



HAWE Product Overview

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Compact hydraulic power packs
type KA und KAW



Prop. directional spool valve
type PSL und PSV

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type PLVC

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Preface

HAWE Hydraulik SE was established as „Heilmeyer & Weinlein, Fabrik für Oelhydraulik GmbH & Co. KG in Munich in 1949. Innovative ideas, high product quality and a lot of enthusiasm has contributed to HAWE's steady growth. We now have more than 2200 employees, a worldwide sales network with sales offices in Germany, 14 HAWE subsidiaries and more than 30 representatives international.

The product range has been widened continuously over the years, covering standard valves e.g. pressure valves etc. as well as many products tailored for special purposes such as pre-fill valves, lifting/lowering valves etc.

There are three distinguishing features that make HAWE products unique in the fluid power industry:

All HAWE products are developed based on the HAWE modular design concept. Secondly, all pressurized parts are made of steel. And finally, sustainable business takes top priority during manufacture and installation, meaning certification according to ISO 9001 (quality management), ISO 14001 (environmental management) and EN 16001 (energy management) is a given.

This Product Overview is intended to give you a summary of the general capabilities of the variety of pumps, valves, and other equipment manufactured by HAWE. This publication is supplemented with additional product specific pamphlets (listed at "Additional Information"), which contain detailed technical specifications as well as further information. The technical information contained in these pamphlets is substantial and include guarantee and warranty relevant details. These pamphlets may be ordered from your local HAWE sales representative (see addresses on page 278) or directly from HAWE in Munich (contact: info@hawe.de).

It goes without saying that your sales partner (please see "Office addresses" attached for the addresses) and our "Technical Support" team in Munich would be glad to help with the selection, configuration and specification of the optimal HAWE products for you.



Production Site
Freising





Headquarters Munich

**OUR VERTICAL RANGE
OF MANUFACTURE ENSURES
SUPERIOR QUALITY!**



Production Site
Kirchheim



Production Site
Sachsenkam



Production Site
Dorf

Note:

All information from HAWE, our staff or our representatives provide product or system options for further investigation by users having technical expertise. Before you select or use any product or system it is important that you analyse all aspects (incl. safety regulations) of your application and review the information concerning the product or system in the current product catalogue.

All dimensions in mm, subject to change without notice!

Our vertical range of manufacture ensures superior quality!

Efficiency:

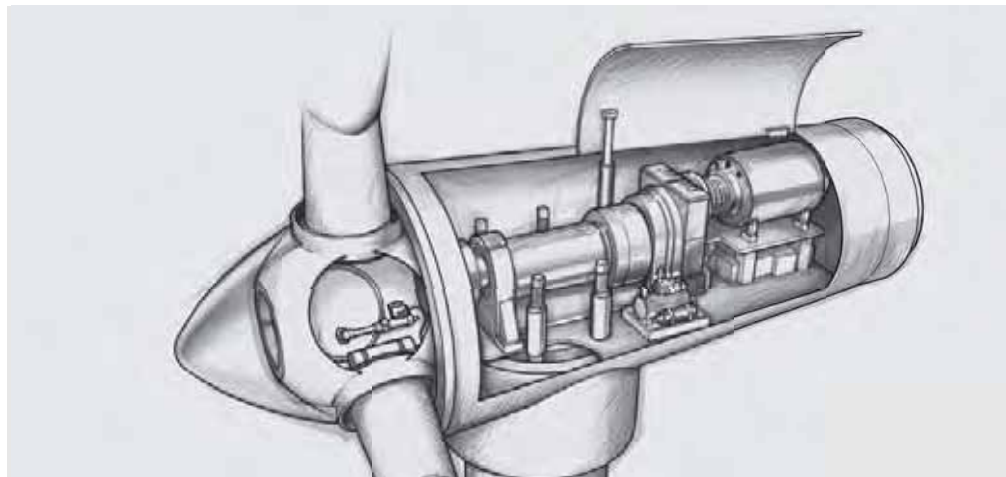
Example: Machine tools

- Compact hydraulic power packs with small tank capacity
- Zero leakage directional seated valves instead of directional spool valves
- Accumulator charged operation with idle pump circulation

Example: Truck mounted cranes

- Variable displacement axial piston pumps with clever controller technique
- Well-engineered Load-Sensing systems
- Quick response and directional spool valves with minimized leakage

HAWE Proportional directional spool valve:
Sensible and powerfull fine adjustability for all mobile application with a maximum of robustness. Also in harsh environments and up to 420 b



Flexibility:

Example: Tractors for logging and agriculture

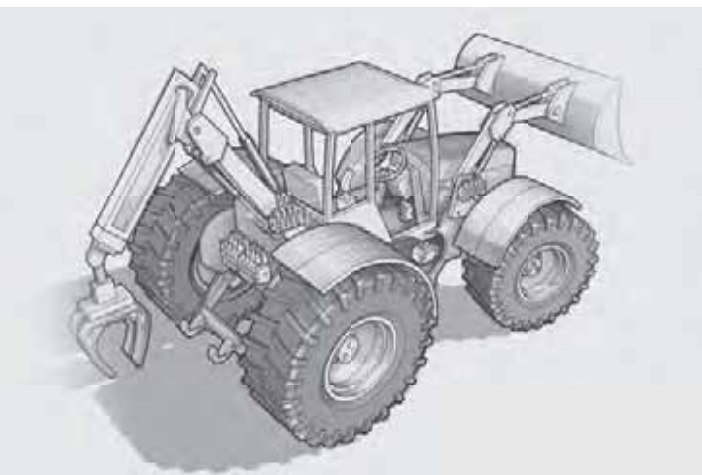
- Accurate controls that can be easily customized and extended
- One product covering all functions (boom, supports, steering etc.)
- Various sizes can be combined, additional function can be integrated

Example: Food processing

- Versatile, compact hydraulic power packs
- AC or DC-drive for low and high pressure applications
- All required functions can be implemented via directly mounted modular valve banks

We offer a wide range of various directional seated valves to ensure a safe and powerful functionality of your machine.





Reliability:

Example: Wind energy plants

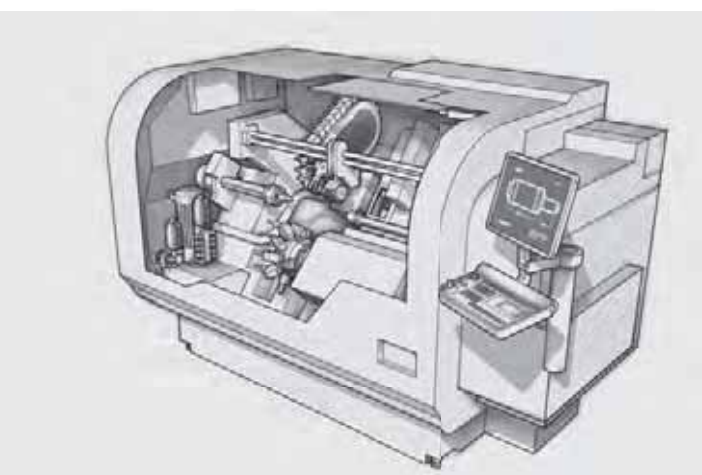
- Sturdy long-lived components ensure long service life
- Modular design eases maintenance
- Hydraulic controls also for severe ambient conditions (hot, cold, moist, etc.)



We provide with our compact hydraulic power packs energy efficient solutions for brake controls.

Example: Construction machines

- Well proven systems consisting of pump, hydraulic controls, over-center valve and electronics
- Modular electronic controls perfectly fitting the hydraulics
- Various approved solutions for oscillation dampening



Technology:

Example: Tools with hydraulic drive

- High power density via compact design
- Wide range of modular high pressure components (max. 700 bar)
- Two-stage pumps efficiently generate the necessary working pressure

Example: Hydraulic presses

- Hydraulic power controlled reliable and smooth
- Decentralized hydraulic controls via compact hydraulic power packs
- Various solutions for synchronous operation

SOLUTIONS FOR A WORLD UNDER PRESSURE

Efficiency in modules

Hydraulics is based on a simple principle that allows its use in a wide variety of different applications. In order to use all of these variations, we offer a modular range of products. As a direct result of our development philosophy, the individual HAWE components supplement one another to form one complete product range. They can then be combined to form solutions and systems. Unified components and the possibility to combine them individually serve to increase efficiency at an ideal price-performance ratio.

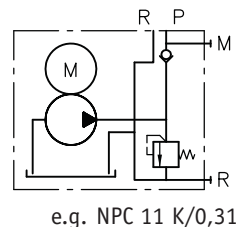
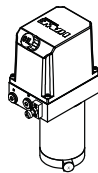
- individual components supplement one another to form one complete product range
- allows customer-specific solutions



Compact hydraulic power packs

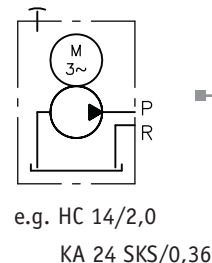
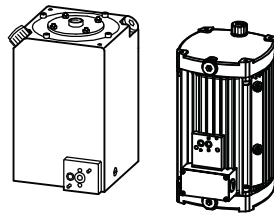
Type NPC

for miniature hydraulic systems
with 5...10% ED ($P_{\max} = 700$ bar,
 $Q_{\max} = 2.1$ lpm)



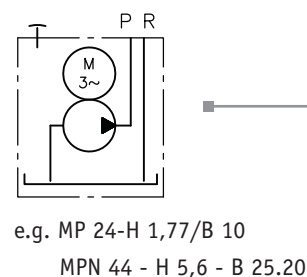
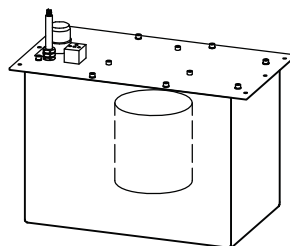
Type HC, HCW, KA, KAW

for miniature hydraulic systems
with 10...30% ED ($P_{\max} = 700$ bar,
 $Q_{\max} = 20.1$ lpm), available in 4 sizes,
also as dual circuit pump



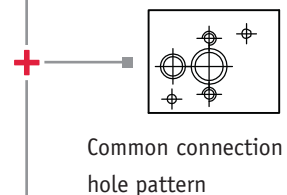
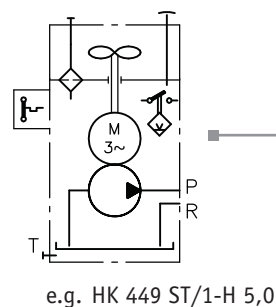
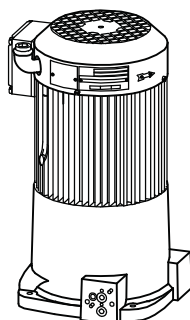
Type MP, MPN, MPW, MPNW

suitable for intermittent or load/no
load operation ($P_{\max} = 700$ bar,
 $Q_{\max} = 15$ lpm) available in 5 sizes,
also as dual stage pump, various
tank sizes



Type HK, HKF, HKL

suitable for continuous operation
($P_{\max} = 700$ bar, $Q_{\max} = 16$ lpm),
available in 3 sizes, also as double
and triple circuit pump



Order examples

NPC 11 K/0,31 - 1/320 - R - 24
 KA 44 LFK/H 2,5
 MPN 44 - HZ 0,9/12,3 - B 25.20
 HK 449 ST/1 - H 5,0 -
 C 16 -

Compact hydraulic power packs

B31/450 - EM11 V - 13 - G 24
 NE 21 - 320/25 -
 AS 1 F 2/300 -
 AP 34 - 43/24 -

Connection blocks

BWH 1 - NW - 33 - G 24

VB 21 GM - RH - 3 - G 24
 BVZP 1 F 23 - G 52/22 - H 14 N 15/0 - 1 - 1 - G 24
 BWN 1 F - HJ 5 - 1 - 1 - G 24

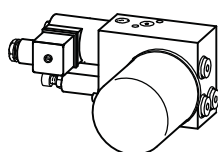
Directly mounted valve banks

The practical modular system allows individual combinations.

Connection blocks

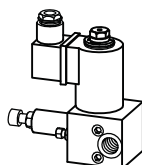
Type A

e.g. AS1F2/300-G24



Type B

e.g. B31/450-EM11V-13-G24



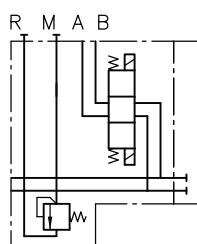
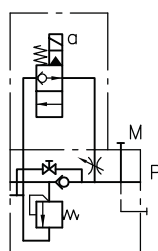
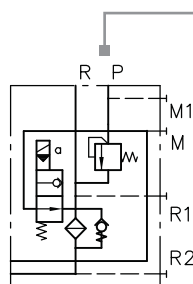
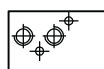
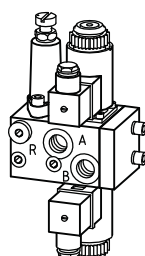
Type C

e.g. C5



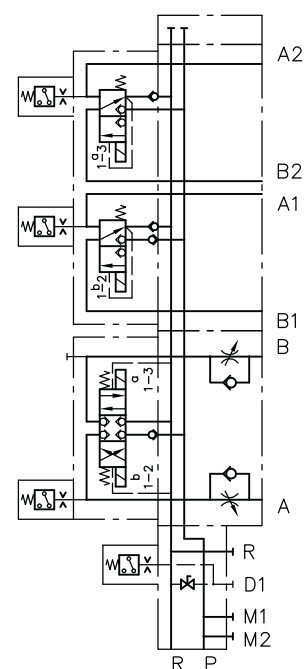
Type SKC, SWC

e.g. SWC1/150-L-1-G24



Directly mounted valve bank

Connection hole pattern for pipe connection
 or direct mounting of a directional valve bank
 e.g. BVZP1F23-G52/22-H14N15/0-1-1G24



1.1 Compact hydraulic power packs

Miniature hydraulic power packs type NPC	12
Compact hydraulic power packs type HC and HCW	14
Compact hydraulic power packs type KA and KAW	18
Hydraulic power packs type MP and MPN	22
Compact hydraulic power packs type HK, HKF, HKL	26
Connection blocks type A, B, and C	32
Valve bank type BA	34
Valve bank type BVH	40



*Compact hydraulic power packs
type KA and KAW*



*Compact hydraulic power packs
type HK, HKF and HKL*

Compact hydraulic power packs

Type	Nomenclature	Design	p _{max}	Q _{max}
NPC	Radial piston pump - With integrated electric motor - Direct current supply	Oil immersed compact hydraulic power pack for short period operation	750 bar	approx. 1.36 lpm
HC, HCW	Radial piston or gear pump - With integrated electric motor 3-phase or 1-phase version	Oil immersed compact hydraulic power pack for intermittent operation	Radial piston pump 700 bar	approx. 4.4 lpm
			Gear pump 180 bar	approx. 3.4 lpm
KA, KAW	Radial piston or gear pump - With integrated electric motor 3-phase or 1-phase version	Oil immersed compact hydraulic power pack for intermittent operation	Radial piston pump 700 bar	approx. 7 lpm
			Gear pump 180 bar	approx. 24.1 lpm
MP, MPN	Radial piston pump and/or gear pump - With integrated motor - Single- or dual-circuit pump	Oil immersed compact hydraulic power pack for intermittent or load/no load operation	Radial piston pump 700 bar	13.1 lpm
			Gear pump 220 bar	135 lpm
HK, HKF, HKL	Radial piston pump and/or gear pump - With integrated motor 3-phase version	Oil immersed compact hydraulic power pack for continuous and intermittent operation	Radial piston pump 700 bar	approx. 13 lpm
			Gear pump 180 bar	16 lpm

Connection blocks/mounted valves

Type	Nomenclature	Design	p _{max}	Q _{max}
A, B, C	Connection blocks For completion of hydraulic power packs	Add-on valve enabling pipe connection or mounting of valves	700 bar	approx. 20 lpm
BA	Valve bank - Directional seated valve - Zero leakage	Valve bank enabling pipe connection Actuation: solenoid, pressure-actuated or manual, mechanical	400 bar	20 lpm
BVH	Valve bank - Directional seated valve - Zero leakage	Valve bank enabling pipe connection	400 bar	20 lpm

Compact hydraulic power packs

1.1

Miniature hydraulic power packs type NPC

The NPC compact hydraulic power pack can be universally used in short period operation for all consumers with low oil requirements. The energy is supplied by direct current. A pressure-limiting valve is integrated into the intermediate flange. The NPC can be used on construction sites and in other mobile applications. It can be developed into a compact, complete hydraulic control by connecting valves from the VB or BWN(H) ranges.

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
- Long service life and excellent reliability achieved by using radial piston pumps
- Environmentally sound thanks to low oil fill volumes and minimum amount of oil to be disposed of
- Low costs for hydraulic fluid
- Co-ordinated range of valves and accessories from the modular system

Intended applications:

- Rivets
- Ventilation of winch brakes
- Hydraulic jigs
- Crimping



Nomen-clature:	Radial piston pump with integrated electric motor (version for 3-phase mains)
Design:	Oil immersed compact hydraulic power pack for short period operation
p _{max} :	750 bar
Q _{max} :	approx. 1.36 lpm (V _g = 0.09 - 0.76 cm³/rev)

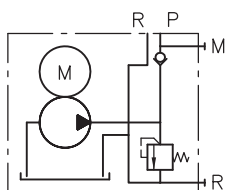
Design and order coding example

NPC 11	/ 0,87	- 1/170	- R	- G12	BWN 1 - NN - 35 - 1 - G12
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					Valve assembly	■ BWN1, BWH1, VB01 or BVH ■ can be mounted directly, without connection blocks according to D 7470 B/1, D 7302, D 7788 BV
					Motor voltage	12V DC or 24V DC
					Check valve	With/without check valve
					Pressure limiting valve and setting	■ 1 = Tool adjustable ■ 2 = Manually adjustable
					Delivery flow [lpm]	
Basic type, size	Type NPC, size 11 and 12					

Function

Symbol:



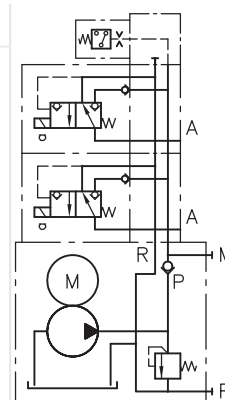
Example circuitry:

NPC 11 / 0,87 - 1/170 - R - G 12

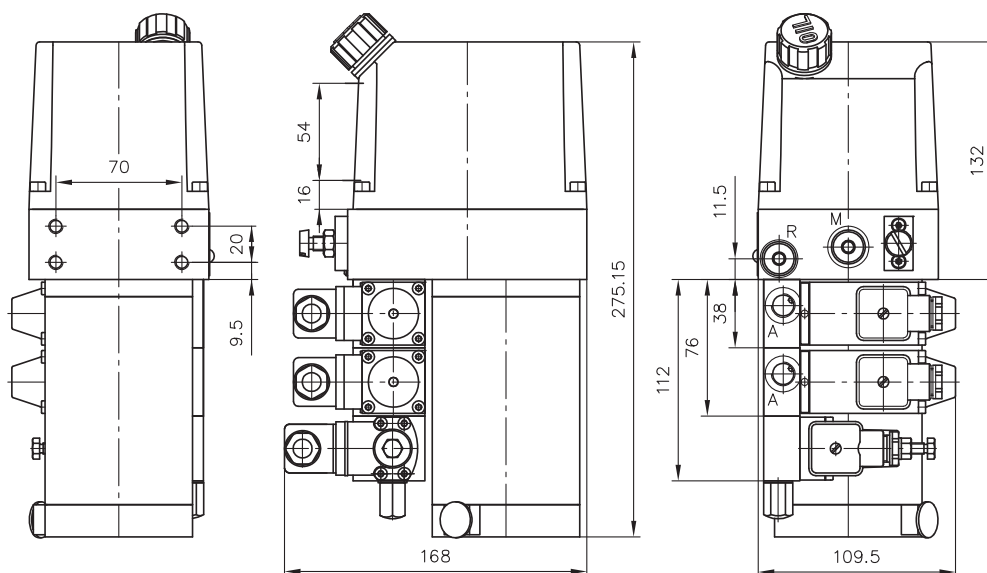
Compact hydraulic power pack type NPC, pump delivery flow approx. 0.87 lpm

BWN 1 - NN - 35 - 1 - G 12

Directly mounted valve bank type BWN with two valve sections and pressure switch for gallery P, 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 130](#)
- Type BVH: [Page 40](#)
- Type BWH, BWN: [Page 138](#)
- Pressure switches type DG: [Page 266](#)
- Electronic pressure transducer type DT: **D 5440 T ++**

See also section "Devices for special applications"

- Hydraulics for clamping
- Devices for up to 700 bar

Compact hydraulic power packs

1.1

Compact hydraulic power packs type HC and HCW

The ready-for-connection compact hydraulic power pack can be used in applications where consumers with a low oil volume requirement have to be connected in intermittent operation (S 3), e.g. in machine tool and jig construction, or in general machine engineering. The power pack consists of the housing (tank) with integrated motor and pump. The filling gauge on HC(W) size 2, 3 and 4 types enables the fluid level to be controlled even during operation. The electrical connections are made via an integrated terminal box. Compact control systems can be created by mounting various combinations of connection blocks and valve banks. Float switches and temperature switches are optionally available for perfect monitoring.

Features and benefits:

- Wide range of application achieved with four sizes
- Direct current version for voltage supply with 12 V DC or 24 V DC
- Long service life and excellent reliability achieved by using radial piston pumps
- Low oil fill volumes make it environmentally sound thanks to the small amount of oil to be disposed of and the low costs for hydraulic fluid
- Co-ordinated range of valves and accessories from modular system
- Suitable for vertical and horizontal installation

Intended applications:

- Brake and rotor adjustment modules on wind turbines
- Tracking systems on solar panels and parabolic aerials
- Clamping systems on machine tools and jigs
- Rivets and clinching equipment
- Welding robots
- Lubrication systems



Nomenclature:	Radial piston pump with integrated electric motor (3-phase or 1-phase version)
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 approx. 4.4 lpm (V _g = 1.6 cm ³ /rev) Gear pump approx. 3.4 lpm (V _g = 1.3 cm ³ /rev)
V _{usable max} :	8 l

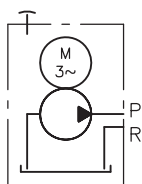
Design and order coding example

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) or gear pump Z Dual circuit pump ■ Combinations: ■ Radial piston pump - gear pump ■ Radial piston pump - radial piston pump
Basic type, size	Type HC (3-phase motor) and type HCW (1-phase motor, power reduction of 30 ... 50% depending on size), size 1 to 2, type HCG (direct current motor), size 1 ■ Horizontal version with low profile (type HC..L) or vertical version ■ Usable volume V_{usable} 0.5 l to 1.1 l ■ With/without fluid level gauge ■ With DC-motor (Type HCG) for short time operation				

Function

Symbol:



Example circuit:

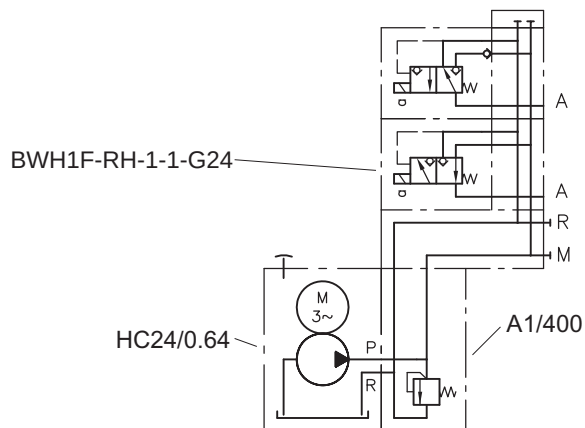
HC 24/0.64 -

 Hydraulic power pack type HC, size 24,
 pump delivery flow approx. 0.64 lpm

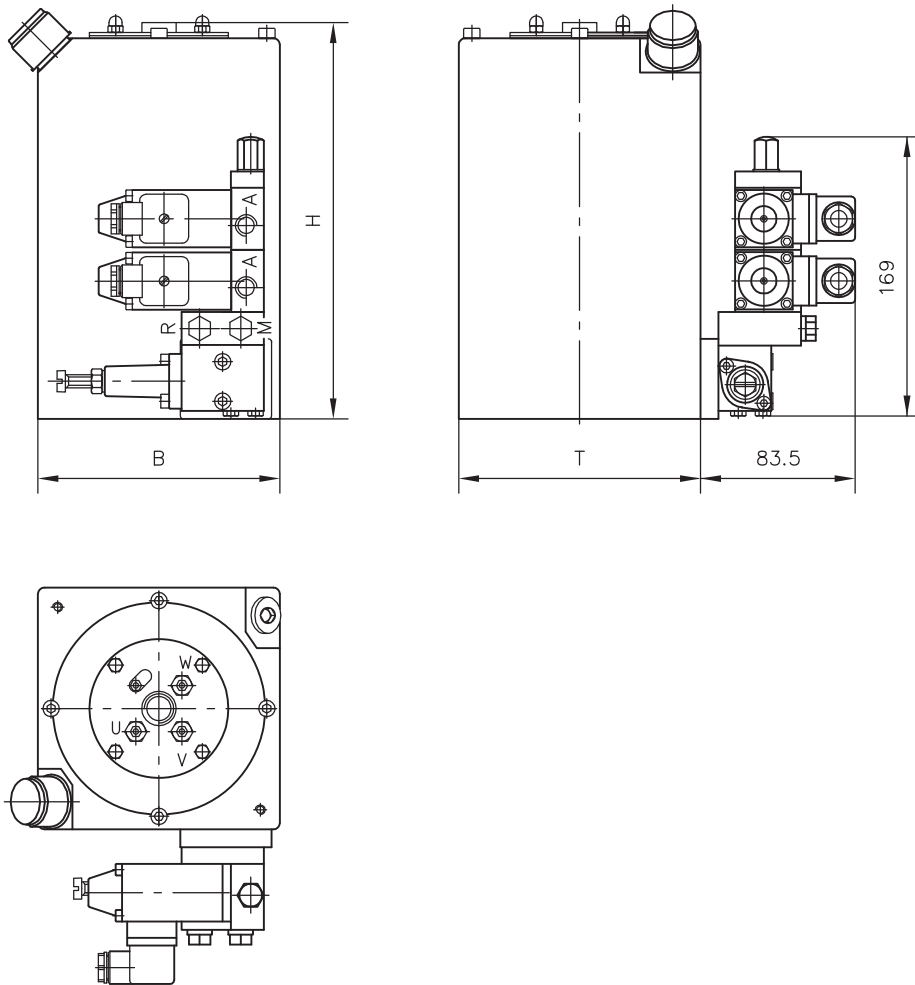
- A1/400

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

- BWH1F - RH1 - 1 - 1 - G 24

 Directly mounted valve bank
 type BWH1


General parameters and dimensions



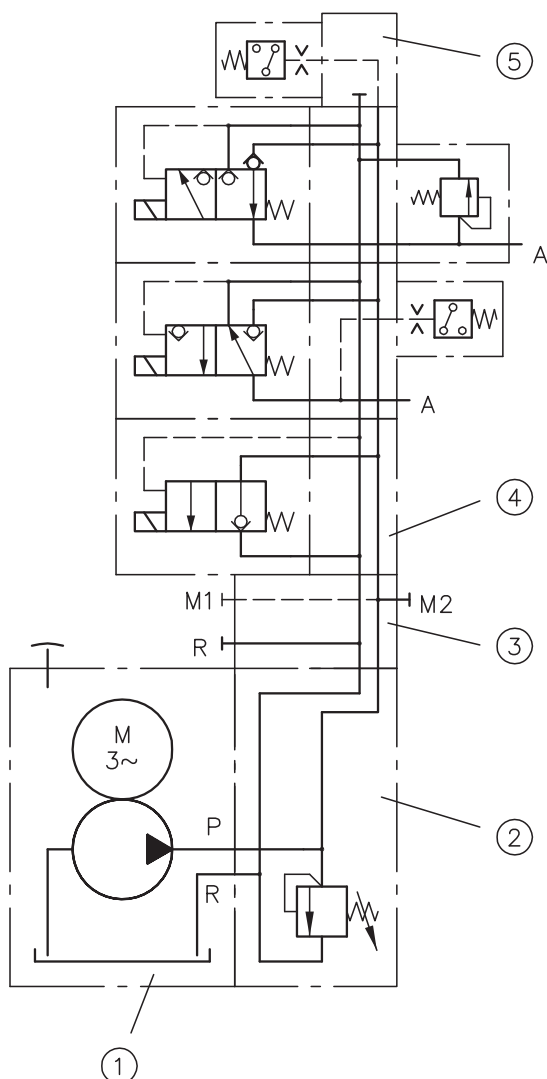
	Radial piston pump (3 cyl.)			Gear pump					Dimensions [mm]		
	Max. pressure	Delivery flow		Max. pressure	Delivery flow						
	p _{max} [bar]	Q _{pu} [lpm] 50 Hz	Q _{pu} [lpm] 60 Hz	p _{max} [bar]	Q _{pu} [lpm] 50 Hz	Q _{pu} [lpm] 60 Hz			P _N [kW] ¹⁾	m [kg] ²⁾	H
HC 14	700 - 160	0,2 - 1,05	0,2 - 1,2	-	-	-	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 input depends on the respective operation pressure and can be up to $1.5 \times P_N$

2) Without oil filling

Example circuit:

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 packs type HC: [D 7900](#)
- Compact hydraulic power packs type HCG: [D 7900 G](#)

Connection blocks:

- Types A, B and C: [Page 32](#)

Directly mountable valve banks:

- Type VB: [Page 130](#)
- Type BWH, BWN: [Page 138](#)

- Type BVZP: [Page 146](#)
- Type SWR, SWS: [Page 88](#)
- Type BA: [Page 34](#)
- Type BVH: [Page 40](#)

See also section "Devices for special applications"

- Hydraulics for clamping
- Devices for up to 700 bar

Compact hydraulic power packs

1.1

Compact hydraulic power packs type KA and KAW

The ready-for-connection compact hydraulic power pack consists of a housing (tank) with integrated motor and pump. The tank volume (effective volume) can be increased by extensions. A vertical and a horizontal variant are available. A filling gauge enables visual control of the fluid level even during operation. The electrical connections are made via an integrated terminal box. Compact control systems can be created by mounting various combinations of connection blocks and valve banks. Float switches and temperature switches are optionally available for perfect monitoring.

