HPV-02

Variable Pump
for closed loop circuit

Linde Hydraulics move the world

Linde pioneered mobile hydrostatic transmissions.
Over the last 40 years Linde have fitted almost 2 million vehicles in the fields of:

- Earthmoving and Construction Machinery
- Agricultural and Forestry Equipment
- Municipal Vehicles
- Materials Handling Vehicles

with hydrostatic drive and gear units. By using this concept on its own forklift trucks, Linde have become the world leader in materials handling technology.

Through this ‘in house know how’ Linde as the system supplier can offer you a complete carefree package:

- From initial discussions to optimum solution
- Technical support throughout the project
- World-wide after sales service

This together with our understanding of partnership, ensures your guarantee of:

- High level technology
- Durable components
- Cost effectiveness

HPV-02

CONTENTS **Page**

1. CHARACTERISTICS AND TECHNICAL DATA

Features

- Compact design with high power density
- Reliable and durable
- Low noise
- High efficiency
- Superior quality

Sizes

- 55, 75, 105 and 135 cm^3/rev

Design Characteristics

- Axial piston pump, swash plate design
- Swash angle 21°
- Precise and robust control
- Integral boost pump with cold start valve
- Integrated high pressure relief and make-up valves
- Integrated low pressure valves for boost, servo and cooler circuits
- Fitted replaceable cartridge filter
- SAE 2 bolt mounting flange with ANSI splined shaft
- SAE A, B, B-B and C rear flange (PTO)
- Tandem and multiple pump options

Design changes are reserved.
Refer to installation drawings for exact dimensions

Technical Data

Rated Sizes	Nominal displacement	[cm³/rev]	**55**	**75**	**105**	**135**
	Maximum displacement	[cm³/rev]	54.8	75.9	105.0	135.6
Speed	Max. speed, continuous	[rev/min]	3300	3100	2900	2700
	Max. speed, intermittent *1	[rev/min]	3700	3500	3200	2900
Pressure	Continuous pressure	[bar]	250			
	Max. operational pressure *2	[bar]	420			
	Max. intermittent pressure	[bar]	500			
	Permissible housing pressure (absolute)	[bar]	2.5			
Torque	Continuous input torque *3	[Nm]	220	305	420	540
	Max. input torque *4	[Nm]	350	485	670	870
Power	Continuous power *5	[kW]	75	98	127	153
	Max. power *6	[kW]	121	157	204	245
Shaft loads	Axial input force *7	[N]	2000			
	Axial output force *7	[N]	2000			
	Radial *7	[N]	on request			
Temperature	Permissible housing temperature	[°C]	90			
Weights	With mech-hydraulic servo *8	[kg]	42	47	58	72
	Max. moment of inertia *9	[kgm² x 10⁻²]	0.30	0.84	1.49	2.20
Main dimensions			see page 6			

*1) Higher speeds on request
*2) Corresponds to setting of pressure relief valve, other setting possible
*3) At max. continuous pressure
*4) At max. pressure and 19 bar boost pressure
*5) At max. continuous speed and continuous pressure
*6) At max. speed, max. pressure and 19 bar boost pressure
*7) Definition: see page 6
*8) Including boost pump: Additional weight: with Hydraulic control 2 kg and with Electro-hydraulic control 4kg.
*9) Includes boost pump

Product Code

HPV		-02						
	Rated size: • 55 • 75 • 105 • 135	**Shaft rotation** • Right hand = R, Left hand = L	**Control** • Mechanical - hydraulic = M1 • Electro-hydraulic (2 solenoids) = E1 (12 or 24V) • Electro-hydraulic (3 solenoids) = E2 (12 or 24V) • Hydraulic = H1	**Pressure cut-off valve** • without = X • with = P • with setting value	**Setting of high pressure relief valve**	**Boost pump and suction** • without = X • internal = i • external = e • hybrid = h	**PTO flange type** • SAE A = A • SAE B = B • SAE B-B = B-B • SAE C = C

Examples

HPV **105-02 R E2 12 X 420 i C**	• Rated size 105 cm³/rev • Right hand rotation • Electro-hydraulic control E2 with 12V solenoids • No pressure cut-off • High pressure relief valve setting 420 bar • Boost pump with internal suction • PTO flange SAE-C
HPV **135-02 L H1 P400 420 e A**	• Rated size 135 cm³/rev • Left hand rotation • Hydraulic control H1 • With pressure cut-off at 400 bar • High pressure relief valve setting 420 bar • Boost pump with external suction • PTO flange SAE-A

2. CONTROLS

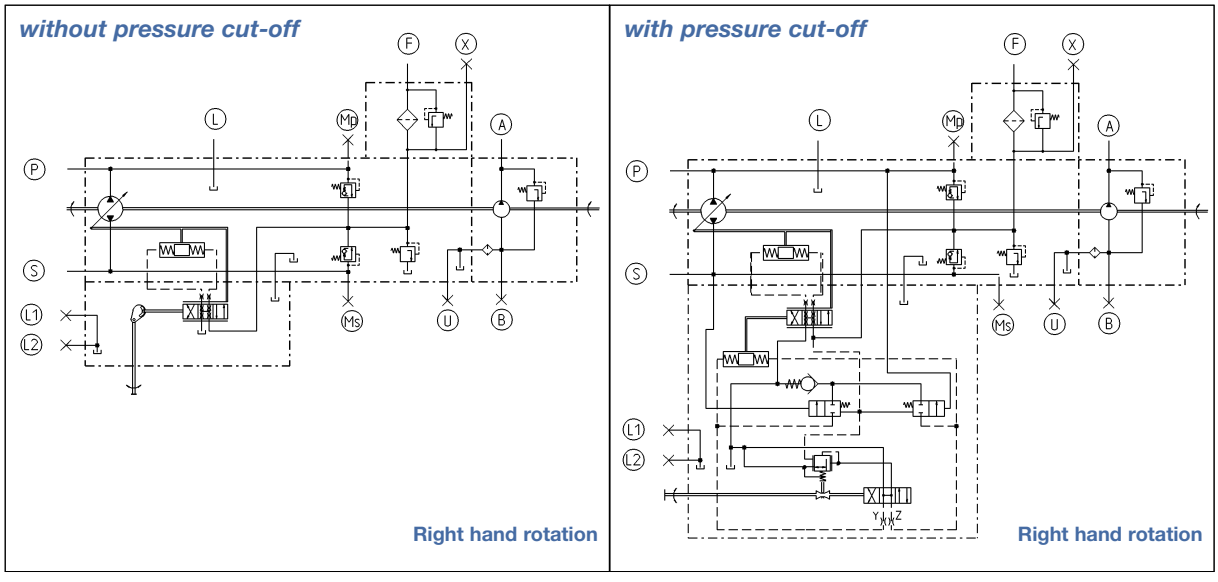
2a. Mechanical-hydraulic Control

This contol can be supplied with or without pressure cut-off

Circuit Diagram and Function

By turning the control lever the pump flow rate and direction of flow are controlled via a cam plate with progressive characteristic.

