HAWE Products

Our current product range

Solutions for a World under Pressure

HAWE HYDRAULIK

HAWE product range – Contents

Compact hydraulic power packs type KA and KAW

Proportional directional spool valves type PSL and PSV

Hydraulic clamps type HSE and HSA

Pressure switches type DG and analogous electronic pressure transducers

Programmable logic valve controls type PLVC

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HAWE Hydraulik produces and develops hydraulic components and solutions for many sectors of the mechanical engineering and plant engineering industries. HAWE also helps to resolve global problems regarding energy, infrastructure, efficient production, nutrition and resources.

View of the Alps from the HAWE plant in Kaufbeuren, Germany

With over 65 years' experience and a focus on constantly incorporating new technologies, HAWE is a responsible partner for you when it comes to conserving resources, reducing costs, making machinery safer and developing innovative ideas.
The product range includes constant and variable pumps, hydraulic power packs, valves, sensors and accessories. The modular system is complemented by electronic components which are perfectly coordinated with the hydraulic components and simplify control, signal evaluation and fault detection. All pressurised parts are made from steel, which allows for pressures of up to 700 bar and guarantees that components are durable, safe and compact in mid-pressure ranges.
As a result, HAWE Hydraulik products offer concrete benefits for manufacturers and their customers thanks to the consistent modular design which has been tailored to solutions for a world under pressure. "Solutions for a World under Pressure"

Information about this compact product catalogue

This compact catalogue is structured according to nomenclature and offers an initial overview of the available components and their performance data. Thanks to our approach of consistently designing all components based on a modular system, our components can be easily combined to form space-saving units offering added value.
If your requirements are not covered by the product range shown here, we will also be glad to design bespoke hydraulic solutions.
Your HAWE sales representative or sales partner can provide additional technical documentation, drawings or 3D models for individual components and even complete solutions. They will be glad to assist you with selecting and configuring your system, commissioning and service.
The contact data for the contact partner in your region is attached and can also be found at HAWE Hydraulik SE - Global Website.

Compact
oil immersed hydraulic power packs
with valve mounting

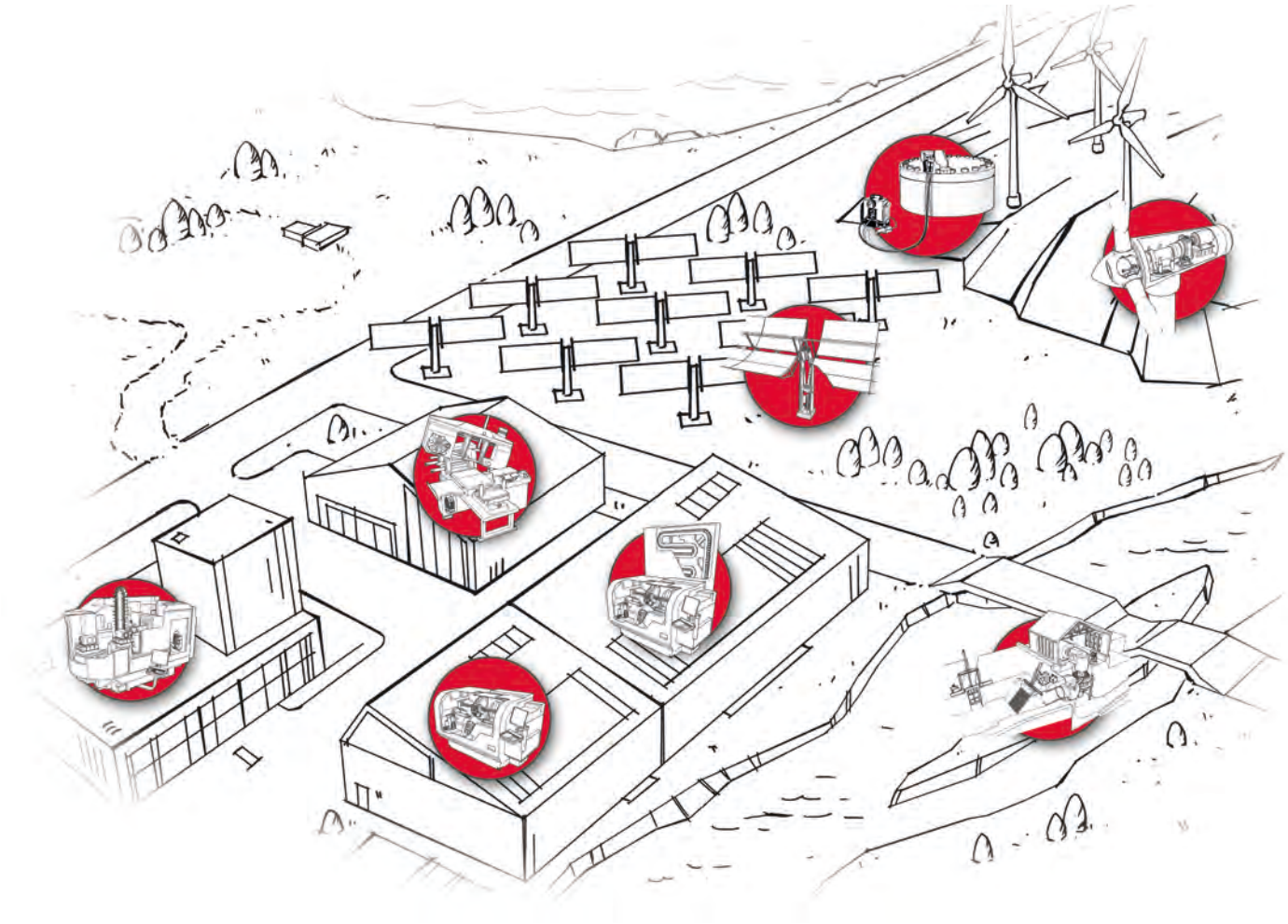
Axial piston pumps
with high power density

Zero-leakage seated valves
up to 700 bar

Directional spool valves
modular and flexible

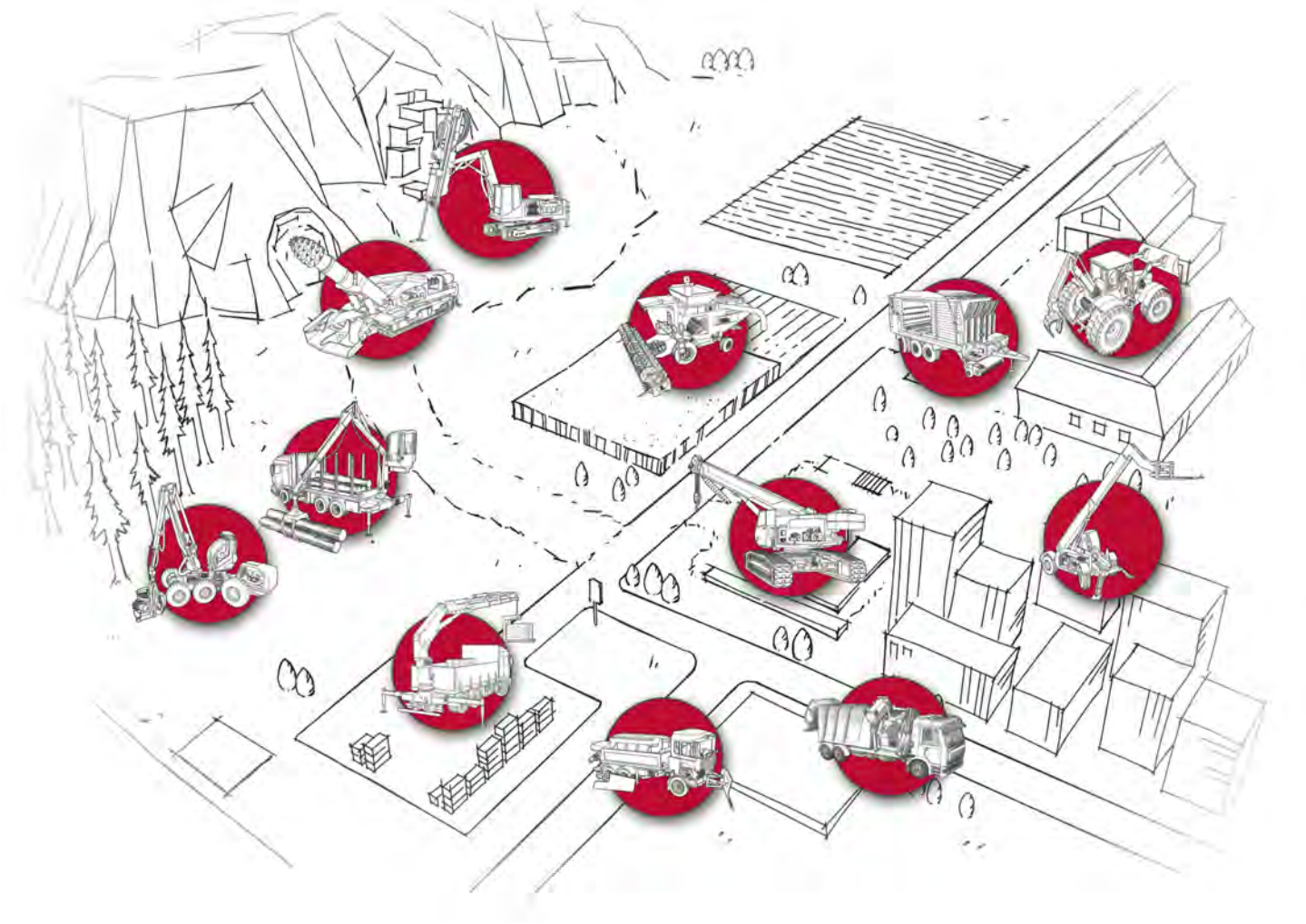
Solutions for a World under Pressure

HAWE - Intelligent solutions to tackle global problems



Stationary hydraulics

In machine tools, testing machinery and many other industrial applications, tensioning and clamping functions are often actuated using hydraulics. In addition to the high output density and energy-efficient drive concept, the integrated monitoring functions also prove particularly useful during operation.
Compact hydraulic power packs in standby mode, a speed-controlled drive concept and an accumulator charging mode are just some of the methods used to increase system efficiency. What's more, zero-leakage directional seated valves, high pressure and intelligent control by the electronics system open up other application fields such as hydraulic tools and renewable energy.



Mobile hydraulics

HAWE Hydraulik provides manufacturers of mobile machines with components for creating an energy-efficient system to help them comply with established standards and regulations.
Proportional directional spool valves regulate the movement speed of the hydraulic consumers continuously and independently of the load. Load-holding valves reliably secure the position of the load and are an important system element for suppressing unwanted oscillations. Axial piston pumps provide the flow rate required depending on the specific needs. When individual components are supplied from a single source, you can be sure that they have been coordinated with one another and you know how they will interact with one another.
Our Sales and Service representatives will be glad to provide you with professional, local assistance for adapting our products to your specific needs – before, during and after commissioning.

Pumps

1.1 Hydraulic pumps

Radial piston pump type R and RG

Variable displacement axial piston pump type V60N

Radial piston pumps

Type	Design / features	p_{max} (bar)	V_{max} (cm^3/rev)
R, RG, RZ	**Radial piston pump / dual-stage pump** ▪ Single pump ▪ Motor pump ▪ Hydraulic power pack **Features and benefits:** – High level of efficiency – Compact design – Max. 14 separate pressure outlets – Available from the modular product range as a hydraulic power pack with valve banks	R 7631: 700 R, RG 6010: 700 R, RG 6011: 700 R, RG 6012: 700 R, RG 6014: 700 R, RG 6016: 700 HP/LP: RZ 7631: 700/200 RZ 6910: 700/200 RZ 6911: 700/200 RZ 6912: 700/200 RZ 6914: 700/200 RZ 6916: 700/200	R 7631: 1.59 R, RG 6010: 4.58 R, RG 6011: 10.7 R, RG 6012: 21.39 R, RG 6014: 42.78 R, RG 6016: 64,18 HP/LP: RZ 7631: 1.59/7.9 RZ 6910: 4.58/26 RZ 6911: 10.7/89.6 RZ 6912: 21.4/89.6 RZ 6914: 42.8/89.6 RZ 6916: 64.2/89.6

Axial piston pumps

Type	Design / features	p_{max} (bar) (Operation/peak)	V_{max} (cm^3/rev)
V30D	**Variable displacement axial piston pump** ▪ Single pump ▪ Pump combination **Features and benefits:** – Low-noise emissions – Wide controller options – Full torque available at the second pump in tandem pump applications	045: 350/420 075: 350/420 095: 350/420 115: 250/300 140: 350/420 160: 250/300 250: 350/420	045: 45 075: 75 095: 95 115: 115 140: 140 160: 160 250: 250
V30E	**Variable displacement axial piston pump** ▪ Single pump ▪ Pump combination **Features and benefits:** – Low noise emissions – Wide controller options – Full torque available at the second pump in tandem pump applications	095: 350/420 160: 350/420 270: 350/420	095: 95 160: 160 270: 270
V80M	**Variable displacement axial piston pump** ▪ Single pump ▪ Pump combination **Features and benefits:** – High rotation speed – High nominal pressure – Less installation space – Full torque available at the second pump in tandem pump applications	200: 400/450	200: 202
V60N	**Variable displacement axial piston pump** ▪ Single pump ▪ Pump combination **Features and benefits:** – Optimized power-to-weight ratio – High self-suction speed – Wide controller options	060: 350/400 090: 350/400 110: 350/400 130: 400/450	060: 60 090: 90 110: 110 130: 130
K60N	**Fixed displacement axial piston pump** ▪ Single pump **Features and benefits:** ▪ Optimized power-to-weight ratio ▪ High rotation speed ▪ Different shaft and flange versions	012: 400 017: 400 025: 400 034: 400 047: 400 064: 400 084, 984: 400 108, 9108: 400	012: 12.6 017: 17.0 025: 25.4 034: 34.2 047: 47.1 064: 63.5 084, 984: 83.5 108, 9108: 108

Air-driven hydraulic pumps

Type	Design / features	p_{max} (bar)	V_{max} (cm^3/stroke)
LP	**Air-driven hydraulic pump** ▪ Single pump ▪ Hydraulic power pack **Features and benefits:** – High operating pressures – Suitable for explosion-proof systems and equipment – No electrical energy – Hydraulic power packs with direct valve mounting	80: 700 125: 1500 160: 1500	80: 6.00 125: 28.30 160: 28.30

Hand pumps

Type	Design / features	p_{max} (bar)	V_{max} (cm^3/stroke)
H, HE, HD	**Hand pump** ▪ Single-acting ▪ Double-acting **Features and benefits:** – Sturdy design – Hand pumps with integrated tank – Safety and drain valve	H - 16: 350 H - 20: 220 H - 25: 150 HE - 3: 800 HE - 4: 600 HD - 13: 350 HD - 20: 220 HD - 30: 150	H - 16: 6.00 H - 20: 9.40 H - 25: 14.70 HE - 3: 3.00 HE - 4: 4.00 HD - 13: 13.00 HD - 20: 20.00 HD - 30: 30.00

Individual pumps

1.1 Radial piston pump type R, RG and RZ

Radial piston pumps are a type of hydraulic pump. They consist of valve-controlled pump cylinders that are arranged radially.
The radial piston pump type R, RG and RZ has a closed pump housing. Therefore, besides use as a motor pump outside an oil tank, installation in the container of a hydraulic power pack is also possible. The radial piston pump is available with several pressure outlets which enable the same or several different volumetric flows. Type RZ is a classic dual-stage pump consisting of a radial piston pump and a gear pump. The radial piston pump type RG has plain bearings which have a longer storage life. This type is therefore used in extreme operating conditions.
Extremely high volumetric flows can be achieved by arranging up to 6 radials in parallel. When the radial piston pump is used in the hydraulic power pack, it is suitable for use as a highly compact control system. Connection blocks and valve banks can be mounted on the cover plate of the hydraulic power packs.

Nomen-clature:	Radial piston pump
Design:	Single pump ; dual-stage pump
p_{max}:	700 bar
Q_{max}:	91.2 l/min
V_g:	64.18 cm³/rev

Features and benefits:
- High level of efficiency
- Compact design
- Max. 14 separate pressure outlets
- Available from the modular product range as a hydraulic power pack with valve banks

Intended applications:
- Press construction
- Jig construction
- Testing and laboratory devices
- Lubricating systems

Design and order coding example

RZ 0,9 / 2 - 16

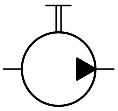
Sizes Delivery flow gear pump [lpm]

Basic type, delivery flow [lpm]
- Type R (version with roller bearing)
- Type RG (version with plain bearing)
- Type RZ (dual-stage pump)

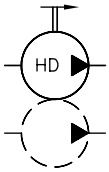
Additional versions:
- With several pressure ports
- With separate ports for the flow of one or two pump elements (Q_{max} = 4,4 lpm) e.g. as control oil supply

Function

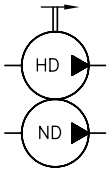
Single pump type R and RG



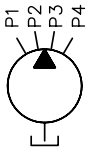
Single pump type RZ
only high-pressure section,
low-pressure section is
installed by customer



Single pump type RZ
High and low-pressure section

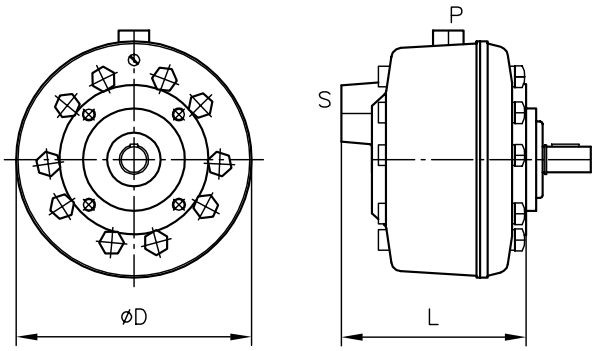


Pump with several pressure
outlets (example for an Single
pump)

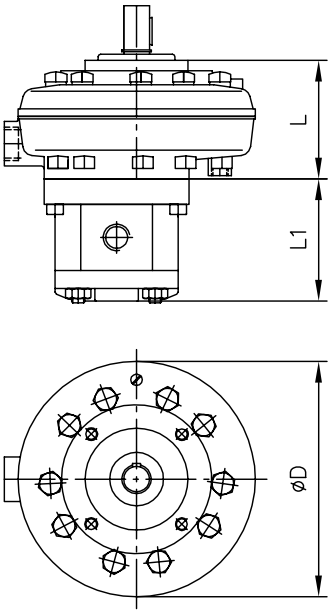


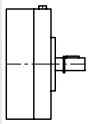
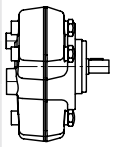
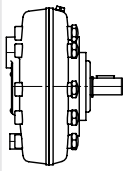
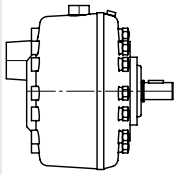
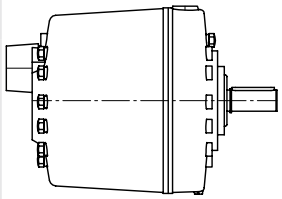
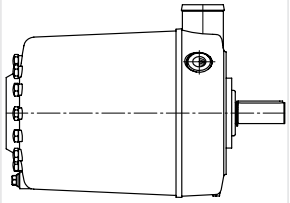
General parameters and dimensions

Single pump type R and RG



Single pump type RZ



Design		Number of cylinders	Delivery flow Q_{pu} (lpm) (approximate reference value at 1450 rpm) and max. pressure p_{max} (bar)						Dimensions [mm]		
			700 bar	550 bar	450 bar	250 bar	160 bar	P_N [kW]	D	L	m [kg]
7631		2	0.18	0.28	0.43	0.92	-	0.25...0.55	130	53/58	3.2
		3	0.27	0.42	0.64	1.35	-				
		5	0.46	0.7	1.08	2.27	-				
6010/ 6910		1	0.3	0.5	0.8	1.7	2.2	0.25...3	174	82.5/85.5	3.1
		2	0.6	1.0	1.6	3.3	4.4				
		3	0.9	1.5	2.5	5.1	6.5				
6011/ 6911		5	1.4	2.6	4.2	8.3	10.9	0.55...5.5	185	86/85	5.8
		7	2.1	3.7	5.8	11.8	15.3				
6012/ 6912		10	2.7	5.3	8.2	16.8	21.7	2.2...11	185	146/125	10.5
		14	4.0	7.4	11.6	23.5	30.4				
6014/ 6914		20	6.1	11.0	17.4	35.0	43.4	5.5...22	218	250/221	24.2
		28	8.0	15.0	23.0	47.0	60.8				
6016/ 6916		42	12.7	22.0	34.5	70.0	91.2	11...30	238	311/320	39.1

- The data listed represent only a selection of the various different versions
1) Standard motor, design IM B 35 for motor pumps or IM B 5 for hydraulic power packs

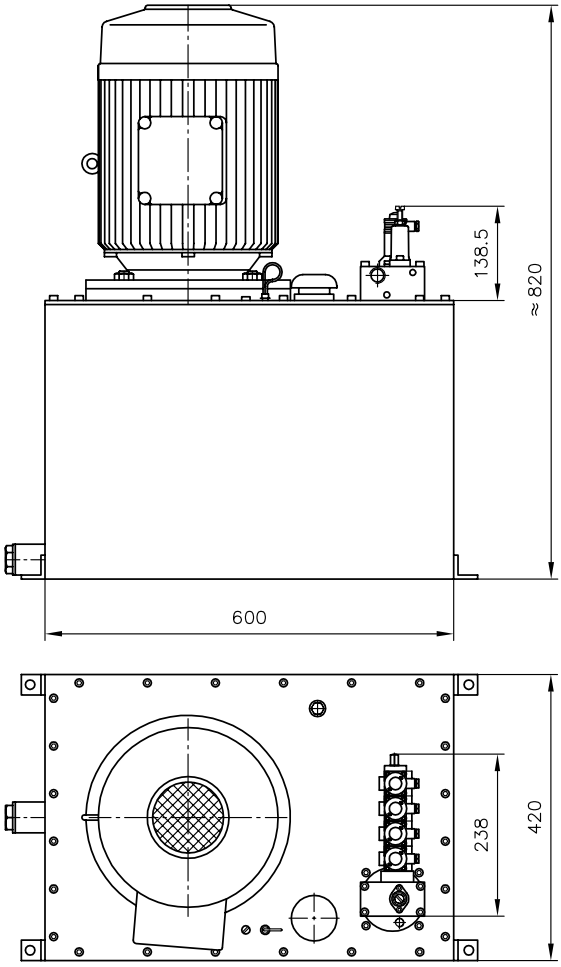
Gear pump

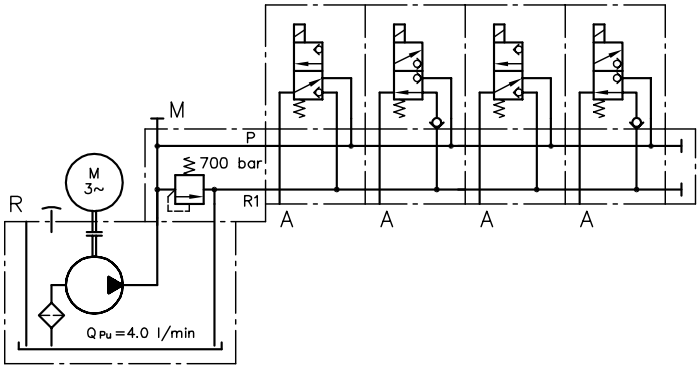
Size	Delivery flow Q_{pu}[lpm] and max. pressure p_{max} [bar]			Dimensions [mm]	m [kg]
	120 bar	80 bar	40 ... 60 bar	L1	
/1	5,2	8,8	11,3	70 ... 86	1,2
/2	12,3	16	37	96 ... 132	3,1
/3	24	110	135	140 ... 178	8,4

- The data listed represent only a selection of the various different versions

Circuit example:

R 4.0/B 50 A 700 - VB 11 DM - HRHR - 1 - G 24 - V 5.5





Associated technical data sheets:

- Radial piston pump type R and RG: D 6010
- Motor pump and hydraulic power pack type R and RG: D 6010 H
- Radial piston pumps with several pressure connections type R, RG: D 6010 D, D 6010 DB
- Radial piston pump type R and RG with one main pressure connection and one or two ancillary pressure connections: D 6010 S

Directly mountable valve banks:

- Type VB:Page 114
- Type BWH(N):Page 120
- Type SWR: Page 76

Individual pumps

1.1 Variable displacement axial piston pump type V30E

Variable displacement axial piston pumps operate according to the bent axis principle. They adjust the geometric output volume from maximum to zero. As a result they vary the flow rate that is provided to the loads.

The axial piston pump type V30E is designed for open circuits in mobile hydraulics and operate according to the swash plate principle. They are available with the option of a thru-shaft for operating additional hydraulic pumps in series.

The sturdy pump is particularly suitable for continuous operation in challenging applications. The range of pump controllers allows the axial piston pump to be used in a variety of applications.

Features and benefits:

- Low noise emissions
- Wide controller options
- Full torque available at the second pump in tandem pump applications

Intended applications:

- Machines for forestry and agricultural purposes
- Cranes and lifting equipment
- Construction machines

Nomenclature:	**Axial piston pump Variable pump**
Design:	**Single pump Multiple pump**
p_{max}:	**System pressure: 350 bar Peak pressure: 420 bar**
$V_{g\,max}$:	**270 cm³/rev**

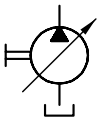
Design and order coding example

V30E	- 095	R	S	F	N	- 1	- 2	- XX	/LSP	/120	- 200

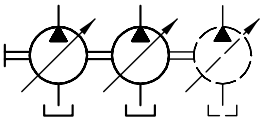
- **Pressure specification [bar]**
- **Torque setting [Nm]**
- **Controllers** See section "Controller"
- **Release**
- **swash plate angle indicator** With/without swash plate angle indicator
- **Housing version** With/without thru-shaft
- **Seal material**
  - NBR (N)
  - EPDM (E)
  - FKM (V, C)
- **Flange version**
  - Flange ISO 3019-2 (G)
  - Flange SAE J744 (F, W)
- **Shaft version**
  - Spline shaft DIN 5480 (D)
  - Parallel key (K)
  - Spline shaft SAE J744 (S, U)
- **Rotating direction** Anti-clockwise (L), clockwise (R)
- **Nominal size**
- **Basic type**

Function

Single pump



Multiple pump



Controller

Pressure controller:

- Pressure controller (P, Pb)
- Electro-proportional pressure controller (P-PMVPS)

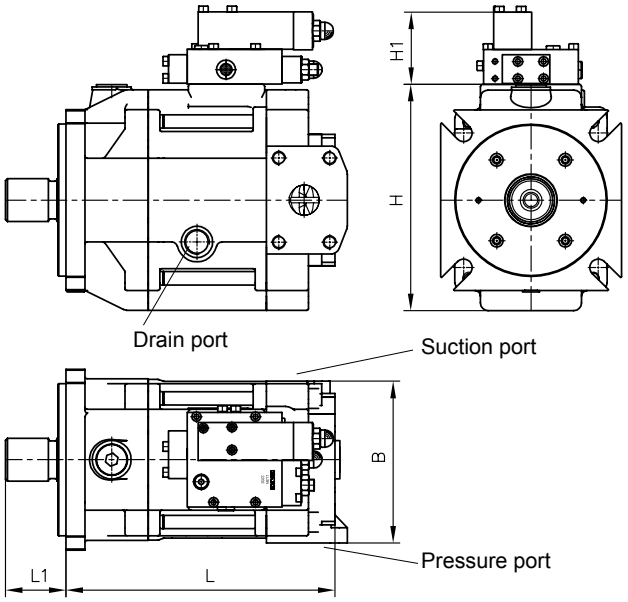
Flow controller

- Load-sensing controller with integrated pressure limitation (LSP, LSPb)
- Load-sensing controller with integrated pressure limitation and electric pump direction switching (LSP-BVPM)
- Electro-hydraulic flow controller with integrated pivoting angle pick-up and control electronics for adjustment of setpoint and actual value (EM.CH)

Power controller:

- Power controller (L)
- Power controller (Lf, Lf1)

General parameters and dimensions



(connection locations for clockwise operation)

1 Drain port
2 Suction port
3 Pressure connection

Parameters

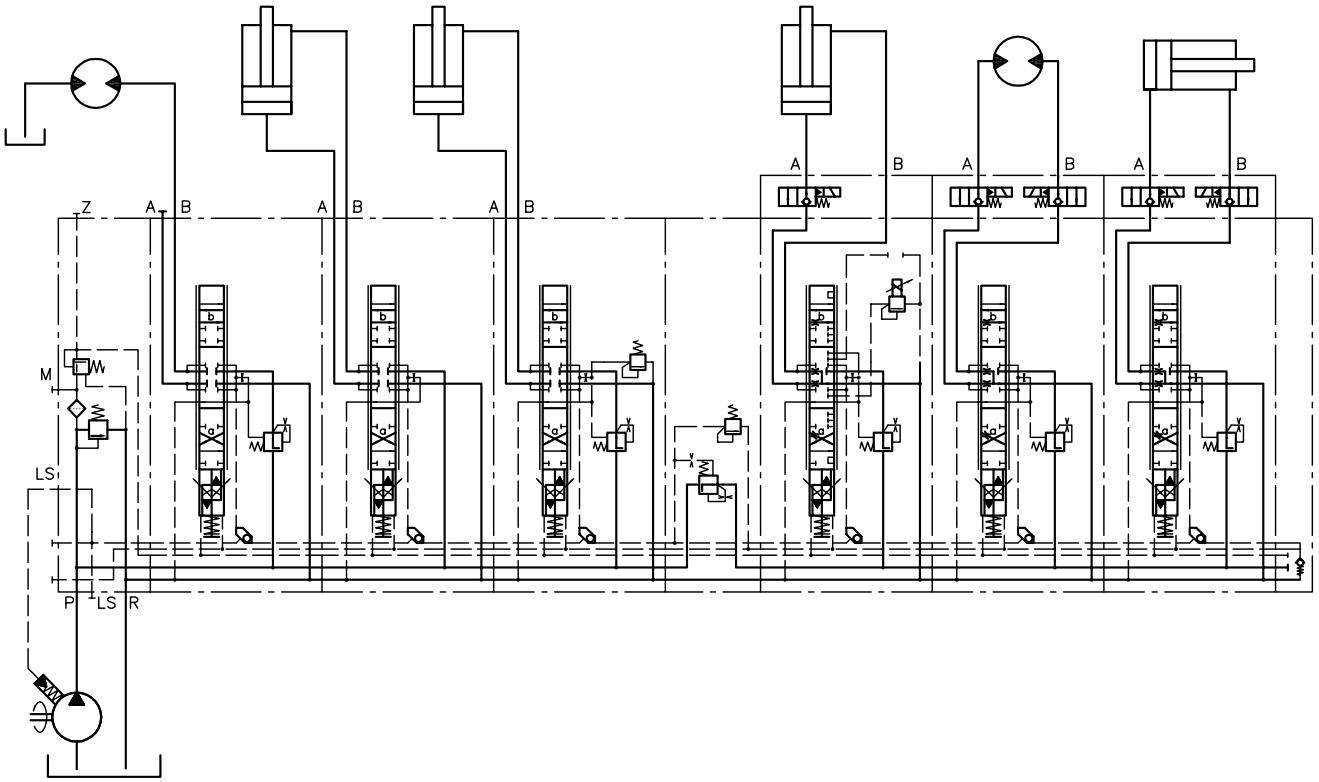
	Geom. delivery volume	Nominal pressure	Max. rotation speed	Dimensions [mm] approx.					m [kg]
	V_g [cm³/rev]	p_{nom} (p_{max}) [bar]	n [rpm]	L	L1	H	H1	B	(with controller)
V30E - 095	95	350 (420)	2500	296	75	236	36	190	57
V30E - 160	160		2100	332	75	273	36	212	77
V30E - 270	270		1800	399	88	326	36	266	129

Ports

	Pressure connection	Suction port	Drain port
V30E - 095	1 1/4" SAE J518	2 1/2" SAE J518	G 3/4
V30E - 160	1 1/4" SAE J518	2 1/2" SAE J518	G 3/4
V30E - 270	1 1/2" SAE J518	3" SAE J518	G 1

Circuit example:

V30E-270-LSFN-2-1/03-LSP-320



Associated technical data sheets:

- Variable displacement axial piston pump type V30E: D 7960 E

Similar products:

- Variable displacement axial piston pump type V30D: Page 20
- Variable displacement axial piston pump type V60N: Page 26
- Fixed displacement axial piston pump type K60N: Page 30
- Variable displacement axial piston pump type V80M: Page 24

Suitable proportional directional spool valve:

- Type EDL: Page 82
- Type PSL/PSV size 2, 3 and 5: Page 90
- Type PSLF/PSVF size 3, 5 and 7: Page 96

Suitable accessories:

- Proportional amplifier type EV1M3: Page 272
- Proportional amplifier type EV2S: Page 274
- Proportional amplifier type EV1D: Page 272

Individual pumps

1.1 Variable displacement axial piston pump type V30D

Variable displacement axial piston pumps operate according to the bent axis principle. They adjust the geometric output volume from maximum to zero. As a result they vary the flow rate that is provided to the loads.

The axial piston pump type V30D is designed for open circuits in industrial hydraulics and operate according to the swash plate principle. They are available with the option of a thru-shaft for operating additional hydraulic pumps in series.

The sturdy pump is particularly suitable for continuous operation in challenging applications. The range of pump controllers allows the axial piston pump to be used in a variety of applications.

Features and benefits:

- Low-noise emissions
- Wide controller options
- Full torque available at the second pump in tandem pump applications

Intended applications:

- Presses
- Industrial plants
- Marine cranes and winches
- Power pack assembly

Nomenclature:	**Axial piston pump Variable pump**
Design:	**Single pump Multiple pump**
p_{max}:	**System pressure: 350 bar Peak pressure: 420 bar**
$V_{g\,max}$:	**250 cm³/rev**

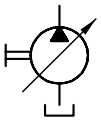
Design and order coding example

V30D	- 095	R	SF	N	- 1	- 1	- XX	/LN	-2	/120	- 200

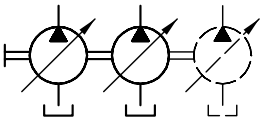
- **Pressure specification [bar]**
- **Torque setting [Nm]**
- **Additional versions** e.g. stroke limitation
- **Controller** See section "Controller"
- **Release**
- **swash plate angle indicator** With/without swash plate angle indicator
- **Housing version** With/without thru-shaft
- **Seal material**
  - NBR (N)
  - EPDM (E)
  - FKM (V)
- **Shaft version/flange version**
  - Spline shaft DIN 5480 (D)
  - Spline shaft SAE J744 (S)
  - Parallel key (K)
- **Rotating direction** Anti-clockwise (L), clockwise (R)
- **Nominal size**
- **Basic type**

Function

Single pump



Multiple pump



Controller

Pressure controller:

- Pressure controller (N)
- Pressure controller with remote-control port (P, Pb)

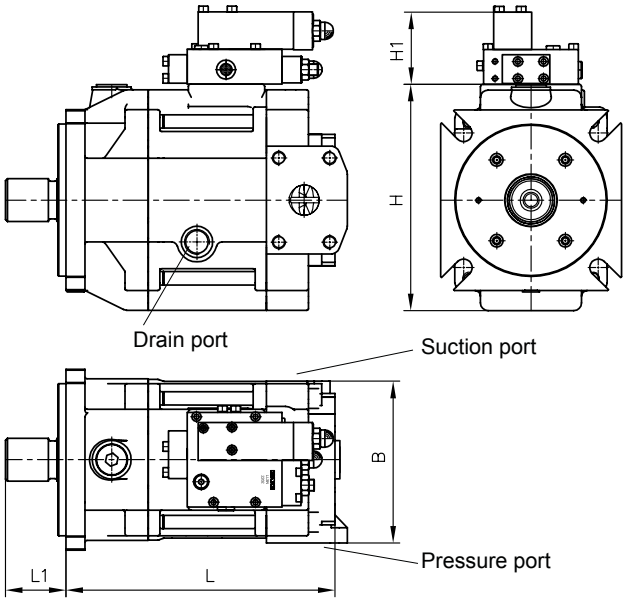
flow controller

- Load-sensing controller (LS)
- Load-sensing controller with integrated pressure limitation (LSN)
- Flow controller for setting a constant, speed-independent volumetric flow (Q, Qb)
- Electro-proportional flow controller with rising characteristic (V)
- Hydraulic-proportional flow controller with rising characteristic (VH)

Power controller:

- Power controller (L)
- Power controller, hydraulically adjustable (Lf1)

General parameters and dimensions



(connection locations for clockwise operation)

1 Drain port
2 Suction port
3 Pressure connection

Parameters

	Geom. delivery volume	Nominal pressure	Max rotation speed	Dimensions [mm]					m [kg]
	V_g [cm³/rev]	p_{nom} (p_{max}) [bar]	n [rpm]	L	L1	H	H1	B	(with controller)
V30D - 045	45	350 (420)	2600	268	68	150	82	160	40 (46)
V30D - 075	75		2400	310	80	170	86	178	60 (66)
V30D - 095	95		2200	341	93	196	87	196	70 (76)
V30D - 115	115	250 (300)[1)]	2000	341	93	196	87	196	70 (76)
V30D - 140	140	350 (420)	2200	363	90	212	85	212	85 (91)
V30D - 160	160	250 (300)[1)]	1900	363	90	212	85	212	85 (91)
V30D - 250	265	350 (420)	1800	432	115	224	97	272	130 (136)

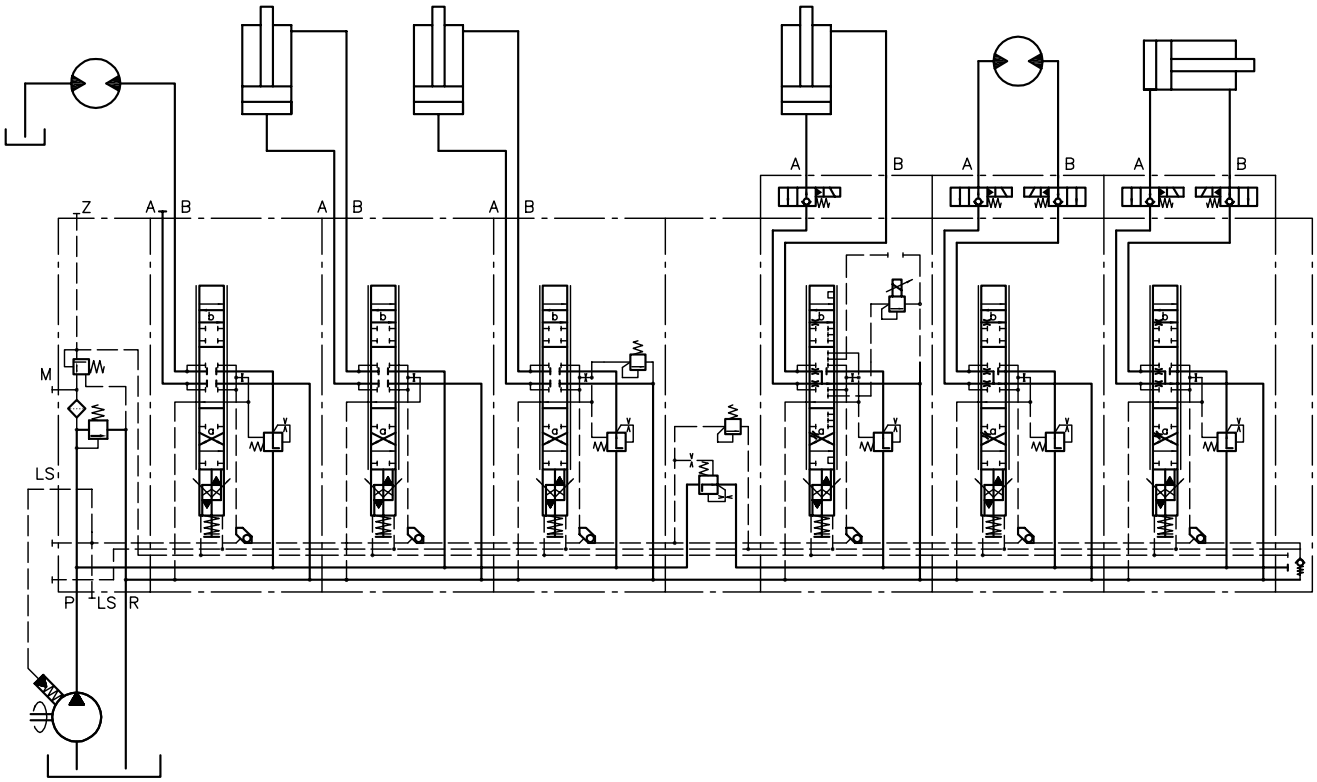
1) Higher pressures are possible with reduced delivery flow

Ports

	Pressure connection	Suction port	Drain port
V30D - 045	3/4" SAE J518	1 1/2" SAE J518	G 1/2
V30D - 075	1" SAE J518	2" SAE J518	G 3/4
V30D - 095	1 1/4" SAE J518	2" SAE J518	G 3/4
V30D - 115	1 1/4" SAE J518	2" SAE J518	G 3/4
V30D - 140	1 1/4" SAE J518	2 1/2" SAE J518	G 3/4
V30D - 160	1 1/4" SAE J518	2 1/2" SAE J518	G 3/4
V30D - 250	1 1/2" SAE J518	3" SAE J518	M 33x 2

Circuit example:

V30D-250-LSN-2-1/05-LSN-320



Associated technical data sheets:

- Variable displacement axial piston pump type V30D: D 7960,

Similar products:

- Variable displacement axial piston pump type V30E: Page 16
- Variable displacement axial piston pump type V60N: Page 26
- Fixed displacement axial piston pump type K60N: Page 30
- Variable displacement axial piston pump type V80M: Page 24

Suitable proportional directional spool valve:

- Type EDL: Page 82
- Type PSL/PSV 2, 3 and 5: Page 90
- Type PSLF/PSVF 3, 5 and 7: Page 96

Suitable accessories:

- Proportional amplifier type EV1M3: Page 272
- Proportional amplifier type EV2S: Page 274
- Proportional amplifier type EV1D: Page 272

Individual pumps

1.1 Variable displacement axial piston pump type V80M

Variable displacement axial piston pumps operate according to the bent axis principle. They adjust the geometric output volume from maximum to zero. As a result they vary the flow rate that is provided to the loads.

The axial piston pump type V80M is designed for open circuits in mobile hydraulics and operate according to the swash plate principle. They are available with the option of a thru-shaft for operating additional hydraulic pumps in series.

The sturdy pump is particularly suitable for continuous operation in challenging applications. The range of pump controllers allows the axial piston pump to be used in a variety of applications.

Features and benefits:

- High speed
- High nominal pressure
- Less installation space
- Full torque available at the second pump in tandem pump applications

Intended applications:

- Machines for forestry and agricultural purposes
- Cranes and lifting equipment
- Construction machines

Nomenclature:	**Axial piston pump**
Version:	**Single pump** **Multiple pump**
p_{max}:	**System pressure: 400 bar** **Peak pressure: 450 bar**
$V_{g\,max}$:	**202 cm³/rev**

Design and order coding example

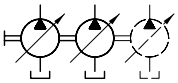
V80M	- 200	R	S	F	N	- 1	- 1	- XX	/LN	-2	/120	- 200

- **Basic type**
- **Nominal size**
- **Rotating direction** Counter clockwise (L), clockwise (R)
- **Shaft version**
  - Spline shaft (DIN 5480) (D)
  - Spline shaft and flange SAE (S)
- **Flange version**
  - DIN (W)
  - SAE (F)
- **Seals**
  - NBR (N)
  - FKM (V)
- **Versions with housing** With/without thru-shaft
- **swash plate angle indicator** With/without swash plate angle indicator
- **Release**
- **Controller** See section "Controller"
- **Additional versions**
- **Torque setting [Nm]**
- **Pressure specification [bar]**

Function

Single pump

Multiple pump



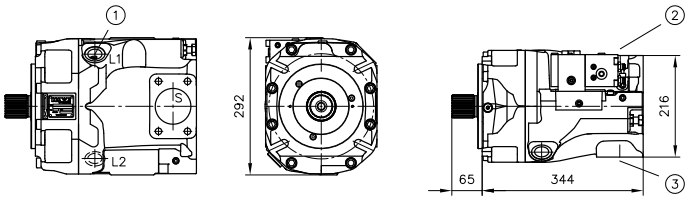
Controller

Pressure controller:
- Pressure controller (N)

Flow controller:
- Load-sensing controller (LSN)

Power controller:
- Power controller (L)

General parameters and dimensions



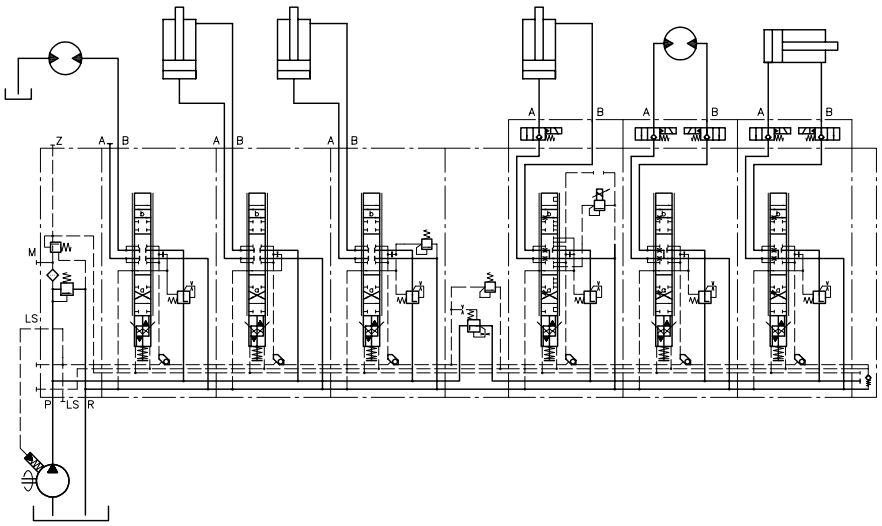
(connection locations for clockwise operation)

1 Drain port
2 Suction port
3 Pressure connection

Parameters

	Geom. output volume V_g [cm³/rev]	Nominal pressure p_{nom} (p_{max}) [bar]	Self-suction speed n [min⁻¹]	Ports			m [kg] (with controller)
				Drain port	Suction port	Pressure port	
V80M - 200	200	400 (450)	1800	G 1	3"	1 1/2"	130 (136)

Circuit example:



Associated technical data sheets:
- Variable displacement axial piston pump V80M: D 7962 M

Similar products:
- Variable displacement axial piston pump type V30D: Page 20
- Variable displacement axial piston pump type V30E: Page 16
- Variable displacement axial piston pump type V60N: Page 26
- Fixed displacement axial piston pump type K60N: Page 30

Suitable prop. directional spool valve:
- Type EDL: Page 82
- Type PSL/PSV size 2, 3 and 5: Page 90
- Type PSLF/PSVF size 3, 5 and 7: Page 96

Suitable accessories:
- Proportional amplifier type EV1M3: Page 272
- Proportional amplifier type EV2S: Page 274
- Proportional amplifier type EV1D: Page 272

Individual pumps

1.1 Variable displacement axial piston pump type V60N

Variable displacement axial piston pumps operate according to the bent axis principle. They adjust the geometric output volume from maximum to zero. As a result they vary the flow rate that is provided to the loads.

The axial piston pump type V60N is designed for open circuits in mobile hydraulics and operate according to the swash plate principle. They are available with the option of a thru-shaft for operating additional hydraulic pumps in series.

The pump is fitted above all to the power take-off on commercial vehicle transmissions.

The range of pump controllers allows the axial piston pump to be used in a variety of applications.

Features and benefits:

- Optimized power-to-weight ratio
- High self-suction speed
- Wide controller options

Intended applications:

- Municipal trucks
- Cranes and lifting equipment
- Machines for forestry and agricultural purposes
- Truck-mounted concrete pumps

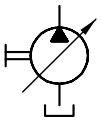
Nomen-clature:	**Axial piston pump Variable pump**
Design:	**Single pump Multiple pump**
p_{max}:	**System pressure: 400 bar Peak pressure: 450 bar**
$V_{g\ max}$:	**130 cm³/rev**

Design and order coding example

V60N - 110 R S F N - 1 - 0 - 03 /LSNR -2 - 320

- **Pressure specification [bar]**
- **Stroke limitation** — With/without max. stroke limitation
- **Controller** — See section "Controller"
- **Release**
- **Additional function**
- **Housing version**
  - Axial ports
  - Radial ports with thru-shaft
  - Radial ports
- **Seal material**
  - NBR (N), FKM (V)
- **Flange version**
  - Flange ISO 7653-1985 (Y, P)
  - Flange ISO 3019-2 (G)
  - Flange SAE J744 (X, Z, F)
- **Shaft version**
  - ISO 14 parallel key splined shaft (D)
  - Spline shaft DIN 5480 (M)
  - Spline shaft SAE J744 (H, U, T, S, Q)
- **Rotating direction** — Anti-clockwise (L), clockwise (R)
- **Nominal size**
- **Basic type**

Function



Controller

Pressure controller

- Pressure controller (NR)
- Electro-proportional pressure controller with rising characteristic (PR)
- Electro-proportional pressure controller with falling characteristic (P1R)

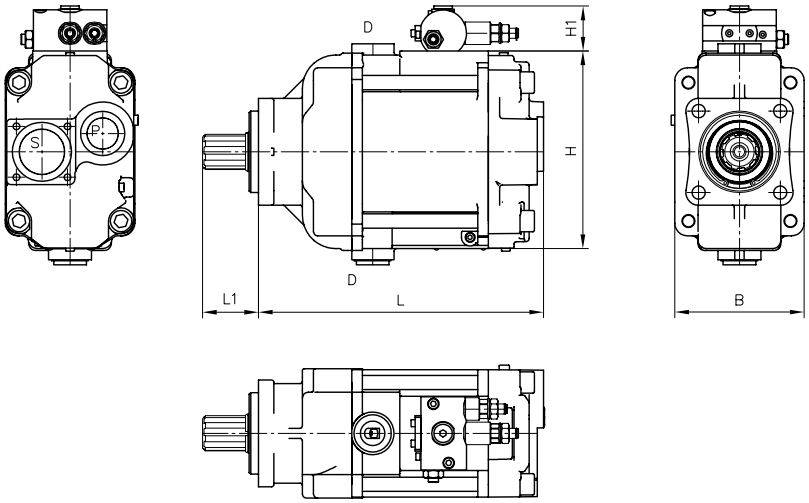
Flow controller

- Load-sensing controller with integrated pressure limitation (LSNR, LSNRT)
- Flow controller for setting a constant, speed-independent volumetric flow (QNR)
- Electro-proportional flow controller with rising characteristic (V)
- Electro-proportional flow controller with falling characteristic (V1)

Power controller

- Power controller (L, /ZL)

General parameters and dimensions



Parameters

	Geom. output volume	Nom. pressure	Max. speed	Dimensions [mm]					m [kg]
	V_g [cm³/rev]	p_{nom} (p_{max}) [bar]	n [rpm]	L	L1	H	H1	B	
V60N - 060	60	350 (400)	2500	254	55	177	45	115	24
V60N - 090	90		2300	278	55	184	45	120	27
V60N - 110	110		2200	280	55	194	45	125	30
V60N - 130	130	400 (450)	2100	270	55	210	45	130	31

Ports

	Pressure port P	Suction port S	Drain port D	LS connection
V60N - 060	G 3/4	1 1/2" SAE J518	G 3/4	G 1/4
V60N - 090	G 1			
V60N - 110				
V60N - 130				

Circuit example:

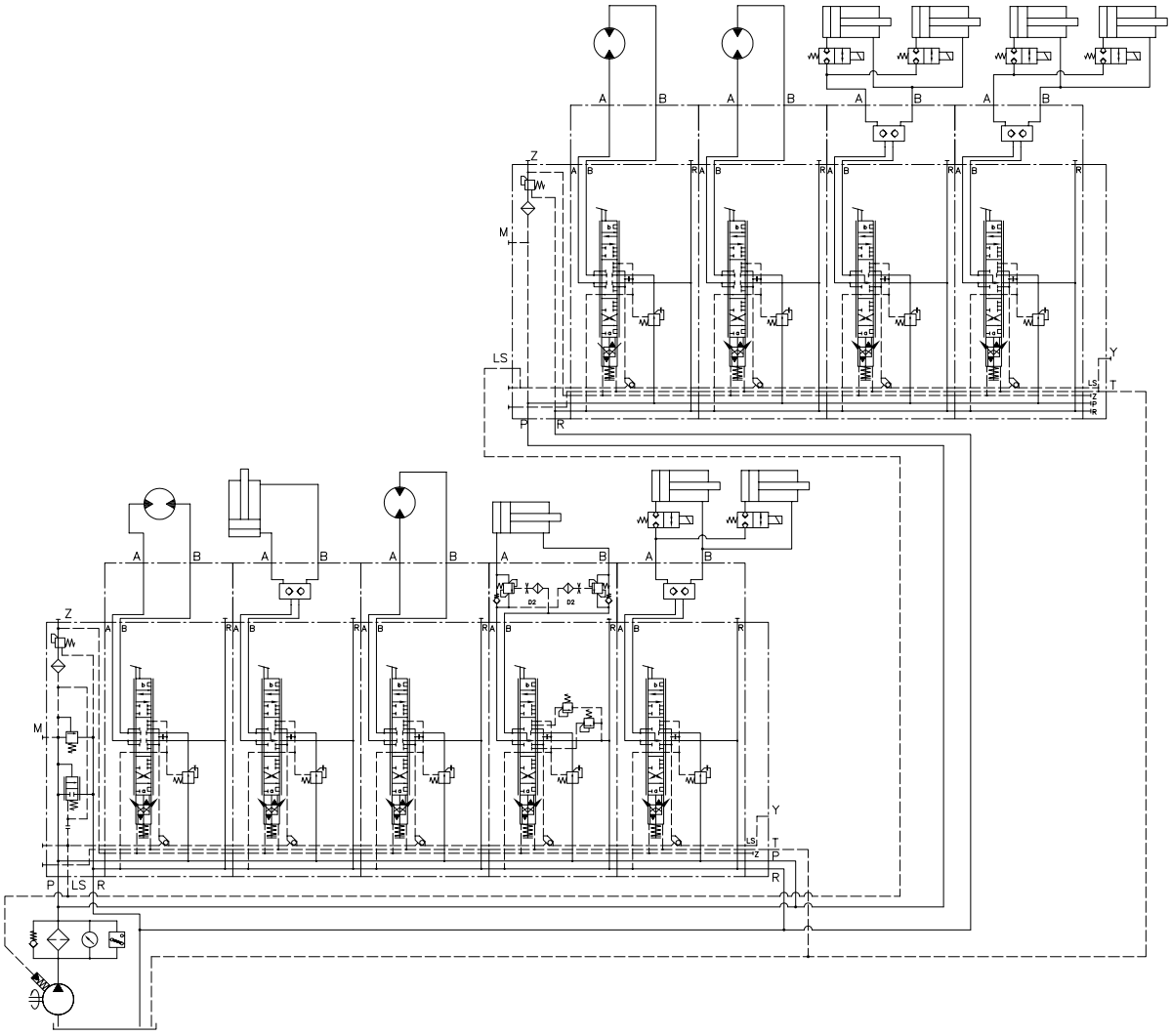
V60N-130 RSFN-1-0-03 / LSNR-2-250

PSV 31/D280-2

- A 2 L 25/25/EA1/2
- A 2 H 40/40/EA1/2 DRH
- A 2 L 25/25/EA1/2
- A 2 H 3/3 A 100 B 100/EA1/2 AL-0-D 4/120-BL-0-D 4/120
- A 2 H 3/3/EA1/2 DRH
- E 18-G 24

PSV 31-1

- A2 L 25/25/EA1/2
- A2 L 25/25/EA1/2
- A2 H 3/3/EA1/2 DRH
- A2 H 3/3/EA1/2 DRH
- E 1 - G24



Associated technical data sheets:

- Variable displacement axial piston pump type V60N: D 7960 N

Similar products:

- Variable displacement axial piston pump type V30D:Page 20
- Variable displacement axial piston pump type V30E: Page 16
- Fixed displacement axial piston pump type K60N:Page 30
- Variable displacement axial piston pump type V80M:Page 24

Suitable prop. directional spool valves:

- Type EDL: Page 82
- Type PSL/PSV size 2, 3 and 5: Page 90
- Type PSLF/PSVF size 3, 5 and 7: Page 96

Suitable accessories:

- Proportional amplifier type EV1M3: Page 272
- Proportional amplifier type EV2S: Page 274
- Proportional amplifier type EV1D: Page 272

Individual pumps

1.1 Variable displacement axial piston pump type K60N

Fixed displacement axial piston pumps operate according to the bent axis principle. They have a constant output volume and therefore deliver a constant flow rate at a specific rotation speed.

The axial piston pump type K60N is designed for open circuits in mobile hydraulics and operates based on the bent axis principle.

The pump is fitted mainly to the power take-off on commercial vehicle transmissions.

Features and benefits:

- Optimized power-to-weight ratio
- High rotation speed
- Different shaft and flange versions

Intended applications:

- Machines for forestry and agricultural purposes
- Cranes and lifting equipment
- Truck-mounted concrete pumps
- Municipal trucks

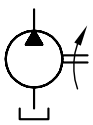
Nomen-clature:	Axial piston pump Constant pump
Design:	Single pump
p_{max}:	400 bar
$V_{g\ max}$:	108 cm³/rev

Design and order coding example

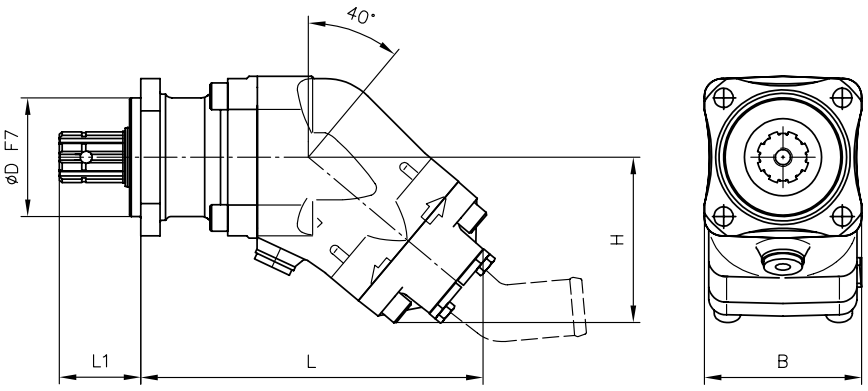
K60N - 064 R S F N - S - F12

- **Basic type**
- **Nominal size**
- **Rotating direction**: Counter clockwise (L), clockwise (R)
- **Shaft version**
  - ISO 14 parallel key splined shaft (D)
  - SAE-C, SAE-B J 744 spline shaft (S)
- **Flange version**
  - DIN ISO 7653 (Y)
  - SAE-C, SAE-B J 744 (F)
- **Seal material**
  - NBR (N), FKM (V)
- **Additional versions**: Bypass valve

Function



General parameters and dimensions



Parameters

	Geom. output volume	Nom. pressure	Self-suction speed	Dimensions [mm]					m [kg]
	V_g [cm³/rev]	p_{nom} (p_{max}) [bar]	n [rpm]	L	L1	H	B	∅D	
K60N - 012	12,6	400	3300	207	48	145	95	80/101.6/--	7,5
K60N - 017	17,0	400	3200						
K60N - 025	25,4	400	2550	209	53	156	118	80/101.6/--	8,5
K60N - 034	34,2	400	2250						
K60N - 040	41,2	400	2200	246	67	185	143	80/101.6/127	15,5
K60N - 047	47,1	400	2200						
K60N - 056	56,0	400	2100						
K60N - 064	63,6	400	2050						
K60N - 084	83,6	400	1700	276	72	212	160	80/--/127	27,0
K60N - 090	90,7	400	1700						
K60N - 108	108,0	400	1700	276	85	231	180	80/--/127	29,5
K60N - 130	130,0	350	1600						

Associated technical data sheets:

- Fixed displacement axial piston pump type K60N: D 7960 K

Similar products:

- Variable displacement axial piston pump type V30D: Page 20
- Variable displacement axial piston pump type V30E: Page 16
- Variable displacement axial piston pump type V60N: Page 26
- Variable displacement axial piston pump type V80M: Page 24
- Axial piston motor type M60N: Page 254

Suitable prop. directional spool valves:

- Type EDL: Page 82
- Type PSL/PSV size 2, 3 and 5: Page 90
- Type PSLF/PSVF size 3, 5 and 7: Page 96

Suitable load-holding valves:

- Type LHK, LHDV, LHT: Page 198

Individual pumps

1.1 Air-driven hydraulic pump type LP

Air-driven hydraulic power packs are pneumatically driven, reciprocally acting plunger pumps. They operate as pneumatic pressure amplifiers with oscillating movement and automatic stroke reversal control.

The air-driven hydraulic pump type LP can generate up to 1500 bar. It is available as an single pump or as a hydraulic power pack with different tank sizes and valve banks. The delivery flow is dependent on the air pressure set and the flow resistance currently present. It can decay to standstill.

Applications are in laboratory presses, in fixture design, in lubrication systems or in potentially explosive atmospheres.

Features and benefits:

- High operating pressures
- Suitable for explosion-proof systems and equipment
  No electrical energy
- Hydraulic power packs with direct valve mounting

Intended applications:

- Construction and construction materials machinery
- fixture design
- Testing and laboratory equipment

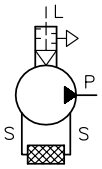
Nomen-clature:	Air driven hydraulic pumps
Design:	Single pump
$p_{hydraulicmax}$:	1500 bar
p_{airmax} :	10 bar
Q_{max}:	12 l/min

Design and order coding example

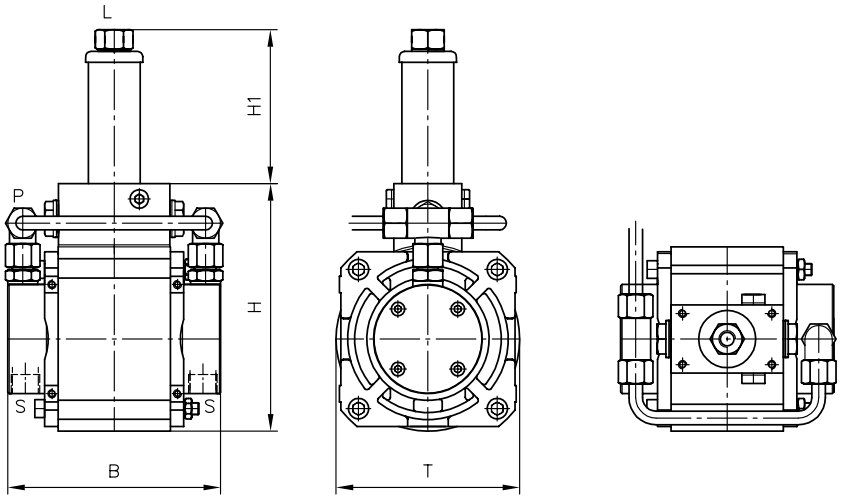
LP 125 - 16 | E | /S 81

- **Additional elements**
  - Suction parts for hydraulic pumps
- **Design** — **Hydraulic pump**
  - Ready-to-connect version
  - Individual version for self-installation
- **Basic type, size** — Type LP, size 80, 125, 160

Function



General parameters and dimensions



Basic type and size		p_{max} [bar]	Pressure ratio	Geom. volume per double stroke V_{hydr} [cm³]	Tapped port (air) Pipe diameter for pressure connection (hydr)	Dimensions [mm]				m [kg]
						H	H1	B	T	
LP80-	8	700	1 : 200	1.5	G 1/4 Æ6 mm	119	94	121	85	5
	...									
	16	240	1 : 24	6						
LP125-	8	1500	1 : 243	2	G 3/8 Æ8 mm, Æ10 mm	159	114	156	135	8.5
	...									
	30	160	1 : 16	28.3						
LP160-	8	1500	1 : 400	2	G 1/2 Æ8 mm, Æ10 mm	228	136	156	175	11.5
	...									
	30	265	1 : 24	28.3						

Associated technical data sheets:

- Air-driven hydraulic pump type LP: D 7280
- Hydraulic power pack type LP: D 7280 H

Valve banks :

- Type VB:Page 114
- Type BWH(N):Page 120

Individual pumps

1.1 Hand pump type H, HE and HD

Hand pumps are a type of hydraulic pump. They generate a flow rate manually.
The hand pump type H and HE is single-acting. It draws in oil in one direction and pumps it in the opposite direction. The hand pump type HD is double-acting. It pumps and draws in the same quantity of oil in the pressure line during the forward and backward movement of the hand lever. The hand pump type H, HE and HD is available for pipe connection and manifold mounting.
The hand pump is particularly suitable as an emergency pump or for test benches.

Features and benefits:

- Sturdy design
- Hand pumps with integrated tank
- Safety and drain valve

Intended applications:

- Shipbuilding
- Mining machinery
- fixture design
- Testing and laboratory equipment

Nomen-clature:	Piston pump
Design:	Single acting hand pump Double acting hand pump
p_{max}:	800 bar
V_{max}:	30 cm³/stroke

Design and order coding example

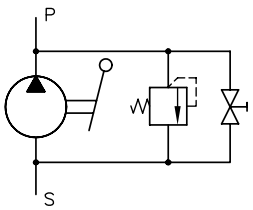
HD 13 | AS | - K 0,5 | - 110

- **Pressure setting (bar)**
- **With/without tank** — Usable volume $V_{use.}$ 0,35 l and 0,5 l
- **Additional elements**
  - Drain valve (A)
  - Pressure limiting valve (fixed or manually adjustable) (S)
- **Basic type, size** — Type H (single-acting, open design),
  Type HE (single-acting, encapsulated design)
  Type HD (double-acting, encapsulated design)

  - With/without pressure resistant suction port
  - Versions for manifold mounting

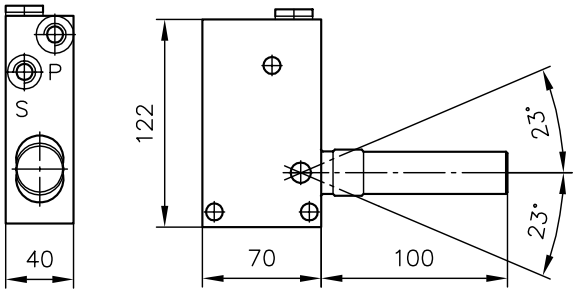
Function

Design with pressure limiting valve and drain valve

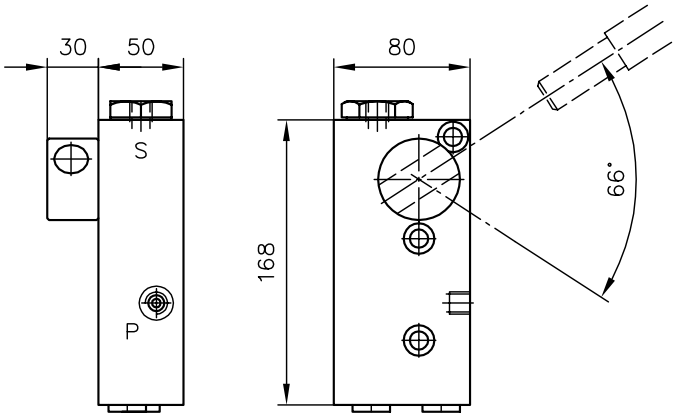


General parameters and dimensions

H..



HE.. and HD..



	p_{max} [bar]	V_{max} [cm³/stroke]	Tapped ports (BSPP)		m [kg]
			P	S	
H 16	350	6	G 1/4	G 1/4	3.1
H 20	220	9.4			
H 25	150	14.7			
HE 3	800	3	G 1/4	G 1/4 and G 3/8	4.8
HE 3	800	3			
HD 13	350	13			
HD 20	220	20			
HD 30	150	30			

Associated technical data sheets::

- Manual pump type H, HD and HE: D 7147/1

1.2 Hydraulic Unit

Compact Unit
Model KA und KAW

Compact unit
Model HK, HKF und HKL

Compact hydraulic power packs

Type	Design / tank volume (l)	p_{max} (bar)	V_{max} (cm^3/rev)
NPC	**Radial piston pump** ▪ With integrated electric motor ▪ Direct current supply ▪ Suitable for short period operation – Fill volume 1.0 – Usable volume 0.65	11: 750 12: 750	11: 0.46 12: 0.46
HC, HCW	**Radial piston or gear pump** ▪ With integrated electric motor ▪ 3-phase or AC version ▪ Suitable for intermittent operation – Vertical approx. 1.16 – 2.5 – Usable volume approx. 0.50 – 1.5	HP/LP: 1: 700/180 2: 700/180	 1: 0.76 2: 1.59
KA, KAW	**Radial piston or gear pump** ▪ With integrated electric motor ▪ 3-phase or AC version ▪ Suitable for intermittent operation **KA 2** – Fill volume approx. 3.9 – 11.1 – Vertical approx. 1.85 – 8.95 **KA 4** – Fill volume approx. 13 – 31 – Vertical approx. 5 – 25	HP/LP: 2: 700/180 4: 700/180	HP/LP: 2: 3.61/7.9 4: 9.17/30.2
MP, MPN	**Radial piston pump and/or gear pump** ▪ With integrated electric motor ▪ Single-circuit or dual-circuit pump ▪ Suitable for intermittent or load/no load operation – Fill volume approx. 17 – 100 – Usable volume approx. 10 – 75	HP/LP: MP - 1: 700/220 MP - 2: 700/200 MPN - 4: 700/220	HP/LP: MP - 1: 0.95/4.76 MP - 2: 1.59/26 MPN - 4: 9.17/60
HK, HKF, HKL	**Radial piston pump and/or gear pump** ▪ With integrated electric motor ▪ 3-phase version ▪ Suitable for continuous and intermittent operation **HK 2** – Fill volume approx. 2.77 – Usable volume approx. 0.85 **HK 3** – Fill volume approx. 4.65 – 6.1 – Usable volume approx. 1.45 – 2.90 **HK 4, HKF 4** – Fill volume approx. 5.8 – 15.4 – Usable volume approx. 1.9 – 11.1 **HKL 3** – Fill volume approx. 3.7 – 13 – Usable volume approx. 1.7 – 9.1	HP/LP: HK - 2: 700 HK - 3: 700/180 HK - 4: 700/180 HKF - 4: 700/180 HKL - 3: 700/180	HP/LP: HK - 2: 1.59 HK - 3: 4.58/4.8 HK - 4: 9.17/17.0 HKF - 4: 9.17/17.0 HKL - 3: 6.11/14.5

Standard hydraulic power packs

Type	Design / tank volume (l)	p_{max} (bar)	V_{max} (cm^3/rev)
FXU	**Radial piston pump / dual-stage pump** ▪ Standard hydraulic power pack – Fill volume approx. 26-650	R: 700 Z: 260 RZ: 700/200	R: 64.2 Z: 63 RZ: 64.2/89.6
A, B, C Connection block Model **A, B, C**	**Connection blocks** ▪ For connecting to the Hydraulic Unit ▪ Pumping Units – Flange valve for Pipe connection or Valve assembly	700	20
LP	**Air-driven hydraulic pump** ▪ Single pump ▪ Hydraulic power pack – Fill volume approx. 5.8–33 – Usable volume approx. 3.8–28	80: 700 125: 700 160: 700	80: 6.00 125: 28.30 160: 28.30

1.2 Compact hydraulic power pack type NPC

Compact hydraulic power packs are a type of hydraulic power pack. They are characterised by a highly compact design, since the motor shaft of the electric motor also acts as the pump shaft.

The ready-for-connection compact hydraulic power pack type NPC is suitable for hydraulic systems with operating mode S2. Type NPC includes a DC motor. The power pack is available in a horizontal or vertical version. Either single-circuit systems or dual-circuit systems can be selected. A radial piston pump or an external gear pump can be used as a hydraulic pump.

The compact hydraulic power pack type NPC is suitable for use as a highly compact control system, since the pressure-limiting valve is integrated and valve banks can be directly mounted.

