhered to.

Technical Data

Max. Displacement Volume	**cm³/rev**	**16**	**22.5**	**31**	**38**	**44**
Type of Gear Pump		**IGP**	**IGP**	**EGP**	**EGP**	**EGP**
Mounting Flange and Drive Shaft Profile		SAE A 16/32 18 t	SAE A 16/32 18 t	SAE A 16/32 9 t	SAE A 16/32 13 t	SAE A 16/32 13 t
Type of Suction in Conjunction with HPR		External	External	External	External	
Max. Permissible Operating Pressure Observe Max. Permissible Rated Pressures for Filter and Color	bar	40	40	165	275	220
Standard PTO Flange and Shaft Spline		SAE A 16/32 9t	SAE A 16/32 9t			
Continuous Output Torque	Nm	175 75 Nm w/SAE A	175 75 Nm w/SAE A			
Max. Output Torque	Nm	250 107 Nm w/SAE A	250 107 Nm w/SAE A			
Cold Start Relief Valve		Integrated	Integrated			

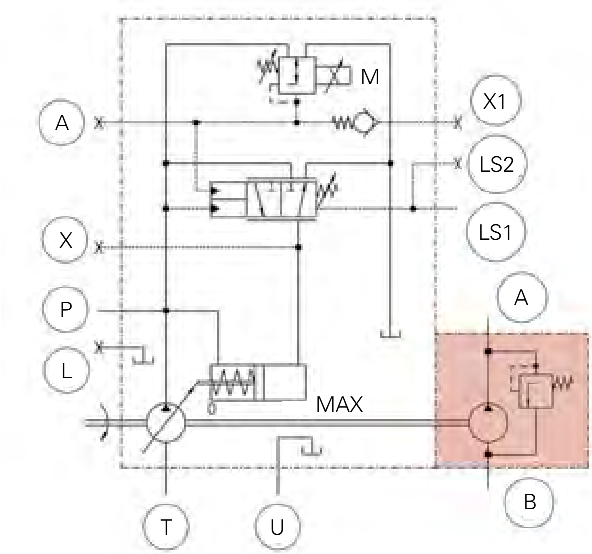
External Gear Pump EGP



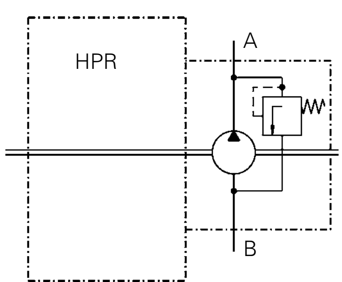
Gear Pumps

The IGP gear pumps include a cold start relief valve and a through drive for attaching additional pumps. In conjunction with an HPR regulating pump suction is always external. IGP types are available in rated sizes of 16 cm³/rev and 22.5 cm³/rev.

Internal Gear Pump IGP with External Suction



External Suction



External suction

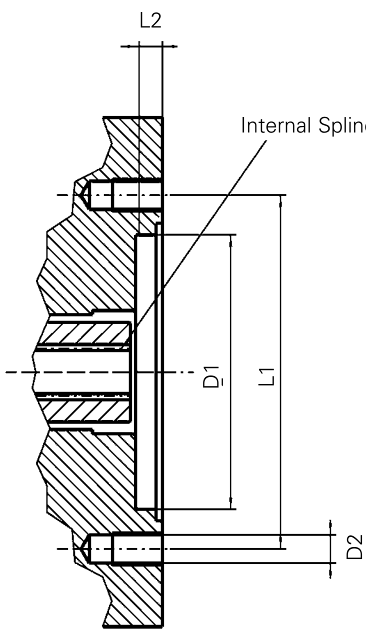
The gear pump supplies the main circuit with oil from the oil tank.

The internal connection is closed.