Controllers with pressure cut-off reduce pump flow when the cut-off pressure is reached. As system pressure is maintained, only a small quantity of residential fluid flows through the high pressure valve thus optimising power consumption and system thermal balance.



P,S High pressure ports
A Pressure port, boost pump
B Suction port, boost pump
F Feed port, boost & control

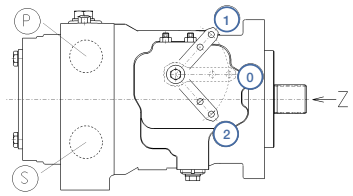
X Test port, control pressure
Ms, Mp Test ports, high pressure
L, U Drain ports
L1, L2 Vent ports

Note for left hand rotation:
A Suction port, boost pump
B Pressure port, boost pump

Flow Direction

The flow direction of the fluid is dependant upon

- the pump direction of rotation
- the over centre direction of the swash plate

Cam lever direction \ Shaft rotation (view on Z)			
	0 → 1	P*	S*
	2 → 0	S*	P*

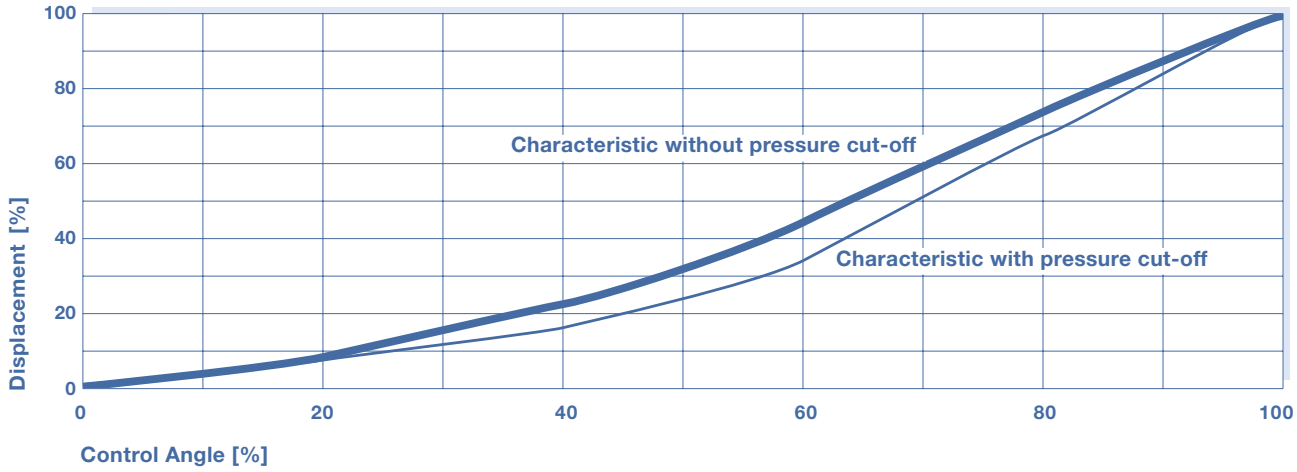
The table shows the flow correlation:

Technical Data

Rated size			For all unit sizes without pressure cut-off	For all unit sizes with pressure cut-off
Control force	*1	[N]	17	13
	Max. intermittent	[N]	500	230
Control torque		[Nm]	1.2	≤ 1
Control angle	Neutral range	± [°]	± 4	± 4
	To end position	± [°]	± 48	± 30
Response time	*2 Minimum	[sec]	0.5	0.5
Reset	Principle		Centred with external force	Self-centred without external force
	Torque	[Nm]	1.2	0.7

*1) With long lever (radius r without / with pressure cut-off = 70/75 mm)
*2) Other response times possible with special restrictors

Displacement Relative to Control Angle



2b. Electro-hydraulic Control

This control can be supplied with 2 or 3 solenoids.
The 2 solenoid version can also be fitted with pressure cut-off.

Circuit Diagram and Function

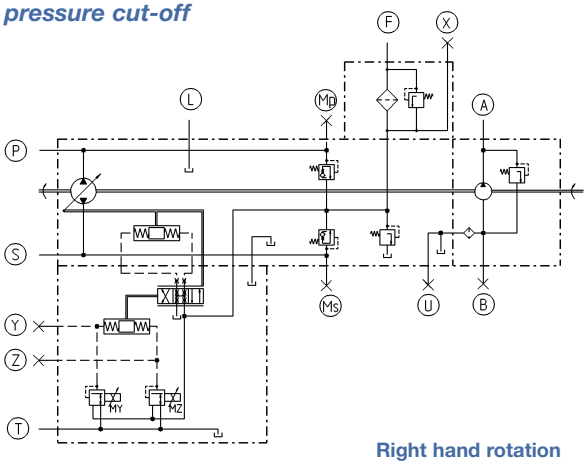
By means of a suitable controller (see Linde brochure “Controls Programme”) the pump flow rate and flow direction are controlled via the energised proportional solenoid.

Controllers with pressure cut-off reduce pump flow when the cut-off pressure is reached. As system pressure is maintained only a small quantity of residual fluid flows through the high pressure valve thus optimising power consumption and system thermal balance

Electro-hydraulic control E1 has 2 proportional solenoids and is suitable for general application.

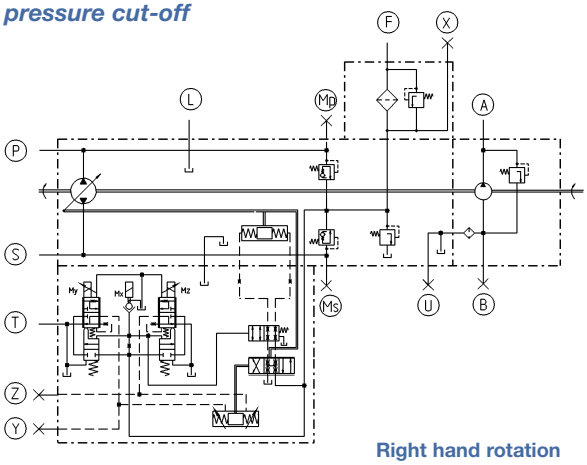
Electro-hydraulic control E2 is fitted with an additional switching solenoid and complies to Linde Standards.
It’s use is recommended for mobile applications where specific criteria have to be met in the event of electrical faults occuring. In these cases (e.g. cable break or false signals) the additional **third solenoid** ensures the pump swash is returned to neutral slowly and the vehicle is then brought to a stop in a smooth and jerk free manner.