Nomen-clature:	**Radial piston pump with integrated electric motor (DC)**
Design:	**Oil immersed compact hydraulic power pack For short period operation**
p_{max}:	**750 bar**
Q_{max}:	**1.36 lpm ($V_{g\,max}$ = 0.76 cm³/rev)**

Features and benefits:

- Very low space requirements and easy to transport
- Supplied with direct current at 12V DC or 24V DC
- Particularly suited to mobile applications and construction site operation
- Long lifetime and excellent reliability achieved by using radial piston pumps
- Environmentally sound thanks to low oil fill volumes and minimum cost of disposal
- Low costs for hydraulic fluid
- Co-ordinated range of valves and accessories from the modular system

Intended applications:

- Riveting
- Brakes for wind power plants
- Hydraulic jigs
- Crimping
- Embossing

Design and order coding example

NPC 11	/ 0,87	- 1/170	- R	- G12	BWN 1 - NN - 35 - 1 - G12

Valve assembly
- BWN1, BWH1, VB01
- Can be directly assembled without connection blocks according to D 7470 B/1, D 7302

Motor voltage 12V DC or 24V DC

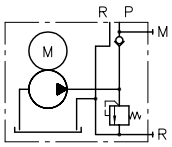
Check valve With/without check valve

Pressure limiting valve and setting
- 1 = Fixed
- 2 = Manually adjustable

Delivery flow [lpm]

Basic type, size Type NPC, size 11 and 12

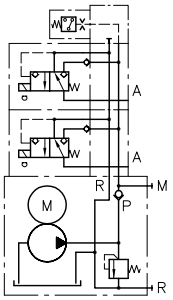
Function



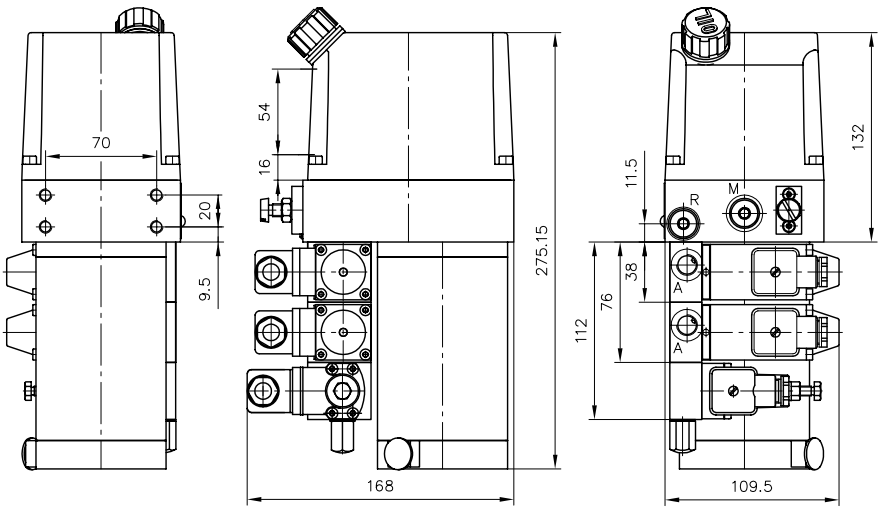
Circuit example:

NPC 11 / 0.87 - 1/170 - R - G 12
Compact hydraulic power pack type NPC
pump delivery flow approx. 0.87 lpm

BWN 1 - NN - 35 - 1 - G 12
Directly mounted valve bank type BWN with two valve sections and pressure switch in P gallery, solenoid voltage 12V DC



General parameters and dimensions



	Delivery flow						Max. pressure		
	Q_{pu} [lpm]						p_{max} [bar]	P_N [kW]	m [kg]
NPC 11 (24 V)	0.2	0.31	0.44	0.61	0.87	1.05	750	0.1/0.3	6
NPC 11 (12 V)								0.1/0.25	6
NPC 12 (24 V)	0.4	0.65	0.94	1.28	1.71	2.14	750	0.6	8
NPC 12 (12 V)								0.6	8

Associated technical data sheets:

- Compact hydraulic power pack type NPC: D 7940

Directly mountable valve banks:

- Type VB: Page 114
- Type BWH, BWN: Page 120
- Pressure switches type DG: Page 262
- Electronic pressure transducer type DT: D 5440 T/1, D 5440 T/2

Compact hydraulic power packs

1.2 Compact hydraulic power pack type HC and HCW

Compact hydraulic power packs are a type of hydraulic power pack. They are characterised by a highly compact design, since the motor shaft of the electric motor also acts as the pump shaft.

The ready-for-connection compact hydraulic power pack type HC and HCW includes an electric drive which runs in oil. The stator is securely attached to the housing (tank). The compact hydraulic power pack is suitable for hydraulic systems with the operating modes S2 or S3. The heat is dissipated via surface convection so that no external cooler is usually necessary.

A radial piston pump or external gear pump can be used as a hydraulic pump.

The compact hydraulic power pack type type HC and HCW is suitable as a highly compact control system, since connection blocks and valve banks can be directly mounted.

Nomen-clature:	**Radial piston or gear pump with integrated electric motor (three-phase or alternating current design)**
Design:	**Oil immersed hydraulic power pack for intermittent service (S3-service)**
p_{max}:	**Radial piston pump 700 bar Gear pump 180 bar**
Q_{max}:	**Radial piston pump 4.4 lpm (V_g = 1.6 cm³/rev) Gear pump approx. 3.4 lpm (V_g = 1.3 cm³/rev)**
$V_{usable\ max}$:	**8 l**

Features and benefits:

- Long lifetime and high pressures thanks to use of radial piston pumps
- Low oil fill volumes make it environmentally sound thanks to small amount of oil to be disposed of and low costs for hydraulic fluid
- Co-ordinated range of valves and accessories from modular system
- Suitable for vertical and horizontal installation

Intended applications:

- Clamping systems on machine tools and jigs
- Rivets and clinching equipment
- Welding robots

Design and order coding example

HC24	/0,6	- A1/400	- BWH1F-HH-1-1-G24	- 400V 50 Hz

Motor voltage 3 ~ 400V 50 Hz, 3 ~ 460V 60 Hz
1 ~ 230V 50 Hz, 1 ~ 110V 60 Hz (3~phase motor)

Optional directly mounted directional valve bank

Connection block

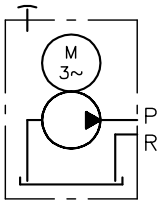
Pump version **Single circuit pump**

- Radial piston pump H (3-, 5- or 6-cylinders) oder Gear pump Z

Basic type, size Type HC (3-phase motor) and type HCW (single-phase-motor, power reduction of 30 ... 50% depending on size), size 1 to 2, type HCG (direct current motor), size 1

- Lying at low installation Heights (Model HC..L)
- Alternative standing version
- Usable volume V_{usable} 0.5 l to 1.5 l
- With/without fluid level gauge
- With DC-motor (Type HCG) for short time operation

Function



Example circuit:

HC 24/0.64

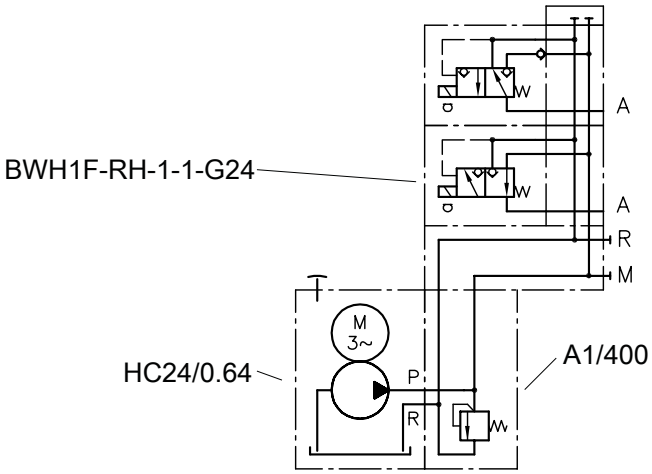
Pump unit type HC, size 24, pump delivery flow approx. 0.64 lpm

- A1/400

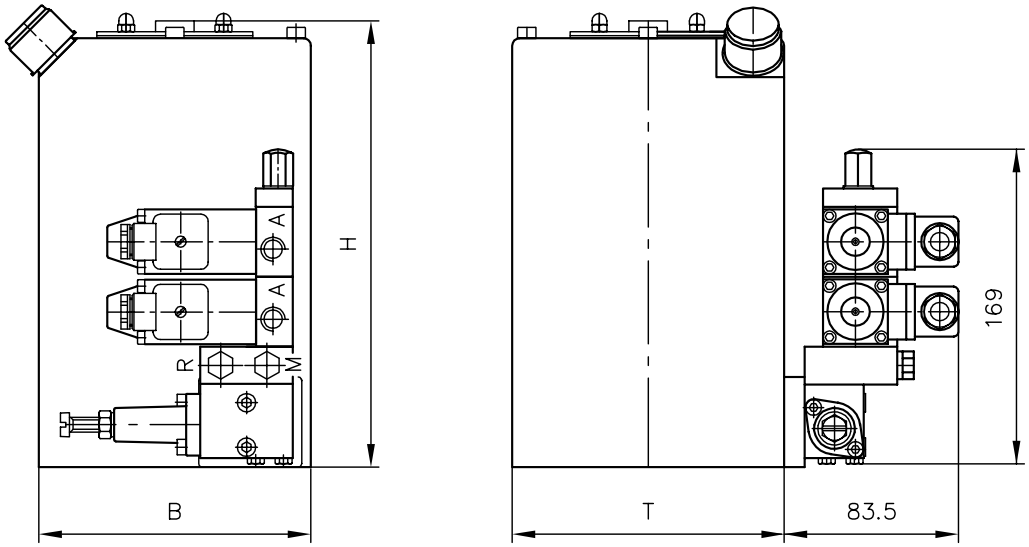
Connection block type A and pressure-limiting valve (400 bar)

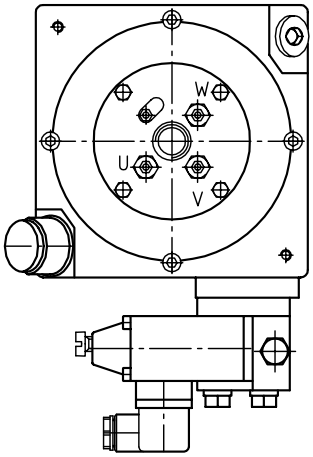
- BWH1F - RH1 - 1 - 1 - G 24

Directly mounted valve bank type BWH 1



General parameters and dimensions



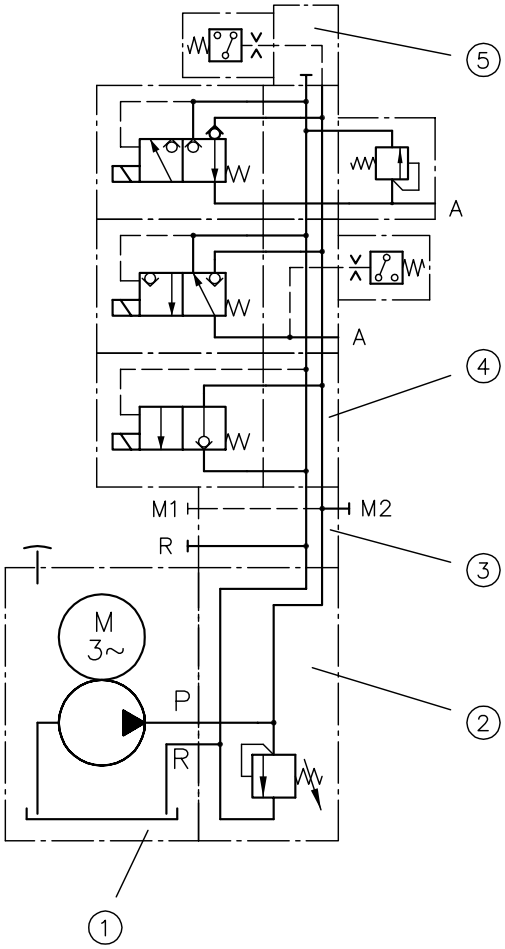


	Radial piston pump (3 cylinders)			Gear pump					Dimensions [mm]		
	Max. pressure	Delivery flow		Max. pressure	Delivery flow						
	p_{max} [bar]	Q_{pu} [lpm] 50 Hz	Q_{pu} [lpm] 60 Hz	p_{max} [bar]	Q_{pu} [lpm] 50 Hz	Q_{pu} [lpm] 60 Hz	P_N [kW] 1)	m [kg] 2)	H	B	T
HC 14	700 - 160	0.2 - 1.05	0.2 - 1.2	-	-	-	0.18	6.3	197	120	120
HC 12	600 - 120	0.4 - 2.15	0.5 - 2.5	-	-	-	0.25				
HC 24	700 - 185	0.27 - 2.27	0.3 - 2.7	150	0.4 - 1.6	0.5 - 1.9	0.55	10.1	243	148	148
HC 22	700 - 140	0.52 - 4.41	0.6 - 5.3	150	0.9 - 3.4	1.1 - 4	0.55				

1) The actual power consumption depends on the respective operation pressure and can be up to 1.5 x P_N
2) Without oil filling

Circuit example:

HC 24/0.64 - A2/400
- BWH 1 F 1-DH3 R/230-33-G24
- 3x400V 50Hz



1 Compact hydraulic power pack
2 Connection block
3 Adapter plate
4 Valve section
5 End plate

Associated technical data sheets:
- Compact hydraulic power pack type HC and HCW: D 7900
- Compact hydraulic power pack type HCG: D 7900 G

Connection blocks:
- Type A, B and C: Page 62

Directly mountable valve banks:
- Type VB: Page 114
- Type BWH, BWN: Page 120

Directly mountable valve banks:
- Type BA: Page 144
- Type BVH: Page 124

Compact hydraulic power packs

1.2 Compact hydraulic power pack type KA and KAW

Compact hydraulic power packs are a type of hydraulic power pack. They are characterised by a highly compact design, since the motor shaft of the electric motor also acts as the pump shaft.

The ready-for-connection compact hydraulic power pack type KA and KAW includes an electric drive which runs in oil. The stator is securely attached to the housing (tank). The compact hydraulic power pack is suitable for hydraulic systems with the operating modes S2 or S3. The heat is dissipated via surface convection so that no external cooler is usually necessary.

For systems with high loads, an external fan that enables additional heat dissipation can be optionally mounted on the housing. The fan is powered by a separate motor independently of the pump motor. The type KA contains a 3-phase motor, the type KAW contains a single-phase-motor. The compact hydraulic power pack type KA and KAW is available in horizontal and vertical versions. Modules can be added to the tank so that different usable oil volumes are possible. Either single-circuit systems or dual-circuit systems can be selected. A radial piston pump or external gear pump can be used as a hydraulic pump. The compact hydraulic power pack type KA and KAW is suitable as a highly compact control system, since connection blocks and valve banks can be directly mounted.

Nomenclature:	**Radial piston or gear pump with integrated electric motor (3-phase or 1-phase version)**
Design:	**Oil immersed hydraulic power pack for intermittent or load/no load operation (S3-service)**
p_{max}:	**Radial piston pump 700 bar Gear pump 180 bar**
Q_{max}:	**Radial piston pump 7 lpm (V_g = 2.29 cm³/rev) Gear pump approx. 24.1 lpm (V_g = 7.9 cm³/rev)**
$V_{tank\ max}$:	**30 l**

Features and benefits:

- Additional separately driven fan for maximum utilisation of power
- Fill/usable volumes can be flexibly extended by modular tank extensions
- Long lifetime and excellent reliability achieved by using radial piston pumps
- Low oil fill volumes make it environmentally sound thanks to small cost of disposal and low costs for hydraulic fluid
- Co-ordinated range of valves and accessories from modular system
- Suitable for vertical and horizontal installation
- Optimum efficiency thanks to suboil motor cooling, direct transmission of force and cleverly designed heat dissipation

Intended applications:

- Brake and rotor adjustment modules on wind turbines
- Clamping systems on machine tools and appliances
- Hydraulic torque wrenches
- Rivets and clinching equipment
- Presses
- Handling systems

Design and order coding example

KA28	22	L1	KFTP	/HZ0,59/8,8	- ...	- 3x400V	- G1/2x300

Oil drain hose

Motor voltage 3 ~ 400V 50 Hz, 3 ~ 460V 60 Hz, 3 ~ 690V 50 Hz, 1 ~ 230V 50 Hz, 1 ~ 110V 60 Hz (1~phase motor)

Valve design

Pump version

Single circuit pump
- Radial piston pump H or gear pump Z

Dual circuit pump
- with joint connection pedestal for pressure connections P1 and P3
- Combinations: Radial piston pump - radial piston pump (HH) and radial piston pump - gear pump (HZ)

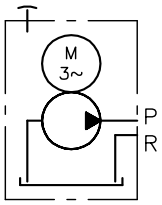
Additional function
- Oil sight glass
- Level gauge with level switch
- Temperature switch
- Silica gel filter (instead of breather filter)
- Additional fans
- Various electrical connection variants

Installation position Horizontal for low installation heights (type KA..L) or vertical (type KA..S)

Tank size

Basic type, size Type KA (3~phase motor) and KAW (1~phase motor, power reduction 30 ... 50% dep. on size), size 2 and 4

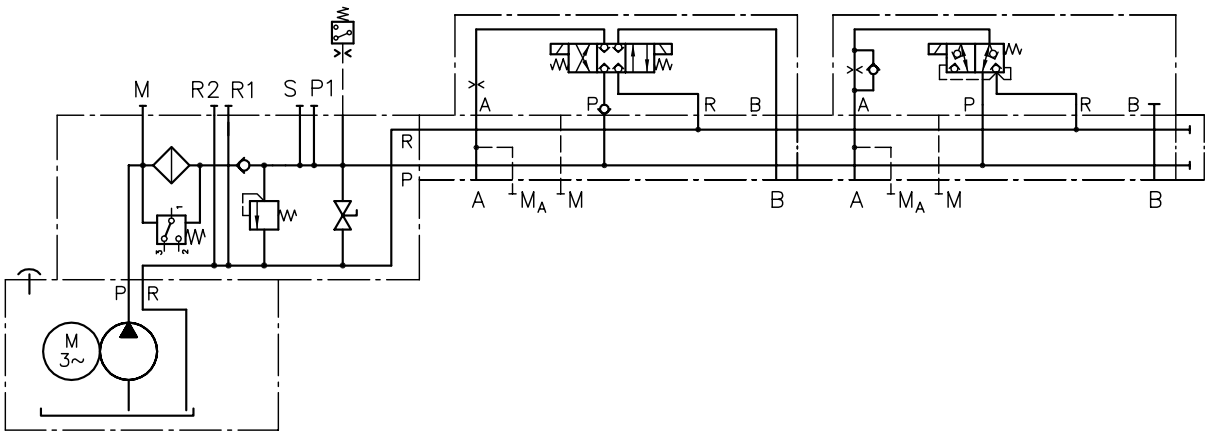
Function



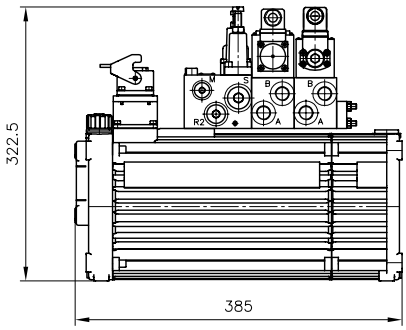
Circuit example:

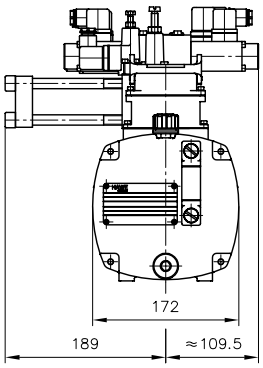
KA 231 LKP/H 0.59 - AX 34 D101VE1B/400 - BA 2

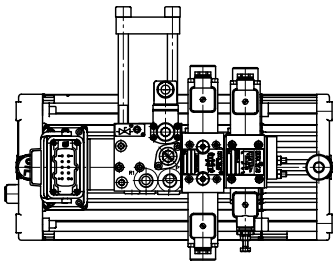
- NBVP 16 G/R/AB 2.0 - M/0
- NBVP 16 Y/ABR 1.5/4 - M/0
- 1 - G 24



General parameters and dimensions





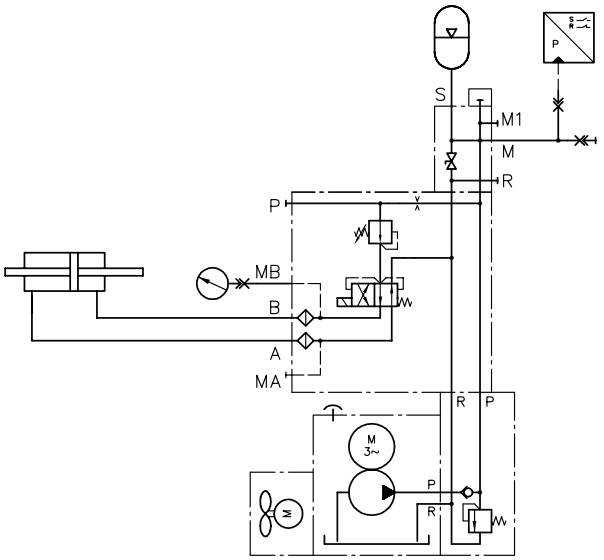


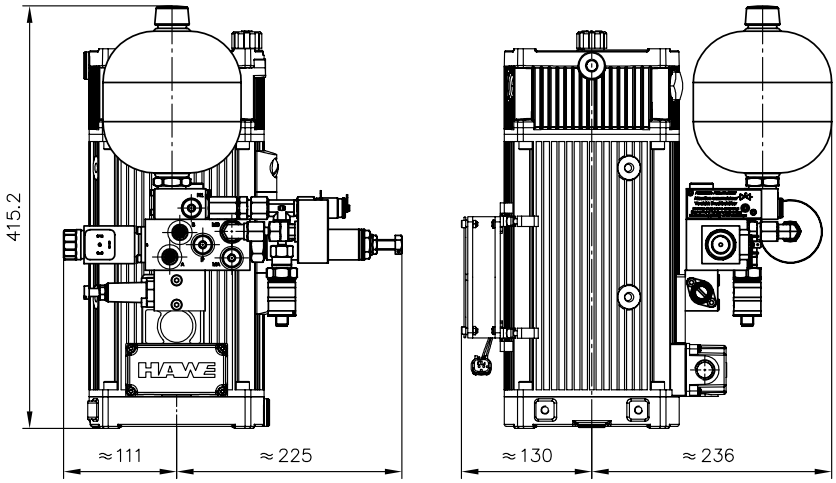
	3-cylinder radial piston pump			6-cylinder radial piston pump			Gear pump			
	p_{max} [bar]	Q_{max} [lpm] 50 Hz	Q_{max} [lpm] 60 Hz	p_{max} [bar]	Q_{max} [lpm] 50 Hz	Q_{max} [lpm] 60 Hz	p_{max} [bar]	Q_{max} [lpm] 50 Hz	Q_{max} [lpm] 60 Hz	P_N [kW]
KA 21	700 - 45	0,63 - 10,02	0,76 - 12,05	360 - 55	1,26 - 7,84	1,52 - 9,42	170 - 60	2,23 - 6,7	2,68 - 8,04	0,55
KA 22	700 - 140	0,63 - 0,02	0,76 - 12,05	700 - 180	1,26 - 7,84	1,52 - 9,42	170 - 55	2,23 - 22,04	2,68 - 26,47	1,1
KA 23	700 - 60	0,31 - 4,89	0,37 - 5,93	485 - 30	0,62 - 9,79	0,75 - 11,85	170 - 50	1,09 - 4,90	1,32 - 5,94	0,37
KA 24	700 - 160	0,31 - 4,89	0,37 - 5,93	700 - 80	0,62 - 9,79	0,75 - 11,85	170 - 65	1,09 - 10,74	1,32 - 13,04	0,75
KA 26	700 - 160	0,63 - 10,02	0,76 - 12,05	700 - 205	1,26 - 7,84	1,52 - 9,42	170 - 65	2,23 - 22,04	2,68 - 26,47	1,4
KA 28	700 - 185	0,31 - 4,89	0,37 - 5,93	700 - 90	0,62 - 9,79	0,75 -11,85	170 - 75	1,09 - 10,74	1,32 - 13,04	1.2

	3-cylinder radial piston pump			6-cylinder radial piston pump			Gear pump			
	p_{max} [bar]	Q_{max} [lpm] 50 Hz	Q_{max} [lpm] 60 Hz	p_{max} [bar]	Q_{max} [lpm] 50 Hz	Q_{max} [lpm] 60 Hz	p_{max} [bar]	Q_{max} [lpm] 50 Hz	Q_{max} [lpm] 60 Hz	P_N [kW]
KA 42	700 - 220	0.84 - 11.8	2.0 - 14.4	700 - 110	3.3 - 23.8	4.0 - 28.9	200 - 130	1.6 - 18.0	2.0 - 22.0	- 2.6
										- 3.9
KA 44	700 - 220	1.6 - 5.98	1,01 - 7,25	700 - 110	1,68 - 11,97	2,04 - 14,53	200 - 130	0,84 - 9,1	1,01 - 11,1	- 1,5
										- 2,2
										- 3,0

Circuit example:

KA 281 S16K/H3.61-FSHS-24VDC
-A 14/230
-BVH 11 W/CZ52/117GM/B3.5H
-82 - AC1002/130/3A
-XM 24
3x400V 50Hz





Associated technical data sheets:

- Compact hydraulic power packs type KA: D 8010, D 8010-4

Similar products:

- Type HC, HCG: Page 42

Suitable connection blocks:

- Type A, B and C: Page 62

Directly mountable valve banks:

- Type VB: Page 114
- Type BWH, BWN:Page 120
- Type SWR, SWS: Page 76
- Type BA: Page 144
- Type BVH: Page 124

Compact hydraulic power packs

1.2 Compact hydraulic power pack type MPN

Compact hydraulic power packs are a type of hydraulic power pack. They are characterised by a highly compact design, since the motor shaft of the electric motor also acts as the pump shaft.

The ready-for-connection compact hydraulic power pack type MPN and MPNW includes an electric drive which runs in oil. The stator is securely attached to the housing (tank). The compact hydraulic power pack is suitable for hydraulic systems with the operating modes S2 or S3. The heat is dissipated via surface convection so that no external cooler is usually necessary.

The type MPN contains a 3-phase motor, the type MPNW contains a single-phase-motor. Different tank sizes enable different usable oil quantities. Either single-circuit systems or dual-circuit systems can be selected. A radial piston pump , an external gear pump or internal gear pump can be used as a hydraulic pump.

The compact hydraulic power pack type MPN and MPNW is suitable as a highly compact control system, since connection blocks and valve banks can be directly mounted.

Nomen-clature:	**Radial piston and/or gear pump with integrated motor single or dual-circuit pump**
Design:	**Oil immersed hydraulic power pack for intermittent or load/no load operation (S2-/S3-/S6-service)**
p_{max}:	**Radial piston pump 700 bar (high pressure), gear pump 220 bar (low pressure)**
Q_{max}:	**12.4 lpm (high pressure) (V_g = 9.17 cm³/rev) 83 lpm (low pressure) (V_g = 61 cm³/rev)**
$V_{t\ max}$:	**100 l**

Features and benefits:

- Intermittent or load/no load operation (S2-/S3-/S6-service)
- Long lifetime and excellent reliability achieved by using radial piston pumps
- Low oil fill volumes make it environmentally sound thanks to small cost of disposal and low costs for hydraulic fluid
- Two-stage valves and switch units for press control systems can be directly flange mounted
- Co-ordinated range of valves and accessories from modular system
- Dual-circuit pumps available

Intended applications:

- Brake and rotor adjustment modules on wind turbines
- Counterbalance as well as machine tools
- Presses and other shaping machines
- Handling and clamping systems on machine tools and fixtures
- Lubrication systems

Design and order coding example

MPN 44	- H 1,5	- B10.20	D	- ...	- 3 ~ 230V 50 Hz

Motor voltage 3 ~ 230/400V Δγ 50 Hz, 3 ~ 500V γ 50 Hz,
1 ~ 230V 50 Hz, 1 ~ 110V 60 Hz (single-phase-motor)

Valve mounting

Additional options
- Level gauge
- Level switch
- Temperature switch
- Various means of electrical connection

Design
- For installation in self-made oil tanks: as single pump or cover plate version
- With tank, usable volume V_{usable} 10 l to 75 l

Pump version

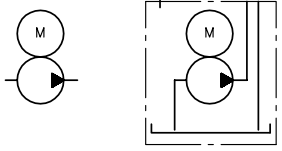
Single-circuit pump
- Radial piston pump H or gear pump Z
- Internal gear pump IZ

Dual-circuit pump
- Combinations:
  - Radial piston pump - radial piston pump (HH)
  - Radial piston pump - gear pump (HZ)

Basic type, size Type MPN (3-phase motor) and MPNW (single-phase motor)
Depending on the size, single-phase motor has 30 to 50% less power

Function

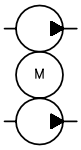
Single stage pump
(radial piston pump, gear pump)



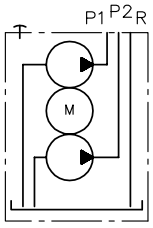
Installation pump

Hydraulic power pack (incl. tank)

Dual stage pump
(radial piston/gear pump,
gear pump/gear pump)

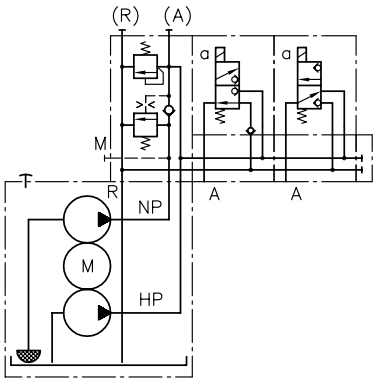


Installation pump



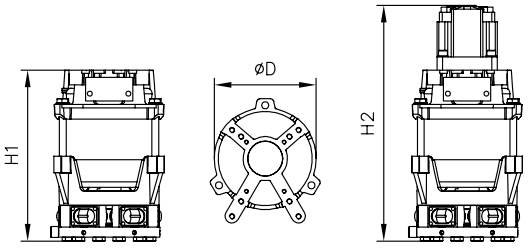
Hydraulic power pack (incl. tank)

Circuit example:

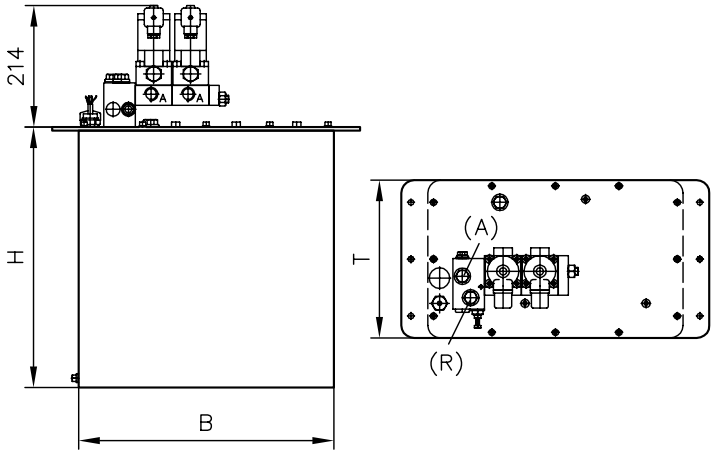


General parameters and dimensions

Single-circuit pump, dual-circuit pump
(without tank)



Compact hydraulic power pack
(tank with mounted valves)



	Radial piston pump (3 cyl.)			Gear pump					Dimensions [mm]		
	Max. pressure	Delivery flow		Max. pressure	Delivery flow						
	p_{max} [bar]	Q_{pu} [lpm] 50 Hz	Q_{pu} [lpm] 60 Hz	p_{max} [bar]	Q_{pu} [lpm] 50 Hz	Q_{pu} [lpm] 60 Hz	P_N [kW][1]	m [kg][2]	H1[2]	$H2_{max}$	ÆD
MPN 42	700 - 250	2,39 - 7,33	2,87 - 8,8	200 - 60	8,46 - 30,02	10,2 - 36,02	2,1	12,9	251/258	431	
MPN 44	700 - 250	1,53 - 5,37	1,84 - 6,44	200 - 55	5,37 - 25,99	6,4 - 31,19	2,1				
MPN 46	700 - 250	3,16 - 11,12	3,8 - 13,34	200 - 40	12,41 - 71,73	14,89 - 86,08	3,0	18,5	274/281	454	165
MPN 48	700 - 330	2,36 - 4,06	2,83 - 4,87	220 - 60	4,16 - 34,91	4,99 - 41,89	3,0				
MPN 404	700 - 340	3,1 - 3,49	3,7 - 4,19	220 - 45	2,7 - 68,16	2,25 - 81,79	4,2	26,4	298/313	486	

1) The actual power consumption is dependent on the respective operation pressure and can be up to 1.5xP_N
2) Values apply to radial piston pump/gear pump versions

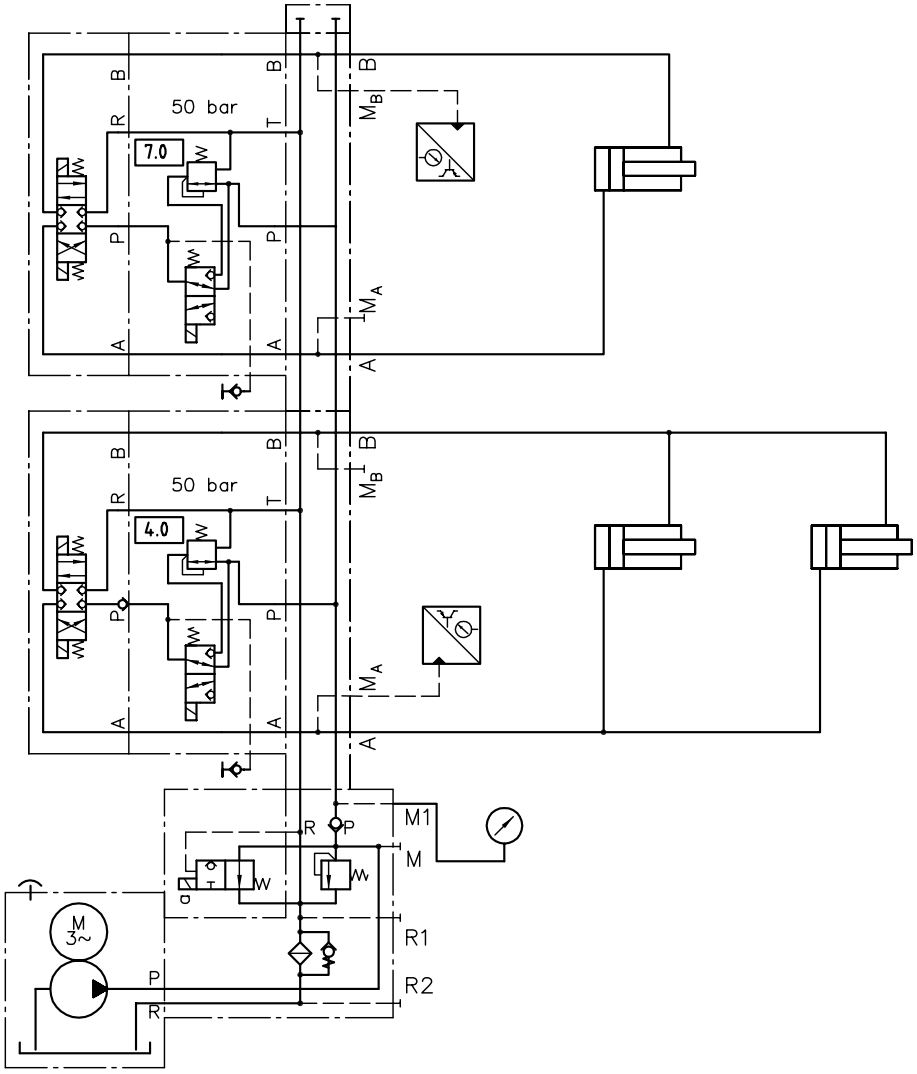
Version with tank:

Size	Tank size	H [mm]	W [mm]	D [mm]
MPN 4.	B 25	458	402	250
	B 55	470	560	350
	B 110	495	560	350
	B 25 L	283	623	250
	B 55 L	305	560	350

Circuit example:

MPN 44-Z 8.8-B 10 KT

-AS 1 F 3/160
-BA 2
-NBVP 16 G/R-GM/NZP 16 LZY 5/50-G 8 MA/GM/3-X 84 V-DG 5E-250-1/4
-NBVP 16 G-GM/NZP 16 LZY 5/50-G 8 MA/GM/3-X 84 V-DG 62
-1-G 24
-X 84 V-9/250
-3 x 400/230 V 50 Hz



Associated technical data sheets:

- Compact hydraulic power pack type MPN and MPNW: D 7207

Connection blocks:

- Type A, B and C: Page 62

Flange-mountable valve banks:

- Type VB: Page 114
- Type BWH, BWN: Page 120
- Type BA: Page 144
- Type BVH: Page 124

Compact hydraulic power packs

1.2 Compact hydraulic power pack type HK, HKF and HKL

Compact hydraulic power packs are a type of hydraulic power pack. They are characterised by a highly compact design, since the motor shaft of the electric motor also acts as the pump shaft.

The ready-for-connection compact hydraulic power pack type HK, HKF, HKL and HKLW includes an electric drive which runs in oil. The stator is securely attached to the housing (tank). The compact hydraulic power pack is suitable for hydraulic systems with the operating modes S2, S3 or S6.

A fan, which effectively dissipates the heat from the hydraulic system, is mounted on the housing. In the case of type HKF, the fan is powered by a separate motor independently of the pump motor. In the case of type HK, the fan is securely attached to the motor shaft. An external cooler is not generally required. The type HK, HKF and HKL contains a 3-phase motor, the type HKLW contains a single-phase-motor. The compact hydraulic power pack type HK and HKF has a vertical housing, while type HKL and HKLW has a horizontal housing. Single-circuit, dual-circuit or triple-circuit systems can be selected. A radial piston pump , an external gear pump or internal gear pump can be used as a hydraulic pump.

The compact hydraulic power pack type HK, HKF, HKL and HKLW is suitable as a highly compact control system, since connection blocks and valve banks can be directly mounted.

Nomenclature:	**Radial piston pump and/or gear pump with integrated motor (version for 3-phase mains)**
Design:	**Oil immersed compact hydraulic power pack for permanent and intermittent operation (S1/S6 service)**
p_{max}:	**Radial piston pump 700 bar (high pressure) Gear pump 180 bar (low pressure)**
Q_{max}:	**Radial piston pump (high pressure) 13.0 lpm (V_g = 9.17 cm³/rev) Gear pump (low pressure) 24 lpm (V_g = 17.0 cm³/rev)**
$V_{usable\ max}$:	**11.1 l**

Features and benefits:

- Suitable for continuous operation with intermittent load S6 and continuous operation S1
- Additional external fan for optimum use of power
- Wide range of applications, with three sizes available
- Long lifetime and excellent reliability thanks to use of radial piston pumps
- Environmentally friendly thanks to low oil filling volume; low cost of disposal and low hydraulic fluid costs
- Tailored range of valves and accessories from modular system
- One-circuit to three-circuit pumps available

Intended applications:

- Clamping systems on machine tools and turning centres
- Handling and clamping systems on machine tools and fixtures
- Welding machines, robots
- Endurance test bench construction
- Hydraulic torque wrenches

Design and order coding example

HK 34	8	LST	- H 3,6	3 x 400V 50Hz

Motor voltage
3 ~ 230/400V Δγ 50 Hz, 3 ~ 265/460V Δγ 60 Hz
1 ~ 230V 50 Hz, 1 ~ 115V 60 Hz (1~phase motor)

Pump version

Single circuit pump
- Radial piston pump H, gear pump Z, internal gear pump IZ

Dual circuit pump with joint connection pedestal for pressure ports P1 and P3
- Combinations:
  - Radial piston pump - radial piston pump (HH)
  - Radial piston pump - gear pump (HZ)

Dual circuit pump with separate connection pedestals
- Radial piston pump H or gear pump Z

Additional functions
- Temperature and level switch, single or double version
- Additional leakage port (Type HK 4.L)

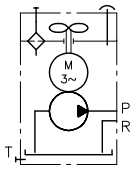
Tank size
Type HK: Usable volume V_{usable} 0.85 l to15.4 l, Type HKL: Usable volume V_{usable} 1.7 l to 9.1 l
- Various filler neck designs

Basic type, size
Type HK, size 2 to 4, type HKF (with auxiliary blower for increased cooling), size 4
Type HKL (3~phase motor) and HKLW (1~phase motor), size 3

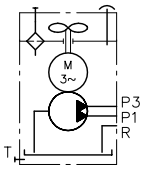
Additional versions:
- With molded motor
- With frequency-controlled drive

Function

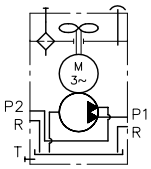
Single stage pump
(radial piston pump, or gear pump)



Dual stage pump
(radial piston/radial piston pump, or gear pump/gear pump, or radial piston pump/gear pump)

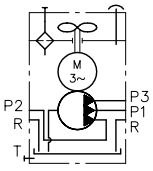


Joint pump pedestal



Separate pump pedestals

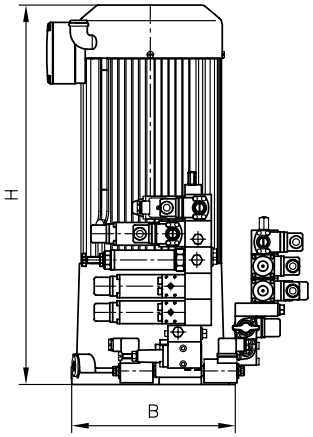
Triple-circuit pump
(only radial piston pump)

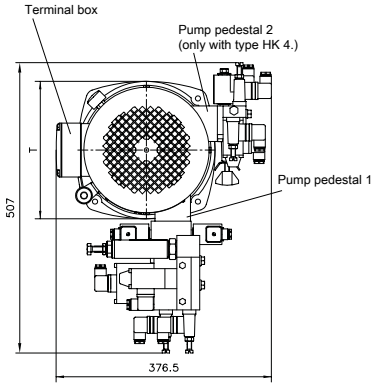


Separate pump pedestals

General parameters and dimensions

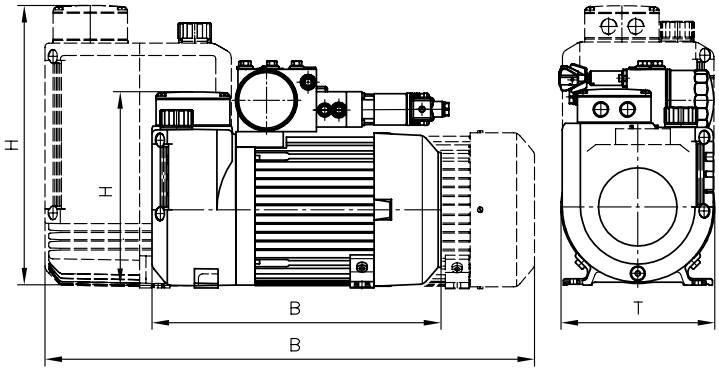
HK..





1 Terminal box
2 Pump pedestal 2 (only for type HK 4.)
3 Pump pedestal 1

HKL..



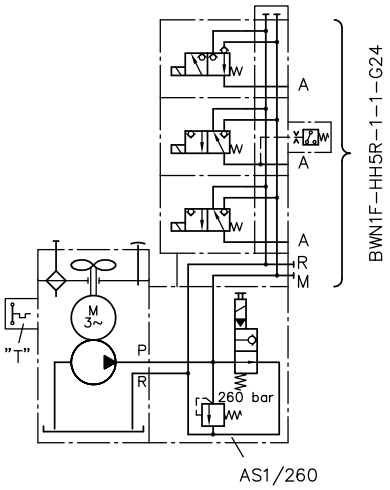
	Radial piston pump			Gear pump				Dimensions [mm]			
	Max. pressure	Delivery flow		Max. pressure	Delivery flow						
	p_{max} [bar]	Q_{pu} [lpm] 50 Hz	Q_{pu} [lpm] 60 Hz	p_{max} [bar]	Q_{pu} [lpm] 50 Hz	Q_{pu} [lpm] 60 Hz	P_N [kW]1)	H_{max}	B	T	m [kg]
HK 24	700 - 220	0.46 - 1.77	0.55 - 2.12	-	-	-	0.55	340	196	196	13
HK 33	560 - 100	1.25 - 6.5	1.5 - 7.8	170 - 100	2.7 - 6.9	3.24 - 8.28	0.8	405	212	212	20.5
HK 34	700 - 170	1.25 - 6.5	1.5 - 7.8	170 - 160	2.7 - 6.9	3.24 - 8.28	1.1	405	212	212	20.5
HK(F) 43	610 - 90	2.08 - 13.1	3.36 - 15.72	170 - 80	4.5 - 16	3.29 - 19.2	1.5	460	240	240	29
HK(F) 44	700 - 130	2.08 - 13.1	2.5 - 15.72	170 - 110	4.5 - 24	3.29 - 28.8	2.2	460	240	240	29
HK(F) 48							3	833	240	240	40
HKL(W) 32	700 - 220	1.65 - 8.7	1.98 - 10.44	170 - 130	2.7 - 11.3	3.24 - 13.56	1.8	358	617	196	19.2
HKL(W) 34											
HKL 38	700 - 220	1.65 - 8.7	1.98 - 10.44	170 - 130	2.7 - 11.3	3.24 - 13.56	2.2	358	617	196	22.2

1) The actual power consumption is dependent on the respective operation pressure and can be up to 1.5 x P_N

Circuit examples:

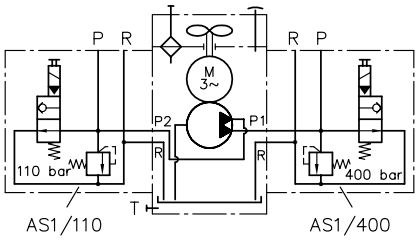
HKF 489 D-DT/1P1M-H2.6
-AS1/260
-BWN1F-HH5R-1-G24
-3x400/230V50Hz

Compact hydraulic power pack HKF 489 with level switch with two switch points (coding D-D);
temperature switch (coding T) with Harting plug coding P1 and oil filler (coding M)



HK449/1P1-H 2.5-Z6.9
-AS1/400-G24
-AS1/110-G24
-3x400/230V50Hz

Compact hydraulic power pack HK 44 with radial piston pump H 2.5 and gear pump Z 6.9 on separate pump pedestals,
two connection blocks (type AS1/..) with pressure limiting valve (400 bar and 110 bar) and idle circulation valve (mounting of valve banks possible)



Associated technical data sheets:

- Compact hydraulic power pack type HK 4: D 7600-4
- Compact hydraulic power pack type HK 3: D 7600-3
- Compact hydraulic power pack type HK 2: D 7600-2
- Compact hydraulic power pack type HKL and HKLW: D 7600-3L

Connection blocks:

- Type A, B and C: Page 62

Directly mountable valve banks:

- Type VB: Page 114
- Type BWH, BWN: Page 120
- Type BA:Page 144
- Type BVH: Page 124

Hydraulic power pack

1.2 Standard hydraulic power pack type FXU

Standard hydraulic power packs are a type of hydraulic power pack. They are characterised by their very flexible design and customer-specific modular adjustment options.
Units of the FXU (Flexunit) range are used to create pressure for stationary oil-hydraulic installations.
The units have oil containers made either of aluminium or of steel. The pump is located in the tank. Single pumps or combinations of pumps are possible.
Both radial piston pumps and external gear pumps are used as well as combinations of external gear pumps with radial piston pumps.
The pumps are installed below the tank cover in an aluminium container or in a steel container.

Nomenclature:	**Standard hydraulic power pack (S1 operation) Single-circuit pump, dual-circuit pump With radial piston pump and/or gear pump in the tank**
Version:	**Radial piston pump and/or gear pump**
p_{max}:	**HP/LP: 700/280 bar**
Q_{max}:	**HP/LP: 91/80 lpm Radial piston pump: Vg = 64.2 cm³/rev Gear pump: Vg = 63 cm³/rev**
V_{Tank} max:	**565 l**

Features and benefits:

- Hydraulic power pack for continuous operation (S1 operation)
- Long lifetime and excellent reliability when using radial piston pumps
- Low noise production when using gear pumps
- Combinations of radial piston pumps and gear pumps available for dual-stage systems
- Quick to configure due to tailored modular system
- Customer-specific documentation with EPlan Fluid schematic, step model and adjusted data sheet
- Possible to directly mount all HAWE valve banks

Intended applications:

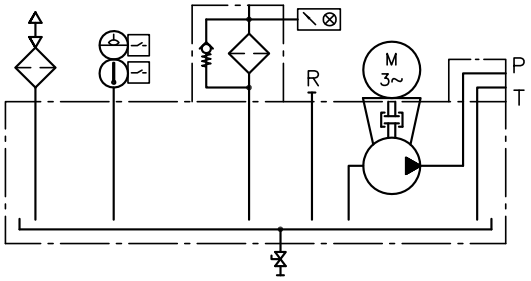
- Machine tools with a continuous flow rate requirement
- Recycling systems
- Plastics machinery
- Unloading stations in material handling
- Pressing applications such as vulcanising and briquetting
- Incremental launching systems for bridge building

Design and order coding example

FXU	- Z9	BL 44	- F020/0A	- NT1/A	- UA	- V4,0-3 x 400/230 V 50 Hz	- A3/185

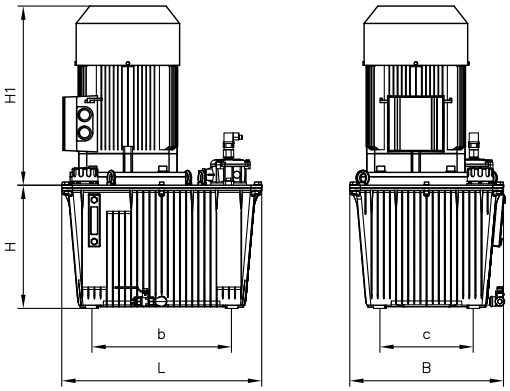
- **Basic type**
- **Pump** Radial piston pump (R...) or gear pump (Z...)
- **Tank** Nominal size
- **Filter**
- **Monitoring**
- **Pedestrial**
- **Motor version, nominal power, nominal voltage**
- **Connection block**

Function

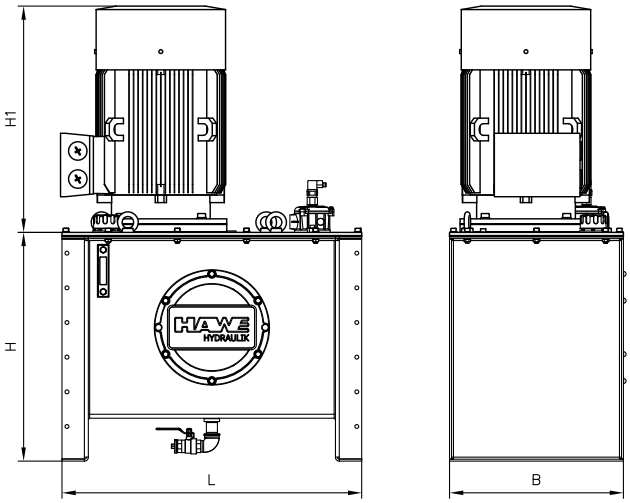


General parameters and dimensions

BL ...



BS ...



Tank size	H [mm]	L [mm]	B [mm]	b [mm]	c [mm]	H1 [mm]	V_{max} tank [l]
BL 30	291	490	350	326	176	445	26
BL 44	324	515	425	341	241	614.5	40
BL 70	374	605	475	422.5	282.5	659.5	63
BS 100	693	670	528	--	--	667	90
BS 160	693	910	528	--	--	759.5	145
BS 250	693	1310	528	--	--	759.5	225
BS 400	765	1270	904	--	--	783	360

Associated technical data sheets:

- Standard hydraulic power pack type FXU: D 6020
- Radial piston pump type R and RG: D 6010
- Dual-stage pump type RZ: D 6910

Suitable connection blocks

- Connection blocks type A for hydraulic power packs: D 6905 A/1
- Connection blocks type B for hydraulic power packs: D 6905 B
- Connection block type C 5 and C 6: D 6905 C

Flange-mountable valve banks

- Valve bank (nominal size 6) type BA: D 7788
- Valve bank type BNG: D 7788 BNG
- Valve bank (directional seated valve) type BVH: D 7788 BV
- Valve bank (directional seated valve) type VB: D 7302
- Valve bank (directional seated valve) type BWN and BWH: D 7470 B/1

Standard power packs

1.2 Air-driven hydraulic power pack type LP

Air-driven hydraulic power packs are pneumatically driven, reciprocally acting plunger pumps. They operate as pneumatic pressure amplifiers with oscillating movement and automatic stroke reversal control.

The air-driven hydraulic power pack type LP can generate up to 1500 bar. It is available as a single pump or as a hydraulic power pack with different tank sizes and valve banks. The delivery flow is dependent on the air pressure set and the hydraulic counter pressure currently present. It can drop away to standstill.

Applications are in laboratory presses, in fixture design, in lubrication systems or in potentially explosive atmospheres.

Features and benefits:

- High operating pressures
- Suitable for explosion-proof systems and equipment
  No electrical energy
- Hydraulic power packs with direct valve mounting

Intended applications:

- Construction and construction materials machinery
- fixture design
- Testing and laboratory equipment

Nomen-clature:	Air-driven hydraulic power pack
Design:	Hydraulic power pack
$p_{hydraulicmax}$:	1500 bar
p_{airmax} :	10 bar
Q_{max}:	12 l/min

Design and order coding example

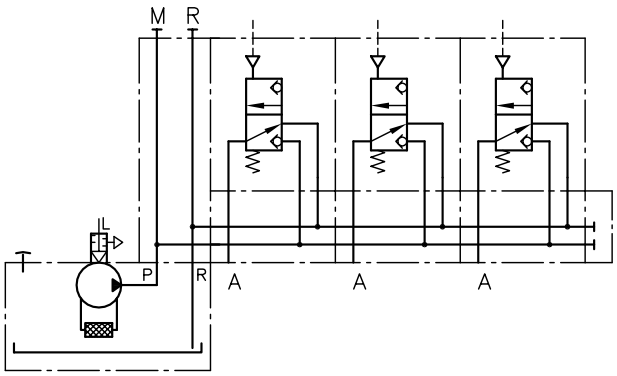
LP 125 - 16 /B4 VB 11 LP - HHH - 1

Valve mounting
- Valve bank type VB
- Valve bank type BWN and BWH

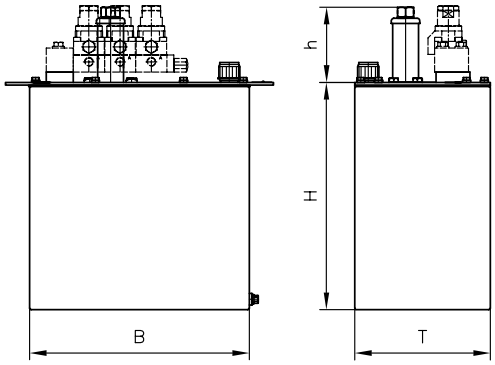
Design **Hydraulic power pack**
- Tank version, usable volume V_{usable} 5 l to 28 l
- Cover plate version (for installation in self-manufactured oil tanks)

Basic type, size Type LP, size 80, 125, 160

Function



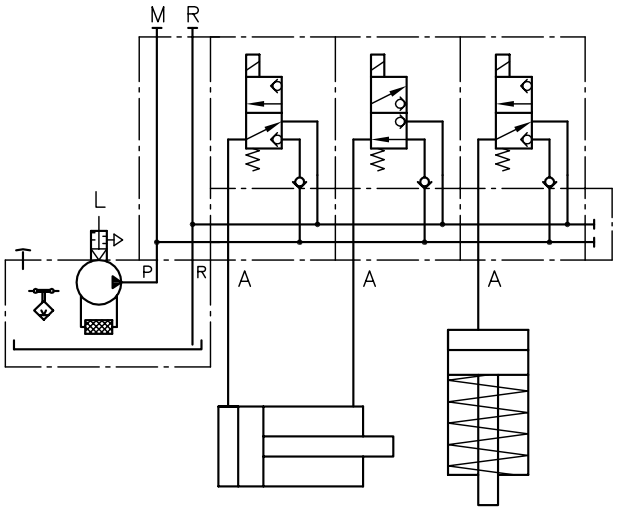
General parameters and dimensions



Basic type and size	B	H	T	h	V_{max} tank (l)	m (kg)
LP 80-..B4	200	242,5	200	94	7	5,7
LP 125-..B4	200	242,5	200	110	5,8	5,7
LP 125-..B10	324	332,5	200	132	16,6	8,5
LP 125-..B25	402	410	250	130	34	15,1
LP 160-..B10	324	332,5	200	132	13,5	8,5
LP 160-..B25	402	410	250	130	33	15,1

Circuit example:

LP 125-10/B 10 D
-VB 11 LM-NRN-1-G 24



Hydraulic power pack in tank version with air-driven hydraulic pump type LP125-10, tank size B10 as well as level switch D (N/C contact) and valve bank type VB11 attached.

Associated technical data sheets:

- Air-driven hydraulic pump type LP: D 7280
- Hydraulic power pack type LP: D 7280 H

Valve banks :

- Type VB:Page 114
- Type BWH(N):Page 120

Mounted valves

1.2 Connection block type A, B and C

A connection block represents the connecting link between the hydraulic power pack and the hydraulic control. The connection blocks described here are suitable for combining with compact hydraulic power packs.

A valve bank can be directly attached to the connection block type A such that a compact hydraulic control unit is produced. As standard the type A contains a pressure-limiting valve that can be supplemented with a pressure or return line filter, or an idle circulation valve, among other items. The connection block type B controls single-acting cylinders, e.g. in pallet lifting equipment. The integrated pressure-limiting valve limits the maximum lifting force. The lowering speed is adjusted using the integrated throttle. The connection block type C has only a pump and return port and is used in hydraulic systems with decentral valve blocks.

The connection blocks type A, B and C can be combined, e.g. with the compact hydraulic power packs type KA, HK and MPN.

Nomen-clature:	Connection blocks to the completion of hydraulic power packs
Design:	Add-on valve enabling pipe connection or direct mounting of valve banks
p_{max}:	System pressure: 700 bar
Q_{max}:	approx. 20 lpm

Features and benefits:

- Enables compact and sturdy direct mounting of ongoing components at the compact power packs of HAWE Hydraulik
- Intermediate plates enable versatile addition of other components
- Efficient and space saving solution for mounting individual valves or valve banks to single and dual circuit pumps
- Pressure/return line filters, pressure-limiting valves, pressure switches, etc. can be directly integrated

Intended applications:

- Lifting devices
- Machine tools
- Modules for braking or rotor blade adjustment at wind power systems
- Tracking systems for solar panels and parabolic antennas

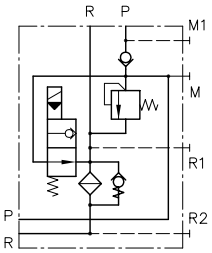
Design and order coding example

AS3F2 /420 - G24

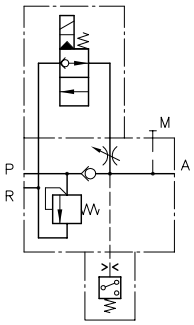
- **Solenoid voltage** 12V DC, 24V DC, 230V AC
- **Pressure setting (bar)**
- **Basic type** **Type A, B, C** see table

Function

A



B



C

Options, type A, B, C

Type A with pressure-limiting valve (fixed or manually adjustable, also with unit approval as safety valve for safeguarding hydraulic accumulators)

- For direct pipe connection
- To attach valve banks

Options:

- Check valve in P gallery
- Prop. pressure-limiting valve
- Return line filter, Pressure filter
- Idle circulation valve (solenoid-actuated)
- Shut-off valve, accumulator charging valve

Type B with pressure-limiting valve to actuate single- and double-acting cylinders

- For direct pipe connection

Options:

- Check valve in P gallery
- Throttle for regulating the drain speed
- Idle circulation valve open or closed in neutral position
- Pressure switch in P gallery
- Pressure dispersal for independent return stroke (type B to DW)

Type C without additional elements

- For direct pipe connection

Options:

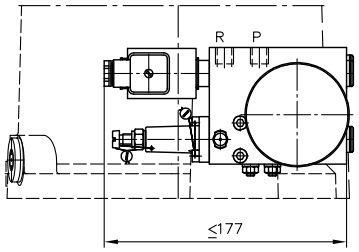
- For pipe connection (pump side) of all type A, B connection blocks (Type C15, C16 - connection block with hole pattern of the pump, type C36)

Additional versions

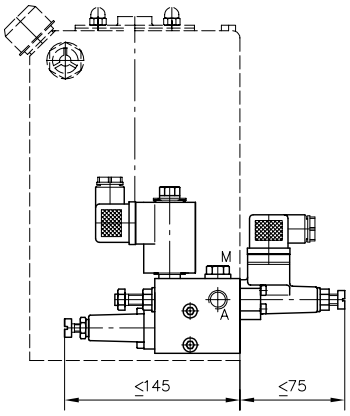
- Connection blocks for dual-stage pumps
- Intermediate blocks for dual-stage pumps type S, V, C30
- Spacer plates for single and dual-circuit pumps type U.
- Additional intermediate block for second pressure stage type V, S

General parameters and dimensions

AS ..
Example: HK 44/1 - H 2.08 **- ASX 3 F2 B/400 - G 24**



B..
Example: HC 14/1.95 **- B 31/180 - EM 11V - 13/3 - G 24**



Associated technical data sheets:

- Connection blocks type A for hydraulic power packs: D 6905 A/1
- Connection block type AX, with unit approval: D 6905 TUV
- Connection blocks type B for hydraulic power packs: D 6905 B
- Connection block type C 5 and C 6: D 6905 C

Suitable compact hydraulic power packs:

- See "Compact hydraulic power packs" section

Products with shared connection pattern:

- Two-stage valves type NE 21: Page 192
- Switch units type CR: Page 152

Suited valve banks for combination:

- Type VB: Page 114
- Type BWH, BWN: Page 120
- Type BA: Page 144
- Type BVH: Page 124

2.1 Directional spool valves

Directional spool valves type SWR and SWS

Proportional directional spool valves type PSL and PSV

On/off directional spool valve

Type	Design / actuation	p_{max} (bar)	Q_{max} (lpm)
SG, SP	**Directional spool valve, single valve** ▪ Single valve for pipe connection ▪ Individual valve for manifold mounting – Solenoid – Manual – Mechanical – Pressure-actuated	SG - 0: 400 SG - 1: 400 SG - 2: 400 SG - 3: 400 SG - 5: 400 SP - 1: 400 SP - 3: 400 SP - 5: 400	SG - 0: 12 SG - 1: 20 SG - 2: 30 SG - 3: 50 SG - 5: 100 SP - 1: 12 SP - 3: 50 SP - 5: 100
SW, SWP, NSWP	**Directional spool valve, single valve** ▪ For pipe connection ▪ Individual valve for manifold mounting **Directional spool valve, valve bank** ▪ With manifold mounting ▪ Combination with pump units – Solenoid	SW - 1: 315 SW - 2: 315 SWP - 1: 315 SWP - 2: 315 NSWP - 2: 315	SW - 1: 12 SW - 2: 25 SWP - 1: 12 SWP - 2: 25 NSWP - 2: 25
SWR, SWS	**Directional spool valve, valve bank** ▪ With series connection ▪ Combination with pump units – Solenoid	SWR - 1: 315 SWS - 2: 315	SWR - 1: 12 SWS - 2: 25
HSF	**Directional spool valve, single valve** ▪ Individual valve for manifold mounting – Electro-hydraulic – Hydraulic	3: 400 4: 400	3: 80 4: 160

Proportional directional spool valve

Type	Version / actuation	p_{max} (bar)	Q_{max} (lpm)
EDL	**Prop. directional spool valve (load sensing) valve bank** ▪ With series connection – Solenoid	2: 320	2: 50
PSL, PSV	**Prop. directional spool valve (load sensing) valve bank** ▪ With series connection – Manual – Electro-hydraulic – Pressure-actuated	2: 420 3: 420 5: 400	2: 60 3: 120 5: 270
PSLF, PSVF, SLF	**Proportional directional spool valve (load sensing) single valve** ▪ Individual valve for manifold mounting **Valve bank** ▪ With manifold mounting – Manual – Electro-hydraulic – Pressure-actuated	3: 420 5: 400 7: 420	3: 120 5: 270 7: 500

Valve combinations

Type	Version / actuation	p_{max} (bar)	Q_{max} (lpm)
NSMD	**Combination of directional spool valve and pressure-reducing valve** **As single valve** ▪ Individual valve for manifold mounting **As valve bank** ▪ Valve banks are available with type BA – electro-magnetic	2: 120	2: 80

Directional spool valves

2.1 Directional spool valve type SG and SP

Directional spool valves are a type of directional valve. They control the direction of movement and the velocity of single and double-acting hydraulic consumers.
The directional spool valve type SG is available as a single valve for pipe connection. Type SP is available as a valve for manifold mounting. Due to the robust design the directional spool valve type SG and SP reaches operating pressures up to 400 bar. It is of versatile use due to different types of actuation.
Intended applications include mobile hydraulics, in particular in special vehicles, in municipal trucks and in shipbuilding.

Features and benefits:

- Sturdy design
- Suited for maritime applications
- Various actuation variants

Intended applications:

- Mining machinery
- Cranes and lifting equipment
- Ship building
- Road vehicle

Nomen-clature:	**Directional spool valve**
Design:	**Single valve for pipe connection** **Individual valve for manifold mounting**
Actuation:	**Solenoid** **Manual** ▪ **With automatic spring return** ▪ **With detent** **Mechanical** ▪ **Roller head** ▪ **Pin head** **Pressure-actuated** ▪ **(Individual and combined with manual operation)** ▪ **Hydraulic** ▪ **Pneumatic**
p_{max}:	**400 bar**
Q_{max}:	**100 l/min**

Design and order coding example

SP 1 SG 3	D E	3E	- A - MD 3/24	- 120

Pressure setting pressure limiting valve [bar]

Actuation mode

Pressure limiting valve

Function

- Parallel- or series connection
- Directional spool valves either with positive (blocked between switching positions) or negative (slightly floating position) overlap
- SP 1 with/without check valve insert

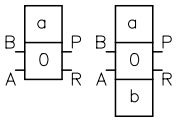
Basic type and size

Directional spool valve SG 0 to 5, SP 1, SP 3, SP 5
Directional spool valves type SP for manifold mounting, sizes 1, 3, 5

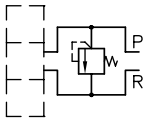
Function

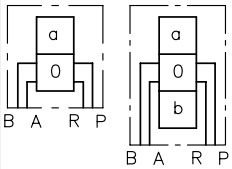
Basic symbol

SG	SP
Individual valve for pipe connection	Individual valve for manifold mounting

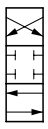
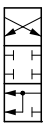
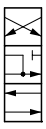
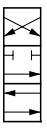
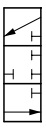


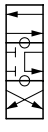
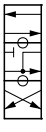
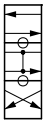
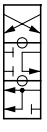
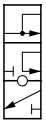
With pressure-limiting valve





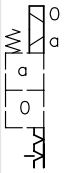
Circuit symbol

G	C	D	E	N	W	R	V	Z	U
									

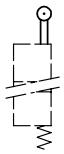
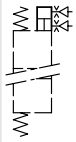
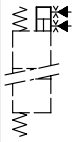
L	F	H	Y	S	X
					

- Circuit symbol Z, U, X: only for size 2, 3 and 5

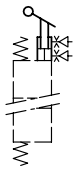
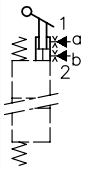
Actuations:

Manual		Solenoid	
A, AK	**C, CK**	**ME, MD**	**MU**
Return spring	Detent		
			
		Solenoid voltage: 12V DC, 24V DC, 110V AC, 230V AC	

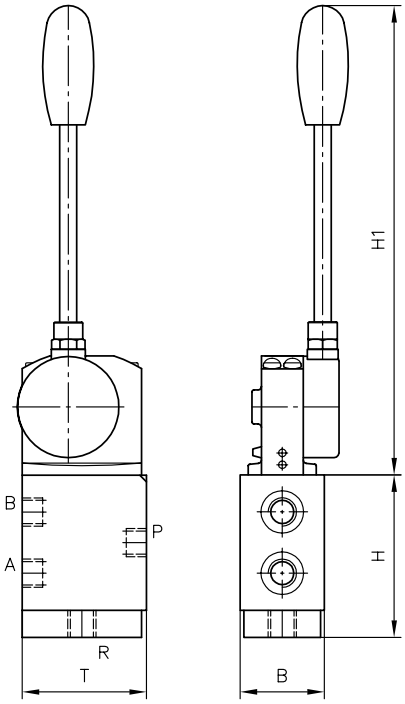
Actuations:

Mechanical		Pressure		
RE, RD	**BE, BD**	**NE, ND**	**NU**	**NM**
Roller head	Pin head	Pneumatic		Hydraulic
				
Actuation forces: 90 - 280 N (according to size)		Control pressures: pneumatic 5 - 10 bar hydraulic 12 - 20 bar		

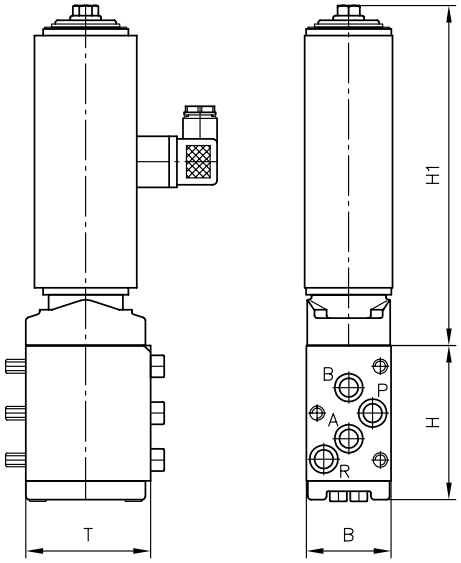
Actuations:

Double acting	
KD	**KM**
Pneumatic / manual	Hydraulic / manual
	
Control pressure: Pneumatic 5 ... 10 bar Hydraulic 12 ... 20 bar	

SG with manual actuation



SP with solenoid actuation



	Q_{max} [lpm]	Operating pressure p_{max} [bar] for actuation			Ports	Dimensions [mm]				m_{max} [kg]
		Solenoid	Mechanical	Manual/ pressure		H	H1	B	T	
SG 0	12	200	400	400	G 1/4, G 3/8	59.5	151	39.5	51	0.8 ... 1.0
SG 1	20	200	400	400	G 3/8	59.5	151	39.5	51	0.8 ... 1.0
SG 2	30	315	400	400	G 3/8	100.5	342	49.5	73	2.5 ... 5.7
SG 3	50	315	400	400	G 1/2	100.5	342	49.5	73	2.5 ... 5.7
SG 5	100	200	315	400	G 1	110	342	50	80	2.9 ... 6.1
SP 1	20	200	400	400	-	59.5	151	40	51	0.8 ... 1,0
SP 3	50	315	400	400	-	94.5	342	49.5	73	2.5 ... 5.7

Associated technical data sheets:

- Directional spool valve type SG and SP: D 5650/1
- Actuations:
  - Manual operation for directional spool valves, type S: D 6511/1
  - Electrical operation for directional spool valves type S: D 7055
  - Mechanical operation for directional spool valves, type S: D 5870
  - Pressure actuation for directional spool valves: D 6250

Male connectors:

- Line connector type MSD and others: D 7163
- With economy circuit: D 7813, D 7833

Directional spool valves

2.1 Directional spool valve type SW, SWP and NSWP

Directional spool valves are a type of directional valve. They control the direction of movement and the velocity of single and double-acting hydraulic consumers.
The directional spool valve type NSWP and SWP is available as a manifold mounting valve. Type NSWP is available with a nominal size 6 hole pattern (NG 6). Type SW is available as a single valve for pipe connection. The directional spool valve type NSWP can be flexibly adapted to different control tasks by means of additional functions in the pump line and/or on the consumer side (e.g. restrictors, restrictor check valves).
Intended applications for the directional spool valve type NSWP, SWP and SW include industrial hydraulics, in particular machine tools.