Features and benefits:

- Additional external fan for optimum load set
- Fill/effective volumes can be flexibly extended by modular tank extensions
- Long service life and high reliability achieved by using radial piston pumps
- Low oil fill volume makes it environmentally sound thanks to the small amount of oil to be disposed of and the low costs for hydraulic fluid
- Co-ordinated range of valves and accessories from modular system
- Suitable for vertical and horizontal installation
- Optimum efficiency achieved by 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
- Torque wrenches
- Rivets and clinching equipment
- Presses
- Handling systems



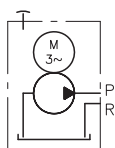
Nomenclature:	Radial piston or gear pump with integrated motor single or dual circuit pump
Design:	Oil immersed hydraulic power pack for intermittent or load/no load operation (S3-service)
p _{max} :	Radial piston pump 700 bar Gear pump 180 bar
Q _{max} :	Radial piston pump approx. 7 lpm (V _g = 2.29 cm ³ /rev) Gear pump approx. 24.1 lpm (V _g = 7.9 cm ³ /rev)
V _{tank max} :	2 ... 10 l

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 - Filling gauge with float switch - Temperature switch - Silica gel filter (instead of breather filter) - Additional fans - Various electrical connection variants (type KA...S)			
				Installation position Horizontal version with low installation heights (type KA..L) or vertical version (type KA..S)			
				Tank size [l]			
Basic type, size				Type KA (3~phase motor) and KAW (1~phase motor, power reduction 30 ... 50% dep. on size), size 2 and 4			

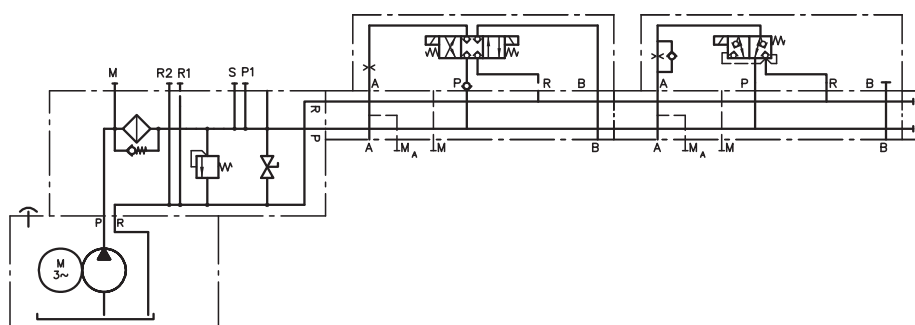
Function

Switching symbol:

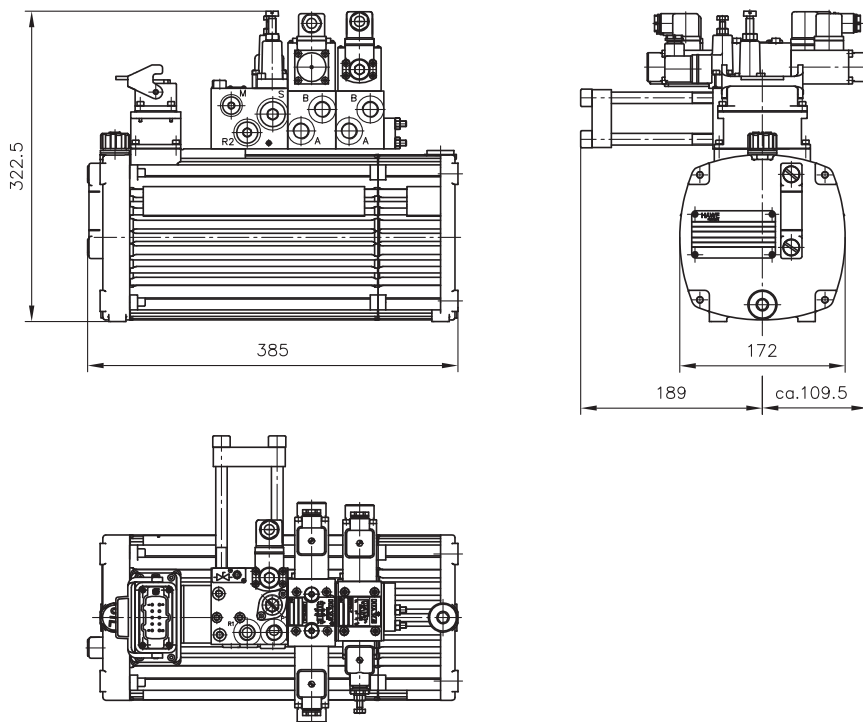


KA 231 LKP/H 0.59 - A1 D 10-B 400-3/380 - BA 2

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



General parameters and dimensions

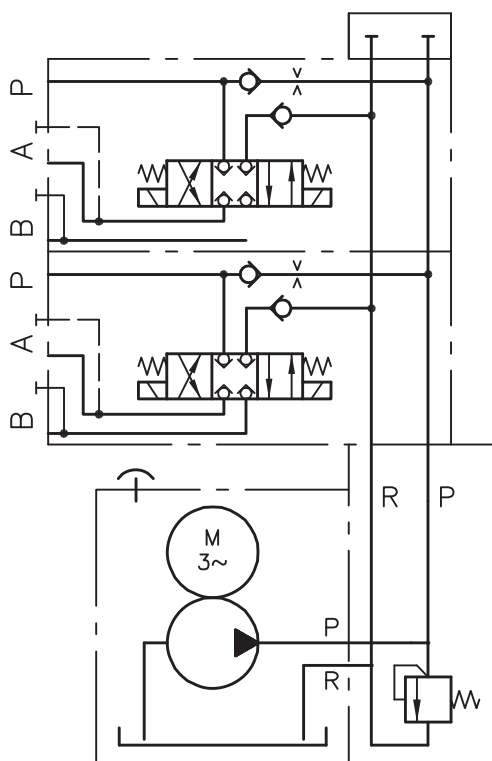


	3-cylinder radial piston pump			6-cylinder radial piston pump			Gear pump			
	$p_{\max}$ [bar]	$Q_{\max}$ [lpm] 50 Hz	$Q_{\max}$ [lpm] 60 Hz	$p_{\max}$ [bar]	$Q_{\max}$ [lpm] 50 Hz	$Q_{\max}$ [lpm] 60 Hz	$p_{\max}$ [bar]	$Q_{\max}$ [lpm] 50 Hz	$Q_{\max}$ [lpm] 60 Hz	P_N [kW]
KA 21	700 - 45	0,63 - 10,02	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	1,0

	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 44	700 - 220	0,84 - 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

Example circuit:

KA 44 S/H 3.2 -A 1/250
 -BVH 11 G/GM/R/2
 -BVH 11 G/GM/R/2
 -GM 24
 3x400V Hz-1.5kW


Associated technical data sheets:

- Compact hydraulic power packs type KA: [D 8010](#), [D 8010-4](#)

Similar products:

- Compact hydraulic power packs type HC and HCG: [Page 14](#)

Suitable connection blocks:

- Types A, B and C: [Page 32](#)

Directly mountable valve banks:

- Type VB: [Page 130](#)
- Type BWH, BWN: [Page 138](#)
- Type BVZP: [Page 146](#)
- Type SWR, SWS: [Page 88](#)
- Type BA: [Page 34](#)
- Type BVH: [Page 40](#)

See also section "Devices for special applications"

- Clamping hydraulics
- Geräte bis 700 bar

Compact hydraulic power packs

1.1

Hydraulic power packs type MP and MPN

These compact hydraulic power packs are designed for use in stationary applications, which work in intermittent or load/no load operation. Two different pumps can be easily mounted as an option to make this type particularly suitable for dual-stage drives such as in presses or dual-circuit systems. The tank size and drive power can be easily adjusted to the system requirements using several sizes. Compact control systems can be created by directly mounting connection blocks and valve banks.

Features and benefits:

- Intermittent or load/no load operation S3 or S6
- Long service life and excellent reliability achieved by using 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
- Two-stage valves and switch units for press controls can be directly 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 and provision of clamping pressure for lathe chucks, tailstocks and steady rests on large machine tools and turning centres
- Presses and other shaping machines
- Handling and clamping systems on machine tools and jigs
- Lubrication systems



Nomenclature:	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}:	13.1 lpm (high pressure) (V _g = 10.7 cm ³ /rev) 135 lpm (low pressure) (V _g = 60 cm ³ /rev)
V_{t max}:	approx. 100 lpm

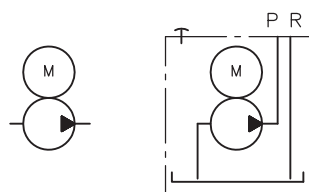
Design and order coding example

MPN 44	- H 1,5	- B10.20	D	- ...	- 3 ~ 230V 50 Hz
					Motor voltage 3 ~ 230/400V ΔY 50 Hz, 3 ~ 500V Y 50 Hz, 1 ~ 230V 50 Hz, 1 ~ 110V 60 Hz (1-phase motor)
					Valve mounting
					Additional options ■ Filling gauge ■ Float switch ■ Temperature switch ■ Various means of electrical connection
					Design ■ For installation in self-made oil tanks: as individual 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, only MPN) ■ Radial piston pump - gear pump (HZ) ■ Gear pump - gear pump (ZZ, only MP)
Basic type, size					Type MP (3-phase motor) and MPW (1-phase motor), sizes 1 and 2 Type MPN (3-phase motor) and MPNW (1-phase motor), size 4 1-phase motor, power reduction by 30 ... 50% depending on size

Function

Single stage pump

(radial piston pump, gear pump)

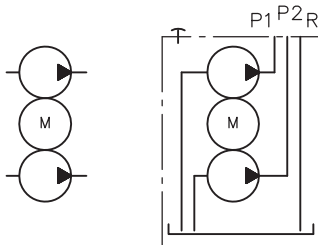


Installation pump

Hydraulic power pack (incl. tank)

Dual stage pump

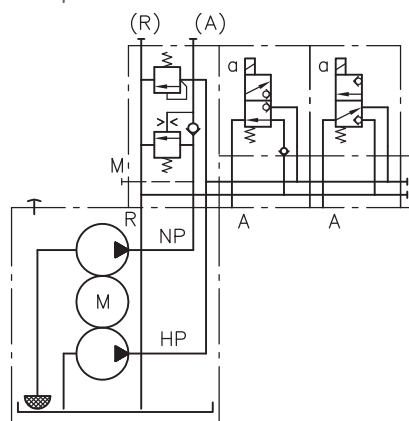
(radial piston/gear pump, gear pump/gear pump)



Installation pump

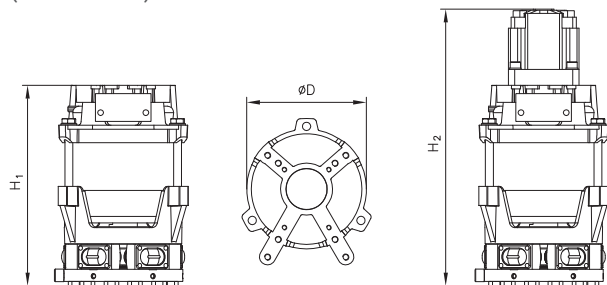
Hydraulic power pack (incl. tank)

Example circuit:

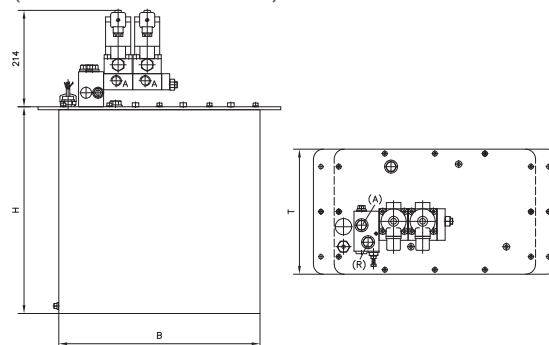


General parameters and dimensions

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⁾
MP 14	700 - 220	0,27 - 1,07	0,32 - 1,28	150 - 15	0,5 - 6,9	0,6 - 8,29	0,25	5,2/5,0	183/228	249	124
MP 12	700 - 250	0,53 - 2,1	0,64 - 2,52	150 - 60	2 - 6,9	2,4 - 8,28	0,37				
MP 24	700 - 310	0,46 - 1,73	0,55 - 2,08	150 - 35	2 - 12,3	2,4 - 14,76	0,75	9,1/7,7	195/291	322,5	140
MP 22	700 - 260	0,88 - 3,51	1,06 - 4,21	150 - 18	4 - 41,4	4,8 - 49,68	0,55				
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	165
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	
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 input is dependent on the respective operation pressure and can be up to $1.5 \times P_N$

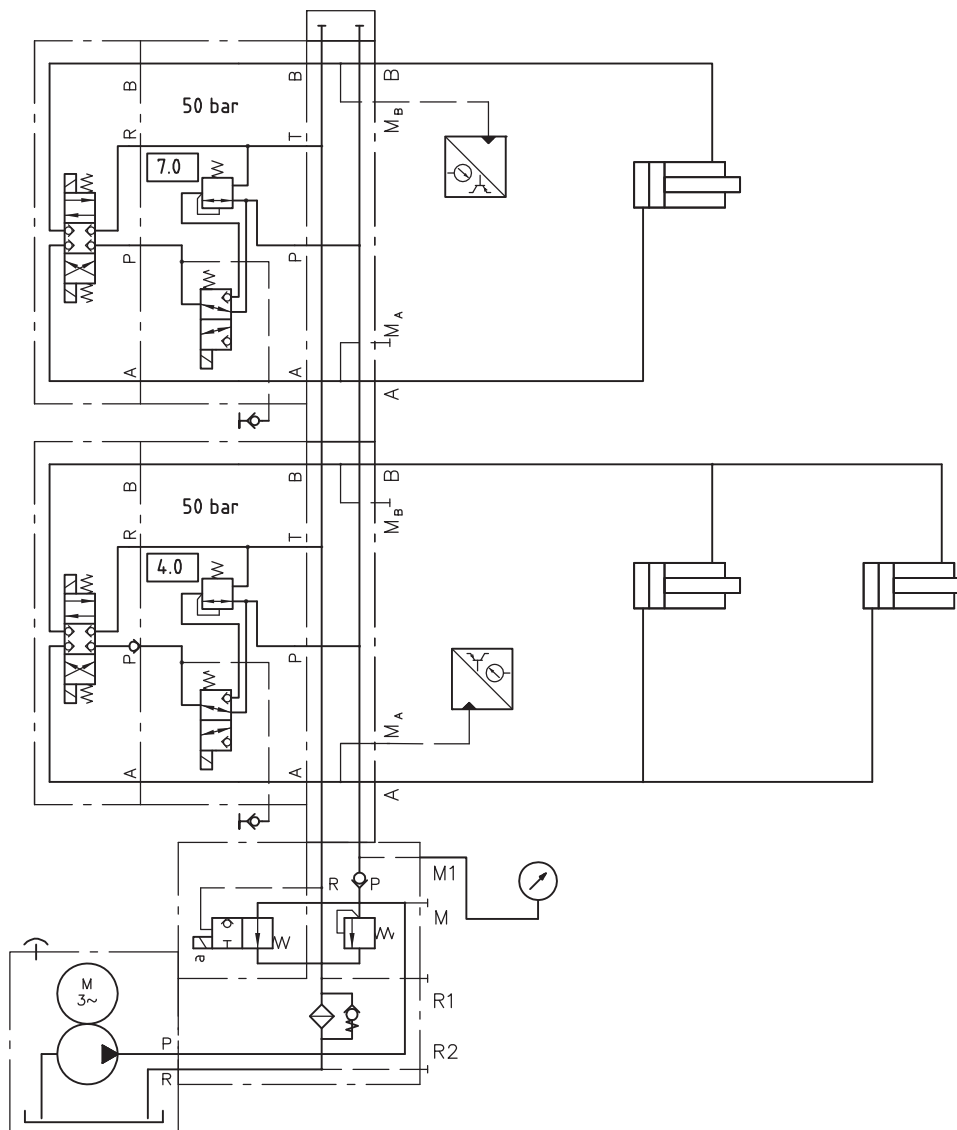
2) Values apply to radial piston pump/gear pump versions

Version with tank:

Size	Tank size	H [mm]	W [mm]	D [mm]
MP 1.	B 3	225	216	136
MP 1., MP 2.	B 5	265	258	160
MP 2., MPN 4.	B 10	358	324	200
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

Example circuit:

MPN 44-Z 8.8-B 10 KT -AS 1 F 3/160
 -BA 2
 -NBVP 16 G/R-GM/NZP 16 LZV 5/50-G 8 MA/GM/3-X 84 V-DG 5E-250-1/4
 -NBVP 16 G-GM/NZP 16 LZV 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 packs type MP, MPW: [D 7200](#), [D 7200 H](#)
- Compact hydraulic power packs type MPN, MPNW: [D 7207](#)

Connection blocks:

- Types A, B and C: [Page 32](#)

Directly mountable valve banks:

- Type VB: [Page 130](#)
- Type BWH, BWN: [Page 138](#)

- Type BVZP: [Page 146](#)
- Type SWR, SWS: [Page 88](#)
- Type BA: [Page 34](#)
- Type BVH: [Page 40](#)

See also section "Devices for special applications"

- Hydraulics for clamping
- Devices for up to 700 bar

Compact hydraulic power packs

1.1

Compact hydraulic power packs type HK, HKF, HKL

Because of the unique integrated fan configuration, the “ready for connection” hydraulic power packs are ideal for continuous operation. Another version for temperature sensitive applications features an auxiliary blower, thereby gaining improved cooling (approx. 25%). This type is available for single circuit operation (radial piston or gear pump), dual circuit operation (radial piston and/or gear pump) or triple circuit operation (radial piston pump only). Both single and dual circuit pumps are also available as a horizontal version (type HKL). Complete hydraulic control systems can be created by directly mounting various combinations of connection blocks and valve banks to the hydraulic power pack. These hydraulic power packs are used for machine tools (lathes and milling machines), jigs or general machine applications, making a commonly used external radiator superfluous.

Features and benefits:

- Suited for permanent and intermittent operation (S1/S6 service)
- Additional separately driven fan for maximum utilisation of power
- 3 sizes enable wide field of application
- Radial piston pumps ensure long service life and high reliability
- Small filling volume minimize costs for fluid and fluid disposal
- Matching valve and accessories from a modular system
- Available as single to triple circuit pump

Intended applications:

- Supply of clamping pressure for lathe chucks, tail stocks, steady rests at machine tools and machining centers
- Welding machines, roboter
- Endurance test benches
- Endurance test bench construction
- Torque wrench



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} :	700 bar (radial piston pump) 180 bar (gear pump)
Q _{max} :	Radial piston pump (high pressure) approx. 13 lpm (V _g = 9.15 cm ³ /rev) Gear pump (low pressure) 24 lpm (V _g = 17.0 cm ³ /rev)
V _{usable max} :	approx. 11.1 l

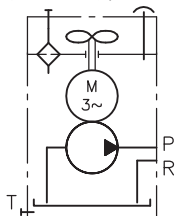
Design and order coding example

HK 34	8	LST	- H 3,6	3 x 400V 50Hz
Motor voltage 3 ~ 230/400V ΔY 50 Hz, 3 ~ 265/460V ΔY 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 fluid level switch - Additional leakage port (Type HK 4.L)				
Tank size Type HK: Usable volume V_{usable} 0.85 l to 15.4 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				

Function

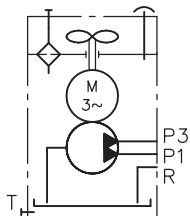
Single stage pump

(radial piston pump, or gear pump)

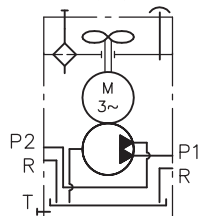


Dual stage pump

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



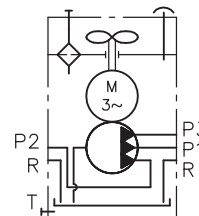
Joint pump pedestal



Separate pump pedestals

Triple circuit pump

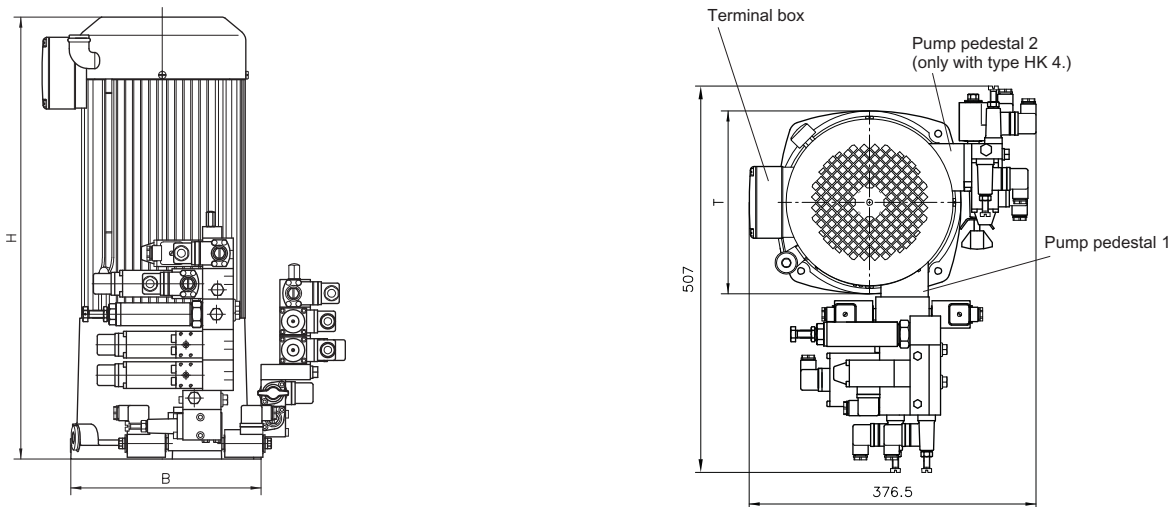
(only radial piston pump)



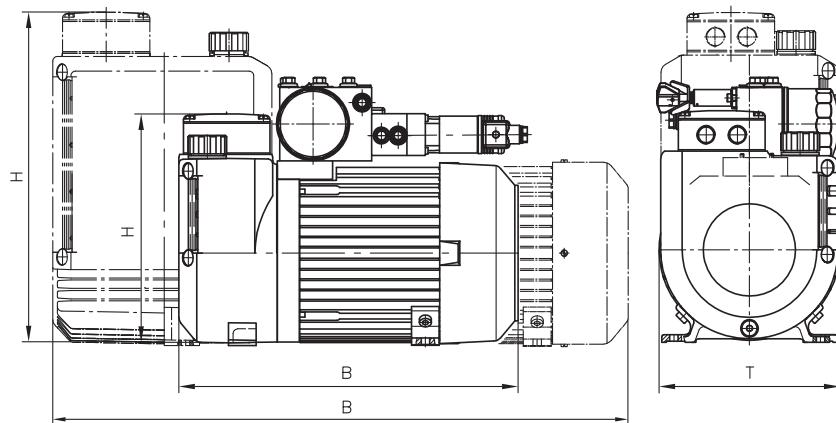
Separate pump pedestals

General parameters and dimensions

HK..



HKL..



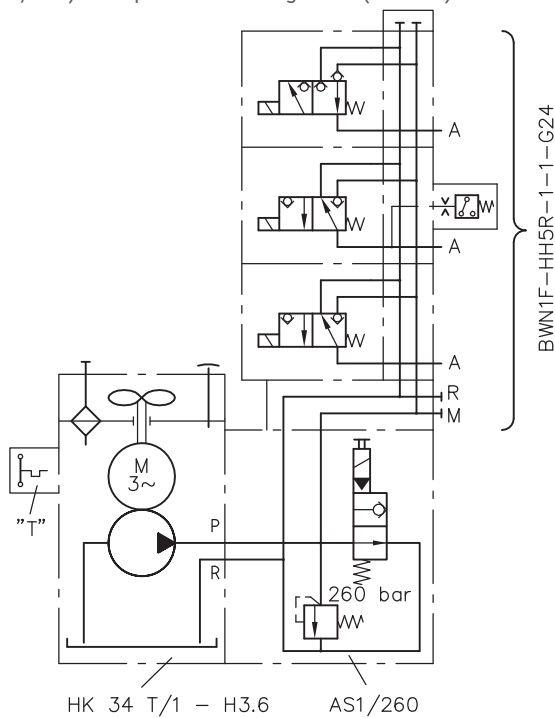
	Radial piston pump			Gear pump								
	Max. pressure	Delivery flow		Max. pressure	Delivery flow							
	p _{max} [bar]	Q _{pu} [lpm] 50 Hz	Q _{pu} [lpm] 60 Hz	p _{max} [bar]	Q _{pu} [lpm] 50 Hz	Q _{pu} [lpm] 60 Hz		P _N [kW] ¹⁾	H _{max}	B	T	
HK 24	700 - 220	0.46 - 1.77	0.55 - 2.12	-	-	-	0.55	340	196	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 input is depends on the respective operation pressure and can be up to $1.5 \times P_N$

Example circuits:

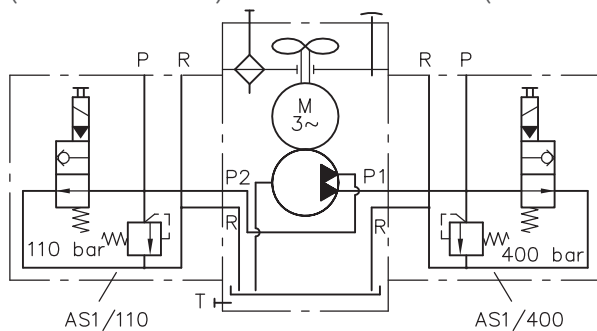
HK34T/1-H 3.6-AS1/260-BWN1F-H H5 R-1-1-G24

Compact hydraulic power pack type HK 34 with temperature switch (coding T), radial piston pump H 3.6, connection block (type AS 1/260) with pressure-limiting valve (260 bar) and idle circulation valve as well as directly mounted valve bank type BWN 1



HK44 /1-H 2.5-Z 6.9-AS1/400-AS1/110-G24

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



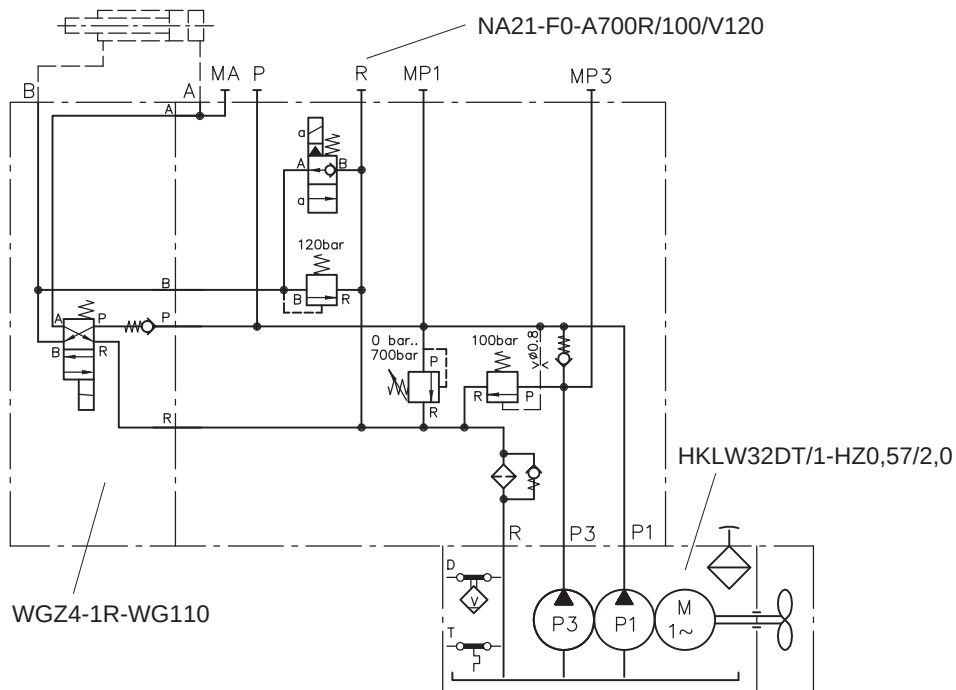
Example circuit:

HKLW32DT/1-HZ0.57/2.0

- NA21F0-A700R/100/V120

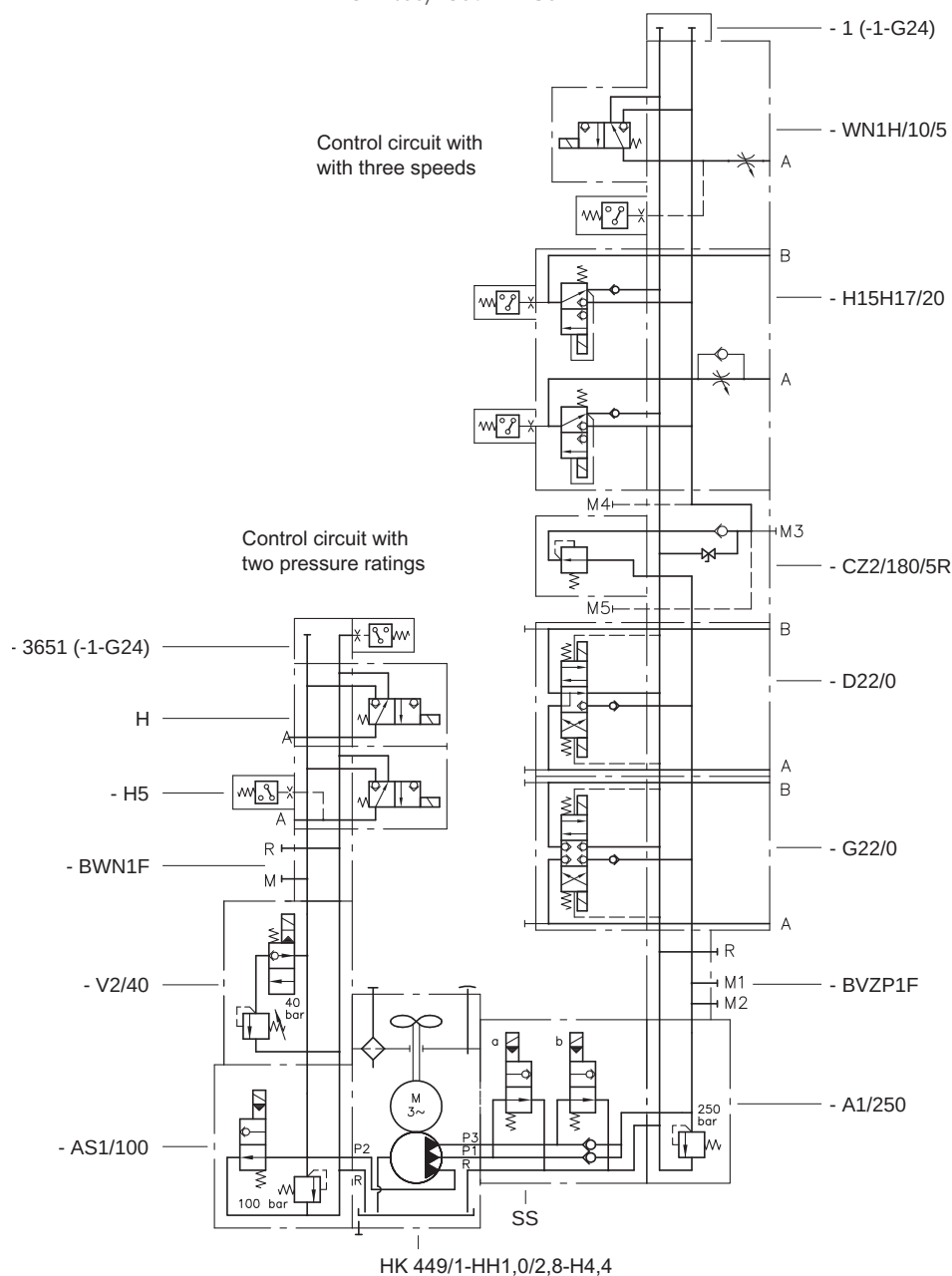
- WGZ4-1R-WG110

1 ~ 110V 60 Hz



Example circuit:

HK449/1-HH1.0/2.8-H4.4 -SS - A1/250
 - BVZP1F -G22/0 -D22/0 -CZ2/180/5R
 - H15H17/20 -WN1H/10/5 -1-1
 - AS1/100 -V2/40
 - BWN1F-H5H-3651-1-G24
 3 ~ 400/230V ∇ Δ 50 Hz



Associated technical data sheets:

- Compact hydraulic power packs type HK 4, HKF 4: [D 7600-4](#)
- Type HK 3: [D 7600-3](#)
- Type HK 2: [D 7600-2](#)
- Type HKL 3, HKLW 3: [D 7600-3L](#)

Connection blocks:

- Type A, B and C: [Page 32](#)

Directly mountable valve banks:

- Type VB: [Page 130](#)
- Type BWH, BWN: [Page 138](#), Type BVZP 1: [Page 146](#)
- Type SWR, SWS: [Page 88](#)
- Type BA: [Page 34](#)
- Type BVH: [Page 40](#)

See also section "Devices for special applications"

- Hydraulics for clamping, devices for up to 700 bar

Compact hydraulic power packs

1.1

Connection blocks type A, B, and C

Connection blocks are used to develop types HC, KA, MP, MPN, HK, HKF and HKL compact hydraulic power packs into a ready-for-connection solution. Compact control systems can be created by directly mounting valve banks to the connection blocks on type A (see “complete solutions in modular system”).

