HPV-02

Variable Pump
for closed loop circuit

We move the world.

Hydraulic Components + Electronic Components from Linde this means total Vehicle Management through the complete Linde System.

Linde – the pioneer in **mobile hydraulics** – discovered and perfected hydrostatics as the ideal drive system for mobile machinery. Since 1959, Linde has equipped more than two million vehicles in the fields of

- Construction Equipment
- Agricultural Machinery
- Forestry Equipment
- Municipal Vehicles
- Material Handling

with hydrostatic drives and working systems. The use of these systems in our own fork lift trucks has made Linde the world market leader! Electronics also play an important role in those applications.

Linde products have been leaders in the field of mobile hydraulics for many years. Our customers can rely on our systems expertise and our know-how.
Linde engineers are masters of their field – whether it involves better power utilization, the best possible interaction among the total-system components, ease of operation or safety.

Components and systems from Linde are also widely used in **stationary machines**. Many different uses and applications can be served: woodworking machines, mixers, agitators and centrifuges in process engineering, presses, drilling machines, cable winches, plastic-processing machines, theater engineering, ships' helms and other marine applications, rotary drums for the cement and sugar industries, material handling systems, amusement park rides, and many others.

Whether it's closed or open loop systems,

Linde hydraulics is always the right choice.

HPV-02

CONTENTS

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, 135, 165 and 210 cm^3/rev as well as tandem and multiple pumps

Design Characteristics

- Axial piston pump, swash plate design
- Swash angle 21°
- Precise and robust control
- Integral boost pump (sizes 55-135 with cold start valve)
- Integrated high pressure relief and make-up valves
- Integrated low pressure valves for boost, servo and cooler circuits
- Integrated towing/short circuit valve (optional)
- Fitted replaceable cartridge filter
- SAE 2-bolt mounting flange with ANSI splined shaft (sizes 55-165)
- SAE 4-bolt mounting flange with ANSI splined shaft (size 210)
- SAE A, B, B-B and C rear flange (PTO)
- SAE A = Standard (built-in)
- Tandem and multiple pump options

The data on which this brochure is based correspond to the current state of development. We reserve the right to make changes in case of technical progress. The dimensions and technical data of the individual installation drawings are prevailing.

Technical Data

Rated Sizes	Nominal displacement	[cm^3/rev]	**55**	**75**	**105**	**135**	**210**
	Maximum displacement	[cm^3/rev]	54.8	75.9	105.0	135.6	210.0
Speed	Max. speed, continuous	[rev/min]	3300	3100	2900	2700	2300
	Max. speed, intermittent *1	[rev/min]	3700	3500	3200	2900	2500
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	840
	Max. input torque *4	[Nm]	350	485	670	870	1340
Power	Continuous power *5	[kW]	75	98	127	153	201
	Max. power *6	[kW]	121	157	204	245	322
Shaft Loads	Axial input force *7	[N]	2000				
	Axial output force *7	[N]	2000				
	Radial *7	[N]	on request				
Temperature	*10	[°C]	90				
Weights	With mech-hydraulic servo *8	[kg]	44	49	60	74	122
	Max. moment of inertia *9	[$kgm^2 \times 10^{-2}$]	0.54	0.84	1.49	2.20	4.75
Main dimensions			see chapter 6				

under development

*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 chapter 6
*8) automotive control: on request
*9) includes boost pump
*10) min. permissible viscosity > 10 cSt

2. CONTROLS

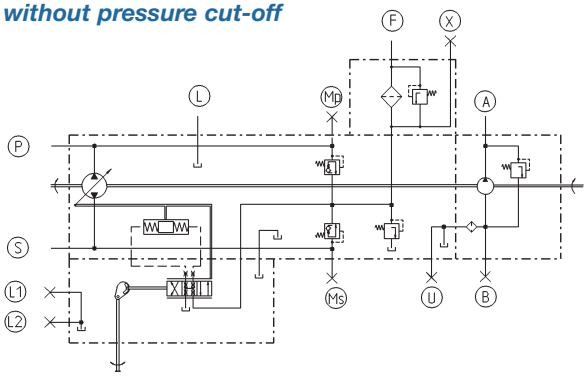
2.1 *Mechanical-hydraulic Control M1*

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

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

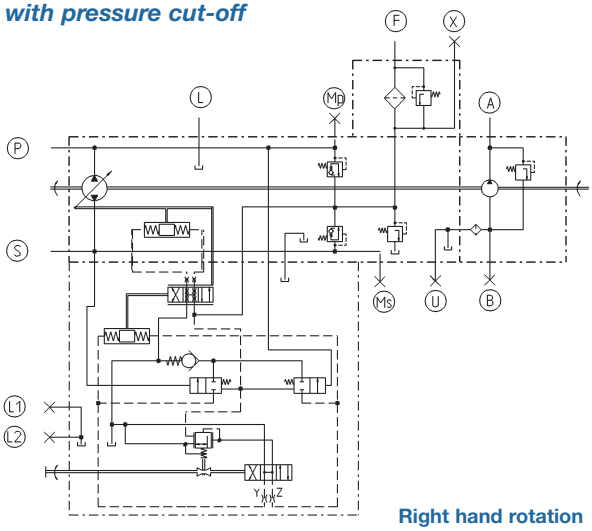
Controllers with pressure cut-off reduce pump flow when the cut-off pressure is reached. As system pressure is maintained, only a small quantity of residential fluid flows through the high pressure valve thus optimising power consumption and system thermal balance.