Features and benefits:

- Compact valve banks possible
- Proportional functions easy to control
- Large range of variants
- Can be combined with NG6 sub-plates (type BA2)

Intended applications:

- Machine tools
- Construction and construction materials machinery
- Offshore and marine technology
- Road vehicles

Nomen-clature:	**Directional spool valve**
Design:	**Individual valve for pipe connection Individual manifold mounting valve Valve bank manifold mounting Combination with hydraulic power packs**
Actuation:	**Solenoid**
p_{max}:	**315 bar**
Q_{max}:	**25 l/min**

Design and order coding example

NSWP2	G	/M	/R	/ ABR1,0	/50	/G24	- 3/8

Single connection block for direct installation in the pipe G 3/8 (type NSWP and SWP2)

Voltage of the actuation solenoids 12V DC, 24V DC, 110V AC, 230V AC

- Solenoids with various plug versions

Pressure switch or pressure gauge at A or B

Additional elements at A and/or B Restrictor check valve or orifice

Additional elements at P Check valve or orifice

Solenoid version

- black/white solenoid or proportional solenoid
- Solenoid with detent
- Solenoid version conforming ATEX (p_{max} = 210 bar)

Function

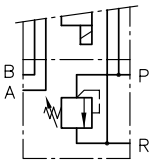
- Indiv. valve with check valve or orifice in gallery P and/or check valve in gallery R (type SWP)
- Indiv. valve with 6/2-way function

Basic type, size Directional spool valve SW, SWP size 1 and 2
NSWP size 2, connection hole pattern NG 6 (CETOP)

Function

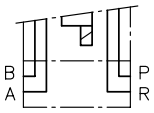
Sub-plate for pipe connection

- 1/4 S(R)



Sub-plate with pressure limiting valve[1)]

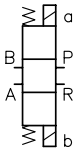
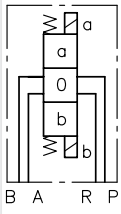
- 3/8



Sub-plate[2)]

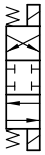
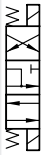
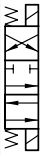
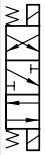
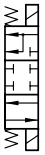
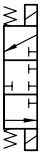
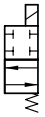
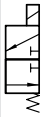
1) Only for type SWP 1
2) Only for type NSWP and SWP 2

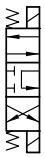
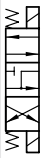
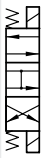
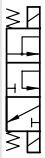
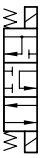
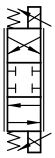
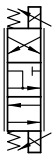
Valve sections

Basic symbol	
Individual valve	
SW	**SWP / NSWP**
	

Valve sections

Circuit symbol

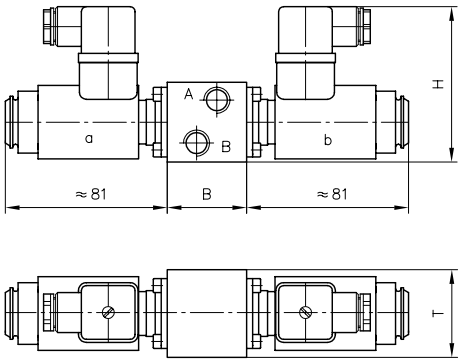
May be connected either in parallel or in series within a valve bank											
G	**D**	**E**	**O**	**C[3)]**	**N**	**B**	**W**	**K**	**Q**	**R[3)]**	**U[3)]**
											

Only connected in series within a valve bank (only type SW1)					Spool for proportional adjustment	
L	**F**	**H**	**S**	**Y**	**G**	**D**
						

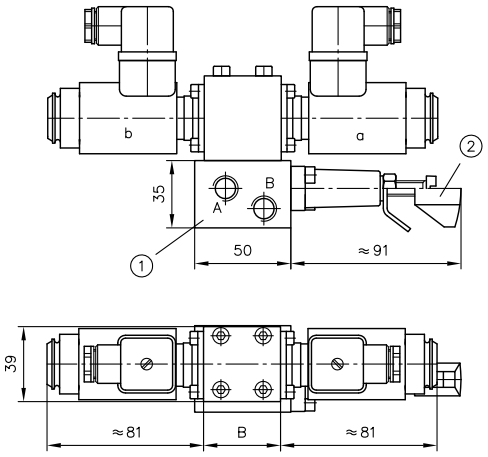
3) Only for type SWR 1

General parameters and dimensions

SW



SWP/NSWP2



1 Single connection block

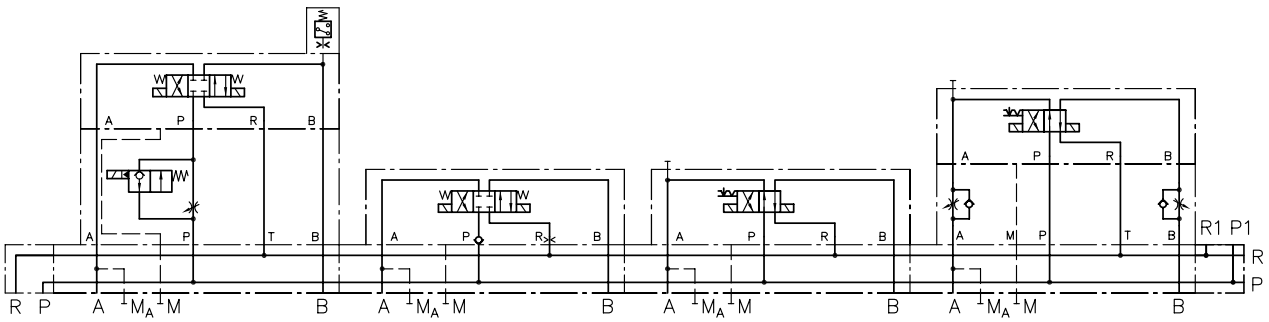
2 Pressure-limiting valve

	Q_{max} [lpm]	p_{max} [bar]	Ports	Dimensions [mm]			m [kg]	
				H	B	T	Individual directional spool valve	Sub-plate
SW/SWP 1	12	315	G 1/4	77 ... 90	40	40 ... 44	1.1 ... 1.5	0.6 ... 0.7
SW/SWP 2	25	315	G 3/8, G 1/4	78 ...- 82.5	60 ... 70	40 ... 45	1.1 ... 2.4	0.8
NSWP2			NG 6					

Circuit example 1:

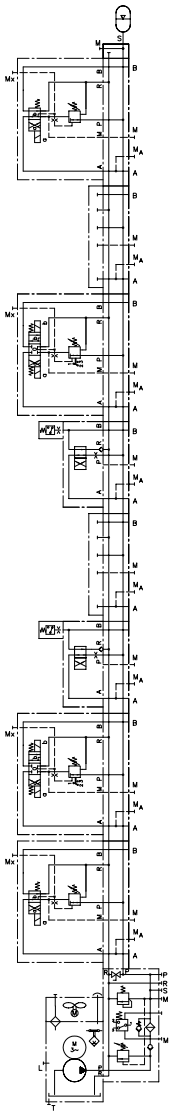
BA2-A5

-NSWP2G/M/03/NZP16V/PQ20/0
-NSWP2G/M/R/B1,0
-NSWP2K/M/20/0
-NSWP2K/M/20/NZP16Q33/0
-2-L24



Circuit example 2:

HKF44V9LD/1-Z16
-AL21D10V-F60/80-2
-BA2-NSMD2K/G/B2/0
-NSMD2G/GRK/B2/0
-NSWP2W/M/B1.0/06/S/0
-NG6X/0
-NSWP2W/M/B1.0/06/S/0
-NSMD2G/GRK/B2/0
-NG6X/0
-NSMD2K/G/B2/0
-80-AC2001/40-X24



Combinable products:

- Valve bank type BA: Page 144
- Intermediate plate type NZP: D 7788 Z
- 6/2-directional spool valve: **Sk 7951-J-6/2**

Similar products:

- Valve banks type SWR and SWS: Page 76
- Clamping modules type NSMD: Page 100

Associated technical data sheets:

- Directional spool valve type SW: D 7451
- Directional spool valve type NSWP 2: D 7451 N

Male connectors:

- Line connector type MSD and others: D 7163
- With economy circuit: D 7813, D 7833

Directional spool valve

2.1 Directional spool valve bank type SWR and SWS

Directional spool valves are a type of directional valve. They control the direction of movement and the velocity of single and double-acting hydraulic consumers.
The directional spool valve bank type SWS is available with series connection. The consumers can be operated with on-off or proportional control. Versions are available for usage in potentially explosive atmospheres. By means of additional functions in the pump line, in the intermediate plates (longitudinal and sandwich valve combination) and ancillary blocks the directional spool valve bank can be flexibly adapted to different control tasks.
Intended applications include mobile hydraulics, in particular civil engineering, agricultural engineering and material handling.

Nomen-clature:	Directional spool valve
Design:	Valve bank Combination with hydraulic power packs
Actuation:	Solenoid
p_{max}:	315 bar
Q_{max}:	25 l/min

Features and benefits:

- Can be combined for forklift trucks with lifting modules
- Suitable for constant pressure systems
- Proportional movements can also be controlled independently of the load
- Extensive range of ancillary blocks
- Compact and extremely space-saving dimensions

Intended applications:

- Material handling
- Wind turbines
- Construction and construction materials
- Handling and assembly techn.
- Municipal trucks

Design and order coding example

SWR1 | A-6/230 | - GG | - 1 | - G24

Solenoid voltage 12V DC, 24V DC, 110V AC, 230V AC
- Solenoids with various plug versions

End plate
- Additional ports P and/or R (P can be blocked)
- Idle circulation valve (ON/OFF, proportional)
- End spool valve

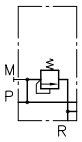
Valve sections
- Directional spool valve
- Additional options for the valve sections:
  - Options upstream (orifice, flow controller)
  - Consumer-side additional functions in ancillary block, e.g. double check valves, shock valves (load-holding valves etc.)

Connection block/adapter plate
- Pressure limiting valve (for pipe connection)
- Idle circulation valve
- 3-way flow controller

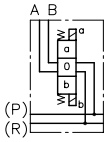
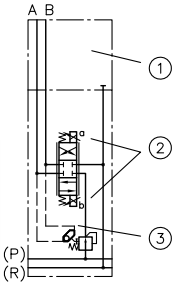
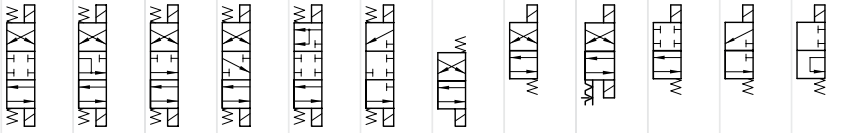
Basic type, size Type SWR 1 and SWS 2

Function

Connection blocks:

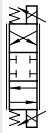
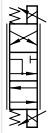
A 6	F/D
	
With fixed pressure limiting valve (for pipe connection)	For direct mounting onto hydraulic power packs (type KA, HC, MP, HK)

Valve sections:

Basic symbol		Symbol											
SWR 1	SWS 2	G	D	E	O	C	N	B	W	K	Q	R	U
													

1 Ancillary block with additional function (on the consumer side)
2 Actuation
3 Additional function (on the pump side)

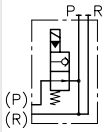
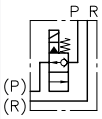
Spool valves suited for prop. actuation

G	D
	

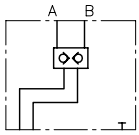
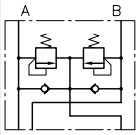
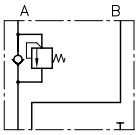
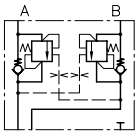
Additional versions for valve sections:

- b/w solenoids with stroke limitation
- prop. solenoids with stroke limitation
- solenoids also available in ATEX-compliant version (p_{max} = 210 bar)

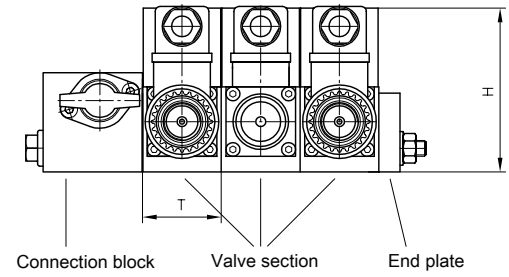
End plates (SWR 1/SWS 2):

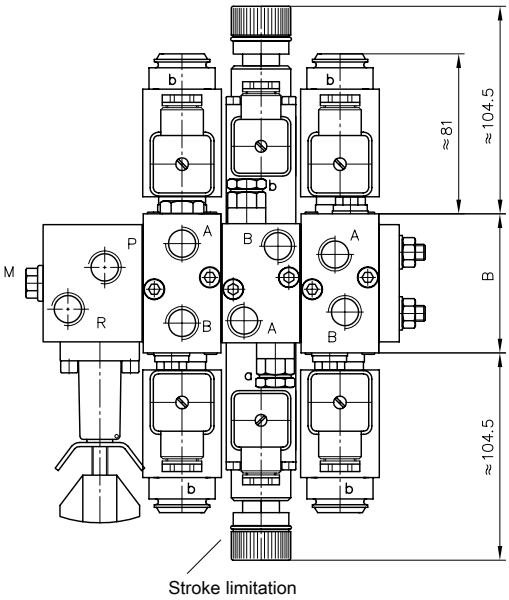
Series	With circulation valve	With lockable pump output
		

Ancillary block type SWS 2 with additional functions (consumer side):

Releasable check valve	Shock valve	Sequence valve	Over center valve
			

General parameters and dimensions





1 Connection block
2 Valve section
3 End plate
4 Stroke limitation

	Q_{max} [lpm]	p_{max} [bar]	Ports	Dimensions [mm]			m_{max} [kg]	
				H	B	T	Individual section	Connection block
SWR 1	12	315	G 1/4	77 - 90	40	40	1.1 - 1.5	0.6 - 0.7
SWS 2	25	315	G 3/8, G 1/4	78 - 82.5	60	40	1.1 - 2.4	0.8

Circuit example:

SWS 2 A 7/200

Valve bank type SWS, size 2, connection block with pressure-limiting valve (manually adjustable, set to 200 bar)

- G/M/2/2 RH

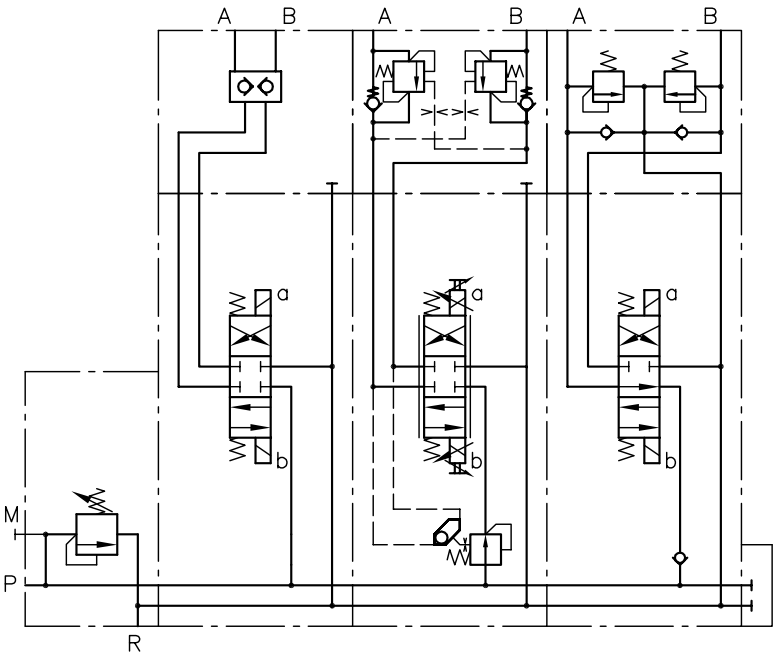
1. Valve section with circuit symbol G with solenoid actuation, no additional function in P gallery, with releasable check valves for A and B in the ancillary block

- G 10/MPF/DW/2 AL B 7/180 BLC 4/140

2. Valve section with circuit symbol G and proportional spool, max. flow rate A and B with 10 lpm, proportional solenoid MP with stroke limitation for A and B, pressure compensator in P gallery of the basic block (DW), ancillary block with load-holding valve for A (set to 180 bar) and for B (set to 140 bar)

- E/M/R/2 AN100 BN 100-1-G 24

3. Valve section with circuit symbol E and solenoid actuation, a check valve in the P gallery, ancillary block featuring shock and servo-suction valves for ports A and B (set to 100 bar), standard end plate, solenoid voltage 24V DC



Associated technical data sheets:

- Directional spool valve type SW: D 7451
- Directional spool valve bank type SWS: D 7951

Suited products for combination:

- Pressure switches type DG3.., DG5.E: Page 262

Similar products:

- Proportional directional spool valve type EDL: Page 82

Suitable male connectors:

- Line connector type MSD and others: D 7163
- With economy circuit: D 7813, D 7833/1
- Proportional amplifier type EV2S: Page 274

Directional spool valve

2.1 Directional spool valve type HSF

Directional spool valves are a type of directional valve. They control the direction of movement and the velocity of single and double-acting hydraulic consumers.
The directional spool valve type HSF is a manifold mounting valve. Due to the robust design, it reaches operating pressures of up to 400 bar.
Adjustable threaded throttles are used to adjust the response time. Harsh switching operations and decompression surges, particularly in the event of high pressure and large consumer volumes, can be avoided this way.

Features and benefits:

- Smooth switching for large flow rate
- Suitable for high pressures due to steel housing

Intended applications:

- Mining machinery (incl. oil production)
- Cranes and lifting equipment
- Construction and construction materials machinery
- Material handling (industrial trucks, etc.)

Nomen-clature:	Directional spool valve
Design:	Individual valve for manifold mounting
Actuation:	Electro-hydraulic Hydraulic
p_{max}:	400 bar
Q_{max}:	160 l/min

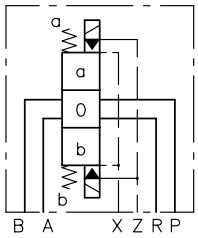
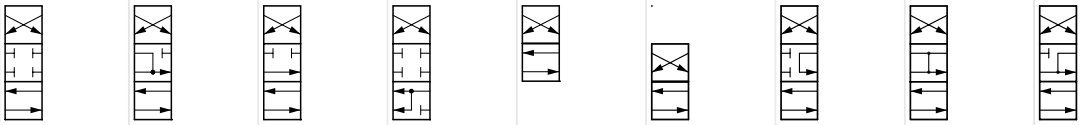
Design and order coding example

HSF4	/C321	- L	- 1	- G24	- 300

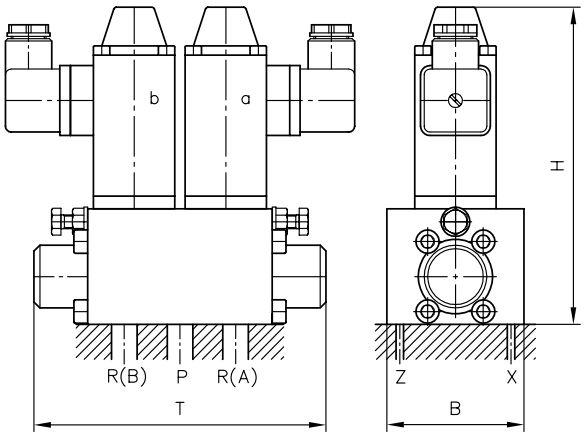
- **Pressure setting pressure limiting valve [bar]**
- **Solenoid voltage** 12V DC, 24V DC, 98V DC, 205V DC, 110V AC, 230V AC
- **End plate** Internal or external control oil return
- **Valve sections** With/without adjustable switching speed
- **Connection block**
  - With/without pressure limiting valve (Fixed or manually adjustable)
  - Internal or external control oil supply (max. 160 bar)
- **Basic type and size** Type HSF: Manifold mounting

Function

Valve sections:

Basic symbol	Symbol								
HSF	G	D	E	C	W	B	L	H	F
									
Manifold mounting valve	All flow pattern symbols also available with adjustable response time								

General parameters and dimensions



	Q_{max} [l/min]	p_{max} [bar]	Dimensions [mm]			m [kg]
			H	B	T	
HSF 3	80	400	137	59	126	2,8
HSF 4	160	400	157	70	184	5

Associated technical data sheets::

- Directional spool valve type PSL and PSV: D 7700-2; D 7700-3
- Directional spool valve type HSF: D 7493 E
- Directional spool valve type HSL: D 7493 L

Male connectors:

- Line connector type MSD and others: D 7163
- With economy circuit: D 7813, D 7833/1

Directional spool valve

2.1 Proportional directional spool valve type EDL

Proportional directional spool valves are a type of directional valve. They control the direction of movement and the velocity of individual or multiple hydraulic consumers actuated simultaneously. Control is independent of the load and continuous.
The directional spool valve type EDL with series connection is actuated directly. The flow rates for the individual consumers can be individually adjusted. The proportional directional spool valve can be flexibly adapted to different control tasks by means of additional functions in the intermediate plates and ancillary blocks.
The directional spool valve type EDL can be combined directly with the proportional directional spool valve type PSL and PSV in size 2 and is therefore suitable for constant and variable pump systems. It is used in mobile hydraulics, in particular in civil engineering and agricultural engineering.

Features and benefits:

- One valve for different control functions and small flow quantities
- Energy-saving closed-centre systems
- Compact and lightweight design
- Modular system can be directly combined with type PSL/PSV-2

Intended applications:

- Construction and construction materials machinery
- Cranes and lifting equipment
- Machines for forestry and agricultural purposes
- Municipal trucks

Nomenclature:	**Directly Prop. directional spool valves as per load-sensing principle**
Version:	**Valve bank in series connection**
Actuation:	**solenoid-actuated**
p_{max}:	**320 bar**
$Q_{max.\ consumer}$:	**48 l/min**
$Q_{pu\ max}$:	**100 l/min**

Design and order coding example

EDL - DA2 L 40/25 E /2 - G24

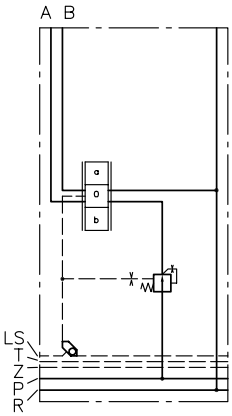
- **Solenoid voltage** 12V DC, 24V DC
  - Actuated via prop. amplifier or PLVC
- **Ancillary blocks**
- **Confirmation** Type E, EI
- **Volumetric flow** Volumetric flow indicator, side A, B (3...40)
- **Spool** Type L, H
- **Spool block** Section with inflow controller
- **Basic type** Type EDL: directly actuated proportional directional spool valve

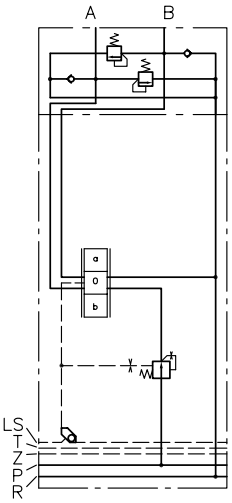
Function

Valve sections:

Circuit symbol	
L	**H**
	

Versions of valve sections:





Additional functions in the ancillary block:

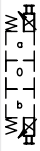
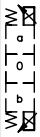
- Shock and servo-suction valves
- Load-holding valves
- Check valves with release, no leakage
- Floating and block functions can be switched

Characteristic values for max. volumetric flows:

	$Q_{A, B}$				
Size 2	3	6	10	25	40

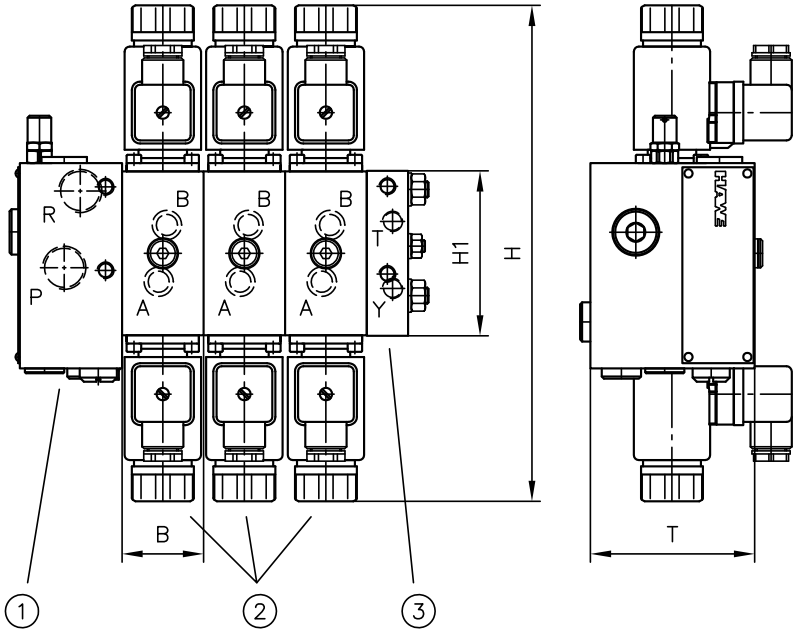
- Characteristic value corresponds to the max. volumetric flow [lpm] of inflow controller versions at the consumer ports A and/or B
- Volumetric flows for A and/or B can be selected separately

Actuations:

Basic type	Brief description	Circuit symbol (example)
E	electrical actuation with stroke limitation	
EI	electrical actuation without stroke limitation and with emergency manual actuation	

General parameters and dimensions

PSL/EDL



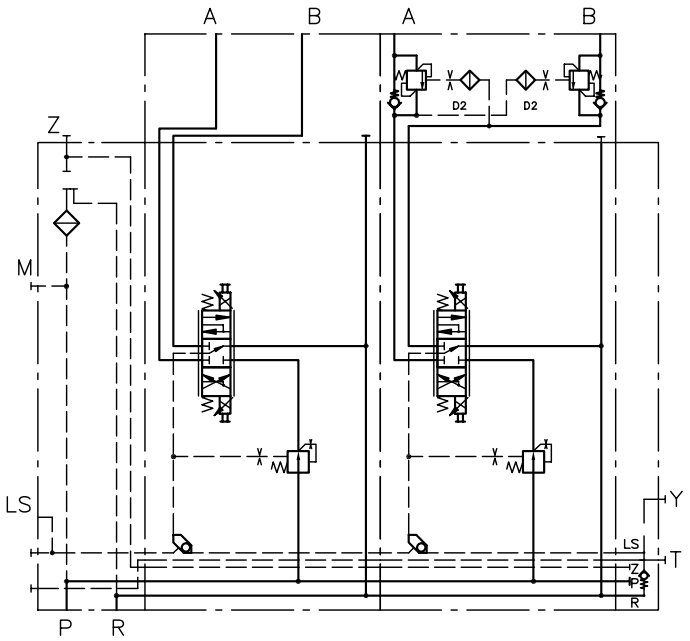
1 Connection block
2 Valve section
3 End plate

	Flow [lpm]		Oper. pressure [bar]	Ports		Dimensions [mm]				m [kg]
	Q_{max}	$Q_{pu\ max}$	p_{max}	P, R	A, B	H	H1	B	T	Per valve section[1)]
EDL	3 ... 40	80	320	G 1/2, 3/4-16 UNF-2B	G 3/8, 3/4-16 UNF-2B	241	80	40	64	1.8 ... 2.9

1) Dep. on actuation and additional functions

Circuit example:

PSV 3-2
- DA2L40/25/E/2
- DA2L25/16/E/24l-0-A4/210-Bl0-B4/210
- E4-G24



Associated technical data sheets:

- Proportional directional spool valve type EDL: D 8086
- Proportional directional spool valve, type PSL and PSV size 2: D 7700-2
- Proportional directional spool valve, type PSL, PSM and PSV size 3: D 7700-3
- Proportional directional spool valve, type PSL, PSM and PSV size 5: D 7700-5
- Connection block type HMPL and HMPV for proportional directional spool valve: D 7700 H

Directional spool valve

2.1 Directional spool valve bank type DL

Throttling directional spool valves are a type of directional valve. They continuously and manually meter the flow rate in hydraulic systems with single and double-acting consumers. The throttling directional spool valve type DL influences the speed of the consumer by throttling the pump circulation via a parallel circuit (bypass control). The close fit of the spool in the throttling directional spool valve means that the leakage is limited to a minimum for lifting functions.

The throttling directional spool valve type DL is suitable for applications in material handling and for lifting equipment.

Features and benefits:

- Compact design with up to 10 segments
- Various actuation variants for manual actuation
- Simple pressure reductions in downstream sections using intermediate plates
- Combinations possible for controlling lifting devices

Intended applications:

- Material handling (industrial trucks, etc.)
- Machines for agricultural and forestry purposes
- Construction and construction materials machinery
- Road vehicle

Nomen-clature:	**Throttling directional spool valve**
Design:	**Valve bank design with integrated bypass pump circulation control**
Actuation:	Manual ▪ **Return spring, detent**
p_{max}:	315
Q_{max}:	90

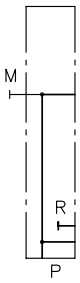
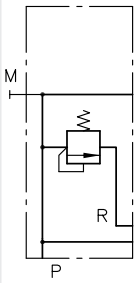
Design and order coding example

DL3 | 1 | - 3 | - GGD | - B/E1 | - 2 | - 210

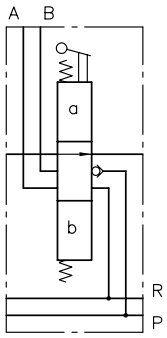
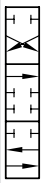
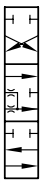
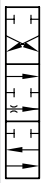
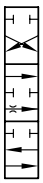
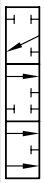
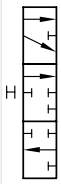
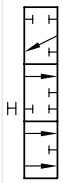
- **Pressure specification [bar]**
- **End plate**
- **Actuation, mounting**
- **Valve sections**
  - Directional spool valve
  - Valve section options:
    - Intermediate plate with pressure-limiting valve for all downstream valve sections
    - Additional functions on the consumer side in the ancillary block (e.g. double check valves, shock valves, load-holding valves etc.) (size 3)
- **Port size** G 1/4, G 3/8, G 1/2 (BSPP)
- **Connection block**
  - With/without pressure limiting valve
  - With shock valve
- **Basic type, size** Type DL, sizes 1 to 4

Function

Connection blocks:

DL .5	DL .1
	
Without pressure-limiting valve	With pressure-limiting valve

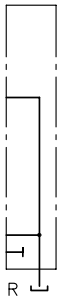
Valve sections:

Basic symbol	Symbol						
	G and B	D	E	N	R	A	P
							
						Reduced internal leakage due to reduced spool valve play	

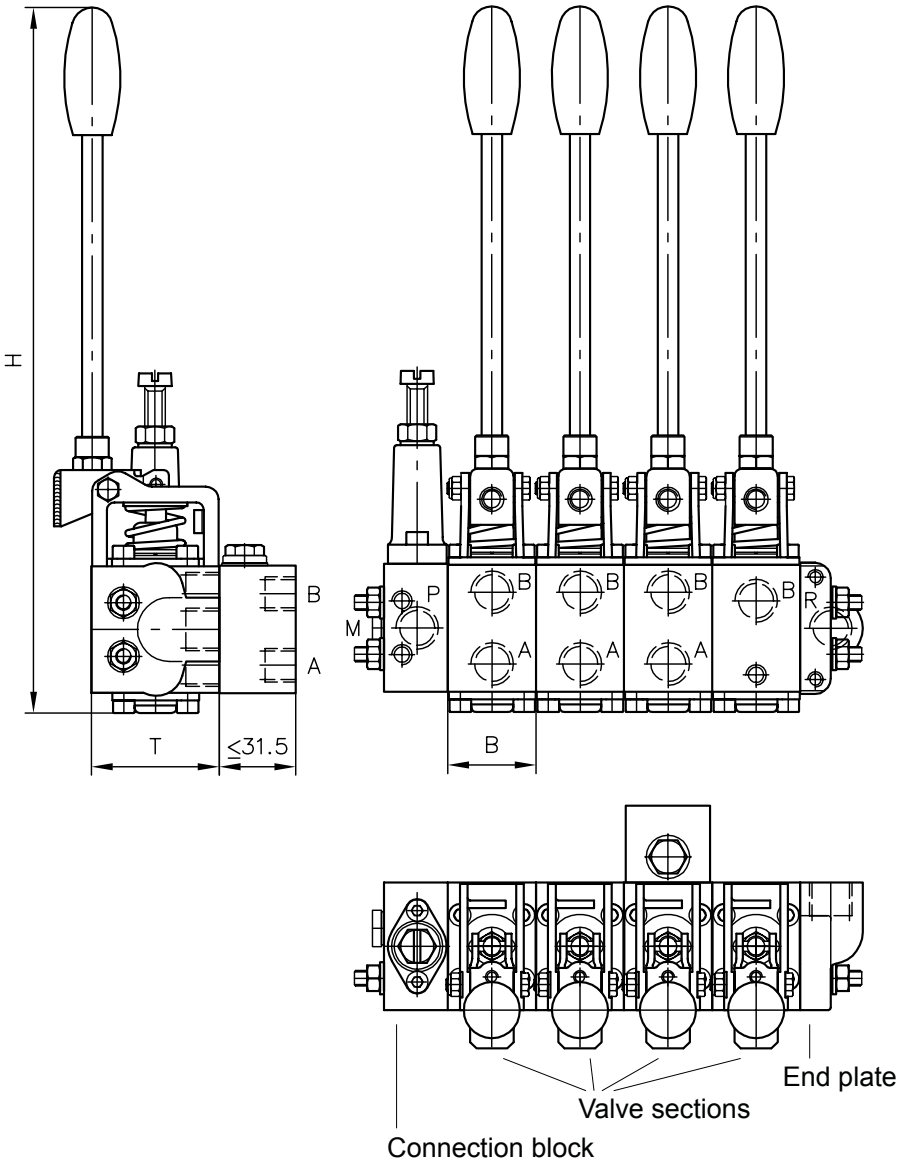
Versions of valve sections:

- Additional function on the pump side (orifice, 2-way flow control valve)
- Valve sections for size 3 with consumer-side additional functions in ancillary block (e.g. double check valves, shock valves, load-holding valves etc.)
- Manual operation with return spring for switching position “a” and detent for switching position “b”
- Manual operation with detent in both switching positions
- Manual operation with combinations of contact switch, switch cam and switch carrier
- Manual operation with different mounting directions

End plates:

2	3
	
Standard end plate with port R	End plate for subsequent connection of a DL

General parameters and dimensions



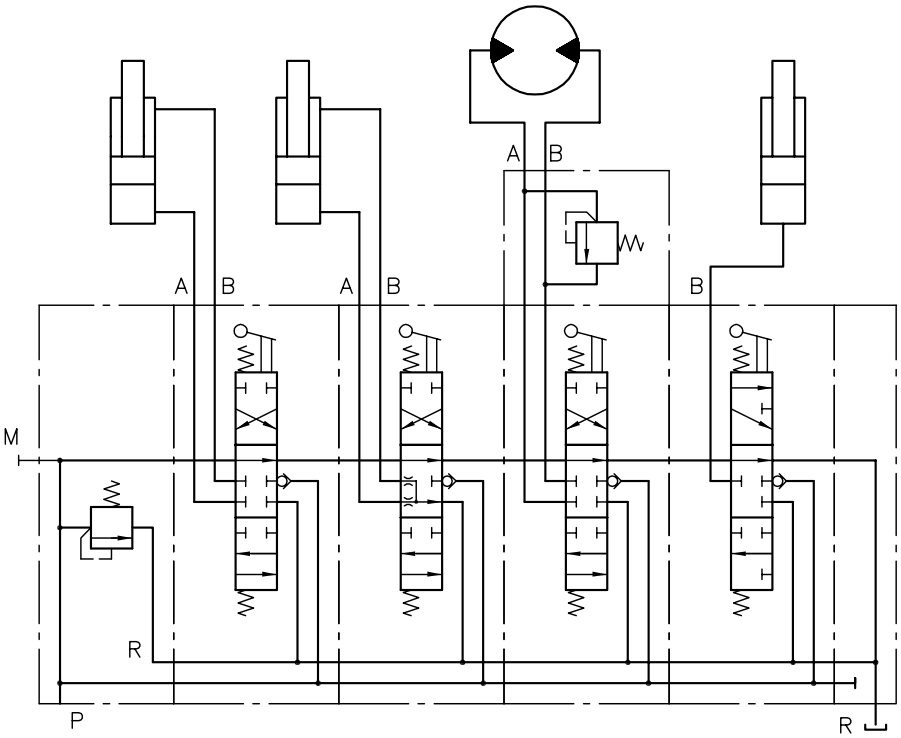
1 Connection block
2 Valve section
3 End plate

	Q_{max} [lpm]	p_{max} [bar]	Ports			Dimensions [mm]			m [kg]
			Characteristic value	A, B	H, P, R	H	B	T	
DL 1	12 ... 16	315	1	G 1/4	G 1/4	192	31,5	45	0,5
DL 2	20 ... 30	315	1	G 1/4	G 3/8	278	34,5	50	0,85
			2	G 3/8	G 3/8				
DL 3	30 ... 60	250	2	G 3/8	G 1/2	351	39,5	60	1,4
			3	G 1/2	G 1/2				
DL 4	90	250	3	G 1/2	G 3/4	368	39,5	70	1,8

Circuit example:

DL 21-2-G D G71 N-B/E1-2-180

Directional spool valve DL, size 2 with pressure-limiting valve (set to 180 bar),
port size 2 with G 3/8 threaded connections, circuit symbols G, D, G, N; circuit symbol G with pressure-limiting valve in port A (coding 71),
valve sections with manual operation B (series with hand lever) and mounting type E1 (ports A, B are directed towards the front,
valve spool is pushed into the housing for switching position “a”), valve bank with end plate 2 (coding 2)



Associated technical data sheets:

- Directional spool valve bank type DL: D 7260
- Directional spool valve bank type DL 4: D 7510

Directional spool valves

2.1 Proportional directional spool valves type PSL and PSV

Proportional directional spool valves are a type of directional valve. They control the direction of movement and the velocity of individual or multiple hydraulic consumers actuated simultaneously. Control is independent of the load and continuous.
The proportional directional spool valve type PSL is suitable for constant pump systems and type PSV for variable pump systems with a pressure/flow controller. The volumetric flows and load pressures for the individual consumers can be individually adjusted. The proportional directional spool valve type PSL and PSV can be adapted to various control tasks, e.g. for safety functions. All sizes can be combined with each other.
The proportional directional spool valve type PSL and PSV is used in mobile hydraulics, in particular in crane and lifting equipment, construction and mining machinery, drilling equipment as well as in offshore and marine technology.

Nomenclature:	**Prop. directional spool valves as per load-sensing principle**
Version:	**Valve bank in series connection**
Actuation:	**Manual** ▪ **Return spring** ▪ **Detent** **Electro-hydraulic, pressure-actuated** ▪ **Hydraulic** ▪ **Pneumatic**
p_{max}:	**400 bar**
$Q_{max.\ consumer}$:	**240 l/min**
$Q_{pu\ max}$:	**300 lpm**

Features and benefits:

- One product for various control functions and volume quantities
- Energy-saving Closed-Center systems
- Compact and lightweight design
- Modular system with wide range of design variants

Intended applications:

- Construction/construction material machinery
- Mining machinery (incl. oil production)
- Cranes and lifting equipment
- Machines for forestry and agricultural purposes
- Municipal machinery

Design and order coding example

PSL41F | **/380** | **- 3** | **- A2J40/40/EA/3** | **- E4** | **- G24**

Solenoid voltage 12V DC, 24V DC
- Actuated via prop. amplifier or PLVC
- Solenoids with various plug versions
- Explosion proof solenoids

End plates

Valve sections with actuation

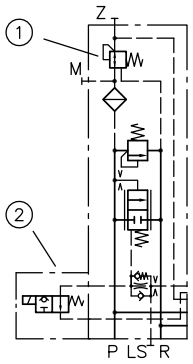
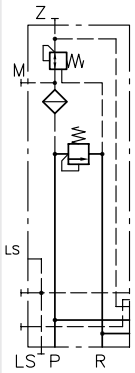
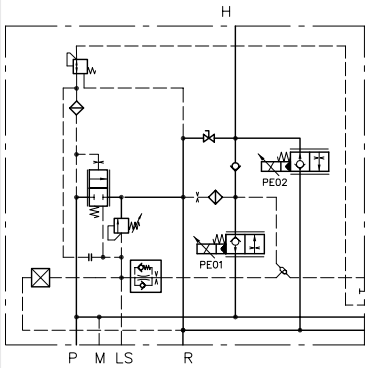
Size

Connection block
- Various connection threads
- Pressure limiting valve (piloted main pressure limiting valve)
- Suited for both constant and variable displacement pump systems (type PSM)

Basic type
Type PSL (hydraulic oil supply by constant pump), sizes 2, 3 and 5
Type PSV (hydraulic oil supply by variable pump), sizes 2, 3 and 5
Type HMPL (hydraulic oil supply by constant pump) for industrial trucks, sizes 2 and 3
Type HMPV (hydraulic oil supply by variable pump) for industrial trucks, sizes 2 and 3

Function

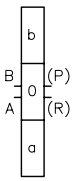
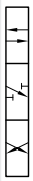
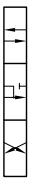
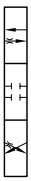
Connection blocks:

PSL	PSV	HMPL (HMPV)
		
1 Pilot pressure regulating valve **2** 2/2-way solenoid valve		
Connection block for constant pump systems with integrated 3-way controller, pressure-limiting valve and LS shutdown	Connection block for variable pump systems with or without pressure-limiting valve	Connection block for constant delivery pump with incorporated proportional seated valve for lifting and lowering

Additional versions of connection blocks:

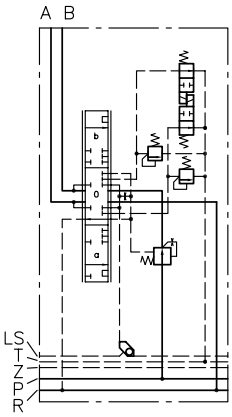
- 2/2-way solenoid valve for randomly switching the pump direction
- Additional damping option of the 3-way/pump controller
- Additional isolation valve to minimise the pump direction resistance
- Version with additional shut-off valve for the pump line, can be switched randomly
- Proportionally adjustable pressure limitation

Valve sections:

Basic symbols	Circuit symbol								
	L	M	F	H	J	B	R	O	G
									

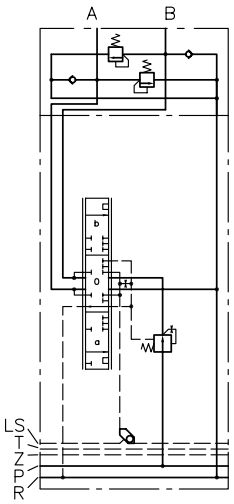
Versions of valve sections:

- Load pressure signal outputs at A, B; A and B together
- 3/3 directional spool valve with 2-way input and output controller
- Version with and without 2-way inflow controller
- Function deactivation feature
- Secondary pressure-limiting valves (can be selected for A and/or B)
- Prop. Pressure limitation of individual functions
- Version with ancillary blocks
- Intermediate plates for various additional functions
- Combination of various sizes possible in one valve bank
- Version with EX solenoid for use in potentially explosive areas
- Version with explosion-proof, intrinsically safe magnets for mining applications
- Version with CAN actuation



Additional functions in the ancillary block:

- Shock and servo-suction valves
- Load-holding valves
- Differential circuits
- Check valves with release, zero-leakage
- Floating and block functions can be switched
- Proportional seated valves in accordance with D 7490/1 for lifting and lowering functions with plunger cylinders



Characteristic values for max. volumetric flows:

	$Q_{A, B}$							
Size 2	3	6	10	16	25	40		
Size 3	3	6	10	16	25	40	63	80
Size 5	16	25	40	63	80	120	160	

- Characteristic value corresponds to the max. volumetric flow [lpm] of inflow controller versions at the consumer ports A and/or B
- Volumetric flows for A and/or B can be selected separately
- Increasing the control pressure enables 60 lpm (size 2), 120 lpm (size 3) and 240 lpm (size 5) per consumer port side.
- Version with 2-way inflow controller and check valve function, or damping elements

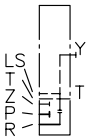
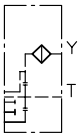
Actuations:

Basic type	Brief description	Circuit symbol (example)
A	Manual actuation	 Combination of electro-hydraulic and manual actuation
C	Detent (continuous)	
E **EA**	Electro-hydraulic actuation in combination with manual operation	
EI CAN **EA CAN**	CAN: Actuation variant with CAN control in combination with manual operation	
H, P **HA, PA**	Hydraulic and pneumatic actuation in combination with manual operation	
HEA	Combination of H, E and A actuation	

Intermediate plates:

- Electrically or hydraulically actuated shut-off valve for all downstream consumers
- With pressure-limiting valve to limit the operation pressure of all downstream valves
- For random switchable reduction of the volumetric flow of all downstream consumers
- Priority module, size 3

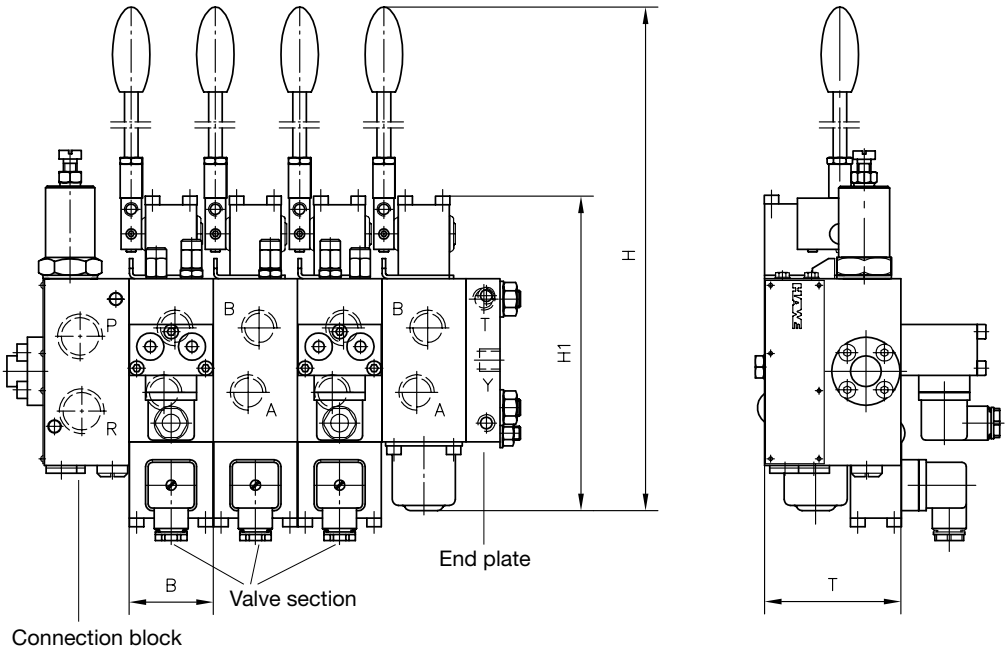
End plates:

E1	E2
	
Standard end plate	With additional Y-port for LS-input signal

Additional versions of end plates:

- End plate with internal leakage oil routing (no T gallery)
- End plates with additional P and R gallery
- Adapter plate to combine size 5 and 3 (coding ZPL 53), size 5 and 2 (coding ZPL 52) and size 3 and 2 (coding ZPL 32)
- End plate with integrated connection block function for dual-pump/dual-circuit systems

General parameters and dimensions



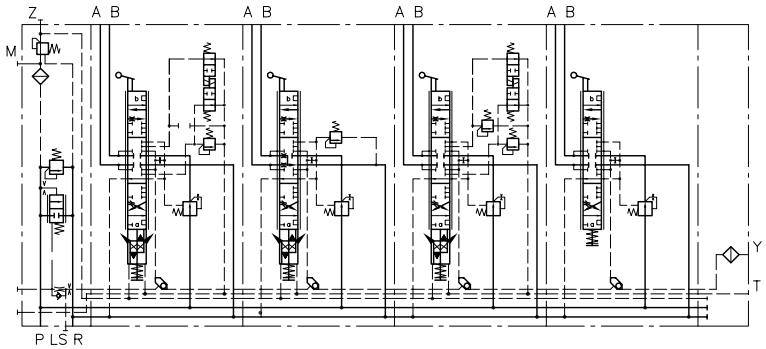
1 Connection block
2 Valve section
3 End plate

	Flow [lpm]		Oper. pressure [bar]	Ports		Dimensions [mm]				m [kg]
	Q_{max}	$Q_{pu\ max}$	p_{max}	P, R	A, B	H	H1	B	T	Per valve section[1)]
PSL/PSV 2	3 ... 54	80	420	G 1/2, 3/4-16 UNF-2B	G 3/8, 3/4-16 UNF-2B	272	150	40	60	1.8 ... 2.9
PSL/PSV 3	3 ... 120	200	420	G 1/2, G 3/4, G 1, 1 1/16-12 UNF-2B	G 1/2, G 3/4, 7/8-14 UNF-2B	364	195	50	80	3.3 ... 4.1
PSL/PSV 5	16 ... 240	300	400	G 1, G 1 1/4, 1 5/8-12 UN-2B	G 1, 5/16-12 UNF-2B	400	224	62.5	100	3.7 ... 4.5

1) Dep. on actuation and additional functions

Circuit example:

PSL 41/350 - 3	-32 J 25/16 A300 F1/EA -42 O 80/63 C250/EA -42 J 63/63 A100 B120 F3/EA -31 L 40/16/A	- E2 - G24
Type PSL valve bank for constant pump systems Connection block: – Coding for thread size (here 4 = G 3/4) – Coding for pilot pressure-reducing valve (here 1) – Coding for set pressure at pressure-limiting valve (here 350 bar) Size: 3	1. Valve section: (exemplary for all subsequent valve sections): – Directional spool valve block with coding for consumer connection size (here 3 = G 1/2) – Coding for the type of directional spool valve block (here 2) – Circuit symbol (here J) – Coding for max. consumer volumetric flow to ports A and B (here 25 and 16 lpm) – Coding of additional functions (here A 300; secondary pressure-limiting valve at port A set to 300 bar, function deactivated for port A (here F1)) – Coding for actuation type (here EA)	End plate: – Coding for end plate (here E2) – Coding for 24V DC solenoid voltage (here G24)



Products suitable for combination:

- Load-holding valves type LHT, LHDV: Page 198
- Joystick: Proportional pressure-reducing valve type KFB 01: D 6600-01

Additional electrical components:

- Proportional amplifier:Page 272
- Programmable logic valve control type PLVC: Page 276
- CAN node type CAN-IO: Page 276
- Other electronic accessories See "Electronics"

Associated technical data sheets:

- Proportional directional spool valve, type PSL and PSV size 2: D 7700-2
- Proportional directional spool valve, type PSL, PSM and PSV size 3: D 7700-3
- Proportional directional spool valve, type PSL, PSM and PSV size 5: D 7700-5
- Actuation for proportional directional spool valves type PSL/PSV: D 7700 CAN

Associated technical data sheets:

- Connection block type HMPL and HMPV for proportional directional spool valve: D 7700 H
- Proportional directional spool valve type EDL: D 8086

Directional spool valve

2.1 Proportional directional spool valve type PSLF, PSLV and SLF

Proportional directional spool valves are a type of directional valve. They control the direction of movement and the velocity of individual or multiple hydraulic consumers actuated simultaneously. Control is independent of the load and continuous.
The proportional directional spool valve type PSLF is suitable for constant pump systems and type PSVF for variable pump systems with a pressure/flow controller. The proportional directional spool valve type PSLF and PSVF is available as an individual manifold mounting valve or in the valve bank. The volumetric flows and load pressures for the individual consumers can be individually adjusted. The directional spool valve can be adapted to different control tasks. Connections on the rear permit easy access to the valve for servicing, even in tight installation spaces. All sizes can be combined with each other.
The proportional directional spool valve type PSLF and PSVF is used in mobile hydraulics, in particular in crane and lifting equipment, construction and mining machinery, drilling equipment as well as in offshore and marine technology.

Features and benefits:

- Max. flow 1000 lpm at 420 bar
- Rear side ports for easy access to valves, even in small installation spaces
- Flange design can be combined across all sizes with fast valve replacement
- Simultaneous operation of several functions at full speed

Intended applications:

- Construction machinery and machines for building materials
- Cranes and lifting equipment
- Offshore and marine technology
- Mining machinery

Nomen-clature:	**Prop. directional spool valve acc. to the Load-Sensing principle**
Design:	**Individual manifold mounting valve** **Valve bank via individual manifold mounting valves**
Actuation:	**Manual** ▪ **Return spring** ▪ **Detent** **Electro-hydraulic** **Pressure** ▪ **Hydraulic** ▪ **Pneumatic**
p_{max}:	**400 bar**
$Q_{max.\ consumer}$:	**400 l/min**
$Q_{pu\ max}$:	**1000 lpm**

Design and order coding example

PSLF	A1/380/4	- 3	- A2J40/40/EA/3	- E2	- G24

Solenoid voltage 12V DC, 24V DC
- Operated using a proportional amplifier or PLVC
- Magnets with different plug versions
- Explosion-proof magnets

End plates

Valve sections with actuation

Size

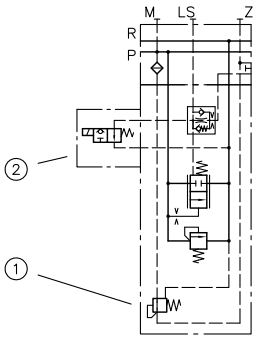
Connection block
- Various connection threads
- Pressure-limiting valve (pilot-controlled main pressure-limiting valve) in connection block

Basic type Type PSLF (supply via constant pump),
Type PSVF (supply via variable displacement pump),
size 3, 5 and 7

Function

Connection blocks:

PSLF

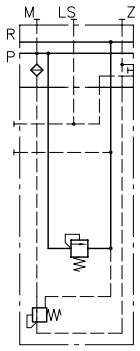


1 Pilot pressure valve

2 2/2-way solenoid valve

Connection block for constant pump systems with integrated 3-way controller, pressure-limiting valve and LS shutdown

PSVF

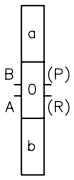
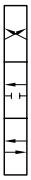
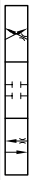
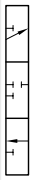


Connection block for variable pump systems with and without pressure-limiting valve

Additional versions of connection blocks:

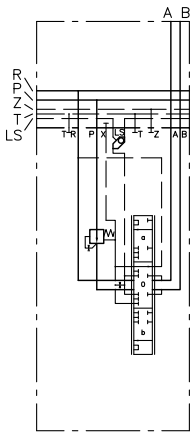
- 2/2-way solenoid actuated directional valve for arbitrary idle pump circulation
- Additional damping of the 3-way flow controller or pump controller
- Proportional adjustable pressure limitation

Valve sections:

Basic symbol	Circuit symbol								
	L	M	F	H	J	B	R	O	G
									

Versions of valve sections:

- Load-signal outlets at A, B; A and B together
- Version with and without 2-way inflow controller
- Function deactivation
- Secondary pressure-limiting valves (can be individually selected for A and/or B)
- Proportional pressure limitation of the individual functions
- Sub-plates with different additional functions
- Sub-plates for ancillary blocks
- Sub-plates for combining various sizes
- Combination of various sizes in one valve bank possible
- Version with EX solenoid for use in potentially explosive areas
- Version with explosion-proof, intrinsically safe solenoids for mining applications

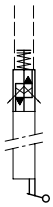


Key figures for max. flow rates:

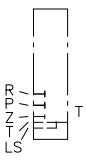
	$Q_{A, B}$							
Size 3	3	6	10	16	25	40	63	80
Size 5	16	25	40	63	80	120	160	
Size 7	120	160	250	320	400			

- Key figure represents the max. flow rate (lpm) at consumer ports A or B for version with inflow controller
- Flow rates for A and/or B can be selected individually
- Increasing the control pressure means that 60 lpm (size 2), 120 lpm (size 3), 240 lpm (size 5) and 500 lpm (size 7) is possible per consumer port side.
- Versions with 2-way inflow controller and check valve function

Actuations:

Basic type	Brief description	Circuit symbol (example)
A	Manual operation	 Combination of electro-hydraulic and manual operation
C	Detent (stepless)	
E **EA**	Electro-hydraulic actuation in combination with manual operation	
EI CAN **EA CAN**	CAN: Actuation variant with CAN control in combination with manual operation	
H, P **HA, PA**	Hydraulic and pneumatic actuation in combination with manual operation	
HEA	Combination of H, E and A actuation	

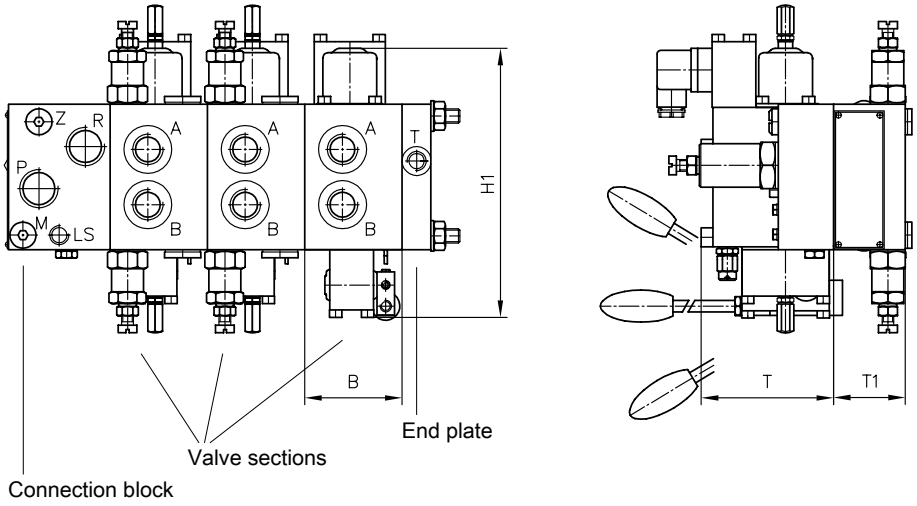
End plates:

E1	E2
 Standard end plate	 Additional Y-input for LS control signal

Additional versions of end plates:

- End plate with internal leakage oil routing (no tank connection)
- End plates with additional R port
- Adapter plate for combining size 5 and 3 (coding ZPL 53)

General parameters and dimensions



1 Connection block
2 Valve sections
3 End plate

	Flow [lpm]		Oper. pressure [bar]	Ports		Dimensions [mm]				m [kg]	
	Q_{max}	$Q_{PU\ max}$	p_{max}	P, R	A, B	H1	B	T	T1	1)	2)
PSLF/PSVF 3	3 - 120	200	420	G 3/4, 1 1/16-12 UN-2B	G 1/2, G 3/4, 7/8-14 UNF-2B	195	50	80	50	3.3 ... 4.1	6.6 ... 7.6
PSLF/PSVF 5	16 - 210	350	400	G 1, G 1 1/4, SAE 1 1/2"	G 1, SAE 1"	224	62.5	100	100	3.7 ... 4.5	10.9 ... 16.3
PSLF/PSVF 7	120 - 500	1000	400	G 1 1/2, SAE 1 1/2"	G 1 1/4, SAE 1 1/4"	305	106	101	95	13	23

1) Per valve section depending on actuation and additional functions
2) Per valve section complete with sub-plate

Products suitable for combination:

- Load-holding valves type LHT, LHDV: Page 198
- Joystick: Proportional pressure-reducing valve type KFB 01: D 6600-01

Additional electrical components:

- Proportional amplifier:Page 272
- Programmable logic valve control type PLVC: Page 276
- CAN node type CAN-IO: Page 276
- Other electronic accessories See "Electronics"

Associated technical data sheets:

- Proportional directional spool valve type PSLF, PSVF and SLF: D 7700-F
- Proportional directional spool valve banks type PSLF and PSVF size 7: D 7700-7F
- Actuation for proportional directional spool valves type PSL/PSV: D 7700 CAN

Directional spool valve

2.1 Clamping module type NSMD

Clamping modules combine a directional spool valve, pressure reducing valve and pressure switch.

The clamping module type NSMD has the standard connection pattern nominal size NG 6. It controls power-driven clamping devices, e.g. hydraulically-driven hollow and solid clamping cylinders for automatic lathes. It regulates the clamping pressure and monitors it. The clamping pressure is adjusted at the downstream pressure switch using a manual, mechanical or electrically-proportional adjustment device. A special safety circuit monitors the switching position of the valve.

Throttling options in the spool end position and/or rapid and creeping movements are possible as an additional function for one or both consumer ports. The clamping module type NSMD can be combined with other valves as a valve bank type BA to form a valve block.

Features and benefits:

- Directional valve, pressure-reducing valve and pressure switch in one device
- Adjustment of pressure-reducing valve and pressure switch with an adjustment device (manual or electro-proportional)
- The controlled pressure is picked up directly at the consumer port
- Valve with connection pattern in accordance with DIN 24340-A6

Intended applications:

- Machine tools (cutting)
- Machine tools (non-cutting) - forming and cutting
- Handling and mounting technology (industrial robots, etc.)

Nomen-clature:	**Valve combination consisting of:** ▪ **Directional spool valve (4/3-, 4/2-way function)** ▪ **Pressure reducing valve with tracked pressure switch**
Design:	**Individual valve for manifold mounting (Valve banks with sub-plates type BA are available)**
Actuation:	**Solenoid**
p_{max}:	**120 bar**
Q_{max}:	**25 l/min**

Design and order coding example

NSMD 2 | D1 | /MDA | /GRK | - G24

Solenoid voltage — 12V DC, 24V DC, 110V AC, 230V AC
Solenoids with various plug versions

Clamping pressure adjustment, pressure range, switching flow rate

- Slotted head screw + hexagon nut
- Wing screw + wing nut
- Lockable turning handle
- Electro-proportional adjustment with/without additional function monitoring

Actuation

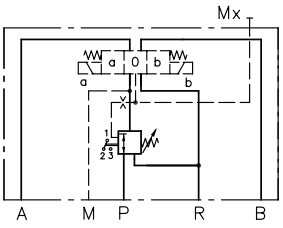
Function

- With pressure switch
- With orifice (flow limitation in accumulator mode)

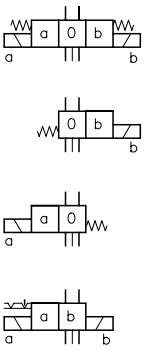
Basic type, size — Type NSMD size 2 with connection hole pattern conf. NG 6

Function

Basic symbols



D, E, G, D1, E1, G1



Symbols

D

D1

B, W, K

E

E1

B1, W1, K1

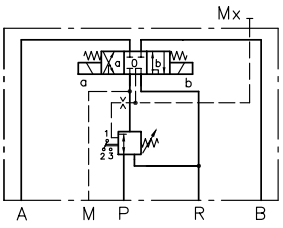
G

G1

Further functions:

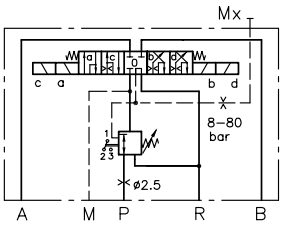
G1/MD

Pressure reducing function and throttle in switching positions a and b



G/MM6

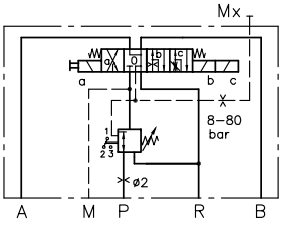
Rapid traverse and creeping in both directions



G/MMDA7

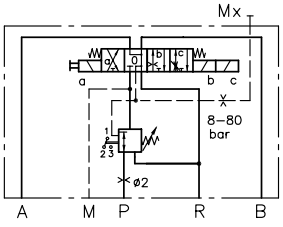
Rapid traverse and creeping in one direction featuring also a limitation for rapid traverse (switching position a, c) rapid traverse in opposing direction (switching position b)

Switching position a, speed limitation is possible by means of a throttle with pressure reduction and pressure monitoring

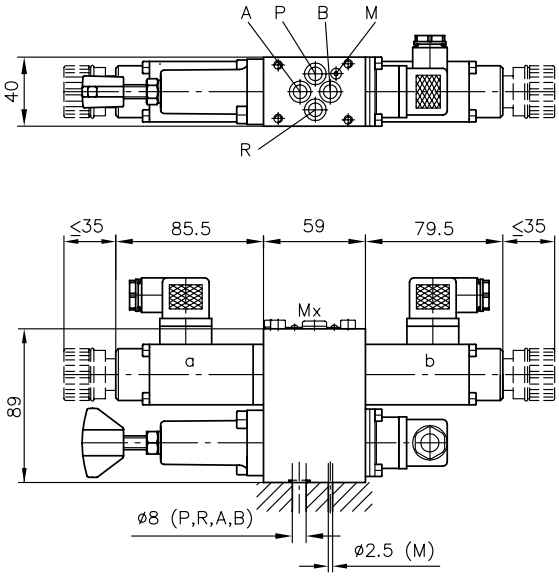


G/MMA7

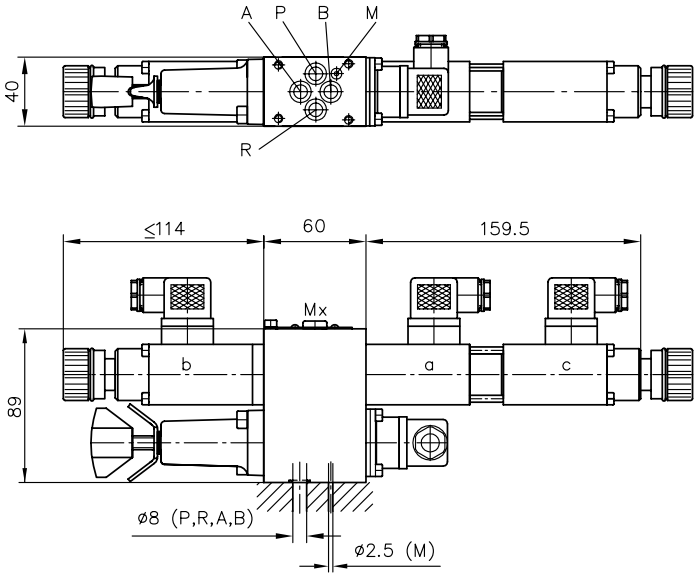
Switching position with fixed rapid traverse speed without pressure reduction and pressure monitoring.



NSMD2 K...



NSMD2 G...



	Q_{max} [lpm]	p_{max} [bar]	Clamping pressure range [bar]	Trigger flow [lpm]	Connection hole pattern[1]	Dimensions [mm]			m [kg]	
						H	B	T	Individual valve[2]	Additional function
NSMD2	25	120	H: 2 ... 17 A: 4 ... 36 G: 5 ... 50 B: 6 ... 60 E: 8 ... 80	1: 1 ... 3 -: 2 ... 4 3: 3 ... 5 4: 4 .. .6 5: 5 ... 7 6: 6 ....8 7: 7 ... 9	Hole pattern conf. DIN 24340-A6	see illustration			2.2 ... 3.8	+ 0.6 ... 1.1

1) Mx port: G 1/8
2) Depending on circuit symbol and actuation type

Circuit examples:

NSMD2K/M/GDK/B2.5-G24

Clamping module type NSMD size 2 with standard connection diagram in accordance with DIN 24340-A6, circuit symbol K, detented version, clamping pressure range G, 5-50 bar and min. switching flow rate 2-4 lpm. Clamping pressure adjustment with a tracked pressure switch is actuated using a wing bolt and wing nut.

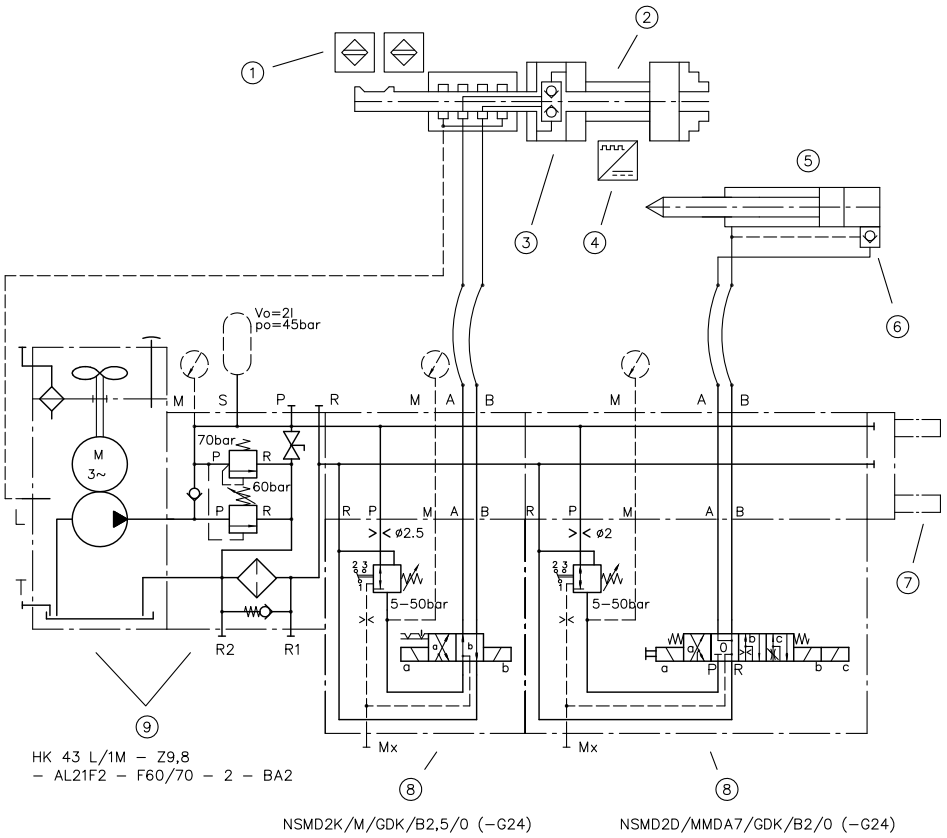
A 2.5 mm ∅ orifice is present in the P gallery, 24V DC solenoid voltage.

NSMD2G1/MD/E4VK/B1-G12

Clamping module type NSMD size 2 with standard connection diagram, in accordance with DIN 24340-A6, circuit symbol G1 with pressure monitoring at port A, adjustable throttle position for switching position a and b. Valve for clamping pressure range E, 8-80 bar and switching flow rate 4-6 lpm. Clamping pressure adjustment with a tracked pressure switch is actuated using a self-locking turn knob. A 1 mm ∅ orifice is present in the P gallery, 12V DC solenoid voltage.

Circuit example:

HK 43L/1M-Z 9,8-AL 21F2-F60/70-2-BA 2 - NSMD2K/M/GDK/B2,5/0
- NSMD2D/MMDA7/GDK/B2/0-G24



1 End position control
2 Clamping device
3 Releasable double check valve
4 Stand-still controller
5 Tailstock spindle
6 Releasable check valve
7 End plate
coding 11
8 Clamping module with sub-plate
9 Compact hydraulic power pack with connection block

Associated technical data sheets:
- Clamping module type NSMD: D 7787

Products:
- Directional valves type NSWP2: Page 72
- Directional seated valves type NBVP16: Page 134

Plates:
- Valve banks type BA2: Page 144
- Intermediate plate type NZP: D 7788 Z

Male connectors:
- Line connector type MSD and others: D 7163
- With economy circuit: D 7813, D 7833

2.2 Directional seated valves

Directional seated valve bank type VB

Valve bank type BVH

Directional seated valves type BVG, BVE, BVP and NBVP

(Solenoid-actuated) seated valves

Type	Design / actuation	p_{max} (bar)	Q_{max} (lpm)
G, WG and Others	**Directional seated valve with various actuations** ▪ Individual valve for manifold mounting – Solenoid – Pressure-actuated – Manual	0: 500 1: 700 2: 700 3: 400 4: 350	0: 6 1: 12 2: 25 3: 65 4: 120
VB	**Directional seated valve, zero-leakage, valve bank** ▪ For pipe connection ▪ Combination with pump units – Solenoid – Pressure-actuated – Manual	01: 500 11: 700 21: 700 31: 400 41: 350	01: 6 11: 12 21: 25 31: 60 41: 120
WN, WH	**Directional seated valve, zero-leakage, single valve** ▪ Individual valve for manifold mounting ▪ Combination with connection block for pipe connection – Solenoid	WN - 1: 350 WH - 1: 450 WH - 2: 350 WH - 3: 350 WH - 4: 350	WN - 1: 5 WH - 1: 8 WH - 2: 15 WH - 3: 30 WH - 4: 60
BWH, BWN	**Directional seated valve, zero-leakage, valve bank** ▪ For pipe connection ▪ Combination with pump units – Solenoid	BWN - 1: 350 BWH - 1: 450 BWH - 2: 350 BWH - 3: 350	BWN - 1: 5 BWH - 1: 8 BWH - 2: 15 BWH - 3: 30
BVH	**Version** ▪ Valve bank for pipe connection – Solenoid	11: 400	11: 20
VZP	**Directional seated valve, zero-leakage, single valve** ▪ Individual valve for manifold mounting – Solenoid	1: 450	1: 15
EM, EMP	**Directional seated valve, zero-leakage, single valve** ▪ Screw-in valve ▪ Combination with connection block for pipe connection ▪ Combination with connection block for swivel fitting – Solenoid	EM - 1: 450 EM - 2: 400 EM - 3: 400 EM - 4: 350 EMP - 2: 400 EMP - 3: 400 EMP - 4: 350	EM - 1: 20 EM - 2: 40 EM - 3: 80 EM - 4: 160 EMP - 2: 40 EMP - 3: 80 EMP - 4: 160
BVG, BVP, NBVP	**Directional seated valve, zero-leakage, single valve** ▪ For pipe connection ▪ Individual valve for manifold mounting – Solenoid – Hydraulic – Pneumatic – Manual	1: 400	1: 20
BVE	**Directional seated valve, zero-leakage, single valve** ▪ Screw-in valve ▪ Combination with connection block for pipe connection ▪ Combination with connection block for manifold mounting – Solenoid	1: 500 3: 400 5: 400	1: 20 3: 70 5: 300
VP	**Directional seated valve, zero-leakage, single valve** ▪ Individual valve for manifold mounting	1: 400	1: 15

Type	Design / actuation	p_{max} (bar)	Q_{max} (lpm)
	– Solenoid – Hydraulic – Pneumatic		
VH, VHR, VHP	**Directional seated valve, zero-leakage** ▪ Single valve for pipe connection ▪ Individual valve for manifold mounting ▪ Valve bank – Manual	VH - 1: 700 VH - 2: 500 VHP - 1: 700 VHR - 1: 700 VHR - 2: 500	VH - 1: 12 VH - 2: 25 VHP - 1: 12 VHR - 1: 12 VHR - 2: 25

Valve combinations

Type	Design / actuation	p_{max} (bar)	Q_{max} (lpm)
BA	**Valve bank** ▪ Directional spool valve ▪ Directional spool valve ▪ Directional seated valve – Solenoid – Pressure-actuated – Manual – Mechanical	2: 500	2: 50
HSV	▪ Single valve for pipe connection – Solenoid	21: 315 22: 315 61: 350 71: 400	21: 20 22: 30 61: 60 71: 120
CR	▪ Single valve for pipe connection – Solenoid – Manual	HP/LP: 4: 400/60 5: 400/60	HP/LP: 4: 8/80 5: 20/160
HMT, HST	▪ Valve bank – Solenoid	HST - 2: 315 HST - 3: 315 HMT - 3: 315	HST - 2: 40 HST - 3: 80 HMT - 3: 90

Directional seated valves

2.2 Directional seated valve type G, WG and others

Directional seated valves are a type of directional valve. As ball valves they have zero leakage in the closed state.