2 solenoid control without pressure cut-off



Right hand rotation

3 solenoid control without pressure cut-off



Right hand rotation

P, S High pressure ports
A Pressure port, boost pump
B Suction port, boost pump

F Feed port, boost & control
X, Y, Z Test port, control pressure
Ms, Mp Test ports, high pressure

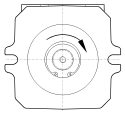
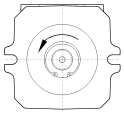
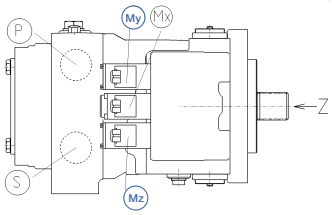
L, U Drain ports
T Vent ports
My, Mz Proportional solenoids connectors
Mx Switching solenoid connector

Note for left hand rotation:
A Suction port, boost pump
B Pressure port, boost pump

Flow Direction

The flow direction of the fluid is dependant upon

- the pump direction of rotation
- the over centre direction of the swash plate

Active solenoid \ Shaft rotation (view on Z)			
	My	P*	S*
	Mz	S*	P*

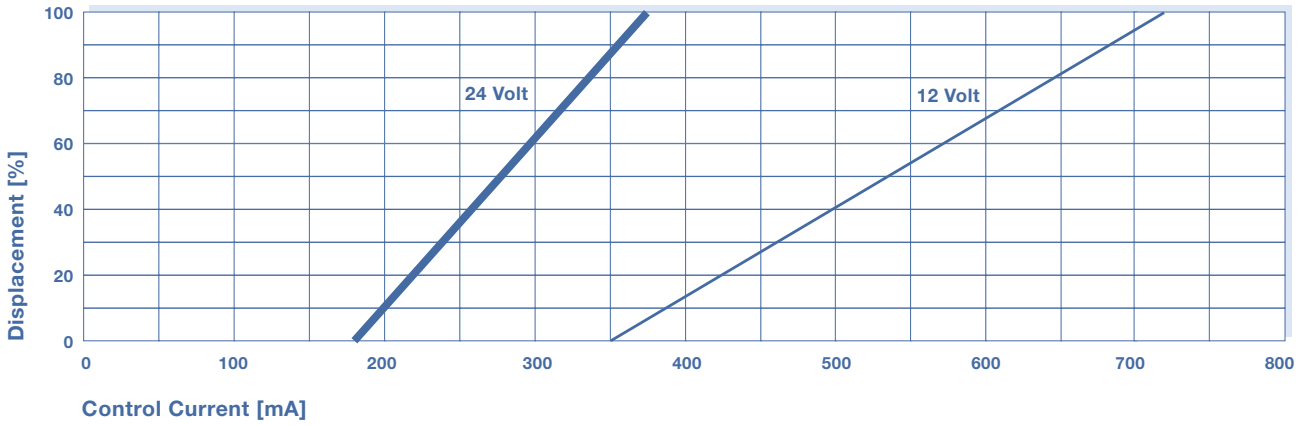
The table shows the flow correlation:

Technical Data

Rated size		**For all unit sizes with and without pressure cut-off**	
Connector type	With E1 control	Hirschmann	
	With E2 control	AMP-Junior-Timer, 2-pin	
Rated voltage = Limiting voltage	[V]	12	24
Voltage type		Direct (d.c.)	
Power consumption	[W]	15.6	
Rated current = Limiting current	[mA]	1,300	650
Control current	Swash begin [mA]	350 ± 10	175 ± 10
	Swash end [mA]	720	360
Relative duty cycle	[%]	100	
Protection class		IP 6K 6K, Part 9	
Contol types	With Linde transducers: digital via Pulse Width Modulation PWM	100 Hz Rectangle, Pulse duty ratio variable over control range	
	Alternative option: Analogue control	Direct current (with or without superimposed dither signal for stability and reducing hysterisis effects, dither ± 125 mA, 32-40 Hz, pulse duty ratio 1:1)	
Response time *	Minimum [secs]	0.5	

* Other response times possible with special restrictors.

Displacement Relative to Control Current



2c. Hydraulic Control

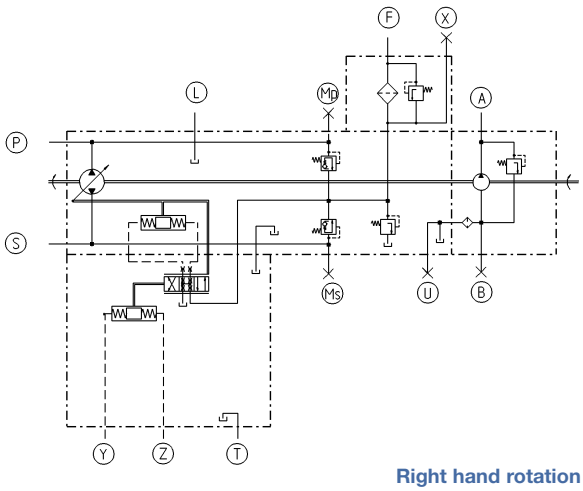
This control can be supplied with or without pressure cut-off

Circuit Diagram and Function

By means of a suitable pilot pressure control valve (see Linde Brochure “Controls Programme”) the pump flow rate and flow direction are controlled.

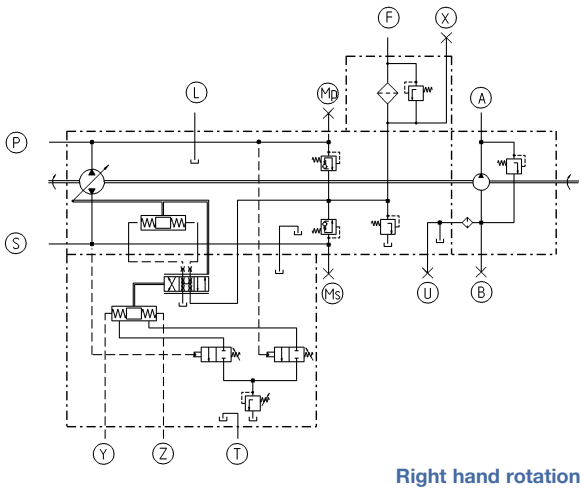
Controllers with pressure cut-off reduce pump flow when the cut-off pressure is reached. As system pressure is maintained, only a small quantity of residual fluid flows through the high pressure valve thus optimising power consumption and system thermal balance.