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

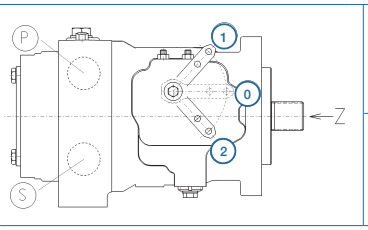
X Test port, control pressure
Ms, Mp Test ports, high pressure
L, U Drain ports
L1, L2 Vent ports

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

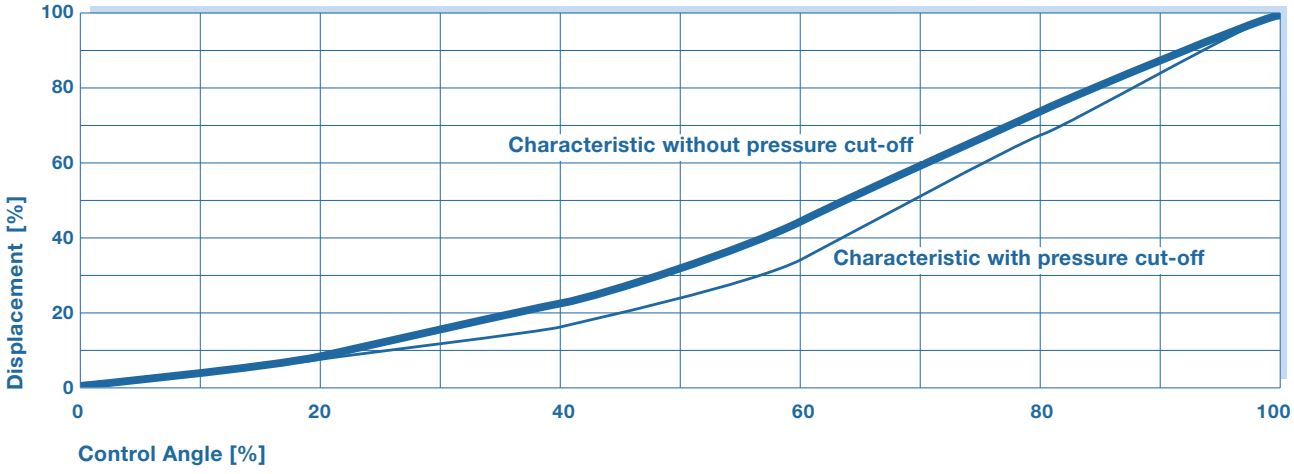
- the pump direction of rotation
- the over centre direction of the swash plate

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

The table shows the flow correlation:

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



2.2 Electro-hydraulic Control E1/E2

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

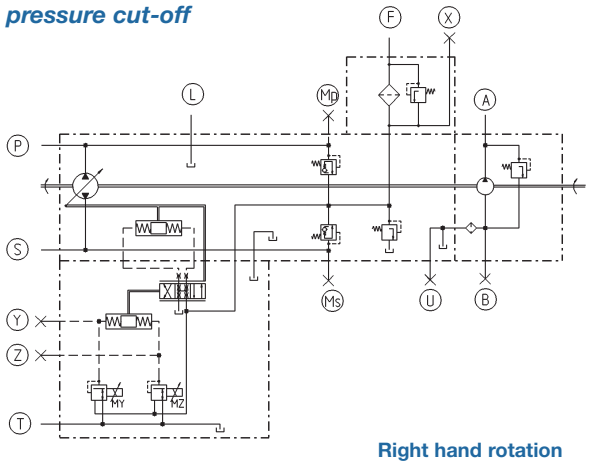
By means of a suitable controller (see Linde brochure “Controls Programme”) the pump flow rate and flow direction are controlled via the energised proportional solenoid.

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.

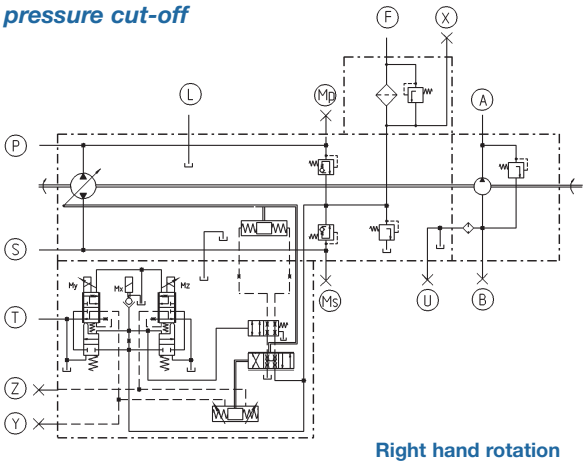
Electro-hydraulic control E2 is fitted with an additional switching solenoid and complies to Linde Standards.
It’s use is recommended for mobile applications where specific criteria have to be met in the event of electrical faults occuring. In these cases (e.g. cable break or false signals) the additional **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