The directional seated valve type G, WG, H, P, K, T and D is available as a 2/2, 3/2, 4/2, 3/3 and 4/3 directional seated valve with different actuation types. Actuation using a hand lever enables switchable pressures of up to 700 bar.

Appropriate connection blocks enable direct pipe connection. The directional seated valves are available in a combination of valves in valve bank type VB.

Features and benefits:

- Zero-leakage ball valve construction with high switching reliability
- Solenoid, pressure, mechanical or manual actuation
- Low shifting forces and gentle, smooth switching
- Operating pressures up to 700 bar

Intended applications:

- Machine tools (cutting and non-cutting)
- Clamping equipment, punching tools, jigs
- Rubber and plastics machinery
- Oil hydraulics and pneumatics

Nomen-clature:	**Directional seated valve, zero leakage**
Design:	**Individual valve, manifold mounting combination with sub-plates for pipe connection**
Actuation:	**Solenoid Pressure (hydraulic, pneumatic) Mechanical (roller, pin) Manual (hand lever, adjusting knob)**
p_{max}:	**700 bar**
Q_{max}:	**120 l/min**

Design and order coding example

G R2 - 3 R - 1/2 - G24

Solenoid voltage 12V DC, 24V DC, 110V AC, 230V AC

Indiv. connection blocks for pipe connection

Additional versions:

- Connection blocks with by-pass check valve or pressure limiting valve between P and R
- Connection block with bridge rectifier circuit. Check valves in "GRAETZ"-circuitry ensure flow direction through the valve

Additional elements

- With check valve insert for port P
- With check valve insert for port P
- With return pressure stop for port R
- Position monitoring (size 3 and 4)

Size Size 0 to 4

- Size 1 also available with industrial connection hole pattern NG 6 (CETOP), type NG
- Size 12 with interchangeable coil
- Size 22 reinforced version 700 bar

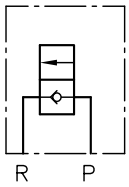
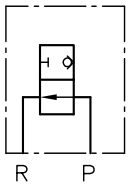
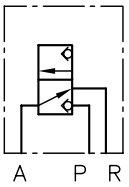
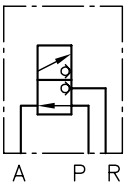
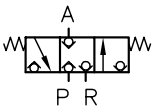
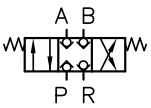
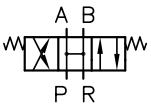
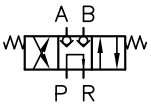
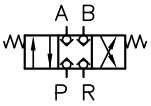
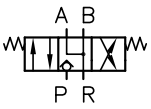
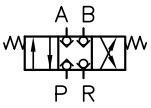
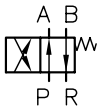
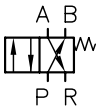
Function

- 2/2-way directional valve (R2, S2)
- 3/2-way directional valve (3, Z3)
- 3/3-way directional valve (21, 39)
- 4/3 directional valve (22, 45, 46, 47, 48, 49)
- 4/2-way directional valve (4, Z4)

Actuation

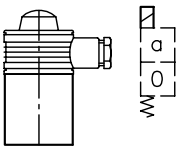
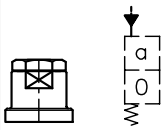
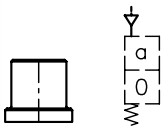
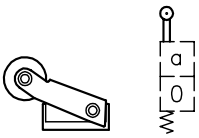
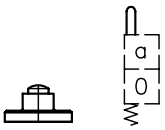
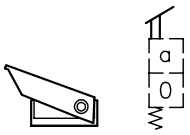
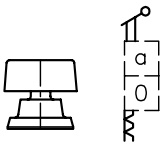
- Solenoid (G, WG)
- Hydraulic (H)
- Pneumatic (P)
- Mechanical (K, T, F, D)

Function

2/2-way directional valve		3/2-way directional valve		3/3-way directional valve	4/3-way directional valve	4/2-way directional valve	
R2	S2	3	Z3	21, 39	22, 45, 46, 47, 48, 49	4	Z4
					22  45  46  47  48  49 		

- Simplified symbols for 3/3-, 4/3- and 4/2-way functions
- Type 21, 22 not in size 4
- Type 39, 45, 46, 47, 48, 49 only in size 22
- Type 4, Z4 only in size 1

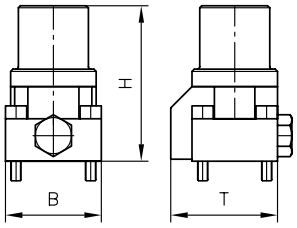
Actuation:

Solenoid		Pressure		Mechanical		Manual	
		Hydraulic	Pneumatic	Roller	Pin	Hand lever	Turn knob
G	WG	H	P	K	T	F	D
							
Solenoid voltages: 12V DC, 24V DC (type G) 230V AC (type WG)		Control pressure $p_{contr.\ max}$ [bar]: 400... 700 Control pressure $p_{contr.\ min}$ [bar]: 9... 16	 15 2.5... 4	Shifting force [N]: 25... 80 Shifting travel [mm]: 10.5... 30	 51... 20 4 and 5	Shifting force [N]: 25... 80 Shifting travel [mm]: 20.5... 45	Shifting torque [Ncm]: 45... 98

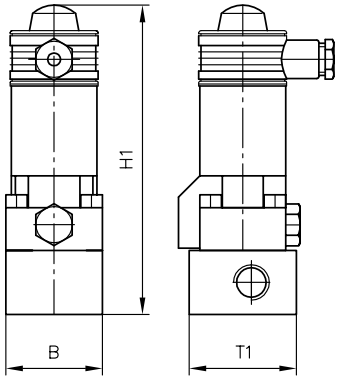
- Valve with solenoid actuation also available in ATEX-compliant version (24V DC)

General parameters and dimensions

Individual valve



Valve with connection block



	Dimensions						
Size	**H_{max}**	**$H1_{max}$**	**B**		**T_{max}**	**T1**	**m_{max} [kg]**
			2/2- and 3/2-way	**3/3- and 4/3-way**			
0	90.5	110.5	36	75	41.5	40.0	0.8/1.0
1, 12	115	145	45	92	50	50	1.4/1.9
2, 22	126.5; 134.5	156.5; 161.5	56; 56	116; 116	62.5; 67.5	56; 56	2.9/3.9; 3.0/4.0
3	162	202	70	144	91.5	70	5.7/7.1
4	226	226	80	162	127	125	16.3/20.1

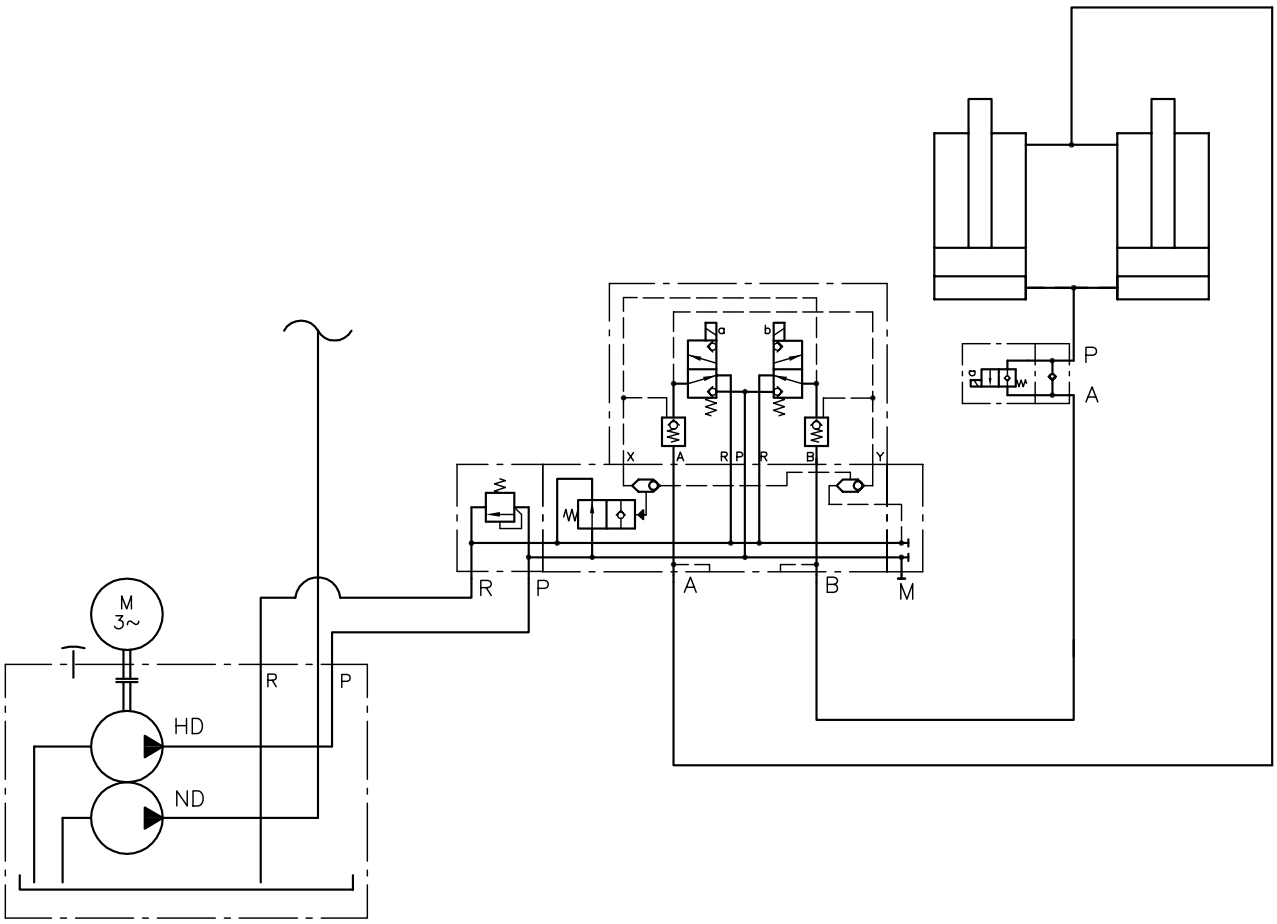
	Q_{max} [lpm]	p_{max} [bar]								Ports
Size		**Solenoid**		**Pressure**		**Mechanical**		**Manual**		
		G	**WG**	**H**	**P**	**K**	**T**	**F**	**D**	**P, R, A, B**
0	6	300... 500		500	-	-		-	500	G 1/4
1, 12	12	350... 500 (700)		500... 700		400... 700		400... 700		G 1/4 and G 3/8
2	25	350 ... 500		500		400... 500		400... 500		G 3/8 and G 1/2
22	25	700								
3	65	350... 400		400		350	-	350	-	G 1/2 and G 3/4
4	120	350		-		-				G 3/4 and G 1

Circuit example:

RZ 4.0/2-12.3-B 75-V 5.5
- 3 x 690/400 V 50 Hz

VB 22 AM 1/500
-G 49/U 22
-8 E-2-G 24

GR 2-12-3/8 C-G 24



Associated technical data sheets:

- Directional seated valve type G, WG and others: D 7300
- Directional seated valve type NG, NGW and others: D 7300 N
- Directional seated valve type G, WG and others with position monitoring: D 7300 H

Valve banks:

- Valve banks type VB: Page 114

Male connectors:

- Line connector type MSD and others: D 7163
- With economy circuit: D 7813, D 7833

Directional seated valves

2.2 Valve bank (directional seated valve) type VB

A valve bank combines different valves for operating independent consumers.
The valve bank type VB comprises several directional seated valves of type G, WG among others that are connected in parallel. The directional seated valves as ball valves have zero leakage in the closed state. They are attached to sub-plates. These sub-plates are clamped between the inlet section (P and R port) and the end plate via tension rods. Pressure switches or pressure-limiting valves can be integrated into the pumps and/or consumer lines.
2/2 and 3/2- 4/2, 3/3 and 4/3 directional seated valves are available with different types of actuation. The valve bank can be mounted directly to compact hydraulic power packs using connection blocks.

Features and benefits:

- Compact hydraulic controls for high pressure
- Combination with compact hydraulic power packs result in cost efficient turn-key solutions
- Elimination of time-consuming installation due to combination with hydraulic power packs
- Simple repairs thanks to modular structure of the systems

Intended applications:

- Machine tools (chipping and non-chipping)
- Clamping, punching and jigs
- Rubber and plastics machinery
- Oil hydraulics and pneumatics

Nomen-clature:	Directional seated valve, zero leakage
Design:	Valve bank for pipe connection
Actuation:	Solenoid Pressure: Hydraulic, Pneumatic Manual: Hand lever, Turn knob
p_{max}:	700 bar
Q_{max}:	120 l/min

Design and order coding example

VB12 F M DCNR5 1 WG230

Solenoid voltage 12V DC, 24V DC, 110V AC, 230V AC

Port size G 1/4 (1), G 3/8 (2), G 1/2 (3) (BSPP)

Valve sections Symbols: 2/2-way directional valve, 3/2-way directional valve, 3/3-way directional valve, 4/3-way directional valve, 4/2-way directional valve

Valve section options

- Pressure switch for P or the consumer side
- Pressure reducing valve reducing the pressure in the downstream gallery P
- Orifices in gallery P and/or return pressure stop in gallery R

Sub-plates

- With 2-way flow controller by-passing to the tank
- Pressure reducing valve reducing the pressure in the downstream gallery P
- With pressure limiting valve and throttle
- With idle circulation valve and/or shuttle valve

Intermediate plates

- With pressure reduction for gallery P or throttle for port A (parallel connection)

Actuation

Connection block/adapter plate

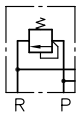
- For pipe connection
- For direct mounting at compact hydraulic power packs
- For direct mounting at hydraulic power packs

Basic type, size Type VB size 01, 12, 21, 22, 31, 41

Function

Connection blocks:

A .-1/..



For pipe connection, with fixed pressure limiting valve (/..- pressure specification in bar)

C, D, E

For mounting onto hydraulic power packs type R, Z and RZ, depending on tank and size

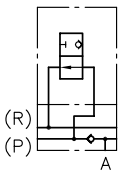
F

For mounting onto compact hydraulic power packs (type KA, HC, MP, MPN, HK)

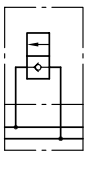
G

Valve sections:

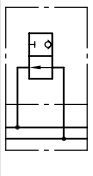
A



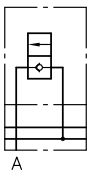
D



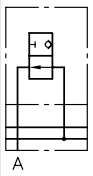
F



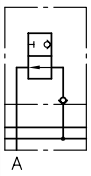
B



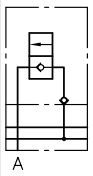
C



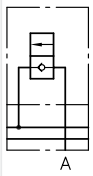
E



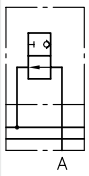
Q



P

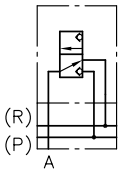


O

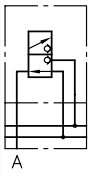


- A not for VB 01, VB 11 only with tapped ports G 1/4

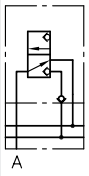
H



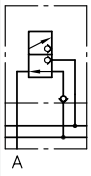
L



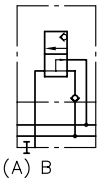
N



R

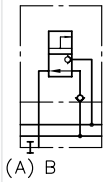


Y

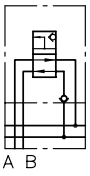


Simplified flow pattern

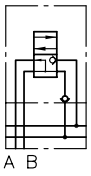
I



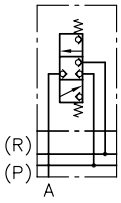
S



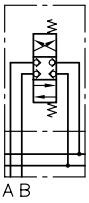
T



J, G39

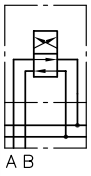


G , G49

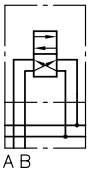


Simplified flow pattern

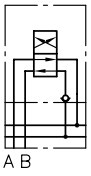
HX



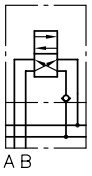
LX



NX



RX



Simplified flow pattern

- J, I, Y, S, T, G39, G49 only available for VB 21, 22
- G not available for VB 41
- HX, LX, NX, RX only available for VB 11

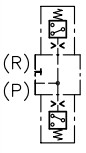
End plates:

Standard end plate

/2

End plate with accumulator drain valve

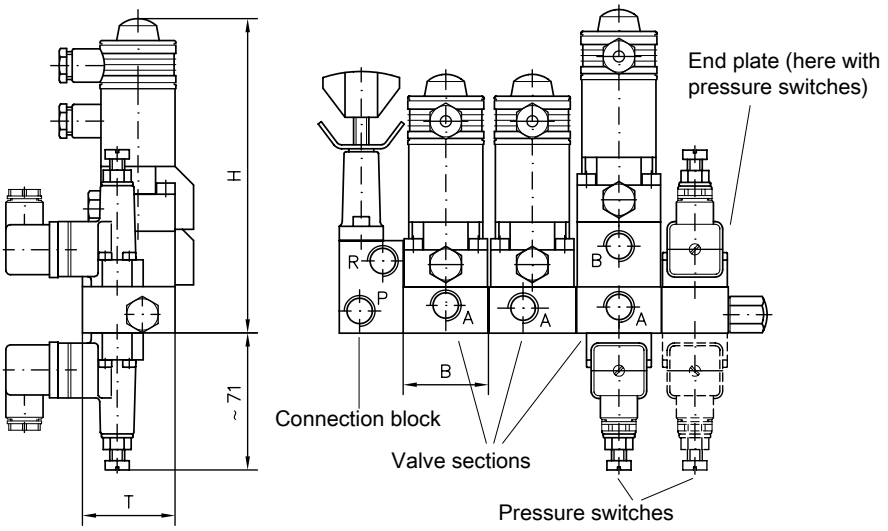
/3 ... /65



End plates with one or two pressure switches type DG 3..

- /2, /3 ... /65 only available for VB01 and VB11

General parameters and dimensions



1 Connection block
2 Valve sections
3 Pressure switches
4 End plate (here with pressure switches)

	Q_{max} [lpm]	p_{max} [bar]					Ports	Dimensions [mm]			m [kg]
		Solenoid	Pressure		Manual						per valve section
		M	H	P	F	D	P, R, A, B	H	B	T	
VB 01	6	300 ...- 500	-	500	-	500	G 1/4	110 ... 135	38	40	0.6 ... 1.25
VB 12	12	350 ... 500 (700)	500 ... 700		400 ... 700		G 1/4 and G 3/8	139 ... 174	46	50	1.1 ... 2.3
VB 21	25	350 ... 500 (700)	500		400 ... 500		G 3/8 and G 1/2	180 ... 220	58	63	2.0 ... 4.6
VB 22	25	700						172 ... 221	58	70	2.2 - 4.8
VB 31	65	350 ... 400	400		-	350	G 1/2 and G 3/4	202 ... 252	72	80	4.5 ... 9.1
VB 41	120	350	-		-		G 3/4 and G 1	265 ... 312	82	100	8.9 ... 14

Circuit example:

MP24A - H1.39/B5 - A1/300

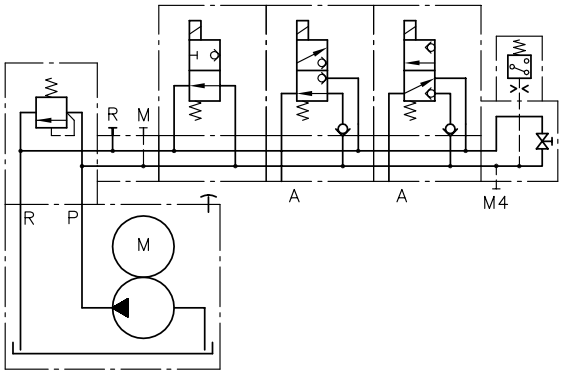
Compact hydraulic power pack type MP size 2, connection block with pressure limiting valve (tool adjustable)

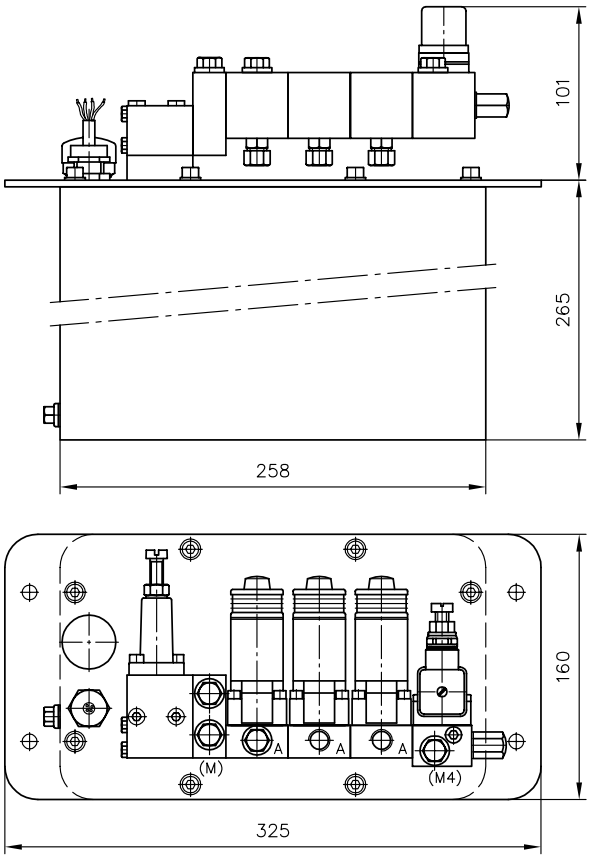
- VB01FM - FRN/32 - 1 - WG230

Valve bank type VB size 0 with 3 valves (actuation type M (solenoid), solenoid voltage 230V 50/60 Hz) and end plate. Here 32 with pressure switch and drain valve

Parameters of the circuit example:

- Q_{pu} = approx. 1.39 lpm (at 1450 rpm)
- $p_{max\ pu}$ = 400 bar
- p_{system} = 300 bar (set pressure of the pressure-limiting valve)
- Tank V_{usable} = approx. 6 l, V_{total} = approx. 7.7 l





Suites compact hydraulic power packs:

- Type MP, MPN, MPNW, MPW: Page 50
- Type HC, HCW, HCG: Page 42
- Type HK, HKF, HKL: Page 54
- Type NPC: Page 40
- Type KA, KAW: Page 46
- Connection blocks type A: Page 62

Suites hydraulic power packs:

- Standard power pack FXU with pumps R, RG, RZ: Page 58

Corresponding pamphlets (data sheets):

- Valve bank (directional seated valve) type VB: D 7302

Suited valves:

- Directional seated valves with various actuations: Page 108

Accessories:

- Pressure switches type DG 3.., DG 5 E: Page 262
- Pressure reducing valves type CDK: Page 180

Male connectors:

- Line connector type MSD and others: D 7163
- Economy circuit type MSD: D 7813, D 7833

Directional seated valves

2.2 Directional seated valve type WN and WH

Directional seated valves are a type of directional valve. As ball valves they have zero leakage in the closed state.
The directional seated valves type WN and WH are manifold mounting valves. 2/2 and 3/2 directional seated valves are available. These are also available combined as 3/3 and 4/3 directional seated valves. The type WH contains an internal pressure balance. As a result, the permissible operating pressure is higher than the type WN.
Appropriate connection blocks enable direct pipe connection. The directional seated valves are available in a combination of valves in valve bank type BWN and BWH.

Features and benefits:

- Excellent price/performance ratio
- Compact design
- Directional seated valves with zero leakage
- Solenoid version with 8-watt technology

Intended applications:

- Machines for forestry and agricultural purposes
- Clamping, punching and jigs
- Clamping equipment, punching tools, jigs
- Process engineering systems

Nomen-clature:	Directional seated valve, zero leakage
Design:	Individual valve, manifold mounting combination with connection blocks for pipe connection
Actuation:	Solenoid
p_{max}:	450 bar
Q_{max}:	60 l/min

Design and order coding example

WN1 | H | 1 | - 1/4 | - G24

Solenoid voltage 12V DC, 24V DC, 110V AC, 230V AC
- Versions with M12-plug and 8-Watt solenoid

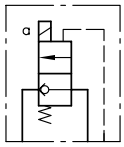
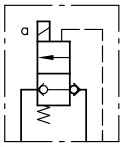
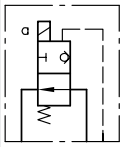
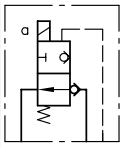
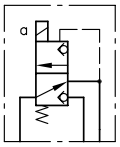
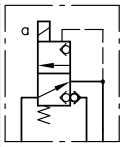
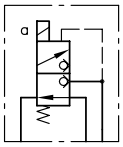
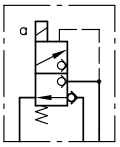
Single connection block Port size G 1/4, G 3/8, G 1/2 (BSPP)
- By-pass check valve or pressure limiting valve between P and R

Additional elements
- Return pressure stop for port R
- Check valve insert for port P
- Pressure limiting valve

Function
- 2/2-way directional valve (F, D, Q, E)
- 3/2-way directional valve (H, R, M, N)
- 3/3-way directional valve (J, U)
- 4/2-way directional valve (W)

Basic type, size Type WN, size 1
Type WH, size 1 to 4

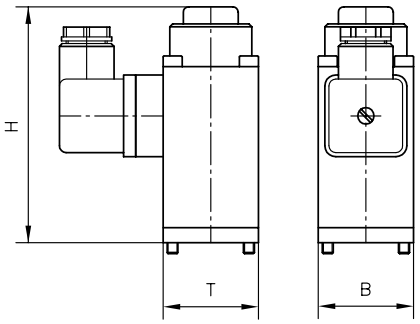
Function

D	Q	F	E	H	N	M	R
							

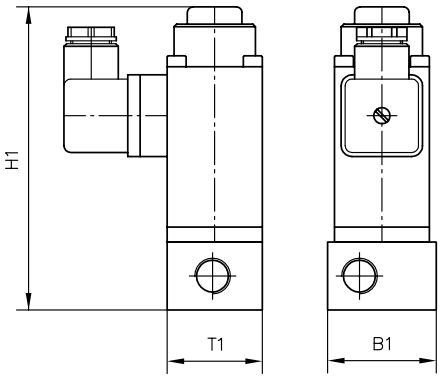
- Symbols show type WH
  View type WH
- Type WN 1 without de-pressuring duct for the solenoid (add. leakage duct is not necessary)
  Type WN1 without solenoid relief (no leakage line)

General parameters and dimensions

Individual valve



Valve with sub-plate for pipe connection



	Q_{max} [lpm]	p_{max} [bar]	Ports	Dimensions (individual valve) [mm]			m_{max} [kg]	Dimensions (with sub-plate) [mm]			m [kg]
				H	B	T		H1	B1	T1	
WN 1	5	320 ... 350	G 1/4	87	35	35	0.6	112	40	35	0.9
WH 1	8	450	G 1/4	87	35	35	0.6	112	40	35	0.9
WH 2	15	350	G 1/4	95.2 ... 101.7	35	35	0.65 ... 0.7	125.2 ... 131.7	40	40	1.0
WH 3	30	350	G 3/8	93.5 ... 103.5	45	45	1.2 ... 1.3	128.5 ... 138.5	50	50	1.8
WH 4	60	350	G 1/2	118 ... 133	60	60	2.7 ... 3.0	158 ... 173	70	70	3.6 ... 4.0

Associated technical data sheets:

- Directional seated valve type WN and WH: D 7470 A/1

Valve banks:

- Type BWN1, BWH: Page 120

Male connectors:

- Line connector type MSD and others: D 7163
- With economy circuit: D 7813, Economy circuit type MSD 4 P55: D 7833

Directional seated valves

2.2 Valve bank (directional seated valve) type BWN and BWH

A valve bank combines different valves for operating independent consumers.
The valve bank type BWN or BWH comprises several directional seated valves of type WN or WH that are connected in parallel. The directional seated valves as ball valves have zero leakage in the closed state. They are attached to sub-plates. These sub-plates are clamped between the inlet section (P and R port) and the end plate via tension rods. Pressure switches or pressure-limiting valves can be integrated into the pumps and/or consumer lines.
2/2 and 3/2- directional seated valves . Combined, these are also available as 3/3 and 4/3 directional seated valves. The valve bank can be mounted directly to compact hydraulic power packs using connection blocks.

Features and benefits:

- Modular concept
- Adapter plates for flange-mounting on hydraulic power packs or combination with other valve types
- With the valve bank version, option to incorporate additional functions in the sub-plate, such as pressure-limiting valves, pressure switches etc.
- Energy-efficient solutions in connection with hydraulic accumulators

Intended applications:

- Machine tools (chipping and non-chipping)
- Rubber and plastic machinery
- Mining machinery (incl. oil production)
- Rubber and plastics machinery

Nomen-clature:	**Directional seated valve, zero leakage**
Design:	**Valve bank** ▪ **For pipe connection** ▪ **Combination with hydraulic power packs**
Actuation:	**Solenoid**
p_{max}:	**450 bar**
Q_{max}:	**30 lpm**

Design and order coding example

BWH2 | **A-1/300** | **- FH5N5** | **- 1** | **- 1** | **- G24**

Solenoid voltage 12V DC, 24V DC, 110V AC, 230V AC
- Versions with M12-plug and 8-Watt solenoid

Port size G 1/4, G 3/8 (BSPP)

End plate
- With one or two pressure switches
- With accumulator drain valve
- With additional pressure limiting valve in gallery P

Valve sections
- Directional valves type WH or WN
- Valve section options:
  - Return pressure stop
  - Pressure switch for the consumer ports or for gallery P
  - Pressure limiting valves at the consumer port
  - Pressure reducing valve reducing the pressure in the downstream P gallery
- Additional sections:
  - Pressure reducing valve
  - Indiv. sub-plate with pressure switch
  - Separation plate for gallery P

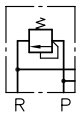
Connection block/adapter plates
- For pipe connection, with/without pressure limiting valve, manually or fixed, with/without prop. pressure limiting valve
- For direct mounting at compact hydraulic power packs
- For direct mounting at hydraulic power packs
- Adapter plates for combination with directional valves type BVZP or SWR/SWP

Basic type, size Type BWN, size 1 and type BWH, size 1 to 3

Function

Connection blocks/adapter plates:

A-1/...



For pipe connection, with fixed pressure-limiting valve (/...- pressure specification in bar)

C

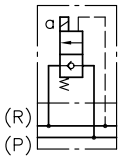
For mounting onto hydraulic power packs

F

For mounting on compact hydraulic power packs with connection block (type KA, HC, MP, MPN and HK)

Valve sections:

D



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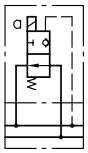

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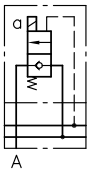

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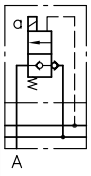

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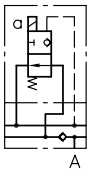

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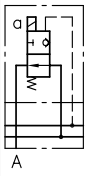

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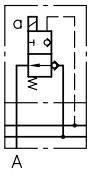

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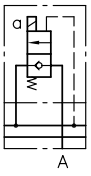

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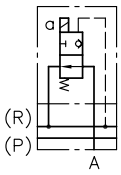

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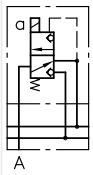

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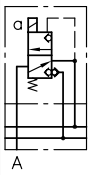

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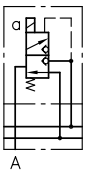

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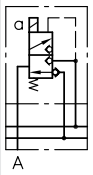

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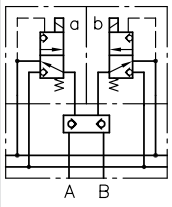

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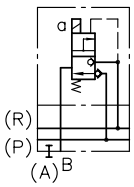

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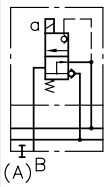

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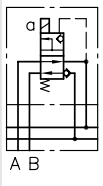

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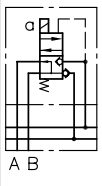

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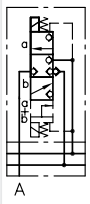

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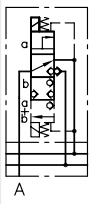

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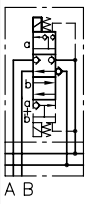


Additional options for the valve sections:

- Pressure switches in the consumer or pump channel. The pressure switches (type DG 3..) are directly flange-mounted to the sub-plate.
- Pressure-limiting valves in the consumer channel (for 3/2- or 3/3-way directional valves, for size 1). The pressure-limiting valve is directly incorporated in the sub-plate.
- Pressure-reducing valves for pressure reduction in the subsequent pump channel.

End plates:

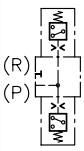
1

Standard end plate

2

End plate with accumulator drain valve

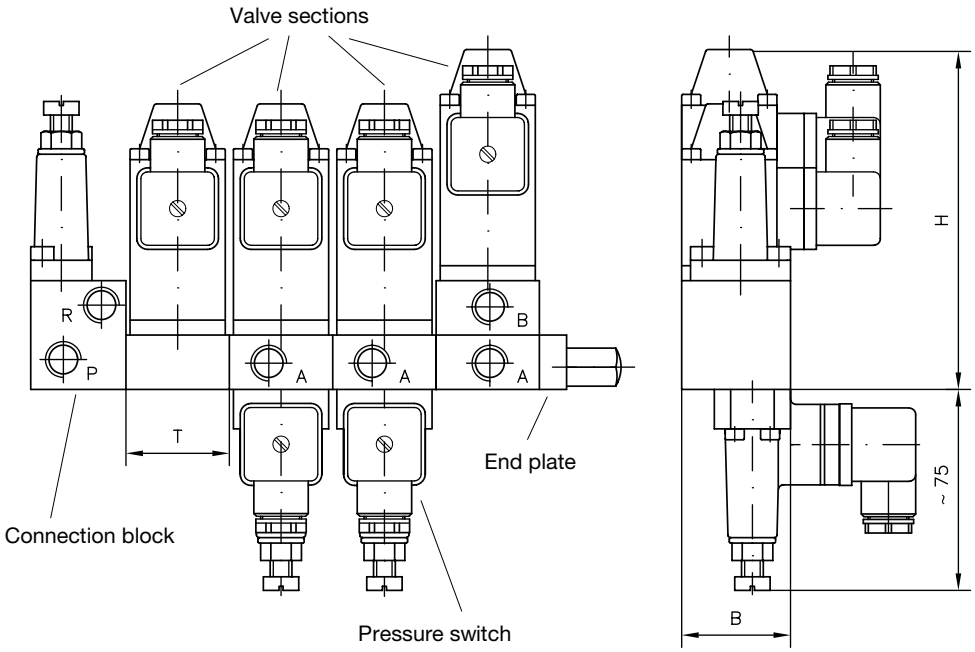
3../3..



End plate with one or two pressure switches connected to the P gallery

General parameters and dimensions

Version for pipe connection:



1 Connection block
2 Valve sections
3 End plate
4 Pressure switches

	Q_{max} [lpm]	p_{max} [bar]	Ports P, R, A, B	Dimensions [mm]			m [kg]
				H	T	B	
BWN 1	5	350	G 1/4	116.5 ... 131.5	38	40	0.8 ... 0.9
BWH 1	8	450	G 1/4	116.5 ... 131.5	38	40	0.8 ... 0.9
BWH 2	15	350	G 1/4	122 ... 157.5	38	50	0.9 ... 1.1
BWH 3	30	350	G 3/8	155.5 ... 168	50	60	1.9 ... 2.4

- Weight m [kg] per individual element: + 0.3 kg per pressure switch fitted

Associated publications:
- Valve bank (directional seated valve) type BWN and BWH: D 7470 B/1
- Directional seated valve type WN and WH: D 7470 A/1

Connection block:
- Type A: Page 62

Compact hydraulic power packs:
- Type HC, HCW, HCG: Page 42
- Type HK, HKF, HKL: Page 54
- Type NPC: Page 40
- Type KA, KAW: Page 46

Hydraulic accessories:
- Pressure switches type DG 3.., DG 5E: Page 262
- Pressure reducing valves type CDK: Page 180

2.2 Valve bank (directional seated valve) type BVH

A valve bank combines different valves for operating independent consumers.
The valve bank type BVH comprises several directional seated valves that are connected in parallel. As cone valves the directional seated valves have zero leakage in the closed state. The valve sections are connected using banjo bolts. 2/2, 3/2, 4/2 and 4/3-way directional seated valves are available.
Depending on the functional requirement, pressure reducing valves, pressure switches, check valves, restrictors or restrictor check valves are integrated into the valve section. The valve bank can be flange-mounted directly on compact hydraulic power packs or integrated into a pipe system via a piping block.

Features and benefits:

- Flexible expandability
- Compact and lighter design (elimination of the base plates)

Intended applications:

- Auxiliary and clamping functions on machine tools and fixtures
- Auxiliary and clamping functions on forming machine tools
- Brake and rotor adjustment modules on wind turbines

Nomen-clature:	**Valve sections Directional seated valve Zero leakage**
Version:	**Valve sections for pipe connection**
Actuation:	**Solenoid**
p_{max}:	**400 bar**
Q_{max}:	**20 l/min**

Design and order coding example

BVH 11 | M/CZ/35/M/R/2 | - 8 | - G24

Solenoid voltage 12V DC, 24V DC, 110V AC, 230V AC

End plate
- With tapped plugs at P, R
- With accumulator port and drain valve

Valve sections
- With individual pressure reduction (parallel connection)
- Additional elements:
  - Pressure-reducing valves
  - Orifice and/or check valve in P gallery
  - Orifice or restrictor check valve for A
  - Return pressure block in R gallery
  - Pressure switches for A

Basic type Type BVH 11 for direct mounting onto connection blocks type A etc. (for compact hydraulic power packs type KA, MPN, HC, HK, HKF, HKL)

Function

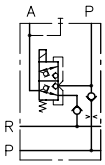
Connection blocks/adapter plates:

BVH

Direct mounting onto connection blocks type A etc.
for compact hydraulic power packs type KA, MPN, HC, HK, HKF, HKL

Valve sections:

H



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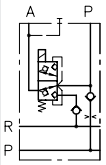

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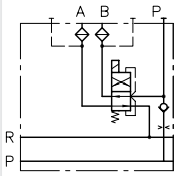

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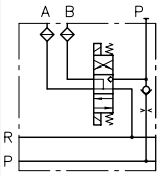
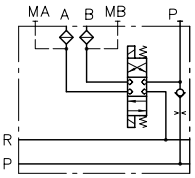


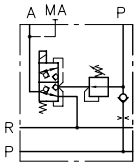
G



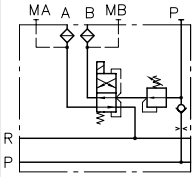
Additional options for the valve sections:

Individual pressure reduction (parallel connection)

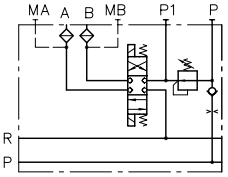
BVH 11 H/CZ...



BVH 11 W/CZ...

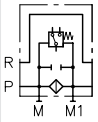


BVH 11 G/CZ...



Pressure filter

BVH 11 ZD



Actuations:

M:	Solenoid actuation (p_{max}= 400 bar)
GM:	Solenoid actuation (p_{max}= 250 bar)

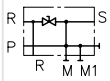
End plates:

-1

Tapped plug at P, R

-81

with accumulator port and drain valve



General parameters and dimensions

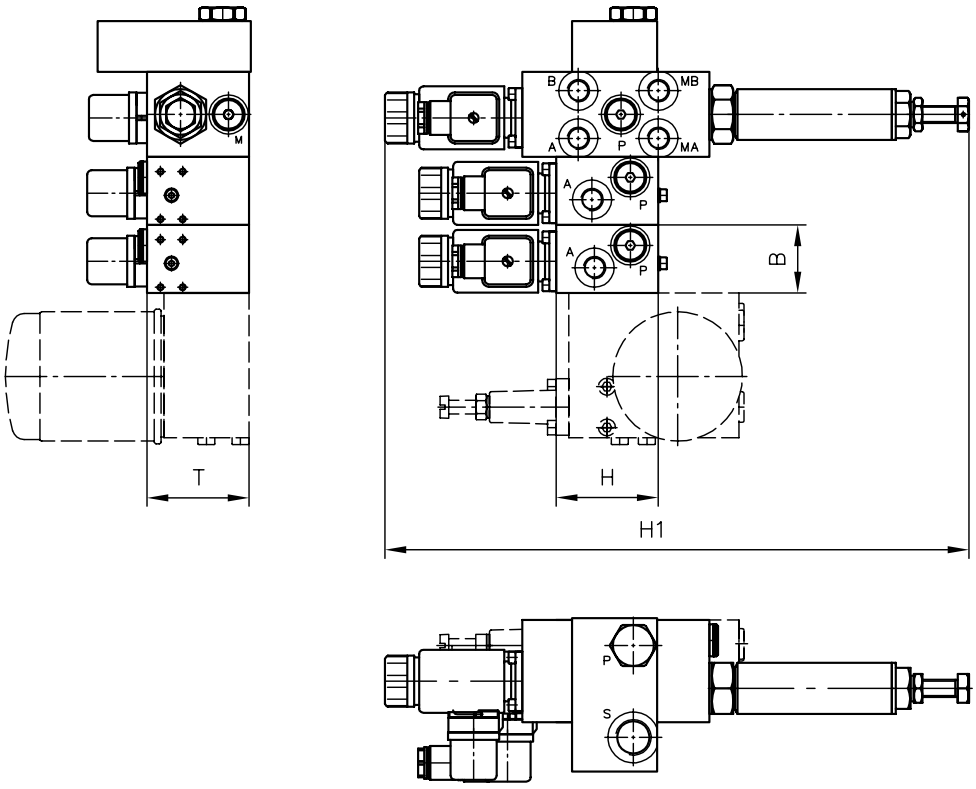
(A1F1/310)

- BVH 11 H/M/R/2
- BVH 11 M/M/R B2.5/3
- BVH 11 W/CZ 5/35/M/R/22 - 81 - G 24

Type BVH valve bank for direct mounting at type A connection block

Valve section 1 with 3/2-way function circuit symbol H, P check valve (coding R), no pressure switch (coding 2)
Valve section 2 with 3/2-way function circuit symbol M, check valve and orifice in P gallery (coding R, B, 2, 5) and pressure switch for A (coding 3)
Valve section 3 with 4/2-way function circuit symbol W, individual pressure-reducing valve set to 35 bar (coding CZ5/35) and check valve in P gallery (coding R), no pressure switch
End plate for accumulator port (coding 8) and 24V DC solenoid voltage

Mounted valve type BVH



	Q_{max} [lpm]	p_{max} [bar]	Ports (BSPP)	Dimensions [mm]				m [kg]
			A, B, P, R, M	H	H1	B	T	Valve section
BVH	20	400	G 1/4	60	343	40/50	60	0,8

Circuit example:

KA 281 SKT/Z 9.8

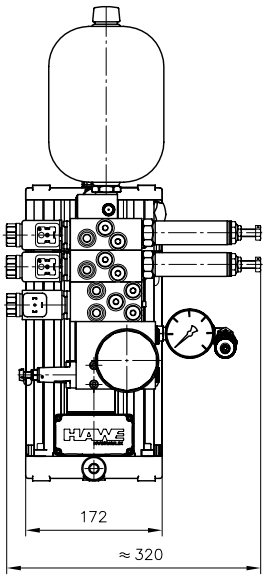
Compact hydraulic power pack type KA
1 kW motor power;
Connection block with return line filter
and TÜV-approved safety valve
set to 120 bar

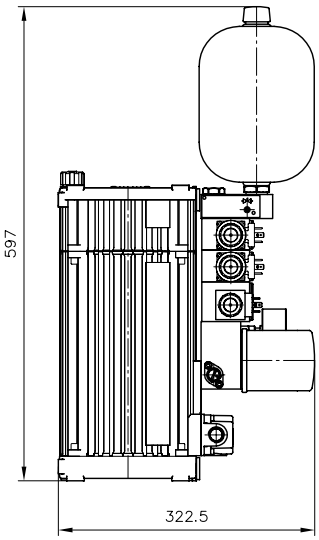
- AX 3 F 1 E/120
- BVH 11 W/M/RH/2
- BVH 11 M/CZ5/35/M/RHB 2.5
- BVH 11 M/CZ5/35/M/RHB 2.5
- 82-X 24 - AC 2001/60/3/A 3x400V 50 Hz

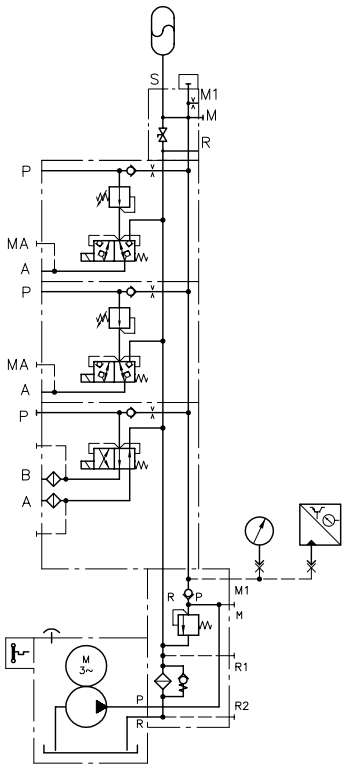
Valve bank type BVH with three valve sections,
two clamping functions with individually
adjustable clamping pressure

Parameters of the circuit example

- Q_{Pu} = 9.8 lpm (at 1450 rpm)
- $p_{max\ Pu}$ = 170 bar
- p_{System} = 120 bar
- $p_{switch\text{-}off\ feature}$ = 50 bar
- V_{use} = approx. 3 l







Associated technical data sheets:

- Valve bank (directional seated valve) type BVH: D 7788 BV

Compact hydraulic power packs:

- See section "Compact hydraulic power packs"

Connection blocks:

- Type A: Page 62

Combinable products:

- Directional seated valves type NBVP: Page 134
- Pressure reducing valves type CDK, DK: Page 180

Accessories:

- Pressure switches type DG: Page 262
- Hydraulic accumulator type AC: Page 258

Plug:

- Line connector type MSD and others: D 7163

Directional seated valves

2.2 Directional seated valve type VZP

Directional seated valves are a type of directional valve. The seated valve type VZP is a manifold mounting valve. Zero-leakage ball-seated and cone-seated valves of the same size are combined.

The twin layout of the 3/2 and 2/2-way directional seated valves means that all functional elements for valve function and actuation share one housing, making them very compact. Depending on the pairing, these valves can realise either one 4/4, 4/3 or 3/3-way function, or two independent 3/2 and 2/2-way individual functions. Compared with individual valves for manifold mounting of conventional layout, the advantages are lower spatial requirements and the possibility of directly mounting pressure switches for monitoring the consumer pressure. A particularly compact option is to combine several valves connected in parallel in one valve bank (type BVZP).

Nomenclature:	Directional seated valve, zero leakage
Design:	Individual valve, manifold mounting
Actuation:	Solenoid
p_{max}:	450 bar
Q_{max}:	15 lpm

Features and benefits:

- Good price-performance ratio
- Max. operating pressures up to 450 bar
- Adapter plates for flange-mounting on compact hydraulic power packs
- Option to incorporate additional functions in the sub-plate, such as pressure switches, throttle and check valve combinations etc.

Intended applications:

- Machine tools (cutting and non-cutting)
- Mining machinery (incl. oil production)
- Clamping equipment, punching tools, jigs
- Rubber and plastics machinery

Design and order coding example

VZP1 | H | 12B1,0 | - G12

Solenoid voltage 12V DC, 24V DC, 110V AC, 230V AC
- Versions with M12-plug and 8-Watt solenoid

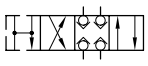
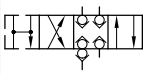
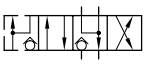
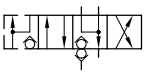
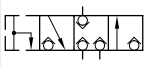
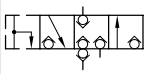
Additional elements
- Indiv. valves with check valve insert in gallery P
- Indiv. valves with return pressure stop in gallery R
- Pressure switch for the consumer ports

Function
- 4/2-way functions via directional spool valve
- 4/3-way directional seated valve (G, D, E, O)
- 3/3-way directional seated valve (J, P)
- 2/2- and 3/2-way directional seated valve (F, D - H, M, N, R)

Basic type, size Twin valve type VZP, size 1
- Connection blocks for pipe connection

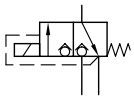
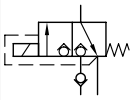
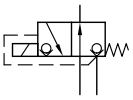
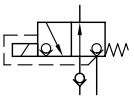
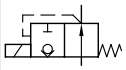
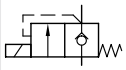
Function

Cone seated valves with 4/3- (4/4-) or 3/3- (3/4-) way functions up to 400 bar

E	G	D	O	P	J
					

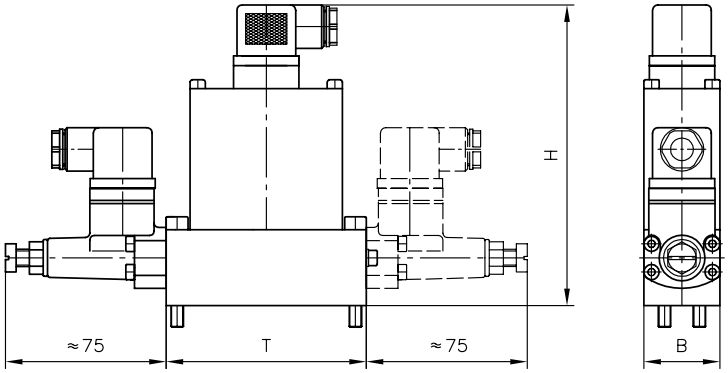
- 4. Switching position when both solenoids are energized simultaneously

Ball seated valves with 3/2- (2/2-) way functions up to 450 bar (always two valve functions in one valve body)

H	N	M	R	F	C
					

General parameters and dimensions

VZP 1 (example with mounted pressure switches)



	Q_{max} [lpm]	p_{max} [bar]	Dimensions [mm]			m [kg]
			H	B	T	
VZP 1	5... 15	250... 450	137... 142	35... 39	92	1.9... 2.2

- Weight m [kg] +0.3 kg per mounted pressure switch

Associated technical data sheets:

- Directional seated valve type VZP: D 7785 A

Accessories:

- Pressure switches type DG 3.., DG 5E: Page 262

Male connectors:

- Line connector type MSD and others: D 7163

Directional seated valves

2.2 Directional seated valve type EM and EMP

Directional seated valves are a type of directional valve. As cone valves they are tightly sealed without leakage in the closed state.
The directional seated valves type EM and EMP are screw-in valves. 2/2 directional seated valves with direct or pilot-controlled electromagnetic actuation are available. The directional seated valve type EM is available as a directional valve or damped switching (soft-shift). Type EMP is a proportionally actuated directional seated valve with throttle function.
Appropriate connection blocks make possible direct pipe connection or manifold mounting. You can obtain additional components, e.g. a drain valve, bypass throttle valve, pressure switch or flow control valve.

Features and benefits:

- Zero leakage in blocked state
- Directly switching up to approx. 3 lpm and piloted up to 160 lpm
- Minimized flow resistance even at high flow rate
- Long lifetime due to hardened valve seats

Intended applications:

- Cranes and lifting equipment
- Road construction industry
- Materials handling, industrial trucks etc.
- Handling and assembly robots, etc.

Nomen-clature:	**Directional seated valve, zero leakage**
Design:	**Screw-in valve Combination Combination with connection block for pipe connection Combination with connection block for swivel fitting Combination with connection block for manifold mounting**
Actuation:	**Solenoid**
p_{max}:	**450 bar**
Q_{max}:	**160 lpm**

Design and order coding example

EM 21 | V | - 3/8 | - G24

Solenoid voltage 12V DC, 24V DC, 110V AC, 230V AC

Versions with
- Versions with M12-plug and 8-Watt solenoid
- Quarter-turn plug, plugs of Co. KOSTAL or AMP

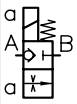
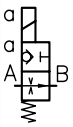
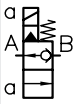
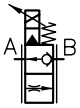
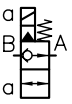
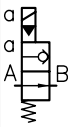
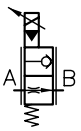
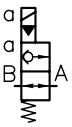
Connection blocks

Versions with
- Drain valve
- Drain valve and drop-rate braking valve
- Drain valve and by-pass check valve
- Bypass- throttle
- Pressure switch
- 2-way flow controller

Function
- V - 2/2-way valve (NC-type)
- S - 2/2-way valve (NO-type)

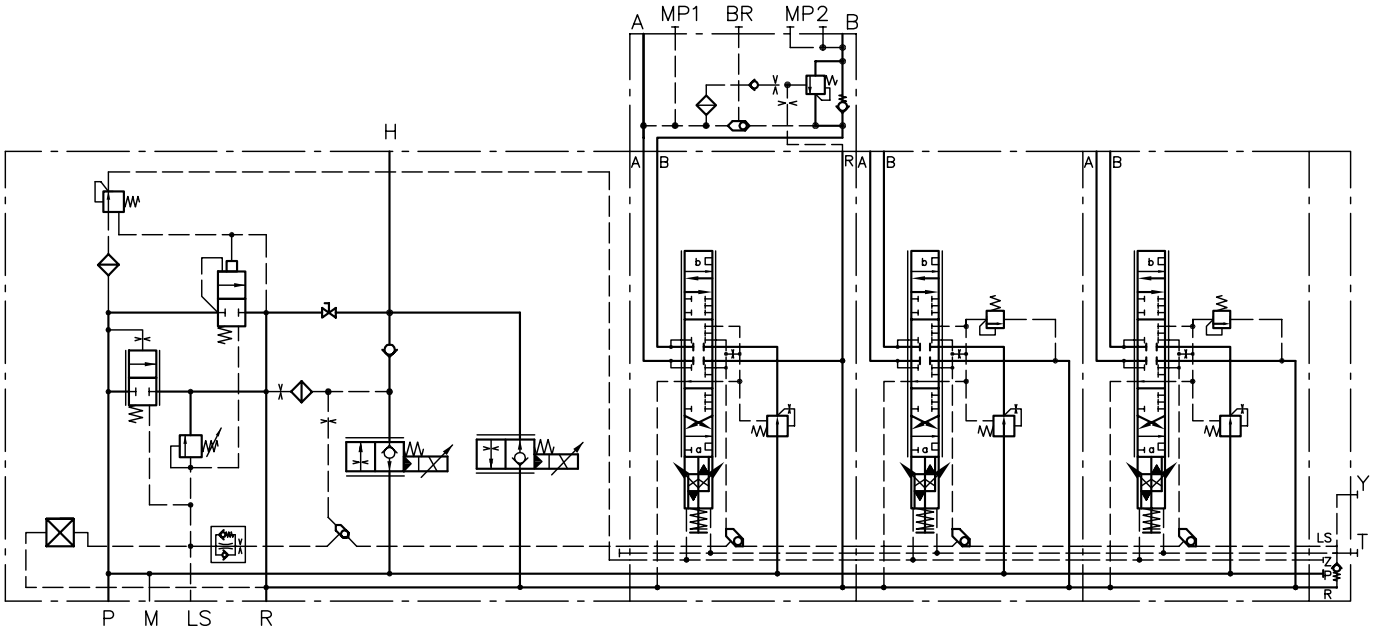
Basic type, size
- Type EM: Directional valve, size 1 to 4
- Type EMP: Prop. valve, size 1 to 4

Function

	Flow in arrowed direction		Arbitrary flow direction	Flow in arrowed direction		Arbitrary flow direction
	Energized open			Energized closed		
Directly actuated	EM .1 D 			EM .1 DS 		
Pilot actuated	EM .1 V 	EMP .1 V 	EM .2 V 	EM .1 S 	EMP .1 S 	EM .2 S 

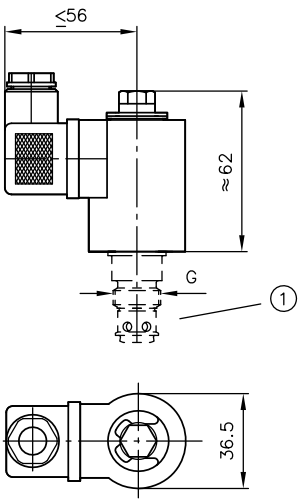
Circuit example:

HMPL 5 US 1/PVPV/250-3
- A2 L 25/25/EI/3 BL 5 D7/120
- 32 L 25/25 C160/EI
- 32 L 63/63 C220/EI
- E4 - AMP 12 K4



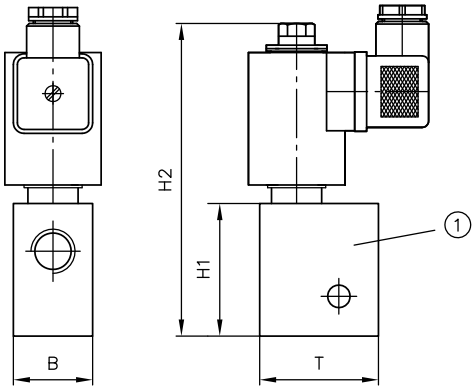
General parameters and dimensions

Screw-in valve



1 Screw-in valve

Valve compl. with connection block for pipe connection



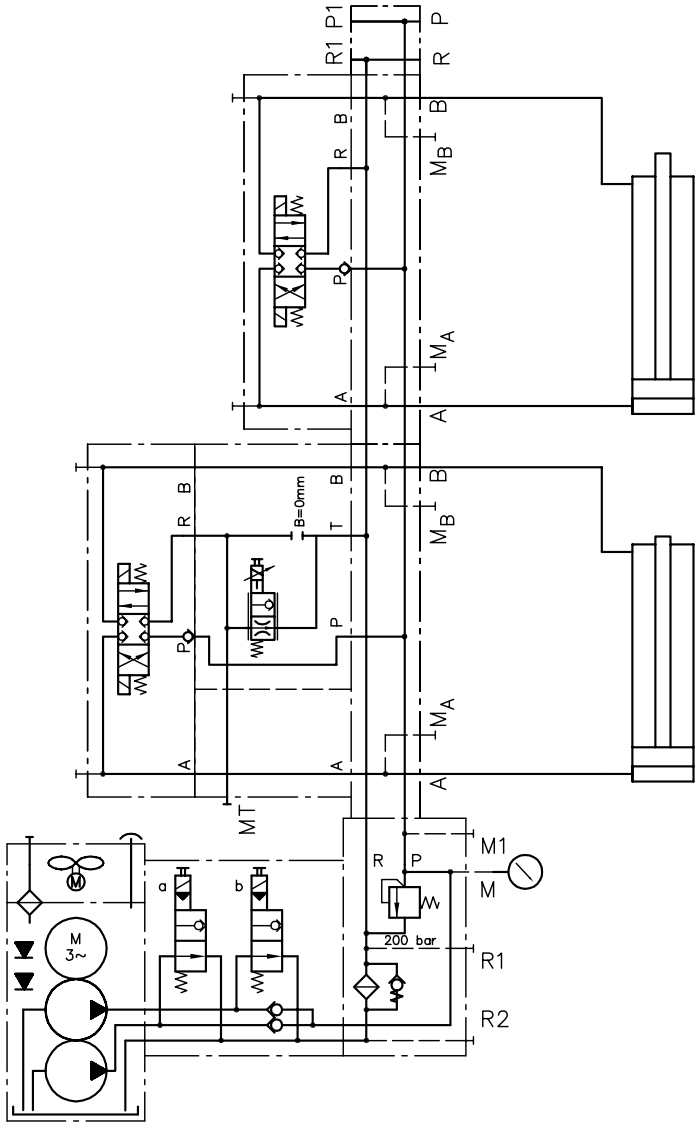
1 Connection block

			Screw-in valve		Valve with connection block					
	Q_{max} [lpm]	p_{max} [bar]	G	m [kg]	Ports	Dimensions [mm]				m [kg]
						H1	H2	B	T	
EM 11 (D, DS)	5	450	M 14 x 1.5	0.3	G 1/4	40	approx. 120	20	35	0.6
EM 21 (D, DS)	3	400	M 18 x 1.5	0.35	G 1/4	50	approx. 120	30	45	0.7
EM 1.. (V, S)	20	450	M 14 x 1.5	0.3	G 1/4	40	approx. 120	20	35	0.6
					G 3/8			25	45	
EM/EMP 2.. (V, S)	40	400	M 18 x 1.5	0.35	G 3/8	50	approx. 120	30	45	0.7
					G 1/2				50	
EM/EMP 3.. (V, S)	80	400	M 18 x 1.5	0.4	G 1/2	60	approx. 133	40	55	1.0
					G 3/4				60	
EM/EMP 4.. (V, S)	160	400	M 33 x 2	0.6	G 3/4	70	approx. 150	40	65	1.2
					G 1			50	70	

- Pressure above 300 bar only with manifolds made of steel. Pay attention to the possibly reduced rigidity of the thread with other materials (e.g. cast, aluminium).

Circuit example:

KA 442 LFK/HH 13.1/13.1
-SS-A 1 F 3/200
-BA 2
-NBVP 16 G/R-GM/NZP 16 TSPG/TB 0/3
-NBVP 16 G/R-GM/3
-2-G 24
-X 84 G-9/250
-3 x 400/230V 50 Hz-4.0 kW/24V DC



Suitable products:

- Intermediate plates NG 6 type NZP: D 7788 Z
- Connection blocks type HMPL and HMPV: Page 90
- Lifting/lowering valves type HSV: Page 150
- Lifting modules type HST, HMT etc.: Page 154

Associated technical data sheets:

- Directional seated valves type EM, EMP: D 7490/1, D 7490/1 E

Accessories:

- Pressure switches type DG 3.., DG 5E: Page 262
- Drop-rate braking valves type SB, SQ, SJ: Page 210
- Suitable proportional amplifiers: Page 272

Male connectors:

- Line connector type MSD and others: D 7163
- With economy circuit: D 7813, D 7833
- Proportional amplifier type EV2S: Page 274

Directional seated valves

2.2 Directional seated valve type BVG, BVP and NBVP

Directional seated valve BVG, BVP, NBVP

Directional seated valves are a type of directional valve. As cone valves they are tightly sealed without leakage in the closed state.

The directional seated valve type BVG is installed directly in the pipe. The valves type BVP and NBVP are valves for manifold mounting. The type NBVP has the standard connection pattern nominal size NG 6. 2/2, 3/2, 3/3 and 4/3 directional seated valves are available with different types of actuation. All connections can be subjected to the same pressures. Depending on the functional requirement, a check valve, restrictors and/or restrictor check valves are integrated into type NBVP, for example. Type NBVP is used together with other valves in valve bank type BA.

Features and benefits:

- Explosion-proof design
- 4th switching position on 4/3 directional valves
- 8-Watt solenoid

Intended applications:

- Machine tools
- Woodworking and processing machinery
- Testing machinery
- Jig construction

Nomen-clature:	**Directional seated valve, zero leakage**
Design:	**Individual valve for pipe connection Individual valve, Manifold mounting**
Actuation:	**▪ Solenoid ▪ Hydraulic ▪ Pneumatic ▪ Manual**
p_{max}:	**400 bar**
Q_{max}:	**20 l/min**

Design and order coding example

BVG1 - R /B2 - 1/4 - WGM 230

Actuations: Solenoid, hydraulic, pneumatic, manual

Connection size or connection block

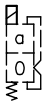
Additional elements
- Orifice in one port
- NBVP: orifice and/or check valve in the P gallery, orifice, restrictor check valve and/or pressure switches in port A, B, return pressure stop in T

Function
- 2/2-way directional valve (R, S), also available in version with position monitoring (RK, SK)
- 3/2-way directional valve (Z, Y), also available in version with position monitoring (ZK)
- 4/3-way directional valve (G, D)

Basic type, size Type BVG and BVP, size 1 and 3
Type NBVP (with standard connection pattern NG 6), size 1

Actuations:

Solenoid



Solenoid voltages: 12V DC, 24V DC, 110V AC, 230V AC

- BVP 1, NBVP16 also available in ATEX-compliant version
- Version with M12 plug and 8-watt solenoid

Hydraulic

Control pressure:
$p_{contr.\ min}$ = 24 bar
$p_{contr\ max}$ = 320 bar

Pneumatic

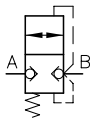
Control pressure:
$p_{contr.\ min}$ = 2... 3.5 bar
$p_{contr.\ max}$ = 15 bar

Manual

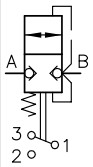
Actuation torque:
approx. 1.5 ... 3 Nm

Function

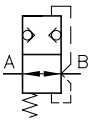
R



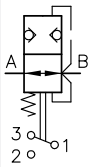
RK



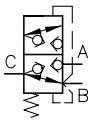
S



SK

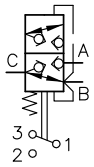


Z

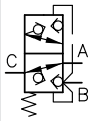


- Further circuit symbols available

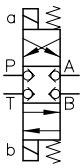
ZK



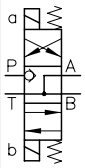
Y



G



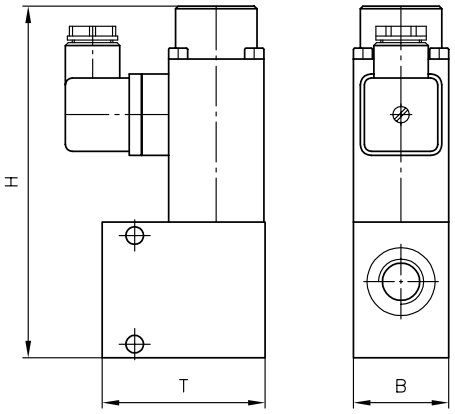
D



- additional switching symbols available
- **G, D:** only for type NBVP16
- Versions with contact switch for position monitoring

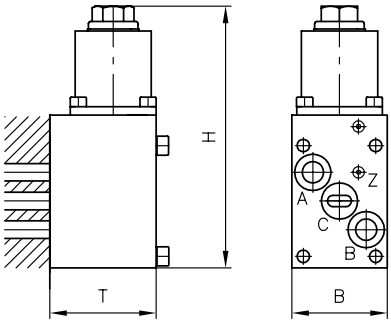
General parameters and dimensions

BVG



Version for pipe connection
(solenoid actuation)

BVP, NBVP



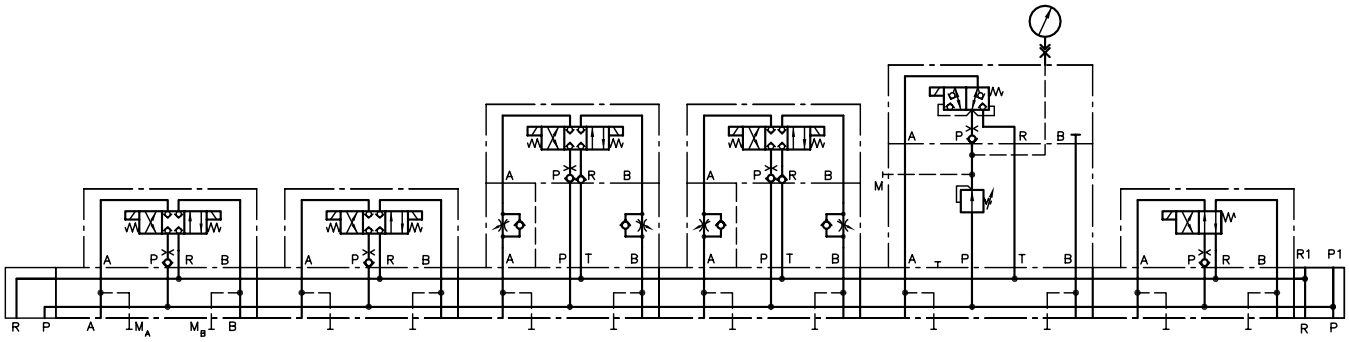
Version for base manifold mounting
(hydraulic actuation)

	Q_{max} [lpm]	p_{max} [bar]	Ports	Dimensions [mm]			m_{max} [kg]
			A, B, C	H_{max}	B_{max}	T_{max}	
BVG 1	20	400/250[1)]	G 1/4, G 3/8	115 (130)	60	40	1.6
BVP 1					35	39	1.0
NBVP 16	20	400/250[1)]	NG 6	230	45	45	2.1

[1)] with solenoid actuation GM.. and WGM

Circuit example:

BA2A5
- **NBVP16G/B2.0R/3**
- **NBVP16G/B2.0R/3**
- **NBVP16G/R/S/NZP16Q22/3**
- **NBVP16G/R/S/NZP16Q22/3**
- **NBVP16Y/B2.0R/2/NZP16CZ5/50/3 - X84V - 9/100A**
- **NBVP16W/B2.0R/3**
- **2 - LM24**



Associated technical data sheets:
Directional seated valves
- Directional seated valve type BVG 1 and BVP 1: D 7765
- Directional seated valve type NBVP 16: D 7765 N

Products:
- Type BA: Page 144
- Type NZP: Page 144
- Type BVH: Page 124

Male connectors:
- Line connector type MSD and others: D 7163
- With economy circuit: D 7813, D 7833

Directional seated valves

2.2 Directional seated valve type BVE

Directional seated valves are a type of directional valve. As cone valves they are tightly sealed without leakage in the closed state.
The directional seated valve type BVE is a screw-in valve. 2/2 and 3/2 directional seated valves are available. All connections can be subjected to the same pressures.
Optionally a version for highly viscous media (e.g. lubricating grease) is available.
Appropriate connection blocks make possible direct pipe connection or manifold mounting.