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 and return filter, pressure limiting valves, switches etc. can be 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



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} •	700 bar
Q _{max} •	approx. 20 lpm

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	

Options, type A, B, C

Type A with pressure-limiting valve (pre-set or manually adjustable, also with unit approval)

- For direct pipe connection
- To attach valve banks

Options:

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

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)

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

- For direct pipe connection

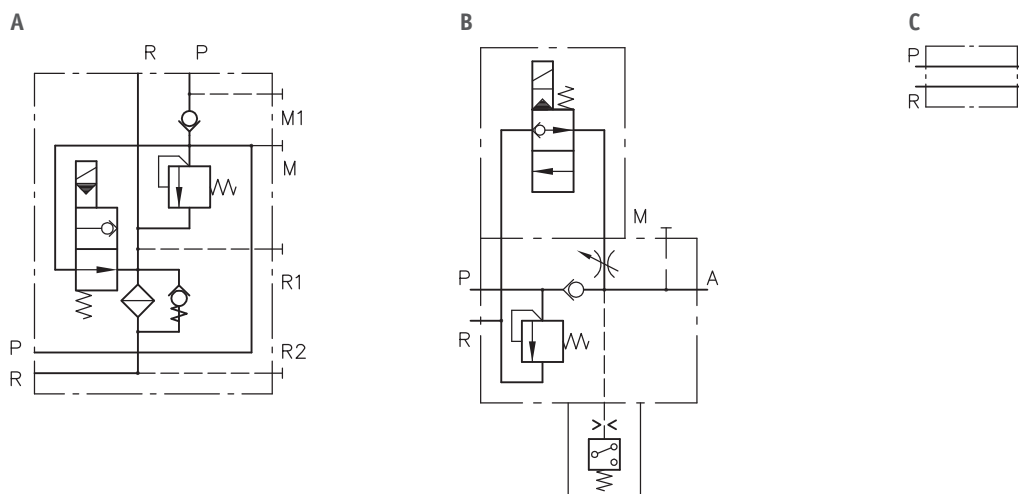
Options:

- 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
- Automatic clamping and releasing via the pressure switch (type B..DW)

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

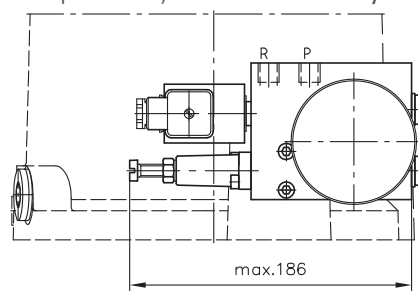
Function



General parameters and dimensions

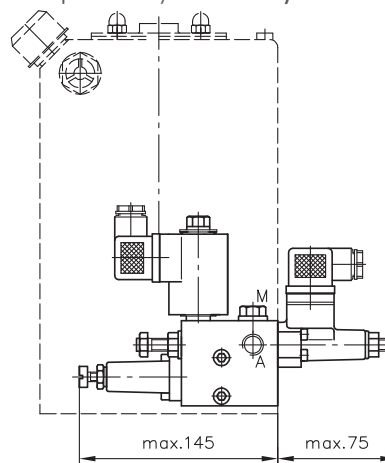
AS ..

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



B..

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



Associated technical data sheets:

- Type A etc.: [D 6905 A/1](#)
- Type AX: [D 6905 TÜV](#)
- Type B: [D 6905 B](#)
- Type C: [D 6905 C](#)

Suitable compact hydraulic power packs:

- See section
Compact hydraulic power packs

Products with shared connection diagram:

- Two-stage valves type NE 21: [Page 206](#)
- Switch units type CR: [Page 164](#)
- Directional spool valves type SKC: [SKP, SKH](#)
- Type SWC: [Page 88](#)

Suited valve banks for combination:

- Type VB: [Page 130](#)
- Type BWH, BWN: [Page 138](#)
- Type BVZP: [Page 146](#)
- Type SWR, SWP, SWS: [Page 88](#)
- Type BA: [Page 34](#)
- Type BVH: [Page 40](#)

Compact hydraulic power packs

1.1

Valve bank type BA

Thanks to the identical flange pattern of type BA sub-plates, they can be combined very flexibly with type A.. connection blocks. On the pump side, this enables direct mounting (without intermediate plate) to the connection blocks of the compact hydraulic power packs. Directional seated valve banks and directional spool valve banks (e.g. type BWN, BWH, BVH, VB, BVZP, SWR, SWP and SWS) can be flanged to the valve section side. Valves and intermediate plates with standard connection patterns (type NSMD2, NSWP2, NBVP16, NBMD16, NG..-1, NZP16) can be mounted individually. Additional functions for the pump or consumer side (e.g. throttle and throttle check valve, pressure-reducing valve or pressure switch) enable flexible adaptation to changing operating conditions. Hydraulic clamping systems (e.g. in machine tools) with the associated wide range of requirements are the typical application areas.

Features and benefits:

- Sub-plates for flexible combination with directional valve types with NG6 (CETOP) standard connection pattern
- Valve bank can be flanged directly to 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 P, R, A and B connections can be integrated
- Diaphragm 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} :	400 bar
Q _{max} :	20 lpm

Design and order coding example

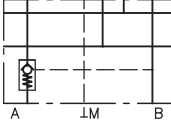
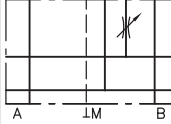
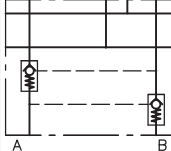
BA2 A5	NBVP16 NBVP16 NSWP2	S G G	0 B0,8 R B0,6 R	/ABR2,0/BBR1,5 /ABR1,0/BBR1,5	/A3B9/400 /50	/S /S	/0	- 1	- G24
									Solenoid voltage 12V DC, 24V DC, 230V AC, 110V AC End plate ■ Drain valve with/without pressure switches ■ with one or two accumulator ports with/without release valve and/or with/without 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
									Switching 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:

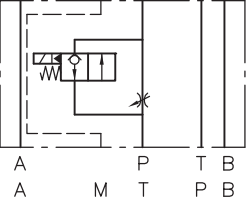
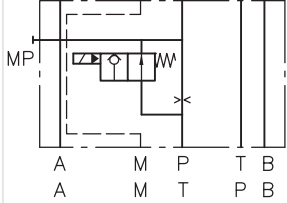
BA2 ..	BA2 A5	BA2 A8
Direct mounting onto type A, AF etc. connection blocks at type KA, MP, MPN, HC, HK(F), HKL compact hydraulic power packs	Version for pipe connection without pressure-limiting valve	Like version BA2 A5 but with check valve in R
		

Sub-plates for plate assembly valve

BA2.../0	BA2../1	BA2../2	BA2../3	BA2../5
				

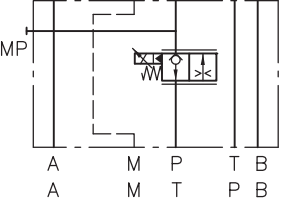
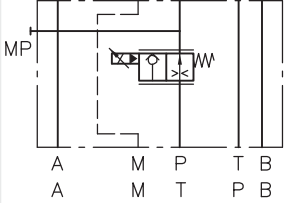
Additional options for the valve sections:

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...
	

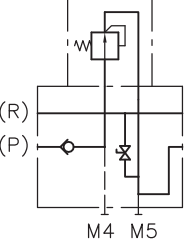
Example: .../NZP16TV/TB1.0/...
Type B1.0 orifice and type EM21V by-pass valve in T gallery

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

/NZP16(T)VP	/NZP16(T)SP
	

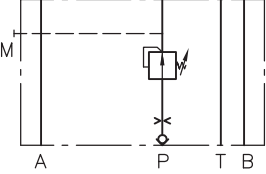
Example: .../NZP16VP/...
Type EMP21V proportional throttle valve in P gallery

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...


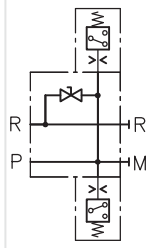
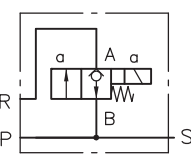
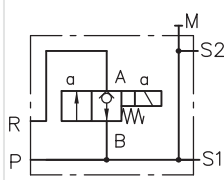
Example: .../NZP16CZ08/350/B0.8R/...
Type CDK0.8 pressure-reducing valve set to 350 bar with orifice and check valve in P gallery

Actuations:

M: Solenoid actuation ($p_{\max} = 400 \text{ bar}$)
 GM: Solenoid actuation ($p_{\max} = 250 \text{ bar}$)
 H: Hydraulic actuation

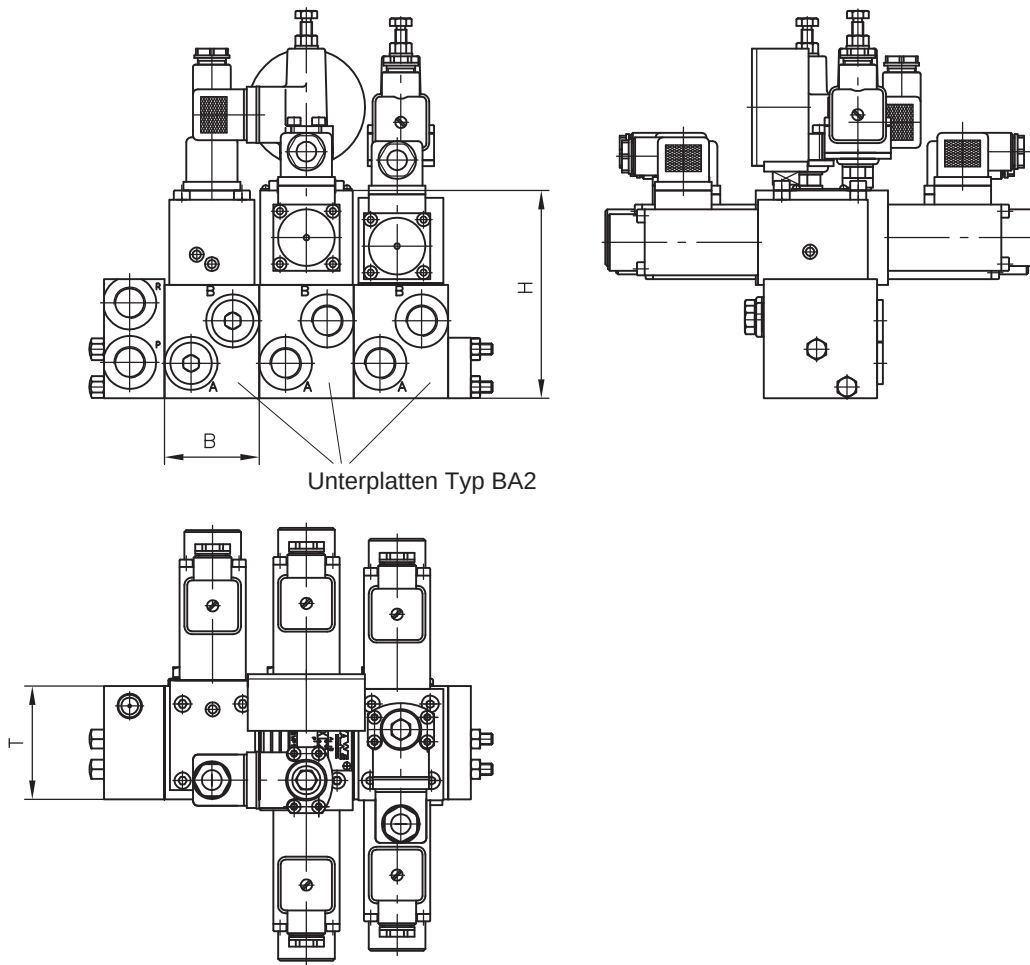
P: Pneumatic
 A: Manual actuation
 T: Pin
 K: Roller

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
					

General parameters and dimensions

BA



	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

Compact hydraulic power packs

1.1

Valve bank type BVH

Type BVH valve banks can be very flexibly combined with type A connection blocks. Segments are mounted using a hollow screw in the P gallery. In addition to the seated valve functions, the additional functions in the P and R gallery (e.g. check valve, orifice in P gallery, filter, pressure switch in A gallery) have been integrated into the valve segment. The benefits of this technical design are the flexible bearing and the expansion options that can be easily adapted to the corresponding application at the end user. The main areas of application are hydraulic clamping systems and the machine tool industry.

Features and benefits:

- Very flexible expansion options and maintenance of valve banks at end user
- Compact and lighter design

Intended applications:

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



Nomenclature:	Valve sections Directional seated valve Zero leakage
Version:	Valve sections for pipe connection
Actuation:	Solenoid
p _{max} :	400 bar
Q _{max} :	20 lpm

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 type A etc. connection blocks (for type KA, MP, MPN, HC, HK, HKF, HKL compact hydraulic power packs)

Function

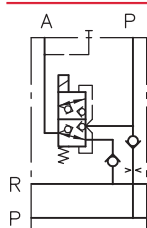
Connection blocks/adaptor plates:

BVH

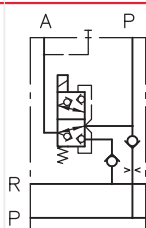
Direct mounting onto type A etc. connection blocks
 for type KA, MP, MPN, HC, HK, HKF, HKL compact hydraulic power
 packs

Valve sections:

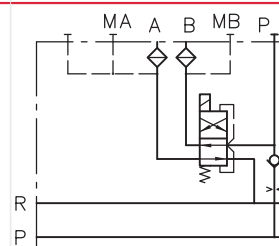
H



M



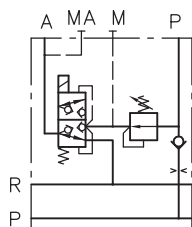
W



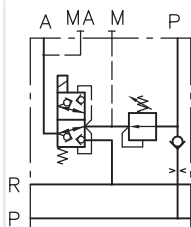
Additional options for the valve sections:

Individual pressure reduction (parallel connection)

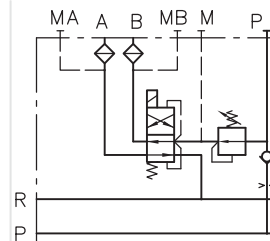
BVH 11 H/CZ...



BVH 11 M/CZ...



BVH 11 W/CZ...



Actuations:

M: Solenoid actuation ($p_{\max} = 400$ bar)

GM: Solenoid actuation ($p_{\max} = 250$ bar)

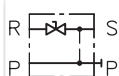
End plates:

without

Tapped plug at P, R

-8

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 - 8 - G 24

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

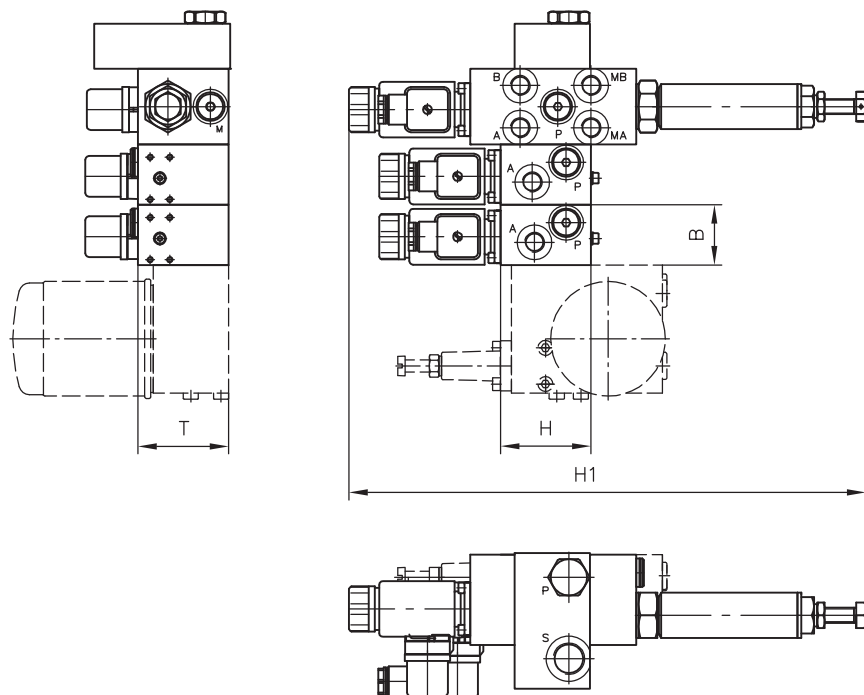
Valve section 1 with 3/2-way function switching symbol H, P check valve (coding R), no pressure switch (coding 2)

Valve section 2 with 3/2-way function switching 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 switching 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

BVH



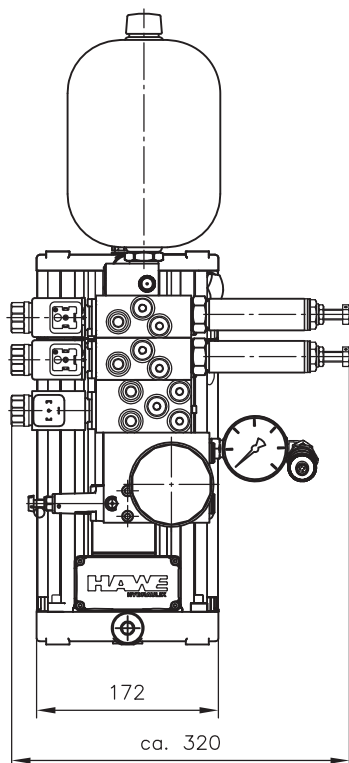
	$Q_{\max}$ [lpm]	$p_{\max}$ [bar]	Ports (BSPP)	Dimensions [mm]				m [kg]
			A, B, P, R, M	H	H1	B	T	Valve section
BVH	20	400	G 1/4	60	343	40/50	60	0,8

Example circuit:

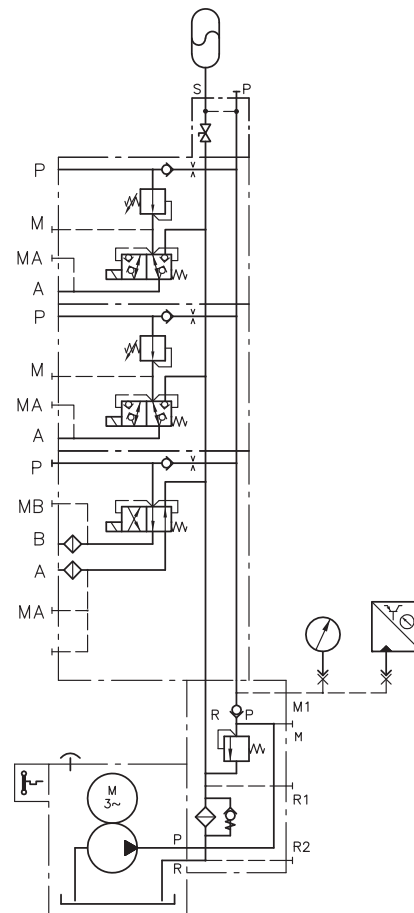
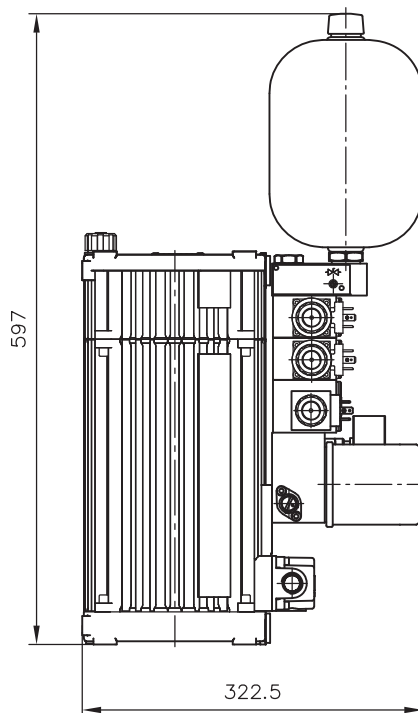
KA 281 SKT/Z 9.8

- 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
- 8-X 24 - AC 2001/60/3/A 3x400V 50 Hz

Type KA compact hydraulic power pack
 1 kW motor output;
 Connection block with return filter
 and TÜV-approved safety valve
 set to 120 bar



Type BVH valve bank with three valve segments,
 two clamping functions with individually adjustable
 clamping pressure



Parameters of the example circuit:

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

Associated technical data sheets:

- Type BVH directional valve banks:
[D 7788 BV](#)

Compact hydraulic power packs:

- See section
 "Compact hydraulic power packs"

Connection blocks:

- Type A: [Page 32](#)

Combinable products:

- Directional seated valves type NBVP:
[Page 156](#)
- Pressure-reducing valves type CDK, DK:
[Page 196](#)

Accessories:

- Type DG pressure switches: [Page 266](#)
- Type AC diaphragm accumulators: [Page 268](#)

Plug:

- with LEDs including: [D 7163](#)

1.2 Standard pumps and power packs

Radial piston pumps type R and RG	46
Variable displacement axial piston pumps type V30D and V30E	50
Variable displacement axial piston pump type V60N	54
Variable displacement axial piston pump type V40M	58



*Radial piston pumps
type R and RG*



*Variable displacement
axial piston pumps
type V60N*

Standard pumps and power packs

Type	Nomenclature/version	$p_{\max}$	$Q_{\max}$	$V_{\max}$
R, RG	Radial piston pump ■ Individual pump ■ Motor pump ■ Hydraulic power pack	700 bar	91.2 lpm (1450 rpm)	$V_g = 64.18 \text{ cm}^3/\text{rev}$
V30D, V30E	Variable displacement axial piston pump ■ Individual pump ■ Pump combination	Continuous: 350 bar Peak: 420 bar	65 ... 392 lpm (1450 rpm)	$V_{g \max}$: 45 ... 270 cm^3/rev
V60N	Variable displacement axial piston pump ■ Individual pump ■ Pump combination	Continuous: 350 bar Peak: 420 bar	85 ... 185 lpm (1450 rpm)	$V_{g \max}$: 60 ... 130 cm^3/rev
V40M	Variable displacement axial piston pump ■ Individual pump ■ Pump combination	Continuous: 250 bar Peak: 320 bar	65 lpm (1450 rpm)	$V_{g \max}$: 45 cm^3/rev

Standard pumps

1.2

Radial piston pumps type R and RG

The radial piston pumps consist of valve-controlled pump cylinders that are arranged radially. Higher volumetric flows can be achieved by arranging up to 6 radials in parallel. The pump is usually driven by an electric motor, which is connected to the pump via a flange and coupling. The closed pump housing allows for installation in a tank (hydraulic power pack) as well as installation outside a tank (motor pump). The possibility of a radial piston pump with several pressure outlets (several equal or different volumetric flows) is particularly innovative. Type RG with slide bearings is used in extreme operating conditions to increase the service life of the bearings. Compact control systems can be created by mounting various connection blocks and valve banks onto the cover plate of the hydraulic power packs.

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



Nomen-clature:	Radial piston pump
Design:	Individual pump Pump complete with motor Hydraulic power pack
p _{max} :	700 bar
Q _{max} :	91.2 lpm (V _g = 64.18 cm³/rev)
V _{tank max} :	approx. 470 l

Design and order coding example

R 11,6

/ M 7,5

K

Options

- Fluid level gauge
- Temperature switch
- Float switch

Function, drive

Motor pump

- With/without industrial standard motor (output P_N in kW)

Hydraulic power packs

- Version with tank, with/without industrial standard motor
Consumable volume V_{cons.} 6 l to 450 l
- Cover plate version (for installation on customer furnished tanks), with/without industrial standard motor
- Combination motor + pump (for installation on customer furnished cover plates and tanks)
- With direct current drive (design 6011)

Basic type, delivery flow [lpm]

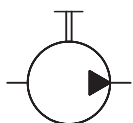
Type R (version with roller bearing) and type RG (version with slide bearing)

Additional versions:

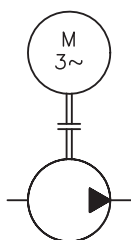
- With several pressure ports
- With separate ports for the flow of one or two pump elements (Q_{max} = 4,4 lpm)
e.g. as control oil supply
- Integrated switch-off valve at two pressure ports

Function

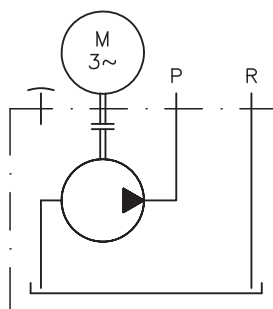
Individual pump



Pump complete with motor



Hydraulic power pack

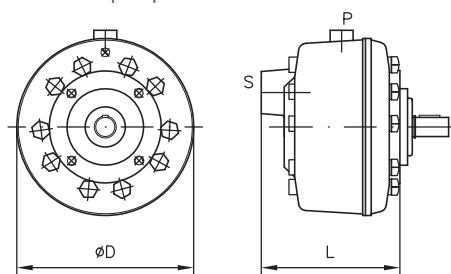


Pump with several pressure outlets (example for an individual pump)

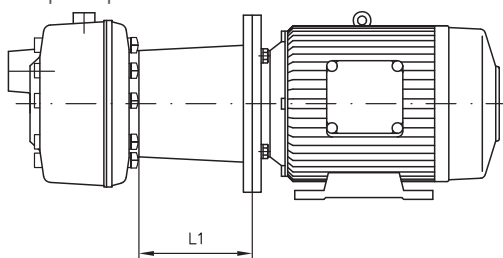


General parameters and dimensions

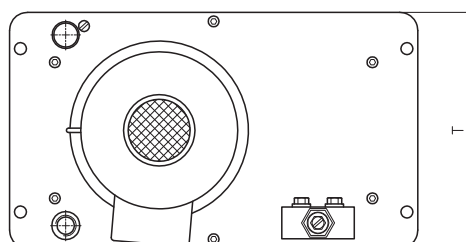
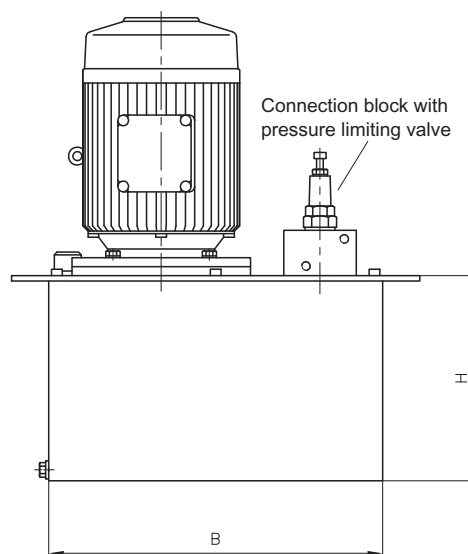
Individual pump

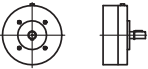
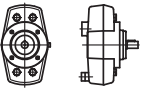
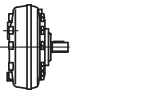
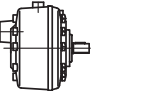
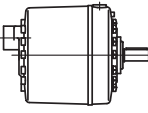


Pump complete with motor



Hydraulic power pack



Design		Number of cylinders	Delivery flow Q_{pu} (lpm) (approximate reference value at 1450 rpm) and max. pressure p_{max} (bar)					P_N [kW]	Tank sizes $V_{use.}$ [l]	Dimensions [mm]			
			700 bar	550 bar	450 bar	250 bar	160 bar			D	L	L _{1max}	m [kg] ²⁾
7631		2	0.18	0.28	0.43	0.92	-	0.25...0.55	6...45	130	53	109	3.2
		3	0.27	0.42	0.64	1.35	-						
		5	0.46	0.7	1.08	2.27	-						
6010		1	0.3	0.5	0.8	1.7	2.2	0.25...3	6...80	174	82.5	113	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		5	1.4	2.6	4.2	8.3	10.9	0.55...5.5	6...160	185	86	155	5.8
		7	2.1	3.7	5.8	11.8	15.3						
6012		10	2.7	5.3	8.2	16.8	21.7	2.2...11	20...160	185	146	188	10.5
		14	4.0	7.4	11.6	23.5	30.4						
6014		20	6.1	11.0	17.4	35.0	43.4	5.5...22	80...450	218	250	188	24.2
		28	8.0	15.0	23.0	47.0	60.8						
6016		42	12.7	22.0	34.5	70.0	91.2	11...30	120...450	238	311	212	39.1

- The parameters listed here represent only a choice from a variety of possibilities.