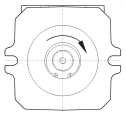
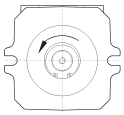
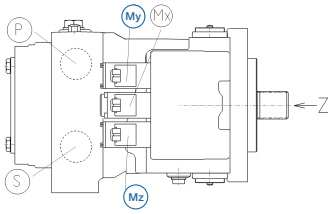
L, U Drain ports
T Vent ports
My, Mz Proportional solenoids connectors
Mx Switching solenoid connector

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

Flow Direction

The flow direction of the fluid is dependent upon

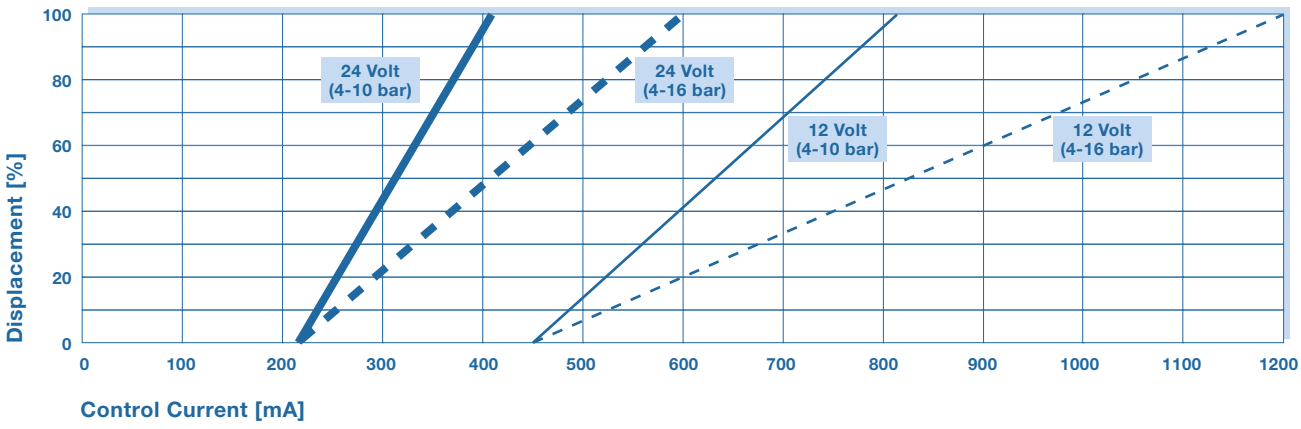
- the pump direction of rotation
- the over centre direction of the swash plate

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

The table shows the flow correlation:

Rated size		For all unit sizes with and without pressure cut-off	
Connector type	With E1-control	Hirschmann/AMP-JT, 2-pin	
	With E2-control	AMP-JT, 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]	450 ± 10	225 ± 10
	Swash end [mA]	820 (1200) *1)	410 (600) *1)
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 *2) [s]	0.5	

*1) On request
*2) Other response times possible with special orifices.



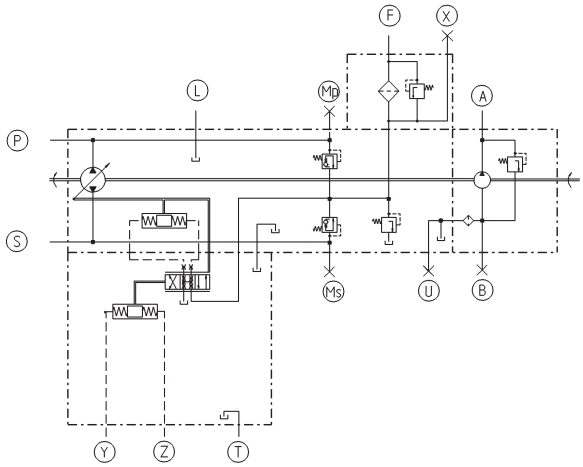
2.3 Hydraulic Control H1

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

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

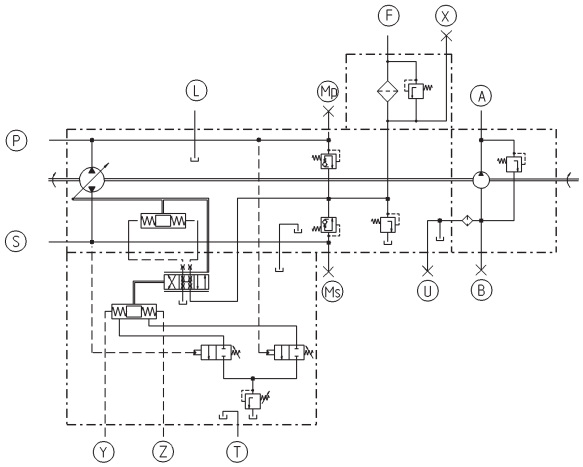
Controllers with pressure cut-off reduce pump flow when the cut-off pressure is reached. As system pressure is maintained, only a small quantity of residual fluid flows through the high pressure valve thus optimising power consumption and system thermal balance.