Features and benefits:

- Any flow direction
- No interaction between actuation elements and medium
- No resinification or sticking as a result of increased temperatures is possible.
- For highly viscous media (e.g. lubricating grease)

Intended applications:

- Lubrication systems
- Mining machinery
- Construction and construction material machinery
- Handling and mounting technology

Nomenclature:	**Directional seated valve, zero leakage**
Design:	**Individual valve for pipe connection Individual valve for manifold mounting**
Actuation:	**Solenoid**
p_{max}:	**500 bar**
Q_{max}:	**300 l/min**

Design and order coding example

BVE1	- R	-B1,0	- G 24	- 3/8

Port size or connection block — **Version**
- With threaded connection
- For manifold mounting

Solenoid voltages — 12 V DC, 24 V DC, 110 V AC, 230 V AC

Versions with
- M12 plug and 8 watt solenoid
- AMP, DEUTSCH plugs

Additional elements
- Orifice in one port

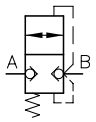
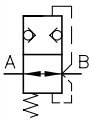
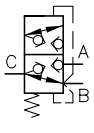
Function
- 2/2-way directional valve (R, S)
- 3/2-way directional valve (Z)

Basic type, size — Type BVE, size 1, 3 and 5

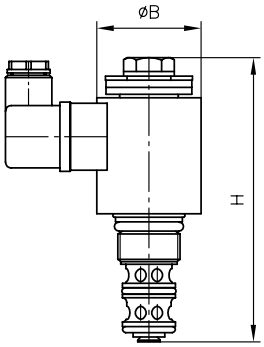
Actuations:

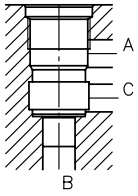
Solenoid

Function

R	S	Z
		

General parameters and dimensions





	Q_{max} [lpm]	p_{max} [bar]	Dimensions [mm]		m_{max} [kg]
			H_{max}	B_{max}	
BVE 1	20	500	121	37	0,4
BVE 3	70	400	122,5	45	0,7
BVE 5	300	400	206,5	72	1,5

Associated technical data sheets:
Directional seated valves

- Directional seated valve type BVE: D 7921

Similar products

- Type BA: Page 144
- Type NZP: Page 144
- Type BVH: Page 124
- Type BVG, BVP, NBVP: Page 134

Suitable male connectors:

- Line connector type MSD and others: D 7163
- With economy circuit: D 7813, D 7833

Directional seated valves

2.2 Directional seated valve type VP

Directional seated valves are a type of directional valve. As cone valves they are tightly sealed without leakage in the closed state.
The directional seated valve type VP is a valve for manifold mounting. 2/2, 3/2 and 4/2 directional seated valves with different types of actuation are available. All connections can be subjected to the same pressures.
The directional seated valve type VP is suitable above all for highly viscous media (e.g. lubricating grease). Appropriate connection blocks make possible direct pipe connection.

Features and benefits:

- Any flow direction
- No interaction between actuation elements and medium
- No sticking or resinification as a result of increased temperatures is possible.
- Suitable for highly viscous media (e.g. lubricating grease)
- Explosion-proof version

Intended applications:

- Lubricating systems
- Mining machinery
- Construction and construction materials machinery
- Handling and assembly technology

Nomen-clature:	**Directional seated valve, zero leakage**
Design:	**Manifold mounting**
Actuation:	**Solenoid Hydraulic Pneumatic**
p_{max}:	**400 bar**
Q_{max}:	**15 l/min**

Design and order coding example

VP1 - R - 3/4 - G24

Actuation
- Solenoid
- Mechanical: roller, feeler
- Manual: lever, turn-knob

Optional connection block For direct pipe connection

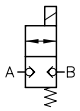
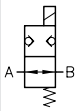
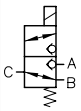
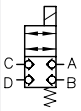
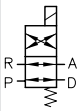
Function 2/2-way directional seated valve (R, S)
3/2-way directional seated valve (Z)
4/2-way directional seated valve (W, G)

Basic type, size Type VP, size 1
- Versions conforming ATEX

Actuation:

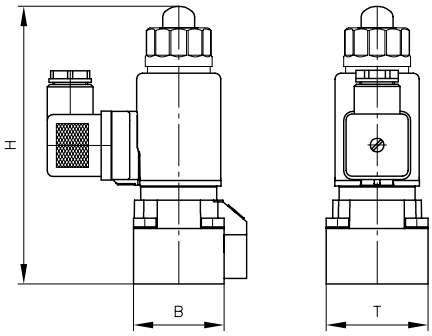
Solenoid	Hydraulic	Pneumatic
		
Solenoid voltage: 12V DC; 24V DC; 110V AC, 230V AC	Control pressure: $p_{control\ min}$ = 24 bar $p_{control\ max}$ = 320 bar	Control pressure: $p_{control\ min}$ = 2 ... 3.5 bar $p_{control\ max}$ = 15 bar

Function

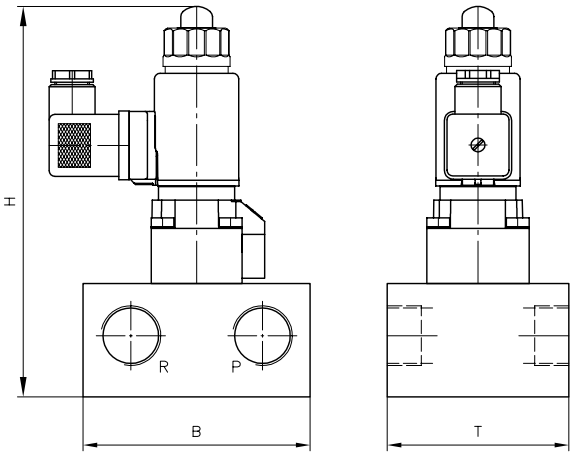
R	S	Z	G	W
				

General parameters and dimensions

Individual valve
Example: VP1R-G24



Valve with sub-plate
Example: VP1W-3/4-WG 230



	Q_{max} [lpm]	p_{max} [bar]	Ports	Dimensions [mm]			m_{max} [kg]
			A, B, C	H_{max}	B_{max}	T_{max}	
VP 1	15	400	G 1/4, G 3/8, G 3/4	127	40	50	1.0
VP 1 with sub-plate				147 ... 177	50 ... 100	45 ... 80	1.5 ... 2.2

- H_{max}: Values apply for electro-magnetic actuation

Associated technical data sheets:

- Directional seated valve type VP: D 7915

Similar products:

- Directional seated valve type BVG1, BVP1, NBVP16: Page 134
- Directional seated valve type BVE: Page 138

Male connectors:

- Line connector type MSD and others: D 7163
- With economy circuit: D 7813, D 7833

Directional seated valves

2.2 Directional seated valve type VH, VHR, and VHP

Directional seated valves are a type of directional valve. As ball valves they have zero leakage in the closed state.

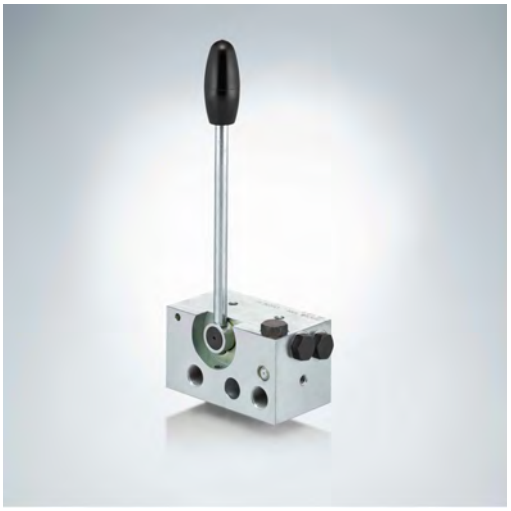
A hand lever operates the eccentric shaft that controls the plunger for opening or closing the valve seats. The actuation is undertaken via the hand lever with automatic centring in the neutral position or with a notch. The directional seated valve type VH is suitable for pipe connection. The directional seated valve bank type VHR comprises several valves of type VH that have been clamped together connected in parallel via a tension rod to form a valve bank. The directional seated valve type VHP is available as a manifold mounting valve.

Features and benefits:

- Pressures up to 700 bar manually switchable
- Actuation using hand lever with automatic centring in zero position or with notch
- Different arrangements in valve bank possible
- Leakage-free seated valve technology

Intended applications:

- Construction and construction materials machinery
- Offshore and marine technology
- Process engineering systems
- Oil hydraulics and pneumatics



Nomen-clature:	Directional seated valve, zero leakage
Design:	Individual valve for pipe connection Individual valve, manifold mounting, bankable
Actuation:	Manual
p_{max}:	700 bar
Q_{max}:	25 l/min

Design and order coding example

VH 1 VHR 1	H1 G1/N1/E2

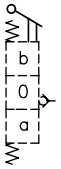
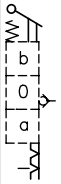
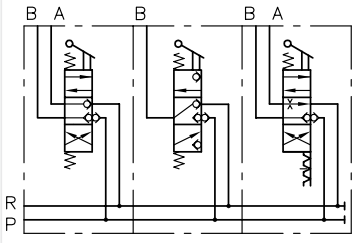
Function/valve sections with actuation Hand lever with automatic return (1) or detent (2)

Additional versions:

- Actuation with contact switch for neutral position monitoring (K), optionally for single valves and valve banks

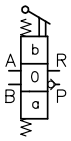
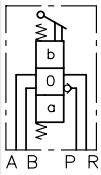
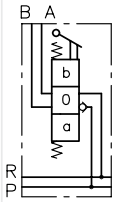
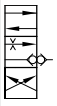
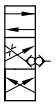
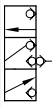
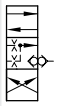
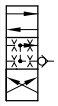
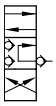
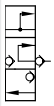
Basic type, size Type VH (Individual valve for pipe connection)
Type VHP (Individual valve, manifold mounting)
Type VHR (Valve bank)
Size 1 and 2

Actuation:

Return spring	Detent	
		Symbol type VHR.. 

- Return spring : automatic return to neutral position only up to approx. 50 bar. At pressures over 50 ... 700 bar the lever must be reset manually.

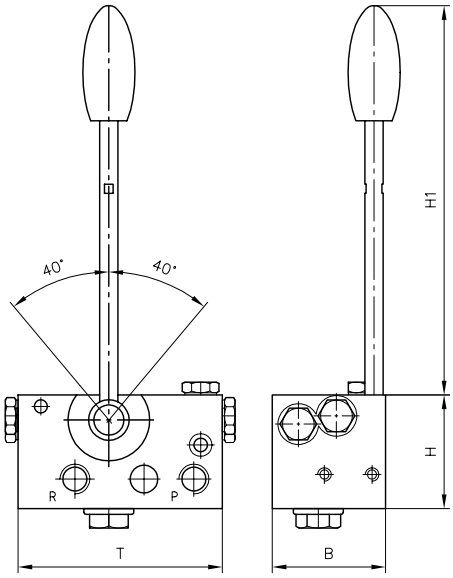
Function

Basic symbols			Symbol							
VH	VHP	VHR	G	E	M	N	D	H	L	S
										

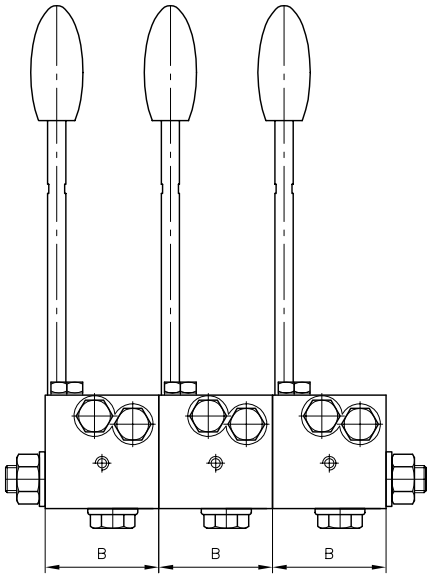
- On type VHR max. 7 or 5 valves (size 1 or 2) can be combined
- Type H, L and S only as single valve, not for type VHR

General parameters and dimensions

Individual valve **VH..**



Valve bank **VHR..**



	Q_{max} [lpm]	p_{max} [bar]	Ports	Dimensions [mm]				m [kg]
				H	H1	B	T	Valve section
VH 1, VHP 1, VHR 1	12	700	G 1/4	50	172	50	90	1.6
VH 2, VHR 2	25	500	G 3/8	60	162	60	120	3

Associated technical data sheets:

- Directional seated valve type VH, VHP and VHR: D 7647

Similar products:

- Directional seated valve type NBVP 16: D 7765 N

2.2 Valve bank (nominal size 6) type BA

A valve bank combines different valves for operating independent consumers.
The directional valve bank type BA consists of several valve sections that are fitted to sub-plates with NG 6. Using these items compact control blocks can be assembled flexibly.
The intermediate plates type NZP make possible additional functions and contain, e.g., pressure-reducing valves, shock valves, load-holding valves etc. An intermediate plate can be inserted between the sub-plate and the valve. The valve bank type BA can be flange-mounted directly on the compact hydraulic power pack.

Features and benefits:

- Sub-plates for flexible combination of directional valve types with NG 6 (CETOP) standard connection pattern
- Valve bank can be flange mounted directly on the connection block of a compact hydraulic power pack or connected as a separately arranged valve bank for pipe connection
- Pressure switches and/or any other monitoring elements can be connected directly
- Additional elements, such as orifices, throttles and check valves for connections P, R, A and B can be integrated
- Hydraulic accumulator can be mounted directly

Intended applications:

- Clamping systems on machine tools and equipment
- Process control on deforming machine tools
- Brake and rotor adjustment modules on wind turbines

Nomenclature:	Sub-plates/directional seated valve, zero leakage
Version:	Valve section with sub-plates for pipe connection
Actuation:	Solenoid Pressure-operated ▪ Hydraulic ▪ Pneumatic Manual Mechanical ▪ Pin ▪ Roller
p_{max}:	500 bar
Q_{max}:	50 lpm

Design and order coding example

BA2 A5	NBVP16 NBVP16 NSWP2	S G G	B0,8 R B0,6 R	/ABR2,0/BBR1,5 /ABR1,0/BBR1,5	/A3B9/400 /50	/S /S	/0 /3 /0	- 1	- G24

Solenoid voltage 12V DC, 24V DC, 230V AC, 110V AC

End plate
- Drain valve with/without pressure switches
- with one or two accumulator ports with/ without release valve and/or with/without drain valve

Sub-plate
- Check valves with release
- Throttle
- Additional pressure gauge connections

Additional elements in R Return pressure stop

Pressure switch/pressure gauge in A and/or B

Additional elements in A, B Throttle check valve in A and/or B
Throttle valve in A and/or B

Additional elements in P Check valve
Orifice

Circuit symbol of the directional valve

Valve sections

Directional valves
- Type NSMD2, NSWP2, NBVP16, NBMD16, NG..-1, NZP16

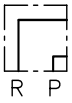
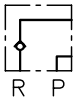
Intermediate plates for series connection
- Type CZ: with pressure-reducing valve in P gallery

Intermediate plates for parallel connection type NZP
- with throttle and/or throttle check valves
- with pressure-reducing valves
- with short-circuit and by-pass valves
- for random switching of a 2nd speed

Connection block
- Direct mounting onto type A, AF etc. connection blocks (for type KA, MP, MPN, HC, HK(F), HKL compact hydraulic power packs)
- Variant for pipe connection with/without pressure-limiting valve (A5)

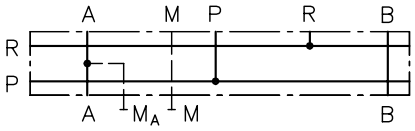
Function

Connection blocks/adapter plates:

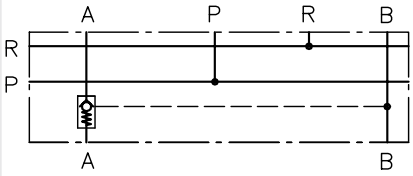
BA2 ..	BA2 A5	BA2 A8
Direct mounting onto type A, AF etc. connection blocks at type KA, MP, MPN, HC, HK(F), HKL compact hydraulic power packs	Version for pipe connection without pressure-limiting valve 	Like version BA2 A5 but with check valve in R 

Sub-plates for plate assembly valve

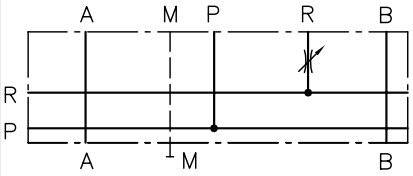
BA2.../0



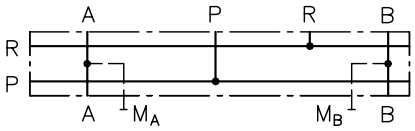
BA2../1



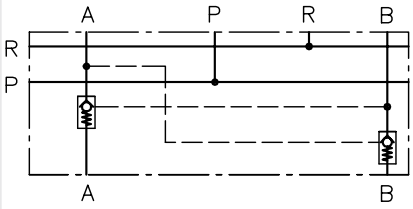
BA2../2



BA2../3



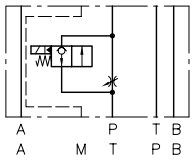
BA2../5



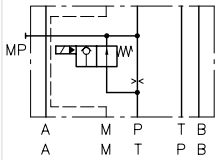
Valve section additional options

Intermediate plates for 2nd speed with orifice/throttle in P and T gallery

/NZP16(T)V/P(T)Q20...



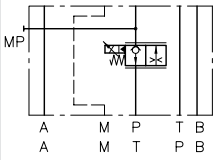
/NZP16(T)S/P(T)B...



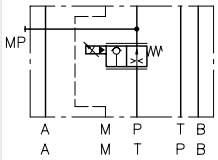
Example: .../NZP16TV/TB1.0/...
Type B1.0 orifice and type EM21V by-pass valve in T gallery

Intermediate plate for variable speed adaptation via proportional throttle in P and T gallery

/NZP16(T)VP

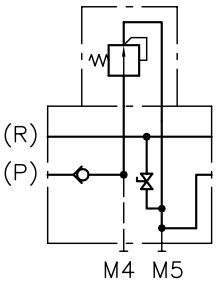


/NZP16(T)SP



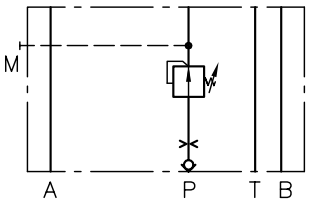
Example: .../NZP16VP/...
Type EMP21V proportional throttle valve in P gallery

Intermediate plate (series connection) with pressure-reducing valve for pressure reduction of the subsequent P gallery .../CZ...



Example: BAZ-CZ2/180/5R
Type CDK3 pressure-reducing valve set to 180 bar with check valve

Intermediate plates (parallel connection) with pressure-reducing valve in P gallery .../NZP16(26)CZ...

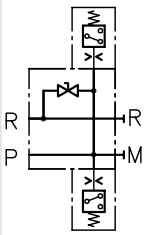
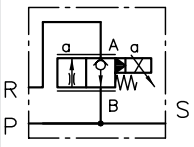
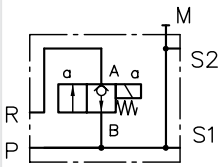


Example: .../NZP16CZ08/350/B0.8R/...
Type CDK0.8 pressure-reducing valve set to 350 bar with orifice and check valve in P gallery

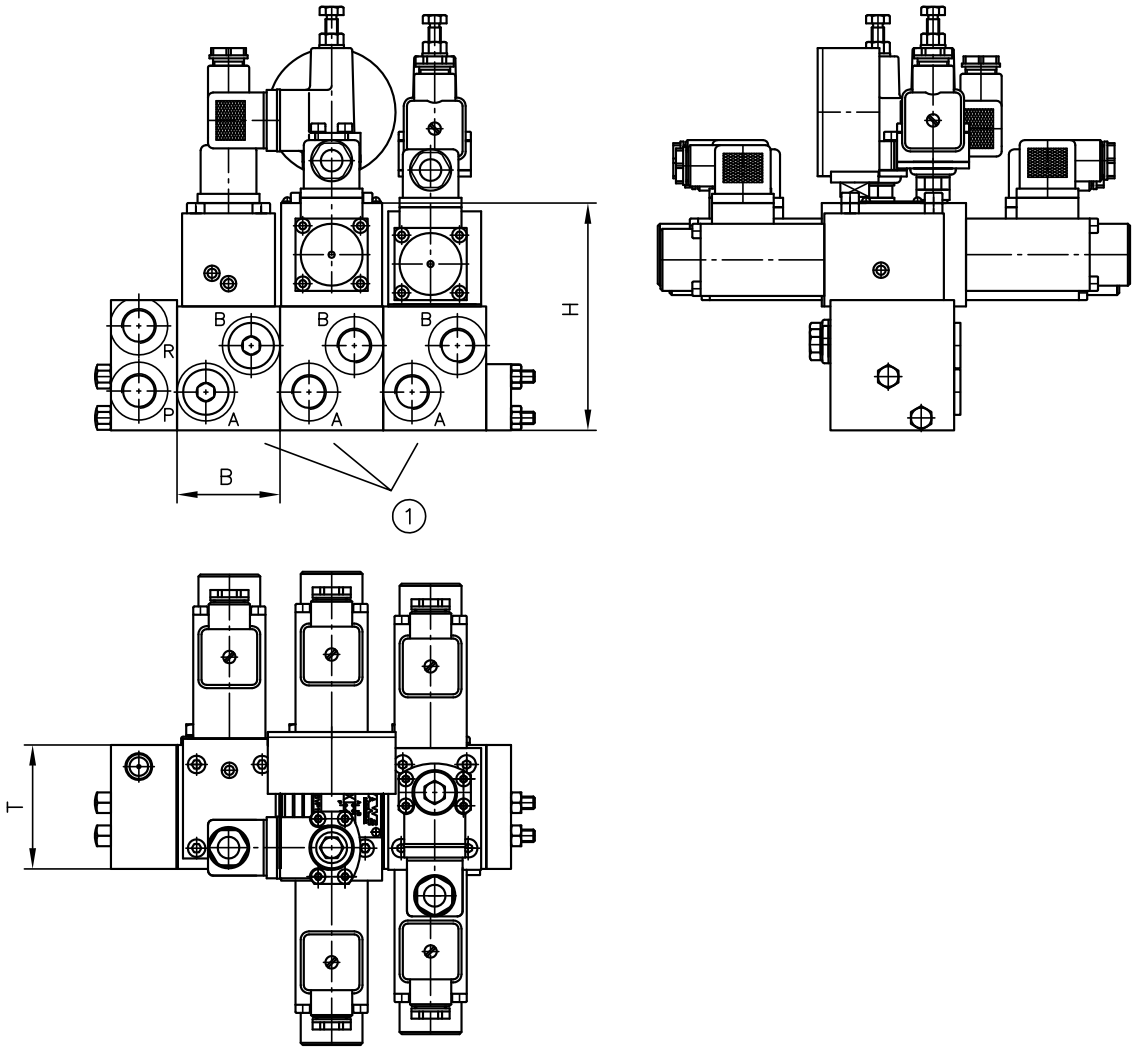
Actuations:

M:	Solenoid actuation (p_{max}= 400 bar)	P:	Pneumatic
GM:	Solenoid actuation (p_{max}= 250 bar)	A:	Manual actuation
H:	Hydraulic actuation	T:	Pin
		K:	Roller

End plates

-1	-6	-422	-8	-80/-8W	-880(88W)/...
Series	with drain valve	with drain valve and pressure switches	with accumulator port and drain valve	with accumulator port and release valve	with two accumulator ports and release valve
					

Mounted valve type BA



1 Sub-plates type BA2

	Q_{max} [lpm]	p_{max} [bar]	Ports (BSPP)	Dimensions [mm]			m [kg]
			A, B, P, R, M	H	B	T	Valve section
BA2	20	400	G 1/4, G 3/8	139	50	60	0,8

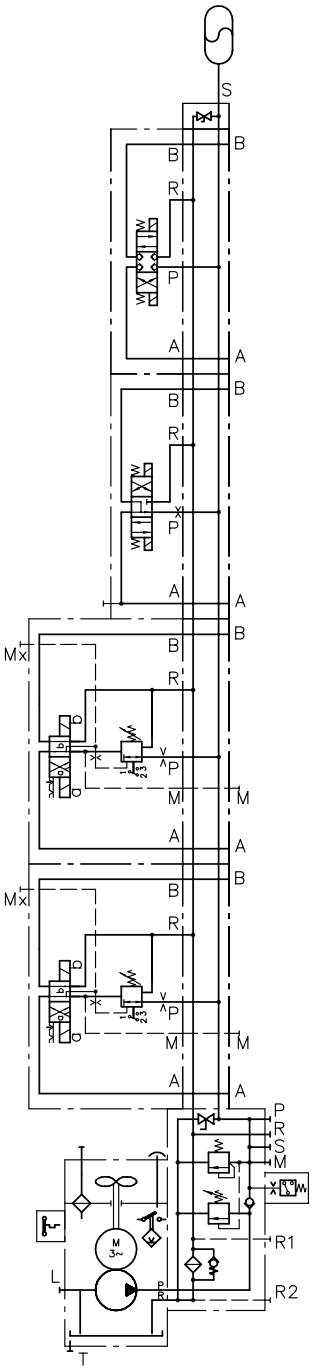
Circuit example:

HK 449 LDT/1 - Z16
- AL21R F2 - F/50/60 - 7/45

Type HK compact hydraulic power pack size 4;
connection block with accumulator charging valve, setting: 50 bar,
pressure-limiting valve,
setting: 60 bar,
filter and pressure switch,
setting: 45 bar

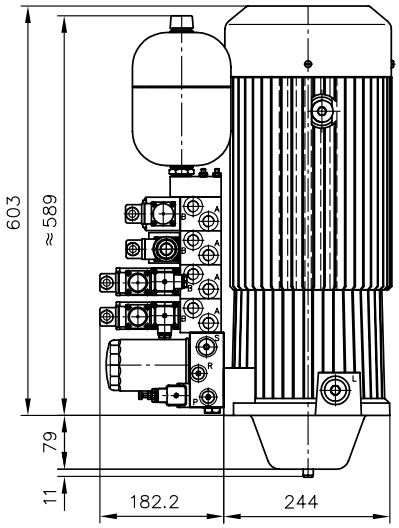
- BA2
- NSMD2W/GRK/B2.0/0
- NSMD2W/GRK/B2.0/0
- NSWP2D/B2.0/20/1
- NBVP16G/0
- 8 - AC2001/35 - L24

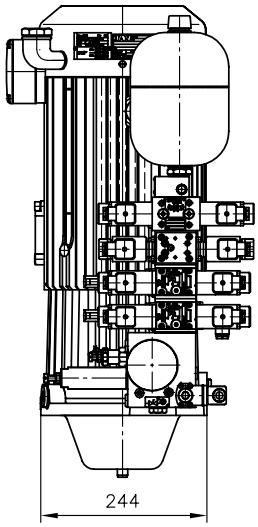
Type BA2 valve bank with four industrial standard valves mounted on sub-plates, two clamping functions for work piece clamping with combined option to adjust pressure and pressure switches, two additional functions for indexing and tool clamping



Parameters of the example circuit:

- Q_{Pu} = 16 lpm (at 1450 rpm)
- $p_{max\ Pu}$ = 110 bar
- p_{System} = 60 bar
  (pressure-limiting valve setting)
- $p_{switch\text{-}off\ feature}$ = 50 bar
- V_{load} = approximately 5 l





Associated technical data sheets:

- Valve bank (nominal size 6) type BA: D 7788
- Intermediate plate type NZP: D 7788 Z

Suitable compact hydraulic power packs:

- See chapter on hydraulic power packs

Suitable connection block:

- Type A: Page 62

Combined products:

- Clamping module type NSMD: D 7787
- Directional spool valves type NSWP: Page 72
- Directional spool valve type SWPN: D 7451 AT
- Directional seated valves type NBVP: Page 134

Suitable accessories:

- Pressure switches type DG: Page 262
- Hydraulic accumulator type AC: Page 258

Suitable plugs:

- Line connector type MSD and others: D 7163

Directional seated valves

2.2 Lifting/lowering valve type HSV

Lifting-lowering valves are a combination of directional valves and metering valves.
The valve block type HSV provides the function of a 2/2-way directional seated valve with electrical actuation for lowering the load. Adjustable throttle valves or flow control valves independent of the load control the lowering speed. An integrated pressure-limiting valve limits the permissible load.
The lifting/lowering valve type HSV is used to control lifting equipment with single-acting cylinders.

Features and benefits:

- Optimum control of lifting and lowering function
- High pressures up to 400 bar
- Zero leakage to prevent unwanted lowering of loads and platforms
- Integrated overpressure protection

Intended applications:

- Cranes and lifting equipment
- Materials handling
- Road vehicle
- Mining machinery

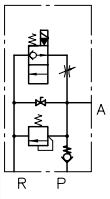
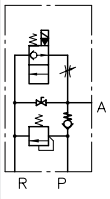
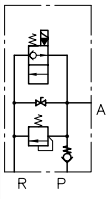
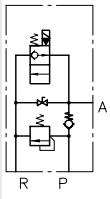
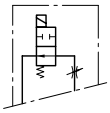
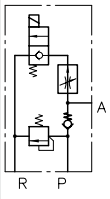
Nomen-clature:	**Valve combination consisting of:** ■ 2/2-way directional seated valve, solenoid actuated ■ Pressure-limiting valve ■ Check valve optional ■ Throttle or 2-way flow control valve
Design:	**Individual valve for pipe connection**
Actuation:	**Solenoid**
p_{max}:	**400 bar**
Q_{max}:	**120 l/min**

Design and order coding example

HSV 21 - R1 - R-150 - G24

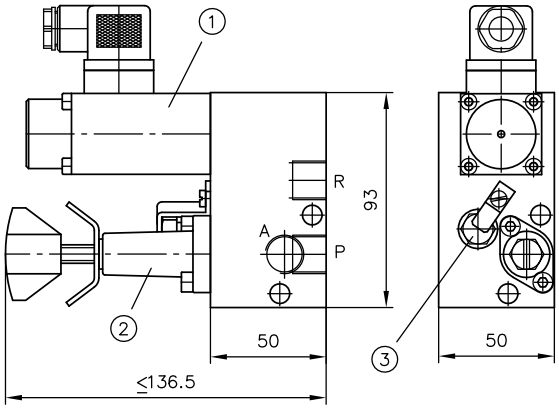
- **Solenoid voltage** — 12 V DC, 24 V DC, 110 V AC, 230 V AC
  HSV 21 and HSV 22 also in explosion-proof version
- **Pressure limiting valve** — Manually adjustable or fixed, pressure setting in bar
- **Function**
- **Basic type, size** — Type HSV, sizes 2 and 7

Function

	With throttle		Without throttle		With/without throttle	With 2-way flow control valve
	R 1	R 2	R 3	R 4	S 1 ... S 4	R 6
HSV 21 HSV 22 HSV 71						

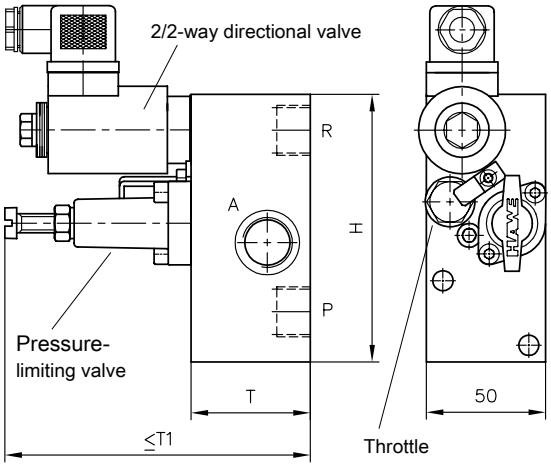
General parameters and dimensions

HSV 21; HSV 22



1 2/2 directional seated valve
2 Pressure-limiting valve
3 Throttle

HSV 71



1 2/2 directional seated valve
2 Pressure-limiting valve
3 Throttle

	Q_{max} [lpm]	p_{max} [bar]	Ports		Dimensions [mm]			m [kg]
			P	A, R	H	T	T1	
HSV 21	20	315	G 3/8	G 3/8	see illustration			2.2
HSV 22	30	315	G 3/8	G 1/2	see illustration			2.2
HSV 71	120	315	G 3/4	G 3/4	100	80	160	3.1

Associated technical data sheets:

- Lifting/lowering valve type HSV: D 7032

Similar products:

- Connection block type HMPL and HMPV for proportional directional spool valve: D 7700 H

Male connectors:

- Line connector type MSD and others: D 7163
- With economy circuit: D 7813, D 7833

Directional seated valves

2.2 Switch unit type CR

Switch units combine the function of a directional seated valve with a pressure valve and check valve. They control dual stage pumps, a combination of high-pressure pump and low-pressure pump, in bottom and top ram presses. The low-pressure circuit and the high-pressure circuit are combined for rapid movement.

If the low-pressure value is reached or exceeded, the switch unit type CR switches the low-pressure circuit to circulation. The high-pressure pump carries out the pressing action. The switch unit hydraulic release acts automatically. It initiates surge-free decompression that relieves the press. In the closed state the switch unit has zero leakage.

The switch unit type CR can be attached directly to hydraulic power packs type MPN and RZ.

Features and benefits:

- Special valve for controlling upstroke presses
- Smooth, gentle switching
- No pressure drop during press operation due to zero leakage
- Fully automatic switching of the low-pressure pump to circulation

Intended applications:

- Machine tools (presses)
- Woodworking and processing machinery
- Printing and paper technology
- Foodstuff and packaging machinery

Nomen-clature:	**Valve combination consisting of:** ▪ 2/2-directional seated valve ▪ Ball-type check valve ▪ Pressure valve
Design:	**Individual valve for pipe connection**
Actuation:	**Solenoid** **Manual**
p_{max}:	**HP 400 bar** **NP 60 bar**
Q_{max}:	**HP 20 lpm** **NP 160 lpm** **A → R 300 lpm**

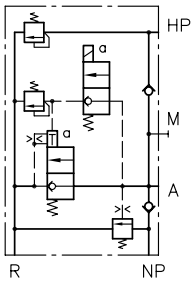
Design and order coding example

CR4 M-WG230 - 400/60

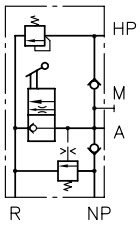
- **Pressure settings [bar]** High-/low pressure
- **Actuation mode**
  - Solenoid
    Voltage of the actuation solenoids 24V DC, 230V AC 50/60 Hz
  - Manually
- **Basic type, size** Type CR, size 4 and 5

Function

CR 4M; CR 5M

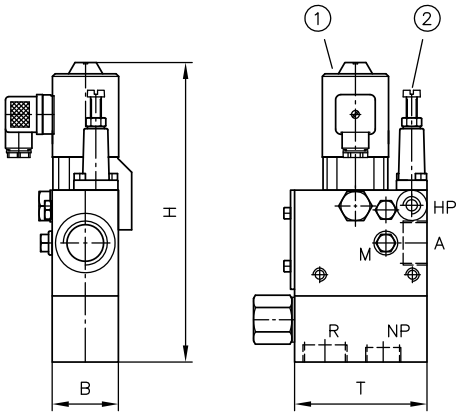


CR 4H

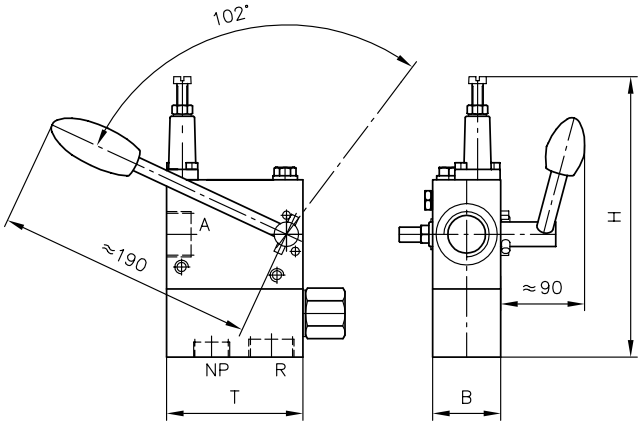


General parameters and dimensions

CR 4M



CR 4H



1 Actuating solenoid

2 Pressure-limiting valve

	Q_{max} [lpm]			p_{max} [bar]		Ports				Dimensions [mm]			m [kg]
	HP	NP	A→R	HP	NP	A and R	HP	NP	M	H	B	T	
CR 4M	8	80	200	400	(0) ... 60	G 1	G 1/4	G 3/4	G 1/4	247.5	50	100	5.2
CR 4H	8	80	200	400	(0) ... 60	G 1	G 1/4	G 3/4	G 1/4	202	50	100	4.7
CR 5M	20	160	300	400	(0) ... 60	G 1 1/4	G 3/8	G 1	G 1/4	277.5	63	135	10.0

Associated technical data sheets:

- Switch unit type CR: D 7150

Male connectors:

- Line connector type MSD and others: D 7163

Similar products:

- Two-stage valves type NE: Page 192

Hydraulic power packs:

- Compact hydraulic power packs type MP, MPN, MPNW, MPW: Page 50

Directional seated valves

2.2 Lifting module type HMT and HST

Lifting modules or hoist control valves are a combination of directional valves and pressure control valves. They are used to control a lifting function. The flow rate is controlled or limited proportionally both on lifting and also on lowering.
In the lifting module type HMT and HST directional seated valves are used that ensure the load is held securely. Two-way flow control valves are used to limit the maximum flow rate. Valve sections of type SWS can be attached space-savingly to the lifting module to control additional functions. The lifting module type HMT and HST is suitable for use in industrial trucks and agricultural machinery.

Features and benefits:
- Flexible design for fixed or variable displacement pump systems
- Low spatial requirements due to steel design
- Flexible combination with directional valves

Intended applications:
- Materials handling (industrial trucks etc.)
- Cranes and lifting equipment
- Road vehicle

Nomenclature:	**Valve combination according to type consisting of:** ▪ 2-way flow control valves ▪ 2-way seated valves ▪ Directional spool functions
Design:	**Valve bank**
Actuation:	**Solenoid**
p_{max}:	**315 bar**
Q_{max}:	**90 lpm**

Design and order coding example

HMT34D - 1/250 - G/MP/0/2 - 31EP - G 24

End plate
- With two P ports and one R port
- With prop. idle circulation valve
- With solenoid valve for the parking brake

Valve sections, ancillary- and intermediate blocks
Various intermediate blocks for mast tilting, mast shifting, auxiliary hydraulics
Directional valve sections type SWR 1 with additional functions
Directional valve sections type SWS 2

Connection block
Pressure setting [bar] of the pressure limiting valve

Additional versions
- Connection blocks type SWR, SWS
  - With flow divider
  - With/without pressure limiting valve
  - With shut-off valve for P and H (lift)

Basic type
Lifting modules and hoist control valves

Drive concept and application:

	Drive concept		Application					
	1	2	Scissor lift	Miniature stacker, Walkie stacker	Counter balance truck	Reach truck	Order picker (warehouse)	
							no man aloft	man aloft
HST	x	x	x	x	x	x	x	x
HMT		x			x	x	x	(x)

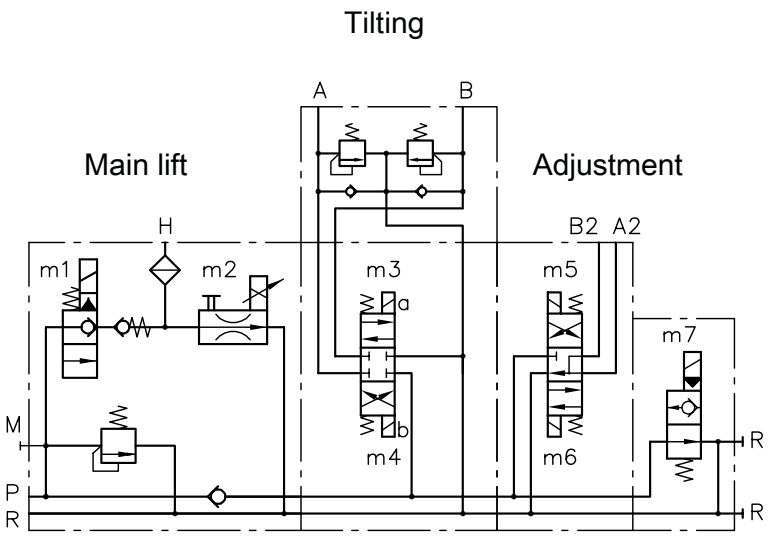
Drive concepts:

- 1: Constant pump, lifting/lowering via a controller (throttle)
- 2: Lifting via a speed-controlled pump, lowering via a controller (throttle)

Circuit example:

HMT 34-1/200-70F
-G/M/0/2 AN40 BN130
-D/M/0/02
-31E-P12/G 24

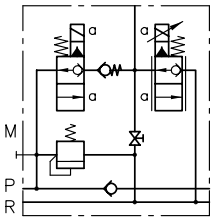
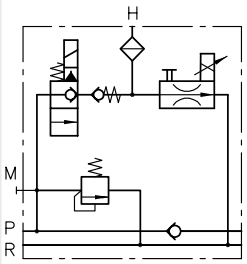
Lifting module type HMT, size 3, port size 4 with pressure-limiting valve (set to 200 bar), output controller with 70 l control orifice closed in normal position; segment G with shock and servo-suction valves (set values 40 and 130 bar) in ancillary block; end plate with idle circulation valve open in neutral position, proportional solenoid voltage for flow control valves 12V DC, solenoid voltage for directional spool valve and directional seated valves 24V DC



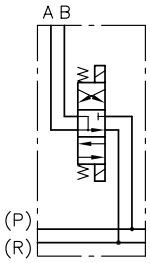
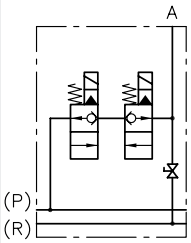
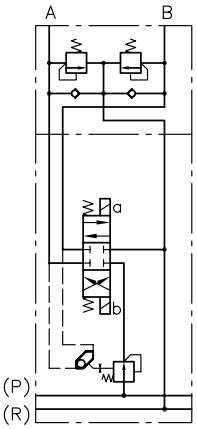
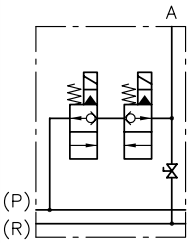
1 Main stroke
2 Tilt
3 Fork adjustment

Function

Lifting modules and connection blocks:

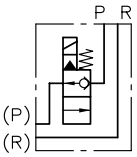
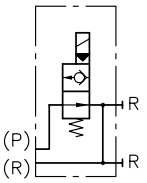
HST	HMT
	

Intermediate blocks (main and initial lift):

Size 2		Size 3	
D	**T2**	**G/M/DW/2 AN... BN...**	**T2**
			

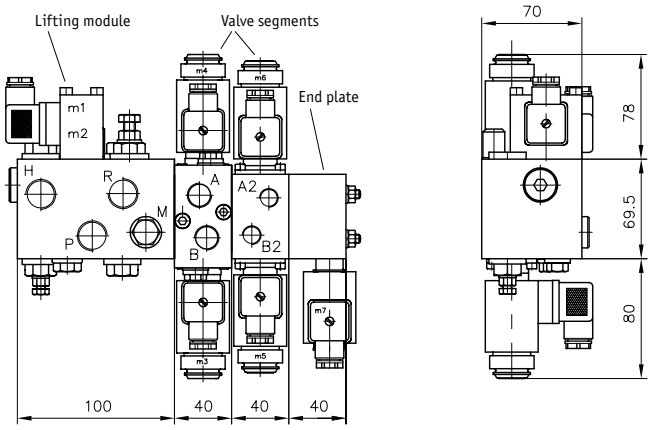
- Size 2: Hole pattern SWR 1, size 3: Hole pattern SWR 2/SWS 2

End plates:

Size 2 and 3	Size 2 and 3	Size 3	Size 3
1	**2**	**21E**	**31E**
			

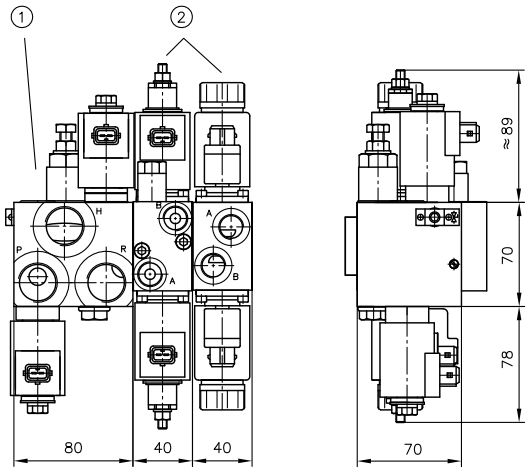
General parameters and dimensions

HMT 34 ...



1 Lifting module
2 Valve segments
3 End plate

HST 3 ...



1 Lifting module
2 Valve segments

	Q_{max} [lpm]	p_{max} (bar)	Note	Ports
HST 2	20 - 40	315	Connection blocks of lifting module Add-on components: - SWR/SWS-Valve sections - Intermediate blocks - End plates	P, R, H= G 1/2;M = G 3/8
HST 3	30 - 60			P, R, H= G 3/4;M = G 3/8
HMT 3	70 - 90			H, P, R= G 1/2;M = G 3/8
HMT 34	70 - 90			H= G 3/4;P, R = G 1/2; M = G 3/8

Associated technical data sheets:

- Type HMT: **Sk 7758 HMT ff**
- Type HST: **Sk 7650 HST ff**

Information on additional lifting modules on inquiry

Similar products:

- Directional spool valves type SWR, SWS 2: Page 76
- Connection blocks type HMPL and HMPV: Page 90

Male connectors:

- Line connector type MSD and others: D 7163
- With economy circuit: D 7813, D 7833
- Proportional amplifier type EV2S: D 7818/1

2.3 Pressure control valves

Directly controlled pressure-limiting and sequence valves type MV, SV

Proportional pressure-limiting valves type PMV and PDV

Pressure-limiting and sequence valves (also proportional)

Type	Design / adjustability	p_{max} (bar)	Q_{max} (lpm)
MV, SV, DMV	▪ Single valve for pipe connection or manifold mounting ▪ Screw-in valve, installation kit – Fixed – Adjustable	MVG - 13: 700 MVG - 14: 700 MV, SV - 4: 700 MV, SV - 5: 700 MV, SV - 6: 700 MV, SV - 8: 700 DMV - 4: 350 DMV - 5: 350 DMV - 6: 350 DMV - 8: 315	MVG - 13: 8 MVG - 14: 8 MV, SV - 4: 20 MV, SV - 5: 40 MV, SV - 6: 70 MV, SV - 8: 160 DMV - 4: 20 DMV - 5: 40 DMV - 6: 75 DMV - 8: 160
CMV(Z), CSV(Z)	▪ Screw-in valve – Fixed – Adjustable	CMV - 1: 500 CMV - 2: 500 CMV - 3: 500 CSV - 2: 315 CSV - 3: 315 CSVZ - 2: 315 CMVZ - 2: 500	CMV - 1: 20 CMV - 2: 40 CMV - 3: 60 CSV - 2: 40 CSV - 3: 60 CSVZ - 2: 40 CMVZ - 2: 40
DV, AS	▪ Single valve for pipe connection or manifold mounting – Fixed – Adjustable	DV - 3: 420 DV - 4: 420 DV - 5: 420 AS - 3: 350 AS - 4: 350 AS - 5: 350	DV - 3: 40 DV - 4: 80 DV - 5: 120 AS - 3: 50 AS - 4: 80 AS - 5: 120
VR	▪ Insert valve ▪ Housing version – Fixed	1: 315 2: 315 3: 315 4: 315	1: 15 2: 40 3: 65 4: 120
PMV, PDV	▪ Single valve for pipe connection or manifold mounting – Electro-proportional	PMV - 4: 700 PMV - 5: 450 PMV - 6: 320 PMV - 8: 180 PDV - 3: 350 PDV - 4: 350 PDV - 5: 350	PMV - 4: 16 PMV - 5: 60 PMV - 6: 75 PMV - 8: 120 PDV - 3: 40 PDV - 4: 80 PDV - 5: 120

Pressure reducing valves (also proportional)

Type	Design / adjustability	p_{max}/p_A (bar)	Q_{max} (lpm)
ADC, ADM, ADME, AM	▪ Screw-in valve ▪ For pipe connection – Fixed	ADC 1: 300/25 ADM 1: 315/70 ADME 1: 315/70 AM 1: 400/100	ADC 1: 2 ADM 1: 10 ADME 1: 8 AM 1: 2
ADM, VDM	▪ Single valve for pipe connection or manifold mounting ▪ Directly controlled or pilot-controlled – Fixed – Adjustable	ADM 1: 315/70 ADM 11: 320/250 ADM 21: 320/250 ADM 22: 320/250 ADM 32: 320/250 ADM 33: 320/250 VDM 3: 400/300 VDM 4: 400/300 VDM 5: 400/300	ADM 1: 10 ADM 11: 12 ADM 21: 25 ADM 22: 25 ADM 32: 60 ADM 33: 60 VDM 3: 40 VDM 4: 70 VDM 5: 120
CDK, CLK, DK, DLZ, DZ	▪ Screw-in valve according to the 2-way principle ▪ Combination with connection block – Fixed – Adjustable	CDK - 3: 500/450 CLK - 3: 500/450 DLZ - 3: 400/380 DK - 3: 500/450 DZ - 3: 500/450	CDK - 3: 22 CLK - 3: 22 DLZ - 3: 22 DK - 3: 22 DZ - 3: 22
PM, PMZ	▪ Installation kit ▪ Individual valve for manifold mounting – Electro-proportional	PM - 1: 40/30 PM - 11: 40/30 PM - 12: 40/30 PM - 22: 40/30 PMZ - 1: 40/30	PM - 1: 2 PM - 11: 2 PM - 12: 2 PM - 22: 2 PMZ - 1: 2
PDM	▪ Single valve for pipe connection or manifold mounting – Electro-proportional	11: 320/320 12: 320/320 21: 320/180 22: 320/180 3: 350/350 4: 350/350 5: 350/350	11: 12 12: 12 21: 20 22: 20 3: 40 4: 80 5: 120
KFB, FB	▪ Single valve for pipe connection – Manual	01: 120/30	01: 2

Directional valves (follow-up, shut-off, switch-off valves)

Type	Design / adjustability	p_{max} (bar)	Q_{max} (lpm)
CNE	▪ 2-way idle circulation valve ▪ Screw-in valve – Fixed	2: 500 21: 500 22: 420 23: 500	2: 30 21: 30 22: 30 23: 30
NE	▪ Two-stage valve (high-pressure / low-pressure stage) ▪ Single valve for pipe connection – Fixed	HP/LP: 20, 21: 700/55 70: 500/60 80: 500/30	HP/LP: 20, 21: 10/40 70: 16/100 80: 25/180
LV, ALZ	▪ Shut-off valve (idle circulation valve, directly controlled or pilot-controlled) ▪ Single valve for pipe connection or manifold mounting – Fixed – Adjustable	LV - 10: 350 LV - 20: 350 LV - 25: 350 ALZ - 3: 350 ALZ - 4: 350 ALZ - 5: 350	LV - 10: 12 LV - 20: 25 LV - 25: 25 ALZ - 3: 50 ALZ - 4: 80 ALZ - 5: 120
DSV, CDSV	▪ Single valve for pipe connection or manifold mounting ▪ Screw-in valve – Fixed – Manual	CDSV - 1: 600 DSV - 21-1: 400 DSV - 2-2: 400 DSV - 2-3: 400	CDSV - 1: 8 DSV - 21-1: 20 DSV - 2-2: 40 DSV - 2-3: 60

Load-holding valves

Type	Design / adjustability	p_{max} (bar)	Q_{max} (lpm)
LHK, LHDV, LHT	▪ Single valve for pipe connection or manifold mounting ▪ Screw-in valve, version for banjo bolt mounting – Fixed – Adjustable	LHK - 2: 400 LHK - 3: 360 LHK - 4: 350 LHDV - 33: 420 LHT - 2: 400 LHT - 3: 420 LHT - 5: 400	LHK - 2: 20 LHK - 3: 60 LHK - 4: 100 LHDV - 33: 80 LHT - 2: 28 LHT - 3: 130 LHT - 5: 250

Pressure control valves

2.3 Pressure-limiting valve type MV, SV and DMV

Pressure-limiting valves and sequence valves are types of pressure control valves. Pressure-limiting valves safeguard the system against excessive system pressure or limit the operation pressure. Sequence valves generate a constant pressure difference between the inlet and outlet flow.

Type MV and SV is a directly controlled valve that is damped as standard. Versions that correspond to the Pressure Equipment Directive are also available.

Features and benefits:

- Operating pressures up to 700 bar
- Various adjustment options
- Numerous configurations

Intended applications:

- General hydraulic systems
- Test benches
- Hydraulic tools

Nomen-clature:	Pressure-limiting valve, sequence valve (directly controlled)
Design:	Individual valve for pipe connection Screw-in valve Individual manifold mounting valve Assembly kit
Adjustment:	Fixed Manually adjustable
p_{max}:	700 bar
Q_{max}:	160 lpm

Design and order coding example

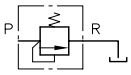
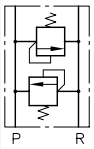
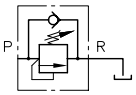
MVS 52	B	R	X	- 650

- **Pressure setting]**
- **Optionally without dampening (X)**
- **Adjustability (while pressurized)**
  - fixed
  - Manually adjustable
  - Adjustable with turn knob (self-locking/lockable)
- **Pressure range and volumetric flow** — Pressure ranges A, B, C, E and F
- **Basic type, size** — Type MV.., DMV.. and SV..

Additional versions

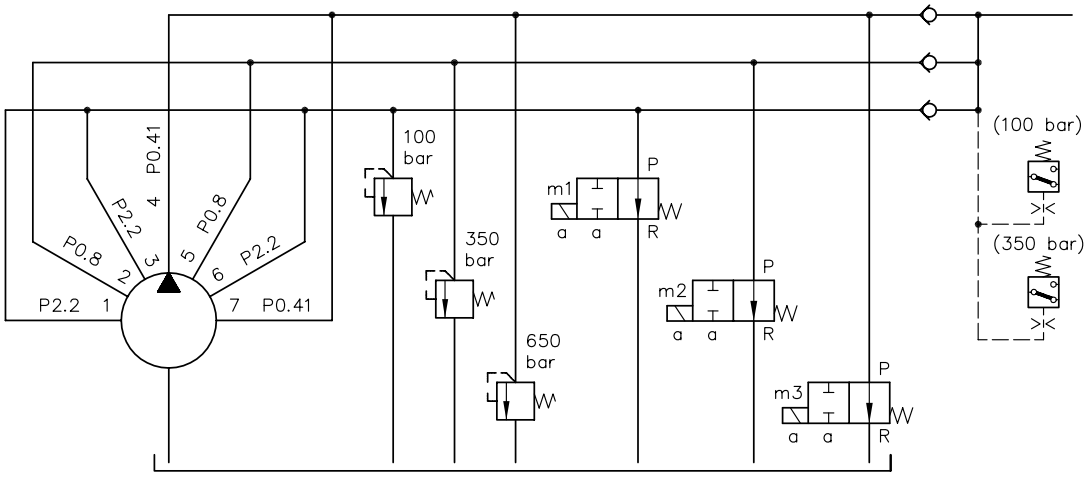
- Pressure-limiting valves with unit approval (TÜV valves) (type MVX, MVSX, MVEX, MVPX, SVX, size 4, 5 and 6)
- Various actuations: ball head for controls via cam, lever etc. (type MVG and MVP only)

Function

	MV[1]	MVS MVG	MVE	SV	MVP	DMV	MVCS MVGC	SVC	MVB
									
Function	Pressure limiting valve	Pressure limiting valve and differential pressure regulators				Pressure limiting valve	Pressure-limiting valve with free reflux R→P via a bypass check valve		Pressure limiting valve and differential pressure regulators
Brief description	Corner valve for pipe connection	Corner valve for pipe connection	Screw-in valve	Straight-way valve for straight pipe installation	Manifold mounting valve	Twin valve as shock valve for hydraulic motors	Corner valve for pipe connection	Straight-way valve for straight pipe installation	Assembly kit
Size	4, 5, 6	13, 14, 4, 5, 6, 8	13, 14, 4, 5, 6, 8	4, 5, 6, 8	13, 14, 4, 5, 6, 8	4, 5, 6, 8	13, 14, 4, 5, 6	4, 5, 6	4, 5, 6, 8
$p_{perm\ R}$ [bar]	20	500	500	500	500	350	500	500	200

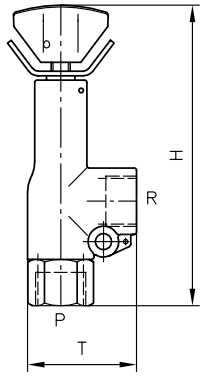
1) Only size 4, 5, 6, and 8
Type MVG and MVGC only size 13 and 14

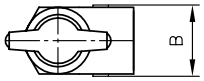
Circuit example:



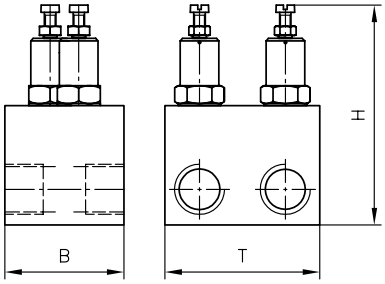
General parameters and dimensions

MV, MVS

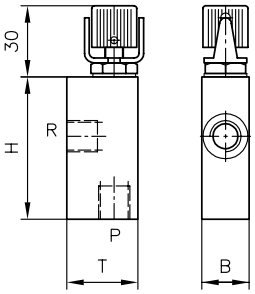




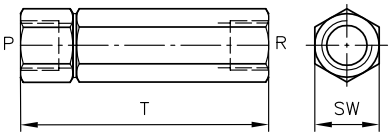
DMV



MVG



SV, SVC



See following table for dimensions

	Size	Dimensions [mm]			m [kg]	Size	Pressure range/ Flow	Ports[1)]
		H_{max}	B/SW	T_{max}				
MV, MVS, MVCS, MVE	4	126	24	48	0.3	4	F: 80/20 E: 160/20 C: 315/20 B: 500/20 A: 700/12	G 1/4, G 3/8
	5	142	29	60	0.4			
	6	164	36	70	0.7			
	8	208	40	60	2.0			
DMV	4	107	40	52	0.7	5	F: 80/40 E: 160/40 C: 315/40 B: 500/40 A: 700/20	G 3/8, G 1/2
	5	123	50	65	1.3			
	6	142.5	60	75	1.8			
	8	192	80	96	4.5			
MVP	4	102	28	35	0.3	6	F: 80/75 E: 160/75 C: 315/75 B: 500/75 A: 700/40	G 1/2 G 3/4
	5	113	32	40	0.5			
	6	133	35	50	0.8			
	8	172	50	60	1.6			
	13, 14	82	29	50	0.3	8	E: 160/160 C: 315/160 Bi: 500/160 A: 700/75	G 3/4, G 1
MVE	13, 14	75	SW 27	-	0.1			
MVG, MVGC	13, 14	94	20	42	0.3	13	H: 700/5	G 1/4
SV, SVC	4	-	SW 22	87	0.2	14	N: 50/8 M: 200/8 H: 400/8	G 1/4
	5	-	SW 27	108	0.4			
	6	-	SW 32	132	0.9			
SV	8	-	SW 41	157	0.9			

1) For pipe connection versions only

Associated technical data sheets:

- Pressure-limiting valve type MV, SV and DMV: D 7000/1
- Pressure-limiting valve and pre-load valve type MVG, MVE and MVP: D 3726
- Pressure-limiting valve (installation kit) type MV: D 7000 E/1
- Multiple pressure-limiting valve type MV: D 7000 M
- Pressure-limiting valve, with unit approval type MV .X: D 7000 TUV

Similar products:

- Pressure control valves for screwing in type CMV, CSV: Page 166
- Pilot-controlled pressure control valves type DV: Page 168
- Pilot-controlled pressure control valves type A: Page 168

Pressure valves

2.3 Pressure control valve type CMV, CMVZ, CSV and CSVZ

Pressure-limiting valves and sequence valves are types of pressure control valves. Pressure-limiting valves safeguard the system against excessive system pressure or limit the operation pressure. Sequence valves generate a constant pressure difference between the inlet and outlet flow.

Type CMV and CSV is a directly controlled valve that is damped as standard. Versions that correspond to the Pressure Equipment Directive are also available. Type CMVZ and CSVZ is not influenced by the pressure conditions downstream and is therefore suitable for use in loss-free sequence control systems.

Valve type CMV and CSV can be screwed-in and can be integrated into control blocks. The necessary mounting holes are straightforward to make.

Features and benefits:

- Operating pressures up to 500 bar
- Various adjustment options
- Easily produced mounting hole

Intended applications:

- General hydraulic systems
- Test benches
- Hydraulic tools

Nomen-clature:	▪ Pressure-limiting valve ▪ Sequence valve (directly controlled)
Design:	Screw-in valve
Adjustment:	▪ Tool adjustable (fixed) ▪ Manually (adjustable)
p_{max}:	500 bar
Q_{max}:	60 l/min

Design and order coding example

CMV 3 | F | R | - 200 | - 1/4

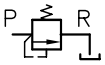
- **- 1/4** — **Single connection block for pipe connection**
- **- 200** — **Pressure setting [bar]**
- **R** — **Adjustability (while pressurized)** fixed or manually adjustable
- **F** — **Pressure range** Pressure ranges B, C, E and F
- **CMV 3** — **Basic type, size** Type CMV (pressure limiting valve), size 1 to 3
Type CSV (pressure difference valve), size 2 to 3

Additional versions:

- Sequence valves CMVZ or CSVZ
- Version with unit approval type CMVX
- Undamped version (CMV)

Function

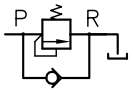
CMV



Pressure limiting valve (port R pressure resistant)

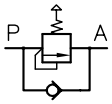
CMVZ

CSV



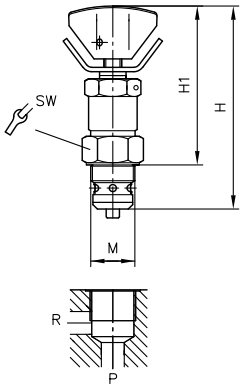
Sequence valves with by-pass check valve

CSVZ

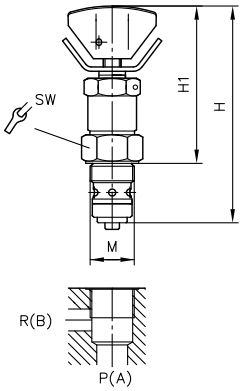


General parameters and dimensions

CMV/CMVZ



CSV/CSVZ



	Size	Q_{max} [lpm]	Pressure range p_{max} [bar]	M	SW = a/f	Dimensions [mm]		m [g]
						H_{max}	$H1_{max}$	
CMV, CMVZ	1	20	F: 80 E: 160 C: 315 B: 500	M 16 x 1.5	SW 22	78	57	90
	2	40		M 20 x 1.5	SW 24	94	72	160
	3	60		M 24 x 1.5	SW 30	114	83	275
CSV, CSVZ	2	40		M 20 x 1.5	SW 24	104	73	150
	3	60		M 24 x 1.5	SW 30	122	82	300

Associated technical data sheets:

- Pressure control valve type CMV, CMVZ, CSV and CSVZ: D 7710 MV
- Safety valve with unit approval type CMVX: D 7710 TUV

Similar products:

- Pressure-limiting valves type MV, SV etc.: Page 162
- Miniature pressure-limiting valves type MVG etc.:Page 162
- Pilot-controlled pressure control valves type DV: Page 168
- Pilot-controlled pressure control valves type AS: Page 168

Pressure valves

2.3 Pressure-limiting valve, pilot-controlled type DV, AS etc.

Pressure-limiting valves are a type of pressure control valve. They safeguard the system against excessive system pressure or limit the operation pressure.
The pressure-limiting valve type DV and AS is pilot-controlled. Type AS also has an additional check valve in the consumer port.

Features and benefits:
- Various adjustment options
- Various additional functions

Intended applications:
- General hydraulic systems
- Test benches

Nomen-clature:	**Pressure-limiting valve Sequence valve Switch-off/release valve (pilot-controlled)**
Design:	**Single valve for pipe connection Individual valve for manifold mounting**
Adjustment:	**Tool adjustable (fixed) Manually (adjustable)**
p_{max}:	**420 bar**
Q_{max}:	**120 l/min**

Design and order coding example

DV3	G	H	R	- WN 1F- 24	- 200

Pressure setting [bar]

2/2-way directional seated valve Optionally with mounted 2/2-way directional seated valve for arbitrary idle circulation

Adjustability in operation fixed or manually adjustable (R)
- Various actuations for the pilot valve: ball head for controls via cam, lever etc. (type DV, DVE)

Pressure range
- N: 2 to 100 bar
- H: 5 to 420 bar

Line connection Pipe connection or manifold mounting

Basic type, size Type DV (internal control oil drain),
Type DVE (external control oil drain),
Type DF (valve for remote control), size 3 to 5
Type AS (additional check valve), size 3 to 5
Type AE (release valve), size 3 to 5

Additional versions:
- Additional switching combinations with the types AS and AE

Function

DV

Pressure limiting, sequence valve

DVE

Follow-up valve

DF

Pressure limiting, sequence valve, follow-up valve or 2/2-way directional valve (remote controlled, depending on the kind of valve connected to port X)

AS

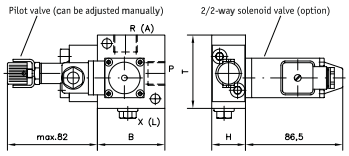
Pressure limiting valve

AE

Release valve (remote controlled), combined function as pressure limiting valve possible (type ASE)

General parameters and dimensions

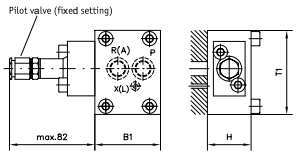
DV .. G



1 Pilot valve (can be adjusted manually)

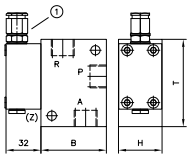
2 2/2-way solenoid valve (option)

DV .. P



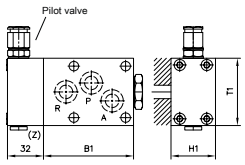
1 Pilot valve (fixed)

AS .. G



1 Pilot valve

AS .. P



1 Pilot valve

Type, size	Q_{max} [lpm]	Pressure range: p_{max} [bar]	Ports	Dimensions [mm]					m [kg]
DV, DVE, DF				H	B	B1	T	T1	
3	50	N: 100 H: 420	G 1/2	30	60	-	66	-	1,1 / -
4	80		G 3/4	40	65	60	71	78	1,5 / 2,0
5	120		G 1	50	80	88	73	81	2,0 / 2,5

Type, size	Q_{max} [lpm]	Pressure range: p_{max} [bar]	Ports	Dimensions [mm]						m [kg][1)]
AS, ASE, AE				H	H1	B	B1	T	T1	
3	50	M: 200 H: 350/300 (type AE)	G 1/2	40	-	60	-	80	-	1,8
4	80		G 3/4	40	40	70	80	94	60	2,2
5	120		G 1	6,3	40	100	94	85	80	4,1

1) Versions for pipe connection/manifold mounting (with installed solenoid valve + 0.6 kg)

Associated technical data sheets:

- Pressure-limiting valve, pilot-controlled type DV, DVE and DF: D 4350
- Pressure valve with check valve type AL, AE and AS: D 6170

Similar products:

- Pressure-limiting valves type MV, SV etc.: Page 162
- Miniature pressure-limiting valves type MVG etc.: Page 162
- Pressure-limiting valves type CMV(Z): Page 166

Pressure valves

2.3 Sequence valves with check valve type VR

Pre-load valves, also called sequence valves are a type of pressure control valve. They generate a largely constant pressure drop between the inlet and outlet on the valve. In the opposite direction the flow can pass freely. In the normal position the valve has minor leakage.

The sequence valve type VR is available as a screw-in valve and in a housing version for in-line installation.

The primary application area is in return lines for oscillation damping, mainly in lifting equipment, lifting platforms, handling systems and in lifting gantries as fall protection.

Features and benefits:

- Compact screw-in valve

Intended applications:

- Lifting equipment
- Lifting platforms
- Handling technology

Nomen-clature:	**Sequence valve**
Design:	**Screw-in valve Combination with housing for pipe connection**
Adjustment:	**Fixed (non-adjustable)**
p_{max}: Δp_{max}:	**315 bar 15 bar**
Q_{max}:	**120 l/min**

Design and order coding example

VR 3 | 3 | C

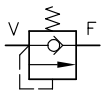
Design with housing
- Cartridge valve
- Versions with housing for pipe connection
- Design with metric fine thread

Pre-load pressure Open-up pressure Δp_{max} 3 to 15 bar

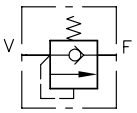
Basic type, size Type VR, size 1 to 4

Function

VR



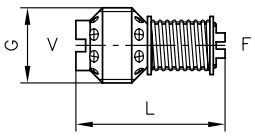
Screw-in valve



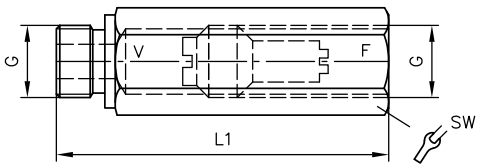
Version with housing for pipe connection

General parameters and dimensions

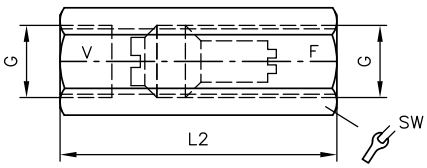
VR 3 3 C
Insert valve



VR 4 9 E
Version with housing



VR 1 15 G
Version with housing



	Q_{max} [lpm]	Δp_{max} [bar] [1]	Dimensions [mm]					m [g][2]
			G (BSPP)	L	L1	L2	SW = a/f	
VR 1	15	3, 5, 7, 9, 12, 15	G 1/4 (A)	31	78	66	SW 19	15/120
VR 2	40	3, 5, 7, 9, 12, 15	G 3/8 (A)	36	82	70	SW 22	25/160
VR 3	65	3, 5, 7, 9, 12	G 1/2 (A)	42	96	80	SW 27	40/270
VR 4	120	3, 5, 7, 9, 12	G 3/4 (A)	54	106	100	SW 32	80/400

1) The selected pre-load pressure e.g. opening pressure cannot beltered
2) Individual valve/design with housing

Associated technical data sheets:

- Pre-load check valve type VR: D 7340

Similar products:

- Pressure-limiting valves type MV, SV etc.: Page 162
- Miniature pressure-limiting valves type MVG etc.: Page 162
- Pilot-controlled pressure control valves type DV: Page 168
- Pressure-limiting valves type CMV: Page 166

2.3 Proportional pressure-limiting valve type PMV and PDV

Proportional pressure-limiting valves are a type of pressure control valve. They remotely control the pressure in hydraulic systems continuously and electrically.
The pressure-limiting valve type PMV is a directly actuated valve in a spring-loaded ball version. The pressure can be set to up to 700 bar. The pressure-limiting valve type PDV is a pilot valve in a piston version, where pressures up to 350 bar can be set. The pressure-limiting valve type PMV and PDV is available as a single valve for pipe connection or as a manifold mounting valve.
The proportional pressure-limiting valve is particularly suitable for maximum pressure limitation in hydraulic systems.

Features and benefits:
- Max. operating pressure 700 bar
- Precise control

Intended applications:
- General hydraulics
- Test benches
- Mining machinery

Nomen-clature:	**Prop. pressure-limiting valve (directly controlled or piloted)**
Design:	**Individual valve for pipe connection Individual valve Manifold mounting**
Adjustment:	**Electro-proportional**
p_{max}:	**700 bar**
Q_{max}:	**120 l/min**

Design and order coding example

PDV4G PMVP4	**H - 44**	**- G24 - G24**

Solenoid voltage — Prop. solenoid
- 12V DC, 24V DC
- Control using proportional amplifier or PLVC

Pressure range [bar]

Basic type, port size, size — Type PMV (pipe connection), type PMVP (manifold mounting)
- Optionally with separate control oil supply, i.e. pressure reduction right above 0 bar, zero-leakage in the main pump circuit (type PMVS, PMVPS)

Type PDV.G (pipe connection), type PDV.P (manifold mounting)
- Additionally with 2/2-way solenoid valves for arbitrary idle circulation

Function

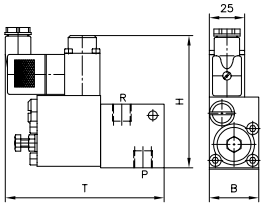
PMV, PDV

Pipe connection

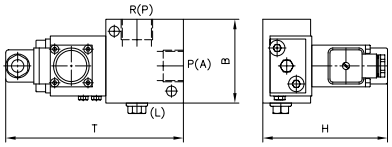
Manifold mounting valve

General parameters and dimensions

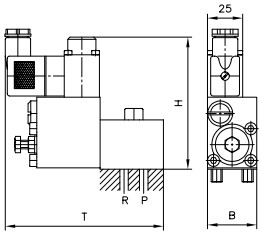
PMV



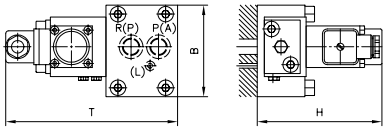
PDV..G



PMVP



PDV..P



	Size	Q_{max} [lpm]	Pressure range p_{max} [bar]	Ports [1]	Dimensions [mm]			m [kg]
					H	B	T	
PMV/PMVP	4	16	41: 180 42: 290 43: 440 44: 700	G 1/4, G 3/8	97/95	35	135	1,2 / 1,1
	5	60	41: 110 42: 180 43: 270 44: 450	G 1/4, G 3/8, G 1/2	98/95	35/40	140	1.2
	6	75	41: 80 42: 130 43: 190 44: 320	G 3/8, G 1/2, G 3/4	102/95	40/50	150/140	1,5/1,3
	8	120	41: 45 42: 70 43: 110 44: 180	G 3/4, G 1	107/97	45/60	160/150	1,9/1,7
PDV.G/PDV.P	3	40	N: 130 M: 200 H: 350	G 1/2	96	66	150	1.8
	4	80		G 3/4	99.5	71/78	155/150	2,2/2,7
	5	120		G 1	104.5	73/81	170/178	2.7/3.2

1) For pipe connection versions only

Associated technical data sheets:

- Proportional pressure-limiting valve type PMV and PMVP: D 7485/1
- Proportional pressure-limiting valve type PDV and PDM: D 7486
- Proportional pressure-limiting valve type NPMVP: D 7485 N
- Intermediate plate type NZP: D 7788 Z

Suitable accessories:

- Proportional amplifier type EV1M3: Page 272
- Proportional amplifier type EV2S: "CAN-IO, EV2S-CAN"
- Proportional amplifier type EV1D: Page 272

2.3 Pressure-reducing valve type ADC, ADM, ADME and AM

Pressure reducing valves are a type of pressure control valve. They maintain a largely constant outlet pressure even at a variable (higher) inlet pressure.
The pressure reducing valve type ADC and AM is suitable for the supply of control circuits with low oil consumption. These valves feature an override compensation, i.e. acting like a pressure-limiting valve if the secondary pressure exceeds the set pressure e.g. due to external forces. There is a design-related leakage flow.