Without pressure cut-off



Right hand rotation

With pressure cut-off



Right hand rotation

P. S High pressure ports
A Pressure port, boost pump
B Suction port, boost pump

F Feed port, boost & control
X Test port, control pressure
Ms, Mp Test ports, high pressure

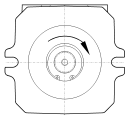
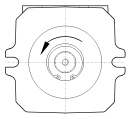
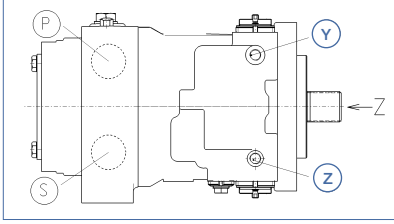
L, U Drain ports
T Vent port
Y, Z Pilot (control) pressure ports

Note for left hand rotation:
A Suction port, boost pump
B Pressure port, boost pump

Flow Direction

The flow direction of the fluid is dependant upon

- the pump direction of rotation
- the over centre direction of the swash plate

Pilot pressure port \ Shaft rotation (view on Z)			
	Y	P*	S*
	Z	S*	P*

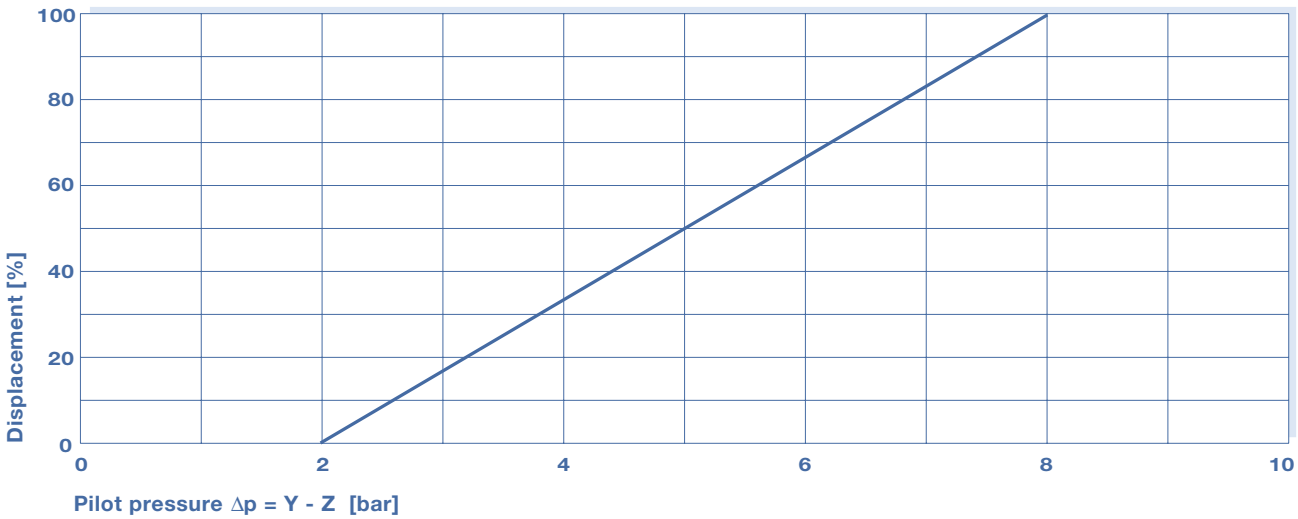
The table shows the flow correlation:

Technical Data

Rated size			For all unit sizes with and without pressure cut-off
Control pressure range	Differential pressure [Y-Z]	[bar]	2-8
Permissible pressure at Y or Z	Maximum	[bar]	30
Response time *	Minimum	[sec]	0.5

* Other response times possible with special restrictors.

Displacement Relative to Pilot Pressure



3. BOOST PUMPS

Boost pump with cold start valve

Technical Description

The boost pump is of the internal gear tooth type and supplies

- Boost flow (make-up)
- Control flow and
- Cooling flow

The boost and cooling circuits are protected by pressure relief valves (low pressure and cold start valves)

Depending on the application, suction can be either

- internal
- external or
- hybrid (simultaneous internal and external suction)

Technical Data

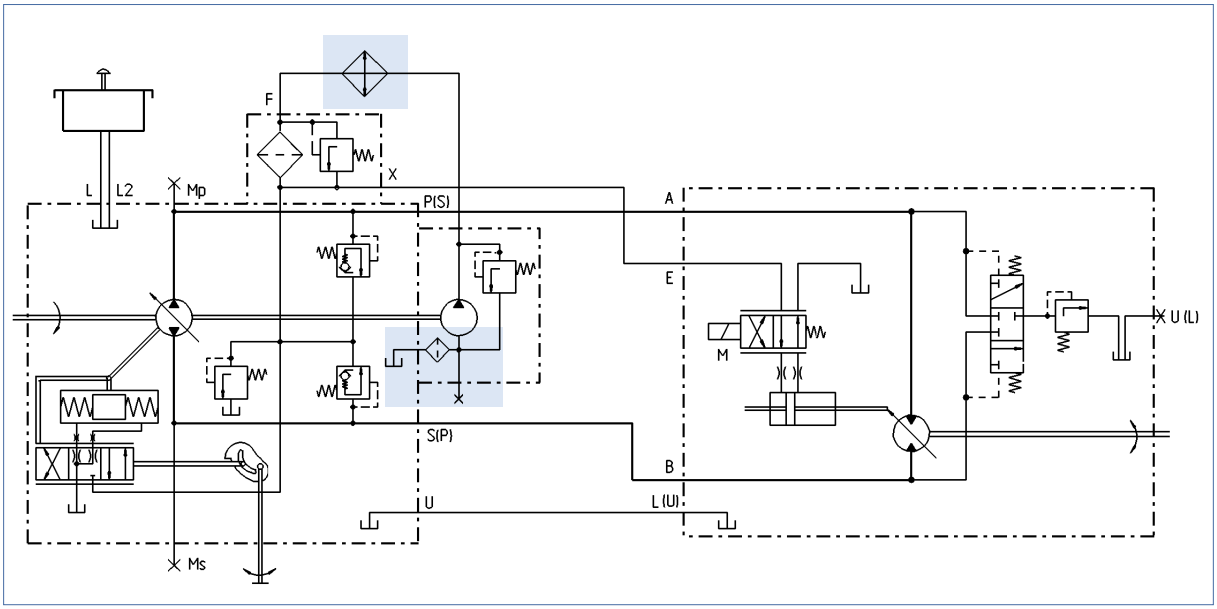
Rated size		**55**	**75**	**105**	**135**
Max. displacement	[cm^3/rev]	16	22.5		
Setting values	Boost pressure [bar]	19			
	Cold start valve [bar]	24			
Pressure	Maximum pressure * [bar]	40			

* Observe max. permissible rated pressures for filter and cooler.