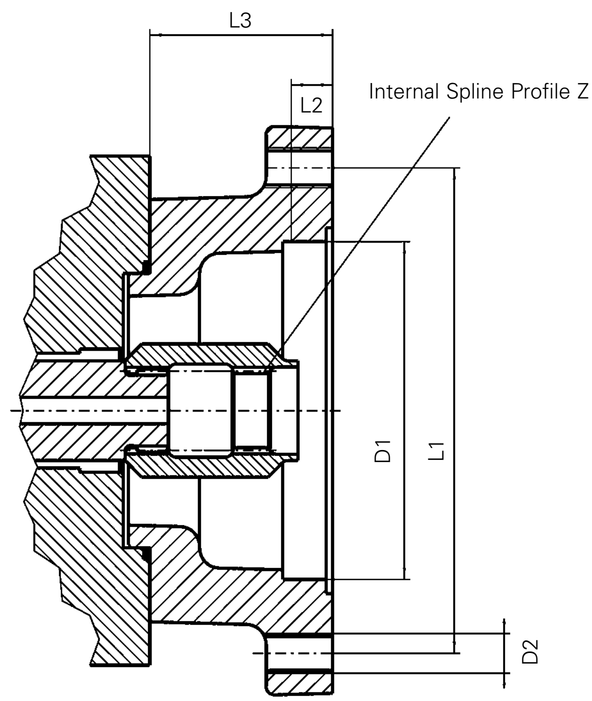
PTO Flange with IGP

Flange Profile 2-hole		SAE A	SAE B	SAE B-B	SAE C
Z Internal Spline Profile in Accordance with ANSI B92.1		16/32 9 t	16/32 13 t	16/32 15 t	12/24 14 t
D1 Spigot Pilot Diameter	mm	82.55	101.6	101.6	127
D2 Thread Size		M 10	M 12	M 12	M16
L1 Hole Distance	mm	106.4	146	146	181
L2 Adapter Length	mm	7	11	11	13
L3 Flange Length	mm	-	55	55	72
Continuous Transfer Torque	Nm	75	175	175	72
Maximum Transfer Torque	Nm	107	250	250	250

PTO SAE A with IGP



PTO SAE B, B-B, and C with IGP



Type of Control

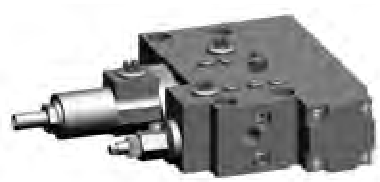
The modular regulator unit enables a wide range of functional system requirements to be met. In all regulator unit versions, the regulating functions are integrated in a housing in order to ensure direct signal transfer without delays and with maximum compactness. All regulators equipped with load sensing function are fully compatible with the Eaton Synchron Control System (see section Eaton LSC-System).

Technical Data

Type of Control	Additional Option	Name of Regulator
Load Sensing	With Pressure Cut-off	LP
	With Power Limitation, Hyperbolic	TL2
	With Electric Override	E1L

LP-Regulator

TL2-Regulator



E1L-Regulator

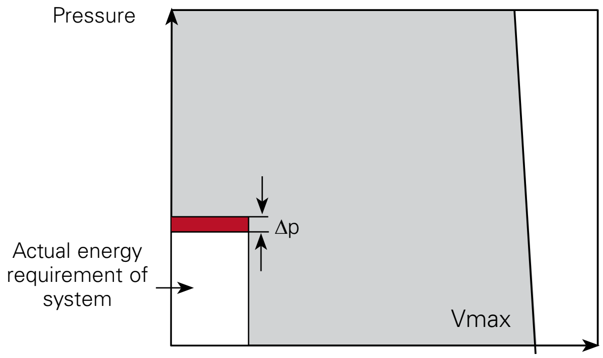
HPR E1L

Type of Control

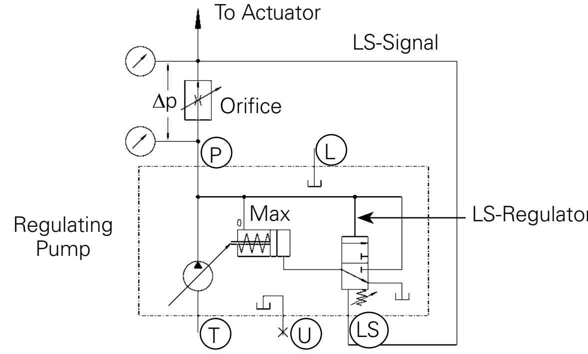
Load sensing LS

Eaton pumps with load sensing control enable the movement speed required of the selected actuator, e.g. of a boom, to be specified via the valve opening. The measured pump and load pressures are continuously balanced by the load sensing regulator of the hydraulic pump.

Load Sensing.
Flow on Demand Control.



Regulating pump with LS-regulator and measure orifice (in valve)



At the regulator a pressure gradient is set which is defined by the actuator requirements. The volume flow results from the orifice A of the control valve and the actual pressure gradient.

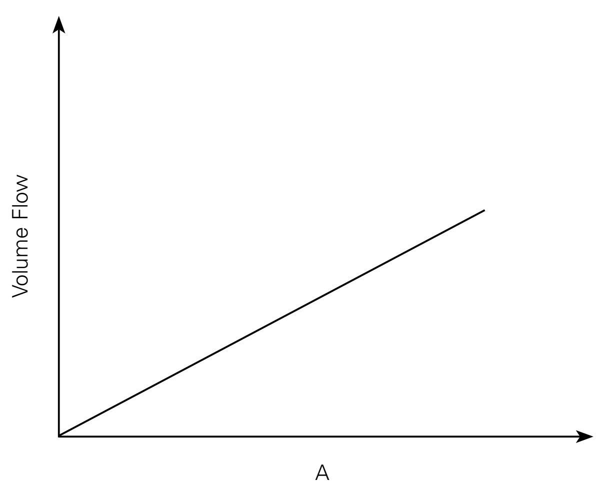
Due to the LS-regulator, the Δp corresponds to the setting value. If the required volume flow differs, the pump displacement is changed accordingly.

This happens automatically and reduces the effort required by the operator. Since varying loads and varying numbers of actuators are compensated automatically.