1) Standard motor, design IM B 35 for pumps complete with motor or IM B 5 for hydraulic power packs.

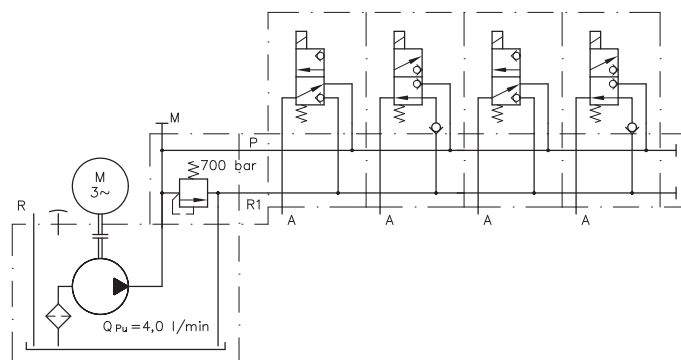
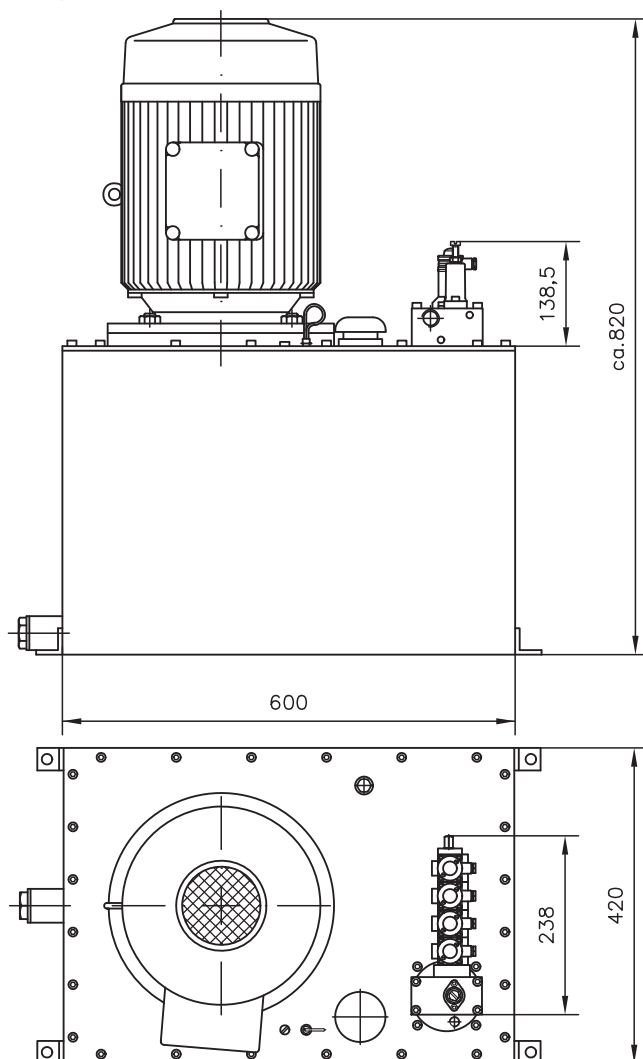
2) Mass of the individual pump

Hydraulic power pack:

Tank size	H [mm]	B [mm]	T [mm]	V_{max} tank [l]
B 6	230	253	315	9.3
B 13	230	368	260	17
B 20	320	368	260	25
B 30	320	448	320	39
B 40	320	448	440	55
B 50	403	600	420	85
B 75	478	600	420	107
B 100	536	650	500	152
B 160	666	650	500	193
B 250	575	1000	600	309
B 400	825	1000	600	469

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 pumps type R, RG: [D 6010](#)
- Motor pumps, hydraulic power packs type R, RG: [D 6010 H](#)
- Radial piston pumps with several pressure ports type R, RG: [D 6010 D](#), [D 6010 DB](#)
- Radial piston pumps with control oil port type R: [D 6010 S](#)
- Hydraulic power packs with gear pump type Z: [D 6820](#)

Directly mountable valve banks:

- Type VB: [Page 130](#)
- Type BWH(N): [Page 138](#)
- Type SWR: [Page 88](#)
- Type SKP: [D 7230](#)

See also section "Devices for special applications"

- Press controls
- Devices for up to 700 bar

Standard pumps

1.2

Variable displacement axial piston pumps type V30D and V30E

The variable displacement axial piston pumps type V30D and V30E are designed for open circuits in industrial and mobile hydraulics and operate according to the swash plate principle. A thru-shaft is optionally available to enable the connection of additional variable displacement pumps or an auxiliary pump. In this context, type V30E represents a design according to the most recent findings in pump design. Above all this concerns the optimised self-suction speed, reduced noise emissions and pulsation, increased service life and significantly reduced weight. A wide range of controllers (modular principle) offers the user a wide range of application possibilities. Individual pumps or multiple pumps may be used for hydraulic circuits with several volumetric flows. Robust design, low performance/weight ratio, long service life (large bearing dimensions) and a swash plate angle indicator are amongst the additional benefits.

Features and benefits:

- Low noise emissions
- Wide range of controllers
- Full torque available at the second pump in tandem pump applications

Intended applications:

- Machines for forestry and agricultural purposes
- Cranes and lifting equipment
- Presses
- Municipal trucks



Nomen-clature:	Variable displacement axial piston pump
Design:	Individual pump Pump combination
p _{max} :	350 bar (continuous) 420 bar (peak)
Q _{max} :	65 ... 392 lpm (1450 rpm)
V _{g max} :	45 ... 270 cm³/rev

Design and order coding example

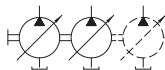
V30D - 095	R	SF	N	- 1	- 1	- XX	/LN	-2	/120	- 200
										Pressure specification [bar]
										Torque setting [Nm] Alternatively specification for power [kW] and speed [rpm]
										Additional versions ■ Conversion with L power controller ■ Max. stroke limitation
										Controllers see "Controller types"
										Release
										Pivoting angle indicator With/without indicator or with pivoting angle pick-up
										Shaft version With/without thru-shaft
										Seal material ■ NBR (N) ■ EPDM (E) ■ FKM (V)
										Shaft journal/flange ■ Spline shaft (DIN 5480) (D) ■ SAE spline shaft and flange (S) ■ Parallel key (K) ■ DIN (W) ■ SAE (F)
										Rotation direction Anti-clockwise (L), clockwise (R)
Basic type, nominal size										■ Individual pumps ■ Dual and multiple pumps (tandem pumps)

Function

Individual pump



Multiple pump



Controller types:

Power controller:

- To restrict the drive torque (L)
- With option to reduce the geom. delivery flow (Lf1)

Load-sensing controller:

- For proportional directional spool valve (LS)
- with pressure limitation (LSN)

Pressure controller:

- For constant pressure systems (N)
- With remote-control port (P)
- With remote-control port for systems that are very sensitive to vibration (Pb)

Flow controller:

- For maintaining a constant flow (Q)
- For maintaining a constant level at higher speeds (Qb)

Electro-hydraulic proportional control of the pump:

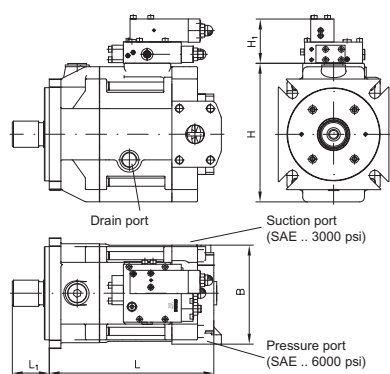
- For continuous delivery flow control using an electronic control card (V)

Controller:

- With hydraulic proportional control of the delivery flow (VH)

General parameters and dimensions

V30



(connection locations for clockwise operation)

	Geom. delivery volume	Delivery flow ¹⁾	Nom. pressure	Self-suction speed	Dimensions [mm] approx.					m [kg]
	V_g [cm ³ /rev]	Q_{max} [lpm]	p_{nom} (p_{max}) [bar]	n [rpm]	L	L1	H	H1	B	(with controller)
V30E - 095	95	139	350 (420)	2600	300	63	190	50	190	59
V30E - 160	160	232		2100	330	65	210	50	210	92
V30E - 270	270	392		1900	399	79	326	50	242	126
V30D - 045	45	65	350 (420)	2600	268	68	150	82	160	40 (46)
V30D - 075	75	109		2400	310	80	170	86	178	60 (66)
V30D - 095	95	139		2200	341	93	196	87	196	70 (76)
V30D - 115	115	167	250 (300) ²⁾	2000	341	93	196	87	196	70 (76)
V30D - 140	140	206	350 (420)	2200	363	90	212	85	212	85 (91)
V30D - 160	160	238	250 (300) ²⁾	1900	363	90	212	85	212	85 (91)
V30D - 250	265	380	350 (420)	1800	432	115	224	97	272	130 (136)

1) Approximate reference value at 1450 rpm

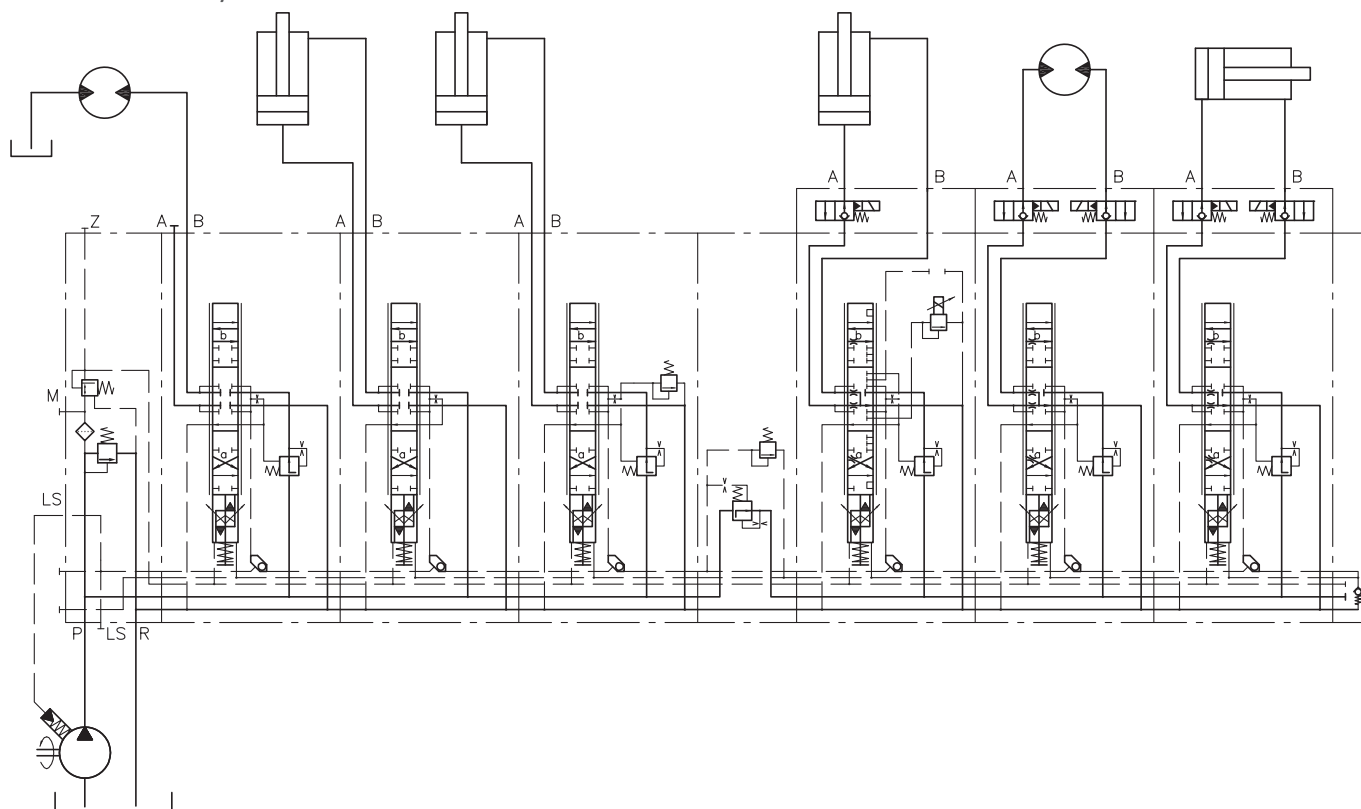
2) Higher pressure is possible with reduced geom. delivery flow

Ports:

	Drain port	Auxiliary port	Suction port	Pressure port
V30E - 095	G 3/4	-	2 1/2"	1 1/4"
V30E - 160	G 3/4	-	2 1/2"	1 1/4"
V30E - 270	G 1	-	3"	1 1/2"
V30D - 045	G 1/2	G 1/4	1 1/2 "	3/4"
V30D - 075	G 3/4	G 1/4	2"	1"
V30D - 095	G 3/4	G 1/4	2"	1 1/4"
V30D - 115	G 3/4	G 1/4	2"	1 1/4"
V30D - 140	G 3/4	G 1/4	2 1/2 "	1 1/4"
V30D - 160	G 3/4	G 1/4	2 1/2 "	1 1/4"
V30D - 250	M 33x 2	Pipe Ø 8	3"	1 1/2"

Example circuit:

V30E-270-LSF N-2-1/03-LSN-320



Associated technical data sheets:

- Type V30D variable displacement axial piston pumps: [D 7960](#),
Type V30E: [D 7960 E](#)

Similar products:

- Type V40M variable displacement axial piston pump: [Page 58](#)
- Variable displacement axial piston pump type V60N: [Page 54](#)
- Type K60N fixed displacement axial piston pump: [D 7960 K](#)
- Type M60N axial piston motor: [D 7960 M](#)

Suitable prop. directional spool valves:

- Type PSL/PSV sizes 2, 3 and 5: [Page 104](#)
- Type PSLF/PSVF sizes 3, 5 and 7: [Page 110](#)

Suitable accessories:

- Prop. amplifier type EV1M2: [Page 276](#)
- Programmable logic valve control type PLVC: [Page 278](#)

See also chapter "Equipment for special applications":

- Mobile hydraulics

Standard pumps

1.2

Variable displacement axial piston pump type V60N

Thanks to its sturdy construction, the variable displacement axial piston pump is designed for direct flange mounting to the power take-off on commercial vehicle gearboxes, or for standard connection using an SAE flange. The benchmark figures for this product are 130 cm³/rev and 450 bar end pressure, allowing for a wide range of applications. These are supported by a high self-suction speed rating and low noise level. Variations with thru-shaft for flange mounting additional variable displacement axial piston pumps and auxiliary pumps are also available. Several different controllers offer the user a wide range of application possibilities. Particular advantages with regard to the mutual coordination arise from a combined application of variable displacement axial piston pumps with proportional directional spool valves type PSV and possibly required load-holding valves type LHT and LHDV.

Features and benefits:

- Good performance/weight ratio
- High self-suction speed
- Different shaft and flange versions

Intended applications:

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



Nomenclature:	Variable displacement axial piston pump
Design:	Individual pump Pump combination
p _{max} :	400 bar (continuous), 450 bar (peak)
Q _{max} :	87 ... 190 lpm (1450 rpm)
V _{g max} :	60 ... 130 cm ³ /rev

Design and order coding example

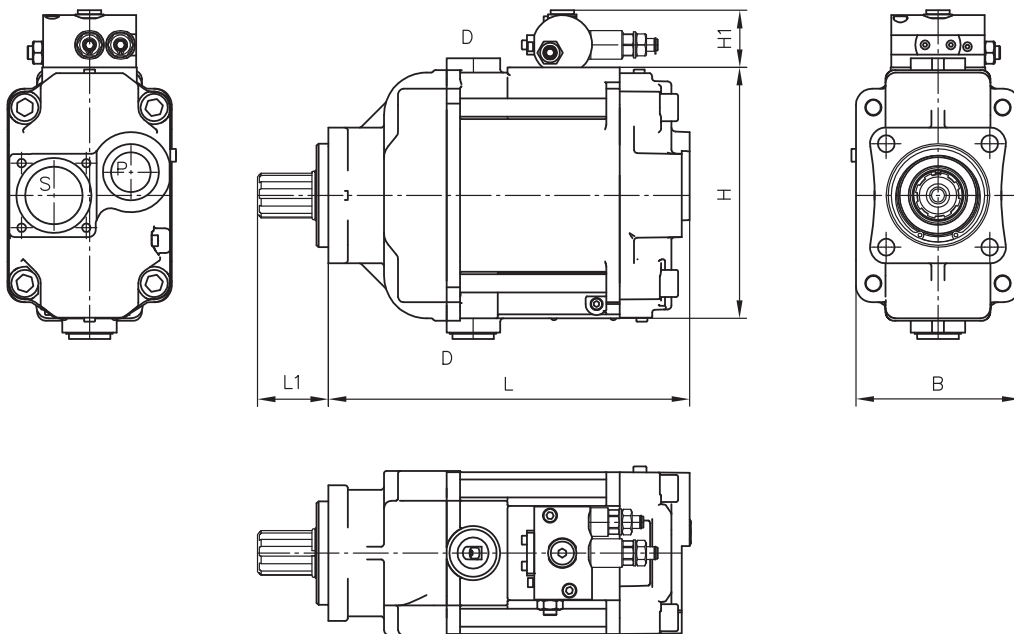
V60N - 110	R	S F	N	- 1	- 0	- 03	/LSNR	-2	- 320
							Pressure specification [bar]		
							Additional versions With/without max. stroke limitation		
							Controllers		
							Load-sensing controller:		
							■ For proportional directional spool valve with pressure limitation (LSNR)		
							Pressure controller:		
							■ For constant pressure systems (NR)		
							Power controller, intermediate plate		
							■ to restrict the drive torque (/ZL)		
							Release		
							Additional function		
							Shaft version With/without thru-shaft, radial ports		
							Seal material		
							■ NBR (N), FKM (V)		
							Shaft journal/flange		
							■ ISO 14 parallel key splined shaft (D)		
							■ SAE-C, SAE-B J 744 spline shaft (S)		
							■ DIN ISO 7653 (Y)		
							■ SAE-C, SAE-B J 744 (F)		
							Rotation direction Anti-clockwise (L), clockwise (R)		
Basic type, nominal size							■ Individual pumps		
							■ Tandem pumps		

Function



General parameters and dimensions

V60N



Characteristic values

	Geom. delivery volume	Delivery flow ¹⁾	Nom. pressure	Self-suction speed	Dimensions [mm]					m [kg]
	V_g [cm ³ /rev]	Q_{max} [lpm]	p_{nom} (p_{max}) [bar]	n [rpm]	L	L1	H	H1	B	
V60N - 060	60	87	350 (400)	2500	254	55	181	44	115	23
V60N - 090	90	130		2300	277	55	189	44	120	26,7
V60N - 110	110	160		2200	279	55	191	44	125	29
V60N - 130	130	188	400 (450)	2100	269,5	55	210	45,1	130	30,8

1) Approximate reference value at 1450 rpm

Ports:

	Drain port D	LS signal port	Suction port S	Pressure port P
V60N - 060	G 3/4	G 1/4	Flange Ø 1 1/2	G 1
V60N - 090				
V60N - 110				
V60N - 130				

Example circuit

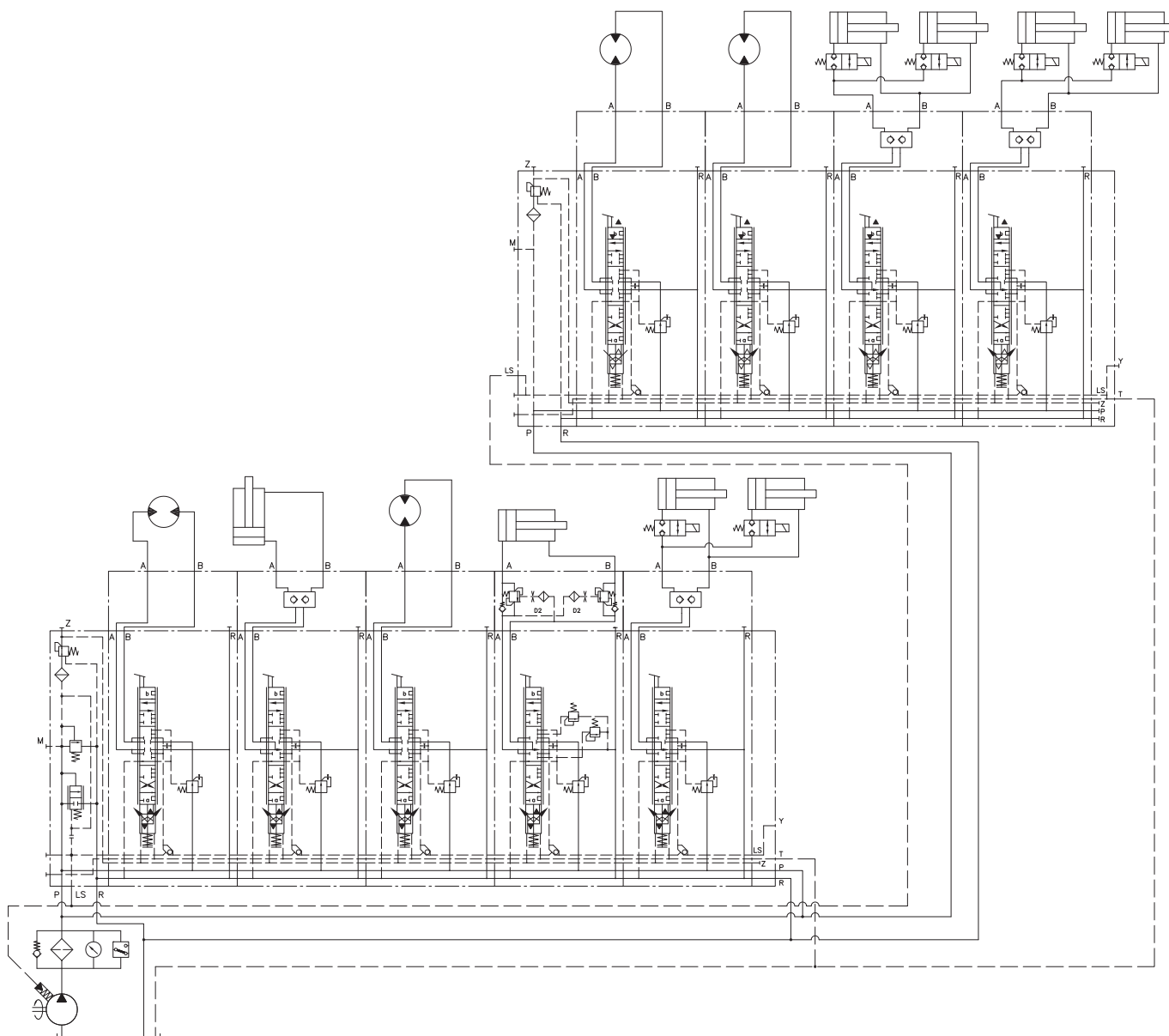
V60N-130 RSFN-1-0-0.00 / LSNR-2-250

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:

- Type V60N variable displacement axial piston pump: [D 7960 N](#)

Similar products:

- Variable displacement axial piston pumps type V40M: [Page 58](#)
- Type V30D and V30E variable displacement axial piston pumps: [Page 50](#)
- Type K60N fixed displacement axial piston pump: [D 7960 K](#)
- Type M60N axial piston motors: [D 7960 M](#)

Suitable prop. directional spool valves:

- Type PSL/PSV sizes 2, 3 and 5: [Page 104](#)
- Type PSLF/PSVF sizes 3, 5 and 7: [Page 110](#)

Suitable load-holding valves:

- Type LHK, LHDV, LHT: [Page 212](#)

See also chapter "Equipment for special applications":

- Mobile hydraulics

Pumps

1.2

Variable displacement axial piston pump type V40M

Thanks to its sturdy construction, the variable displacement axial piston pump is designed for a standard connection using an SAE flange. The benchmark figures for this product are 45 cm³/rev and 320 bar end pressure, allowing for a wide range of applications. These are supported by a high self-suction speed rating and low noise level.

Variations with thru-shaft for flange mounting additional variable displacement axial piston pumps and auxiliary pumps are also available. Several different controllers offer the user a wide range of application possibilities. Particular advantages with regard to the mutual coordination arise from a combined application of variable displacement axial piston pumps with proportional directional spool valves type PSV and possibly required load-holding valves type LHT and LHDV.

Features and benefits:

- Good performance/weight ratio
- High self-suction speed
- Different shaft and flange versions

Intended applications:

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



Nomenclature:	Variable displacement axial piston pump
Version:	Individual pump Pump combination
p _{max} :	250 bar (continuous), 320 bar (peak)
Q _{max} :	65 l/min (1450 rpm)
V _{g max} :	45 cm³/rev

Design and order coding example

V40M - 045	R	T	X	V	- 2	- 0	- 00	/LS-DA
------------	---	---	---	---	-----	-----	------	--------

Controllers

Load-sensing controller:

- for proportional directional spool valve with pressure limitation (LS-DA)

Power controller:

- can be controlled electrically, with falling characteristic curve (P1R1)

Release

Additional function

Shaft version With/without thru-shaft, radial ports

Seal material FKM (V)

Flange SAE-B-2-Hole J744 (X)

Shaft journal Spline shaft SAB-B-B J 744 (T)

Rotation direction Anti-clockwise (L), clockwise (R)

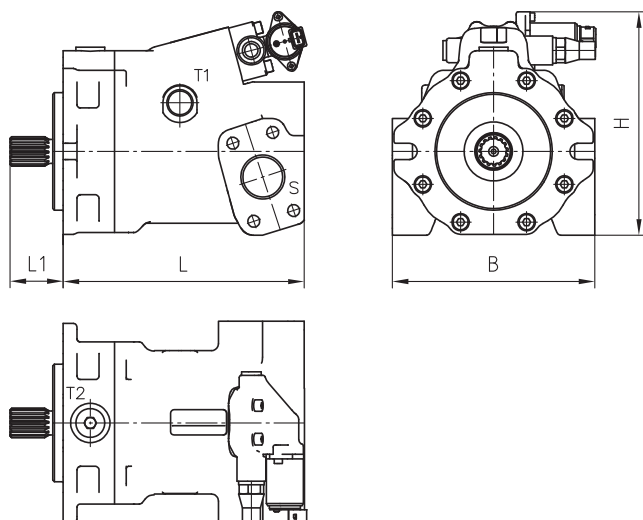
Basic type, nominal size Individual pumps
Tandem pumps

Function



General parameters and dimensions

V40M



	Geom. displacement	Delivery flow ¹⁾	Nom. pressure	Self-suction speed	Dimensions [mm]				m [kg]
	V_g [cm ³ /rev]	Q_{max} [lpm]	p_{nom} (p_{max}) [bar]	n [rpm]	L	L1	H	B	
V40M - 045	46,5	65	250 (320)	2900	208,5	45,9	186	175	20,9

1) Approximate reference value at 1450 rpm

Connections:

	Drain port T	LS-signal port	Suction port	Pressure port P
V40M - 045	7/8-14 UNF-28	M12 x 1.5	SAE 1 1/2" 500 psi	SAE 1" 6000 psi

Associated technical data sheets:

- Variable displacement axial piston pump type V40M: [D 7961](#)

Similar products:

- Variable displacement axial piston pumps type V60N: [Page 54](#)
- Variable displacement axial piston pumps type V30: [Page 50](#)
- Fixed displacement axial piston pump type K60N: [D 7960 K](#)
- Axial piston motors type M60N: [D 7960 M](#)

Prop. directional spool valve:

- Type PSL/PSV sizes 2, 3 and 5: [Page 104](#)
- Type PSLF/PSVF size 3, 5 and 7: [Page 110](#)

Load holding valves:

- Type LHK, LHDV, LHT: [Page 212](#)

See also chapter "Equipment for special applications":

- Mobile hydraulics

1.3 Dual stage pump

Dual stage pumps type RZ

62



*Dual stage pump
type RZ*

Dual-stage pumps

Type	Nomenclature/Design	$p_{\max}$	$Q_{\max}$	$V_{\max}$
RZ	Dual-stage pump			
	■ Radial piston pump and gear pump	Radial piston pump 700 bar	91.2 lpm	$V_{\text{tank max}}$: approx. 470 l
	■ Individual pump			
	■ Motor pump			
	■ Hydraulic power pack	Gear pump 150 bar	135 lpm	

Dual stage pump

1.3

Dual stage pumps type RZ

Dual-stage pumps consist of a high-pressure section (radial piston pump, HP) and a directly coupled low-pressure section (gear pump, LP). The pump is usually driven by one single electric motor, which is connected with the dual-stage pump by means of a flange and a coupling. Compact control systems (e.g. for presses) can be created by mounting two-stage valves and valve banks onto the cover plate of hydraulic power packs.