Circuit Diagram (example)

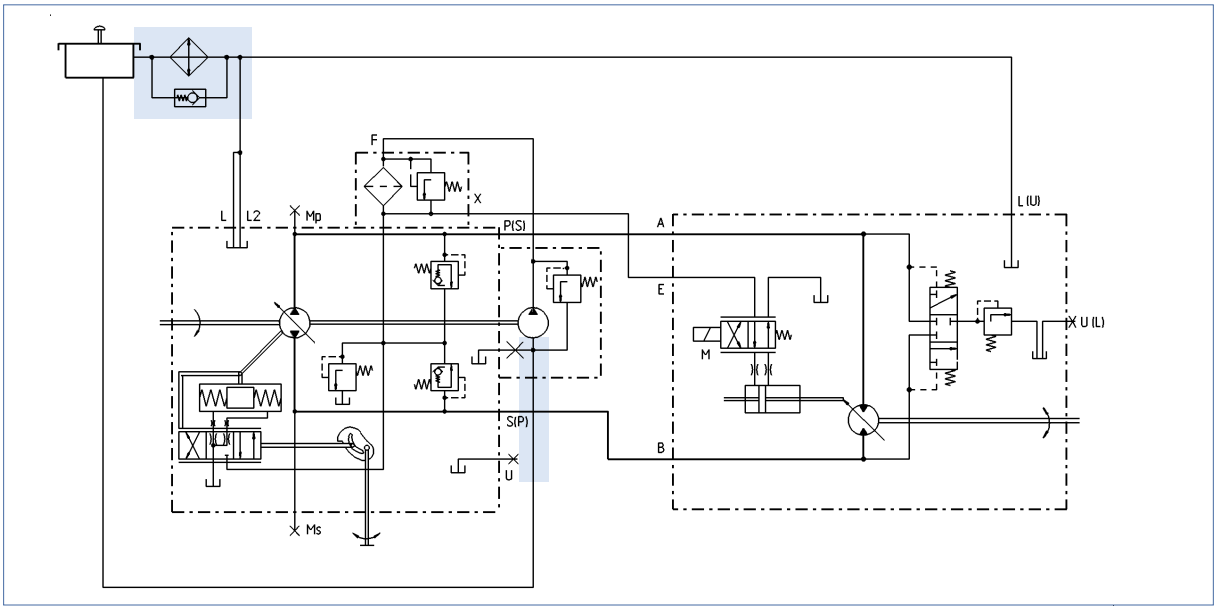
Boost pump with **internal** suction

- HPV-02 pump with mechanical - hydraulic control
- HMV-02 motor with Electro-hydraulic Flip-Flop control
- Oil Cooler in low pressure circuit

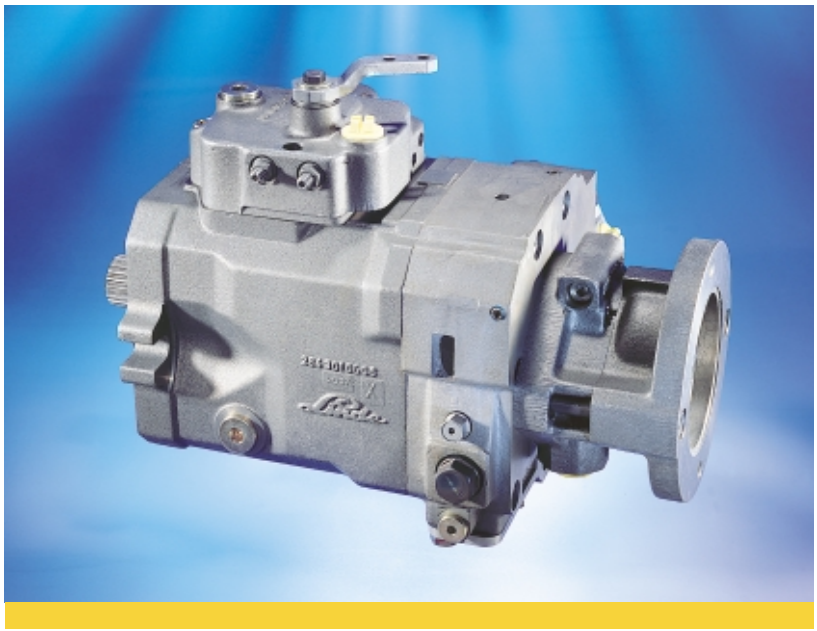


Boost pump with **external** suction

- HPV-02 pump with mechanical - hydraulic control
- HMV-02 motor with Electro-hydraulic Flip-Flop control
- Oil Cooler in return pressure circuit



4. AUXILIARY PUMPS (PTO)



Technical Description

Additional drives, for example supply or service pumps can be driven from the splined through shaft. The power take off (PTO) options available are

- SAE A
- SAE B
- SAE B-B or
- SAE C

Mounting flanges

Main pumps are supplied as standard with SAE A type PTO and require no additional intermediate flange or coupling. For optional **SAE B, B-B** and **C** type PTO's then intermediate mounting flanges and muff couplings are available.
The additional drive (PTO) options can be supplied with or without the boost pump.

Technical Data

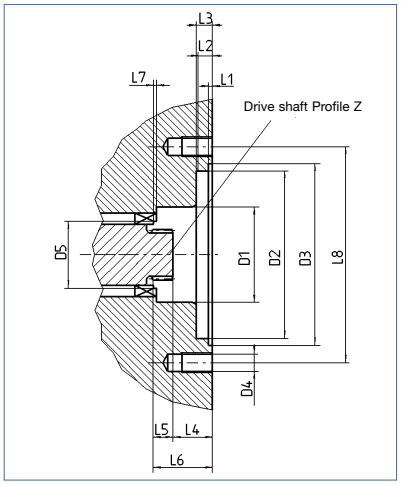
Power take off with boost pump

Transfer Torque / Rated size		55	75	105	135
SAE A	**Continuous [Nm]**	75			
	Max. [Nm]	107			
SAE B	**Continuous [Nm]**	175			
	Max. [Nm]	250			
SAE B-B	**Continuous [Nm]**	175			
	Max. [Nm]	250			
SAE C	**Continuous [Nm]**	175			
	Max. [Nm]	250			

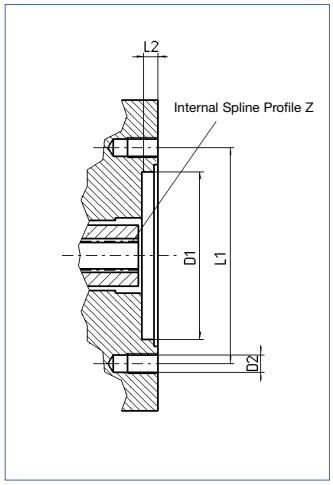
Power take off without boost pump

Transfer Torque / Rated size		55	75	105	135
Continuous	**[Nm]**	220	305	420	540
Max.	**[Nm]**	350	485	670	870