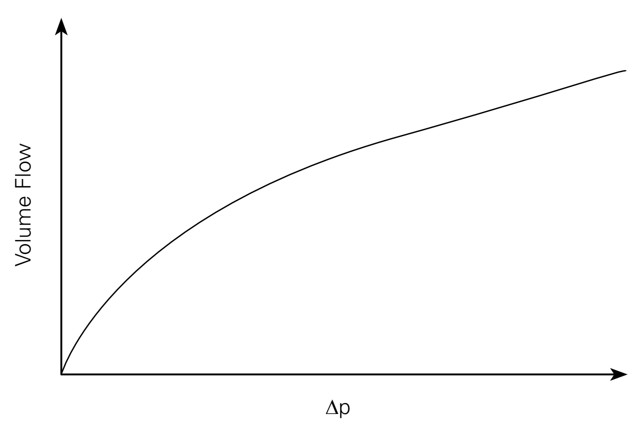
The Δp LS basic setting is possible from 16 to 27 bar with 20 bar as standard

(The LS differential pressure influences the response times of the pump system).

LS-Function at Δp = Constant



LS-Function at Area A = Constant



Benefits of LS-control

- Any volume flow below the pump`s maximum can be set
- Response speed of the machine can be defined
- OEM-specific machine response is possible
- Optimum precision control capability

Demand-oriented pump control offers the following benefits

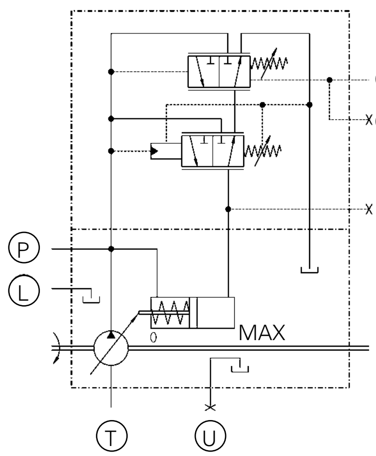
- Load-independent machine control
- Minimum heat generation
- Increased pump service life
- Low noise generation in the whole system
- Fewer components for the control mechansim
- Lower energy consumption, particularly with partial volume flow

Type of Control

LS with Hydraulic Pressure Cut-off LP

In addition to the load sensing function the LP-regulator offers maximum pressure limitation. Once the system pressure reaches the set pressure of the pressure cut-off valve, the LS-regulator is overridden and the pump swashes back, whilst maintaining the system's regulating pressure. The hydraulic pump remains in this state until the system pressure falls below the set pressure. The hydraulic pump then returns to normal LS operation.

LP. LS with Hydraulic Pressure Cut-off



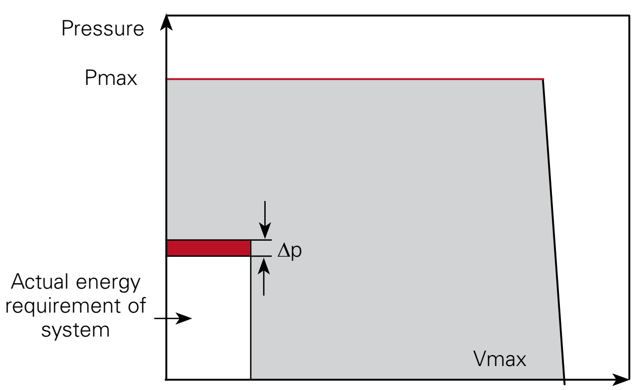
The maximum pressure cut-off valve prevents prolonged operation of pressure relief valves installed in the hydraulic system for protection. This has the following benefits for the hydraulic system:

- Operating pressure is maintained
- No operation in the overload range
- Any operating point under the power curve remains accessible
- Demand-oriented volume flow generation
- Minimum power loss
- Reduced heat and noise generation
- Longer service life of the pump and the entire hydraulic system
- Improved energy consumption of the overall system

Possible maximum pressure control setting ranges

- 125 - 230 bar
- 231 - 350 bar
- 351 - 420 bar

LP-Characteristic Curve



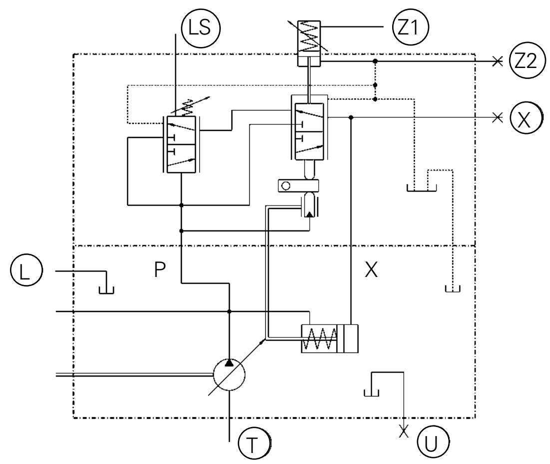
LP-Regulator

Type of Control

LS with Hyperbolic Power Limitation TL2

The control principle with power limitation is used to optimize power utilization of the prime mover in applications where less than the full power capacity is available for the hydraulic system. In addition to the load sensing function the HPR TL2 offers hyperbolic power limitation. The volume flow is limited when the set value is reached.