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

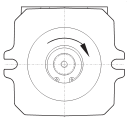
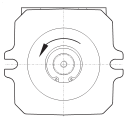
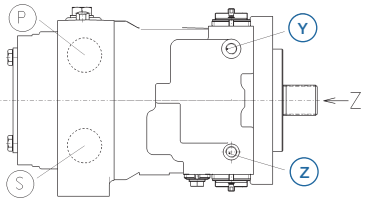
L, U Drain ports
T Vent port
Y, Z Pilot (control) pressure ports

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

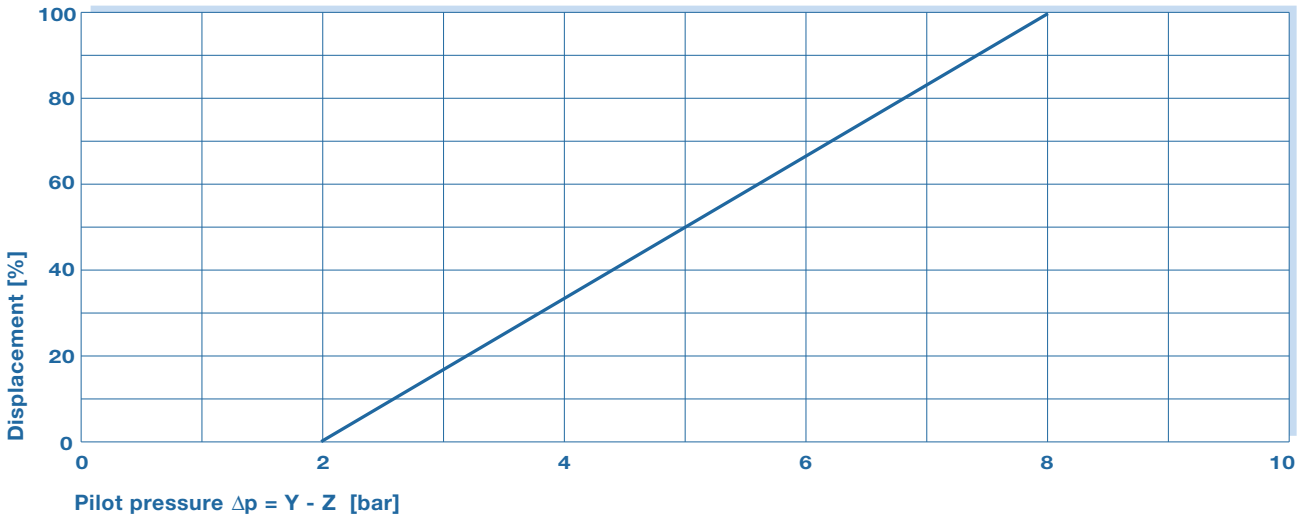
- the pump direction of rotation
- the over centre direction of the swash plate

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

The table shows the flow correlation:

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.



3. BOOST PUMPS

HPV 105-02 with integrated boost pump and cold start valve

HPV 210-02 with boost pump added

The boost pump for the sizes 55-135 is an internal type gear pump, and for the sizes 165-210 an external type gear pump. The boost pump supplies

- Boost flow (make-up/feed)
- Control flow and
- Cooling flow.

All pump sizes include a charge valve, the sizes 55-135 have a cold start valve additionally.

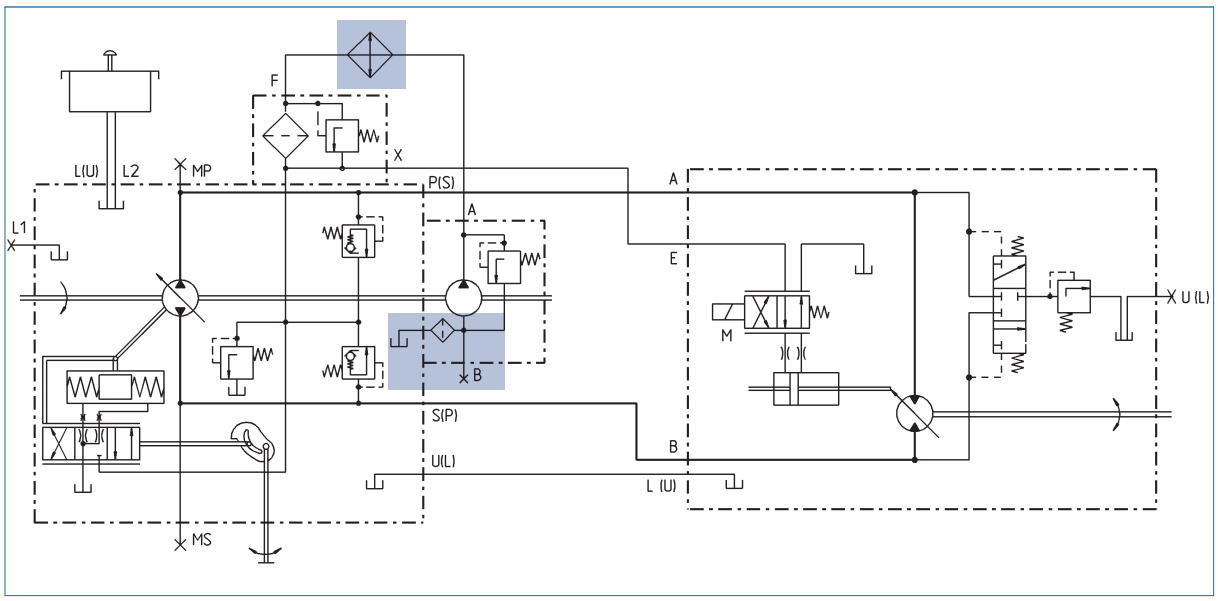
Depending on the application, suction can either be
- internal, external or hybrid (simultaneous internal and external suction)
- for sizes 165-210 external only.