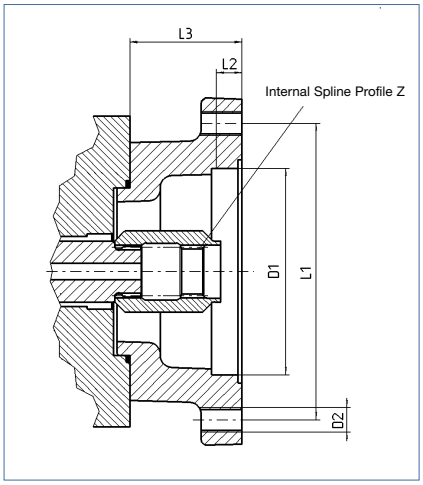
Flange Dimensions



PTO without boost pump



PTO with boost pump
SAE A



PTO with boost pump
SAE B, B-B and C

Flange dimensions for PTO with boost pump

Rated Size		**For all sizes**			
Flange Profile		SAE A	SAE B	SAE B-B	SAE C
		2 hole			
Internal spline profile Z		ANSI B92.1,			
		16/32 spline pitch			12/24 spline pitch
		9 Teeth	13 Teeth	15 Teeth	14 Teeth
D1 Spigot pilot diameter	**[mm]**	82.55	101.6		127
D2 Thread size	**[mm]**	M 10	M 12		M 16
L1 Hole distance	**[mm]**	106.4	146		181
L2 Adapter length	**[mm]**	7	11		13
L3 Flange length	**[mm]**	–	55		72

Flange dimensions for PTO without boost pump

Rated size		**55**	**75**	**105**	**135**
Drive shaft profile Z		ANSI B92.1,			
		16/32 spline pitch			
		15 Teeth	18 Teeth	19 Teeth	21 Teeth
D1	**[mm]**	40	42	48	52
D2 Spigot pilot diameter	**[mm]**	82.55			
D3	**[mm]**	88			
D4	**[mm]**	M 10			
D5 Bearing clearance, max.	**[mm]**	30	35	38	43
L1	**[mm]**	1.5			
L2 Adapter length	**[mm]**	7			
L3	**[mm]**	9			
L4 Minimum distance	**[mm]**	35	39	33	35
L5 Usable spline length	**[mm]**	14	18	19	20
L6 Distance to bearing	**[mm]**	51	57.5	53	55.9
L7 Bearing clearance, min.	**[mm]**	3	3	3	4
L8 Hole distance	**[mm]**	106.4 (2 bolt)			

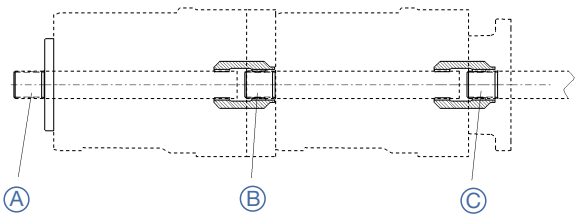
5. TANDEM AND MULTIPLE PUMPS

Tandem and multiple pumps are created by the “series adding on” of single HPV -02 units.

Combinations Available

Rated size back pump \ Rated size front pump	55	75	105	135
55	yes	yes	yes	yes
75	-	yes	yes	yes
105	-	-	yes	yes
135	-	-	-	yes

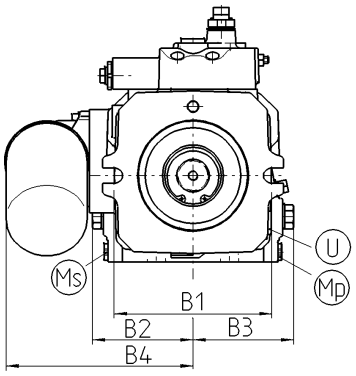
Transfer Torques

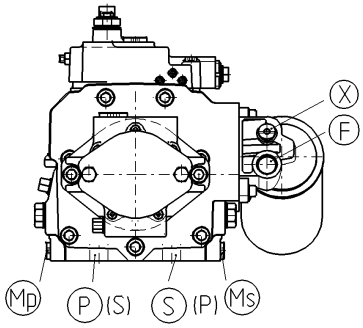
Max. transfer torque \ Rated size front pump				55	75	105	135
							
To Position Ⓐ			[Nm]	570	790	1090	1410
To Position Ⓑ	for rated size of back pump	55	[Nm]	350	350	350	350
	for rated size of back pump	75	[Nm]	-	485	485	485
	for rated size of back pump	105	[Nm]	-	-	670	670
	for rated size of back pump	135	[Nm]	-	-	-	870
To Position Ⓒ (for PTO)			[Nm]	see table on page 4			

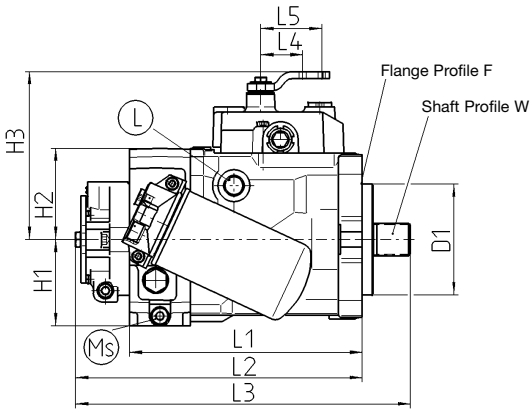
6. MAIN DIMENSIONS

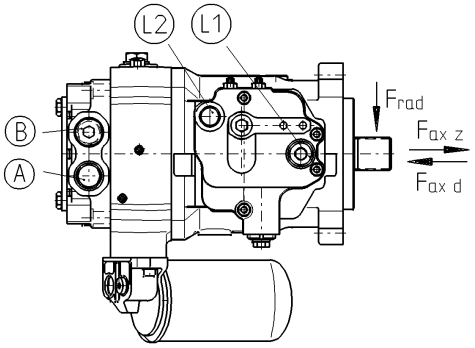
HPV-02 with Mechanical-hydraulic Control