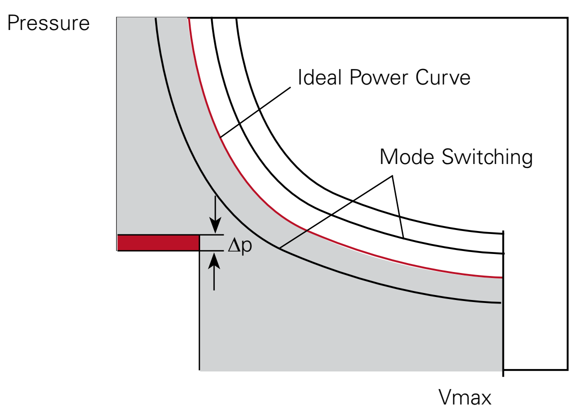
TL2. LS with Hyperbolic Power Limitation



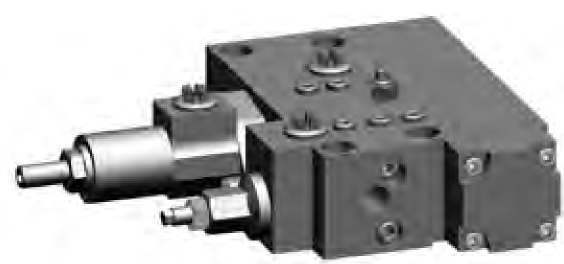
Starting from the set value, the characteristic power limit curve can be moved towards lower or higher power limits via a seperate control pressure connection (hydraulic mode switching).

Due to the ideal hyperbolic characteristics, the output of the prime mover can be utilized optimally, or the pump can be allocated a constant output.

TL2-Characteristic Curve



TL2-Regulator

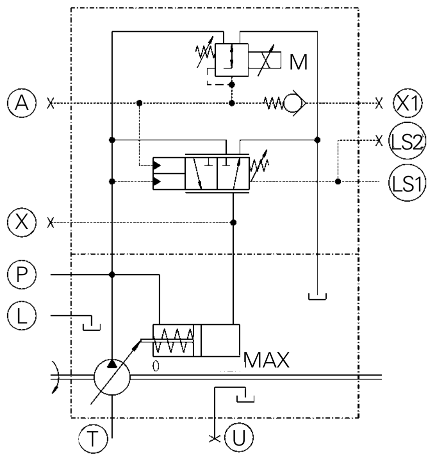


Type of Control

LS with Electric Override E1L

In addition to the load sensing function, the HPR E1L offers electric mode switching override for mode selection and power limit regulation (reduction control). The integration of all functions in the pump regulator enables direct signal transfer without delays. The regulator-specific data are independent of the nominal pump size.

E1L. LS with electric override

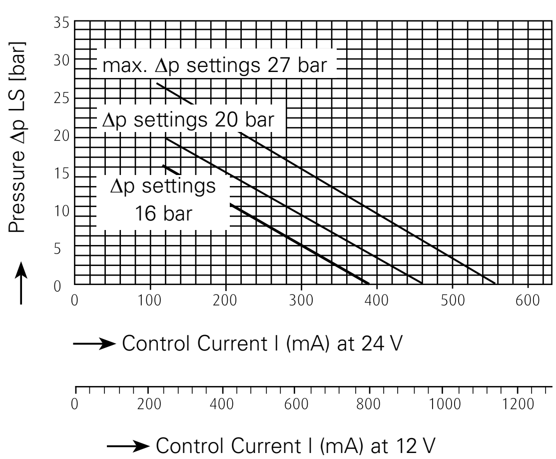


In the event of electric override of the LS-signal, a pressure reducing valve is activated via the proportional solenoid. The control pressure generated in this way acts proportionally against the LS-spring, and the electrical signal is modulated accordingly.

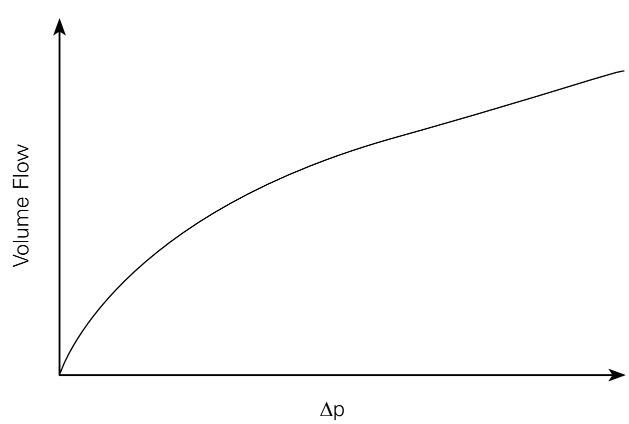
This causes the pump to swash back, thereby reducing its output. The operational availability of the pump control which is a typical Eaton feature, is based on an additional external control feature for the LS-axis.