Features and benefits:

- Two-stage circuits
- Hydraulic power packs with direct valve mounting

Intended applications:

- Presses
- Construction and construction materials machinery



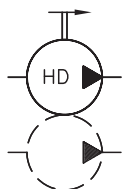
Nomenclature:	Dual stage pump (radial piston and gear pump)
Design:	Individual pump Pump complete with motor Hydraulic power pack
p _{max} :	700 bar (radial piston pump) 150 bar (gear pump)
Q _{max} :	Radial piston pump, 91.2 lpm (high pressure) (V _g = 64.18 cm ³ /rev) Gear pump, 135 lpm (low pressure) (V _g = 89.6 cm ³ /rev)
V _{tank max} :	approx. 470 l

Design and order coding example

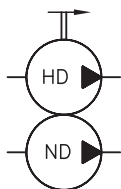
RZ 0,9	/2 - 16	W 7,5
Function, drive [kW]		
Motor pump ■ With /without industrial standard motor		
Hydraulic power packs ■ Version with tank, Consumable volume V_{nom} 6 l to 450 l ■ Cover plate version (for installation on customer furnished tanks), with/without industrial standard motor ■ With built-in two-stage valves type NE or switch units type CR		
Hydraulic power packs for direct pipe connection ■ With tank, consumable volume V_{nom} 12 l to 400 l ■ With/without industrial standard motor		
Gear pump, delivery flow low pressure section [lpm] Gear pump size 1 to 3		
Basic type, delivery flow high pressure section [lpm]		
Type RZ (radial piston pump/gear pump), Type RGZ (version with slide bearing for increased service life), Type RF (version where the high pressure section features a 2-hole SAE-flange) ■ Individual pump (high and low pressure section or only high pressure section alone) ■ Motor pump ■ Hydraulic power pack		

Function

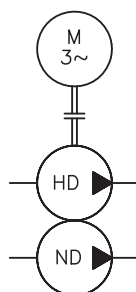
Individual pump
Only high pressure section, low pressure section is customer furnished



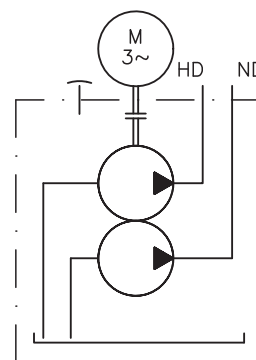
Individual pump
High pressure section and low pressure section



Pump complete with motor

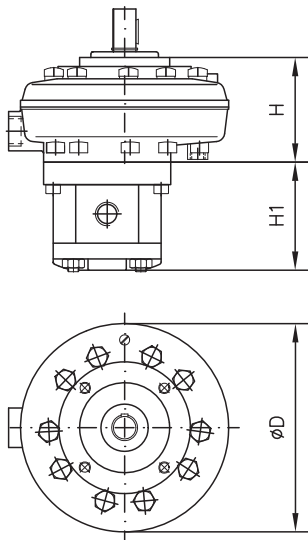


Hydraulic power pack

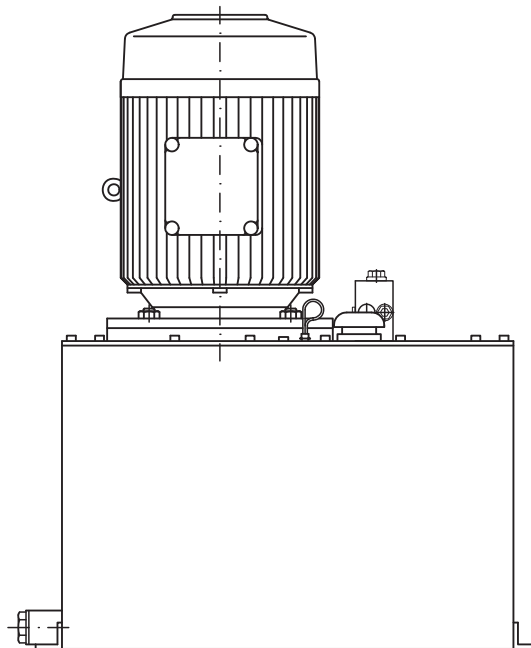


General parameters and dimensions

Individual pump



Hydraulic power pack



For dimensions of motor pumps and hydraulic power packs, see [Page 46](#)

High-pressure section (like radial piston pump type R)

Design	Delivery flow Q_{pu} [lpm] and max. pressure p_{max} [bar] (approx. reference value at 1450 rpm)			Max. permissible drive power ¹⁾	Combina- tion with gear pumps	Tank sizes ²⁾ (selectable)	Dimensions [mm]		m [kg]
	700 bar	450 bar	250 bar				H	D	
7631	RZ 0,18...	RZ 0,64...	RZ 2,27...	1.5	1	13 ... 42	58	130	3.1
6910	RZ 0,9...	RZ 2,5...	RZ 5,1...	3	2	22 ... 80	85.5	175	3.1
6911	RZ 1,4...	RZ 5,8...	RZ 11,8...	11	2 and 3	32 ... 400	85	185	6.3
6912	RZ 2,7...	RZ 8,2...	RZ 16,8...	11		60 ... 400	125	185	10.5
6914	RZ 8,0...	RZ 23,0...	RZ 47,0...	22		100 ... 400	221	218	23.9
6916	RZ 12,7...	RZ 34,5...	RZ 70,0...	30		100 ... 400	320	238	39.1

1) Industry standard motor shape IM B 35 for motor pumps or IM B 5 for hydraulic power packs

2) Minimum size determined by overall height of the pump

Low-pressure section (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	H1	
/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

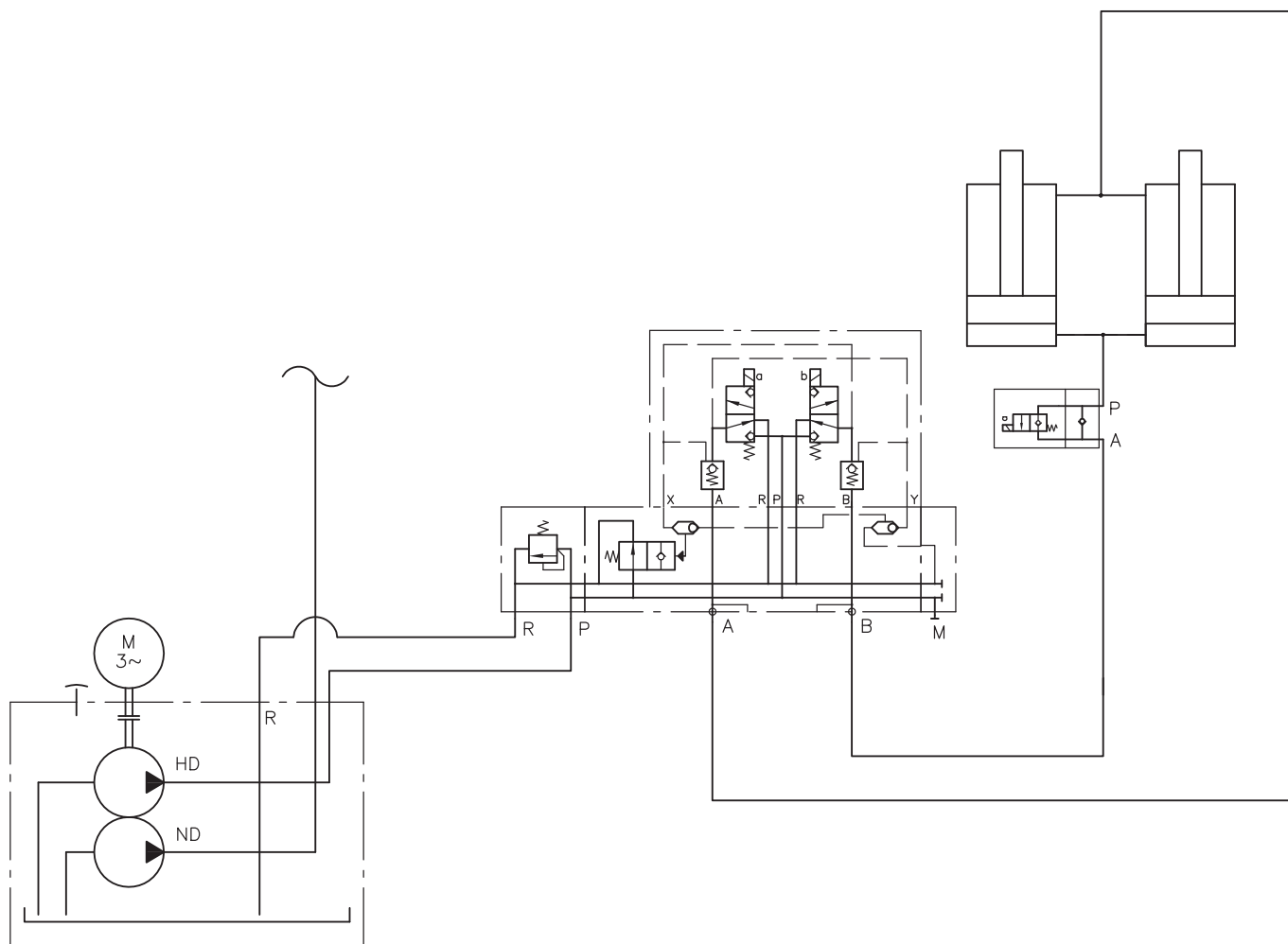
- The data listed represent only a selection of the various differing versions

Example circuit:

RZ 4,0/2-12,3-B 75-V 5,5
 - 3 x 690/400V 50 H

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

GR 2-1-1-3/8 C-G 24


Associated technical data sheets:

- Dual-stage pumps type RZ: [D 6910](#)
- Motorpumps and hydraulic power packs type RZ: [D 6910 H](#)
- Dual stage pump type RF: [D 7410](#)

Similar products:

- Radial piston pumps and hydraulic power packs type R and RG: [Page 46](#)

Valves:

- Two-stage valves type NE: [Page 206](#)
- Switching valves type CR: [Page 164](#)

See also section "Devices for special applications":

- Press controls
- Devices for up to 700 bar

1.4 Air driven hydraulic pumps

Air driven hydraulic pumps type LP

68



*Air driven hydraulic pump
type LP*

Air-driven hydraulic pumps

Type	Nomenclature/Design	$p_{\text{air max}}$	$p_{\text{hydr max}}$	Q_{max}
LP	Air-driven hydraulic pump ■ Individual pump ■ Hydraulic power pack	10 bar	160... 1500 bar	0.9... 12 lpm

Air driven hydraulic pumps

1.4

Air driven hydraulic pumps type LP

The hydraulic pumps type LP are reciprocating, valve-controlled plunger pumps that are available in three sizes. They are basically oscillating pneumatic/hydraulic pressure intensifiers. Stroke reversal is controlled automatically. The stroke frequency is dependent on the air pressure set and the current hydraulic counter pressure, and comes to a complete stop when the pressure limit is reached. As an air-driven hydraulic power pack, the tank version of this type of pump can be combined with directional seated valves for use in different applications. This type of pump is used in laboratory presses, jig construction and lubrication technology, for example. Since they are supplied with energy by means of compressed air, they can be used 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
- Jig construction
- Testing and laboratory equipment

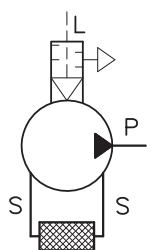


Nomen-clature:	Air driven hydraulic pumps
Design:	Individual pump Hydraulic power pack
p _{hydraulicmax} :	160...1500 bar
p _{airmax} :	10 bar
Q _{max} :	0.9...12 lpm

Design and order coding example

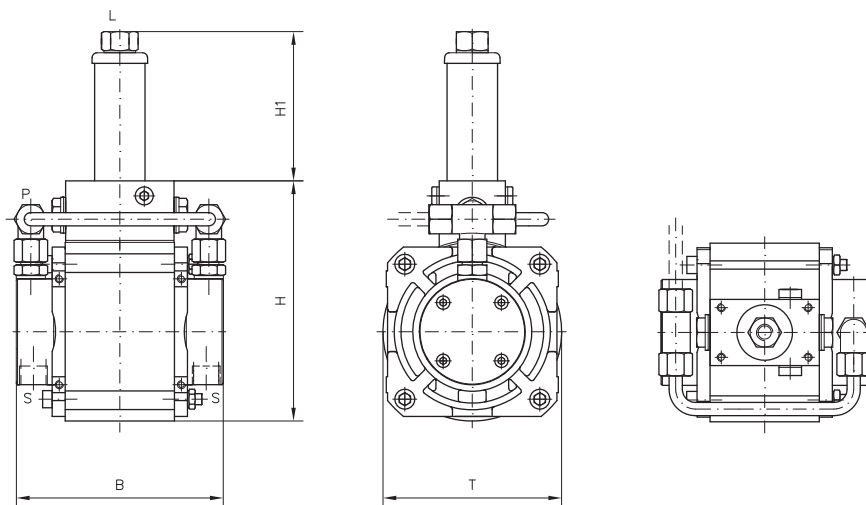
LP 125 - 16	E	/S 81
Additional elements ■ Suction parts for hydraulic pumps ■ Tanks for hydraulic pumps		
Design Hydraulic pump ■ Ready-to-connect version ■ Individual version for self-installation Hydraulic power pack (with type VB, BWH, BWN valve banks) ■ Tank version, usable volume V_{usable} 5 l 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

LP

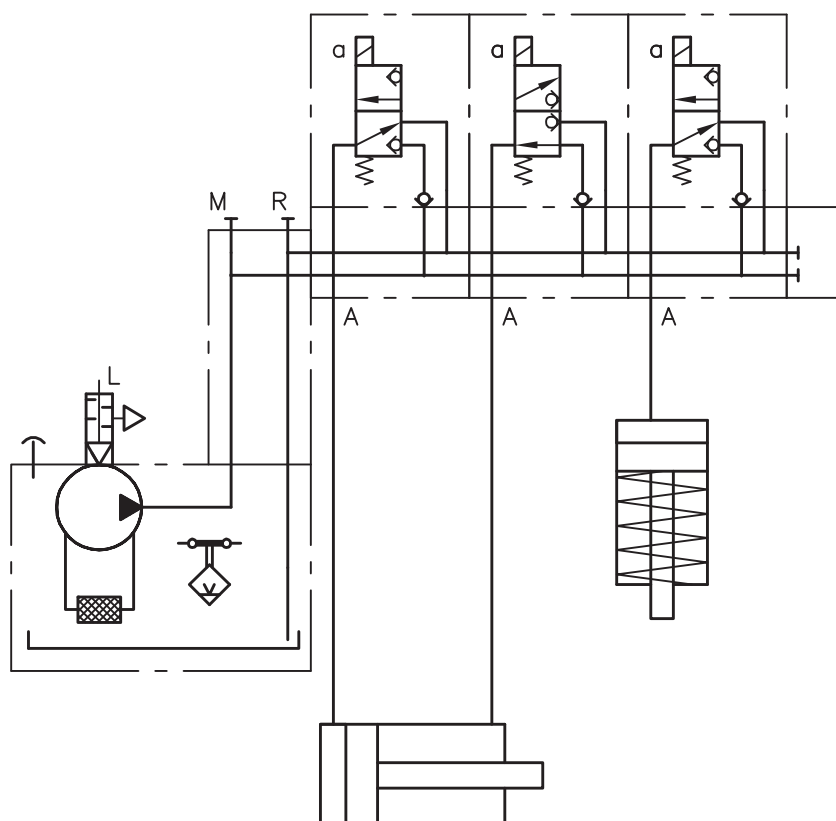


No piping for type LP....

Basic type and size	p _{max} [bar]	Pressure ratio	Geom. volume per double stroke V _{hydr} [cm ³]	Tapped port (air) Pipe diameter for pressure connection (hydr)	Dimensions [mm]				m [kg]
					H	H1	B	T	
LP80-	8	700	1 : 200	G 1/4 Ø6 mm	119	94	121	85	5
	10	630	1 : 63						
	12	430	1 : 43						
	16	240	1 : 24						
LP125-	8	1500	1 : 243	G 3/8 Ø8 mm, Ø10 mm	159	114	156	135	8.5
	10	1500	1 : 155						
	12	700	1 : 108						
	16	600	1 : 60						
	18	470	1 : 47						
	20	380	1 : 38						
	25	240	1 : 24						
	30	160	1 : 16						
LP160-	8	1500	1 : 400	G 1/2 Ø8 mm, Ø10 mm	228	136	156	175	11.5
	10	1500	1 : 255						
	12	700	1 : 177						
	16	700	1 : 100						
	18	700	1 : 78						
	20	620	1 : 63						
	25	390	1 : 40						
	30	265	1 : 24						

Example circuit:

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


Associated technical data sheets:

- Hydraulic pumps type LP: [D 7280](#)
- Hydraulic power packs type LP: [D 7280 H](#)

Valve banks :

- Type VB: [Page 130](#)
- Type BWH(N): [Page 138](#)

See also section "Devices for special applications":

- Press controls
- Devices for explosion hazardous areas (conforming ATEX)
- Devices for up to 700 bar

1.5 Hand pumps

Hand pumps type H, HE, HD and DH

74



*Hand pumps
type H, HE, HD, and DH*

Hand pumps

Type	Nomenclature/Design	Actuation	p _{max}	Q _{max}
H, HE, HD, DH	Piston pump ■ Single acting ■ Double acting	Hand pump	80 ... 800 bar	4 ... 64 cm ³ /stroke

Hand pumps

1.5

Hand pumps type H, HE, HD and DH

The hand pumps type H are available in single acting and double acting versions. The single acting design pumps in one lever direction only, the reverse motion performs the suction stroke. The double acting design pumps and intakes simultaneously in both lever directions. In one particular design, the suction side may be charged with up to 150 bar. The lever mechanism may be protected from harsh environments if desired, and may incorporate a drain valve (connecting P → S), a pressure limiting valve or a tank. These additional options enable the use of this pump in a wide array of application.

Features and benefits:

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

Intended applications:

- Ship building
- Mining machinery
- Jigs
- Test and laboratory equipment



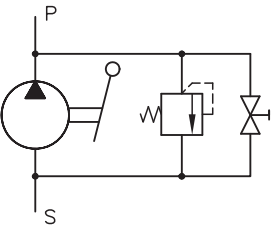
Nomenclature:	Piston pump
Design:	Single acting hand pump Double acting hand pump
p _{max} :	80 ... 800 bar
V _{max} :	4 ... 64 cm³/stroke

Design and order coding example

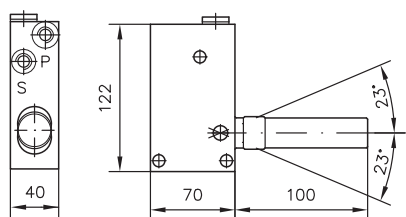
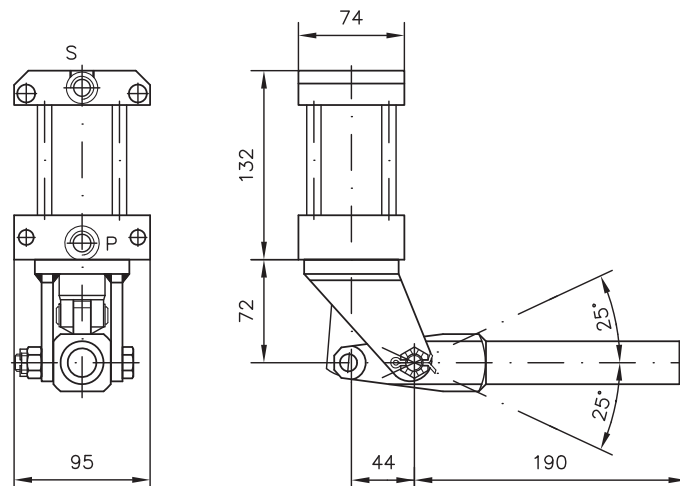
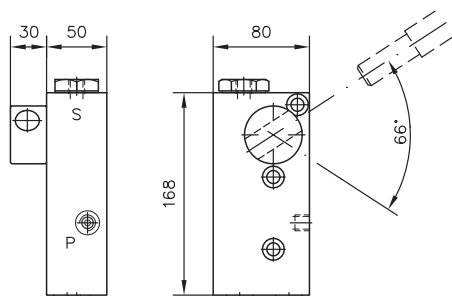
HD 13	AS	- K 0,5	- 110
Pressure setting (bar)			
With/without tank		Usable volume V _{use} . 0,35 l and 0,5 l	
Additional elements		■ Drain valve (A) ■ Pressure limiting valve (tool or manually adjustable) (S)	
Basic type, size		Type H (single acting, open design), Type HE (single acting, encapsulated design) Type DH (double acting, open 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..

DH..

HE.. and HD..


	$p_{\max}$ [bar]	$V_{\max}$ [cm ³ /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			
DH 40	150	51	G 3/8	G 3/8	6.2 ... 6.6
DH 45	100	64			

Associated technical data sheets::

- Hand pumps type H: [D 7147/1](#)

See also section "Devices for special applications":

- Devices for up to 700 bar

2.1 Directional spool valves

Directional spool valves type SG and SP	80
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Clamping modules type NSMD2	116



*Directional spool valves
type SWR and SWS*



*Proportional directional spool valves
type PSL and PSV*

On/off directional spool valves

Type	Nomenclature/version	Actuation	p _{max}	Q _{max}
SG, SP	Directional spool valve, individual valve ■ Individual valve for pipe connection ■ Individual manifold mounting valve	- Solenoid - Manual - Mechanical - Pressure-actuated	200 ... 400 bar	12 ... 100 lpm
SW, SWP, NSWP	Directional spool valve, individual valve ■ For pipe connection ■ Individual manifold mounting valve Directional spool valve, valve bank ■ With sub-plates ■ Combination with hydraulic power packs	- Solenoid	315 bar	12 ... 25 lpm
SWR, SWS	Directional spool valve, valve bank ■ Connected in series ■ Combination with hydraulic power packs	- Solenoid	315 bar	12 ... 25 lpm
HSRL, HSF	Directional spool valve, individual valve ■ Individual manifold mounting valve Directional spool valve, valve bank ■ Connected in series	- Electro-hydraulic - Hydraulic	up to 400 bar	80 ... 160 lpm

Throttling directional spool valve

Type	Nomenclature/version	Actuation	p _{max}	Q _{max}
DL	Throttling directional spool valve, valve bank ■ Connected in series	- Manual - Pressure	250 ... 315 bar	12 ... 90 lpm

Proportional directional spool valve

Type	Nomenclature/version	Actuation	p _{max}	Q _{max}
PSL, PSV	Prop. directional spool valve (Load-Sensing), valve bank ■ Connected in series	- Manual - Electro-hydraulic - Pressure	400 ... 420 bar	Q _{consumer max} 3 ... 240 lpm Q _{Pu max} approx. 300 lpm
PSLF, PSVF, SLF	Prop. directional spool valve (Load-Sensing), individual valve ■ Individual manifold mounting valve Valve bank ■ With sub-plates	- Manual - Electro-hydraulic - Pressure	400 ... 420 bar	Q _{consumer max} 3 ... 470 lpm Q _{Pu max} approx. 1000 lpm

Valve combinations

Type	Nomenclature/version	Actuation	p _{max}	Q _{max}
NSMD	Combination of directional spool valve and pressure-reducing valve As individual valve ■ Individual manifold mounting valve As valve bank ■ Valve banks are available with BA	- Solenoid	120 bar	25 lpm

Directional spool valves

2.1

Directional spool valves type SG and SP

Directional spool valves type SG and SP can be supplied in 5 different sizes and are available in two versions, either for pipe connection (SG) with and without pressure-limiting valve, or as a manifold mounting valve (SP). They are used to control the direction of movement of consumers such as hydrostatic motors and hydraulic cylinders.

The sturdy design means that these valves are suitable for a wide range of applications, such as ship building or mobile hydraulics. The different actuations can also be used for this purpose.

Features and benefits:

- Sturdy design
- Suited for maritime applications
- Various actuations

Intended applications:

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



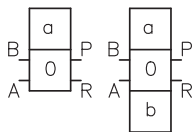
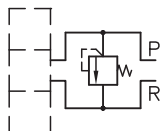
Nomen-clature:	Directional spool valve
Design:	Individual valve for pipe connection or manifold mounting
Actuation:	Solenoid Manual ■ With automatic spring return ■ With detent Mechanical ■ Roller head ■ Pin head Pressure (only or combined with manual actuation) ■ Hydraulic ■ Pneumatic
p _{max} •	200 ... 400 bar
Q _{max} •	12 ... 100 lpm

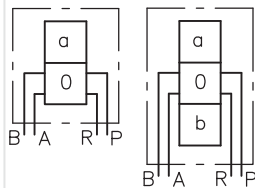
Design and order coding example

SP 1	D		- A	
SG 3	E	3E	- 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

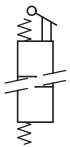
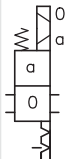
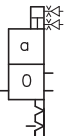
 Individual valve for
 pipe connection

 With pressure limiting
 valve

SP

 Individual valve for
 manifold mounting

Symbol

G	C	D	E	N	W	R	V	Z	U
L	F	H	Y	S	X				

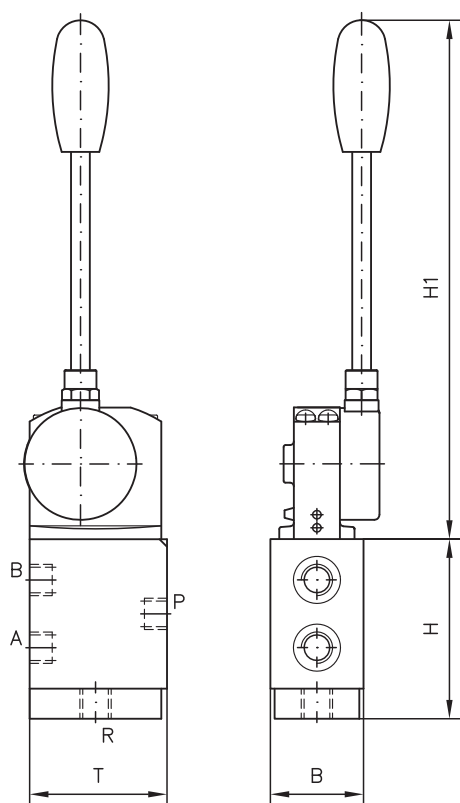
- Symbols Z, U, X: Only size 2, 3, and 5

Actuations:

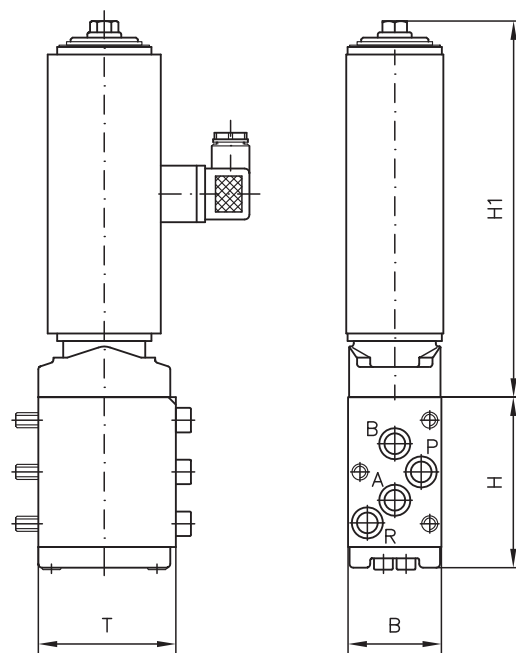
Manual		Solenoid		Mechanical		Pressure			Double acting	
A, AK	C, CK	ME, MD	MU	RE, RD	BE, BD	NE, ND	NU	NM	KD	KM
Spring return	Detent			Roller head	Pin head	Pneumatic		Hydraulic	Pneumatic / manual	Hydraulic / manual
										
		Solenoid voltage: 12V DC, 24V DC, 230V AC other voltage on request		Actuation force: 90 ... 280 N depending on size		Control pressure: Pneumatic 5 ... 10 bar Hydraulic 12 ... 20 bar				

General parameters and dimensions

SG with manual actuation



SP with solenoid actuation



	Q_{max} [lpm]	Operating pressure p_{max} [bar] for actuation			Ports (BSPP)	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	max. 100.5	342	49.5	73	2.5 ... 5.7
SG 3	50	315	400	400	G 1/2	max. 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 valves type SG, SP: [D 5650/1](#)
- Actuations:
 - Manual: [D 6511/1](#)
 - Solenoid: [D 7055](#)
 - Mechanical: [D 5870](#)
 - Pressure: [D 6250](#)

Similar products:

- Directional spool valve connected in parallel and in series type SKP, SKH: [D 7230](#)
- Plugs:**
 - With LEDs etc.: [D 7163](#)
 - With economy circuit: [D 7813](#), [D 7833](#)

Directional spool valves

2.1

Directional spool valves type SW, SWP and NSWP

These directional spool valves are designed as individual valves either for pipe connection (type SW) or for manifold mounting (type SWP, NSWP) or as valve bank (type SWP, NSWP). Actuation is via directly acting pressure resistant single stroke solenoids (wet armature); type NSWP may feature twin solenoids enabling two speed rates or prop. solenoids which may be combined also with a stroke limitation. Versions with ATEX-approval are available as well. The individual manifold mounting valves can be combined with sub-plates enabling pipe connection plus an optional pressure limiting valve. The valve sections type NSWP can be combined with various options either on the pump side e.g. check valves, throttles, or orifices plus orifices or restrictor check valves on the consumer side.