Features and benefits:
- Compact design
- Numerous configurations

Intended applications:
- For control oil supply in pilot circuits

Nomen-clature:	Pressure reducing valve
Design:	Screw-in valve Valve for pipe connection
Adjustment:	Fixed (non-adjustable)
$p_{max\ P}$:	400 bar
$p_{max\ A}$:	100 bar
Q_{max}:	10 lpm

Design and order coding example

ADC 1 - 25 - 1/4

Design
- Cartridge valve
- Design with housing for direct pipe connection
- Version with housing for manifold mounting (type AM 11)

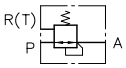
Pressure downstream Pressure at port A [bar]

Basic type Type ADC, AM
Type ADM, ADME
- Type ADM 1 adjustable version available

Function

ADC, AM, ADM, ADME

Screw-in valve



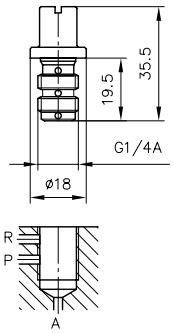
Pipe installation

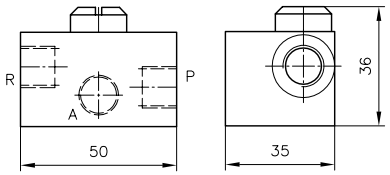
ADC 1 - 25
Pressure reducing valve type ADC 1 as screw-in valve, pressure at A (on the consumer side) approx. 25 bar

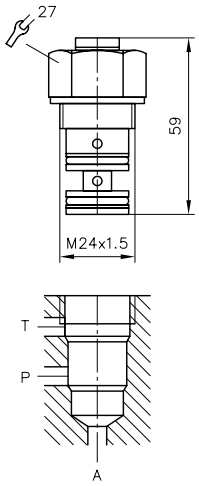
AM 1 - 20 - 1/4
Pressure reducing valve type AM 1, version for pipe connection (threaded connections G 1/4), pressure at A (on the consumer side) approx. 20 bar

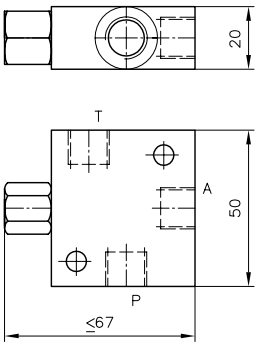
ADME 1 - ...

ADM 1 - 70
Pressure reducing valve type ADM 1, version for pipe connection, pressure at A (on the consumer side) approx. 70 bar









	Q_{max} [lpm]	p_{max} [bar]	Outlet pressure [bar] at A	Ports [1]	m_{max} [kg]	
					Screw-in valve	Pipe installation
ADC 1	2	300	15, 25	G 1/4	0.03	0.32
AM 1	2	400	20, 30, 40, 100	G 1/4	0.03	0.3
ADM 1	8 ... 10	300	15, 20, 30, 70	G 1/4	-	0.34
ADME	8	300	15, 20, 30	-	0.05	-

1) In version for pipe connection only

Associated technical data sheets:
- Pressure-reducing valve type ADC, ADM, ADME and AM: D 7458

Similar products:
- Pressure reducing valves type ADM, VDM: Page 176
- Pressure reducing valves type CDK: Page 180
- Prop. pressure reducing valves type PDM: Page 186
- Miniature prop. pressure reducing valves type PM, PMZ: Page 184

Pressure valves

2.3 Pressure-reducing valve type ADM and VDM

Pressure reducing valves are a type of pressure control valve. They maintain a largely constant outlet pressure even at a variable (higher) inlet pressure.
The pressure reducing valve type ADM is directly controlled, the type VDM is hydraulically pilot-controlled. These valves feature an override compensation, i.e. acting like a pressure-limiting valve if the secondary pressure exceeds the set pressure e.g. due to external forces. There is a design-related leakage flow.

Features and benefits:

- With safety valve function
- Various adjustment options
- Various additional functions

Intended applications:

- General hydraulics
- Jigs
- Test benches

Nomen-clature:	**Pressure reducing valve (directly-controlled or pilot-controlled)**
Design:	**Single valve for pipe connection Individual valve for manifold mounting**
Adjustment:	**Tool adjustable (fixed) Manually (adjustable)**
$p_{max\ P}$:	**400 bar**
$p_{max\ A}$:	**300 bar**
Q_{max}:	**120 l/min**

Design and order coding example

ADM 22 D R - 250

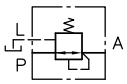
- **Pressure setting [bar]**
- **Adjustability in operation**
  - Fixed (-)
  - Manually adjustable (R)
  - Adjustable with turn knob (self-locking -V/lockable -H)
- **Pressure range** Pressure ranges for outlet pressure at A
- **Basic type, size** Type ADM (non-piloted), size 1 to 3

VDM 5 H R - 250

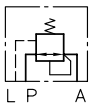
- **Pressure setting [bar]**
- **Adjustability in operation**
  - Fixed (-)
  - Manually adjustable (R)
- **Pressure range** Pressure ranges for outlet pressure at A
- **Basic type, size** Type VDM (hydraulically piloted), size 3 to 5
  - Hydraulically piloted pressure-reducing valve type VDX (pressure-limiting valve at port L)

Function

ADM..

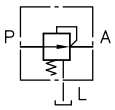


Valve for pipe connection

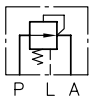


Manifold mounting valve

VDM..



Valve for pipe connection

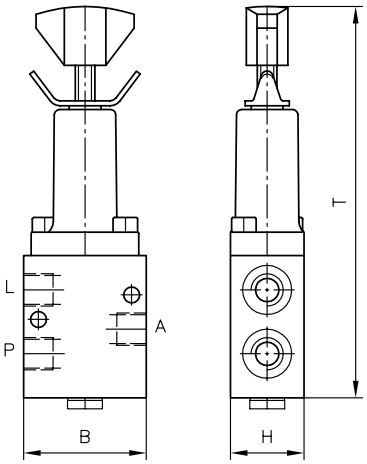


Manifold mounting valve

General parameters and dimensions

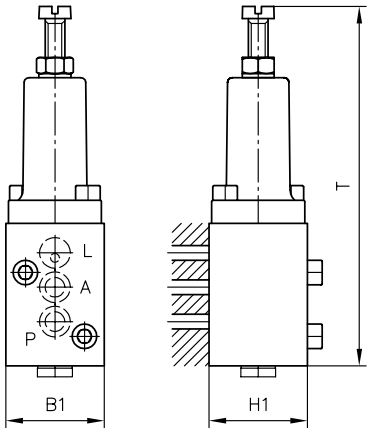
ADM 22 DR

Version for pipe connection
Directly controlled pressure reducing valve type ADM, size 2
for pipe connection
(threaded connections G 3/8, coding 2),
pressure range 30 to 120 bar (coding D),
manually adjustable pressure (coding R)

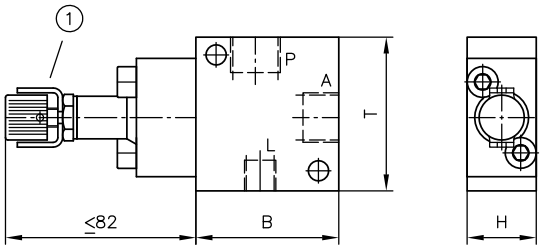


ADM...P

Version as manifold mounting valve

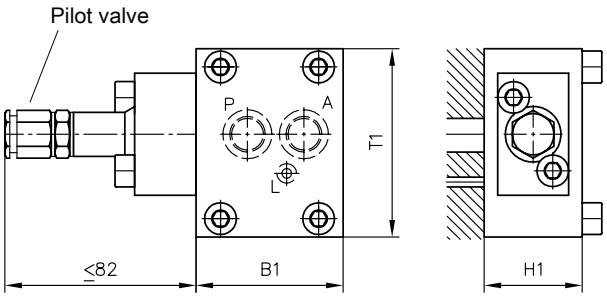


VDM...G
Version for pipe connection



1 Pilot valve

VDM 5 PH - 250
Version as manifold mounting valve
Pilot-controlled pressure reducing valve type VDM, size 5
for manifold mounting (coding P),
pressure range 10 to 400 bar (coding H),
pressure fixed at 250 bar



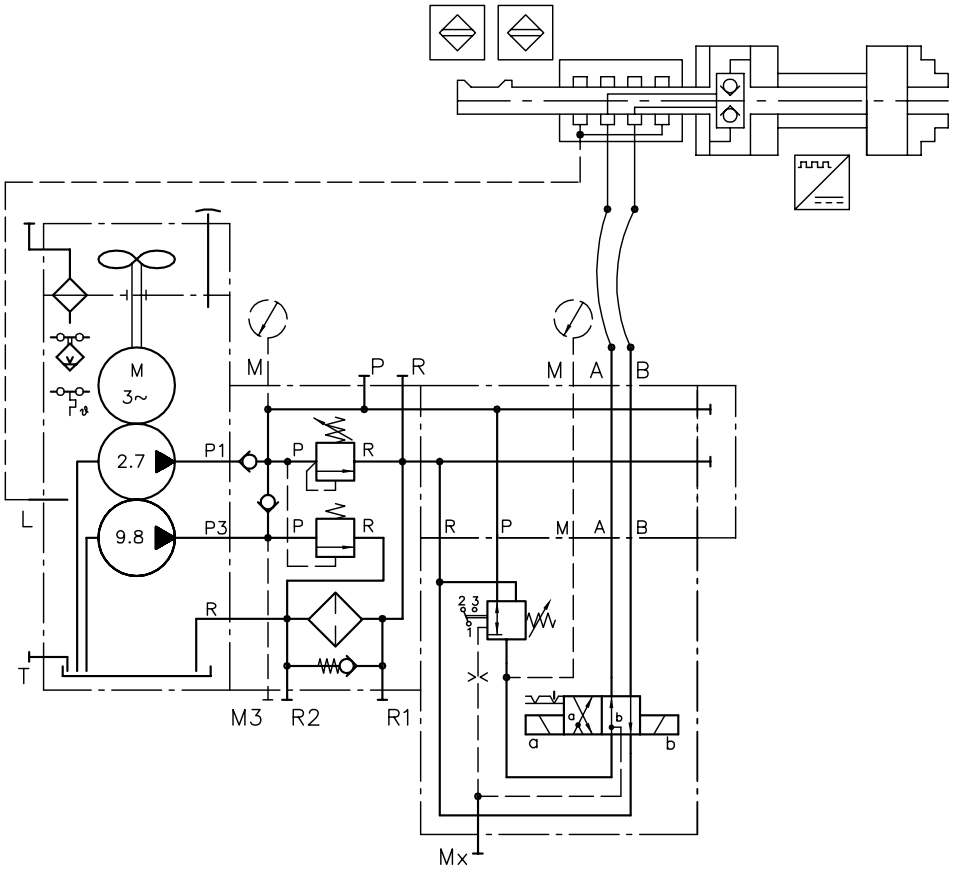
1 Pilot valve

	Q_{max} [lpm]	p_{max} [bar]	$p_{max\ A}$ [bar]	Ports [2]	Leakage flow Q_{leak} [lpm]	Dimensions [mm]						m_{max} [kg] [3]
						H	H1	B	B1	T	T1	
ADM 1...	12	300	F: 30 D: 120 C: 160 A: 250	G 1/4	<0.05	30	35	45	35	141	-	0.6/0.6
ADM 2..	25			G 1/4, G 3/8	<0.05	30	40	50	40	162	-	0.7/0.85
ADM 3..	60		F: 25 D: 100 C: 160 A: 250	G 3/8, G 1/2	<0.07	30	40	50	40	174	-	1.0/1.1
VDM 3..	40	400	N: 100 H: 400[1]	G 1/2	<0.4	30	-	60	-	66	-	1.1/--
VDM 4..	70			G 3/4		40	40	65	60	71	78	1.5/2.0
VDM 5..	120			G 1		50	50	80	88	73	81	2.0/2.5

1) Max. pressure difference between inlet and outlet pressure is 300 bar
2) For pipe connection versions only
3) Versions for pipe connection / manifold mounting

Circuit example:

HK 43 LDT/1 M - ZZ 2.7/9.8
-AN 21 F 2-D45-F50
-BA 2
-NSMD 2 K/GRK/0
-1-G 24



Associated technical data sheets:

- Pressure-reducing valve type ADM: D 7120
- Pressure-reducing valve, pilot-controlled type VDM: D 5579

Similar products:

- Miniature pressure reducing valves type ADC etc.: Page 174
- Miniature prop. pressure reducing valves type PM, PMZ: Page 184
- Pressure reducing valves type CDK: Page 180
- Prop. pressure reducing valves type PDM: Page 186

2.3 Pressure-reducing valve type CDK, CLK, DK, DLZ and DZ

Pressure reducing valves are a type of pressure control valve. They maintain a largely constant outlet pressure even at a variable (higher) inlet pressure.
The pressure reducing valve type CLK features an override compensation, i.e. acting like a pressure-limiting valve if the secondary pressure exceeds the set pressure e.g. due to external forces. The pressure reducing valve type DK features a tracked pressure switch, e.g. pressure and switch are set simultaneously with an adjustment device.
All versions have zero leakage when in the closed state. The valve type CDK and CLK can be screwed-in and can be integrated into control blocks. The necessary mounting holes are straightforward to make.

Features and benefits:

- Zero leakage in closed state

Intended applications:

- General hydraulic systems
- Jigs
- Test benches

Nomen-clature:	Pressure reducing valve (2-way valve)
Design:	Screw-in valve combination with a connection block for ▪ Pipe connection ▪ Manifold mounting
Adjustment:	Fixed Manually (adjustable)
p_{max}:	500 bar
Q_{max}:	22 l/min

Design and order coding example

CDK 3 -2 | R | - 250

- **Pressure setting [bar]**
- **Adjustment**
  - Fixed (-)
  - Manually adjustable (R)
  - Adjustable with turn knob (self-locking -V/lockable -H)
- **Basic type and pressure range** — Type CDK, type CLK (with additional override compensation)
  - Screw-in valve
  - Version with connection block for pipe connection with/without pressure-limiting valve
  - Version with connection block for manifold mounting with/without pressure-limiting valve
  - In intermediate plate design NG6 (type NZP)

DK 2	R	/160	/4R

Additional elements Orifice/throttle

Pressure setting [bar]

Adjustment
- Fixed (-)
- Manually adjustable (R)
- Adjustable with turn knob (self-locking -V/lockable -H)

Basic type and pressure range Type DK (with tracked pressure switch)
Type DZ with type CDK
Type DLZ with type CLK
- With bypass check valve
- Manifold mounting
- Version with connection block for pipe connection

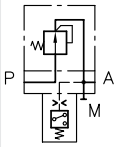
Function

CDK

Screw-in valve

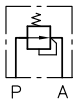
CLK

CDK 3. -..-1/4-DG3.



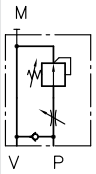
Version for pipe connection, a pressure switch type DG 3. May be installed as option, additional port for pressure gauge

CDK 3. -..-P



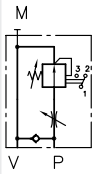
Manifold mounting valve

DZ, DLZ



Manifold mounting valve, optional with orifice/throttle and bypass check valve

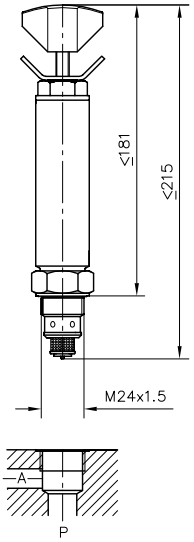
DK



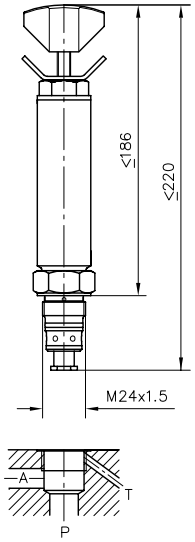
Manifold mounting valve with tracked pressure switch

General parameters and dimensions

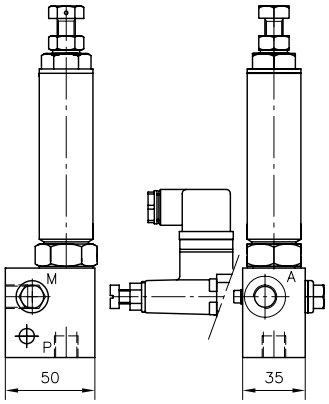
CDK 3..



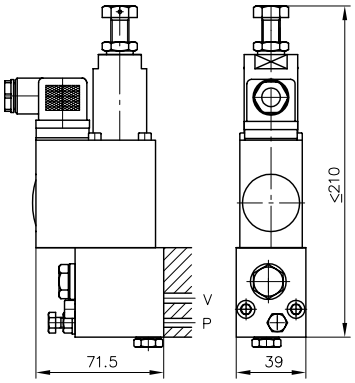
CLK 3..



CDK 3. -..-1/4-DG3.



DK 2.

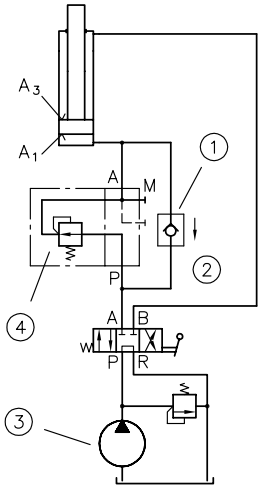


	Q_{max}[lpm]	Pressure range p_{max} [bar]		Ports (BSPP)	m [kg]
CDK 3.-..., CLK 3.-...	6... 22	**..-08:**450[1)]	**..-2:**200 ..	-	0.7
CDK 3. -..-1/4-DG3.		**..-081:**500[1)]	**..-21:**250 ..	G1/4	1.25
CDK 3. -..-P		**..-1:**300 ..	**..-5:**130 ..	-	1.4
DZ..., DLZ..., DK...		**..-11:**380 ..	**..-51:**165	-	

1) Only available as type CDK and DK

Circuit examples

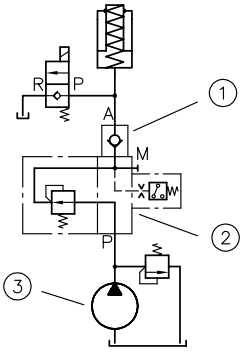
Example of a version
with large flow rate $Q_{A \rightarrow P}$
Example: Q_P = 15 lpm [formula]



Application example for large flow rate

1 E.g. type RK 2G in accordance with D 7445
2 Q_{return} = 45 lpm
3 Q_P = 15 lpm
4 Type CDK 3-2-1/4

Example of a version
with undesired return flow

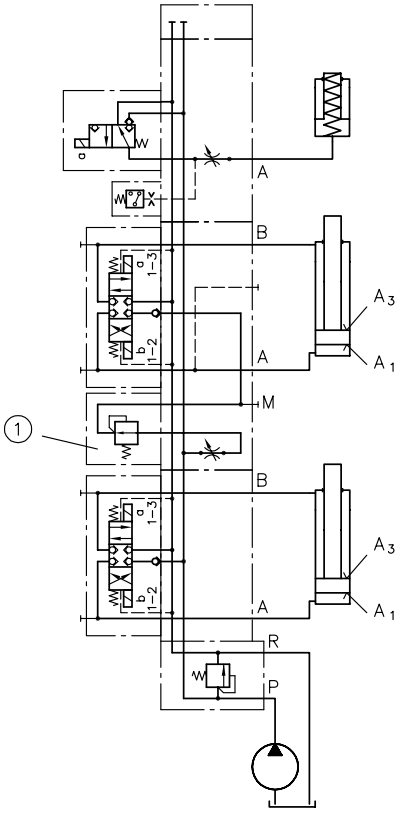


Application example for undesired return flow

1 E.g. type RK 1E in accordance with D 7445
(shown here screwed into connection A of the CDK 3 valve)
2 Type CDK 3- 2-1/4-DG 34

Use in the valve bank,
shown here with seated valves type BVZP 1

BVZP 1 A - 1/300 - G22/0
- G22/CZ2/100/4/2
- WN1H/10/4
- 1 - 1 - G 24



Application example in the valve bank

1 Type CDK 3-2-100 shown here incorporated as
-/CZ 2/100...

Associated technical data sheets:
- Pressure-reducing valve type CDK: D 7745
- Pressure-reducing valve type CLK: D 7745 L
- Pressure-reducing valve type DK, DZ and DLZ: D 7941

Similar products:
- Pressure reducing valves type ADM, VDM, VDX: Page 176
- Miniature pressure reducing valves type ADC etc.: Page 174
- Prop. pressure reducing valves type PDM: Page 186

Intermediate plates:
- Intermediate plate type NZP: D 7788 Z

Accessories:
- Pressure switches type DG 3., DG 5 E: Page 262

2.3 Proportional pressure-reducing valve type PM and PMZ

Proportional pressure-reducing valves are a type of pressure control valve. They remotely control the pressure in hydraulic systems continually and electrically.
The proportional pressure-reducing valve type PM and PMZ is a directly actuated valve with a piston and is controlled electro-proportionally. It continuously maintains a constant pressure on the secondary pressure side, independently of the inlet side. The proportional pressure-reducing valve type PM is available as a single valve. The proportional pressure-reducing valve type PMZ is a twin valve.
The proportional pressure-reducing valve type PM and PMZ is particularly suitable for use as a pilot valve for actuators.

Features and benefits:

- Compact design
- Numerous configurations
- Explosion-proof versions

Intended applications:

- For control oil supply in pilot circuits

Nomen-clature:	Prop. pressure reducing valve
Design:	Assembly kit Individual valve Manifold mounting
Adjustment:	Electro-proportional
$p_{max\ P}$:	40 bar
$p_{max\ A}$:	30 bar
Q_{max}:	2 l/min

Design and order coding example

PM 1 - 11 B 0,6 - G24 - NBR

Seals Different materials NGR, FKM, EPDM

Solenoid voltage Prop. solenoid

- 12V DC, 24V DC
- Control using proportional amplifier or PLVC
  Type PMZ also in an explosion-proof version

Additional elements

- Orifice for oscillation damping in A and B
- Return pressure stop in R

Prop. adjustable nominal pressure difference [bar]

Basic type Type PM
Type PMZ

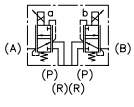
- Assembly kit (type PM 1, PMZ 01, PMZ 11)
- For manifold mounting (type PM 11, PM 12)
- Version in valve bank (type PMZ) with up to 10 prop. pressure-reducing valve sections

Function

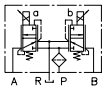
PM 1

PM 11

PMZ 1

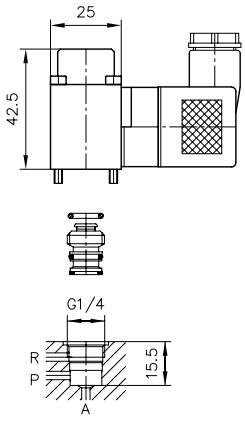


PM 12

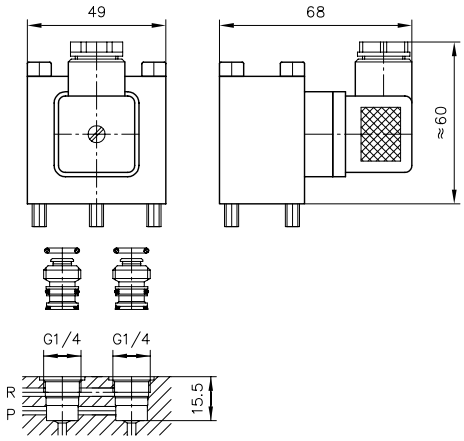


General parameters and dimensions

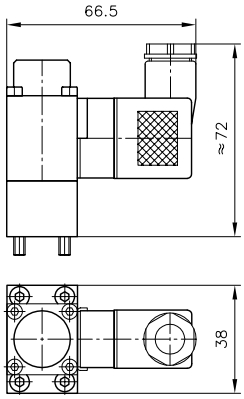
PM 1



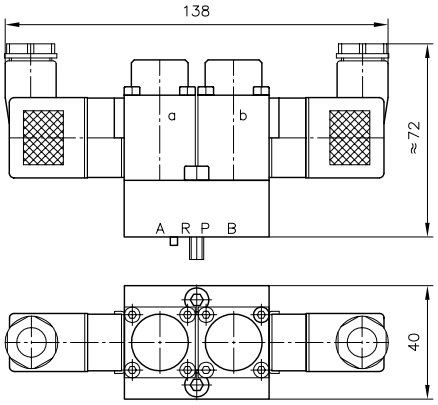
PMZ 1



PM 11



PM 12



	Design		Pressure range (prop. adjustable nom. pressure difference $\Delta p = p_A - p_R$) [bar]
PM 1	Assembly kit	Individual valve	0 ... 30
PMZ 1, PMZ 01		Twin valve	0 ... 30
PM 11	Valve for manifold mounting	Individual valve	0 ... 30
PM 12		Twin valve	0 ... 30

Associated technical data sheets:

- Proportional pressure-reducing valve type PM and PMZ: D 7625

Similar products:

- , Proportional pressure-reducing valve type PDM: Page 186

Suitable accessories:

- Proportional amplifier type EV1M3: Page 272
- Proportional amplifier type EV2S: Page 274
- Proportional amplifier type EV1D: Page 272

2.3 Proportional pressure-reducing valve type PDM

Proportional pressure-reducing valves are a type of pressure control valve. They remotely control the pressure in hydraulic systems continually and electrically.
The proportional pressure-reducing valve type PDM is a piloted valve with a piston and is controlled electro-proportionally. The valve has an external control oil drain. It continuously maintains a constant pressure on the secondary pressure side, independently of the inlet side. The pressure reducing valve is available as a single valve for pipe connection or as a manifold mounting valve.
The proportional pressure-reducing valve PDM is particularly suitable for dynamic control of the pressure level in hydraulic systems.

Features and benefits:
- Integrated overpressure function

Intended applications:
- General hydraulic systems
- Equipment
- Test benches
- Hydraulic tools

Nomen-clature:	Prop. pressure-reducing valve (directly controlled or piloted)
Design:	Individual valve for pipe connection Individual valve Manifold mounting
Adjustment:	Electro-proportional
$p_{max\ P}$:	400 bar
$p_{max\ A}$:	350 bar
Q_{max}:	120 l/min

Design and order coding example

PDMP 2 PDM 4 G	- 43	- G24

Solenoid voltage — Prop. solenoid
- 12V DC, 24V DC
- Control using proportional amplifier or PLVC

Pressure range — Pressure ranges for pressure downstream at A

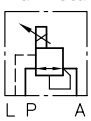
Basic type, size, design — Type PDM (pipe connection), size 11, 21, 22
Type PDMP (manifold mounting), size 11, 22
Type PDM, size 3 to 5
Pipe connection (G), manifold mounting (P)

Function

PDM

Valve for pipe connection:

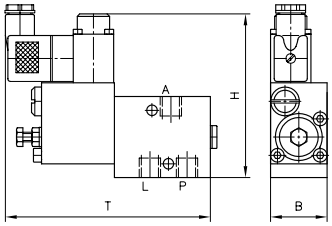
Manifold mounting valve:



General parameters and dimensions

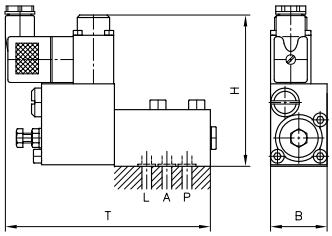
PDM 11, PDM 21, PDM 22

Valve for pipe connection

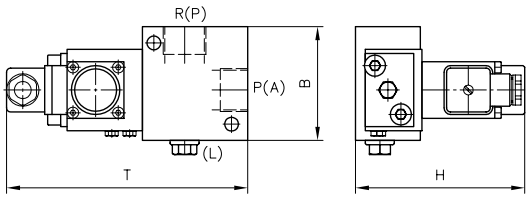


PDMP 11 and PDMP 22

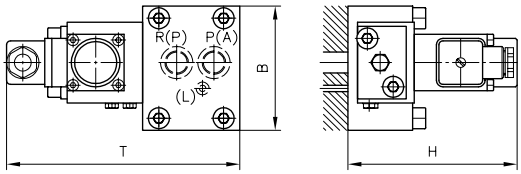
Manifold mounting valve



PDM 3 to 5



PDM 4P and PDM 5P



		Q_{max} [lpm]	Pressure range $p_{max\ A}$ [bar]	Ports [1]	Leakage flow Q_{leak} [lpm]	Dimensions [mm]			m [kg]
						H	B	T	
PDM 11	Directly controlled	12	41: 80 42: 130 43: 200 44: 320	G 1/4	< 0.5	101	33	150	1.5
PDMP 11				-		93,5	35	150	1.4
PDM 21/22		20	41: 45 42: 70 43: 110 44: 180	G 1/4, G 3/8	< 0.5	101	38	157	1.6
PDMP 22				-		96	40	157	1.3
PDM 3 G	Piloted	40	N: 130 M: 200 H: 350	G 1/2	< 0.8	100	65	150	1.8
PDM 4 G		80		G 3/4		99.5	71	155	2.2
PDM 5 G		120		G 1		104.5	73	170	2.7
PDM 4 P		80		-	-	99.5	78	150	2.7
PDM 5 P		120		-	-	104.5	81	178	3.2

1) For pipe connection versions

Associated technical data sheets:

- Prop. pressure reducing valves type PDM: D 7486, D 7584/1

Similar products:

- , Proportional pressure-reducing valve type PM and PMZ: Page 184

Suitable accessories:

- Proportional amplifier type EV1M3: Page 272
- Proportional amplifier type EV2S: Page 274
- Proportional amplifier type EV1D: Page 272

2.3 Proportional pressure-reducing valve type KFB and FB

Proportional pressure-reducing valves are a type of pressure control valve. They manually and continuously operate hydraulic actuators at a distance.
The proportional pressure-reducing valve type FB is available as a single valve for pipe connection. Type KFB is a valve bank and combines several valves.
The proportional pressure-reducing valve type FB and KFB is primarily used for remote control of the directional spool valve type PSL or PSV.

Features and benefits:
- Sturdy design
- Precise control

Intended applications:
- For control oil supply in pilot circuits

Additional versions:
- With UNF thread

Nomen-clature:	**Proportional pressure-reducing valve Hydraulic joystick**
Design:	**Single valve / Valve bank in pipe connection**
p_{max}:	**30 bar**
Q_{max}:	**2 l/min**

Design and order coding example

KFB01 | A | /19 | /F | 1

Additional elements for actuation — Without labelling - with hand lever
1 - Without hand lever
005 - with hand lever bent at an angle of 5°
015 - With hand lever bent at an angle of 15°
025 - With hand lever bent at an angle of 25°
030 - With hand lever bent at an angle of 30°

Manual operation — F - manual operation with return spring
FC - detent

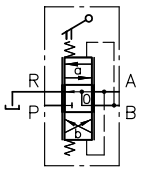
Pressure range of prop. pressure-reducing valve — Pressure ranges
4; 5.5; 7; 9; 11; 14; 19; 30

Valve sections — A - Front section
M - Middle section
E - End section

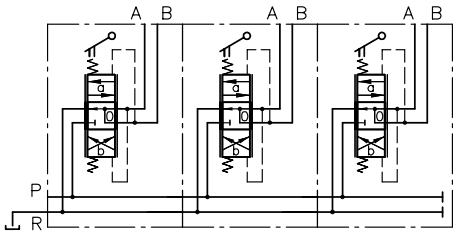
Basic type, size — Type KFB (valve bank)
Type FB (single valve)

Function

Single valve

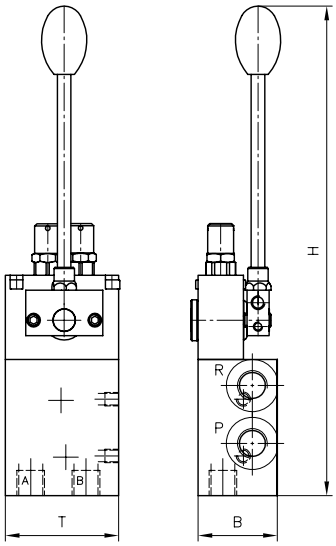


Valve bank

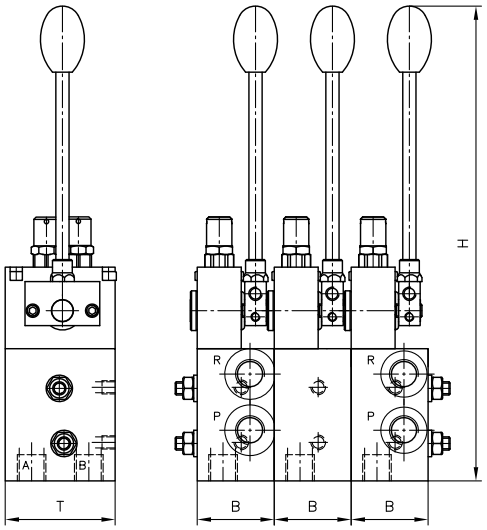


General parameters and dimensions

FB 01



KFB 01



	Q_{max} [lpm]	Pressure range p_{max} [bar]	Ports	Dimensions [mm]		
				H	B	T
FB 01	2	30	G 1/4	215	35	50
KFB 01	2	30	G 1/4	215	35	50

Associated technical data sheets:

- Proportional pressure-reducing valve type KFB 01: D 6600-01

Pressure valves

2.3 Pressure-controlled shut-off valve type CNE

Shut-off valves are a type of pressure control valve. They receive the control oil from a high-pressure circuit and switch the delivery flow of a low-pressure pump to unpressurised circulation if the pressure value set has been reached. During this process, the consumer side is separated from the idle circulation by a zero-leakage check valve. If the pressure on the consumer side drops below the pressure setting, the idle circulation is interrupted and the oil fed to the consumer again.

Via a control line the higher pressure in the high-pressure circuit holds open the pressure-controlled 2 directional valve type CNE and with it the idle circulation. In the low-pressure circuit the valve acts simultaneously as a pressure-limiting valve.

The valve type CNE can be screwed-in and can be integrated into control blocks. The necessary mounting holes are straightforward to make.

Features and benefits:

- Compact design
- Easily produced mounting hole

Intended applications:

- Dual-stage systems (high-pressure, low-pressure)
- Jigs

Nomen-clature:	2-way circulation valve
Design:	Screw-in valve
Adjustment:	Fixed
p_{max}: **$p_{max\ adjust}$:**	500 bar 450 bar
Q_{max}:	30 l/min

Design and order coding example

CNE 2 | C | - 50

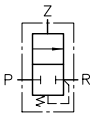
- - 50 → Pressure setting [bar]
- C → Pressure range
- CNE 2 → Basic type, size

Pressure controlled 2-way valve type CNE

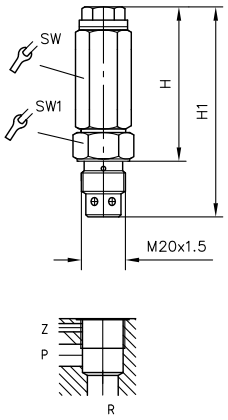
Additional versions:

- Additionally sealed tapped journal to minimize the internal leakage loss (type CNE 21)
- Additionally sealed tapped journal and piston to minimise leakage loss (type CNE 22 and CNE 23)

Function



General parameters and dimensions

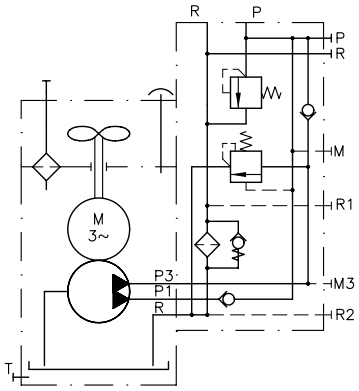


	Q_{max} [lpm]	Operating pressure p_{max} [bar] with		Dimensions [mm]			
		P	Z	H	H1	SW	SW1
CNE 2 CNE 21 CNE 23	30	E: 30 D:45 C:60 B:75 A:90 M:120 L:150	500	70	96	22	24
CNE 22	30	C: 320 B: 450	500	120	147	30	27

Circuit example:

HK448/1-HH..-AN21F2

Idle circulation valve integrated in connection block type AN 21 F2 for compact hydraulic power packs type HK with two pump circuits



Associated technical data sheets:

- Pressure-controlled shut-off valve type CNE: D 7710 NE

Similar products:

- Two-stage valves type NE: Page 192
- Switch units type CR: Page 152
- Shut-off valves type LV, ALZ: Page 194
- Directional valves type AE: Page 168

Connection blocks:

- Connection block type A: Page 62

Pressure valves

2.3 Two-stage valve type NE

Two-stage valves are a type of pressure control valve. They are used in hydraulic systems that are supplied by dual stage pumps, a combination of high-pressure pump and low-pressure pump.

The two-stage valve type NE combines the two pump delivery flows into a common volumetric flow. It switches the low-pressure pump to unpressurised circulation if the pressure value set is reached. It protects both pumps against exceeding the high or low-pressure value set.

The two-stage valve type NE is used with directional valves to control double-acting hydraulic cylinders.

Features and benefits:

- Operating pressures up to 700 bar
- Direct mounting on hydraulic power packs
- Direct combination with valve banks

Intended applications:

- Presses
- Test benches
- Hydraulic tools

Nomen-clature:	**Two stage valve (high pressure (HP) / low pressure (LP) stage)**
Design:	**Individual valve for pipe connection**
Adjustment:	**Fixed**
p_{max}:	**700 bar (HP) / 80 bar (LP)**
Q_{max}:	**25 (HP) / 180 (LP) lpm**

Design and order coding example

NE 20 **- 650/20**

Pressure setting [bar] High- /low pressure

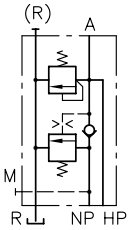
Basic type NE 20, 70 and 80

Additional versions:

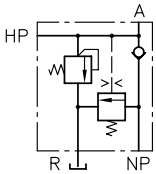
- Direct attachment on pump units type MPN, RZ and FXU possible
- Valve banks type BV can be directly mounted (type NE 21)

Function

NE 20

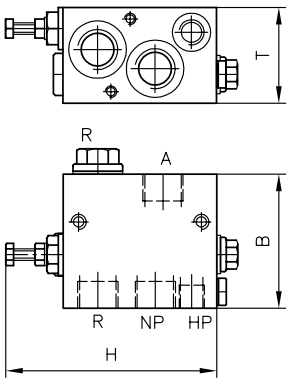


NE 70, NE 80

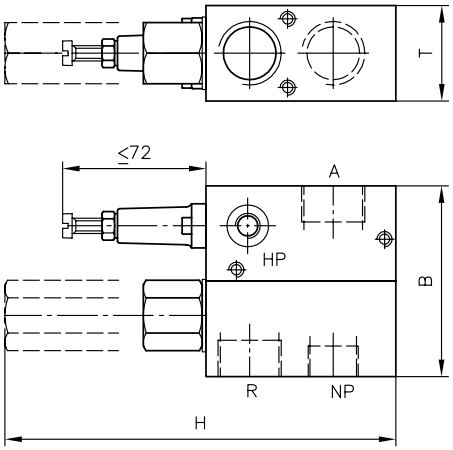


General parameters and dimensions

NE 20



NE 70, NE 80



	Q_{max} [lpm]		p_{max} [bar]		Ports			Dimensions [mm]			m [kg]
	HD	ND	HD	ND	A, R	HP	NP	H	B	T	
NE 20	10	40	20 ... 700	16 ... 80	G 1/2	G 1/4	G 1/2	110	70	50	2.1
NE 70	16	100	(0) ... 500	(0) ... 60	G 1	G 1/4	G 3/4	131	100	50	3.4
NE 80	25	180	(0) ... 500	(0) ... 30	G 1 1/4	G 3/8	G 1	259	120	60	7.0

Associated technical data sheets:

- Two-stage valve type NE: D 7161

Pumps:

- Compact hydraulic power packs type MP, MPN, MPW, MPNW: Page 50
- D 6910, D 6910 H

Similar products:

- Idle circulation valves type CNE: Page 190
- (Press) switch units type CR: Page 152
- Directional seated valves type VB: Page 114

Pressure valves

2.3 Shut-off valve type LV and ALZ

Shut-off valves or accumulator charging valves are a type of pressure control valve. They switch the delivery flow of a pump to unpressurised circulation if the pressure value set is reached. During this process, the consumer side is separated from the idle circulation by a zero-leakage check valve. If the pressure drops in the consumer side, the idle circulation is interrupted and the oil fed to the consumer again.
The shut-off valve type LV and ALZ operates using automatically controlled (pulse independent) step switching in the pilot valve.

Features and benefits:
- Various means of adjustment
- Various additional functions

Intended applications:
- Test benches
- Accumulator systems
- Hydraulic tools

Nomen-clature:	**Shut-off valve (idle circulation valve, directly controlled or pilot-controlled)**
Design:	**Individual valve for pipe connection Individual valve Manifold mounting**
Adjustment:	**Fixed manually adjustable**
p_{max}:	**350 bar**
Q_{max}:	**120 l/min**

Design and order coding example

LV 10 P ALZ 3 G	D CR	- 180 - 250

Pressure setting [bar]

Pressure range
- Fixed (-)
- Manually adjustable (R)

Basic type, size, design

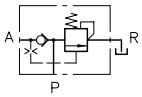
Type LV, size 10, 20, 25
- Pipe connection (-)
- Manifold mounting (P)
- Design with low switching hysteresis (type LV 25)

Type ALZ, size 3 to 5
- Pipe connection (G)
- Manifold mounting (P)

Function

LV, ALZ

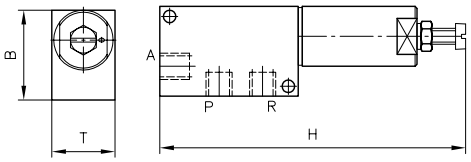
For pipe connection:



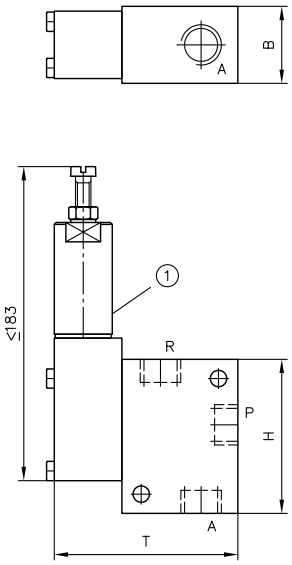
Manifold mounting valve:

General parameters and dimensions

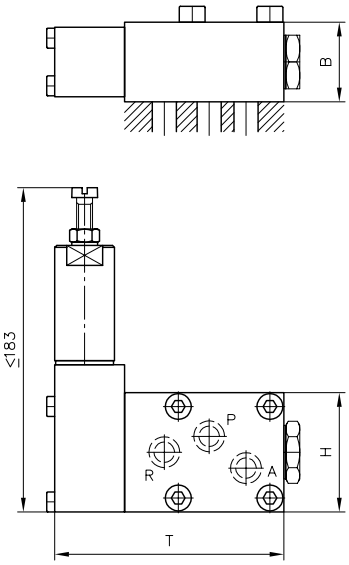
LV ..



ALZ .. G ..



ALZ .. P ..



1 Size 5: turned by 90°

	Control	Q_{max} [lpm]	Pressure range: p_{max} [bar]	Ports[1)]	Dimensions [mm]			m [kg]
					H	B	T	
LV 10	Direct	12	F: 60 E: 140 D: 240 C: 350	G 1/4	155	45	32	0.9
LV 20, LV 25		25	F: 80 E: 140 D: 220 C: 350	G 3/8	205	50	32	1.2
ALZ 3 G	Piloted	50	F: 60 E: 140 D: 240 C: 350	G 1/2	80	40	99	2.0
ALZ 4 G		80		G 3/4	94	40	109	2.4
ALZ 5 G		120		G 1	105	63	135	4.3
ALZ 4 P		80		G 3/4	60	40	119	2.1
ALZ 5 P		120		G 1	80	40	133	4.3

1) For pipe connection versions only

Associated technical data sheets:

- Shut-off valve type LV: D 7529
- Shut-off valve type ALZ: D 6170 ALZ
- Pressure valve with check valve type AL, AE and AS: D 6170

Similar products:

- Release valves type AE: Page 168
- Connection blocks type AL: Page 62

Pressure valves

2.3 Pressure-dependent shut-off valve type DSV and CDSV

Pressure-dependent shut-off valves are a type of pressure control valve. When a set pressure value is reached and exceeded, they block the flow to consumer line B with zero leakage. The valves will open again if the pressure on inflow side A falls below the set value defined by the spring tension.
The pressure-dependent shut-off valve type DSV and CDSV is used as a safeguard pressure gauge, for example.

Features and benefits:

- Various adjustment options

Intended applications:

- General hydraulic systems
- Test benches
- (Pressure gauge) protection valve

Nomen-clature:	**Shut-off valve**
Design:	**Single valve for pipe connection Individual valve for manifold mounting Screw-in valve**
Adjustment:	**Tool adjustable (fixed) Manually (adjustable)**
p_{max}:	**600 bar**
Q_{max}:	**60 l/min**

Design and order coding example

CDSV 1 | A | - 1/4 | - 400

- **Pressure setting [bar]**
- **Design** — with connection block (-1/4); Cartridge valve (-)
- **Pressure range** — Fixed (-) or manually adjustable (R)
- **Basic type, size** — Type CDSV (cartridge valve), size 1

DSV 21-1 | B | - 200

- **Pressure setting [bar]**
- **Pressure range** — Fixed (-) or manually adjustable (R)
- **Basic type, size** — Type DSV (pipe connection), type DSVP (manifold mounting), size 1, 2, 3

Function

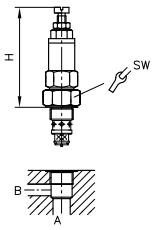
CDSV 1, DSV 2

DSVP 2

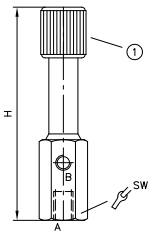
DSVP

General parameters and dimensions

CDSV 1

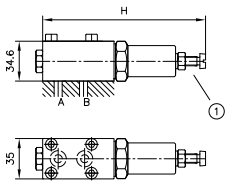


DSV 2-2



1 Manually adjustable

DSVP 21-1



1 Fixed

	Design	Size	Q_{max} [lpm]	p_{max} [bar]	Ports	H_{max} [mm]	SW = a/f	m [kg]
CDSV 1	Screw-in valve	1	10	C: 120 B: 350 A: 600	M 16 x 1.5	69	SW 22	0.13
DSV 2[1)]	Version for pipe connection	1	20	D: 40 C: 100 B: 220 A: 600	G 1/4	185	SW 36	0.7
		2	40	D: 20 C: 60 B: 120 A: 400	G 3/8	193	SW 36	0.9
		3	60	D: 20 C: 60 B: 120 A: 400	G 1/2	193	SW 46	1.1
DSVP 2[1)]	Manifold mounting valve	1	20	D: 40 C: 100 B: 220 A: 600	G 1/4	181	-	1.1

1) Manifold mounting valve only in size 1

Associated technical data sheets:

- Pressure-controlled shut-off valve type DSV: D 3990
- Pressure-controlled shut-off valve type CDSV: D 7876

Pressure valves

2.3 Load-holding valve type LHK, LHDV and LHT

Load-holding valves are a type of pressure control valve. They prevent loads on cylinders or motors dropping in an uncontrolled manner. For this purpose they are pre-loaded with a pressure setting that is higher than the largest possible load. A hydraulic piston controls the opening of the valve to achieve the required lowering velocity.

The load-holding valves type LHK and LHT are suitable for applications that are not particularly prone to oscillations. The load-holding valve type LHDV has special damping characteristics. It is used particularly in conjunction with proportional directional spool valves, e.g. type PSL and PSV.

Shock valves and shuttle valves with or without restrictor check valves can be fitted in the load-holding valves type LHK, LHDV and LHT, e.g. to relieve hydraulic brakes with a delay.

Features and benefits:

- Operating pressures up to 420 bar
- Various adjustment options
- Various configurations

Intended applications:

- Cranes
- Construction machinery
- Lifting devices

Nomen-clature:	**Load holding valve (over center valve, for one sided or alternating load direction) Single or twin valve**
Design:	**Individual or twin valve for pipe connection Individual or twin manifold mounting valve Screw-in valve Version for banjo bolt mounting**
p_{max}:	**450 bar**
Q_{max}:	**250 l/min**

Design and order coding example

LHK44 | G | - 11 | - 160

- **- 160** — **Pressure setting load-holding pressure [bar]**
- **- 11** — **Design** Various housing designs available
- **G** — **Dampening** Without/with, or with restrictor check valve
- **LHK44** — **Basic type, size** Type LHK (valve only, without shock valve), size 2 to 4

Additional versions:

- Some available with release ratio 1 : 2 and 1 : 7
- Version available as assembly kit

LHDV33	- 25WD	- B	6	-200/200-240/240

Pressure setting [bar] Load-holding pressure/load-holding pressure - shock valve pressure/shock valve pressure

Nozzle Release ratio may be altered with different orifice combinations in the range between 1 : 1.2 and 1 : 8.9

volumetric flow

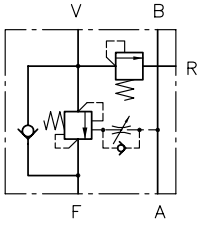
Additional elements
- With shock- and suction valves
- With shuttle valves for brakes
- With restrictor check valve

Basic type, size Type LHDV (with tailored dampening characteristics), size 3
Type LHT, size 2, 3 and 5

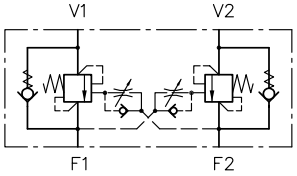
Additional versions:
- Cartridge valve versions
- Type LHT
- Type LHTE, with discharge pressure compensation

Function

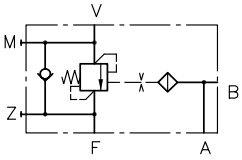
LHK 33 G-15-...



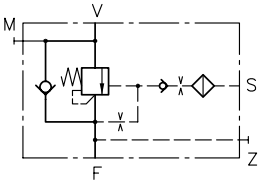
LHK 44 G-21-...



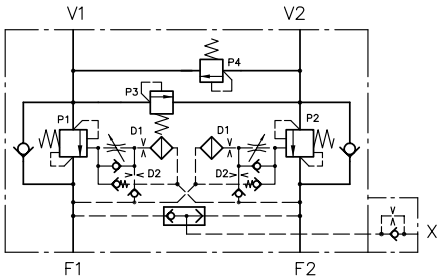
LHT 21 H-14-...



LHT 33 P-11-...

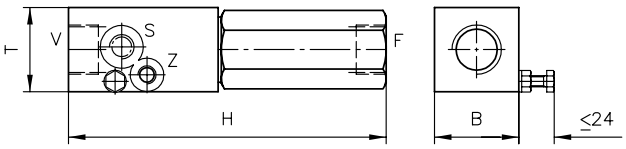


LHDV 33 G-25WD-...

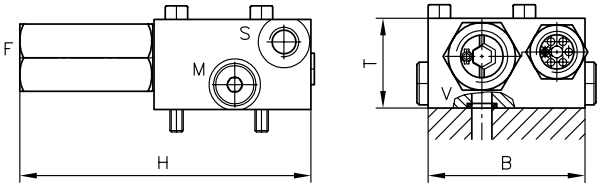


General parameters and dimensions

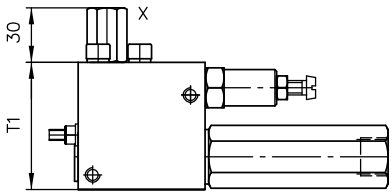
LHK 44 G - 11 - 160
Individual valve

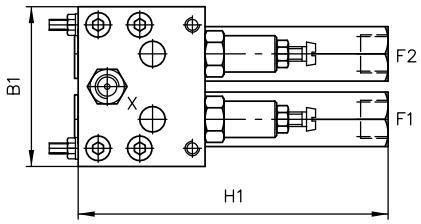


LHT 33 P - 15
Individual valve



LHDV 33 - 25 WD - B 6 - 200/200 - 240/240
Twin valve



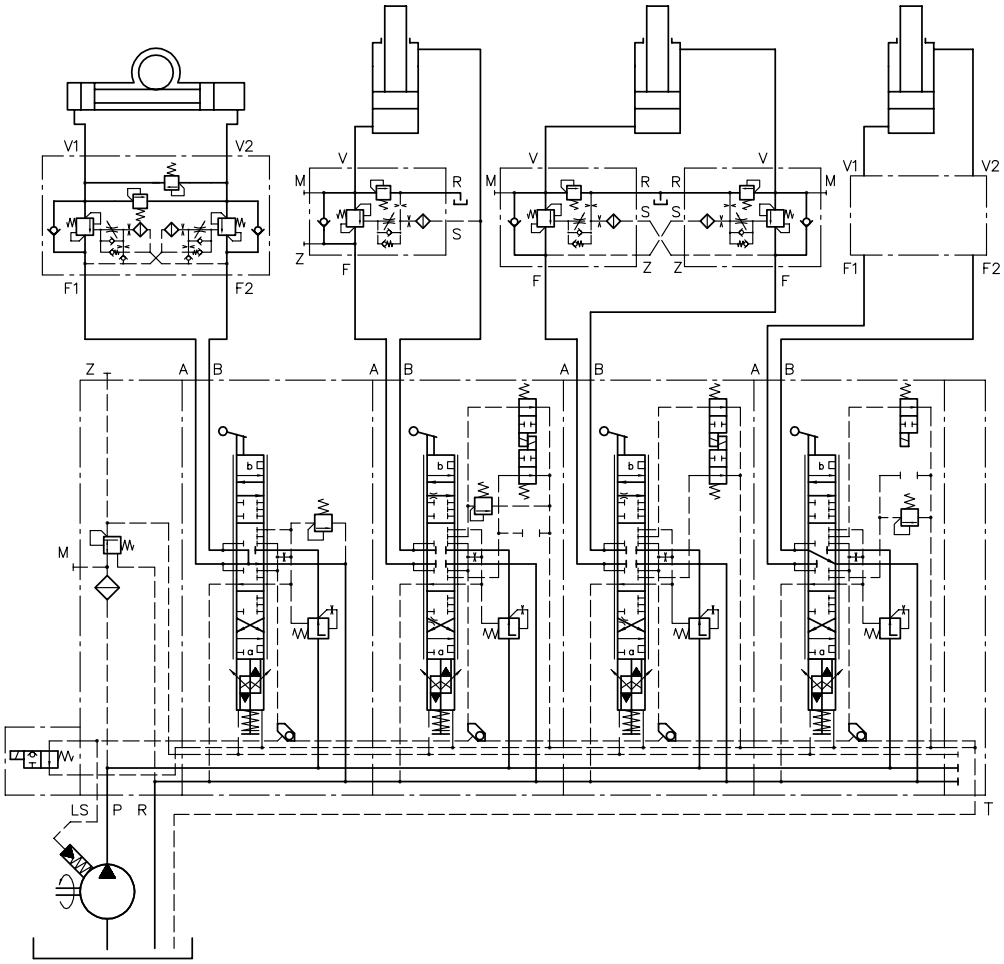


	Design	Q_{max} [lpm]	p_{max} [bar]	Pilot ratio	Ports	Dimensions [mm]			m [kg]
						H/H1	B/B1	T/T1	
LHK 22	Individual valve	20	400	1 : 4.6	G 3/8	97	32	32	0.5
	Twin valve[2)]					98	60	30	2.7
LHK 33	Individual valve	60	360	1 : 4.4	G 1/2	123	40	40	1.0
	Twin valve[2)]					125...291	80	40...60	2.7
LHK 44	Individual valve	100	350	1 : 4.4	G 3/4	170	45	45	1.6
	Twin valve[2)]					170	90	50	3.5
LHDV 33	Individual valve[2)]	80	420	1 : 8...1 : 1.2[1)]	G 1/2	170	50	40	1.8
	Twin valve					170	88	70	4.7
LHT 2	Individual valve	25	400	1 : 8, 1 : 4	G 1/4	132	40	24.8	1.2
	Twin valve					132	50	24.8	0.8
LHT 3	Individual valve[2)]	130	450	1 : 7...1 : 0.53 [1)]	G 1/2	128	70	40	1.6
LHT 5	Individual valve[2)]	250	450	1 : 6...1 : 0.79[1)]	G 1	113	50	50	1.0

1) Release ratio can be altered simply by changing the orifice
2) Note: Design may be significantly different to the illustrated version!

Circuit example:

LHDV 33-25-D6-180/180-200/200
LHDV 33 P-15-D6-280/300
LHDV 33 P-15-D6-280/300
LHK 33 G-21-... in accordance with D 7100



Associated technical data sheets:

- Load-holding valve type LHK: D 7100
- Load-holding valve type LHDV: D 7770
- Load-holding valve type LHT: D 7918

Suitable proportional directional spool valve:

- Proportional directional valves type EDL: Page 90
- Proportional directional valves type PSL, PSV: Page 90
- Proportional directional valves type PSLF, PSVF: Page 96

2.4 Flow valves

Flow control valves with electro-proportional actuation type SE and SEH

Throttles valves type Q, QR, QV and FG

Flow control valves

Type	Design / adjustability	p_{max} (bar)	Q_{max} (lpm)
SF, SD, SK	**2-way and 3-way flow control valve** ▪ Single valve for pipe connection ▪ Manifold mounting valve – Mechanical	SD - 3: 320 SD - 4: 320 SD - 5: 320 SF - 3: 320 SF - 4: 320 SF - 5: 320 SK - 3: 320 SK - 4: 320 SK - 5: 320	SD - 3: 60 SD - 4: 90 SD - 5: 130 SF - 3: 60 SF - 4: 90 SF - 5: 130 SK - 3: 60 SK - 4: 90 SK - 5: 130
SB, SQ, SJ, DSJ	**2-way metering valve, drop-rate braking valve** ▪ Screw-in valve ▪ Combination with housing for pipe connection – Tool adjustable, fixed	SB - 0: 315 SB - 1: 315 SB - 2: 315 SB - 3: 315 SB - 4: 315 SB - 5: 315 SQ - 0: 315 SQ - 1: 315 SQ - 2: 315 SQ - 3: 315 SJ - 0: 315 DSJ - 1: 315	SB - 0: 15 SB - 1: 35 SB - 2: 67 SB - 3: 150 SB - 4: 250 SB - 5: 400 SQ - 0: 15 SQ - 1: 25 SQ - 2: 67 SQ - 3: 150 SJ - 0: 15 DSJ - 1: 25
SE, SEH	**2-way and 3-way flow control valve** ▪ Single valve for pipe connection ▪ Manifold mounting valve – Electro-proportional	SE - 3: 320 SE - 4: 320 SEH - 2: 320 SEH - 3: 320 SEH - 4: 320 SEH - 5: 320	SE - 3: 50 SE - 4: 90 SEH - 2: 30 SEH - 3: 50 SEH - 4: 90 SEH - 5: 120

Flow dividers

Type	Design / adjustability	p_{max} (bar)	Q_{max} (lpm)
TQ	**Flow dividers** ▪ Single valve for pipe connection ▪ Manifold mounting valve – Non-adjustable	3: 350 43: 350 54: 350	3: 70 43: 120 54: 200

Restrictors, restrictor check valves

Type	Design / features	p_{max} (bar)	Q_{max} (lpm)
EB, BE, BC	**Restrictor, restrictor check valve** ▪ Plug-in valve ▪ Screw-in valve ▪ Combination with housing for pipe connection	EB - 0: 500 EB - 1: 500 EB - 2: 500 EB - 3: 500 EB - 4: 500 BE - 0: 500 BE - 1: 500 BE - 2: 500 BE - 3: 500 BE - 4: 500 BC - 1: 700 BC - 2: 700 BC - 3: 500	EB - 0: 6 EB - 1: 12 EB - 2: 40 EB - 3: 100 EB - 4: 120 BE - 0: 12 BE - 1: 25 BE - 2: 40 BE - 3: 80 BE - 4: 120 BC - 1: 20 BC - 2: 35 BC - 3: 60

Throttle valves and throttle shut-off valves

Type	Design / adjustability	p_{max} (bar)	Q_{max} (lpm)
Q, QR, QV, FG	**Throttle valve, restrictor check valve** ▪ Screw-in valve ▪ Single valve for pipe connection ▪ Angle valve ▪ Banjo bolt ▪ Swivel fitting – Tool adjustable	Q, QR - 20: 400 Q, QR - 30: 400 Q, QR - 40: 400 Q, QR - 50: 400 Q, QR - 60: 315 QV - 20: 400 QV - 30: 400 QV - 40: 400 QV - 50: 400 QV - 60: 315 FG: 320	Q, QR - 20: 12 Q, QR - 30: 20 Q, QR - 40: 40 Q, QR - 50: 60 Q, QR - 60: 80 QV - 20: 8 QV - 30: 12 QV - 40: 20 QV - 50: 30 QV - 60: 50 FG: 0.8
ED, RD, RDF	**Throttle valve, restrictor check valve** ▪ Single valve for pipe connection – Tool adjustable, fixed – Manual, adjustable	ED, RD - 11: 500 ED, RD - 21: 500 ED, RD - 31: 500 ED, RD - 41: 500 ED, RD - 51: 500 RDF - 11: 500 RDF - 21: 500 RDF - 31: 500 RDF - 41: 500 RDF - 51: 500	ED, RD - 11: 15 ED, RD - 21: 35 ED, RD - 31: 60 ED, RD - 41: 100 ED, RD - 51: 150 RDF - 11: 15 RDF - 21: 35 RDF - 31: 60 RDF - 41: 100 RDF - 51: 150
CQ, CQR, CQV	**Throttle valve, restrictor check valve** ▪ Screw-in valve – Tool adjustable	CQ - 2: 700 CQR - 2: 700 CQV - 2: 700	CQ - 2: 50 CQR - 2: 50 CQV - 2: 50
AV, AVT, CAV	**Throttle and shut-off valve** ▪ Single valve for pipe connection ▪ Screw-in valve – Tool adjustable, fixed – Manual, adjustable	AV - 2: 500 AV - 3: 400 CAV - 1: 500 CAV - 2: 500 AVT - 6: 630 AVT - 8: 630 AVT - 10: 630 AVT - 12: 630 AVM - 8: 500 AVM - 8L: 315	AV - 2: 40 AV - 3: 100 CAV - 1: 15 CAV - 2: 25

2.4 Flow control valve type SF, SD and SK

Flow control valves are a type of flow valve. They generate a set constant flow rate, largely independently of the load.

The flow control valve type SD, SF and SK can be freely adjusted with different mechanical actuations. The flow control valve type SD, SF and SK is available as a 2-way and 3-way flow control valve. For type SD, the adjustment is made using the adjusting knob; for type SF using the adjusting screw; and for type SK using the roller actuation. The flow control valve type SD, SF and SK is available as a single valve for pipe connection or as a manifold mounting valve.

Pressure-limiting valves and randomly switchable idle circulation valves are additional options. The flow control valve type SD, SF and SK controls the operating speed of the hydraulic consumers.

Features and benefits:

- Various actuation types
- Can also be combined with bypass check valves
- Precise setting

Intended applications:

- Construction machinery
- Machine tools
- General hydraulic systems

Nomen-clature:	2-way flow control valve 3-way flow control valve
Design:	Individual valves for pipe mounting Manifold mounting
Adjustment:	Mechanical ▪ Adjusting knob ▪ Roller actuation ▪ Setting screw
p_{max}:	315 bar
Q_{max}:	130 l/min

Design and order coding example

SF 3 - 3	/15	- S	- G24	- 120

Pressure setting [bar] of the pressure limiting valve (S)

Solenoid voltage G 12, G 24, WG 110 and WG 230

Mounting and add. valve

- Pipe connection (no coding)
- Manifold mounting (P)
- Valve with bypass check valve (R, PR)
- Check valve bridge circuit (B)
- Pressure-limiting valve (S)
- Pressure-limiting and circulation valve (S-WN1F, S-WN1D)

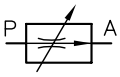
volumetric flow Flow steps via orifices Q_{max} : 3, 6, 15, 36, 50, 60, 70, 90, 130 lpm

Basic type, design, size

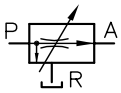
- Type SF, with lock nut, fixed adjustment
- Type SD, with adjusting knob actuation
- Type SK, with roller actuation (open version)
- Type SKR, with roller actuation (closed version, not for manifold mounting)
- Version as 2-way (-2) and 3-way (3) flow control valves
- Size 3 to 5

Function

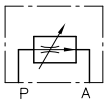
2-way, pipe connection



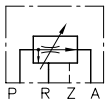
3-way



2-way, manifold mounting valve

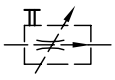


3-way



Actuation:

SF ...

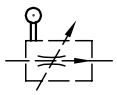


Set screw SW 10
adjustment travel 5 mm

SD ...

Adjusting knob,
adjustment travel
3.8 turns

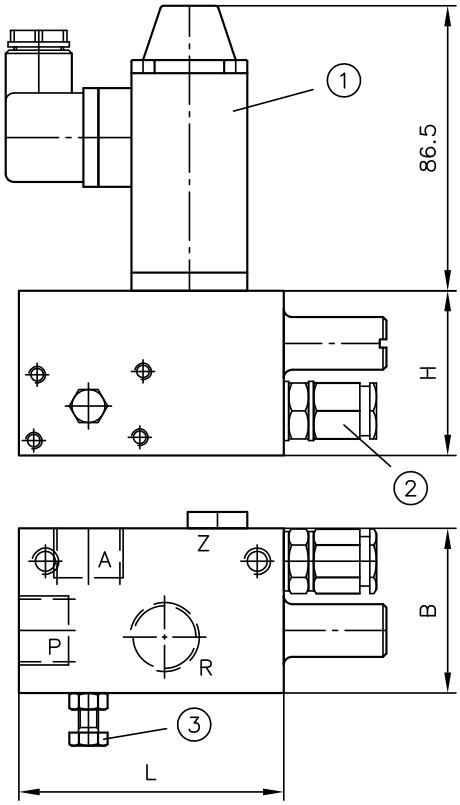
SK ... SKR ...

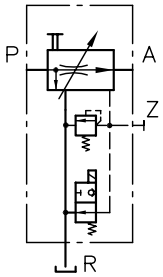


Roller actuation
Unshielded version (SK), Shielded version (SKR)
Actuation travel 15,5 ... 17 mm,
Actuation force 30 ... 70 N

General parameters and dimensions

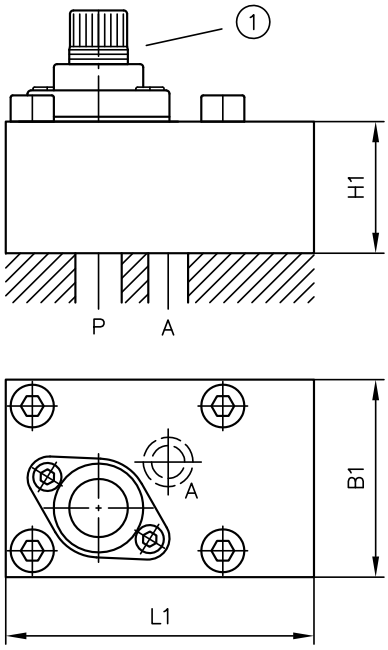
Version for pipe connection





1 Idle circulation valve
2 Pressure-limiting valve
3 Setting screw

Manifold mounting valve



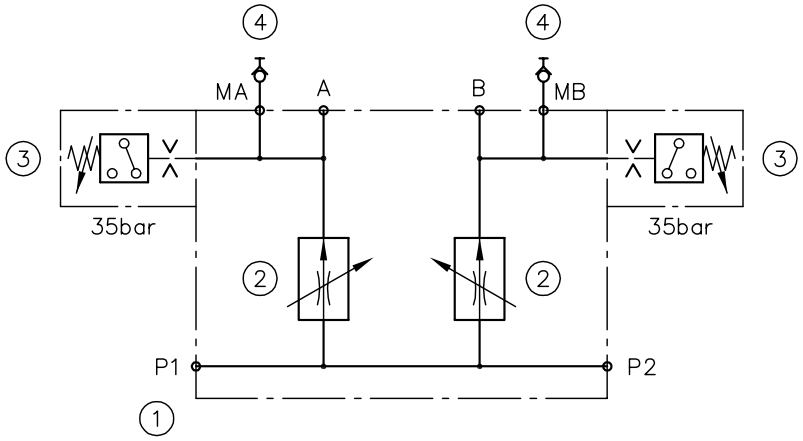
1 Adjusting knob

		Q_{max} [lpm][1]	Ports[2]	Dimensions [mm]						m [kg][3]
2-way	3-way			H	H1	L	L1	B	B1	
S. 2-3		0,3 ... 60	G 1/2	50	40	80	93	50	60	1,4 ... 2,1
	S. 3-3			50	40	80	93	50	60	1,4 ... 2,1
S. 2-4		0.3 ... 90	G 3/4	60	50	85	100	60	70	2
	S. 3-4			60	50	85	100	60	70	2,0 ... 2,6
S. 2-5		1,0 ... 130	G 1	70	50	100	106	70	80	3,1
	S. 3-5			70	50	100	106	70	80	2,8 ... 3,7

1) Different Q_{max} available, see Design and order coding example: "Orifice steps"
2) For pipe connection versions
3) Depending on actuations

Circuit example:

Position	Number	Designation
4	2	SMK 20-G 1/4-PC
3	2	DG 364-35
2	2	SD 2-3/6P
1	1	20,201 H 00



Associated technical data sheets:

- Flow control valve type SD, SF and SK: D 6233

Similar products:

- Drop-rate braking valves type SB, SQ: Page 210
- Prop. flow control valves type SE, SEH: Page 212

Male connectors:

- Line connector type MSD and others: D 7163

2.4 Flow control valve (lowering brake valve) type SB, SQ, SJ and DSJ

Flow control valves are a type of flow valve. They generate a set constant flow rate, largely independently of the load.
The flow control valve type SB and SQ is available as a screw-in cartridge, a housing version with pipe connection or as a banjo screw version. Type SB has a slightly inclined characteristic curve for oscillation damping. Type SQ is largely independent of the load.
The freely movable sliding metering orifice enables greater flow in the opposite flow direction. No bypass check valve is therefore required. The flow control valve type SB and SQ is used to control the lowering speed of single-acting consumers.