This ensures that full pump capacity is available in the event of electronic management irregularities. The relationship between control current (I) at the control solenoid and the associated Δp LS value and the dependence of Δp LS of the pump at constant orifice are shown in the following diagrams.

Δp LS-Reduction



Pump Volume Flow at Fixed Orifice (e.g. Directional Control Valve Opening)



Type of Control

LS with Electric Override E1L

Connector Type	Hirschmann or AMP Junior Timer, 2-pole
Solenoid Voltage	12V or 24V
Supply	From on-board supply system (mobile applications) or external supply (usually stationary applications)
Standard Mounting Direction	See HPR E1L representation

E1L. Mode Switching

A mode switching (mode selection) modulates electrically the falling Δp LS-singal at an orifice (e.g. directional control valve). The current Δp LS value is reduced proportionally or in steps and the pump output adjusted via the pressure reducing valve (see the diagrams on previous page.)

In this way the volume flow of the pump can be reduced using the same orifice. In applications with proportional valves this leads to enhanced control resolution, enhabling particularly precise and sensitive actuator movenment.

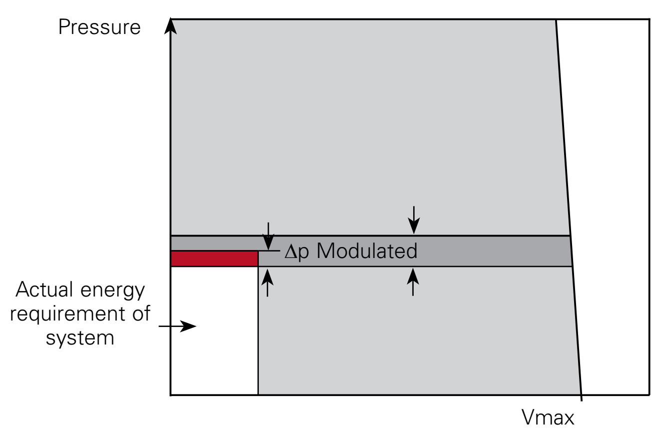
E1L. Power Limit Regulation

Any reduction in the prime mover speed is detected in conjunction with an electronic control unit, and the pump delivery volume is limited through modulation of the Δp LS value to ensure that the maximum power capacity is not exceeded. The volume reduction is the same for all actuators, so that the ratio remains unchanged. The maximum prime mover power is thus available at all times, irrespective of ambient influences and the number of actuators.

In principle, the Δp LS value acting at the LS-pilot can be modulated almost down to zero, whereas modified response times of the pump system should be expected in the operating range near zero.

E1L-Characteristic Curve

Δp= Δp LSmax with Δp LS = f(I)