Features and benefits:

- Compact valve banks
- Simple actuation of proportional functions
- Various versions
- Combinations with NG6 available

Intended applications:

- Machine tools - chipping (milling, drilling, turning, grinding)
- Construction and construction materials machinery
- Offshore and marine technology
- Road vehicle construction



Nomen-clature:	Directional spool valve
Design:	Individual valve for pipe connection Individual manifold mounting valve Valve bank with sub-plates Combination with hydraulic power packs
Actuation:	Solenoid
p _{max} :	315 bar
Q _{max} :	12 ... 25 lpm

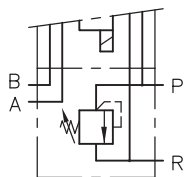
Design and order coding example

NSWP2	G	/M	/R	/ ABR1,0	/50	/G24	- 3/8
							Indiv. connection block
							For direct installation in the pipe work, ports G 3/8 (BSPP) (type NSWP and SWP2), with/without check valve (manually or tool adjustable) between P and R (type SWP1)
							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
							■ ON/OFF-solenoid ($p_{\max} = 315$ bar) ■ Solenoid with detent ■ Prop. solenoid with/without stroke limitation (limiting $Q_{\max}$) ■ Double solenoid (two speed rates) ■ 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

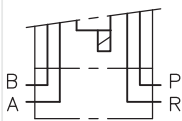
Sub-plate for pipe connection

- 1/4 S(R)



Sub-plate with pressure limiting valve¹⁾

- 3/8



Sub-plate²⁾

1) Only for type SWP 1

2) Only for type NSWP and SWP 2

Valve sections

Basic symbols

Symbol

Individual valve

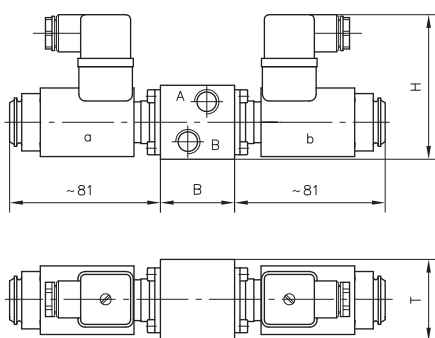
May be connected either in parallel or in series within a valve bank

SW	SWP / NSWP	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 valves suited for prop. actuation				
		L	F	H	S	Y	G	D					

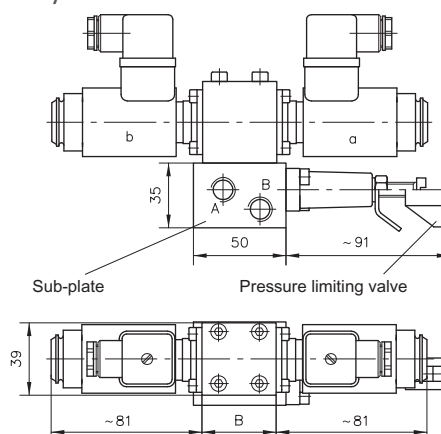
3) Only for type SWR 1

General parameters and dimensions

SW



SWP/NSWP2

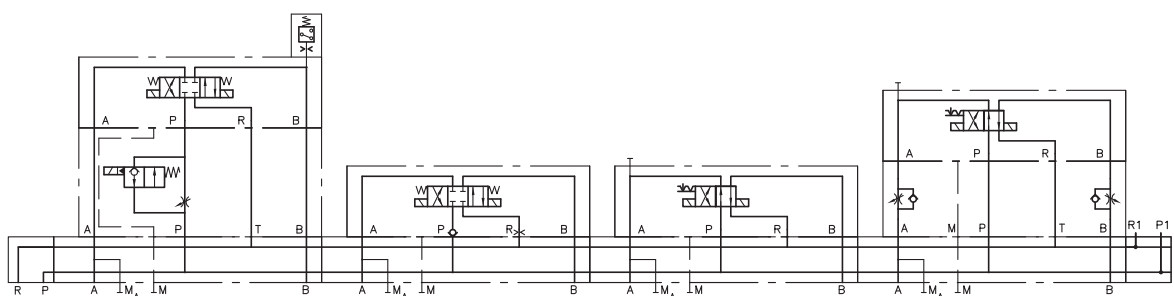


	$Q_{\max}$ [lpm]	$p_{\max}$ [bar]	Ports (BSPP)	Dimensions [mm]			m [kg]	
				H	B	T	Individual directional spool valve	Sub-plate
SW/SWP 1	12	315	G 1/4	77 ... 90	40	40 ... 44	1.1 ... 1.5	0.6 ... 0.7
SW/SWP 2	25	315	G 3/8, G 1/4	78 ... 82.5	60 ... 70	40 ... 45	1.1 ... 2.4	approx. 0.8
NSWP2			NG 6					

Circuit example:

BA2-A5

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



Combinable products:

- Valve bank type BA: [Page 34](#)
- Intermediate plate type NZP: [D 7788 Z](#)
- 6/2-way directional valve: [Sk 7951-J-6/2](#)

Associated technical data sheets:

- Directional spool valves type SW: [D 7451](#)
- Directional spool valves type SWP: [D 7451 P](#)
- Directional spool valves type SWR: [D 7451 R](#)
- Directional spool valves type NSWP: [D 7451 N](#)

Plugs:

- With LEDs etc.: [D 7163](#)
- With economy circuit: [D 7813](#), [D 7833](#)

Similar products:

- Valve banks type SWR and SWS: [Page 88](#)
- Clamping modules type NSMD: [Page 116D 7787](#)

See also section "Devices for special applications":

- Industrial trucks
- Devices for explosion hazardous areas, conforming ATEX
- Proportional valves

Directional spool valves

2.1

Directional spool valves type SWR and SWS

These directional spool valves are designed as valve bank. Actuation is via directly acting pressure resistant single stroke solenoids (wet armature); type SWS may be controlled also via twin solenoids enabling two speed rates or via prop. solenoids optionally with a stroke limitation. Versions with ATEX-approval are available as well. The valve sections consist of an end plate and a connection block (for pipe connection) or an adapter plate (for direct mounting to the hydraulic power packs), held together by a tension rod.

With type SWS, the valve sections can be fitted with additional functions, such as double check valves, load-holding valves or precharge valves etc., in ancillary blocks on the consumer side. It is also possible to integrate a check valve, throttle, orifice or pressure compensator on the pump side. The directional spool valves are primarily used in mobile hydraulics.

Features and benefits:

- Combination with lifting modules available (for fork lifts)
- Proportional movements can be controlled independently from the load
- Wide range of ancillary blocks
- Compact

Intended applications:

- Material handling (industrial trucks etc.)
- Wind turbines
- Construction and construction materials machinery
- Handling and assembly technology (industrial robots etc.)



Nomenclature:	Directional spool valve
Design:	Valve bank Combination with hydraulic power packs
Actuation:	Solenoid
p _{max} :	315 bar
Q _{max} :	12 ... 25 lpm

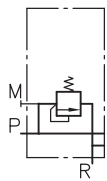
Design and order coding example

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/adaptor plate ■ Pressure limiting valve (for pipe connection)
				■ For direct mounting at compact hydraulic power packs (type HK, HC, MP)
				■ For direct mounting at hydraulic power packs type R
				■ Idle circulation valve
				■ 3-way flow controller
				■ Adapter plates with optional connection of a pressure switch type DG3.. for gallery P
Basic type, size	Type SWR 1 and SWS 2 Type SWC 1 for direct mounting at compact hydraulic power packs type KA, HC, MP, HK			

Function

Connection blocks:

A 6



With tool adjustable pressure limiting valve
(for pipe connection)

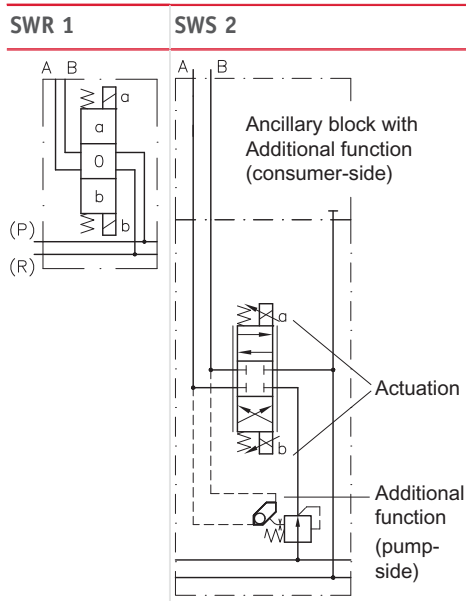
F/D



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

Valve sections:

Basic symbol

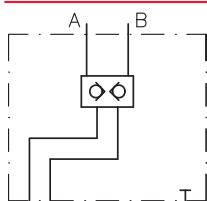


Symbol

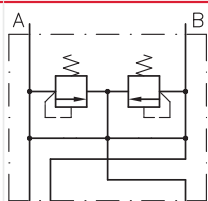
G	D	E	O	C	N	B	W	K	Q	R	U
Only connected in series within a valve bank						Spool valves suited for prop. actuation					
L	F	H	S	Y	G	D					

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

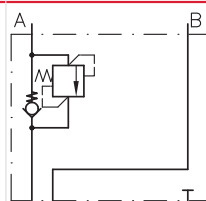
Releasable check valve



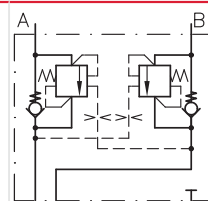
Shock valve



Sequence valve

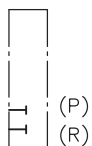


Over center valve



End plates:

SWR 1/SWS 2

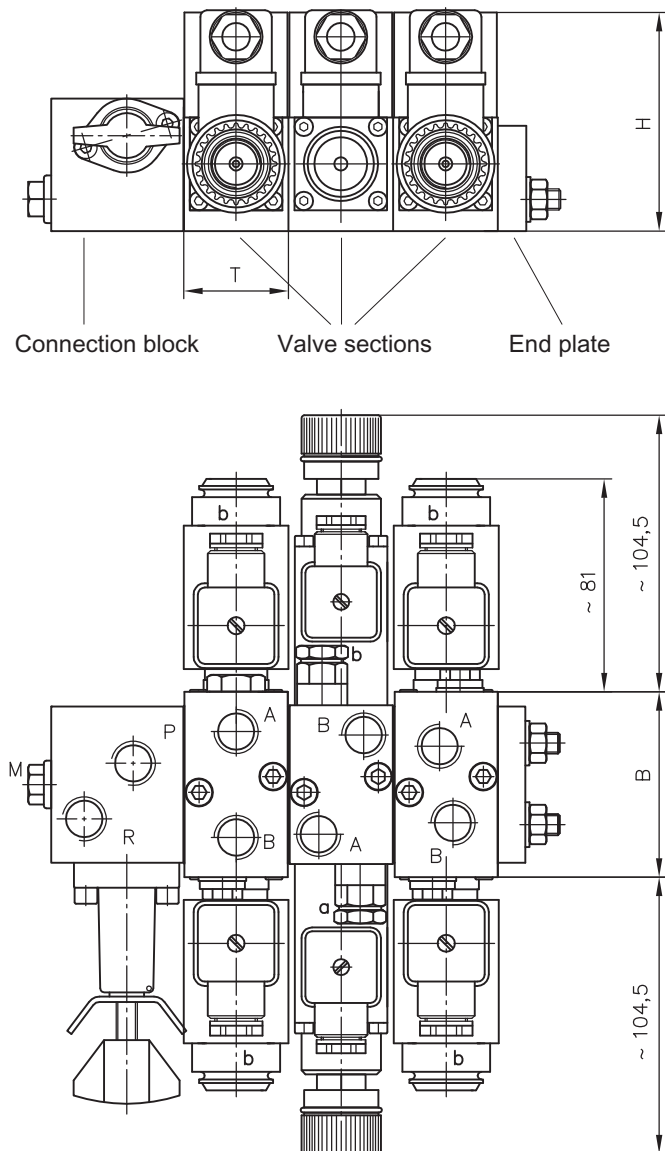


(P)

(R)

General parameters and dimensions

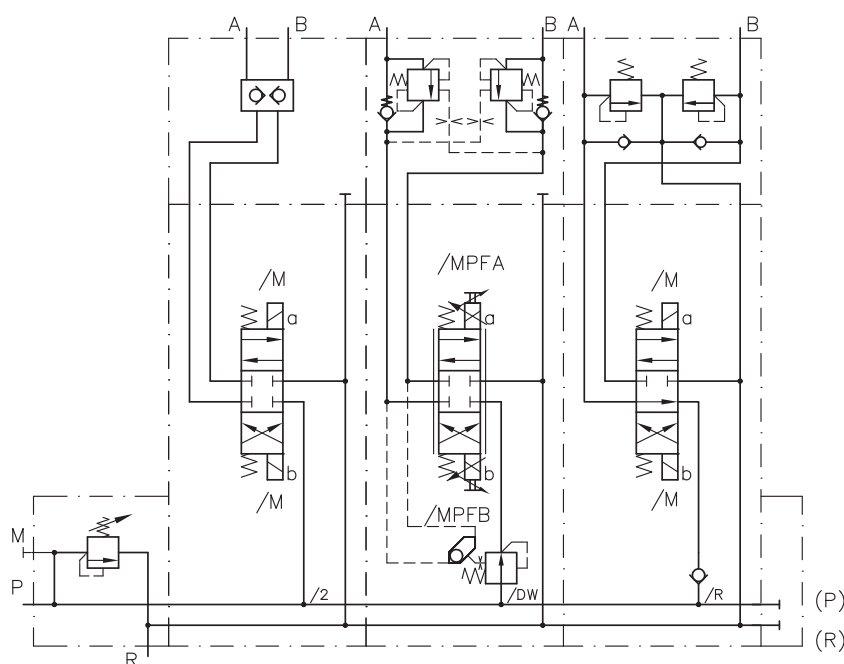
SWR 1, SWS 2



	$Q_{\max}$ [lpm]	$p_{\max}$ [bar]	Ports	Dimensions [mm]			$m_{\max}$ [kg]	
				H	B	T		
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	approx. 0.8

Circuit example:

SWS 2 A 7/200	- G/M/2/2 RH	- G 10/MPF/DW/2 AL B 7/180 BLC 4/140	- E/M/R/2 AN100 BN 100-1-G 24
Valve bank type SWS, size 2, connection block with pressure limiting valve (manually adjustable, factory set to 200 bar)	1. Valve section flow pattern G with solenoid actuation, no additional function in gallery P, with ancillary block featuring releasable check valves for ports A and B	2. Valve section flow pattern G with prop. solenoid actuation (MP) and stroke limitation for A and B (FAB), max. flow for ports A and B is 10 lpm, flow control in gallery P of the basic valve body (DW), ancillary block with over center valves (factory set to A = 180 bar and B = 140 bar)	3. Valve section flow pattern E with solenoid actuation, check valve in gallery P, ancillary block featuring shock and suction valves for ports A and B (both factory set to 100 bar), standard end plate. All solenoids 24V DC


Associated technical data sheets:

- Directional spool valve banks type SWR: [D 7451 R](#)
- Directional spool valve banks type SWS: [D 7951](#)

Suited products for combination:

- Pressure switches type DG3..., DG5.E: [Page 266](#)

Suitable plugs:

- With LEDs etc.: [D 7163](#)
- With economy circuit: [D 7813](#), [D 7833](#)

See also chapter "Equipment for special applications":

- Forklift trucks and lifting equipment
- Mobile hydraulics
- Devices for explosive environments (ATEX-compliant)
- Proportional valves

Directional spool valves

2.1 Directional spool valves type HSRL and HSF

The directional spool valves are available as individual valve for pipe connection (type HSL), manifold mounting (type HSF) or as valve banks (type HSR). These valves are utilized to control the direction of movement of hydraulic consumers. All of them are indirectly electro-hydraulically actuated. The control fluid demand is either taken internally from the main circuit or fed externally from a separate control oil circuit. Harsh switching operations and the risk of decompression surges, particularly in the event of high pressure and large consumer volumes, can be avoided (except with HSRL 3) by using adjustable thread type throttles (adjustable response time). Standard connection blocks or connection blocks with an idle circulation valve, a pressure-limiting valve and integrated pressure-reducing valve are available for series connection. With the HSRL 3 version it is also possible to arbitrarily select different pressure levels.

Features and benefits:

- Soft shifting of high flow
- Suitable for high pressures due to steel housing
- Hydraulic pilot actuation via compact twin solenoids
- Versions conforming ATEX

Intended applications:

- Mining equipment (incl. oil exploration)
- Cranes, lifting-lowering devices
- Construction and construction materials machinery
- Material handling (forklift trucks etc.)



Nomenclature:	Directional spool valve
Design:	Individual manifold mounting valve Valve bank in series connection
Actuation:	Electro-hydraulic Hydraulic
p _{max} :	400 bar
Q _{max} :	80 ... 160 lpm

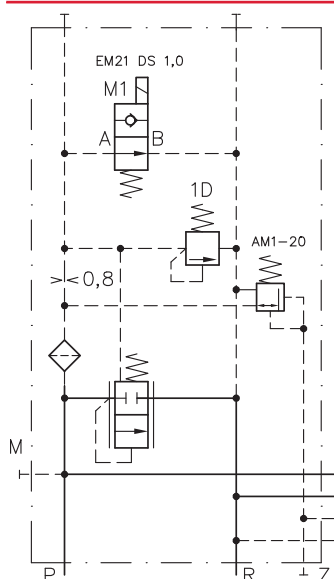
Design and order coding example

HSR3	/B31E	- C1WG	- 1	- G24	- 300
Pressure setting pressure limiting valve [bar]					
Solenoid voltage 12V DC, 24V DC, 98V DC, 205V DC, 110V AC, 230V AC, at HSRL: Solenoid conforming ATEX					
End plate Internal or external control oil return					
Valve sections With/without adjustable switching speed					
Connection block ■ With/without pressure limiting valve (tool or manually adjustable) ■ Internal or external control oil supply (max. 160 bar) ■ Type HSRL: Ancillary blocks to the connection block with various pressure stages					
Basic type and size - Type HSF: Manifold mounting - Type HSRL: Size 3 directional spool valve bank					

Function

Connection blocks (HSR, HSRL):

C 321



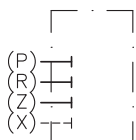
With internal control oil supply picked up from P gallery, idle circulation valve and pressure-limiting valve, optional ancillary blocks for three additional pressure stages

Valve sections:

Basic symbol		Symbol								
HSF	HSRL	G	D	E	C	W	B	L	H	F
Manifold mounting valve	Valve section	All symbols are also available with adjustable response time (not for type HSRL 3)								

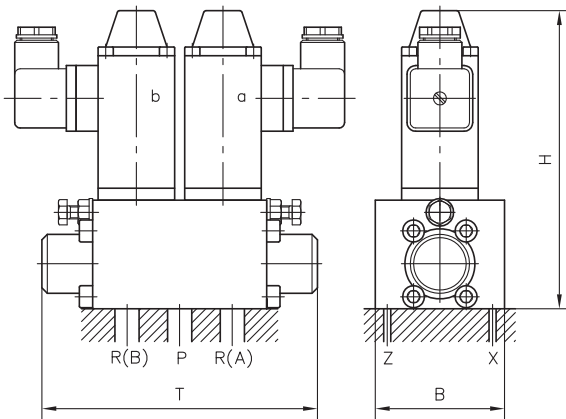
End plates:

HSRL

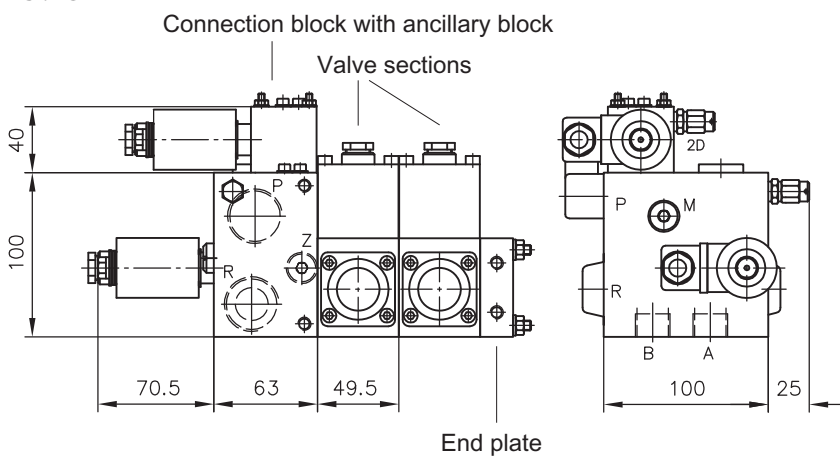


General parameters and dimensions

HSF



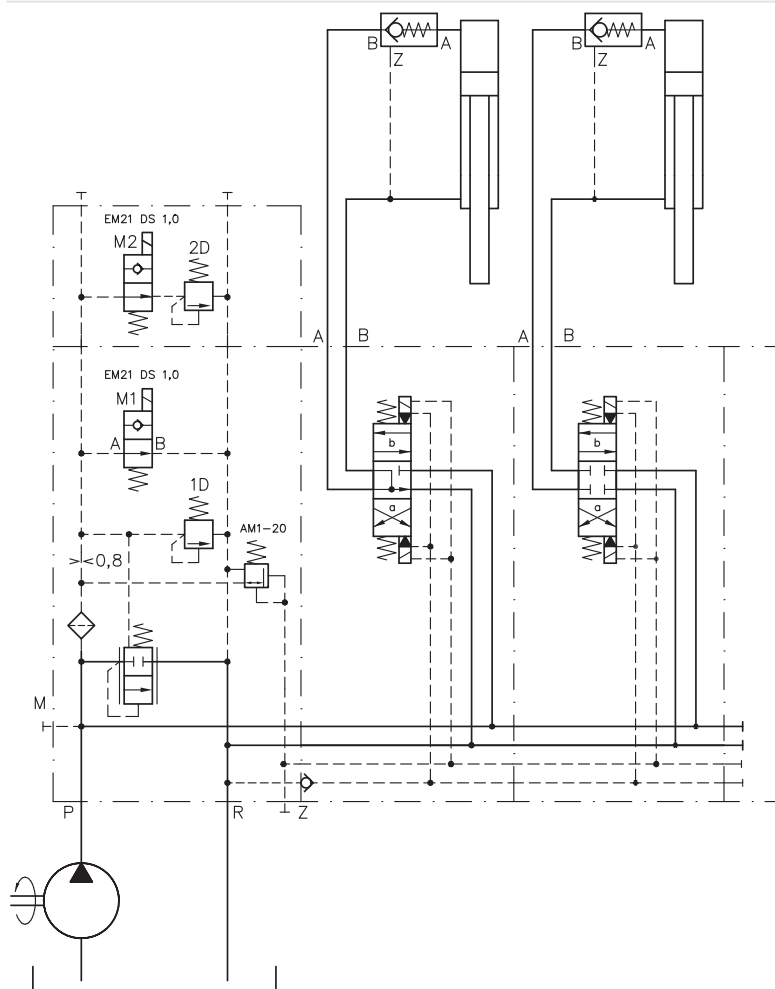
HSRL 3



	$Q_{\max}$ [l/min]	$p_{\max}$ [bar]	$p_{\text{contr.}}$ [bar]	Ports (BSPP)		Dimensions [mm]			m [kg]	
				A, B, P, R	M, X, Z	H	B	T	Individual spool valve or valve section	Connection block
HSF 3						137	59	126		
HSRL 3						see illustration			2.0	1.7 ... 4.0
HSF 4						157	70	184		

Circuit example:
HSRL 3/C322/1D200 2D100 - DG - 1 - G 24

Size 3 valve bank type HSRL, connection block with integrated pressure-reducing valve, idle circulation valve, pilot-controlled pressure-limiting valve, main pressure-limiting valve factory set to 200 bar, second pressure stage set to 100 bar, two valve sections with the symbols D and G and a standard end plate, solenoid voltage 24V DC


Associated technical data sheets::

- Directional spool valve type HSR: [D 7493](#)
- Directional spool valve type HSRL: **Sk 7493 RL**
- Directional spool valve type HSF: [D 7493 E](#)
- Directional spool valve type HSL: [D 7493 L](#)

Plugs:

- With LEDs etc.: [D 7163](#)
- With economy circuit: [D 7813](#), [D 7833](#)

Directional spool valves

2.1

Manually actuated directional spool valves type DL

The directional spool valve bank type DL is used for smooth manual measuring for general hydraulic systems with single and double-acting consumers as well as stationary and mobile lifting devices.

This measuring process is caused by the bypass pump venting line gradually closing and the consumer line simultaneously opening. The movement begins when the throttling effect in the bypass channel causes the pressure to reach the consumer level.

The DLS directional spool valves are designed for industrial trucks (forklift trucks). The primary function (hydraulic cylinder) is therefore integrated into the connection block. A version with a priority flow divider in the connection block is also available. Different additional functions for the valve sections (e.g. shock valves) extend the range of possible applications.

Features and benefits:

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

Intended applications:

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



Nomenclature:	Throttling directional spool valve
Design:	Valve bank, featuring integrated by-pass idle pump circulation
Actuation:	Manual: ■ Spring return, detent Pressure: ■ Pneumatic
p _{max} :	250 ... 315 bar
Q _{max} :	12 ... 90 lpm

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: ■ Secondary pressure limiting valve for consumer port A or B or A and B ■ Intermediate plate with pressure-limiting valve for all downstream valve sections ■ Lock-out circuit for all downstream consumers ■ Additional functions on the pump side (orifice, 2-way flow control valve) ■ Additional functions on the consumer side in the ancillary block (e.g. double check valves, shock valves, load-holding valves etc.) (size 3) ■ Reducing intermediate plate (size 3 into 2) with 3-way flow control valve
			Port size			G 1/4, G 3/8, G 1/2 (BSPP)
			Connection block			■ With/without pressure limiting valve ■ With priority flow divider (e.g. for hydraulic steering circuit) ■ With shock valve ■ With drop-rate braking valve
Basic type, size	Type DL, type DLS for industrial trucks (e.g. fork lifts), type DLSR for variable displacement pumps, size 1 to 4					

Function

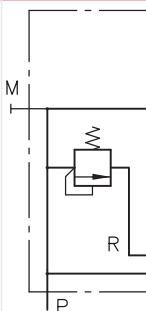
Connection blocks:

DL .5



Without pressure-limiting valve

DL .1



With pressure-limiting valve

Valve sections:

Basic symbol	Symbol						
	G and B	D	E	N	R	A	P

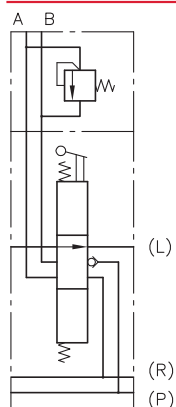
Reduced internal leakage due to reduced spool valve play

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.)
- Reducing intermediate plate (size 3 into 2) with 3-way flow control valve
- Valve section with lock-out circuit for all downstream consumers
- Size 4 also available without check valve in P
- Manual operation with spring return 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
- Manual operation with closed lever housing for sizes 3 and 4
- Pneumatic operation for sizes 3 and 4
- Displacement transducer or contact switch at the valve spool

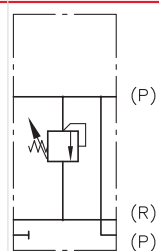
Additional options for the valve sections:

Example: DL 21-1-GDD G71 GG-B/E1-2-180



Secondary pressure-limiting valve at consumer port A or B, or A and B

Example: DL 21-2-GG X5 D-B/E1-2-210



Intermediate plate with pressure-limiting valve for all downstream valve sections

End plates:

2



Standard end plate with port R

3



End plate for subsequent connection of a DL

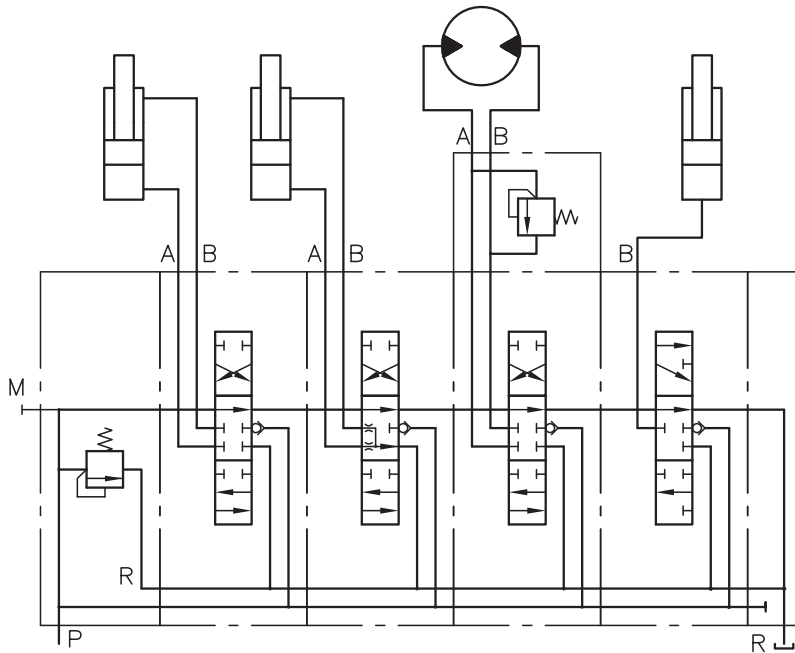
General parameters and dimensions

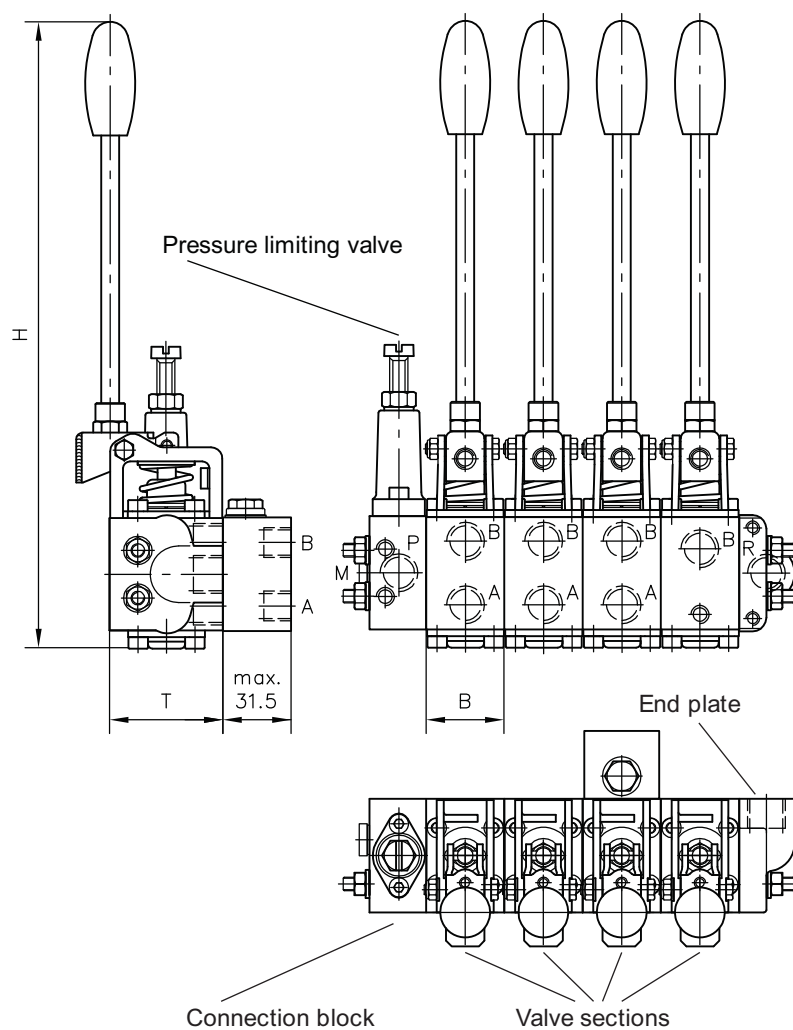
Example circuit:

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

Size 2 DL directional spool valve with pressure-limiting valve (set to 180 bar), size 2 ports with G 3/8 tapped ports, symbols G, D, G, N; 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)

Symbol





	$Q_{\max}$ [lpm]	$p_{\max}$ [bar]	Tapped ports			Dimensions [mm]			m [kg]
			Characteris- tic value	A, B	H, P, R	H	B	T	
DL 1	12 ... 16	315	1	G 1/4	G 1/4	approx. 192	31,5	45	0,5
DL 2	20 ... 30	315	1	G 1/4	G 3/8	approx. 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	approx. 351	39,5	60	1,4
			3	G 1/2	G 1/2				
DL 4	90	250	3	G 1/2	G 3/4	approx. 368	39,5	70	1,8

Associated technical data sheets:

- Directional spool valves type DL: [D 7260](#)

See also section "Devices for special applications":

- Industrial trucks
- Hydraulic for mobile applications

Directional spool valves

2.1

Proportional directional spool valves type PSL and PSV

The directional spool valve bank in series design is available in three sizes in type PSL for constant delivery pump systems and type PSV for variable displacement pump systems (pressure/flow controller). It is intended for load-independent, continuous control of the movement speed of hydraulic consumers. Several consumers can be operated simultaneously and independently from each other. The application area of this valve type is mostly in mobile hydraulics (e.g. crane control). Being able to select different maximum volumetric flows for consumer ports A and B as well as the option to use various additional functions (e.g. secondary pressure limitation, function deactivation, in the basic valve, in intermediate plates and ancillary blocks) guarantees optimal adaptation to the respective control tasks.