Rated size		**55**	**75**	**105**	**135**	**165**	**210**
Displacement	[cm^3/rev]	16	22.5			38	
Setting values	Boost pressure [bar]	19					
	Cold start valve [bar]	25				not Linde-scope of supply	
Pressure	Maximum pressure* [bar]	40					

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

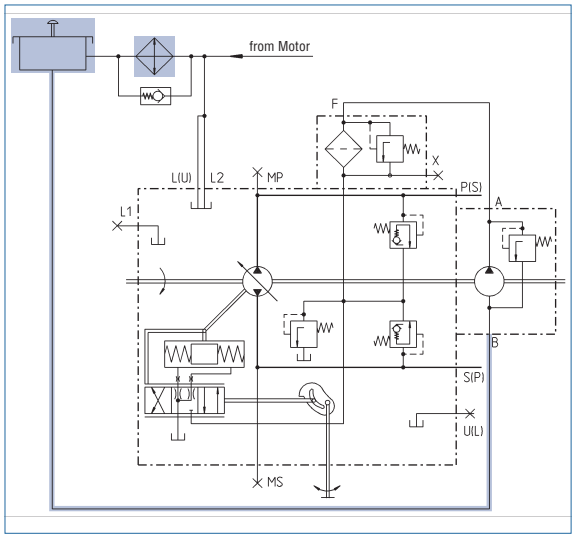
Boost pump with **internal** suction for sizes 55-135

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

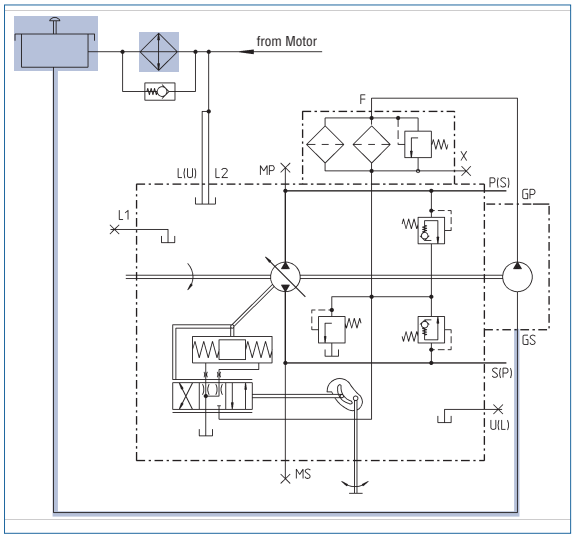


Boost pump with **external** suction for sizes 55-210

- HPV-02 pump with mechanical - hydraulic control
- Oil Cooler in return line

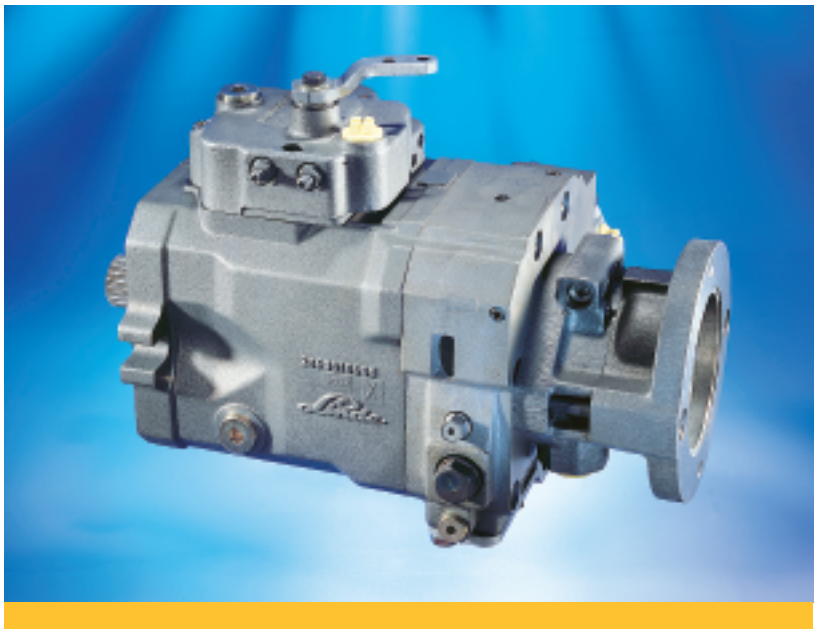


Sizes 55-135



Sizes 165-210

4. AUXILIARY PUMPS (PTO)



With sizes 55-135 additional drives, e.g. utility pumps can be driven from the splined thru-shaft.

With sizes 55-135 power can be taken off with or without boost pump mounted. In case of boost pump mounted the power take off options available are **SAE A-, B-, B-B-** or **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 intermediate mounting flanges and muff couplings are available.

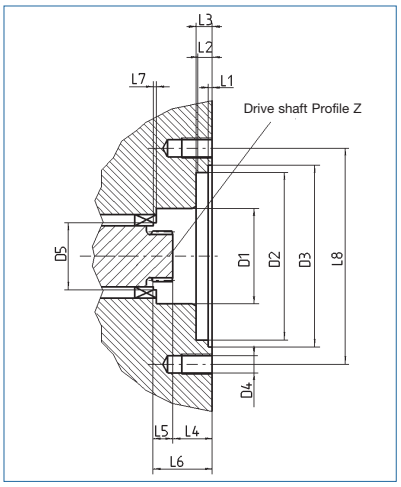
With sizes 165 and 210 power take off can only be realized without boost pump mounted.