E1L-Regulator

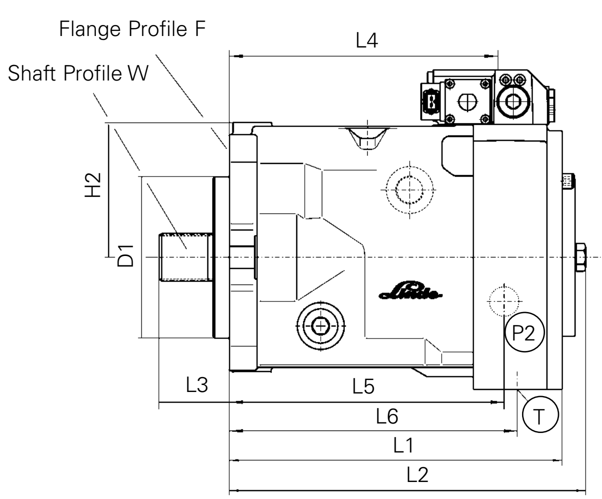
Dimensions

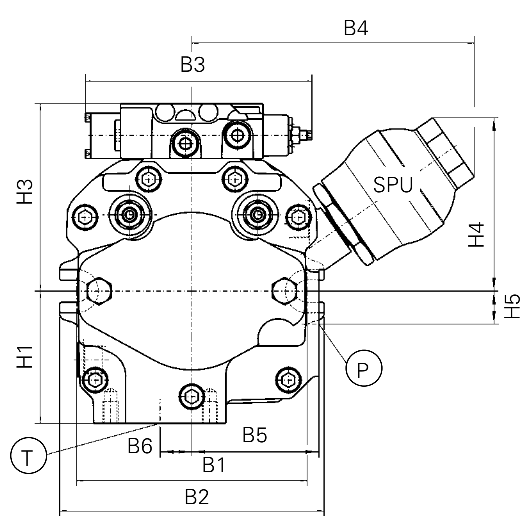
Single Pumps HPR

Port sizes and dimensions HPR Single Pumps

Size	55	75	105	135	165	210
F Flange Profile	SAE C	SAE C	SAE C	SAE D	SAE D	SAE E
Accordance w/ANSI B92.1	2-hole mtng flange	2-hole mtng flange	2-hole mtng flange	2-hole mtng flange	2-hole mtng flange	4-hole
W Shaft Profile in	12/24 Spline Pitch	12/24 Spline Pitch	16/32 Spline Pitch	16/32 Spline Pitch	16/32 Spline Pitch	16/32 Spline Pitch
Accordance w/ANSI B92.1	14 Teeth	14 Teeth	23 Teeth	27 Teeth	27 Teeth	27 Teeth
D1 (mm)	127	127	127	152.4	152.4	165.1
B1 (mm)	181	181	181	229	229	269
B2 (mm)	208	208	208	229	229	225
B3 (mm) LP-Regulator	140	140	140	140	140	140
B3 (mm) E1L-Regulator	178	178	178	178	178	178
B4 (mm)	-	215	222	236	253	262
B5 (mm) Port P	91	91	100	107	124	145
B6 (mm) Port T	21	21	25	40	0	57
H1 (mm)	94	94	104	120	120	145
H2 (mm)	100	93	106	100	116	135
H3 (mm) LP-Regulator	139	139	142	149	166	
H3 (mm) E1L-Regulator	145	145	148	155	172	178
H4 (mm)	-	147	137	146	153	145
H5 (mm) Port P	24	24	26	30	43	27
L1 (mm)	220	232	262	285	359	346
L2 (mm)	240	250	280	303	377	370
L3 (mm)	55	55	55	75	75	75
L4 (mm) SPU	-	192	215	236	256	278
L5 (mm) Port P	183	194	218	244	283	293
L6 (mm) Port T	190	201	227	250	286	296
P High Pressure (SAE)	3/4"	3/4"	1"	1 1/4"	1 1/4"	1 1/2""
T Standard (SAE)	1 1/2"	1 1/2"	2"	2"	2 1/2"	3"
L	M22x1.5	M22x1.5	M22x1.5	M27x2	M27x2	M27x2
U	M22x1.5	M22x1.5	M22x1.5	M27x2	M27x2	M27x2

Threads metric as per ISO 6149
Threads for SAE high pressure port metric as per ISO 261
Socket cap screw as per ISO 4762





Dimensions

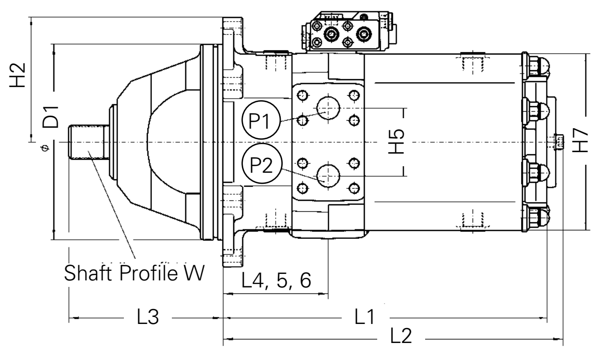
Double Pumps HPR D-02 Back-toBack

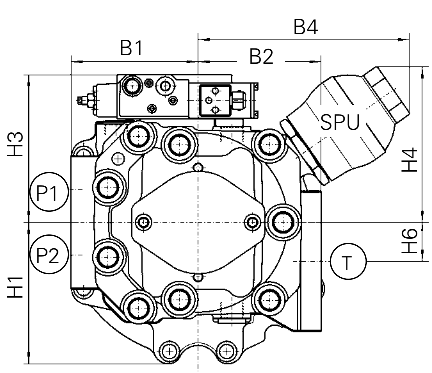
Port sizes and dimensions HPR D-02 Double Pumps

Size	105D	105D	165D
F Flange Profile	Plug-in Version	Plug-in Version	Standard Version
	-	Bell Housing	With SAE Flange
W Shaft Profile in	16/32 Spline Pitch	16/32 Spline Pitch	16/32 Spline Pitch
Accordance w/ANSI B92.1	23 Teeth	23 Teeth	27 Teeth
D1 (mm)	216	409.6	409.6
D2 (mm)	-	428.6	428.6
D3 (mm)	-	456	456
B1 (mm)	124	120	136
B2 (mm)	120	120	147
B3 (mm) LP-Regulator	176	176	176
B4 (mm)	222	222	162.3
H1 (mm)	141	141	168
H2 (mm)	141	141	168
H3 (mm) LP-Regulator	144	144	171
H4 (mm)	137	137	255
H5 (mm) Port P	75	75	80
H6 (mm) Port T	38	38	0
H7 (mm)	196	196	240
L1 (mm)	358	450	578
L2 (mm)	376	468	591
L3 (mm)	171	79	84
L4 (mm)	116	208	276 with SAE Bell Housing
L5 (mm) Port P	116	208	276
L6 (mm) Port T	-	208	276
P High Pressure (SAE)	2 x 1"	2 x 1"	2 x 1 1/4"
T Standard (SAE)	1 x 3"	1 x 3"	1 x 4"
L	M22x1.5	M22x1.5	M27x2
U	M22x1.5	M22x1.5	M27x2