Rated size		55	75	105	135
Flange Profile F		Mounting flange: 2 hole			
		SAE C			SAE D
Shaft Profile W		Ansi B92.1			
		16/32 spline pitch			
		21 Teeth		23 Teeth	27 Teeth
D1 [mm]		127			152.4
B1 [mm]		181			228.6
B2 [mm]		101	116		141
B3 [mm]		101	116		141
B4 [mm]		192	216		219
L1 [mm]		225	242	267	288
L2 [mm]		282	304	329	350
L3 [mm]		335	359	385	425
L4 [mm]	No PCO	48			
	With PCO	52			
L5 [mm]	No PCO	70			
	With PCO	75			
H1 [mm]		88	93	99	106
H2 [mm]		95	103	105	112
H3 [mm]	No PCO	184	188	193	198
	With PCO	220	224	229	234
P		SAE 3/4"	SAE 1"		SAE 1 1/4"
S		SAE 3/4"	SAE 1"		SAE 1 1/4"
A		M26x1.5			
B		M26x1.5			
L		M22x1.5			
U		M22x1.5			
F		M22x1.5			
X		M14x1.5			
Mp		M14x1.5			
Ms		M14x1.5			
L1		M22x1.5			
L2		M22x1.5			
T		M22x1.5			
Y		M14x1.5			
Z		M14x1.5			







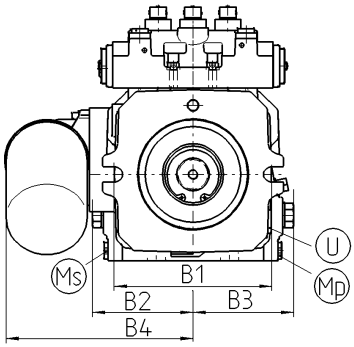


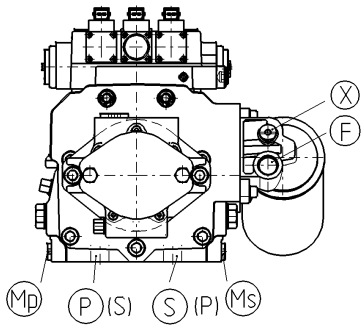
All metric threaded ports to DIN3852
Threaded ports to ISO 6149 on request

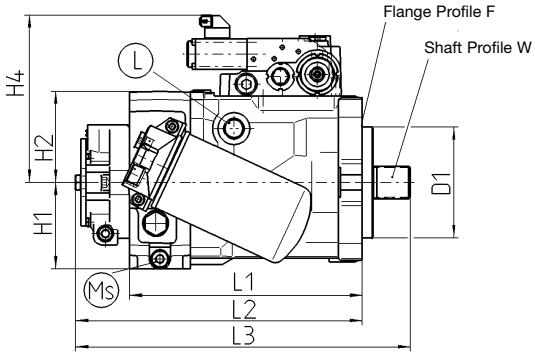
Design changes are reserved.
Refer to installation drawings for exact dimensions

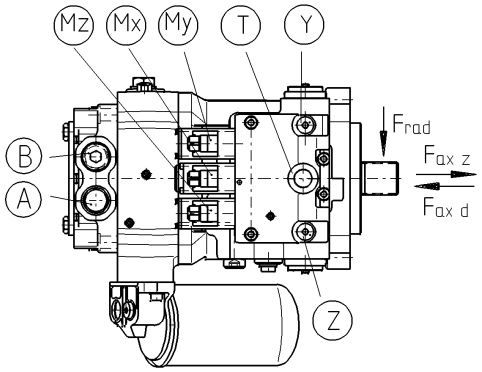
HPV-02 with Electro-hydraulic Control

Rated size		**55**	**75**	**105**	**135**
Flange Profile F		Mounting flange: 2 hole			
		SAE C			SAE D
Shaft Profile W		Ansi B92.1			
		16/32 spline pitch			
		21 Teeth		23 Teeth	27 Teeth
D1 [mm]		127			152.4
B1 [mm]		181			228.6
B2 [mm]		101	116		141
B3 [mm]		101	116		141
B4 [mm]		192	216		219
L1 [mm]		225	242	267	288
L2 [mm]		282	304	329	350
L3 [mm]		335	359	385	425
H1 [mm]		88	93	99	106
H2 [mm]		95	103	105	112
H4 [mm]	**No PCO**	159	164	168	173
	With PCO	195	200	204	209
P		SAE 3/4"	SAE 1"		SAE 1 1/4"
S		SAE 3/4"	SAE 1"		SAE 1 1/4"
A		M26x1.5			
B		M26x1.5			
L		M22x1.5			
U		M22x1.5			
F		M22x1.5			
X		M14x1.5			
Mp		M14x1.5			
Ms		M14x1.5			
T		M22x1.5			
Y		M14x1.5			
Z		M14x1.5			
Mx	**E1 connector**	–			
	E2 connector	AMP-Junior-Timer, 2 pin			
My	**E1 connector**	Hirschmann			
	E2 connector	AMP-Junior-Timer, 2 pin			
Mz	**E1 connector**	Hirschmann			
	E2 connector	AMP-Junior-Timer, 2 pin			









All metric threaded ports to DIN3852
Threaded ports to ISO 6149 on request

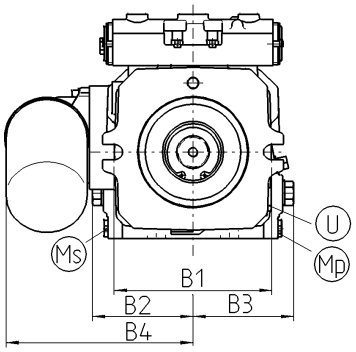
Design changes are reserved.
Refer to installation drawings for exact dimensions

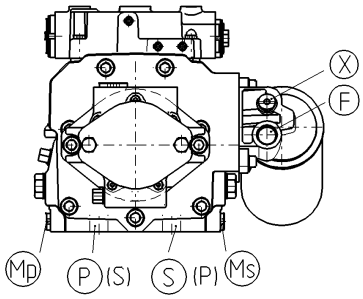
HPV-02 with Hydraulic Control

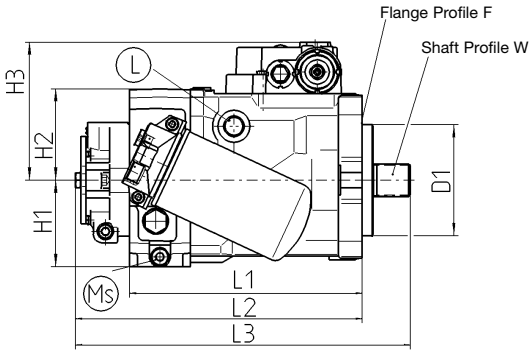
Rated size		**55**	**75**	**105**	**135**
Flange Profile F		Mounting flange: 2 hole			
		SAE C			SAE D
Shaft Profile W		Ansi B92.1			
		16/32 spline pitch			
		21 Teeth		23 Teeth	27 Teeth
D1 [mm]		127			152.4
B1 [mm]		181			228.6
B2 [mm]		101	116		141
B3 [mm]		101	116		141
B4 [mm]		192	216		219
L1 [mm]		225	242	267	288
L2 [mm]		282	304	329	350
L3 [mm]		335	359	385	425
H1 [mm]		88	93	99	106
H2 [mm]		95	103	105	112
H3 [mm]	**No PCO**	149	154	158	163
	With PCO	185	190	194	199
P		SAE 3/4"	SAE 1"		SAE 1 1/4"
S		SAE 3/4"	SAE 1"		SAE 1 1/4"
A		M26x1.5			
B		M26x1.5			
L		M22x1.5			
U		M22x1.5			
F		M22x1.5			
X		M14x1.5			
Mp		M14x1.5			
Ms		M14x1.5			
T		M22x1.5			
Y		M14x1.5			
Z		M14x1.5			