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



Nomenclature:	Prop. directional spool valves as per load-sensing principle
Version:	Valve bank in series connection
Actuation:	Manual ■ Return spring ■ Detent Electro-hydraulicPressure-actuated ■ Hydraulic ■ Pneumatic
p _{max} :	400 ... 420 bar
Q _{max, consumer} :	3 ... 240 lpm
Q _{pu max} :	approx. 300 lpm

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 ■ Ports BSPP or UNF (SAE-12) ■ 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 control 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 control pump) for industrial trucks, sizes 2 and 3				

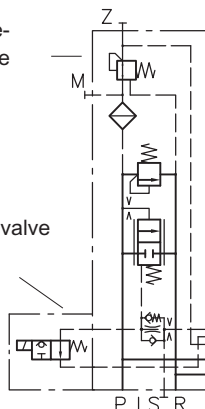
Function

Connection blocks:

PSL

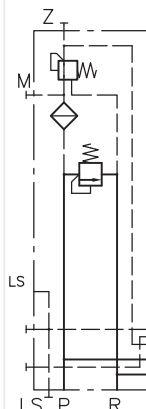
Pilot pressure-reducing valve

2/2-way solenoid valve



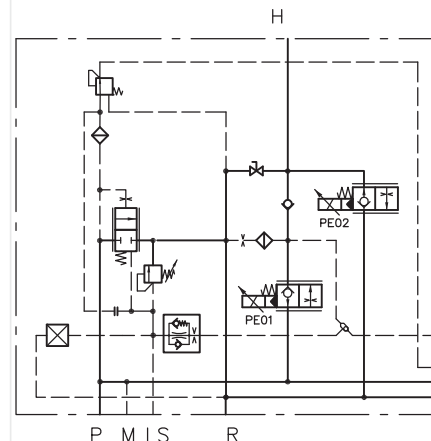
Connection block for constant delivery pump systems with incorporated 3-way controller and pressure-limiting valve

PSV



Connection block for control pump systems with or without pressure-limiting valve

HMPL (HMPV)

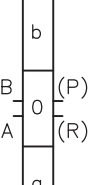
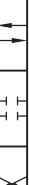
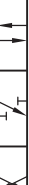
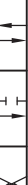
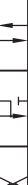
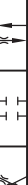
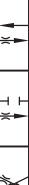
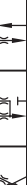


Connection block for constant delivery pump with incorporated proportional seated valve for lifting and lowering

Additional versions of connection blocks:

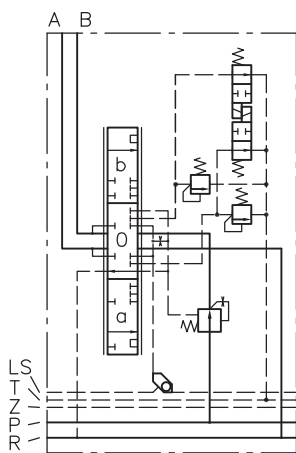
- 2/2-way solenoid valve for randomly switching the pump direction
- Additional damping option of the 3-way/pump controller
- Additional isolation valve to minimise the pump direction resistance
- Version with additional shut-off valve for the pump line, can be switched randomly
- Proportionally adjustable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

Valve sections:

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

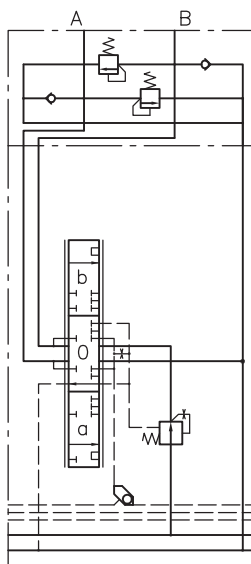
Versions of valve sections:

- 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 input 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 ATEX magnet for use in explosive environments
- Version with explosion-proof, intrinsically safe magnets for mining applications



Additional functions in the ancillary block:

- Shock and servo-suction valves
- Load-holding valves
- Differential circuits
- Check valves with release, no leakage
- Floating and block functions can be switched
- Proportional seated valves as per D 7490/1 for lifting and lowering using 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 input 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.
- Versions with 2-way input controller and check valve function

Actuations:

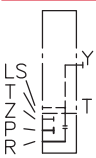
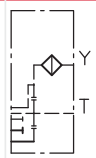
Basic type	Brief description	Switching symbol (example)
A	Manual actuation	
C	Detent (continuous)	
K	Manual actuation via mechanical joystick	
E	Electro-hydraulic actuation	
EA	in combination with manual actuation CAN: Actuation variant with direct CAN actuation	
H, P HA, PA	Hydraulic and pneumatic actuation in combination with manual actuation	
HEA	Combination of H, E and A actuation	

Combination of electro-hydraulic and manual actuation

Intermediate plates:

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

End plates:

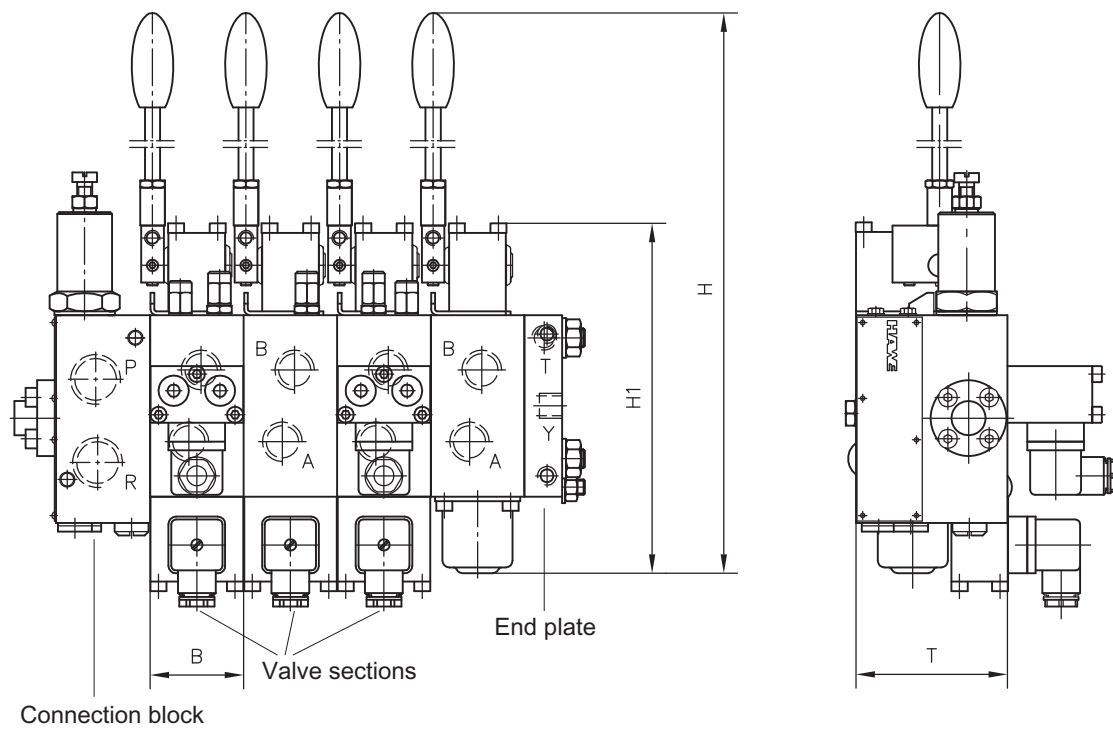
E1	E2
 Standard end plate	 With additional Y-port for LS-input signal

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

PSL



	Flow [lpm]		Oper. pressure [bar]	Ports (BSPP)		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	approx. 272	approx. 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	approx. 364	approx. 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	approx. 400	approx. 224	62.5	100	3.7 ... 4.5

1) Dep. on actuation and additional functions

Example circuit:

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)

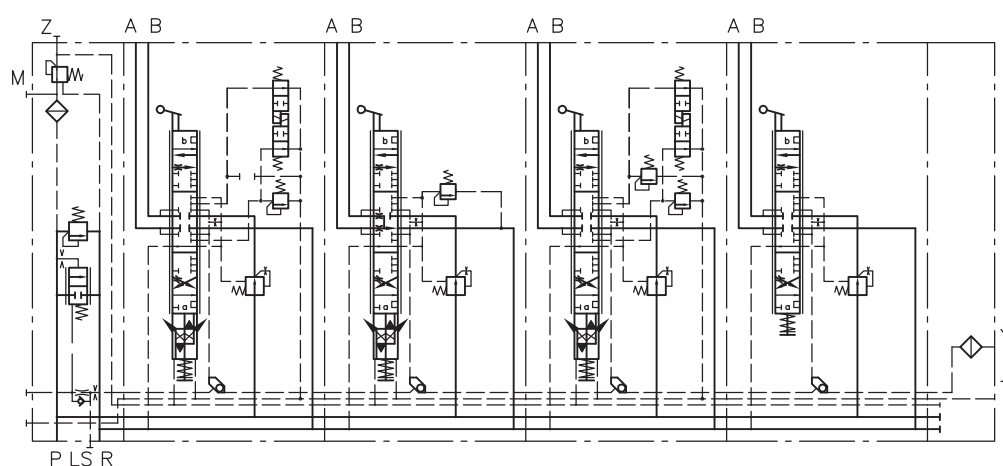
Size: 3

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)
- Switching 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)



Suited products for combination:

- Type LHT, LHDV load-holding valves: [Page 212](#)
- Type KFB hydraulic joystick: [D 6600](#), [D 6600-01](#)

Additional electronic components

- Type EJ joystick: [D 7844](#)
- Type EV1M2, EV1D1 and EV22K2 prop. amplifier (module): [D 7831/1](#)
- Programmable logic valve control type PLVC: [Page 278](#)
- See "Electronics" section [Page 274](#)

Associated technical data sheets:

- Type PSL/PSV prop. directional spool valves, size 2: [D 7700-2](#)
- Type PSL/PSV, size 3: [D 7700-3](#)
- Type PSL/PSV, size 5: [D 7700-5](#)
- Type PSL/PSV prop. directional spool valves with direct CAN actuation: [D 7700 CAN](#)
- Type HMPL/HMPV connection blocks
 Sizes 2 and 3: [D 7700 H](#)

See also section "Devices for special applications":

- Mobile hydraulics
- Devices for explosive environments (ATEX-compliant)
- Proportional valves

Directional spool valves

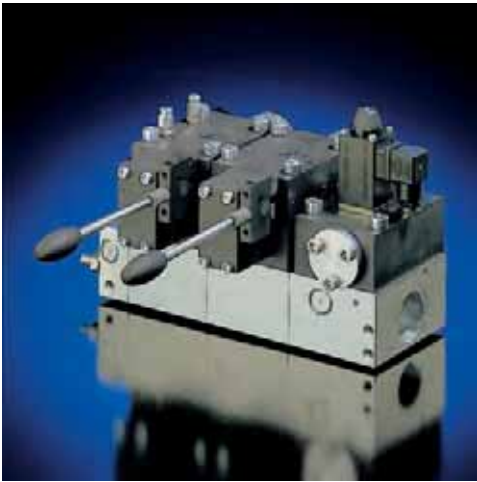
2.1

Prop. directional spool valves type PSLF and PSVF - Manifold mounting design

The directional spool valve bank type PSLF/PSVF consists of valve sections attached via manifolds. Type PSLF is designed for constant delivery pump systems (pressure/flow controller) whereas the type PSVF is for variable displacement pump systems. Both are available in two sizes. They serve to control the direction of motion and provide infinite control of the speed of motion of hydraulic consumers regardless of their load. Several consumers may be operated simultaneously and independently of each other. The main field of application is mobile hydraulics (e.g. boom controls of concrete pumps etc.). Main advantage against type PSL/PSV is simplified servicing as individual valve sections can be replaced easily. The main field of application is mobile hydraulics (e.g. crane controls etc.).

Being able to select different maximum volumetric flows for consumer ports A and B, as well as the option to use various additional functions (e.g. function deactivation) guarantees optimal adaptation to the respective control tasks.

- Features and benefits:**
- Max. flow 1000 lpm at 420 bar
 - Rear side ports for easy access to valves, even in small installation spaces
 - Flange construction 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
 - Crane 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 ... 420 bar
Q _{max. consumer} :	3 ... 470 lpm
Q _{pu max} :	approx. 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

- Port G or UNF (SAE-12)
- Pressure-limiting valve (pilot-controlled main pressure-limiting valve) in connection block

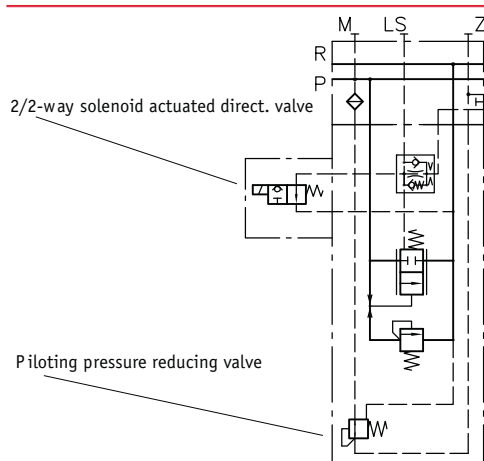
Basic type

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

Function

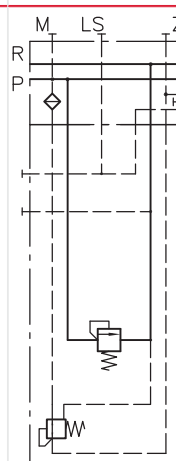
Connection blocks:

PSLF



Connection block for constant delivery pump systems with incorporated 3-way flow controller and pressure limiting valve

PSVF



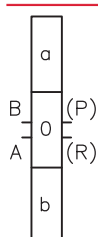
Connection block for variable displacement pump systems with or without pressure limiting valve

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

Valve sections:

Basic symbol



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
- Version with and without 2-way input controller
- Function deactivation
- Secondary pressure-limiting valves (can be individually selected for A and/or B)
- Prop. pressure limitation of individual functions
- Sub-plates with different additional functions
- Combination of various sizes possible in one valve bank
- Version with ATEX magnet for use in explosive areas
- Version with explosion-proof, intrinsically safe magnets for mining applications

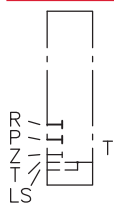
Coding for max. consumer flow:

	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			

- Characteristic value corresponds to the max. volumetric flow (lpm) at the consumer ports A or B for the version with input controller
- Volumetric flows for A and/or B can be selected individually
- 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 input controller and check valve function

Actuations:

Basic type	Brief description	Symbol (example)
A	Manual actuation	
C	Detent (stepless)	
E	Electro-hydraulic actuation	
EA	in combination with manual actuation	
H, P HA, PA	Hydraulic and pneumatic actuation in combination with manual actuation	
HEA	Combination of actuation H, E, and A	 For combination of electro-hydraulic and manual actuation

End plates:
E1


End plate (std.)

E2

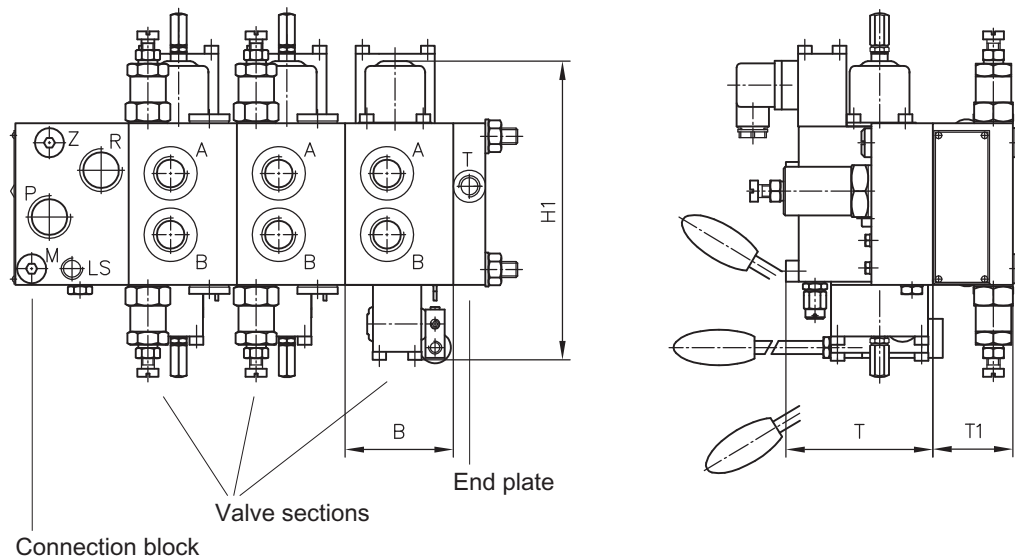

With additional Y-port for LS-input signal

Additional versions of end plates:

- End plate with internal drain line (without T-port)
- End plates with an additional port R
- Adapter plate enabling combination of size 5 with size 3 (coding ZPL 53)

General parameters and dimensions

PSVF

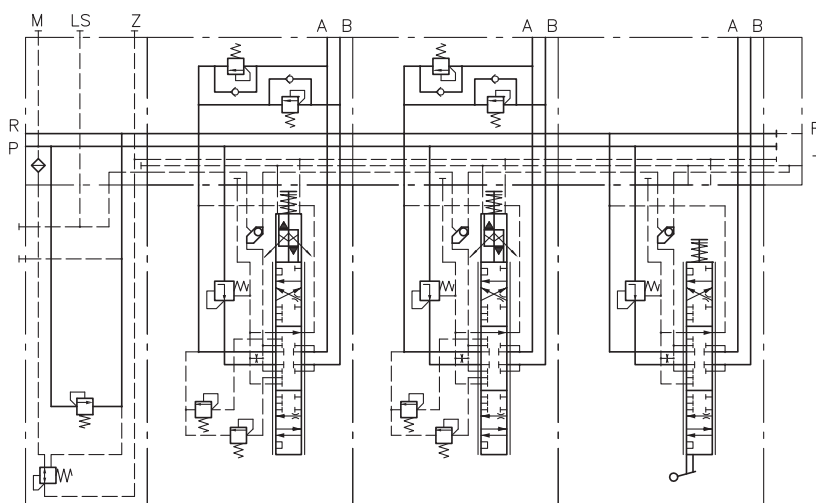


	Flow [lpm]		Oper. pressure [bar]	Ports (BSPP)		Dimensions [mm]				m [kg]	
	Q _{max}	Q _{PU max}	p _{max}	P, R	A, B	H1	B	T	T1	1)	2)
PSLF/PSVF 3	3 ... 120	200	420	G 3/4, 1 1/16-12 UN-2B	G 1/2, G 3/4, 7/8-14 UNF-2B	approx. 195	50	80	50	3.3 ... 4.1	6.6 ... 7.6
PSLF/PSVF 5	16 ... 210	350	400	G 1, G 1 1/4, SAE 1 1/2	G 1, SAE 1 1/2	approx. 224	62.5	100	100	3.7 ... 4.5	10.9 ... 16.3
PSLF/PSVF 7	120-140	1000	400	G 1 1/2, SAE 1 1/2	G 1 1/4, SAE 1	approx. 305	106	101	95	13	23

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

Example circuit:

PSVF A1/380/4-3	- A2 J 40/40 A200 B200 /E /3 AN210 BN210 - A2 J 80/40 A280 B130 /E /3 AN290 BN140 - A2 J 25/16 /EA /3	- E1 - G24
Valve bank type PSVF for variable displacement pump system Connection block: - Coding for flange construction (here A.) - Coding for pilot pressure-reducing valve (here 1) - Coding for set pressure at pressure-limiting valve (here 380 bar) - Coding for thread size of sub-plate (here /4 = G 3/4) Size: 3	1. Valve section: (exemplary for all subsequent valve sections): - Directional spool valve block with coding for flange construction (here A.) - Coding for basic function of the directional spool valve block (here 2) - Symbol (here J) - Coding for max. consumer volumetric flow at port A and B (here 40 and 40 lpm) - Coding of additional functions (here A 200 B 200; secondary pressure-limiting valve at port A and B set to 200 bar) - Coding for the actuation type (here E = electrical-hydraulic) - Coding for sub-plate (here 3AN210 BN210, G 1/2 with shock and servo-suction valve)	End plate: - Coding for end plate (here E1) - Coding for solenoid voltage 24V DC (here G24)



Suited products for combination:

- Load-holding valves type LHT, LHDV: [Page 212D 7100](#), [D 7770](#), [D 7918](#)
- Hydraulic joystick type KFB: **D 6600++**

Electronic accessory components

- Joystick type EJ: [D 7844](#)
- Prop. amplifier (module) type EV1M2, EV1D1 and EV22K2: [D 7831](#), [D 7817/1](#), [D 7831 D](#)
- Programmable logic valve control type PLVC: [Page 278](#)
- see "Electronics" section [Page 274](#)

Associated technical data sheets:

- Prop. directional spool valve type PSLF/PSVF size 3, 5: [D 7700-F](#)
- Prop. directional spool valve type PSLF/PSVF size 7: [D 7700-7F](#)

See also chapter "Equipment for special applications"

- Mobile hydraulics
- Devices for explosive areas (ATEX-compliant)
- Proportional valves

Directional spool valve

2.1

Clamping modules type NSMD2

The clamping modules type NSMD2 are used to actuate power-operated clamping devices such as hydraulically actuated hollow or solid clamping cylinders for automatic lathes. They are available as manifold mounting valves with a standard connection diagram according to DIN 24340-A6. The clamp/release functions of the clamping cylinder, pressure control and, if required, the electrical pressure monitoring are combined in one device. The clamping pressure at the consumer side A or A and B and the pressure switch can be adjusted simultaneously with a manual, mechanical or electro-proportional adjustment device. A special safety circuit monitors the switching position of the valve. 4/3- or 4/2-way directional functions with spring-centred actuation, the latter also with detent actuation, allows for adjustment to the respective application.

The throttling options in the spool end position as well as the rapid and creeping movements are available as an additional function for one or both consumer ports.

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 diagram according to DIN 24340-A4

Intended applications:

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



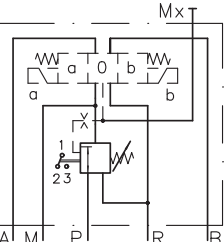
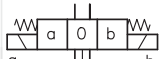
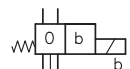
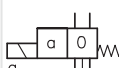
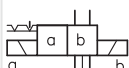
Nomenclature:	Valve combination consisting of: ■ Directional spool valve (4/3-, 4/2-way function) ■ Pressure reducing valve with tracked pressure switch
Design:	Individual valve for sub-plate mounting (Valve banks with sub-plates type BA are available)
Actuation:	Solenoid
p _{max} •	120 bar
Q _{max} •	25 lpm

Design and order coding example

NSMD 2	D1	60	R	- G24
			Solenoid voltage	12V DC, 24V DC, 110V AC, 230V AC Solenoids with various plug versions
			Means of adjustment for the clamping pressure	■ Slotted head screw + hexagon nut ■ Wing screw + wing nut ■ Lockable turning handle ■ Electro-proportional adjustment with/without additional function monitoring
			Additional functions	■ Throttle ■ Rapid and creeping movement (one or both directions)
			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

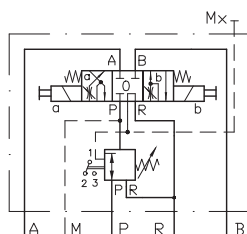
Basic symbols

	D, E, G, D1, E1, G1				
					
			B, W, K		
					

Further functions:

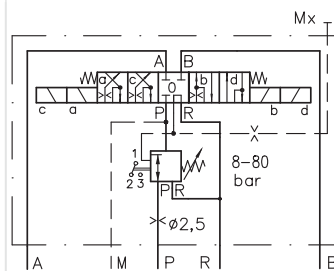
G1/MD

Pressure reducing function and throttle in switching positions a and b



G/MM6

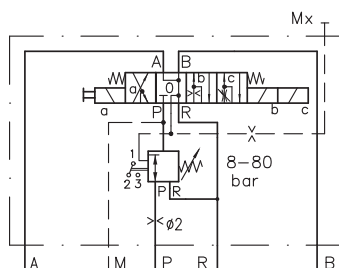
Rapid traverse and creeping in both directions



G/MMDA7

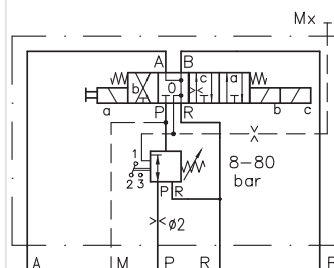
Rapid traverse and creeping in one direction featuring also a limitation for rapid traverse (switching position a, c) rapid traverse in opposing direction (switching position b)

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



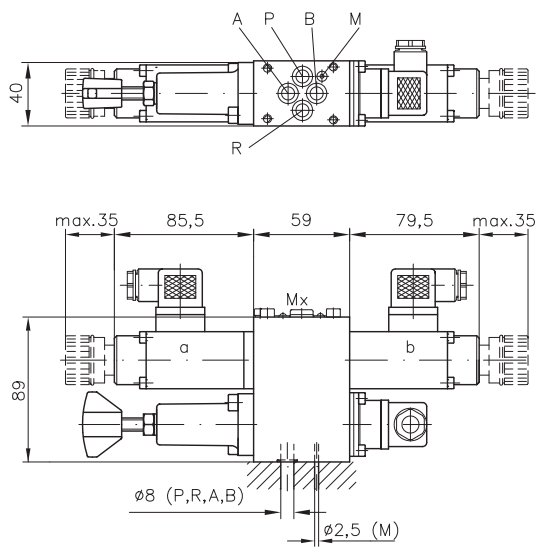
G/MMA7

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

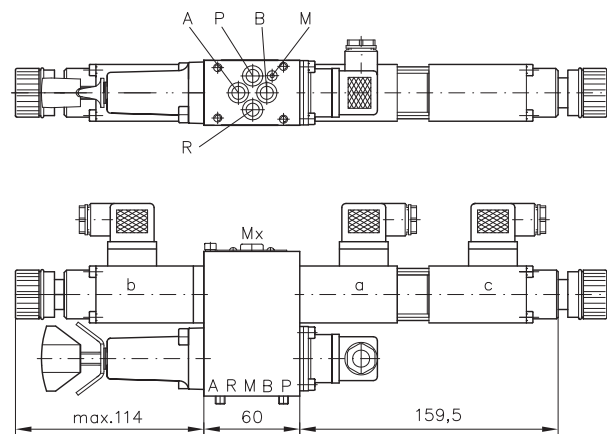


General parameters and dimensions

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	5 ... 50 8 ... 80	2 ... 4 3 ... 5 4 ... 6	Hole pattern conf. DIN 24340-A6	see illustration			2.2 ... 3.8	+ 0.6 ... 1.1

1) Port Mx; G 1/8 (BSPP)

2) Depending on flow pattern symbol and actuation mode

Circuit example:
NSMD2K/M/GDK/B2,5-G24

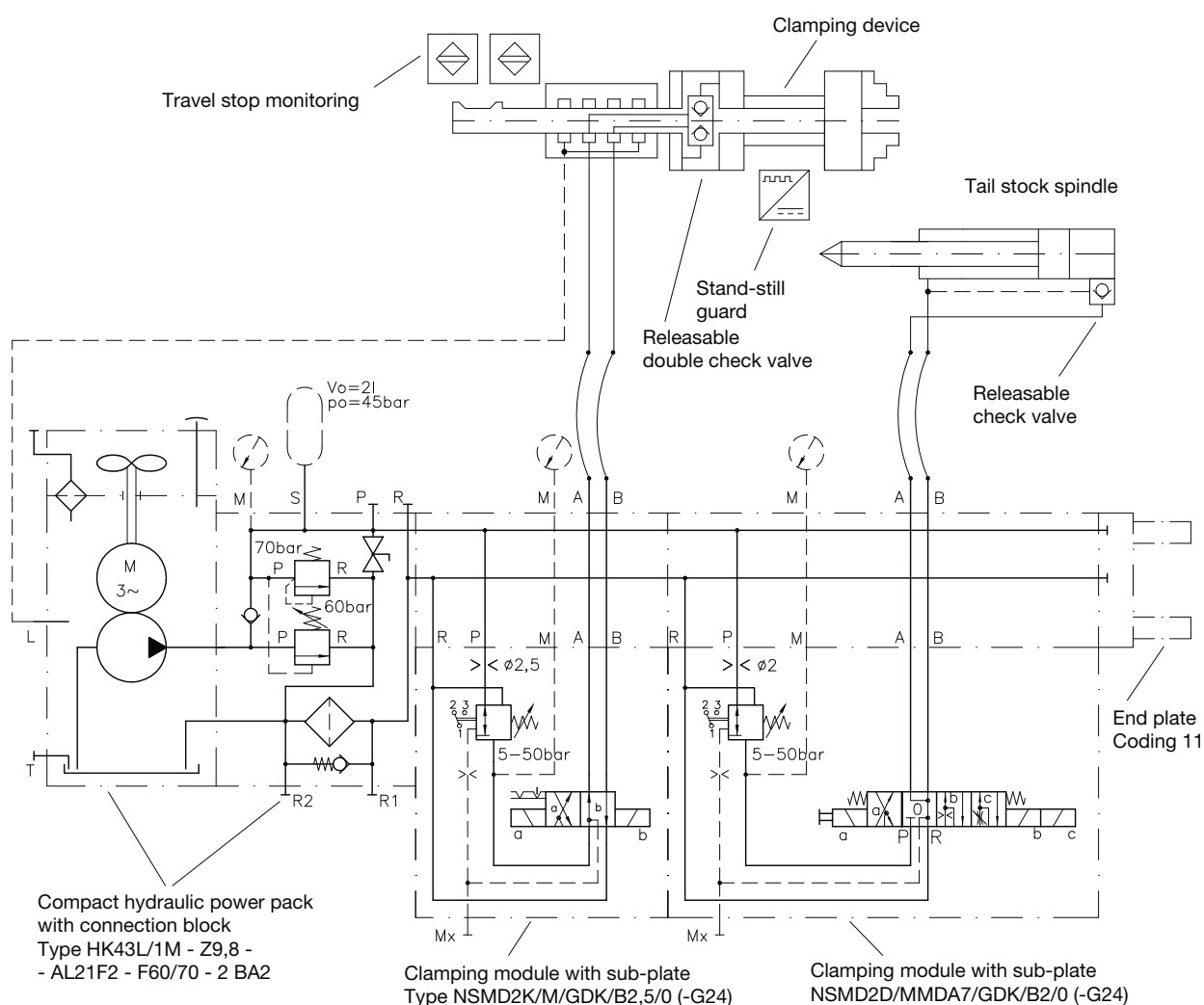
Clamping module type NSMD size 2 with industrial standard (DIN 24340- A6) connection hole pattern, flow pattern symbol K, detented version, clamping pressure range G, 5-50 bar and min. operational flow 2-4 lpm. The actuation for the adjustment of the clamping pressure and tracked pressure switch takes place by means of wing screw and wing nut. An orifice $\varnothing$ 2.5 mm is installed in the P gallery, solenoid voltage 24V DC