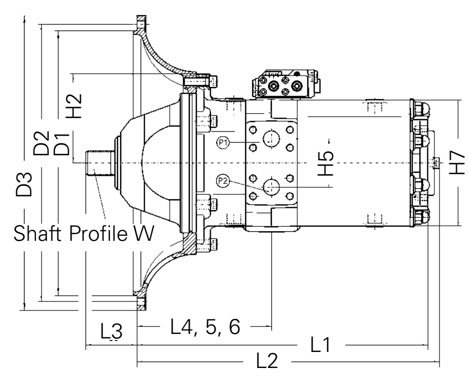
Threads metric as per ISO 6149
Threads for SAE high pressure port metric as per ISO 261
Socket cap screw as per ISO 4762

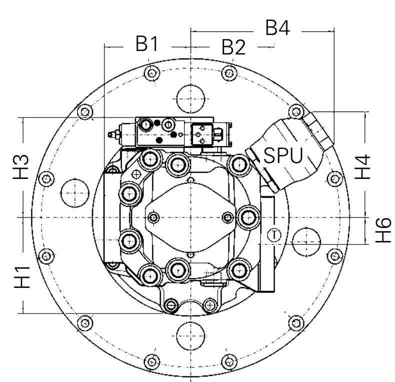
Plug-in Version





With SAE Bell Housing



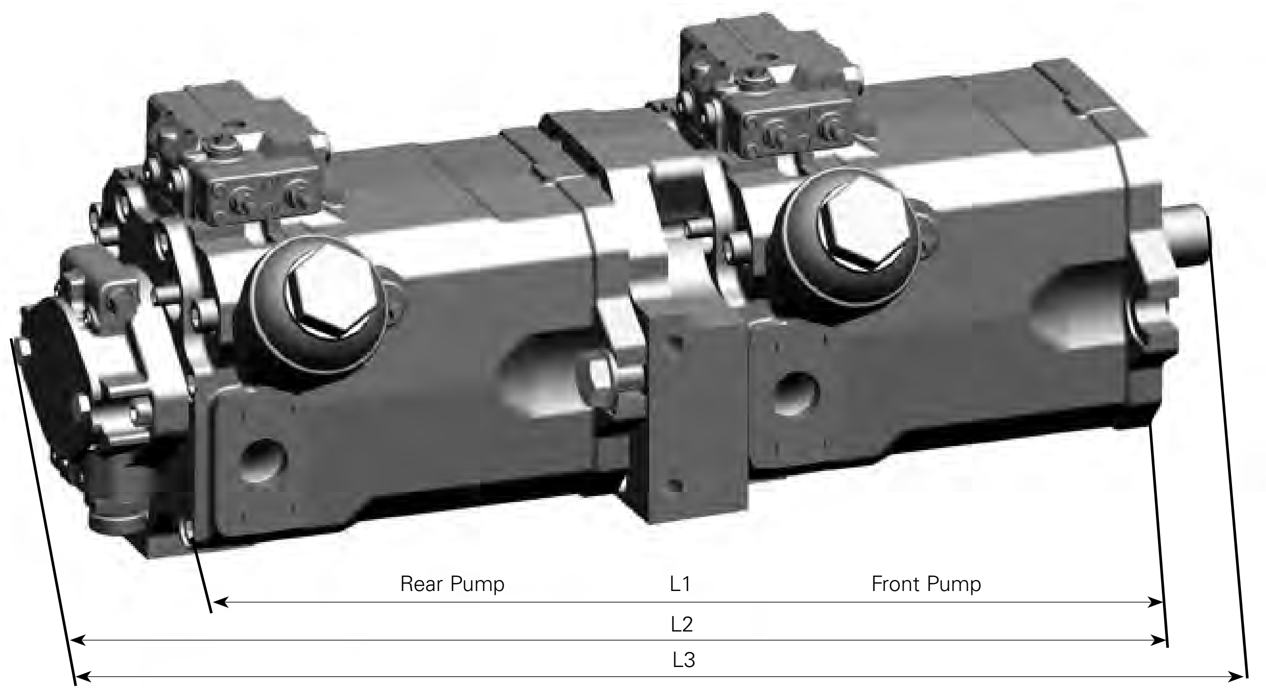


Dimensions

Multiple Pumps

Multiple pumps are created by connecting individual pump units in series, with the pumps arranged by capacity. Positioning the gear pump(s) at the end of the tandem ensures optimum space utilisation, output allocation and load distribution. The following table is based on the attached gear pump acting as a pilot pressure pump for the control circuit.