Features and benefits:
- Oscillation damping and load-independent
- Compact screw-in valve

Intended applications:
- General hydraulic systems
- Industrial trucks
- Lifting equipment

Nomenclature:	2-way flow control valve (drop rate braking valve)
Design:	Screw-in type with housing for in-line installation
Adjustment:	Fixed (pre-set) Tool adjustable from outside
p_{max}:	315 bar
Q_{max}:	400 lpm

Design and order coding example

SB 2 | 1 | C | - 30

Response flow [l/min] Desired factory set response flow within the respective range

Design Adjustable or non adjustable version
- Screw-in version (C)
- Version with housing for pipe mounting (E, F, G)

Additional versions
- With metric of UNF-thread
- With thread adaptor
- As banjo bolt and/or with swiveling screw fitting

Adjustment range Adjustable response flow

Basic type, size Type SB, SQ and SJ, size
Type DSJ, flow control function in both directions for double-acting consumers

Function

SB, SQ

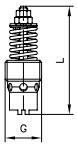
SJ

DSJ

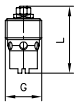
General parameters and dimensions

Screw-in valve ...C

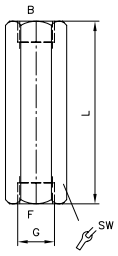
SB, SQ



SJ



With housing...G



	Coding for adjustment range of the set response flow from ... to ... [lpm] below						Ports	Dimensions [mm]			m [g]
	1	3	5	7	9	90	G (Series)	L	L1 max	SW = a/f	
SB 0	1...1.6	1.6...2.5	2.5...4	4...6.3	6.3...10	10...15	G 1/4 (A)	39	78	19	13
SJ 0[1]								24	-	-	35
SB 1	2.5...4	4...6.3	6.3...10	10...16	16...25	25...35	G 3/8 (A)	43	82	22	23
SQ 1											
SB 2	16...21	21...28	28...37	37...50	50...67[2]	-	G 1/2 (A)	49	96	27	40
SQ 2											
SB 3	37...50	50...67	67...90	90...120	120...150[2]	-	G 3/4 (A)	61	106	32	80
SQ 3											
SB 4	80...100	100...125	125...160	160...200	200...250	-	G 1 (A)	78	145	41	150
SB 5	170...200	200...236	236...280	280...335	335...400	-	G 1 1/4 (A)	94	160	50	300
DSJ 1	1.0...21.0						G 3/8 (A)	39	78	19	30

1) Type SJ 0 without coding: adjust. range 0.25 ... 1.2 l/min
2) Not for type SQ..

Associated technical data sheets:

- Flow control valve (lowering brake valve) type SB and SQ: D 6920
- Flow control valve type SJ: D 7395
- Flow control valve type CSJ: D 7736
- Flow control valve type DSJ: D 7825

2.4 Proportional flow control valve type SE and SEH

Proportional flow control valves are a type of flow valve. They generate a constant flow rate independent of the load which can be controlled in an electro-proportional and remote way.

The flow control valve type SE has a directly actuated metering orifice, which has an advantage of approximately Qmin equal to zero in terms of the controllability. The flow control valve type SEH has a piloted metering orifice which is shown to be beneficial in dynamic systems with short reaction times. The flow control valve type SE and SEH is available as a single valve for pipe connection or as a manifold mounting valve. Pressure-limiting valves and randomly switchable idle circulation valves are additional options. The flow control valve type SE and SEH controls the operating speed of hydraulic consumers.

Features and benefits:

- Electrical control of consumer operating speeds
- Automation of operating cycles

Intended applications:

- Construction machines
- Machine tools
- General hydraulic systems
- Mining machinery

Nomen-clature:	**2-way flow control valve 3-way flow control valve**
Design:	**Individual valve for pipe mounting or Screw-in valve**
Adjustment:	**Electro-proportional**
p_{max}:	**315 bar**
Q_{max}:	**120 lpm**

Design and order coding example

SE 2-3 | /30F | - P | - G24

Solenoid voltage — Prop. solenoid
- 12 V DC, 24 V DC
- Controls via prop. amplifier or PLVC

Design and port size
- Pipe connection
- Manifold mounting (P)

Flow [lpm] — Nom. flow of the metering orifice
- Deenergized open
- Deenergized closed (coding F

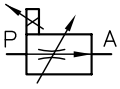
Orifice steps Q_{max} : 3, 6, 10, 15, 22, 30, 36, 50, 70, 90, 120 lpm

Basic type, size — Type SE, with non-piloted metering orifice, size 3, 4
Type SEH, with piloted metering orifice, size 2 to 5
- Available as 2- and 3-way flow control valve

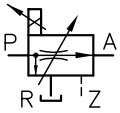
Function

SE, SEH

2-way
Pipe connection

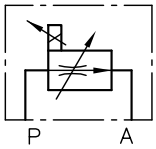


3-way
Pipe connection

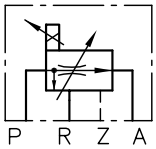


1)

2-way
Manifold mounting valve



3-way
Manifold mounting valve



1) No Z port with type SEH 3-2

Additional functions for flow control valves:

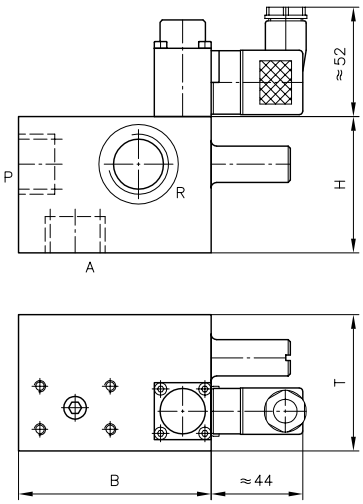
2-way flow control valve

- Version with bypass check valve
- Version with check valve in bridge circuit for free selection of the flow direction

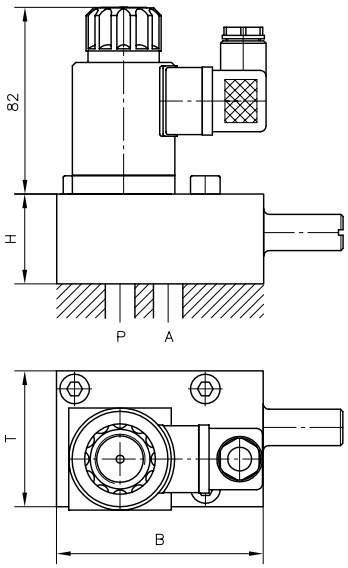
3-way flow control valve

- Version with pressure-limiting valve
- Version with pressure-limiting valve and circulation valve (for pipe connection versions only)
- Version with compulsory closed position of the pressure compensator when not actuated type ...F0
- Version with automatic circulation type ...B 0.6

SEH
Version for pipe connection



SE
Manifold mounting valve

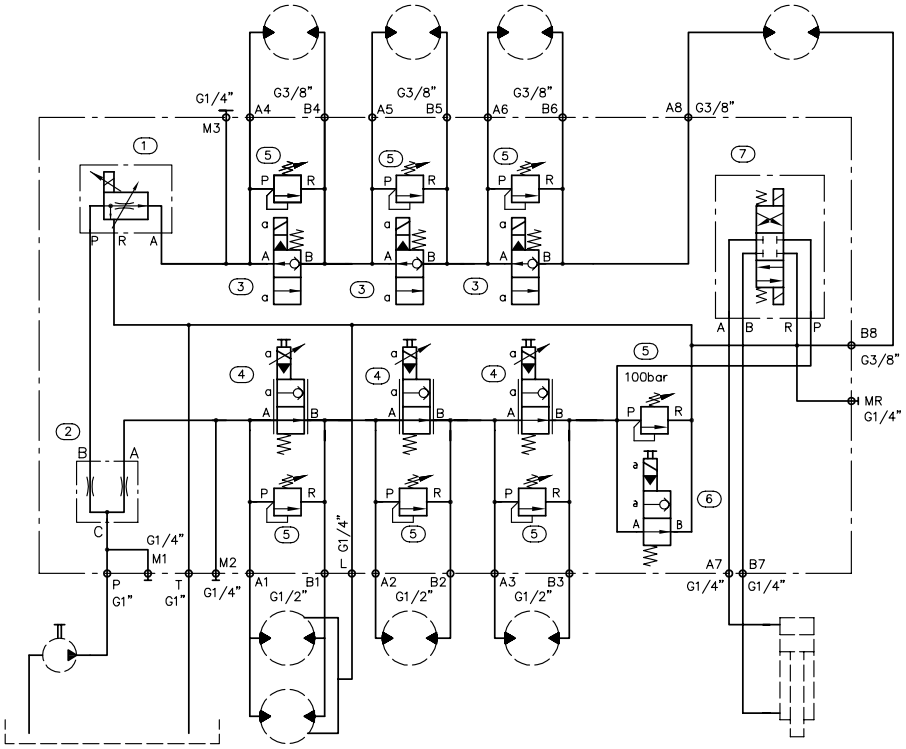


Basic type and size			Q_{max} [lpm][1]	p_{max} [bar]	Ports[2]	Dimensions [mm]			m_{max} [kg]
2-way	3-way					H	B	T	
SE 2-3	SE 3-3	Directly actuated	0,3 ... 50	315	G 1/2	110 ... 120	80 ... 91	50 ... 60	2,2
SE 2-4	SE 3-4		0.6 ... 90	315	G 3/4	120 ... 130	85 ...100	60 ... 70	2,2
SEH 2-2	SEH 3-2	Hydraulically piloted	0.1 ... 36	315	G 3/8	115	55 ... 70	39	1,6 ... 3,3
SEH 2-3[3]	SEH 3-3		0,3 ... 50	315	G 1/2	92,5	80 ... 93	50 ... 60	1,6 ... 3,3
-	SEH 3-4		0,6 ... 90	315	G 3/4	102,5	95 ... 100	60 ... 70	1,6 ... 3,3
-	SEH 3-5		1,0 ... 120	315	G 1	112,5	100	70	1,6 ... 3,3

1) Different Q_{max} available, see Design and order coding example: "Orifice steps"
2) For pipe connection versions
3) For manifold mounting versions only

Circuit example

① SEHD 3-3/30 FP-X 24
② TQ 4 P-A 5/2
③ EM 31 V-X24
④ EMP 31 S-X 24
⑤ MVH 6 C
⑥ EM 31 S-X24
⑦ SWPN 2-G-X24



Associated technical data sheets:

- Proportional flow control valve type SE and SEH: D 7557/1

Similar products:

- Flow control valves type SD and others: Page 206

Suitable accessories:

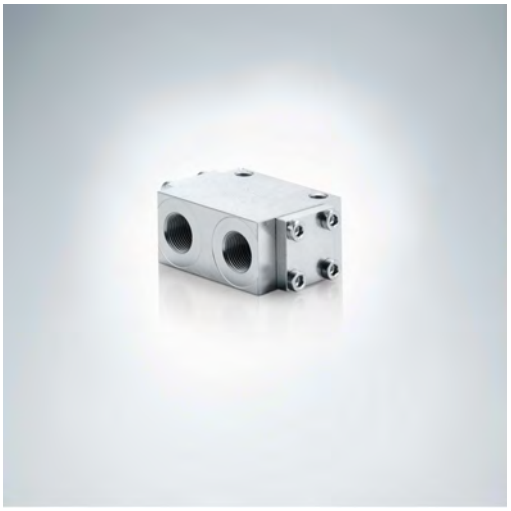
- Proportional amplifier type EV1M3: Page 272
- Proportional amplifier type EV2S: Page 274
- Proportional amplifier type EV1D: Page 272

2.4 Flow divider type TQ

Flow dividers are a type of metering valve. They divide or add together a total flow rate either evenly or using a fixed ratio. The consumer pressures have no effect.
The flow divider type TQ is, due to its simple design, an economical solution for simple dividing tasks, e.g. if two hydraulic consumers with varying loads supplied from one pump are to be moved simultaneously without interaction.
Intended applications include mobile hydraulics and industrial hydraulics.

Features and benefits:
- Excellent dividing accuracy

Intended applications:
- Steering systems
- Synchronous cylinders



Nomen-clature:	Flow dividers
Design:	Individual valve for pipe mounting Manifold mounting
Adjustment:	Non-adjustable
p_{max}:	350 bar
Q_{max}:	200 lpm (nom. total flow)

Design and order coding example

TQ 32	- A	- 2,3 - 3

Coding Flow indicator

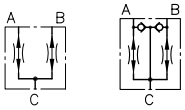
Design
- A – equal division ratio
- R - with bypass check valve

Basic type, size
- Pipe connection (no coding)
- Manifold mounting (P)

Type TQ, size 2 to 5

Function

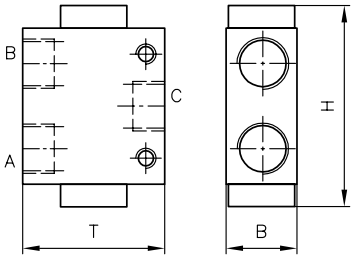
TQ
Pipe connection



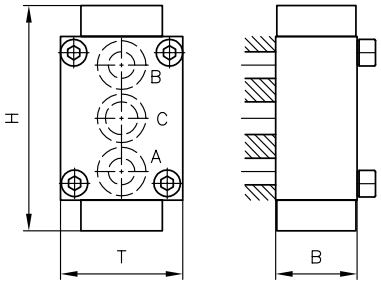
TQ.P
Manifold mounting valve

General parameters and dimensions

TQ...
Pipe mounting



TQ .P
Manifold mounting



	Q_{max} [lpm]	p_{max} [bar]	Ports[1)]			Dimensions[mm]			m [kg]
			A	B	C	H	B	T	
TQ 2..	7.5 ... 70	350	G 1/4, G 3/8	G 1/4, G 3/8	G 3/8	79	30	50	0.6
TQ 3..	7.5 ... 70	350	G 3/8, G 1/2	G 3/8, G 1/2	G 1/2	85	30	60	0.6 ... 0.7
TQ 3P	7.5 ... 70	350	-	-	-	79	30	50	0.7
TQ 4	80 ... 120	350	G 1/2	G 1/2	G 3/4	110	40	60	1.5
TQ 4P	80 ... 120	350	-	-	-	110	40	60	1.6
TQ 5	140 ... 200	350	G 3/4	G 3/4	G 1	134	50	80	3.0
TQ 5P	140 ... 200	350	-	-	-	134	50	80	3.1

1) For pipe mounting versions only

Associated technical data sheets:
- Flow divider, type TQ: D 7381

2.4 Restrictors and restrictor check valve type EB, BE, BC

Restrictors are a type of flow valve. They are used as a local flow resistance that suddenly reduces the line cross-section. The reduction in the cross-section is very short. As a result, the flow rate is only dependent on the pressure difference and not on the viscosity.
The restrictor check valve type BE and BC combines the function of a flow valve with a check valve. The valve is available as a perforated restrictor or as a slotted restrictor. It limits the flow during the switching of directional valves. E.g. it prevents excessively quick accumulator emptying.
The orifice insert type EB is primarily used in valves for manifold mounting. As such an additional intermediate plate is not necessary.

Features and benefits:
- Max. 700 bar
- Simple design and installation

Intended applications:
- General hydraulics
- Winch controls
- Hydraulic pilot systems

Nomen-clature:	Restrictor Restrictor check valve
Design:	Plug-in valve Insert valves Combination with housing for pipe connection
p_{max}:	700 bar
Q_{max}:	120 l/min

Design and order coding example

BC1 - 0,8 G

Design with housing For pipe connection, type BC, BE (E; F, G)

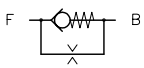
Orifice Hole or slot type orifice, diameter in mm

Basic type, size Type BC, size 1 to 3
Type BE, size 1 to 4
Type EB, size 0 to 4, Orifice insert

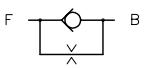
Additional versions
- Type BC and BE with metric thread

Function

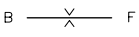
BC
Screw-in valve



BE

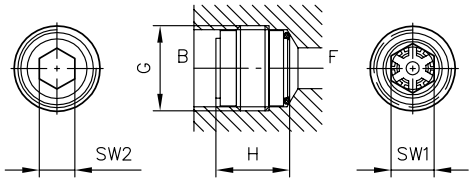


EB
Orifice insert

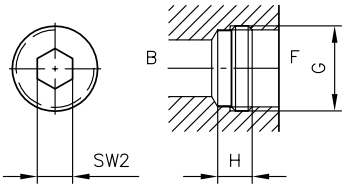


General parameters and dimensions

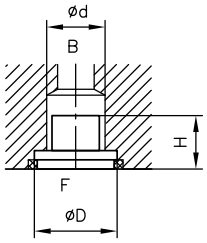
BC..
Screw-in valve



BE ..



EB..
Orifice insert



	Q_{max} [l/min]	p_{max} [bar]	Ports	Dimensions				m [g]
				H [mm]	G / D	SW = a/f 1/Æd	SW = a/f 2	
BC 1	20	700	G 1/4 A	13	G 1/4 A	SW 8	SW 4	6
BC 2	35	700	G 3/8 A	15	G 3/8 A	SW 9	SW 5	10
BC 3	60	500	G 1/2 A	18	G 1/2 A	SW 12	SW 8	24
BE 0	12	500	G 1/8 A	5	G 1/8 A	SW 4	-	2
BE 1	25	500	G 1/4 A	6	G 1/4 A	SW 5	-	4
BE 2	40	500	G 3/8 A	7	G 3/8 A	SW 8	-	6
BE 3	80	450	G 1/2 A	7.5	G 1/2 A	SW 10	-	10
BE 4	120	400	G 3/4 A	9	G 3/4 A	SW 12	-	18
EB 0	6	500	-	1.8	9	5.6	-	2
EB 1	10	700	-	1.8	11	7.5	-	4
EB 2	40	700	-	9	18	12.8	-	6
EB 3	100	500	-	11.5	22	16	-	10
EB 4	120	500	-	10	28	25	-	18

Associated technical data sheets:
- Restrictor check valve type BC: D 6969 B
- Restrictor check valves type BE: D 7555 B
- Orifice type EB: D 6465

Similar products:
- Insert check valves type RK, RB, RC, RE, ER: Page 232
- Restrictor check valves type RD, ED, RDF: Page 222

Flow valves

2.4 Throttle valve type Q, QR, QV and FG

Throttle valves are a type of flow valve. They affect the flow rate for single and double-acting consumers.

The throttle valve type Q and the restrictor check valve type QR and QV are, as slotted throttles, insensitive to micro contamination. The precision throttle valve FG is a thread type throttle. It adjusts the switching time of directional valves, prevents switching surges and dampens oscillations. The restrictor check valve type QR, QV, FG1 and FG2 combines the function of a flow valve with a check valve. It regulates in one flow direction and permits free flow in the other direction.

The valve type Q, QR, QV and FG can be integrated into control blocks or into the pipework as a banjo screw version.

Features and benefits:

- Different installation options
- Simple design

Intended applications:

- General hydraulic systems

Nomen-clature:	**Throttle** **Restrictor check valves**
Design:	**Cartridge** **Individual valve for pipe mounting** ▪ **Corner housing** ▪ **Banjo bolt** ▪ **Swivel fitting**
Adjustment:	**Tool adjustable**
p_{max}:	**400 bar**
Q_{max}:	**120 lpm**

Design and order coding example

QR 20 FG 1	- H 6	K

Version with housing

- Without labelling as a screw-in valve
- Available as a banjo bolt and/or with swivel fitting

Basic type, size, function

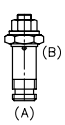
- Throttles type Q, type QR, type QV and precision throttles type FG, subdivided into 5 sizes
- Throttle direction and free flow direction function
- Slot-type throttles, available with or without built-in check valve

Diagram of devices:

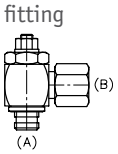
FG

Throttle screw

Banjo bolt



Swivel fitting

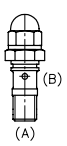


Q

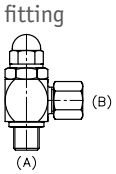
Throttle screw

Throttle screw

Banjo bolt

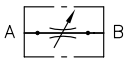


Swivel fitting



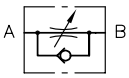
Function

FG, Q



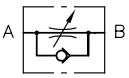
CQ

FG 1, QR



CQR

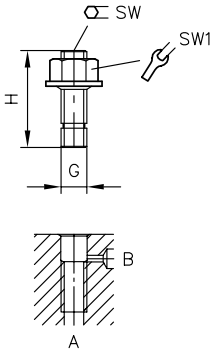
FG2, QV



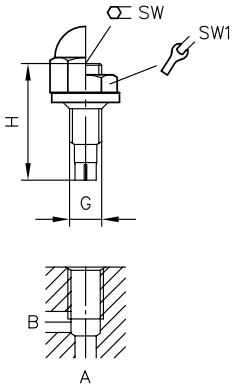
CQV

General parameters and dimensions

FG..



Q..



	Q_{max} [lpm][1)]	p_{max} [bar]	Dimensions				m [g]
			H [mm]	G	SW = a/f	SW =a/f 1	
FG, FG1, FG2	0,15	300	30	M 8	SW 4	SW 13	15
Q20, QR20, QV20	12	400	32	M 8 x 1	SW 4	SW 13	15
Q30, QR30, QV30	25	400	36	M 10 x 1	SW 5	SW 17	25
Q40, QR40, QV40	50	400	41	M 12 x 1.5	SW 6	SW 19	40
Q50, QR50, QV50	90	400	46	M 14 x 1.5	SW 8	SW 22	55
Q 60, QR60, QV60	120	315	58	M 16 x 1.5	SW 10	SW 24	100

1) The values apply to a fully opened valve (observe red marking) and a back pressure of approx. 50 bar (in a throttled direction)

Associated technical data sheets:

- Throttle valve and throttle check valve type Q, QR and QV: D 7730
- Throttle valve and throttle check valve type FG: D 7275

Similar products:

- Throttle valves type CQ, CQR, CQV: Page 224
- Throttle and restrictor check valves type ED, RD, RDF: Page 222
- Restrictor check valves and orifice inserts type EB, BE, BC: Page 218

2.4 Throttle valve type ED, restrictor check valve type RD and RDF

Throttle valves are a type of flow valve. They affect the flow rate for single and double-acting consumers.

The restrictor check valve type RD and RDF combines the function of a flow valve with a check valve. It regulates in one flow direction and permits free flow in the other direction.

Types ED and RD are adjustable.

The valve type ED, RD and RDF can be integrated directly in the line.

Features and benefits:

- Sensitively adjustable
- Wear-resistant

Intended applications:

- General hydraulic systems

Nomen-clature:	Throttle Restrictor check valves
Design:	Individual valve for pipe mounting Screw-in valve
Adjustment:	Manually adjustable (handle, adjusting knob) Fixed
p_{max}:	500 bar
Q_{max}:	130 lpm

Design and order coding example

RD 11 RDF 21	/1,0	- K

Adjustability

- Type ED and RD only
- Without labelling = manually (wing bolt/lock nut)
- K = tool adjustable (setting spindle/lock nut)

Fixed throttles

Diameter in mm, type RDF

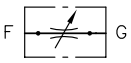
- 0.4 - 0.6 (in increments of 0.1)
- 0.8 - 2.0 (in increments of 0.2)
- 2.5 - 5.5 (in increments of 0.5)

Basic type, size

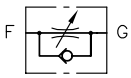
- Type ED, type RD, type RDF, size 1 to 5
- Slot-type throttles, available with or without built-in check valve

Function

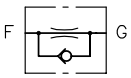
ED



RD

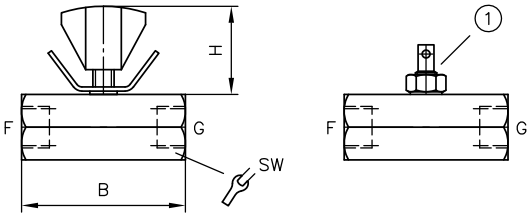


RDF

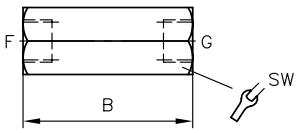


General parameters and dimensions

ED.. and RD..



RDF..



1 Tool adjustable

1)	Q_{max} [lpm] 2)	p_{max} [bar]	Ports	Dimensions [mm]			m [g]
				H	B	SW = a/f	
ED 11..	12	500	G 1/4	23.5	52	SW 24	180
RD 11..				23.5			
RDF 11/..				-			
ED 21..	30	500	G 3/8	24	52	SW 27	215
RD 21..				24			
RDF 21/..				-			
ED 31..	60	500	G 1/2	32.5	62	SW 32	340
RD 31..				32.5			
RDF 31/..				-			
ED 41..	80	500	G 3/4	41	72	SW 41	655
RD 41..				41			
RDF 41/..				-			
ED 51..	130	500	G 1	46.5	82	SW 46	835
RD 51..				46.5			
RDF 51/..				-			

1) The throttle diameter with type RDF canbe only altered by replacing the orifice. Depending on size, diameters between 0.6 and 4 mm are available.
2) These figures correspond to completely opened throttle and represent a back pressure of approx. 50 bar (throttled direction of flow)

Associated technical data sheets:

- Throttle and restrictor check valves type ED, RD, RDF: D 7540, D 2570

Similar products:

- Throttle valves type Q, QR, QV, FG: Page 220
- Throttle valves type CQ, CQR, CQV: Page 224
- Restrictor check valves type EB, BE, BC: Page 218

2.4 Throttle valve and restrictor check valve type CQ, CQR and CQV

Throttle valves are a type of flow valve. They affect the flow rate for single and double-acting consumers.
The throttle valve type CQ and the restrictor check valve type CQR and CQV are, as slotted throttles, insensitive to micro contamination. The restrictor check valve type CQR and CQV combines the function of a flow valve with a check valve. It regulates in one flow direction and permits free flow in the other direction. The double spindle sealing enables leakage-free adjustment, even under pressure.
The valve type CQ, CQR and CQV can be screwed-in and can be integrated into control blocks. The necessary mounting holes are straightforward to make.

Features and benefits:
- Leak-free adjustment under pressure
- Operating pressure up to 700 bar

Intended applications:
- Speed regulation in hydraulic lifting devices

Nomen-clature:	Throttle Restrictor check valves
Design:	Screw-in valve
Adjustment:	Tool adjustable Manually
p_{max}:	700 bar
Q_{max}:	50 l/min

Design and order coding example

CQV 2 - D - 1/4

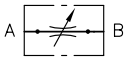
Single connection blocks
- For pipe connection (1/4, 3/8)
- Manifold mounting (in combination with type CQ and CQV only)

Adjustability in operation
- Without labelling = Fixed
- D = Turn knob (with lock nut)
- D3 = Turn knob, diameter 35 mm (without lock nut)

Basic type, size
Type CQ, type CQR, type CQV, size 2
Slot-type throttles, available with or without built-in check valve
- Version with precision control range (size 22)
- Version with strong precision control range (size 23; only with turn knob D3)
- Version with pressure compensator (flow control function)

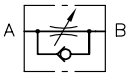
Function

CQ 2, CQ 22, CQ 23



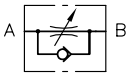
CQ

CQR 2, CQR 22, CQR 23



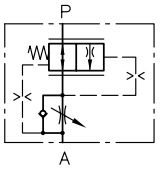
CQR

CQV 2, CQV 22, CQV 23



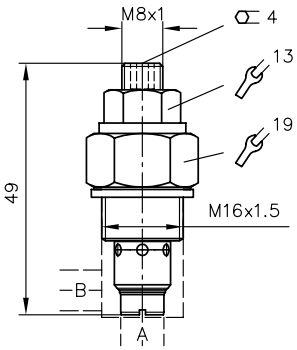
CQV

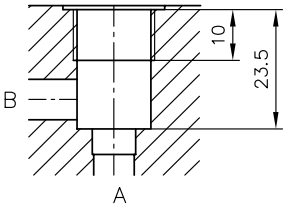
CQ 2 - P - DW



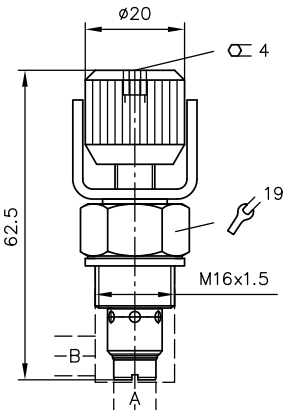
General parameters and dimensions

CQ 2., CQR 2., CQV 2.

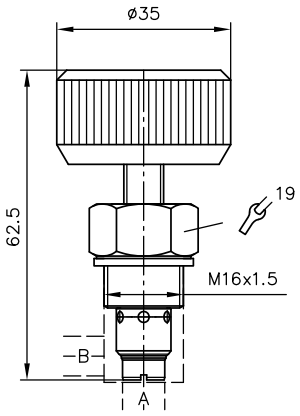




D



D3



	Q_{max} [lpm]	p_{max} [bar]
CQ 2, CQ 22, CQ 23	50 / 30 / 10	700
CQR 2, CQR 22, CQR 23		
CQV 2, CQV 22, CQV 23		

Associated technical data sheets:

- Throttle valve and throttle check valve type CQ, CQR and CQV: D 7713

Similar products:

- Throttle and restrictor check valves type ED, RD, RDF: Page 222
- Throttle valves type Q, QR, QV, FG: Page 220

2.4 Throttle valve and shut-off valve type AV, AVT and CAV

Throttle and shut-off valves are a type of metering valve. With the aid of these valves a pressure drop can be established between the inlet and outlet side. In this way the velocity of cylinders in accumulator circuits and the flow rate in control circuits can be regulated or a consumer line completely shut-off (e.g. to protect a pressure gauge).
The throttle and shut-off valve type AV and AVT produces a throttle effect by means of an annular gap. The valve type CAV, as a slotted throttle, is insensitive to micro contamination.
The valve type AV is available as a screw-in valve or valve for pipe connection. The type AVT is mounted in a T-housing and commercially available pipe screw connections permit direct pipe connection. The valve type CAV can be screwed-in and can be integrated into manifolds. The necessary mounting holes are straightforward to make.

Features and benefits:
- Various configurations
- Sensitive adjustment and complete shut off possible

Intended applications:
- General hydraulic systems

Nomen-clature:	Throttle and shut-off valve with/without by-pass check valve
Design:	Individual valve for pipe mounting Screw-in valve
Adjustment:	Tool adjustable (fixed) Manual (adjustable)
p_{max}:	630 bar
Q_{max}:	100 l/min

Design and order coding example

AV 3AVT 10 CAV 1V	- K	- 1/4

Thread size Version with connection block for pipe connection (type CAV)

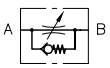
Means of adjustment Fixed
Manually (adjustable)

Basic type, size Type AV, size 2, 3
Type AVT, size 6... 12
Type CAV, size 1, 2

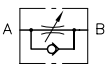
Function

AV, AV.E, AVT, CAV

CAV..R



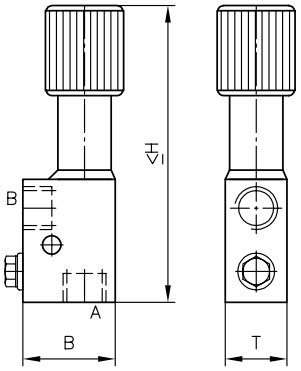
CAV..V, AV..R, AV..RE



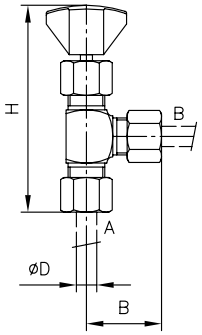
CQV

General parameters and dimensions

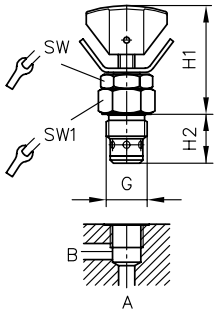
AV..
Valve for pipe connection



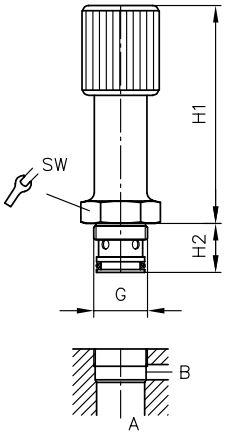
AVT..



CAV..
Screw-in valve



AV..E



	Q_{max} [lpm][1)]	p_{max} [bar]	Port size	Dimensions [mm]							m [kg]
			G	H	H1	H2	B	T	SW = a/f	SW = a/f 1	
AV 2	40	500	G 1/2 (BSPP)	145	-	-	45	30	-	-	0.6
AV 3	100	400	G 3/4 (BSPP)	198	-	-	60	40	-	-	1.7
AV 2E	40	500	M 28 x 1.5	-	115	25	-	-	SW 36	-	0.6
AV 3E	100	400	M 40 x 1.5	-	143	38	-	-	SW 46	-	1.0
AVT 6	12	630	6 mm	91	-	-	31	-	-	-	0.14
AVT 8	25	630	8 mm	94	-	-	32	-	-	-	0.18
AV 10	30	630	10 mm	94	-	-	34	-	-	-	0.23
AVT 12	50	630	12 mm	114	-	-	38	-	-	-	0.32
CAV 1	30	500	M 16 x 1.5	-	42	19	-	-	SW 17	SW 22	0.05
CAV 2	50	500	M 20 x 1.5	-	51	21	-	-	SW 22	SW 24	0.07

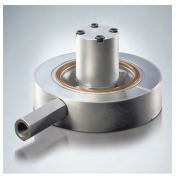
1) The values apply to a back pressure of approx. 10 bar (in a throttled direction)

Associated technical data sheets:
- Shut-off valve type AVT and AVM: D 7690
- Throttle valve and shut-off valve type AV: D 4583
- Throttle valve and shut-off valve CAV: D 7711

Similar products:
- Throttle and restrictor check valves type ED, RD, RDF: Page 222
- Throttle valves type Q, QR, QV, FG: Page 220

2.5 Check valves

Check valve type RK, RB, RC, RE and ER



Check valve and pre-fill valve type F

Check valves

Type	Design	p_{max} (bar)	Q_{max} (lpm)
RK, RB, RC, RE, ER	**Check valve** ▪ Insert valve ▪ Plug-in valve ▪ Combination with housing for in-line installation	RK - 0: 700 RK - 1: 700 RK - 2: 700 RK - 3: 500 RK - 4: 500 RK - 5: 500 RK - 6: 420 RK - 7: 420 RB - 0: 700 RB - 1: 700 RB - 2: 700 RB - 3: 500 RB - 4: 500 RC - 1: 700 RC - 2: 700 RC - 3: 500 RE - 0: 500 RE - 1: 500 RE - 2: 500 RE - 3: 450 RE - 4: 400 ER - 01: 500 ER - 11: 500 ER - 12: 500 ER - 13: 500 ER - 21: 500 ER - 31: 500 ER - 41: 400	RK - 0: 8 RK - 1: 20 RK - 2: 50 RK - 3: 80 RK - 4: 120 RK - 5: 240 RK - 6: 400 RK - 7: 620 RB - 0: 8 RB - 1: 20 RB - 2: 50 RB - 3: 80 RB - 4: 120 RC - 1: 20 RC - 2: 35 RC - 3: 60 RE - 0: 12 RE - 1: 25 RE - 2: 40 RE - 3: 70 RE - 4: 120 ER - 01: 6 ER - 11: 12 ER - 12: 15 ER - 13: 15 ER - 21: 30 ER - 31: 65 ER - 41: 120
CRK, CRB	**Check valve** ▪ Screw-in valve	CRK - 1: 500 CRK - 2: 500 CRK - 3: 500 CRB - 1: 500 CRB - 2: 500	CRK - 1: 30 CRK - 2: 50 CRK - 3: 80 CRB - 1: 20 CRB - 2: 30
B	**Check valve** ▪ Single valve for in-line installation	1: 500 2: 500 3: 500 4: 500 5: 500 6: 500 7: 500	1: 15 2: 20 3: 30 4: 45 5: 75 6: 120 7: 160

Releasable check valves

Type	Design / actuation	p_{max} (bar)	Q_{max} (lpm)
CRH, RHC	**Releasable check valve** ▪ Screw-in valve – Hydraulic	CRH - 1: 500 CRH - 2: 500 CRH - 3: 500 RHC - 1: 700 RHC - 2: 700 RHC - 3: 700 RHC - 4: 500 RHC - 5: 500 RHC - 6: 600	CRH - 1: 20 CRH - 2: 30 CRH - 3: 55 RHC - 1: 8 RHC - 2: 15 RHC - 3: 55 RHC - 4: 100 RHC - 5: 150 RHC - 6: 200
HRP	**Releasable check valve** ▪ Manifold mounting valve – Hydraulic – Electro-hydraulic	HRP - 1: 700 HRP - 2: 700 HRP - 3: 500 HRP - 4: 500 HRP - 5: 500 HRP - 7: 500	HRP - 1: 20 HRP - 2: 35 HRP - 3: 50 HRP - 4: 80 HRP - 5: 140 HRP - 7: 400
RH, DRH	**Releasable check valve** ▪ Single valve for in-line installation ▪ Manifold mounting valve – Hydraulic	RH - 1: 700 RH - 2: 700 RH - 3: 500 RH - 4: 500 RH - 5: 500 DRH - 1: 500 DRH - 2: 500 DRH - 3: 400 DRH - 4: 400 DRH - 5: 400	RH - 1: 15 RH - 2: 35 RH - 3: 55 RH - 4: 100 RH - 5: 160 DRH - 1: 16 DRH - 2: 30 DRH - 3: 60 DRH - 4: 90 DRH - 5: 140

Pre-fill valves

Type	Design / actuation	p_{max} (bar)	Q_{max} (lpm)
F	**Releasable check valve (pre-fill valve)** ▪ Valve in intermediate flange version – Hydraulic	25: 400 32: 400 40: 400 50: 400 63: 400 64: 300 80: 400 81: 400 100: 400 101: 300 125: 400 126: 400 160: 400 161: 400 200: 320	25: 100 32: 160 40: 250 50: 400 63: 630 64: 760 80: 1000 81: 1200 100: 1600 101: 1920 125: 2500 126: 3000 160: 4000 161: 4800 200: 7000

Line rupture protection valve, shuttle valves

Type	Design / adjustability	p_{max} (bar)	Q_{max} (lpm)
LB	**Line rupture protection valve** ▪ Screw-in valve ▪ Combination with housing for in-line installation – Tool adjustable, fixed	1: 500 2: 500 3: 500 4: 500 5: 300	1: 25 2: 50 3: 80 4: 160 5: 250
WV, WVC	**Shuttle valve** ▪ Single valve for in-line installation ▪ Screw-in valve	WV - 6 S: 700 WV - 8 S: 700 WV - 10 S: 500 WV - 12 S: 500 WV - 16 S: 500 WV - 18 L: 315 WVC - 1: 315 WVC - 11: 500	WV - 6 S: 6 WV - 8 S: 15 WV - 10 S: 25 WV - 12 S: 40 WV - 16 S: 100 WV - 18 L: 160 WVC - 1: 6 WVC - 11: 6

Check valves

2.5 Check valve type RK, RB, RC, RE and ER

Check valves are a type of non-return valve. They block the oil flow in one direction and open in the opposite direction. In the closed state they have zero leakage.
The check valve type RK, RB, RC and RE can be screwed-in, type ER can be plugged-in. The spring-loaded ball check valve type RK, RB and ER is very robust and insensitive to soiling. The spring-loaded plate valve type RC can be screwed-in in any direction and is particularly suitable for fast switching sequences. Type RE is a plate valve without a spring.
Type ER can be integrated directly in valves for manifold mounting. As such an additional intermediate plate is not necessary for the check valve function. Type RE is suitable for isolating pressurising loads or as a foot valve for a pump suctuion linde.

Features and benefits:

- Operating pressures
- Easily machined mounting holes
- Sturdy
- Type RK, RB also available with different pre-load pressures

Intended applications:

- General hydraulic systems
- Hydraulic pre-loading

Nomenclature:	**Check valve**
Design:	**Insert valve Plug-in valve Combination with housing for pipe connection**
p_{max}:	**700 bar**
Q_{max}:	**620 lpm**

Design and order coding example

RC 2 **- E**

Design with housing For pipe connection (E, F, G), type RK, RB and RC

Basic type, size Plug-in check valve
Type RK, RB, size 0 ... 7
Type RC, size 1 ... 3
Type RE, size 0 ... 4
Type RE, ER (check valve insert), size 0 to 4

Additional versions:

- Type RK with increased open-up pressure
- Type ER, stainless (size 01 ... 31)
- Type RK, RB, RC and RE with metric thread
- Type RK, RB with UNF thread

Function

RK
Ball seated valves

RB

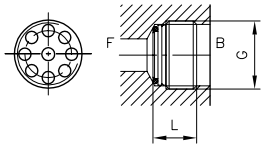
ER

RC
Shim type valves

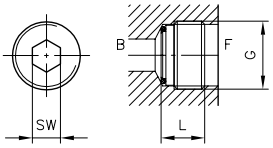
RE

General parameters and dimensions

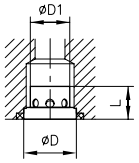
RK ..



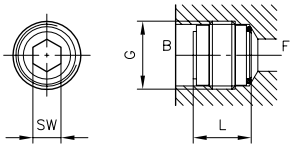
RB..



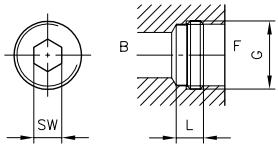
ER ..



RC ..



RE ..



	Q_{max} [lpm]	p_{max} [bar]	Ports	Dimensions [mm]		m [g]
				L	SW	
RK 0/RB 0	10	700	G 1/8 A, 7/16-20 UNF	7.2/7.9	SW 5	5
RK 1/RB 1	20	700	G 1/4 A, 9/16-18 UNF	9/10.3	SW 7	5
RK 2/RB 2	50	700	G 3/8 A, 9/16-18 UNF	11.2/11.7	SW 6	15
RK 3/RB 3	80	500	G 1/2 A, 9/16-18 UNF	13.5/13.2	SW 8	15/20
RK 4/RB 4	120	500	G 3/4 A, 9/16-18 UNF	17.5/17.5	SW 12	35/40
RK 5	240	500	G 1 A	22	-	85
RK 6	400	420	G 1 1/4 A	27.5	-	135
RK 7	620	420	G 1 1/2 A	35	-	280
RC 1	20	700	G 1/4 A	13	SW 4	6
RC 2	35	700	G 3/8 A	15	SW 5	13
RC 3	60	500	G 1/2 A	18	SW 8	24
RE 0	12	500	G 1/8 A	5	SW 4	2
RE 1	25	500	G 1/4 A	6	SW 5	4
RE 2	40	500	G 3/8 A	7	SW 8	6
RE 3	70	450	G 1/2 A	7.5	SW 10	10
RE 4	120	400	G 3/4 A	9	SW 12	18
				L	**D/D1**	**m[g]**
ER 0	6	500	G 1/8 A	5.6	6.1/4.6	0.5
ER 1	12	500	G 1/4 A	5.6	8.6/6.5	1
ER 2	30	500	G 3/8 A	8	14/10.5	5
ER 3	65	500	G 1/2 A	10	17/13	9
ER 4	120	400	G 3/4 A	17.5	28/21	40

Associated technical data sheets:

- Check valve type ER and EK: D 7325
- Check valve type RE: D 7555 R
- Check valves, type RC: D 6969 R
- Check valve type RK and RB: D 7445

Similar products:

- Check valves type CRK, CRB: Page 234
- Check valves type B: Page 236
- Restrictor check valves type EB, BE, BC: Page 218

Check valves

2.5 Check valve type CRK and CRB

Check valves are a type of non-return valve. They block the oil flow in one direction and open in the opposite direction. In the closed state they have zero leakage.

Features and benefits:

- Screw-in valves

Intended applications:

- General hydraulic systems

Nomen-clature:	Check valve
Design:	Screw-in valve
p_{max}:	500 bar
Q_{max}:	80 l/min

Design and order coding example

CRK 2	- 1/4

Individual connection block for pipe connection

Basic type Check valves type CRK and CRB, size 1 to 3

- With/without tapped plug
- With/without tapped blockage/plug combination

Function

CRK

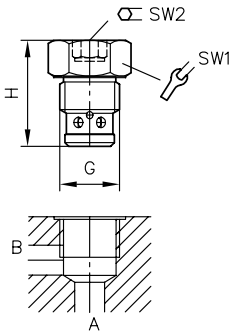
CRK

CRB

CRB

General parameters and dimensions

CRK, CRB



	Q_{max} [lpm]	p_{max} [bar]	Ports	Dimensions			m [g]
			G	H [mm]	SW 1	SW = a/f 2	
CRK 1 / CRB 1	30	500	M 16 x 1.5	31	SW 22	SW 8	70
CRK 2 / CRB 2	50		M 20 x 1.5	35	SW 24	SW 10	110
CRK 3	80		M 24 x 1.5	38	SW 30	SW 12	125

Associated technical data sheets:

- Check valve type CRK, CRB and CRH: D 7712

Similar products:

- Check valves RK, RB, RC, RE, ER: Page 232

Check valves

2.5 Check valve type B

Check valves are a type of non-return valve. They block the oil flow in one direction and open in the opposite direction. In the closed state they have zero leakage.
The check valve type B is available in different housing forms and is suitable for direct in-line installation.
The check valve type B is suitable for usage as a foot valve for a pump suction line due to the low opening pressure.

Features and benefits:

- Flow up to 160 l/min
- Pipe installation

Intended applications:

- General hydraulic systems

Nomen-clature:	**Check valve**
Design:	**Individual valve for in-line installation**
p_{max}:	**500 bar**
Q_{max}:	**160 lpm**

Design and order coding example

B 1 - 2

Basic type, with housing, size Check valve type B, version with housing 1 to 3, size 1 to 7

Additional versions:

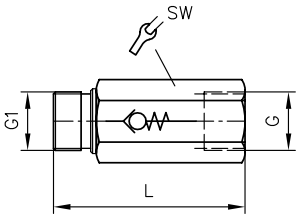
- Open-up pressure 3 bar

Function

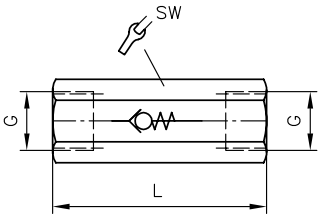
B

General parameters and dimensions

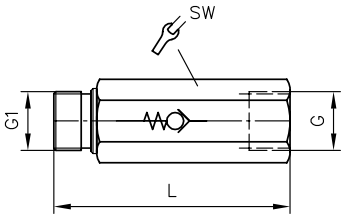
B 1



B 2



B 3



Basic type	Size	Q_{max} [lpm]	p_{max} [bar]	Ports		Dimensions		m [kg]
				G	G1	L [mm]	SW = a/f	
B 1 B 2 B 3	-1	15	500	G 1/4	G 1/4 A	50 ... 60	SW 19	0.11
	-2	20		G 3/8	G 3/8 A	58 ... 67	SW 24	0.16
	-3	30		G 1/2	G 1/2 A	60 ... 66	SW 27	0.19
	-4	45		G 3/4	G 3/4 A	70 ... 78	SW 36	0.36
	-5	75		G 1	G 1 A	94 ... 114	SW 41	0.65
	-6	120		G 1 1/4	G 1 1/4 A	110 ... 130	SW 55	1.3
	-7	160		G 1 1/2	G 1 1/2 A	115 ... 136	SW 60	1.5

Associated technical data sheets:

- Check valves, type B: D 1191

Similar products:

- Check valves type RK, RB, RC, RE, ER: Page 232

Check valves

2.5 Releasable check valve type CRH and RHC

Check valves with hydraulic release are a type of check valve. They block one or both hydraulic consumer lines or are used as a hydraulically actuated drain or circulation valve. Check valve type CRH and RHC has zero leakage when closed.

It can be screwed-in and can be integrated into control blocks. The necessary mounting holes are straightforward to make.

Check valve type CRH and RHC is available with hydraulic release. Hydraulic release suppresses relief surges that can occur at high pressure and with a large consumer volume.

Features and benefits:

- Screw-in valve
- Pressures up to 700 bar
- Flows up to 200 l/min
- Sturdy

Intended applications:

- Industrial hydraulics
- Construction machines

Nomen-clature:	Check valve with hydraulic release
Design:	Valve insert Screw-in valve
Actuation:	Hydraulic
p_{max}:	700 bar
Q_{max}:	200 l/min

Design and order coding example

CRH 3 V

Function
Without pre-release (-)
With pre-release (V)

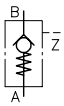
Basic type, size
Releasable check valve
type CRH, size 1 to 3 and
type RHC, size 1 to 6

Additional versions:

- With higher pilot ratio (approx. 4.5 : 1)
- With sealed tapped journal and control piston
- Wth hydraulic relieve of the control piston (type RHCE)

Function

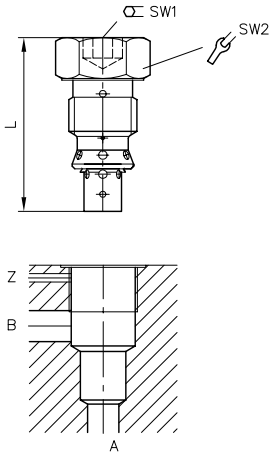
CRH, RHC



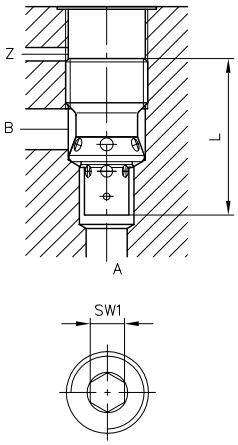
CRH

General parameters and dimensions

CRH



RHC



	Q_{max} [lpm]	p_{max} [bar]	Release ratio	Ports (BSPP)	Dimensions			m [g]
			p_a / p_z		L [mm]	SW = a/f 1	SW = a/f 2	
CRH 1	30	500	2.6	M 16 x 1.5	47	SW 8	SW 22	60
CRH 2	50	500	2.6	M 20 x 1.5	53	SW 10	SW 24	90
CRH 3	80	500	2.5	M 24 x 1.5	61	SW 12	SW 30	150
RHC 1	15	700	2.6	M 16 x 1.5	32	SW 6	-	20
RHC 2	25	700	2.6	M 20 x 1.5	37.5	SW 8	-	40
RHC 3	55	700	2.5	M 24 x 1.5	47	SW 10	-	70
RHC 4	100	500	2.5	M 30 x 1.5	56	SW 12	-	140
RHC 5	150	500	2.8	M 36 x 1.5	67.5	SW 14	-	250
RHC 6	200	500	2.5	M 42 x 1.5	97	SW 19	-	500

Associated technical data sheets:
Releasable check valves

- Check valve type CRK, CRB and CRH: D 7712
- Releasable check valve type RHC and RHCE: D 7165

Similar products:

- Type HRP: Page 240
- Type RH: Page 242

Check valves

2.5 Releasable check valve type HRP

Check valves with hydraulic release are a type of check valve. They block one or both hydraulic consumer lines or are used as a hydraulically actuated drain or circulation valve. In the closed state the check valve type HRP has zero leakage. A leakage line relieves the rear of the control piston. Due to this separate relief the control behaviour of the valve is independent of the pressure in the return.

A solenoid valve can be optionally flange-mounted to arbitrarily control the check valve with the load pressure on the consumer side. The check valve type HRP is available with a hydraulic release. Hydraulic release suppresses relief surges that can occur at high pressure and with a large consumer volume.

Features and benefits:

- Manifold mounting valve for pressures up to 700 bar
- Flows up to 400 lpm
- Electrically controlled
- With hydraulic release for smooth switching

Intended applications:

- Industrial and mobile hydraulics

Nomen-clature:	**Check valve with hydraulic release**
Design:	**Manifold mounting valve**
Actuation:	**Hydraulic Electro-hydraulic**
p_{max}:	**700 bar**
Q_{max}:	**400 l/min**

Design and order coding example

HRP 4 | V | - B 0,4 | - WH 1H B 0,4-G24

Optionally with directly mounted 3/2-way directional seated valve — For arbitrary open-up or for use as 2/2-way directional seated valve

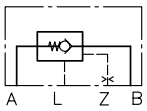
Optionally with orifice insert at control port Z — For preventing decompression surges

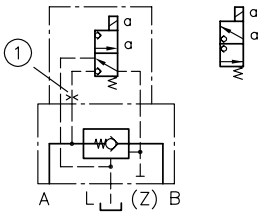
Function — Without pre-release (-)
With pre-release (V)

Basic type, size — Check valve with hydraulic release HRP, size 1 to 7

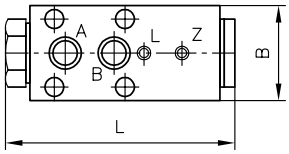
Function

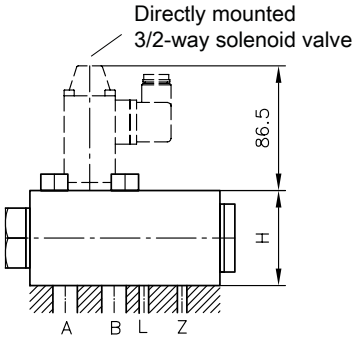
HRP





General parameters and dimensions





1 Flange-mounted 3/2-way solenoid valve

	Q_{max} [lpm]	p_{max} [bar]	Release ratio	Dimensions [mm]			m [kg]
			p_A / p_Z	H	B	L	
HRP 1	20	700	2.9	20	25	74.5	0.25
HRP 2	35	700	3.9	25	30	78	0.4
HRP 3	50	500	4.3	35	35	83	0.7
HRP 4	80	500	3.8	35	50	103.5	1.2
HRP 5	140	500	4.0	40	60	120.5	1.9
HRP 7 V	400	500	3.0	63	100	190	8.0

Associated technical data sheets:

- Releasable check valve type HRP: D 5116

Similar products:

- Releasable check valves type RH: Page 242
- Releasable check valve type RHV: D 3056
- Releasable check valves type CRH, RHC: Page 238
- Releasable twin check valves type DRH: Page 242

Check valves

2.5 Releasable check valve type RH and DRH

Check valves with hydraulic release are a type of check valve. They block one or both hydraulic consumer lines or are used as a hydraulically actuated drain or circulation valve. In the closed state the check valve type RH and DRH has zero leakage. The type DRH is a twin check valve for double-acting consumers.
The check valve type RH and DRH is available with a hydraulic release. Hydraulic release suppresses relief surges that can occur at high pressure and with a large consumer volume.

Features and benefits:
- Pressures up to bar
- with hydraulic release for smooth switching

Intended applications:
- Blocking of leak-free hydraulic cylinders
- Return flow relief
- Hydraulically actuated drain or circulation valve

Nomenclature:	Check valve with hydraulic release or twin check valve
Design:	Individual valve for ▪ Pipe connection ▪ Manifold mounting
Adjustment:	Hydraulic
p_{max}:	700 bar
Q_{max}:	160 l/min

Design and order coding example

RH 3 V

Function Without pre-release (-)
With pre-release (V)

Basic type, size Releasable check valve RH, size 1 to 5

DRH 3 LSS - 30 /100

Pre-charge pressure [bar]

Pressure setting [bar]

Basic type, size, function Releasable double check valve DRH, size 1 to 5

Additional versions:
- With pre-release (one or both sides)
- With shock valves (for hydraulic motors)
- With safety valve preventing slow pressure rises
- With leakage port preventing unintended open-up when pressure migrated from the control side
- Manifold mounting version (type DRH3P)

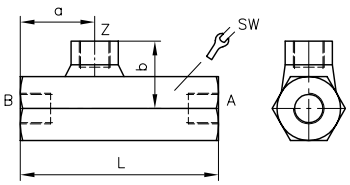
Function

RH

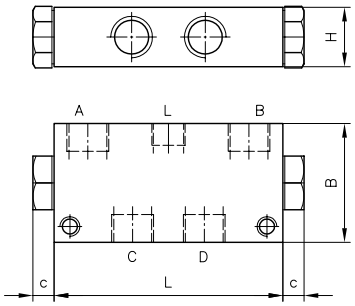
DRH

General parameters and dimensions

RH..



DRH..



	Q_{max} [lpm]	p_{max} [bar]	Release ratio $p_{A(B)}/p_Z$	Ports		Dimensions [mm]				m [kg]
				A, B, C, D	Z	L	a	b	SW = a/f	
RH 1	15	700	2.7	G 1/4	G 1/4	84	31.5	27	SW 24	0.4
RH 2	35	700	3	G 3/8		90	32	28.5	SW 27	0.4
RH 3	55	500	2.4	G 1/2		100	36.5	31	SW 32	0.6
RH 4	100	500	2.4	G 3/4		126	45	35.5	SW 41	1.3
RH 5	160	500	3	G 1		143	52	38	SW 46	1.8
						L	B	H	c	
DRH 1	16	500	2.5	G 1/4	-	70	45	20	8	0.5
DRH 2	30	500		G 3/8		89	60	30	10	1.2
DRH 3	60	500		G 1/2		115	60	30	13	1.6
DRH 4	90	400		G 3/4		150	70	40	15.5	2.9
DRH 5	140	400		G 1		195	80	50	17	5.5

Associated technical data sheets:

- Releasable check valve type RH: D 6105
- Releasable twin check valve type DRH: D 6110

Similar products:

- Releasable check valve type RHV: D 3056
- Type CRH and RHC: Page 234
- Type HRP: Page 240

Check valves

2.5 Check valve and pre-fill valve type F

Check valves and pre-fill valves are a type of non-return valve. Check valves block the oil flow in one direction and open in the other direction. Pre-fill valves are check valves with hydraulic release. They are used, e.g. in top ram presses for suction and emptying the press cylinder on rapid closing and opening.

The check valve and pre-fill valve type F is a spring-loaded disk valve and has zero leakage in the closed state. The valve is attached directly to the cylinder and clamped between the base of the cylinder and the welding-neck flange. Alternatively the valve is installed in the line between the front faces of the welding-neck flanges.

The valves type F25 - F80 are available with hydraulic release. Hydraulic release suppresses relief surges that can occur at high pressure and with a large consumer volume.

Features and benefits:

- Wafer design
- Extremely large flows, up to 7000 l/min

Intended applications:

- Press control systems
- Injection moulding machines

Nomen-clature:	**Check valve Check valve with hydraulic release (pre-fill valve)**
Design:	**Intermediate section between pipe flanges**
Actuation:	**Hydraulic**
p_{max}:	**400 bar**
Q_{max}:	**7000 l/min**

Design and order coding example

F25

Basic type, size Check valve type F, size 25 to 200

F81B-36 **V**

Additional versions: Without pre-release (-)
With pre-release (V), size 25 to 80

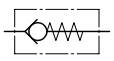
Basic type, size Pre-fill valves type F, size 25 to 200

Additional functions

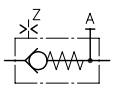
- With holes in the mounting flange (B)

Function

Check valve

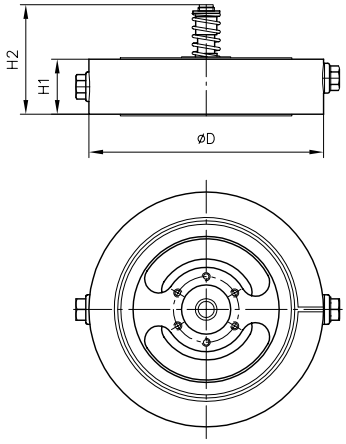


Pre-fill valve

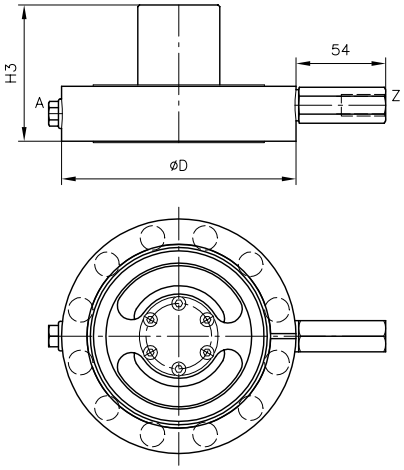


General parameters and dimensions

Check valve



Pre-fill valve



		Q_{max} [lpm]	p_{max} [bar]	Release ratio	Dimensions [mm]				m [kg]	
Check valve	**Pre-fill valve**			p_A / p_Z	**D**	**H1**	**H2**	**H3**	**Check valve**	**Pre-fill valve**
F 25	**F 25-12**	100	400	4.3	83	26	36	43	1	1.1
F 32	**F 32-16**	160		3.6	93	27	45	55	1	1.2
F 40	**F 40-20**	250		3.9	108	28	48.5	60	1.4	1.7
F 50	**F 50-25**	400		4.2	128	29	59	72	2	2.4
F 63	**F 63-30**	630		4.2	143	33.5	69	83	2.8	3.4
	F 64 B-30	760		4,2	143	33,5	69	83	2,8	3,4
F 80	**F 80-36**	1000		4.5	169	38.5	83	97.5	4.4	5.2
	F 81 B-36	1200		4,5	169	38,5	83	97,5	4,4	5,2
F 100	**F 100-45**	1600		4.3	212	44	97	118	9.9	11.7
	F 101 B-45	1920		4,3	212	44	97	118	9,9	11,7
F 125	**F 125-60**	2500		4.3	248	51	127	155	15.8	19.6
	F 126 B-60	3000		4.3	248	65	-	175	-	19.7
F 160	**F 160-76**	4000		4.3	310	70	182	233	43	50
	F 161 B-76	4800		4.3	310	85	-	245	-	44
F 200	**F 200-100**	7000	320	4.0	420	150	250	300	114	120

Associated technical data sheets:

- Check valve and pre-fill valve type F: D 6960

Check valves

2.5 Line rupture protection valve type LB

Line rupture protection valves, also called pipe rupture protection valves are a type of check valve. The valves are normally mounted directly on the cylinder. They prevent uncontrolled cylinder movement in the event of a pipe rupture or hose break.
The line rupture protection valve type LB offers a high level of safety in the event of pressure peaks. It features reproducibly accurate and secure closing at the pre-set trigger flow rate. Higher flow rates cause a plate raised from the valve seat by a spring to be pressed onto the housing seat by the flow forces and cause the valve to close. A variant with orifice bore in the valve plate permits a low flow rate in the locking direction. Type LB is available as a screw-in valve or in a housing version for in-line installation.
The line rupture protection valve type LB is used in industrial vehicles, lifting platforms and lifting equipment.

Features and benefits:

- Pressures up to 500 bar

Intended applications:

- Industrial trucks
- Lifting devices

Nomen-clature:	**Line rupture safety valve**
Design:	**Insert valve Combination with housing for pipe connection**
Adjustment:	**Fixed**
p_{max}:	**500 bar**
Q_{max}:	**160 l/min**

Design and order coding example

LB 2 | **G** | **1,0** | **- 25**

Response flow [lpm] Trigger volumetric flow Q_A in l/min

With/without orifice Orifice diameter 0.5 / 0.8 / 1.0 / 1.2 / 1.5 / 2 (dep. on type and size)

Design
- Screw-in valve (C)
- Design with housing (F, G)
- Fitting

Basic type, size: Line rupture safety valve type LB, size 2 to 4
- Version with imperial thread
- Version with metric thread
- Design with UNF thread

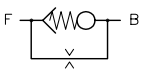
Function

LB

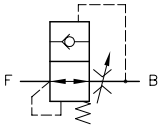
Simplified

Series

With orifice

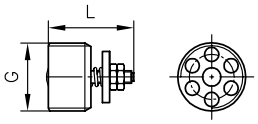


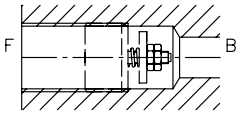
Detailed



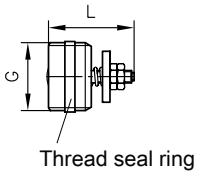
General parameters and dimensions

LB ..C
Screw-in valve



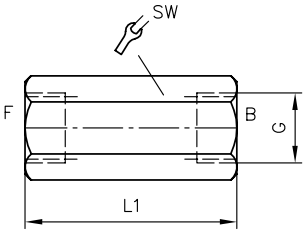


LB 11(21)C

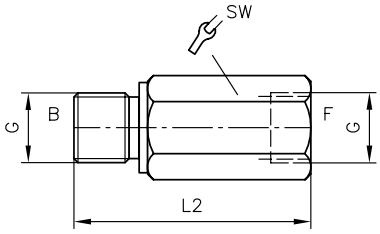


LB ..G

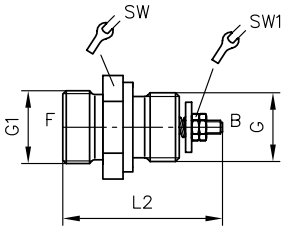
Valve with housing



LB ..F



LB 3 E
LB 4 E



	Q_{max} [lpm]	p_{max} [bar]	Ports		Dimensions [mm]					m [g][2]
			G	G1	L	L1	L2	SW = a/f	SW = a/f 1	
LB 1 (C, G, F)	4 ... 25	500	G 1/4 (A)	-	17.5	48	50	a/f 19	-	6 / 70
LB 11 C[1]	4 ... 25	700	G 1/4 (A)	-	17.5	-	-	-	-	6 / 70
LB 2 (C, G, F)	6.3 ... 50	500	G 3/8 (A)	-	21	52	58	a/f 22	-	12 / 100
LB 21 C[1]	6.3 ... 45	700	G 3/8 (A)	-	25	-	-	-	-	12 / 100
LB 3 (C, G, F)	16 ... 80	500	G 1/2 (A)	-	25	60	65	a/f 27	-	21 / 170
LB 4 (C, G, F)	25 ... 160	500	G 3/4 (A)	-	30.5	72	78	a/f 36	-	45 / 375
LB 3 E **LB 4 E**	4 ... 160	500	G 1/4 A - G 3/4 A	M18x1.5 - M36x2	-	-	46.8 - 64.4	SW 27 - SW 41	SW 7	150/210
LB 5	80 ... 200	300	G 1	-	38	-	-	-	-	102

1) Mounting thread, additionally sealed
2) Dimensions for insert valve and/or housing version

Associated technical data sheets:

- Line rapture protection valves, type LB: D 6990
- Line rupture safety valves type LB.E
  as a screw joint: Sk 6990 E

2.5 Shuttle valve type WV and WVC

Shuttle valves are a type of check valve. They have two inlets and one outlet. As soon as a pressure signal is present on at least one of the two inlets, an outlet signal is generated. The inlet with the higher pressure is automatically connected to the outlet. The other inlet with lower pressure is blocked by a ball (OR operator).
The shuttle valve type WV is integrated in a T-fitting for pipe connection. The type WVC is a screw-in valve. The shuttle valves can withstand pressures up to 700 bar and have low flow resistances.
They can be used for transmitting control pressures or control and operating volumetric flows.

Features and benefits:

- Pressures up to 700 bar
- Insert and housing versions

Intended applications:

- In load-sensing systems
- Construction and construction materials machinery
- Cranes and lifting equipment
- Road vehicle
- General mobile hydraulics

Nomen-clature:	Shuttle valve
Design:	Individual valve for pipe mounting Valve insert Screw-in valve
p_{max}:	700 bar
Q_{max}:	160 l/min

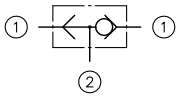
Design and order coding example

WV 10 - S

Design
- High pressure version (S)
- Low pressure version (L)

Basic type, size
Type WV for pipe connection, size 6 to 18
Type WVC and WVH as screw-in valve, size 1
Type WVE as screw-in valve, size 11

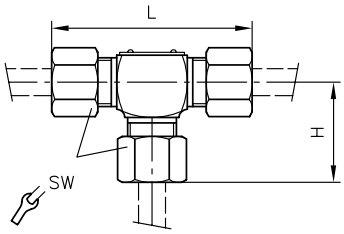
Function



1 Inlet
2 Outlet

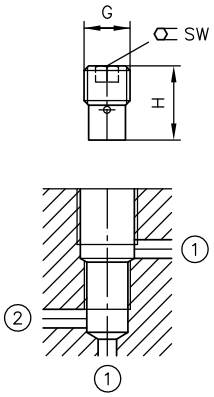
General parameters and dimensions

WV

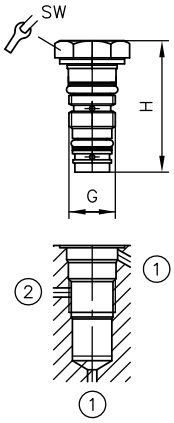


1 Inlet
2 Outlet

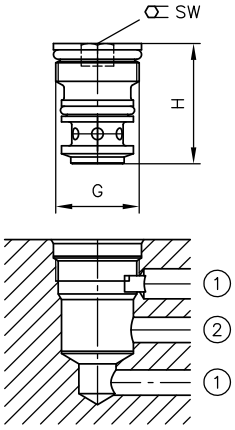
WVC



WVH



WVE



	Q_{max} [lpm]	p_{max} [bar]	External pipe Æ [mm]	Mounting thread	Dimensions [mm]			m [g]
				G	L	H	SW = a/f	
WV 6 - S	6	700	6	--	62	31	17	120
WV 8 - S	15		8		64	32	19	170
WV 10 - S	25	500	10		68	34	22	225
WV 12 - S	40		12		76	38	24	290
WV 14 - S	60		14		80	40	27	320
WV 16 - S	100		16		86	43	30	390
WV 18 - L	150	315	18		80	40	32	340
WVC 1	6		--	M 10 x 1	--	16	5	7
WVH 1	3	700	--	M 10 x 1	--	28.5	14	10
WVE 11	25	500	--	M 18 x 1	--	26	10	20

Associated technical data sheets:

- Shuttle valve type WV and WVC: D 7016

Similar products:

- Shuttle valves type WVH: **Sk 7962**
- Shuttle valves type WVE: **Sk 7088 050**

Hydraulic cylinders and hydraulic motors

Hydraulic clamps type HSE and HSA

Hydraulic motor type M60N

Hydraulic cylinders

Type	Nomenclature / design	p_{max} (bar)	H_{Stroke} (mm)
HSE, HSA	**Hydraulic clamps** ▪ Screw-in version ▪ Manifold mounting	HSE - 12: 500 HSE - 16: 500 HSE - 20: 500 HSE - 24: 500 HSA - 32: 500 HSA - 40: 500	HSE - 12: 8 HSE - 16: 12 HSE - 20: 20 HSE - 24: 20 HSA - 32: 20 HSA - 40: 25

Hydraulic motors

Type	Nomenclature / design	p_{max} (bar)	V_{max} (cm^3/rev)
M60N	**Axial piston fixed motor** **Intended applications:** ▪ Machines for forestry and agricultural purposes ▪ Fan drives ▪ Construction machines ▪ Municipal trucks **Features and benefits:** – Optimised power-to-weight ratio – Rotation speed – Different shaft and flange versions	Operation/peak: 012: 350/400 017: 350/400 025: 350/400 034: 350/400 047: 350/400 064: 350/400 084: 350/400 108: 350/400	012: 12.6 017: 17 025: 25.4 034: 34.2 047: 47.1 064: 63.5 084: 83.6 108: 108

3 Hydraulic clamps type HSE and HSA

Hydraulic clamping cylinder generate a pressure-controlled clamping force at the piston. Without pressure the clamping pistons return to their initial position.
The clamping cylinder type HSE is a screw-in cylinder. The type HSA is a screw-on cylinder. Very high forces can be transmitted in a very small space in fixtures.
The clamping cylinder type HSE and HSA is used in machine tools, machining centres and chucks for clamping, fasten, lock or fix workpieces, tools or machine structures.

Features and benefits:

- Compact design
- Operating pressure up to 500 bar

Intended applications:

- Clamping systems
- Securing systems
- Machine tools

Nomen-clature:	Hydraulic clamps
Design:	Screw-in version Manifold mounting
p_{max}:	500 bar
F_{max}:	60000 N

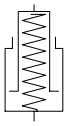
Design and order coding example

HSE 24	- 15
Basic type, piston diameter [mm]	Stroke [mm] Stroke H

Screw-in version type HSE
Manifold mounting version type HSA

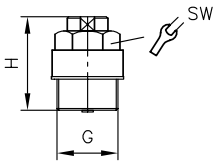
Function

HSE, HSA

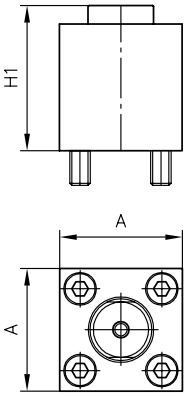


General parameters and dimensions

HSE ..
Hydraulic screw-in clamps



HSA ..
Manifold mounting hydraulic clamps



	Q_{max} [lpm]	Stroke [mm]	F_{max} [N]	Ports	Dimensions [mm]				m [kg]
			with 500 bar		H	H1	SW = a/f	A	
HSE 12	500	2 ... 8	5500	M 20 x 1.5	20.5 ... 32.5	-	SW 24	-	0.05 ... 0.08
HSE 16		3 ... 12	10000	M 24 x 1.5	26.5 ... 41.5	-	SW 24	-	0.08 ... 0.12
HSE 20		4 ... 20	15000	M 30 x 1.5	28.5 ... 56	-	SW 30	-	0.14 ... 0.3
HSE 24		5 ... 20	23000	M 36 x 1.5	34 ... 65	-	SW 36	-	0.25 ... 0.5
HSA 32		20	40000	-	-	71	-	60	1.6
HSA 40		25	60000	-	-	85	-	70	2.5

Associated technical data sheets:

- Hydraulic clamps type HSE and HSA: D 4711

3 Axial piston motor type M60N

Axial piston motors are constant motors. They have a constant displacement and therefore generate a fixed rotation speed dependent on the flow rate.
The axial piston motor type M60N is designed for open and closed circuits and operates based on the bent axis principle.
The motor is particularly suitable for usage in mobile applications.