Power take off with boost pump

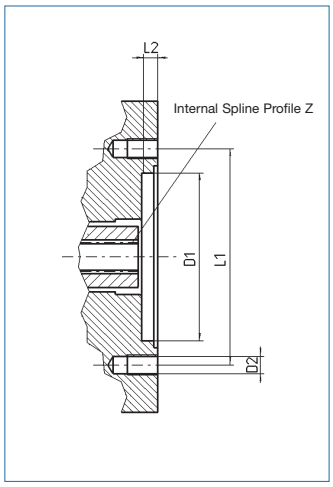
Transfer Torque \ Rated size		55	75	105	135	165	210
SAE A	Continuous [Nm]	75					
	Max. [Nm]	107					
SAE B	Continuous [Nm]	175					
	Max. [Nm]	250					
SAE B-B	Continuous [Nm]	175					
	Max. [Nm]	250					
SAE C	Continuous [Nm]	175					
	Max. [Nm]	250					

Power take off without boost pump

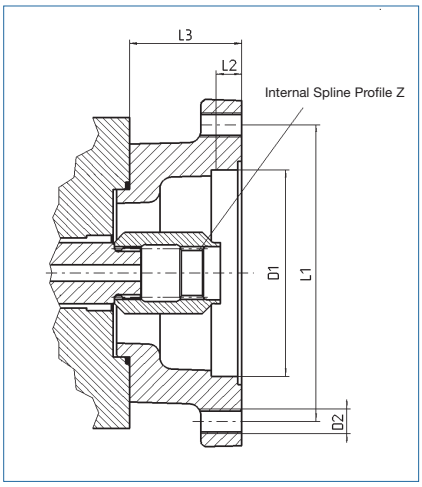
Transfer Torque \ Rated size		55	75	105	135	165	210
Continuous	[Nm]	220	305	420	540	under development	840
Max.	[Nm]	350	485	670	870		1340



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 sizes 55-135**			
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

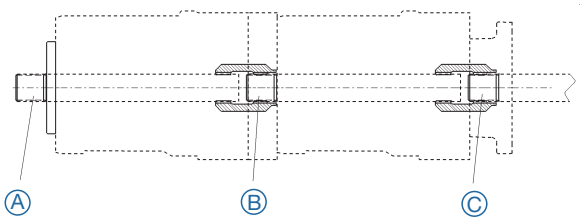
Flange dimensions for PTO without boost pump

Rated size		**55**	**75**	**105**	**135**	**165**	**210**
Drive shaft profile Z		ANSI B92.1,				under development	prototypes
		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 pumps are created by the “series adding on” of single HPV-02 units.
Multiple pumps consist of an HPV-pump and an HPR-pump.

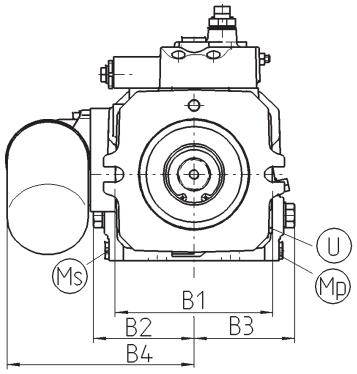
Rated size back pump \ Rated size front pump	55	75	105	135	165	210
55	yes	yes	yes	yes	under development	yes
75	-	yes	yes	yes		yes
105	-	-	yes	yes		yes
135	-	-	-	yes		yes
165	-	-	-	-		-
210	-	-	-	-		yes

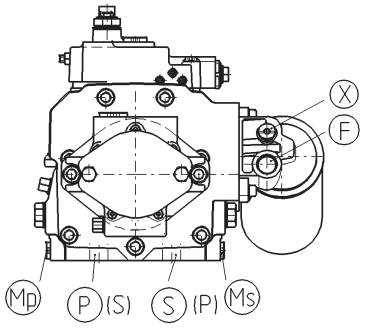
Max. transfer torque \ Rated size front pump			55	75	105	135	165	210
								
To Position Ⓐ		[Nm]	570	790	1090	1410	under development	2180
To Position Ⓑ	for rated size of back pump	55 [Nm]	350	485	570	570		570
	for rated size of back pump	75 [Nm]	-	485	670	790		790
	for rated size of back pump	105 [Nm]	-	-	670	870		**1090**
	for rated size of back pump	135 [Nm]						
	for rated size of back pump	165 [Nm]						
	for rated size of back pump	210 [Nm]						
To Position Ⓒ (for PTO)		[Nm]	see table in chapter 4					