Multiple pump HPR-HPR



Overall Length of Multiple Pump HPR-HPR

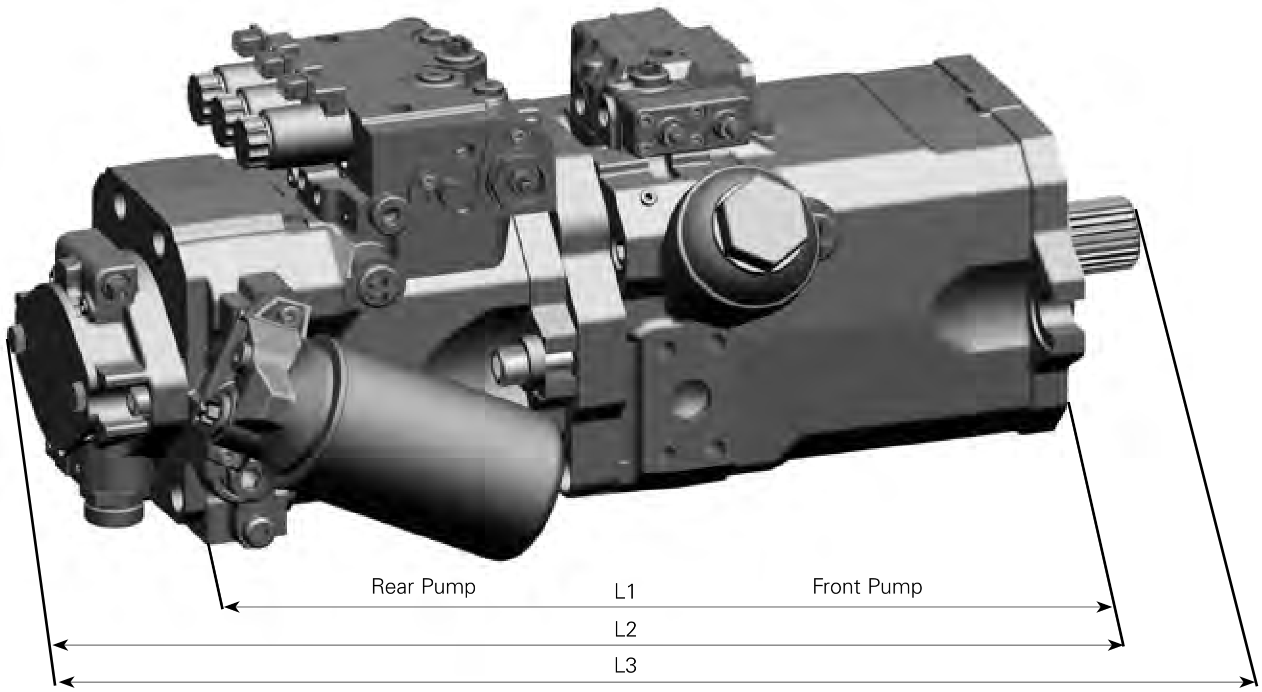
Size	Rear Pump	HPR 55 with gear pump 16 cm³	HPR 75 with gear pump 22,5 cm³	HPR 105 with gear pump 22,5 cm³	HPR 135 with gear pump 22,5 cm³	HPR 165 with gear pump 38 cm³	HPR 210 with gear pump 38 cm³
Front Pump	Lengths (mm)						
HPR 55	L1	488	-	-	-	-	-
	L2	560	-	-	-	-	-
	L3	614	-	-	-	-	-
HPR 75	L1	500	511	-	-	-	-
	L2	572	588	-	-	-	-
	L3	625	642	-	-	-	-
HPR 105	L1	520	531	562	-	-	-
	L2	592	608	624	-	-	-
	L3	646	662	677	-	-	-
HPR 135	L1	536	547	578	634	-	-
	L2	608	624	640	696	-	-
	L3	682	699	714	771	-	-
HPR 165	L1	579	589	621	661	709	-
	L2	636	651	683	723	879	-
	L3	711	726	758	797	954	-
HPR 210	L1	608	620	650	688	736	735
	L2	680	697	712	750	906	907
	L3	755	771	787	824	981	982

Dimensions

Multiple Pumps

Multiple pumps are created by combining individual pump units in series, with the pumps arranged by capacity. Positioning the gear pump(s) at the end of the unit ensures optimum space utilization, output allocation and load distribution. The following table is based on the gear pump acting as boost pump for the HPV variable pump.

Multiple pump HPR-HPV-02



Overall Length of Multiple Pump HPR-HPV

Size	**Rear Pump**	**HPV 55 with gear pump 16 cm³**	**HPV 75 with gear pump 22,5 cm³**	**HPV 105 with gear pump 22,5 cm³**	**HPV 135 with gear pump 22,5 cm³**	**HPV 165 with gear pump 38 cm³**	**HPV 210 with gear pump 38 cm³**
Front Pump	Lengths (mm)						
HPR 55	L1	492	-	-	-	-	-
	L2	549	-	-	-	-	-
	L3	603	-	-	-	-	-
HPR 75	L1	504	521	-	-	-	-
	L2	561	583	-	-	-	-
	L3	614	636	-	-	-	-
HPR 105	L1	524	541	567	-	-	-
	L2	581	603	629	-	-	-
	L3	635	657	682	-	-	-
HPR 135	L1	536	547	578	634	-	-
	L2	608	624	640	696	-	-
	L3	682	699	714	771	-	-
HPR 165	L1	584	600	626	664	639	-
	L2	640	662	688	726	709	-
	L3	715	675	763	800	784	-
HPR 210	L1	612	629	655	691	736	733
	L2	669	691	717	753	906	905
	L3	744	766	792	827	981	980