Features and benefits:

- Optimized power-to-weight ratio
- Rotation speed
- Different shaft and flange versions

Intended applications:

- Machines for forestry and agricultural purposes
- Fan drives
- Construction machines
- Municipal trucks

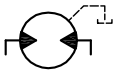
Nomen-clature:	Axial piston fixed motor
Design:	Individual motor
p_{max}:	400 bar
$V_{g\ max}$:	130 cm³/rev

Design and order coding example

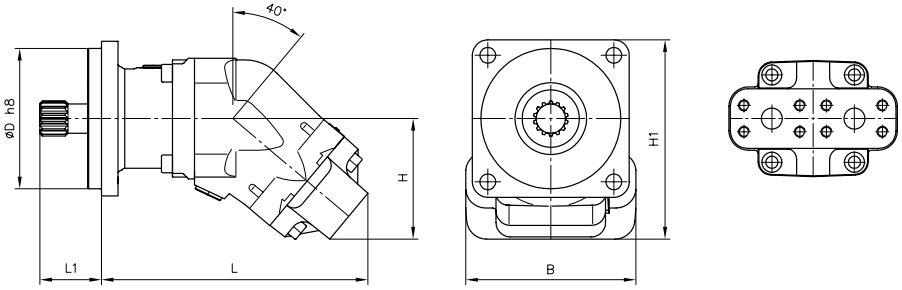
M60N | - 064 | B | S | F | N | - S1 | 00 | -G

- **Basic type**
- **Nominal size**
- **Rotating direction**: Any (B)
- **Shaft version**
  - ISO 14 parallel key splined shaft
  - SAE J744 parallel key
  - SAE J744 spline shaft and flange
  - DIN 6885 parallel key
- **Flange version**
  - Flange ISO 7653 - 1985
  - Flange SAE J744
  - Flange ISO 3019 - 2
- **Seals**: NBR (N), FKM (V), HNBR (H)
- **Version with housing**
  - Axial version
  - Radial version
- **Speed sensor**: With/without speed sensor
- **Ports**

Function



General parameters and dimensions



Parameters

	Geom. displace-ment	Nom. pressure	Max. speed	Dimensions [mm]						m [kg]
	V_g [cm³/rev]	p_{nom} (p_{max}) [bar]	n [rpm]	L	L1	H	H1	B	∅D	
M60N- 012	12,6	350	7500	206	46	97	147,8	-	101,6	9
M60N- 017	17,0	350	7500	206	46	97	147,8	-	101,6	9
M60N- 025	25,4	350	5900	206	46	97	147,8	-	101,6	9
M60N- 034	34,2	350	5900	206	46	97	147,8	-	101,6	9
M60N- 040	41,2	350	5300	242	56	97	147,8	-	101,6	9
M60N- 047	47,1	350	5300	242	56	109	172,5	155	127	9
M60N- 056	56,7	350	5300	242	56	109	172,5	155	127	9
M60N- 064	63,5	350	5300	242	56	109	172,5	155	127	9
M60N- 084	83,6	350	4400	264	56/74	129	192.5/205.2	-	127/152.4	18/35
M60N- 090	90,7	350	4400	264	56/74	129	192.5/205.2	-	127/152.4	18/35
M60N- 108	108,0	350	4400	264	56/74	129	192.5/205.2	-	127/152.4	18/35
M60N- 130	130,0	350	4200	264	56/74	129	192.5/205.2	-	127/152.4	18/35

Associated technical data sheets:

- Axial piston motors type M60N: D 7960 M

Similar products:

- Fixed displacement axial piston pumps type K60N: Page 30

Suitable proportional directional spool valve:

- Type EDL: Page 82
- Type PSL/PSV size 2, 3 and 5: Page 90
- Type PSLF/PSVF size 3, 5 and 7: Page 96

Suitable load-holding valves:

- Type LHK, LHDV, LHT: Page 198

Hydraulic accessories

Pressure switches type DG and analogous electronic pressure transducers

Hydraulic accumulators

Type	Design / piston diameter	p_{max} (bar)	Nominal volume (dm^3)
AC	**Hydraulic accumulators** ▪ Screw-in version	13: 500 40: 400 202: 250 603: 330 725: 250 1002: 210 1035: 350 1414: 140 2001: 100 2002: 250 2035: 350 2825: 250 3225: 210	13: 0.01 40: 0.04 202: 0.16 603: 0.60 725: 0.08 1002: 1.00 1035: 1.00 1414: 1.40 2001: 1.95 2002: 1.90 2035: 1.95 2825: 2.80 3225: 0.32
HPS	**Piston type accumulator** ▪ In-line installation – 50 ... 180 mm	350	0.1 ... 40.00

Hydraulic accessories

Type	Nomenclature / design	Features	p_{max} (bar)
DG	**Spring-loaded piston-type pressure switch, electronic pressure switch** ▪ Manifold mounting ▪ Screw-in version ▪ Version for pipe connection ▪ Electronic (analogue) pressure transducers	**Features and benefits:** ▪ Compact design ▪ Option of integration into the HAWE modular system ▪ Operating pressures up to 1000 bar	1, 5E: 600 3: 700 6: 400
PFM	**Pressure filter** ▪ Pressure filter	▪ Energy-efficient thanks to low back pressure ▪ Long change intervals due to high dirt-holding nominal volume ▪ Filter element replacement is simple and clean	250
Fittings	**Reducing connector, connection fitting, screen filter, filter element, pressure gauge** ▪ Screw-in version ▪ Version for pipe connection	**Features and benefits:** ▪ Compact design ▪ Option of integration into the HAWE modular system ▪ Operating pressures up to 700 bar	350 ... 700

4 Diaphragm accumulator type AC

Diaphragm accumulators are a type of hydraulic accumulator. A diaphragm separates the compressible gas cushion from the hydraulic fluid.
The diaphragm accumulator type AC is used as a source of pressurized oil. It supports or increases the pump delivery flow or stores pressure energy, e.g. for an accumulator charge circuit.
It is used in clamping hydraulics to compensate for volume changes in the event of temperature fluctuations, to cover any leakage losses or for oscillation damping.
With the aid of different fittings the hydraulic accumulator type AC can be integrated into a hydraulic system. Different installation orientations and installation positions are possible.

Features and benefits:

- Compact design
- Option of integration into the HAWE modular system
- Operating pressures up to 500 bar

Intended applications:

- Clamping systems
- Jigs
- Accumulator charging systems

Nomen-clature:	Hydro-pneumatic accumulator
Design:	Screw-in version
p_{max}:	500 bar
V_{max}:	3.5 dm³

Design and order coding example

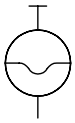
AC 2001	/90	/3A

/3A — Connection thread (hydraulic side)
/90 — Gas pre-charge pressure [bar]
AC 2001 — Basic type, size: Hydraulic accumulator type AC

AC 40 ACS 13	- 1/4 - 1/4	- 200 - 50	/110

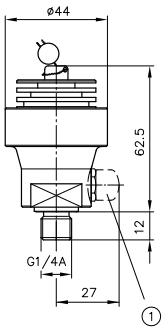
/110 — Setting shut-off valve [bar]
- 200 / - 50 — Gas pre-charge pressure [bar]
- 1/4 / - 1/4 — Connection thread
AC 40 / ACS 13 — Basic type, nom. volume: Hydraulic miniature accumulator type AC and type ACS with shut-off valve, nom. volume in cm³

Function



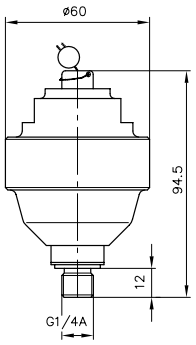
General parameters and dimensions

AC(S) 13 - 1/4

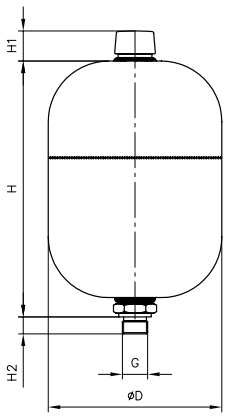


1 Shut-off valve

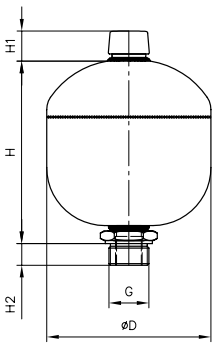
AC 40 - 1/4



AC 0725, AC 202, AC 322, AC 1414



AC 603, AC 1002, AC 2002, AC 2825



	V_0 [dm³]	p_{max} [bar]	Max. gas filling pressure p_0 [bar]	Ports	Dimensions [mm]				m [kg]
					H	H1	H2	D	
Hydraulic miniature accumulator									
AC 13-1/4	0.013	500	250	G 1/4 A	see illustration				0.3
ACS 13-1/4	0.013	500	250	G 1/4 A	see illustration				0.3
AC 40-1/4	0.040	400	250	G 1/4 A	see illustration				0.65
Hydraulic accumulator									
AC 0725/1A	0.075	250	130	G 1/4 A	81	26.5	12	64	0.6
AC 202/2A	0.16	250	130	G 3/8 A	102	26.5	-	74	0.8
AC 322/2A	0.32	210	130	G 3/8 A	101.5	25	12	92.5	1.4
AC 603/3	0.6	330	130	G 1/2	149	23	-	115	3.3
AC 1002/22	1.0	210	130	M 22 x 1,5	151	25	18	136	3.5
AC 1414/2A	1.4	140	130	G 3/8 A	162	25	18	147	4.2
AC 2002/4	1.95	250	130	G 3/4	229	25	-	155	7.5
AC 2825/3	2.8	250	130	G 1/2	246	26.5	18	167	8.2

Associated technical data sheets:

- Miniature hydraulic accumulators, type AC: D 7571
- Diaphragm accumulator type AC: D 7969

Hydraulic accessories:

- Fittings type X84: Page 266

Similar products:

- Piston type accumulator type HPS: Page 260

4 Piston type accumulator type HPS

Piston type accumulators are a type of hydraulic accumulator. A freely moving piston separates the compressible gas cushion from the hydraulic fluid.
The piston type accumulator type HPS supports or increases the pump delivery flow or stores pressure energy. It is used in clamping hydraulics to compensate for volume changes in the event of temperature fluctuations, to cover any leakage losses or to dampen oscillations.
The piston type accumulator type HPS can be installed in different situations with the aid of suitable fastening clips.

Features and benefits:

- Compact design
- Option of integration into the HAWE modular system

Intended applications:

- Accumulator charging systems
- Construction machines
- Wind power plants
- Machine tools

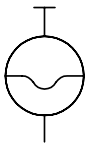
Nomenclature:	**Piston accumulator**
Operation pressure:	**350 bar**
Nominal volume:	**0.1 - 40 dm³**
Internal piston diamater:	**50 - 180 mm**

Design and order coding example

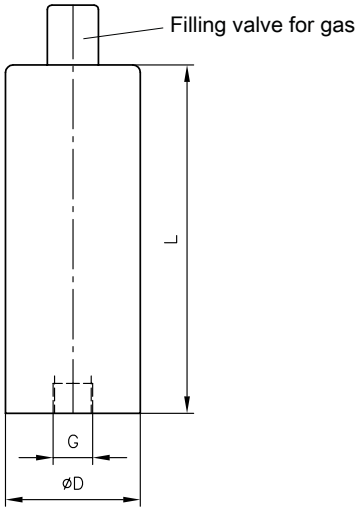
HPS 10 - 350 - 160 - 0050

- **Nom. volume** V_0 [dm³]
- **Int. diameter [mm]**
- **max. operating pressure [bar]** 350 bar
- **Basic type** Piston type hydraulic accumulator type HPS

Function



General parameters and dimensions



1 Gas-filling valve

	Nominal volume V_0 [dm³]	p_{max} [bar]	Ports	Dimensions [mm]	
			G	D	L
HPS 10 - 350 - 050	0.1 ... 1.0	350	G 3/4	60	130 ... 588
HPS 10 - 350 - 080	0,4 ... 4,0		G 3/4	95	166 ... 883
HPS 10 - 350 - 100	2.0 ... 10.0		G 1	115	381 ... 1400
HPS 10 - 350 - 140	4.0 ... 25.0		G 1 1/2	160	418 ... 1783
HPS 10 - 350 - 160	6.0 ... 30.0		G 1 1/2	180	490 ... 1684
HPS 10 - 350 - 180	8.0 ... 40.0		G 1 1/2	205	496 ... 1754

- The data listed represent only a selection of the various differing versions

Associated technical data sheets:

- Piston type accumulators, type HPS: D 7969 HPS

Similar products:

- Diaphragm accumulator type AC: Page 258

4 Pressure switch type DG, electronic pressure transducer type DT

Pressure switches are hydraulic accessories. They close or open electrical contacts when under pressure.

They are used to issue an electrical switching command or signal for further work steps when a predefined pressure value is reached.

The pressure switch type DG 51 E works with a metallic thin-film cell. Two independent switching points can be programmed. Pushbuttons or IO-Link can be used to carry out the setting.

Features and benefits:

- Compact design
- Option of integration into the HAWE modular system
- Operating pressures up to 1000 bar

Intended applications:

- General hydraulic systems
- Machine tools

Nomenclature:	**Spring-loaded piston-type pressure switch** **Electronic pressure switch** **Electronic pressure transducer**
Version:	**Screw-in version** **Manifold mounting** **Designed for pipe connection**
p_{max}:	**1000 bar**

Design and order coding example

DG 51 E | **-A** | **250**

Pressure classification Table 2 Pressure stages

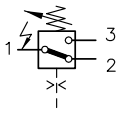
Hydraulic connection Table 1 Hydraulic connection

Basic type Pressure switch type DG

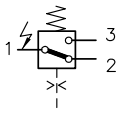
- Type DG 1, 3 (spring-loaded piston-type pressure switch)
- Type DG 51, DG 6 (electrical pressure switch with two switch points)
- Type DT (analogue electronic pressure transducer)

Function

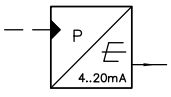
DG 1



DG 3

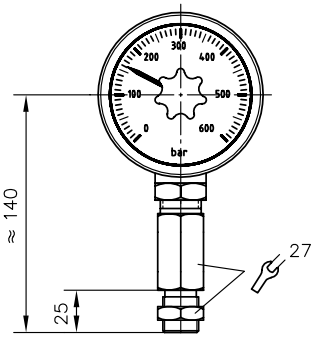


DT

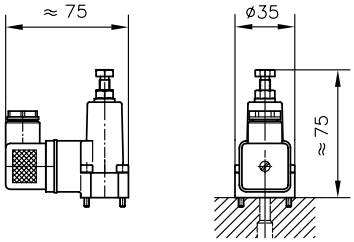


General parameters and dimensions

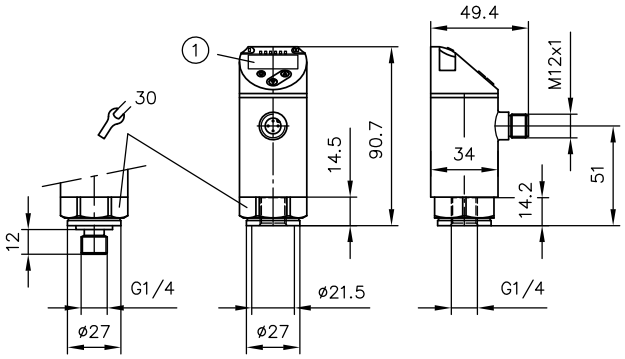
DG 1 R



DG 3 ..

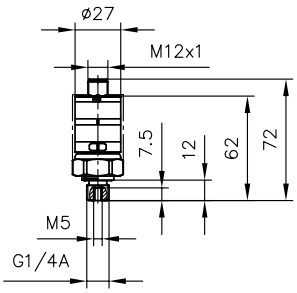


DG 51 E

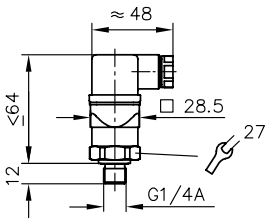


1 Four-digit 10-segment display, alphanumeric

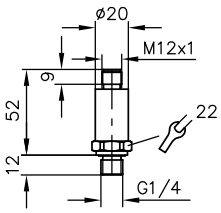
DG 6.



DT 11



DT 2



	Brief description	Pressure setting p_{max} [bar]	Ports	m [kg]
DG 1 R	Adjustment via knob at pressure selection scale	20 to 600 [1]	G 1/2 or G 1/4 A	1.3
DG 3	Compact design as manifold mounting, pressure setting via set screw	4 to 700 [1]	G 1/4 or G 1/4 A [2]	0.3
DG 51 E	Electronic pressure switch with two switch points	0 ... 600	G 1/4 A	0.25
DG 6		0 ... 400	G 1/4 A or M 5	0.08
DT 11	Analogue electronic pressure transducer	0 ... 1000	G 1/4	0.08
DT 2		0 ... 600	G 1/4	0.7

1) The max. operating pressure of 700 bar is not influenced by the max. possible set pressure
2) For versions with adapter only

Associated technical data sheets:

- Pressure switch type DG: D 5440
- Electronic pressure switch type DG 5: D 5440 E/1
- Electronic pressure switch type DG 6: D 5440 F
- Electronic pressure transducer type DT 11: D 5440 T/2

Hydraulic accessories:

- Fittings type X, X 84: Page 266

Similar products:

- Electronic pressure transducer type DT 11: D 5440 T/2
- Electronic pressure transducer type DT 2: D 5440 T/1

4 Pressure filter type PFM

Pressure filters protect downstream hydraulic components against soiling. They are installed in the high-pressure line typically after the pump.
The pressure filter type PFM contains a filter element through which the fluid flows from the inside to the outside. It can be replaced without drips or soiling using standard tools.
The ratio of size to performance is optimal, for this reason the filter has low pressure losses even after absorbing a large amount of soiling.
The pressure filter type PFM is used in machine tools, industrial trucks, lifting platforms and in general in oil hydraulics.

- Energy-efficient thanks to low back pressure
- Long change intervals due to high dirt-holding nominal volume
- Filter element replacement is simple and clean

Intended applications:

- Machine tools
- Industrial trucks
- Lifting platforms
- General oil hydraulics

Nomenclature:	**Pressure filter**
Version:	**In-line installation Can be flanged**
p_{max}:	**250 bar**
Q_{max}:	**90 l/min**

Design and order coding example

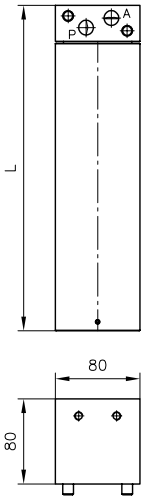
PFM4 -4 8 10 -R4 T -V0 /-

- **Seal** — without = series; KB = cold-resistant
- **Visual clogging display** — VE = electrically 12/24V; V0 = visually; VX = retrofittable; - = without
- **Installation position** — T = vertical; D = suspended
- **By-pass valve** — R4 = 4 bar; X = without
- **Filter fineness** — 10 µm
- **Volumetric flow** — 5 = less than 40 l/min; 8 = less than 90 l/min
- **Port** — 4 = in-line installation; UNF3 = in-line installation 7/8-14 UNF; F = flange design
- **Basic type** — PFM4

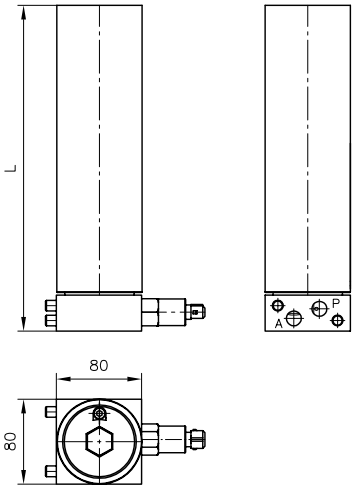
Function

General parameters and dimensions

Flange design with corner dimensions



In-line installation with corner dimensions



Type	Dimensions [mm]
	L
PFM4-45	234
PFM4-F5	236
PFM4-48	305
PFM4-F8	301

Associated technical data sheets:

- Pressure filter type PFM: D 8040

Hydraulic accessories

4 Fittings

Various fittings are available for hydraulic accessories, which are used to connect these hydraulic devices to the pressure lines of HAWE hydraulic power packs and valves in various assembly situations.

Reducing connectors can be used to combine devices. Additional accessory parts such as screen filters and filter elements safeguard the hydraulic devices against larger, stray impurities which may occasionally occur.

The following hydraulic accessories are available for use in hydraulic systems:

- Measurement devices, e.g. pressure gauges, monitor the pressure
- Command devices, e.g. use pressure switches for pressure-controlled switching
- Hydraulic accumulators are also available

Features and benefits:

- Compact design
- Option of integration into the HAWE modular system
- Operating pressures up to 700 bar

Intended applications:

- General hydraulic systems

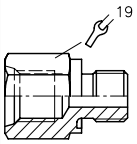
Nomenclature:	**Reducing connector** **Connection fitting** **Screen filter** **Filter element** **Pressure gauge**
Version:	**Screen-in version** **for pipe connection**
P_{max}:	**700 bar**

Design and order coding example

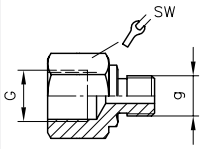
Reducing connectors (various dimensions)

G - g

- **Internal thread - external thread**
- **Inch thread - metric thread**
- **Inch thread - inch thread**
- **Metric thread - metric thread**
- **Metric thread - inch thread**
- **Inch thread - JIS thread**

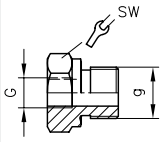


Adapter **G 1/4 - G 1/4 JIS**



SW 19 - 55

Example: **G 1/2A - M 16 x 1.5**

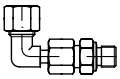


Example: **G 1/2 - G 1A**

Fittings

- Connection fitting with tapped journal G 1/4
- Connection fitting with fastening nut and internal thread connection G 1/4
- Connecting pieces for attaching the cutting ring for external pipe diameters 6 to 20 mm
- Straight screw-in fitting
- Swivel fitting
- L-fitting

Example:
Straight fitting
type X ... G



Example:
Elbow fitting
type X ... V

Example:
Swivel fitting
type X ... S

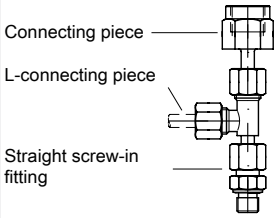
Circuit symbol:

Fitting combinations

Consisting of:

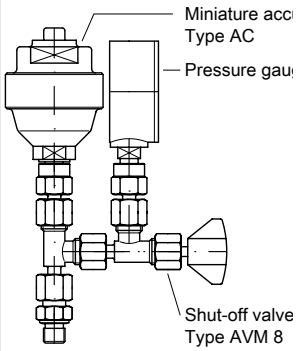
- Connecting piece
- Straight screw-in fitting
- Swivel fitting
- L-connecting piece
- Elbow fitting
- Shut-off valve AVM 8
- Locking element

Please number and image caption



Example: **X 84T**

Please number and image caption

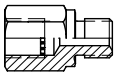


Example: **X 84U - AC 40/100-9/400**

Screen filters and filter elements

Title?

- Inch thread
- Metric thread
- Screw-in strainer disc type HFC (hole Æ 0.63 mm)
- Screw-in wire mesh filter disc type HFC.. F (filter fineness approx. 100 µm)
- Also in housing version



Example HFE 3/8

- Housing version with perforated strainer (hole Æ approx. 0.5 mm)
- Connection thread G 3/8(A)

Example:
HFC 1/4 F
Screw-in wire mesh filter disc for location thread G 1/4, filter fineness approx. 100 µm

Associated technical data sheets:

- Reducing connector type G: D 845
- Fitting type X: D 7065
- Fitting type X 84: D 7077
- High-pressure screen filter type HF: D 7235
- Shut-off valves type AVM 8: Page 226

Electronics

Line connector with economy circuit type MSD

Proportional amplifier type EV2S

Programmable logic valve control type PLVC and CAN-IO

General electronic additional components

Type	Nomenclature / design	Features
MSD etc.	▪ Line connector – With rectifier circuit – With clamp diode – With LED – With economy circuit **Design** ◆ Power supply units	**Features and benefits:** ▪ Compact design ▪ Functions tailored to HAWE products ▪ Simple installation ▪ Energy savings during continuous operation

Proportional amplifiers

Type	Nomenclature / design	Features
EV	▪ Module ▪ Card	**Features and benefits:** ▪ Compact design ▪ Easy commissioning ▪ Functions tailored to HAWE products
EV2S-CAN, EV2S-BT	▪ Line connector	**Features and benefits:** ▪ CAN bus interface ▪ Functions and settings tailored to HAWE products ▪ Precise current-controlled outputs

Electronic controls

Type	Nomenclature / design	Features
PLVC, CAN-IO	**Programmable logic control** ▪ Modular system with - Basic modules - Expansion modules - CAN bus nodes- - Software	**Features and benefits:** ▪ Modular systems with expansion and enhancement modules (Basic and expansion module) ▪ Flexible programming ▪ Different interfaces (RS 232, CAN bus, Profibus) ▪ All output parameters can be customised ▪ Software function modules (PLC programs)

General electronic additional components

5 Line connector with economy circuit type MSD and others

A selection of additional electronic components is available for use in hydraulic systems. Line connectors with and without additional functions, e.g. LEDs for switching position monitoring and protective circuits. Line connectors with economy circuit, e.g. to minimise the temperature at the solenoid and to save energy.
Power supply units for installation in switch cabinets.

Features and benefits:

- Compact design
- Functions tailored to HAWE products
- Simple installation
- Energy savings during continuous operation

Intended applications:

- Hydraulic systems
- Mobile machines and in the industry sector

Nomenclature:	**Line connector with no special feature (standard)** ▪ **With rectifier circuit** ▪ **With clamp diode** ▪ **With LED** ▪ **With economy circuit** **Power supply units**
Version:	**Line connector** **Modules with screw terminals**

General parameters and dimensions

Male connector for solenoid valves (single and twin solenoid)

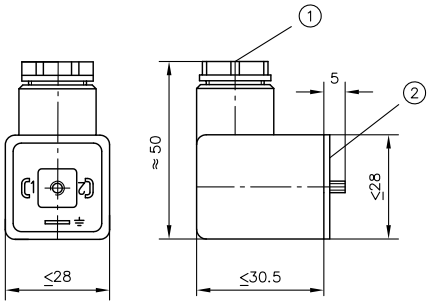
Brief description	Application
No special feature (standard	For all applications with no special requirements
Version with LED	Display of the switching function and EMC protection (note prolonged cut-off times)
Version with clamp diode	For optimum EMC protection (note prolonged cut-off times)
Version with economy circuit	High reliability and prolonged lifetime of the solenoids by reducing the voltage (using pulse width modulation) after a defined period. Recommended for use in areas with high ambient temperatures and/or for application where the solenoids are permanently energised (e.g. safety circuits)
Version with rectifier circuit	Use of DC solenoids with supply voltages of 110V AC, 230V AC

Male connectors with no special feature (DC voltage supply) or the version with rectifier circuit for supply voltage of 110V AC, 230V AC are included as standard in the scope of delivery of the solenoid valve.

Power supply units for solenoid valves

Type	Brief description	Application
MNG	Power supply unit for input voltage 230V AC and output voltage 24V DC, load capacity 5A	Power supply for solenoid-actuated hydraulic valves or electrical amplifiers for proportional solenoids

Example: Line connector form A in accordance with DIN EN 175 301-803



1 Cable fitting Pg 9

2 Flat seal

Associated technical data sheets:

- Line connector type MSD and others: D 7163
- DIN-plug with economy circuit type MSD 4 ECO for 24 V DC: D 7833/1
- Economy circuit plug type MSE 28026 with adjustable economy voltage: D 7832
- Power supply unit type MNG: D 7835

Additional electrical components:

- Proportional amplifier type EV, EV2S: Page 272, Page 274
  - Programmable logic valve control type PLVC and CAN node type CAN-IO: Page 276
- For more about electronic accessories, see "Electronics"

5 Proportional amplifier type EV

Proportional amplifiers actuate proportional solenoid valves by converting an input signal into a corresponding control current.
The proportional amplifier type EV is available as a module for top-hat rail mounting or, alternatively, as a card for a card holder. Highly precise functions are possible thanks to the feedback measurement at the valve outputs.
The control parameters (Imin, Imax, dither, ramp times) are configured using either pushbuttons or a potentiometer.

Features and benefits:
- Compact design
- Easy commissioning
- Functions tailored to HAWE products

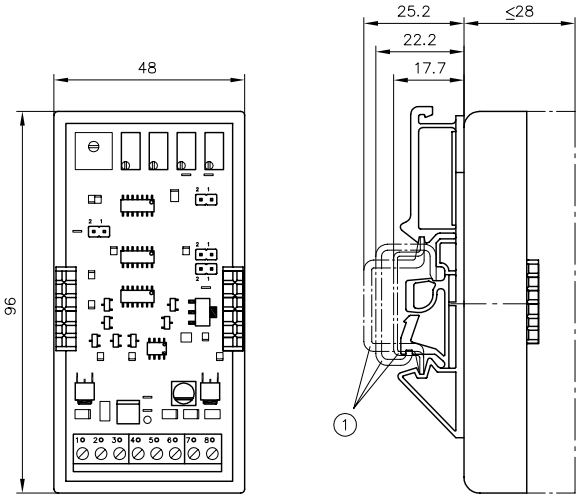
Intended applications:
- For controlling proportional valves
- Switch cabinet installation in an industrial environment

Nomenclature:	**Amplifier units for proportional solenoids**
Version:	**Modules with screw terminals** **Card version with terminal block**

General parameters and dimensions

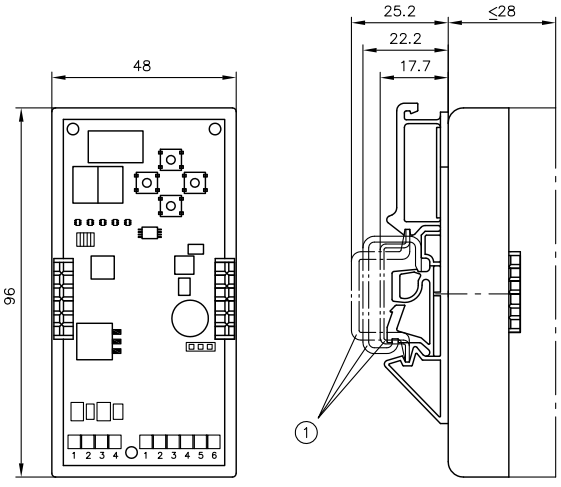
Type	Brief description	Application
EV 1 M 3 EV 1 D	Version as a module (analogue adjustment) Version as a module (digital adjustment)	Use in switch cabinets
EV 22 K 5	Card version	Card suitable for control of two twin proportional solenoids. Use in card holder for one, or in a module rack for max. 3 amplifier cards

EV1M3



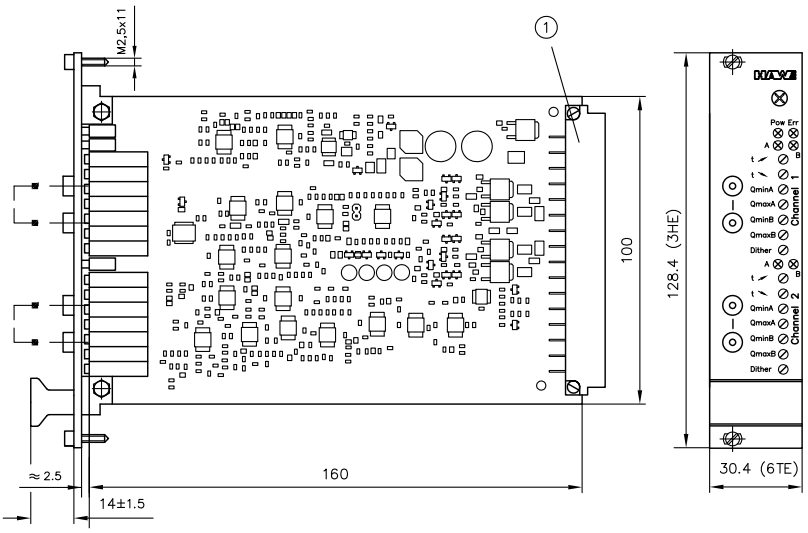
1 Standardized support bars

EV1D



1 Standard support rails

EV22K5



1 Female multipoint connector according to DIN EN 60603-2

Associated technical data sheets:

- Proportional amplifier type EV1M3: D 7831/2
- Proportional amplifier type EV1D: D 7831 D
- Proportional amplifier type EV22K5: D 7817/2

Additional electronic components:

- Line connector with economy circuit type MSD and others: Page 270
- Programmable logic valve control type PLVC: Page 276
- CAN node type CAN-IO: Page 276
- For more about electronic accessories, see "Electronics"

Electronic amplifiers

5 Proportional amplifier type EV2S

Proportional amplifiers actuate proportional solenoid valves by converting an input signal into a corresponding control current.
Valve controls control and regulate complex mobile or stationary hydraulic systems.
The proportional amplifier type EV2S-CAN is a plug amplifier designed to be fitted directly on a proportional single-action or twin solenoid. Parameters can be configured either using the pushbuttons and an integrated display or via CAN bus using computer software.
The proportional amplifier type EV2S-BT can be set using a smartphone and the HAWE eControl app via Bluetooth.

Features and benefits:

- CAN bus interface
- Functions and settings tailored to HAWE products
- Precise current-controlled outputs

Intended applications:

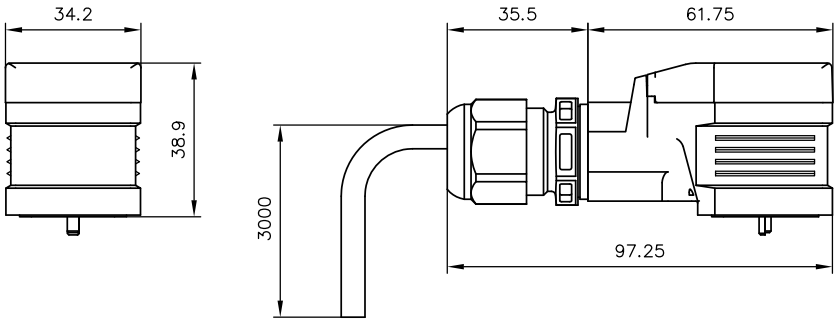
- Mobile machines and in the industry sector
- Connection of analogue proportional valves in CAN bus networks
- Closed control circuits
- Simple expansion of existing systems

Nomenclature:	**Amplifier plug for proportional solenoids**
Version:	**Buttons and display or Bluetooth** **Plug amplifier with M12 connection** **Plug amplifier with 3 m cable** **Plug amplifier** **for two single-action solenoids**

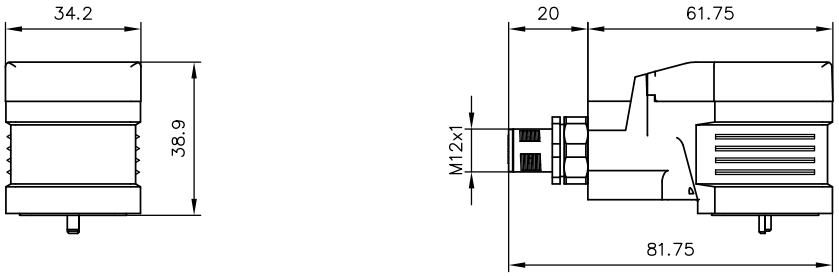
General parameters and dimensions

	EV2S-CAN	EV2S-BT
Number of inputs		
Analogue	2	2
Number of outputs		
Analogue (PWM)	2	2
Interfaces		
CAN bus	x	x
Bluetooth	--	x
Buttons and display	x	--
Power supply	10 to 30 V DC	10 to 30 V DC
Output current	2 A	1.6 A

EV2S-CAN-G-L3K



EV2S-CAN - G - M, EV2S-BT - G - M



Associated technical data sheets:

- Proportional amplifier type EV2S: D 7818/1

Additional electronic components:

- proportional amplifier type EV: Page 272
- Programmable logic valve control type PLVC: Page 276
- CAN node type CAN-IO: Page 276
- For more about electronic accessories, see "Electronics"

Electronic controls

5 Programmable logic valve control type PLVC, CAN-IO

Valve controls control and regulate complex mobile or stationary hydraulic systems.
The programmable valve controllers type PLVC and CAN-IO 14 are freely programmable PLC with integrated proportional amplifiers. Highly precise functions are possible thanks to the feedback measurement at the valve outputs. The number of digital and analogue inputs and outputs can be configured variably.
The valve control type PLVC is of modular design and can be expanded to suit the application. It can be very straightforwardly integrated into existing systems due to the existing interfaces.

Features and benefits:

- Modular systems with expansion and enhancement modules (Basic and expansion module)
- Flexible programming
- Different interfaces (RS 232, CAN bus, Profibus)
- All output parameters can be customised
- Software function modules (PLC programs)

Intended applications:

- Construction machines
- Crane systems
- Complex lifting devices
- Machines for forestry purposes
- Machine tool and press construction

Nomenclature:	**Programmable logic valve control**
Version:	**Modular concept with** ▪ **Basic modules** ▪ **Expansion modules** ▪ **Software**

General parameters and dimensions

	PLVC 21	PLVC 41	PLVC 8	CAN IO 14
Number of inputs [1]				
Digital	13 (5 / 8)	27 (3 / 24)	17 (10 / 7)	1
Analogue	12 (4 / 8)	28 (4 / 24)	23 (11 / 12)	6 (10)
Frequency	3 (3 / -)	3 (3 / -)	3 (3 / -)	
Emergency stop	x	x	x	
Number of outputs [1]				
Digital	16 (8 / 8)	16 (- / 16)	13 (- / 13)	4
Analogue (PWM)	4 (4 / -)	16 (4 / 16)	16 (16 / -)	4
Analogue (0 to 10V)	--	1 (1/-)	--	
Relay	4 (- / 4)	8 (3 / 8)	--	
Auxiliary voltage	--	1 (5V DC)	--	
Interfaces				
RS 232	x	x	x	x
CAN bus	x (x / x)	x	x (x / x)	x
Profibus	x	--	--	
Power supply (10 to 30V DC)	10 (5 / 5)	45 (8 / 37)	32 (16 / 16)	10 to 30 V DC
Output current				2 A (max. 10 in total)

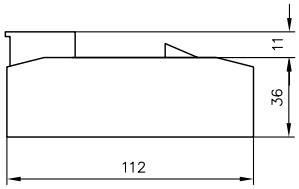
1) Max. number of inputs and outputs for each, values in brackets apply to basic module and expansion modules

Software function modules (examples):

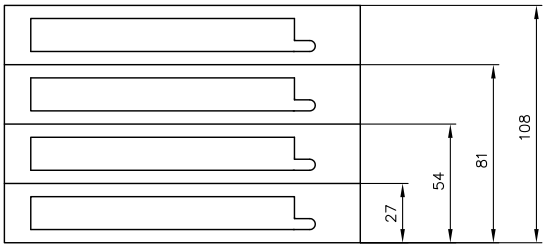
- Position measurement
- CAN bus communication
- Position and flow rate control
- Fault detection
- Controller for closed control circuits
- Ganging
- Electronic flow rate distribution
- Stability
- Limit load control
- Pressure reduction

Advantage: PLC programming using a structured text (ST) (see above) – The customer can customise the control at any time.

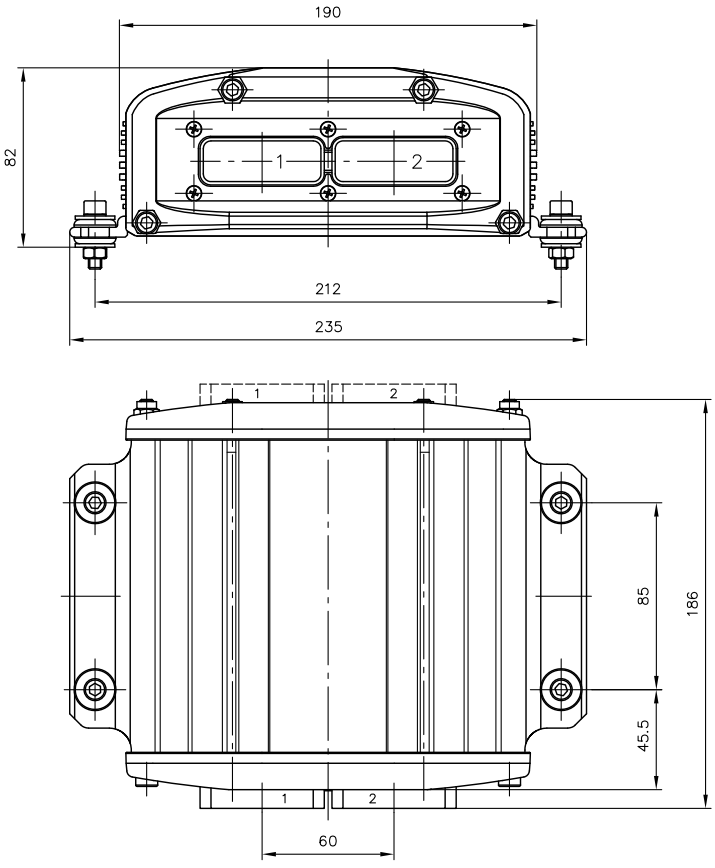
PLVC 21

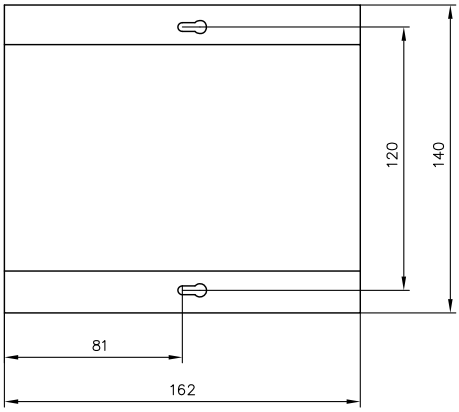


PLVC 41

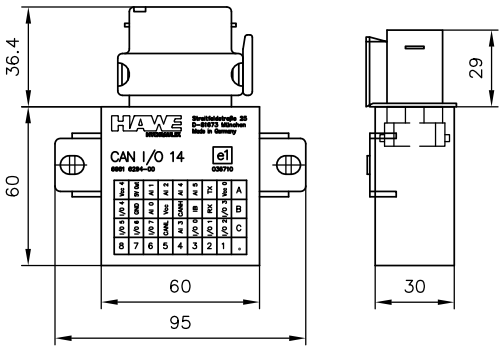


PLVC 8





CAN-IO 14



Associated technical data sheets:

- Programmable logic valve control with Profibus type PLVC 21: D 7845-21
- Programmable logical valve control type PLVC 41: D 7845-41
- Programmable logic valve control type PLVC 8: D 7845 M
- CAN node type CAN-IO: D 7845-IO 14

Additional electronic components:

- proportional amplifier type EV, EV2S: Page 272, Page 274
- For more about electronic accessories, see "Electronics"

Appendix

6 Hydraulic fluids – notes for selection

The performance of a hydraulic system depends to a large extent on the quality of the hydraulic fluid used.

The hydraulic fluid should essentially be selected according to the operating conditions, such as

- Temperature (see viscosity classes)
- Nomenclature (possible ban on certain hydraulic fluids due to undesired reactions with metals, seals, etc.)
- Usage type (e.g. environmentally compatible hydraulic fluids)
- Surroundings (use of existing hydraulic fluids)

Overview of temperature and viscosity

Temperature range:	Surrounding area: -40 to +80°C **Exception:** air-powered pumps type LP (+5 to +80°C) Hydraulic fluid: -25...+80°C Please observe viscosity range and any additional restrictions.
Start temperature:	Down to -40°C permissible Observe start viscosities as long as the steady-state temperature is at least 20K higher for subsequent operation! Biologically degradable or fire inhibiting pressure fluids generally not over max. +60...+70°C.
Viscosity range:	Min. approx. 4 mm^2/s, Max. approx. 1500 mm^2/s Optimal operating range approx. 10...500 mm^2/s

Mineral oils

Hydraulic fluid	Characteristics	Unusual features / restrictions
▪ Hydraulic oils HLP (DIN 51524-2)	Mineral oil with additives improving corrosion, oxidation and wear protection	Common hydraulic fluid
▪ Hydraulic oils HL (DIN 51524-1)	Mineral oil without wear protecting additives	Not suitable for any types of gear pump due to the lack of wear protection additives. ▪ No pumps and power packs with gear pumps type RZ, Z ▪ No compact hydraulic power packs HC, KA, MP, MPN, HK, HKL
▪ Hydraulic oils HVLP (DIN 51524-3)	Mineral oil with same additives as HLP, but with increased viscosity index for use in higher temperature ranges	The viscosity index correctors have a negative effect on the shear strength (viscosity loss approx. 30% when loaded), demulsifying behaviour and air release characteristics, for example. Only use if required due to temperature range. Oil manufacturer must be consulted!
▪ Unalloyed oils H, e.g. - Lubricating oils (DIN 51524-1) - White oils (e.g. NSF H1)	Mineral oil without additives	Due to lack of additives only suitable for systems in the standby mode (S2 or S3 mode) (low lubricity). White oils are mostly used in systems with possible contact with foodstuffs.
▪ Hydraulic oils PAO (tested for compliance with DIN 51524-1 and DIN 51524-2)	Mineral oil with additives improving corrosion, oxidation and wear protection	See information on hydraulic oils HVLP
▪ Special fluids in the aviation sector (MIL H-5606) in the marine sector (NATO H 540)	Mineral oils are based as a rule on naphtenic oil with wide temperature range	Seals made of fluor rubber FPM might be required, depending on hydraulic fluid. Consult the oil manufacturer!
▪ Other mineral oils Engine oils HD ATF automatic transmission fluid (AQ A, suffix A) Diesel Test oil for diesel injection pump test	Mineral oils which basically were developed for other application purposes	More or less suitable hydraulic fluids. Pay attention to the presence of oxidation and corrosion protection as well as material compatibility (above all in relation to the seals). Attention: increased leakage with directional spool valves. Oil manufacturer must be consulted!

Environmentally compatible hydraulic fluids ISO 15380

Hydraulic fluid	Characteristics	Unusual features / restrictions
▪ Seed oil type HETG	Fluids based on seed oils e.g. rape or sunflower with additives show only low temperature resistance (< 60...70°C)	Not suitable for compact power packs type HC, KA, MP, MPN, HK, HKL, all valves with wet armature solenoids as well as control systems utilizing many throttles. HETG fluid show a tendency to gum, ageing, and sticking at higher temperatures (> 60...70°C). Their use should be avoided!
▪ Polyethyleneglycol HEPG PEG-Polyethylene (may be solved in water) PPG-Polypropylene (can't be solved in water)	Fluids based on polyethylene glycol (PEG) Properties similar to mineral oil with regard to lifetime, lubricity and pressure resistance	No restrictions with regard to the operation behavior, but it ▪ Is harmful to standard enamel (does not apply to two-pot enamel) ▪ Will clog cellulose filters (use only glass fiber or metallic filters)! ▪ Shows bad lubrication characteristic with material pairings steel / light alloy or brass ▪ No pumps and power packs with gear pumps type RZ and Z ▪ Do not use compact hydraulic power packs type HC, KA, MP, MPN, HK, HKL ▪ No connection blocks with return line filter type A.F.., AF, BF, EF, FF
▪ Synthetical ester HEES (carbon acid ester, diester, polyester)	Similar qualities i.e. lifetime, lubricating characteristics and pressure resistance, like mineral oil	No restrictions with regard to the operation behavior. Contact with PVC should be avoided.

Flame-resistant hydraulic fluids ISO 12922

Hydraulic fluid	Characteristics	Unusual features / restrictions
▪ HFA (pressurized water, emulsions)	Oil in water emulsion, (water content > 80%) max. temp. range approx. 60°C	There is the danger of corrosion and cavitation due to the high water content, only use devices specially constructed for this purpose (radial piston pumps type R, directional seated valves type G) Max. pump pressure 50...60% (danger of cavitation) minimum content of mineral oil > 4% ▪ Do not use compact hydraulic power packs HC, KA, MP, MPN, HK, HKL – risk of short circuit ▪ No paper filters – risk of blockage No connection blocks with return line filter type A.F.., AF, BF, EF, FF
▪ HFC	Diluted (poly) glycol solution (water content > 35%) max. temp. range up to approx. 60°C	No restrictions with regard to the operation behavior, but it ▪ Incompatible with zinc ▪ No paper filters – risk of blockage No connection blocks with return line filter type A.F.., AF, BF, EF, FF ▪ Will clog cellulose filters (use only glass fiber or metallic filters)! ▪ Shows bad lubrication characteristic with material pairings steel/light alloy or brass ▪ No compact hydraulic power packs HC, KA, MP, MPN, HK, HKL
▪ HFD HFDR phosphoric ester HFDU polyolester	Fluids without water content, properties similar to mineral oil	Normal operation possible Restrictions: ▪ Requires seals out of FPM (FKM) (see also section "Seals") ▪ Oil manufacturer must be consulted!

Special fluids

Hydraulic fluid	Characteristics	Unusual features / restrictions
▪ AT-Brake fluid	Brake fluid based on glycol (DOT 4)	No restrictions with regard to the operation behaviour, but devices must be equipped with EPDM or SBR seals (see "Seals" section) No compact hydraulic power packs type HC, KA, MP, MPN, HK, HKL

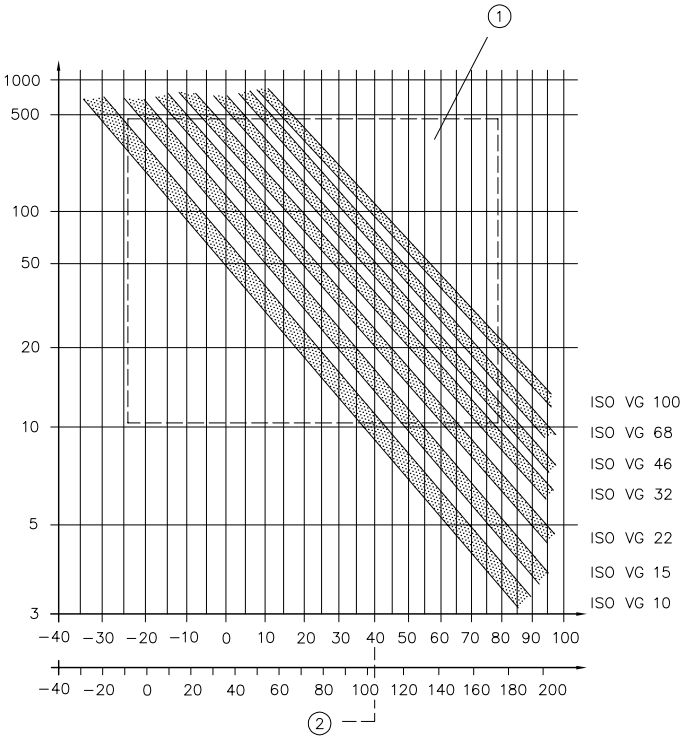
Viscosity grade selection

From the 18 viscosity classes (ISO VG) listed in the standard “ISO viscosity classification for liquid lubricants” (DIN ISO 3448), the ranges ISO VG10 to ISO VG68 are relevant for hydraulic systems. The number after "ISO VG" corresponds to the nominal viscosity at a reference temperature of 40°C. The temperature behaviour displayed in the diagram corresponds to that of mineral hydraulic oils. The characteristic curve increase of HVLP and the environmentally compatible hydraulic fluids is flatter, indicating that the temperature effect is lower.

Due to manufacturer-related differences, the following benchmark figures are to be clarified and compared with the permissible viscosity ranges:

- Viscosity at 40°C
- Viscosity at the lowest (estimated or demanded) temperature
- Viscosity at the highest (presumed, required) temperature
  (to guarantee a good seal life ≤ 80°C!)

Temperature / viscosity curve



1 Optimum range

2 Reference temperature
DIN ISO 3448

Guide lines for selection

- VG10, VG15
  Systems intended for short time operation or use in the open or for clamping devices.
  Systems intended for continuous operation
  (for use in the open, operation in winter only)
- VG22, VG32
  General use
  (when used outside, only summer operation)
- VG46, VG68
  Systems in closed rooms at
  ambient temperatures up to 40°C or tropical conditions

Hydraulic fluid filtration

Fine contamination (e.g. debris and dust) or contamination in the macro range (e.g. wear debris, rubber particles from hoses and seals) may significantly impair the function of a hydraulic system.

Maintain the following hydraulic fluid purities (assuming a thorough flushing has taken place prior to the date of commissioning):

Recommended purity of the hydraulic fluid	Recommended filter fineness	Devices	Note
ISO 4406			
21/18/15...19/17/13	$\beta_{16...25} \geq 75$	Radial piston and gear pumps, valves, cylinders (use in general mechanical engineering)	The purity degree of the hydraulic fluid is especially important for the repeatability accuracy with proportional valves. It should be noted that new hydraulic fluid "from the barrel" does not necessarily fulfil the highest cleanliness requirements.
20/17/14...18/15/12	$\beta_{6...16} \geq 75$	Prop. pressure and flow control valves	
19/17/14	$\beta_{6...16} \geq 75$	Variable displacement axial piston pumps	

Lower limits must be applied for pressure above 250 bar

Service life of the hydraulic fluid

The aging of hydraulic fluids is caused by shearing processes, cracking induced by high temperatures (gumming), mixing with (condensed) water or reaction with other materials (e.g. metal) in the system (sludging). A major factor for the service life of the fluid is beside the anti-shear additives of the fluid the lay-out of the system e.g. tank size, operation temperature, number and design of throttling sections.

Besides the properties of the hydraulic fluid itself (e.g. due to additives for high shear stability), the design of the hydraulic control system (e.g. tank size, steady-state temperature, number and type of throttling points) has a major influence on this.

The following points are to be noted:

- Service temperature in the tank < 80°C
  (mineral oils, hydraulic fluids with low water content) Avoid higher temperatures – Service life reduction – (+10K corresponds to half service life)
- Rotational conditions of hydraulic fluid $\frac{Q_{Pump}[lpm]}{V_{System}[l]}(Reference\ values)$
  - Approx. 0.2...0.4/min for conventional hydraulic power packs
  - Approx. ...1/min in mobile hydraulics
  - Approx. ...4/min for compact hydraulic power packs in standby or load/no load operation
- Control of the hydraulic fluid on a regular base (fluid level, contamination, coloring index, neutralization value etc.)
- Change of the hydraulic fluid on a regular base (depending on fluid type and application conditions)
  Guideline:
  - approx. 4000 ... 8000 h (mineral oil)
  - approx. 2000 h (other hydraulic fluids)
  - or at least annually

  Take into account notes of the fluid manufacturer!

Changing the hydraulic fluid

Do not mix different types of hydraulic fluids! This may lead to undesirable chemical reactions causing sludge, resinification etc.
The relevant manufacturers should be consulted when switching between different hydraulic fluids. In all cases, the whole hydraulic system should be thoroughly flushed.

Interaction with seals

Any question about the compatibility with seal material should be settled with the fluid manufacturer always before using a certain hydraulic fluid (except mineral oil and synthetic esters). A rough overview is given in the table at the start of this section. HAWE utilizes seals made of the follow- ing materials as standard:

- NBR (acrylonitrile rubber, e.g. Bunan, Perbunan) or HNBR (hydrated NBR).

Some devices are available on request with seals made of:

- FPM FPM (also FKM, fluor rubber) e.g. for fluids type HFD
  - The coding ...-PYD should be added to the coding for HAWE devices, e.g. WN1H-G24-PYD
- EPDM (ethylen propylen rubber) or SBR (styrene-butadiene rubber)
  - The coding ...-AT should be added to the coding for HAWE devices, e.g. WN1H-G24-AT (for brake fluid)

Storing hydraulic fluids and hydraulic components

Storage conditions for hydraulic components depend primarily on the following factors:

- seals utilised, moistening with oil during the factory functional test

The storability of rubber materials is generally influenced by the following factors:

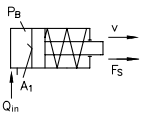
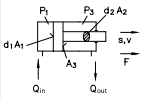
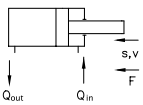
- Warmth, light, humidity, oxygen, ozone

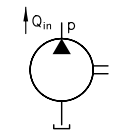
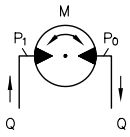
As far as possible, components should be de-energised and without deformation when stored. A storage temperature range of 15 to 20°C is optimum. Relative humidity approx. 65% (+-10%). Exposure to direct sunlight or a light source with strong UV rays should be avoided.
Ozone-producing equipment (electric motors, high-voltage equipment) among other things must not be present in the storage room.
If seals are packaged in plastic bags, these should not contain any plasticisers and, if necessary, should be impermeable to UV light.
Details on storage of elastomers are also available in the following standards:
DIN 7716, MIL-HDBK-695, SAE ARP5316D, SAE AS 1933, DIN 9088.
Hydraulic fluids can be stored for an unlimited period in sealed containers supplied by the manufacturer, as no chemical reactions take place. The presence of atmospheric oxygen, dust and moisture can lead to more or less rapid oxidation and resinification, depending on the type of oil and its additives.
A dark room with virtually constant temperature and humidity is recommended for storage of hydraulic components. The parts should be kept in a plastic bag to protect them from dust and continuous air exchange.
A functional test (manual override, dry switching) should be carried out at least once a year to ensure operation.
Safety-related components: A six-monthly functional test on site and a regular factory inspection including seal replacement every 2 years.
When the hydraulic components are stored as described above, the risk of corrosion is low. Most external parts of HAWE components are coated with a protective layer (galvanised, nitrided) and moistened with oil.

6 Formulas and units

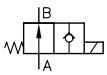
Hydraulic systems planning must be carried out taking a variety of factors into consideration, whereby the hydraulic elements are selected according to the desired functional processes.
The most important condition for this is the definition or specification of relevant consumer variables, such as the loads (load forces, load torques or turning torques), motion functions (travel, speeds, rotational speeds, timing) etc.
Only then is it possible to determine hydraulic consumers (hydraulic motors, hydraulic cylinders), drive units (pumps with drives), control and regulating devices (valve types with actuations) as well as connecting elements (lines, branch points).
Other factors that have an influence on the choice of hydraulic systems and components include noise emission values and thermal budget considerations.
The following formulae and tables are non-binding and are intended to make producing the rough design for a hydraulic system easier.

Equipment	Formulas and description		
General information	Basic equations (static, without any loss)		
	$Q=\frac{V}{t}$ $V=A \cdot s$ $F=p \cdot A$ $p=\frac{F}{A}$ $Q=A \cdot v$ $M=\frac{V \cdot p}{2\pi}$ $v=\frac{s}{t}$	force volume A: Q: v: V: torque s: M:	Force Pressure Area volumetric flow Speed Volume Time Travel (stroke) Torque

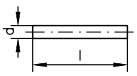
Equipment	Formulas and description		Symbol
Hydraulic cylinders	$A[mm^2]=\frac{\pi}{4} d^2[mm]$ $v\left[\frac{m}{s}\right]=\frac{s[mm]}{1000t[s]}$ $F_S[N]=-0,1 \cdot p_B[\text{bar}] \cdot A[mm^2]$ $p_B[\text{bar}]=\frac{-10F_S[N]}{A_1[mm^2]}$ $Q_{in}[l/min]=0.06 \cdot A[mm^2] \cdot v\left[\frac{m}{s}\right]$	d: A: F_S: p_B: v: Q_{in}: s: t:	piston diameter [mm] piston area [mm²] force [N] operating pressure [bar] Piston speed $\left[\frac{m}{s}\right]$ inflow [lpm] stroke [mm] time [S]	
▪ Double acting	**Extending** Basic equations (balance of forces): $A_1=\frac{\pi}{4} {d_1}^2 \approx 0,78 {d_1}^2$ $A_3=\frac{\pi}{4}({d_1}^2-{d_1}^2)$ $p_1 \cdot A_1=p_3 \cdot A_3-F$ $p_1=\frac{1}{A_1}(p_3 \cdot A_3-F)$ $Q_{in}=A_1 \cdot v$ $Q_{out}=A_3 \cdot v$	Simplified: $p_1[\text{bar}]=\frac{p_3[\text{bar}] \cdot A_3[mm^2]-10F[N]}{A_1[mm^2]}$ $F[N]=\frac{-p_1[\text{bar}] \cdot A_1[mm^2]+p_3[\text{bar}] \cdot A_3[mm^2]}{10}$ p_3 is the result of flow resistance from pipes and valves for Q_{out} Attention: note possible pressure intensification!	
	Retracting Basic equations (balance of forces): $p_1 \cdot A_1=p_3 \cdot A_3+F$ $p_3=\frac{1}{A_3}(p_1 \cdot A_1-F)$ $Q_{in}=A_3 \cdot v$ $Q_{out}=A_1 \cdot v$	Simplified: $p_3[\text{bar}]=\frac{p_1[\text{bar}] \cdot A_1[mm^2]-10F[N]}{A_3[mm^2]}$ $F[N]=\frac{p_1[\text{bar}] \cdot A_1[mm^2]-p_3[\text{bar}] \cdot A_3[mm^2]}{10}$ p_1 result of flow resistance from pipes and valves for Q_{out}	
	A_1: piston area [mm²] A_3: rod side area [mm²] d_1: piston Æ [mm] d_2: rod Æ [mm] F: force [N]	Q_{in}: inflow [lpm] Q_{out}: outflow [lpm] p_1: pressure, piston side [bar] p_3: pressure, rod side [bar] s: stroke, travel [mm]	

Equipment	Formulas and description			Symbol
Hydraulic pumps / hydraulic motors	Basic equations:	$\Delta p = p_1 - p_o$ [1]	Simplified:	 *Hydraulic pump*
	Geometric volume per revolution (piston pumps):	$V = A \cdot h$	$V[cm^3] \approx \frac{A[mm^2] \cdot h[mm]}{1000}$	
	volumetric flow:	$Q = V \cdot n$	$Q[lpm] \approx \frac{V[cm^3] \cdot n[min^{-1}]}{1000}$	
	Middle torque:	$M = \frac{V \cdot \Delta p}{2\pi}$	$M[Nm] \approx \frac{V[cm^3] \cdot \Delta p[bar]}{62}$	
	Power:	$P_{hydr} = \Delta p \cdot Q$	$P_{hyd}[kW] \approx \frac{\Delta p[bar] \cdot Q[lpm]}{612}$	 *Hydraulic motor*
	Power rating (motor)	$P_{mech} = \frac{\Delta p \cdot Q}{\eta_T} = \frac{M \cdot 2\pi n}{\eta_T}$ [2]	$P_{Drive}[kW] \approx \frac{\Delta p[bar] \cdot Q[l/min]}{500}$	
	Power output (pump)	$P_{max} = \Delta p \cdot Q \cdot \eta_T = M \cdot 2\pi n \cdot \eta_T$ [2]	$P_{Output}[kW] \approx \frac{\Delta p[bar] \cdot Q[lpm]}{740} \approx \frac{M[Nm] \cdot n[min^{-1}]}{12000}$	
	V: displacement [cm³] A: effective piston area [mm²] h: double stroke [mm] n: rev. rating [rpm] M: middle torque [Nm] p: pressure [bar] Δp: effective pressure [bar] Q: volumetric flow [lpm] P_{hydr}: hydraulic performance [kW] P_{mech}: mechanical performance [kW] η_T : total efficiency (including volumetric and mechanical losses)		Guideline: A power rating of 1 kW for the drive is necessary to achieve a delivery volumetric flow of Q = 1 lpm with operating pressure p = 500 bar!	

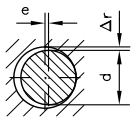
[1] p_o is calculated from line and valve resistance
[2] incl. degree of efficiency $\eta_T \approx 0.82$

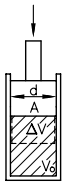
Equipment	Formulas and description	Symbol
Valves Directional valves Pressure valves Metering valves Check valves	Losses of pressure by streaming fluid The pressure loss in hydraulic systems consists of: ▪ Flow resistance of valves ▪ Flow resistance of pipes ▪ Flow resistance due to geometric shape (elbows etc.) Pressure losses Δp in the valves that are caused by the volumetric flow of fluid can be found in the Δp-Q characteristics of the relevant documentation. For the purposes of an initial rough design, a performance loss of approx. 20... 30% in the overall control system can generally be expected.	Examples: Direction-al valve  Pressure limiting valve  Flow control valve  Releasable check valve 

Equipment	Formulas and description		Symbol
Orifices (ideally, sharp edged) e.g. orifice inserts type EB; by-pass check valves type BC, BE	Basic equation: $Q \approx \alpha \cdot \frac{\pi}{4} d^2 \cdot \sqrt{\frac{2 \Delta p}{\rho}}$ Q: volumetric flow [lpm] Δp: flow resistance between A and B [bar] d: orifice diameter [mm] ρ: density (approx. 0.9 g/cm³) α: flow coefficient (approx. 0.78)	Simplified: $Q \approx 0.55 d^2[mm] \cdot \sqrt{\Delta p[bar]}$ $d \approx 1.35 \cdot \sqrt{\frac{Q[lpmin]}{\sqrt{\Delta p[bar]}}}$ $\Delta p \approx \left(\frac{1.82 \cdot Q[lpm]}{d^2[mm]} \right)^2$	

Equipment	Formulas and description		Symbol
Pipes / hoses	The diameter of pipes and/or hoses should be selected in such a way that flow resistance is minimized. Basic equations: $Re = \frac{v \cdot d}{\nu} \cdot 10^3 \quad \lambda_R = \frac{64}{Re} \quad \Delta p = \lambda_R \cdot \frac{l}{d} \cdot \frac{\rho}{2} v^2$		
	λR: pipe flow resistance coefficient Δp: flow resistance [bar] l: pipe length [m] d: pipe diameter [mm] ν: cinematic viscosity [mm²/s] Q: volumetric flow [lpm] Re: Reynolds No. (< 2300) ρ: density (approx. 0.9 g/cm³) v: Flow velocity $\left[\frac{m}{s}\right]$	Simplified: $Q[l/min] \leq 0,108 \cdot d[mm] \cdot \nu \left[\frac{mm^2}{s}\right]$ $d[mm] \geqslant \frac{9.2 \cdot Q[lpm]}{\nu \left[\frac{mm^2}{s}\right]}$ $\frac{\Delta p}{l}\left[\frac{bar}{m}\right] \approx \frac{6,1 \cdot \nu \left[\frac{mm^2}{s}\right] \cdot Q\left[\frac{l}{min}\right]}{d^4[mm]}$	

Equipment	Formulas and description	
Flow resistance due togeometric shape (elbows etc.)	Basic equations: $\Delta p = \varsigma \cdot \frac{p}{2} v^2 \quad v = \frac{Q}{A} = \frac{4Q}{\pi d^2}$	
	90° elbow	ξ = 0,15
	straight pipe fitting	ξ = 0,5
	elbow fitting	ξ = 1,0
	Simplified: $\Delta p[bar] = 2,2 \cdot \xi \cdot \frac{Q^2[lpm]}{d^4[mm]}$	
	Δp: flow resistance [bar] ξ: flow resistance coefficient ν: cinematic viscosity [mm²/s] d: pipe diameter [mm] ρ: density (approx. 0.9 g/cm³)	

Equipment	Formulas and description		Symbol
Leakage losses (by concentric (e = 0) and eccentric gaps)	Basic equation: $Q_L = \frac{\pi \cdot d \cdot \Delta r^3}{12 \cdot \nu \cdot \rho} \cdot \frac{\Delta p}{l} (1\ 1,5 \cdot \varepsilon^2)$	Simplified: $Q_L = 1848 \cdot \frac{d \cdot \Delta r^3}{\nu} \cdot \frac{\Delta p}{l} (1\ 1,5 \cdot \varepsilon^2) \quad \varepsilon = \frac{e}{\Delta r}$	
	e: eccentricity [mm] Δr: gap [mm] Δp: Pressure difference [bar] d: diameter [mm] ν: cinematic viscosity [mm²/s] l: gap length [mm] ρ: density (approx. 0.9 g/cm³)		

Equipment	Formulas and description		Symbol
Volumetric losses (due to pressure increase)	Basic equation: $\Delta V = \beta_p \cdot V_o \cdot \Delta p$ with $\Delta p = p_2 - p_1$		$F = \Delta p \cdot A$ 
	p_1: pressure, start [bar] p_2: pressure, end [bar] V_o: initial volume [l] ΔV: change in volume [l] β_P: compressibility	Simplified: $\Delta V = 0,7 \cdot 10^{-4} \cdot V_o \cdot \Delta p$ $\left(\text{with } \beta_p \approx 0.7 \cdot 10^{-4} \frac{1}{\text{bar}}\right)$	
Volumetric losses (due to temperature rise)	Basic equation: $\Delta V = \beta_T \cdot V_o \cdot \Delta \vartheta$ with $\Delta \vartheta = \vartheta_2 - \vartheta_1$		
	ϑ_1: temperature, start [°C] ϑ_2: temperature, end [°C] $\Delta \vartheta$: temperature, difference [K] V_o: initial volume [l] ΔV: volume alternation [l] β_T: expansion coefficient	Simplified: $\Delta V = 0,7 \cdot 10^{-3} \cdot V_o \cdot \Delta \vartheta$ $\left(\text{with } \beta_T \approx 0.7 \cdot 10^{-3} \frac{1}{K}\right)$	
Pressure increase caused by temperature rise (without volumetric compensation)		$\Delta V = 0,7 \cdot 10^{-4} \cdot \Delta p = 0,7 \cdot 10^{-3} \cdot \Delta \vartheta$ i.e. $\Delta \vartheta \approx 1\text{K} \Leftrightarrow \Delta p \approx 10$ bar	
	Note: A temperature rise of trapped oil volume will cause a pressure increase! (i.e. a pressure limiting valve will be required sometimes) **Guideline:** The pressure will rise by approx. 10 bar for 1 K of temperature increase.		

Equipment	Formulas and description		Symbol
Hydraulic accumulators Pressure alternations, isotherm (slow) adiabatic (quick)	Hydraulic accumulators are intended for the supply of pressurized fluid during sudden demands (quick, adiabatic pressure alternations), compensation of leakage losses or to dampen oscillations (slow, isotherm pressure alternations).		
	Basic equations:	$p_1 = 1,1 \cdot p_o$	
	isotherm (slow)	$\Delta V = V_1 \cdot \left(1 - \frac{p_1}{p_2}\right)$	
	adiabatic (quick)	$\Delta V = V_1 \cdot \left(1 - \left(\frac{p_1}{p_2}\right)^{0,71}\right)$	
	p_o: filling pressure for the gas [bar] p_1: lower operating pressure [bar] p_2: upper operating pressure [bar] V_1: initial volume [l] ΔV: volume alternation [l]		

Equipment	Formulas and description
Cavitation	Approx. 9 % (volumetric) air are solved in oil at atmospheric pressure. There is the danger of bubble cavitation during atmospheric pressure below 0,2 bar. These situations can occur, accompanied by sudden noise, during suction process of pumps and cylinders as well as at extreme throttle sections. The hydraulic components where this occurs will show increased wear.

Equipment	Formulas and description	
Thermal level Dissipation power and oil temperature	The hydraulic power losses in a hydraulic system result in a temperature rise of the fluid and the equipment which is partly radiated to the surroundings via the surface of the system. They roughly amount 20 - 30% of the induced performance. The induced and the radiated heat will balance at some point after the warm-up of the system.	
	Basic equations: $P_V = 0,3 \cdot P_{hydr}$ $\vartheta_{Ölmax} \approx \vartheta_{Umg} + C \cdot \frac{P_V}{A}$	
	Surface with unhindered circulation c ≈75 Surface with bad circulation c ≈ 120 with fan (v ≈ 2 m/s) c ≈ 40 Oil/water radiator c ≈ 5	Simplified: $\vartheta_{Ölmax} \approx \vartheta_{Umg} + C \cdot \frac{0,3 \cdot P_{hydr}[kW]}{A[m^2]}$
	P_v: performance loss, transformed in heat [kW] P_{hydr}: hydraulic performance [kW] ϑ_{oilmax}: max. fluid temperature [°C] ϑ_{amb}: ambient temperature [°C] A: surface of the system (tank, pipes etc.) [m²]	

Conversion table

	Marking	Unit	Factor X	Unit
Pressure	p	$1 \frac{N}{mm^2}$	10	bar
		1 MPa	10	bar
		$1 \frac{kgf}{cm^2}$	1	bar
		1 psi	0.07	bar
Force	F	$1 \frac{kg \cdot m}{s^2}$	1	N
		1 lbf	4.45	N
Length, travel, stroke	l, s, h	1 in	25.4	mm
		1 ft	304.8	mm
Torque	M	$1 \frac{kg \cdot m^2}{s^2}$	1	Nm
Power	P	1 PS, 1 hp	0.74	kW
Area	A	1 ft²	92903	mm²
		1 in²	645.16	mm²
Volume	V	1 ft³	28.92	l
		1 in³	$1.64 \cdot 10^{-2}$	l
		1 UK gal	4.55	l
		1 US gal	3.79	l
Temperatures	T, ϑ	5 (°F-32)/9	1	°C
Weight	m	1 lb	0.45	kg
Cinematic viscosity	v	1 cST	1	$\frac{mm^2}{s}$

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