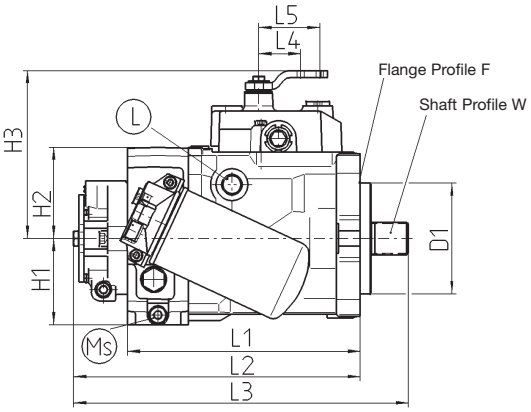
6. MAIN DIMENSIONS

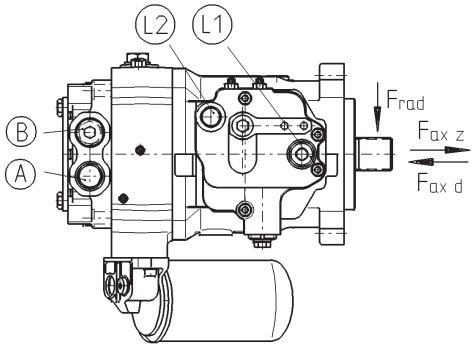
HPV-02 with Mechanical-hydraulic Control M1

Size		55	75	105	135	165	210
Flange Profile F		Mounting flange: 2-hole				under development	prototypes
		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]	w/o PCO	48					
	with PCO	52					
L5 [mm]	w/o PCO	70					
	with PCO	75					
H1 [mm]		88	93	99	106		
H2 [mm]		95	103	105	112		
H3 [mm]	w/o 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					





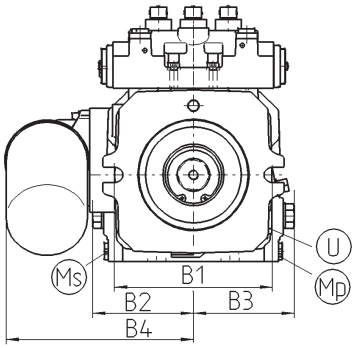


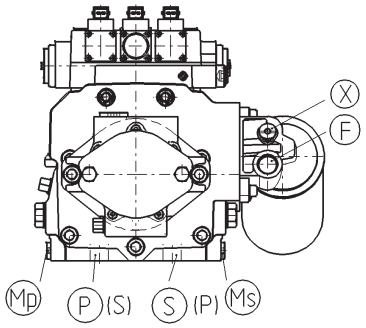


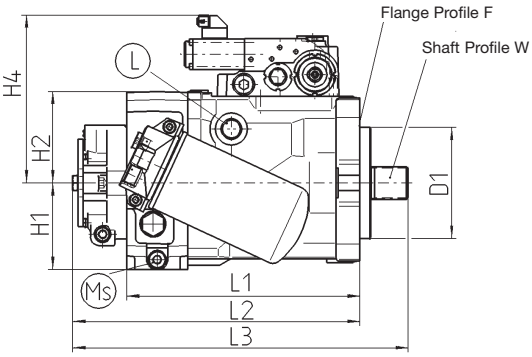
Threads metric as per ISO 6149
Threads for leakage ports metric as per DIN 3852 (with sizes 165-210 metric as per ISO 6149)
Threads for SAE-high pressure port metric as per DIN 3852
Threads as per UN/UNF on request

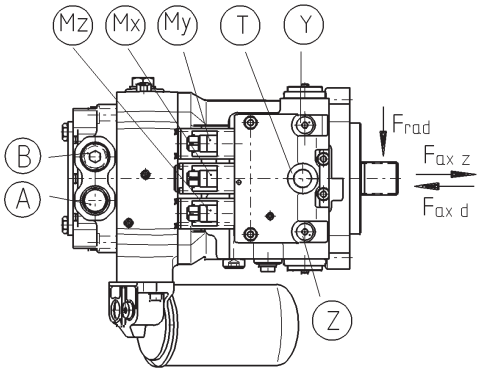
HPV-02 with Electro-hydraulic Control E1/E2

Size			55	75	105	135	165	210
Flange Profile F			Mounting flange: 2-hole				under development	prototypes
			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]		w/o 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-JT					
My	E1 connector		Hirschmann, AMP-JT					
	E2 connector		AMP-JT					
Mz	E1 connector		Hirschmann, AMP-JT					
	E2 connector		AMP-JT					







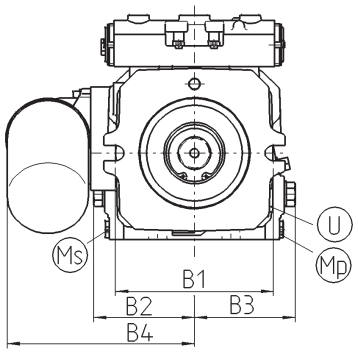


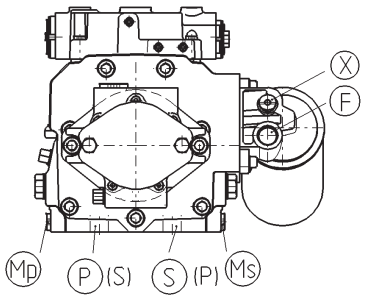
Threads metric as per ISO 6149
Threads for leakage ports metric as per DIN 3852 (with sizes 165-210 metric as per ISO 6149)
Threads for SAE-high pressure port metric as per DIN 3852
Threads as per UN/UNF on request