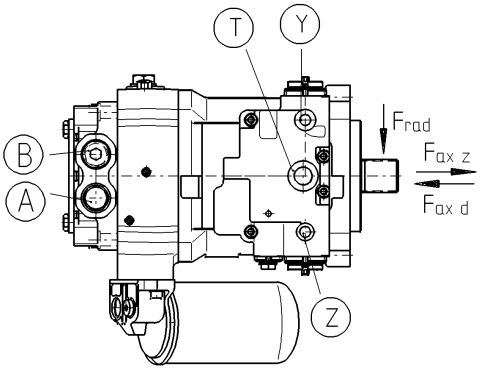
All metric threaded ports to DIN3852
Threaded ports to ISO 6149 on request

Design changes are reserved.
Refer to installation drawings for exact dimensions

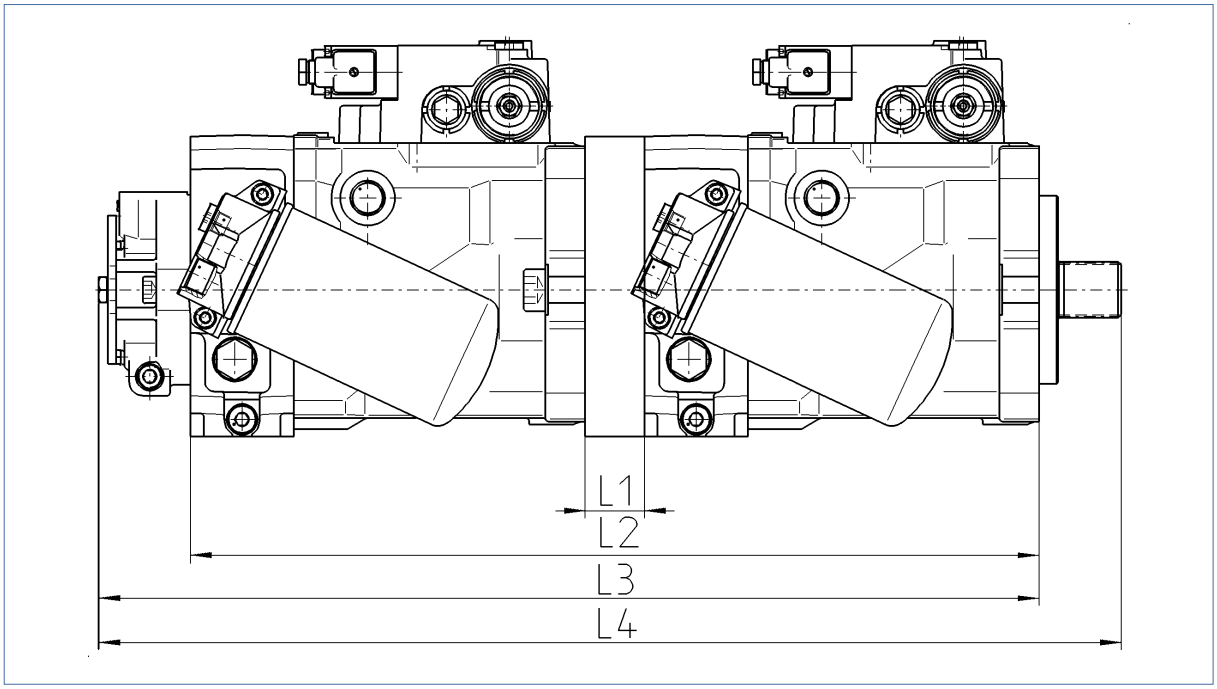








HPV-02 Tandem and Multiple Pumps



Rated size front pump / Rated size back pump		55	75	105	135
55	L1 [mm]	48	–	–	–
	L2 [mm]	498	–	–	–
	L3 [mm]	555	–	–	–
	L4 [mm]	611	–	–	–
75	L1 [mm]	43	43	–	–
	L2 [mm]	510	527	–	–
	L3 [mm]	567	589	–	–
	L4 [mm]	623	645	–	–
105	L1 [mm]	38	38	38	–
	L2 [mm]	530	547	572	–
	L3 [mm]	587	609	634	–
	L4 [mm]	643	665	690	–
135	L1 [mm]	31	31	31	31
	L2 [mm]	544	561	586	607
	L3 [mm]	601	623	648	669
	L4 [mm]	676	698	723	744

Design changes are reserved.
Refer to installation drawings for exact dimensions

7. PRESSURE FLUIDS AND FILTRATION

Permitted Pressure Fluids

- Mineral oil HLP to DIN 51524
- Biodegradeable fluids upon request
- Other pressure fluids upon request

Technical Data

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

Viscosity recommendations

Working temperature [°C]	**Viscosity class [mm²/s] = [cSt] at 40°**
Circa 30 to 40	22
Circa 60 to 80	46 or 68

Linde recommend using only pressure fluids which are confirmed by the producer as suitable for use in high pressure hydraulic installations. For the correct choice of suitable pressure fluid it is necessary to know the working temperature in the hydraulic circuit (closed loop). The pressure fluid chosen must allow the working viscosity to be within the optimum viscosity range (refer to above table).

Attention!
Due to pressure and speed influences the leakage fluid temperature is always higher than the circuit temperature. The temperture must not exceed 90ºC in any part of the system. Under special circumstances, if the stated conditions cannot be observed then please consult Linde.

Filtration

In order to guarantee proper functions and efficiency of the hydraulic pumps the purity of the pressure fluid over the entire operating period, must comply to at least class 18/13 according to ISO 4406.

With modern filtration technology, however, much better values can be achieved which contributes significantly to extending the life and durability of the hydraulic pumps and complete system.

8. TYPICAL APPLICATIONS

Linde Hydraulics Direct Lines

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LHL-HPV-02 08/99E

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