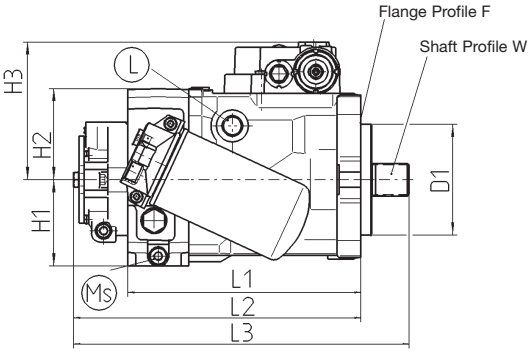
HPV-02 with Hydraulic Control H1

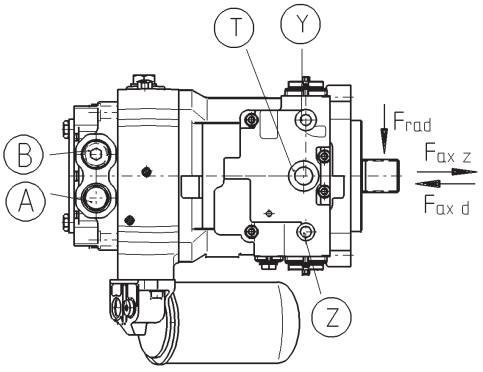
Size		55	75	105	135	165	210
Flange Profile F		Mounting flange: 2-hole				under development	prototypes
		SAE C			SAE D		
Shaft Profile W		ANSI B92.1					
		16/32 spline pitch					
		21 Teeth		23 Teeth	27 Teeth		
D1 [mm]		127			152.4		
B1 [mm]		181			228.6		
B2 [mm]		101	116		141		
B3 [mm]		101	116		141		
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]	**w/o PCO**	194	154	158	163		
	with PCO	185	190	194	199		
P		SAE 3/4"	SAE 1"		SAE1 1/4"		
S		SAE 3/4"	SAE 1"		SAE1 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					

Threads metric as per ISO 6149
Threads for leakage ports metric as per DIN 3852 (with sizes 165-210 metric as per ISO 6149)
Threads for SAE-high pressure port metric as per DIN 3852
Threads as per UN/UNF on request

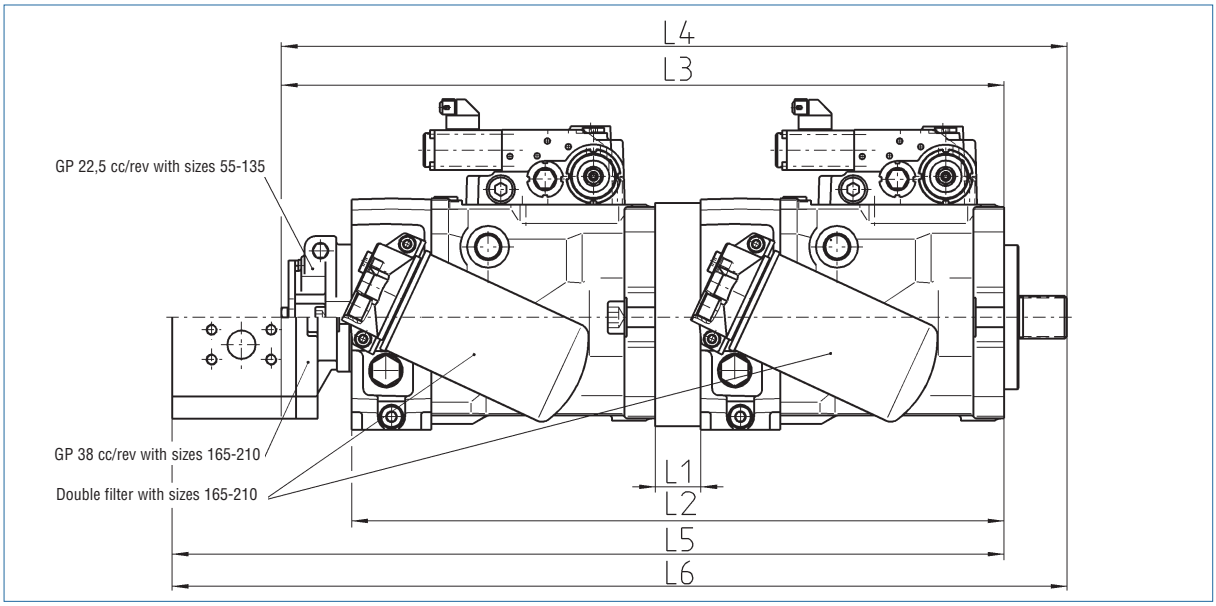








HPV-02 Tandem and Multiple Pumps



In case of tandem pump configuration the required size of the boost pump depends on the actual application. Criteria e.g. are diesel engine speed, number of hydraulic motors fed, working cycles.

Rated size front pump / Rated size back pump		55	75	105	135	165	210
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	690	–		–
	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		–
165	**L1 [mm]**						
	L2 [mm]						
	L5 [mm]						
	L6 [mm]						
210	**L1 [mm]**	40	40	40	55		39
	L2 [mm]	610	627	653	689		731
	L5 [mm]	780	797	823	859		901
	L6 [mm]	855	872	898	933		976

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

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

The hydraulic components and parts are designed for a temperature range of -20 °C to max. +90 °C.

Viscosity Recommendations

Working temperature [¡C]	**Viscosity class [mm²/s] = [cSt] at 40 ¡C**
ca. 30 to 40	22
ca. 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. 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 temperature must not exceed 90 °C 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

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