NSMD2G1/MD/E4VK/B1-G12

Clamping module type NSMD size 2 with industrial standard connection hole pattern conf. DIN 24340-A6, flow pattern symbol G1 with pressure monitoring at port A, adjustable throttle setting for switching position a and b. Valve for clamping pressure range E, 8-80 bar and min. operational flow 4-6 lpm. The actuation for the adjustment of the clamping pressure and tracked pressure switch takes place with self-locking turn knob. An orifice $\varnothing$ 1 mm is installed in the P gallery, solenoid voltage 12V DC

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


Associated technical data sheets:

- Clamping modules type NSMD: [D 7787](#)

Products:

- Directional valves type NSWP2: [Page 84](#)
- Directional seated valves type NBVP16: [Page 156](#)

Plates:

- Valve banks type BA2: [Page 34](#)
- Intermediate plate NG6 type NZP: [D 7788 Z](#)

Plugs:

- With LEDs or to support the EMV etc.: [D 7163](#)
- With economy circuit: [D 7813](#), [D 7833](#)

2.2 Directional seated valves

Directional seated valves with various actuations	124
Directional seated valve bank type VB	130
Directional seated valves type WN and WH	136
Directional seated valve bank type BWH and BWN	138
Directional seated valves type VZP	144
Directional seated valve bank type BVZP	146
2/2-way directional seated valve cartridges type EM, EMP and EMC	152
Directional seated valves type BVG, BVE, BVP and NBVP	156
Directional seated valves type VP	160
Lifting/lowering valves type HSV	162
Switch units (press control valves) type CR	164
Lifting modules and lifting/lowering valves type HMB, HMC, HMT, and HSV, HZV etc.	166
Directional seated valves type VH, VHR and VHP	170
Shut-off valves type DA and EA	172



Directional seated valve bank type VB



Directional seated valves type BVG, BVE, BVP and NBVP

(Solenoid-actuated) seated valves

Type	Nomenclature/Design	Actuation	p _{max}	Q _{max}
VB	Directional seated valve, zero leakage, valve bank ■ For pipe connection ■ For combination with hydraulic power packs	- Solenoid - Pressure - Manual	500... 700 bar	6... 120 lpm
WN, WH	Directional seated valve, zero leakage, individual valve ■ Individual valve for manifold mounting ■ Combination with connection block for pipe connection	- Solenoid	350... 450 bar	5... 60 lpm
BWH, BWN	Directional seated valve, zero leakage, valve bank ■ For pipe connection ■ For combination with hydraulic power packs	- Solenoid	350... 450 bar	5... 60 lpm
VZP	Directional seated valve, zero leakage, individual valve ■ Individual valve for manifold mounting	- Solenoid	250... 450 bar	5... 15 lpm
BVZP	Directional seated valve, zero leakage, valve bank ■ For pipe connection ■ Combination with hydraulic power packs	- Solenoid	450 bar	15 lpm
EM, EMP, EMC	Directional seated valve, zero leakage, individual valve ■ Screw-in valve ■ Combination with connection block for pipe connection ■ Combination with connection block for swivel fitting	- Solenoid	450 bar	1... 160 lpm
BVG, BVE, NBVP	Directional seated valve, zero leakage, individual valve ■ Screw-in valve ■ For pipe connection ■ Individual valve for manifold mounting	- Solenoid - Hydraulic - Pneumatic - Manual	400 bar	20... 300 lpm
VP	Directional seated valve, zero leakage, individual valve ■ Individual valve for manifold mounting	- Solenoid - Hydraulic - Pneumatic	400 bar	15 lpm

Valve combinations

Type	Nomenclature/Design	Actuation	p _{max}	Q _{max}
HSV	■ Individual valve for pipe connection	- Solenoid	315... 400 bar	20... 120 lpm
CR	■ Individual valve for pipe connection	- Solenoid - Manual	HP 400 bar NP 30... 60 bar	HP 8... 20 lpm NP 80... 160 lpm A→ R 160... 300 lpm
HMB, HMC, HMT	■ Valve bank	- Solenoid	315 bar	120 lpm

Manually actuated seated valves

Type	Nomenclature/Design	Actuation	p _{max}	Q _{max}
VH, VHR, VHP	Directional seated valve, zero leakage ■ Individual valve for pipe connection ■ Individual valve for manifold mounting ■ Valve bank	- Manual	500... 700 bar	12... 25 lpm
DA, EA	Directional seated valve, zero leakage ■ Individual valve for pipe connection	- Manual	500 bar	60... 150 lpm

Seated valves

2.2 Directional seated valves with various actuations

These directional seated valves with various actuation modes comprise manifold mounting valves that use spring-loaded balls as valve elements and therefore do not show any leakage. The actuation element used moves the valve to the appropriate switching position using an angled lever and tappet.

The basic versions are designed as 2/2- and 3/2-way directional valves. 3/3- and 4/3-way functions are possible if two valves are housed in one valve block, whereas 4/2-way functions require an additional intermediate plate. The variants of size G...-22 can be used as a reinforced version for fluctuating, pulsating continuous loading and high switching frequency in the upper pressure range.

Connection blocks can be flange-mounted to incorporate the valves into the pipe systems. Optional additional functions in the connection blocks (e.g. pressure-limiting or bypass check valve) extend the range of applications of this valve type. It is possible to combine several valves connected in parallel in one 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



Nomenclature:	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}:	350 ... 700 bar
Q_{max}:	6 ... 120 lpm

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 ■ Lift monitoring (size 3 and 4) Size Size 0 to 4 ■ Size 1 also available with industrial connection hole pattern NG 6 (CETOP), type NG Function ■ 2/2-way directional valve (R2, S2) ■ 3/2-way directional valve (3, Z3) ■ 3/3-way directional valve (21, 39) ■ 4/3-way directional valve (22, 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, 48, 49	4	Z4

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

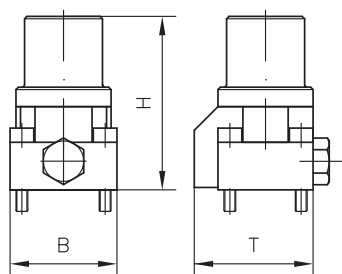
Actuation:

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 $p_{\text{contr. max}}$ [bar]: 400... 700		Shifting force [N]: 25... 80		Shifting force [N]: 25... 80	
		Control pressure $p_{\text{contr. min}}$ [bar]: 9... 16		Shifting travel [mm]: 10.5... 30		Shifting travel [mm]: 20.5... 45	
		15		51... 20		45... 98	
		2.5... 4		4 and 5			

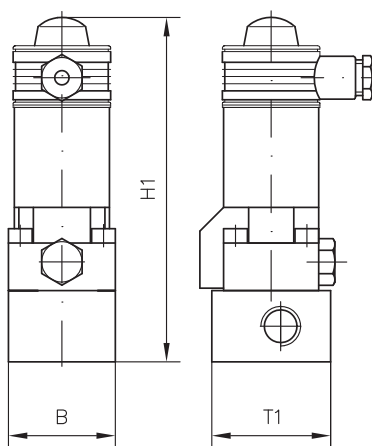
- Valve with solenoid actuation also available in ATEX-compliant version (24V DC)

General parameters and dimensions

Individual valve



Valve with connection block



Size	Dimensions						m _{max} [kg]
	H _{max}	H1 _{max}	B		T _{max}	T1	
			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
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

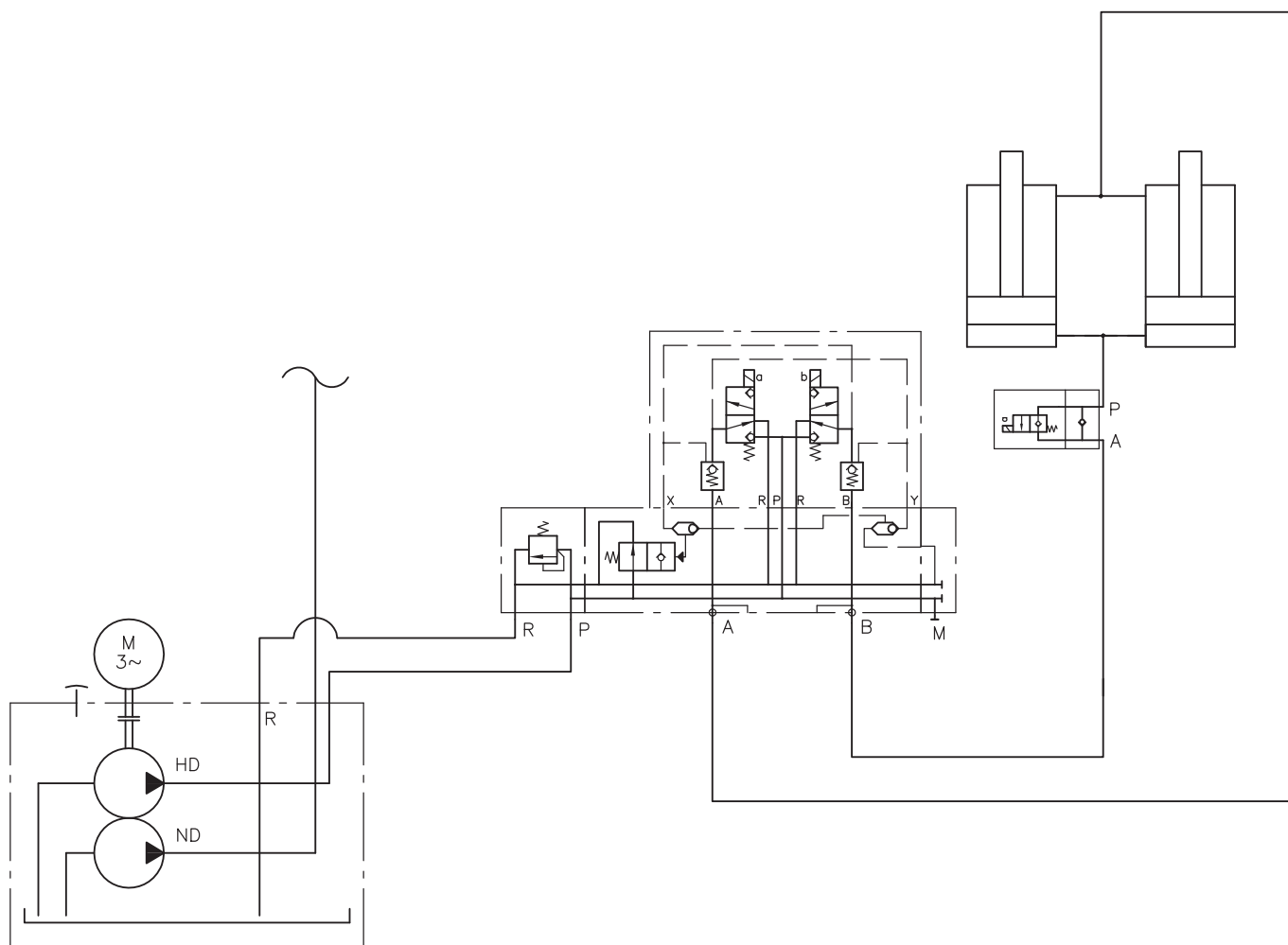
	Q _{max} [lpm]	p _{max} [bar]								Ports (BSPP)
Size		Solenoid		Pressure		Mechanical		Manual		
		G	WG	H	P	K	T	F	D	P, R, A, B
0	6	300... 500		500	-	-		-	500	G 1/4
12	12	350... 500 (700)		500... 700		400... 700		400... 700		G 1/4 and G 3/8
2, 22	25	350... 500 (700)		500		400... 500		400... 500		G 3/8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

Example circuit:

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 valves: [D 7300](#)
- Directional seated valves with standard connection diagram (CETOP3, NG 6): [D 7300 N](#)
- Directional seated valves with lift monitoring: **D 7300 H**

Valve banks:

- Valve banks type VB: [Page 130](#)

Plugs:

- With LEDs etc.: [D 7163](#)
- With economy circuit: [D 7813](#), [D 7833](#)

See also section "Devices for special applications":

- Devices for explosion hazardous areas, conforming ATEX
- Devices for up to 700 bar

Seated valves

2.2 Directional seated valve bank type VB

The valve bank type VB consists of a connection block (with ports P and R), the directional seated valves (acc. to D 7300) installed on sub-plates and connected in parallel plus the end plate. The whole valve bank is held together with one or two tension rods.

Through selection of the sub-plate, different symbols can be achieved with the individual valves, including in conjunction with additional functions (e.g. pressure switches in the consumer channel). These valve banks may be either directly flange-mounted to a pipe system via a connection block or installed directly onto hydraulic power packs (type HK, HC, MP, MPN and KA) using an adapter plate.

Various end plates (e.g. with pressure switch in the P gallery or accumulator drain valve) extend the range of possible applications.

Particularly in conjunction with hydraulic power packs, the compact design enables hydraulic control systems for high pressure and with low spatial requirements to be achieved.

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 integrated 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



Nomenclature:	Directional seated valve, zero leakage
Design:	Valve bank for pipe connection
Actuation:	Solenoid Pressure: Hydraulic, Pneumatic Manual: Hand lever, Turn knob
p_{max}:	500 ... 700 bar
Q_{max}:	6 ... 120 lpm

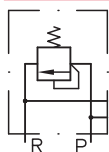
Design and order coding example

VB11	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/adaptor 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, 31, 41					

Function

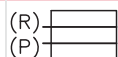
Connection blocks:

A -1/..



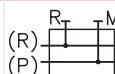
For pipe connection, with tool adjustable pressure limiting valve (/..- pressure specification in bar)

C, D, E



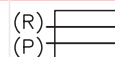
For mounting onto hydraulic power packs type R, Z and RZ, depending on tank and size

F



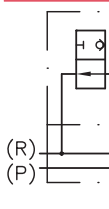
For mounting onto compact hydraulic power packs (type KA, HC, MP, MPN, HK)

G

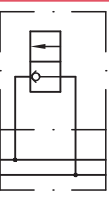


Valve sections:

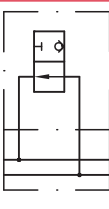
A



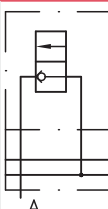
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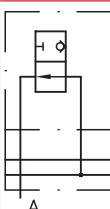
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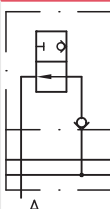
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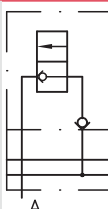
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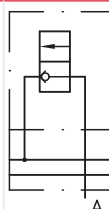
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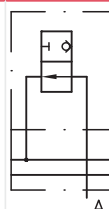
Q



P

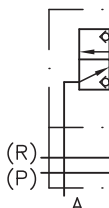


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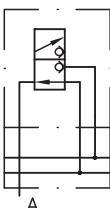


- A for VB 01VB 11 only with tapped ports G 1/4 (BSPP)

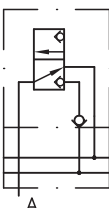
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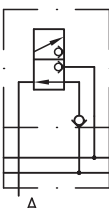
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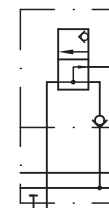
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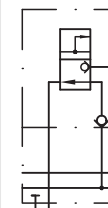
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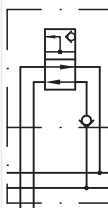
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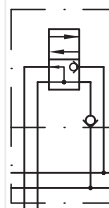
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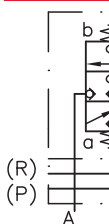


T

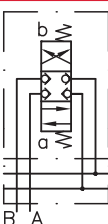


Simplified flow pattern

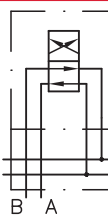
J, G39



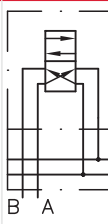
G, G49



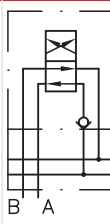
HX



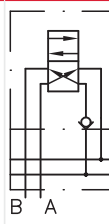
LX



NX



RX

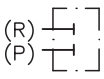
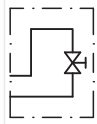
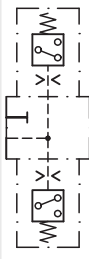


Simplified flow pattern

Simplified flow pattern

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

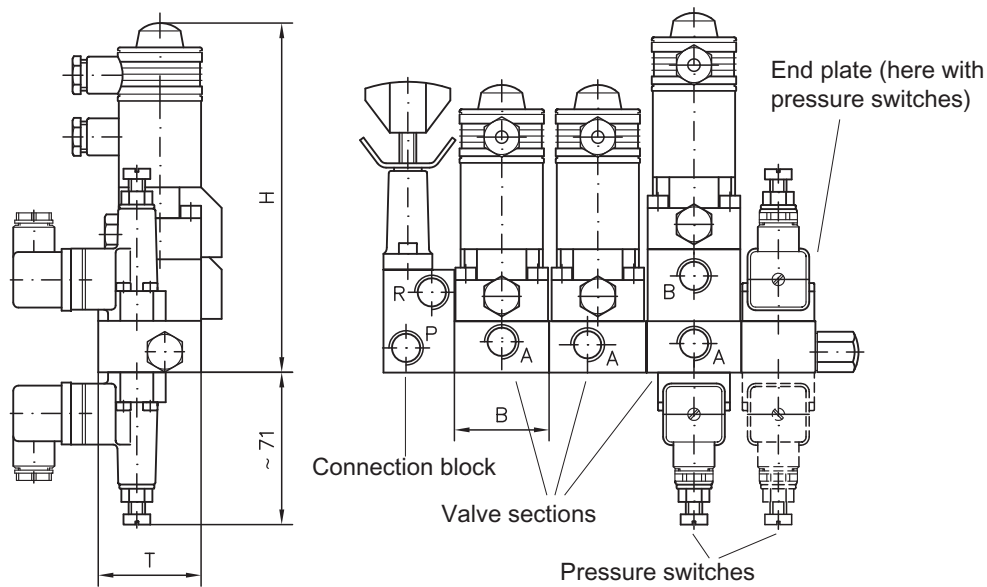
End plates:

	/2	/3 ... /65
		
Standard end plate	End plate with accumulator drain valve	End plates with one or two pressure switches type DG 3..

- /2, /3 ... /65 only with type VB01 and VB11

General parameters and dimensions

VB 01



	Q _{max} [lpm]	p _{max} [bar]					Ports (BSPP)	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 11	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								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

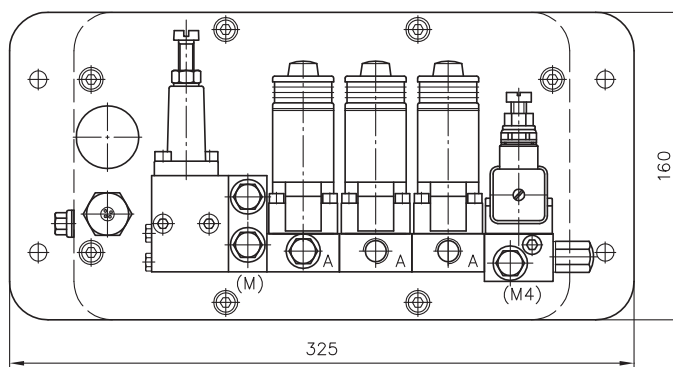
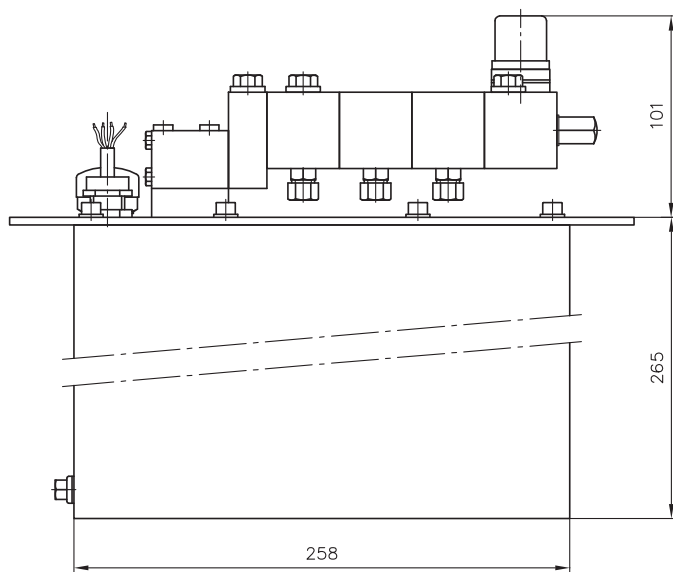
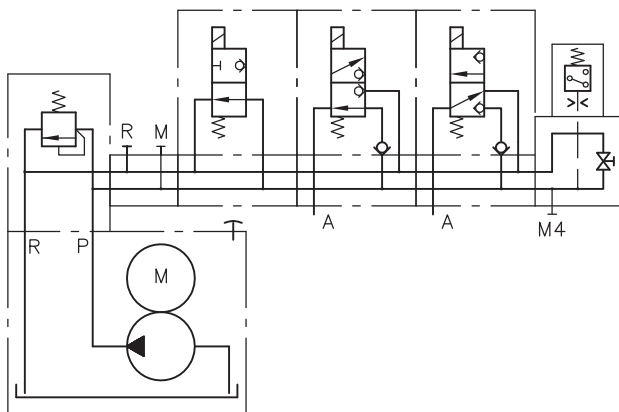
Compact hydraulic power pack type MP size 2, connection block with pressure limiting valve (tool adjustable)

- VB01FM - FRN/32 - 1 - WG230

Valve bank type VB size 0 with 3 valves (actuation mode 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 22](#)
- Type HC, HCW, HCG: [Page 14](#)
- Type HK, HKF, HKL: [Page 26](#)
- Type NPC: [Page 12](#)
- Type KA, KAW: [Page 18](#)
- Connection blocks type A: [Page 32](#)

Suites hydraulic power packs:

- Type R: [Page 46](#)
- Type RZ: [Page 62](#)
- Type Z: **D 6820**

Corresponding pamphlets (data sheets):

- Valve banks type VB: [D 7302](#)

Suited valves:

- Directional seated valves with various actuations: [Page 124](#)

Accessories:

- Pressure switches type DG 3.., DG 5 E: [Page 266](#)
- Pressure-reducing valves type CDK: [Page 196](#)

Plugs:

- With LEDs etc.: [D 7163](#)
- With economy circuit: [D 7813](#), [D 7833](#)

See also section "Devices for special applications":

- Devices for up to 700 bar

Seated valves

2.2 Directional seated valves type WN and WH

These directional seated valves type WN and WH use spring loaded balls as valve elements and therefore do not show any leakage. They are manifold mounting and are available in four sizes. These valves are very compact as the functional valve parts are partly integrated in the solenoid body. The basic versions are designed as 2/2- and 3/2-way directional valves. Whereas 3/3- , 4/3-way functions require two valves to be installed on one valve sub-plate.

Connection blocks can be flange-mounted to incorporate the valves into the pipe systems. Optional additional functions in the connection blocks (e.g. pressure-limiting or bypass check valve) extend the range of applications of this valve type. By combining two valves in one connection block, 3/3- and 4/3-way functions can be achieved.

The type WN (size 1 only) has a simpler design than the WH types (no moving seals and no separate solenoid discharge). Therefore the permissible operating pressure for these more cost-effective variants is lower than for the type WH.

It is possible to combine several valves connected in parallel in one 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



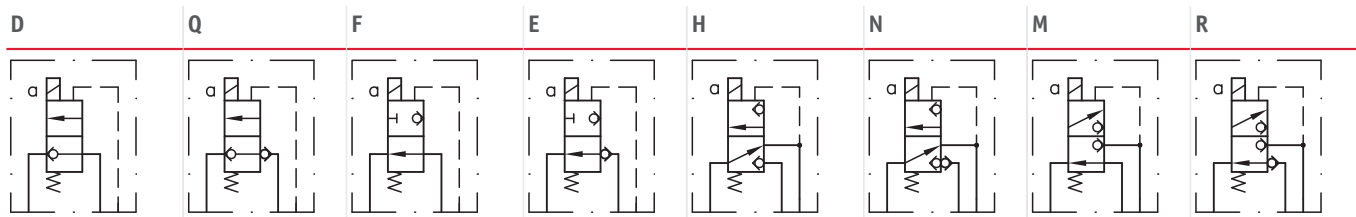
Nomenclature:	Directional seated valve, zero leakage
Design:	Individual valve, manifold mounting combination with connection blocks for pipe connection
Actuation:	Solenoid
p _{max} :	350 ... 450 bar
Q _{max} :	5 ... 60 lpm

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
		Indiv. 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			

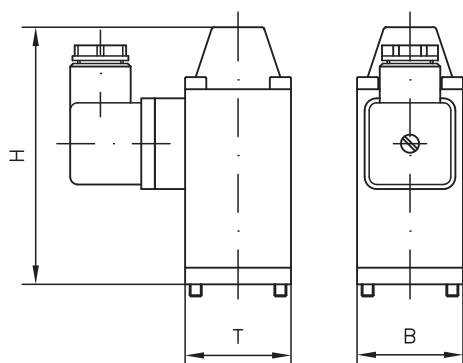
Function



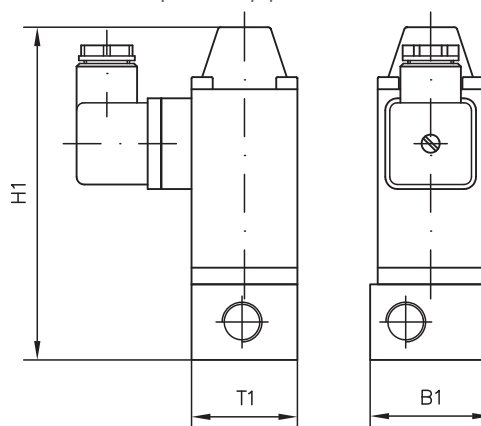
- Symbols show type WH
- Type WN 1 without de-pressuring duct for the solenoid (add. leakage duct is not necessary)

General parameters and dimensions

Individual valve



Valve with sub-plate for pipe connection



	$Q_{\max}$ [lpm]	$p_{\max}$ [bar]	Ports (BSPP)	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	86.5	35	35	0.6	111.5	40	35	0.9
WH 1	8	450	G 1/4	86.5	35	35	0.6	111.5	40	35	0.9
WH 2	15	350	G 1/4	97.0	35	35	0.65 ... 0.7	125	40	40	1.0
WH 3	30	350	G 3/8	95.5	45	45	1.2 ... 1.3	128	50	50	1.8
WH 4	60	350	G 1/2	118.0	60	60	2.7 ... 3.0	158 ... 173	70	70	3.6 ... 4.0

Associated technical data sheets:

- Directional seated valves type WN1, WH: [D 7470 A/1](#)

Valve banks:

- Type BWN1, BWH: [Page 138](#)

Plugs:

- With LEDs etc.: [D 7163](#)
- With economy circuit: [D 7813](#), [D 7833](#)

Seated valves

2.2 Directional seated valve bank type BWH and BWN

The valve bank types BWN and BWH consist of a connection block (with ports P and R), the directional seated valves types BWN and BWH installed on sub-plates and connected in parallel plus the end plate. The whole valve bank is held together with one tension rod.

Through selection of the sub-plate, different symbols can be achieved with the individual valves, including in conjunction with additional functions (e.g. pressure switches or pressure-limiting valves in the consumer channel). These valve banks may be either directly flange-mounted to a pipe system via a connection block (with or without pressure-limiting valve) or installed directly onto hydraulic power packs (type HK, HC, MP, MPN, KA and NPC) using an adapter plate. Various end plates (e.g. with pressure switch in the P gallery or accumulator drain valve) extend the range of possible applications.

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



Nomenclature:	Directional seated valve, zero leakage
Design:	Valve bank ■ For pipe connection ■ Combination with hydraulic power packs
Actuation:	Solenoid
p_{max}:	350 ... 450 bar
Q_{max}:	5 ... 60 lpm

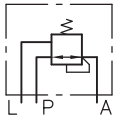
Design and order coding example

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/adaptor plates ■ For pipe connection, with/without pressure limiting valve, manually or tool adjustable, 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

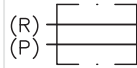
Connection blocks/adapter plates:

A-1/...



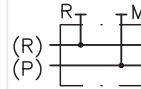
For pipe connection, with tool adjustable pressure-limiting valve (/...- pressure specification in bar)

C



For mounting onto hydraulic power packs

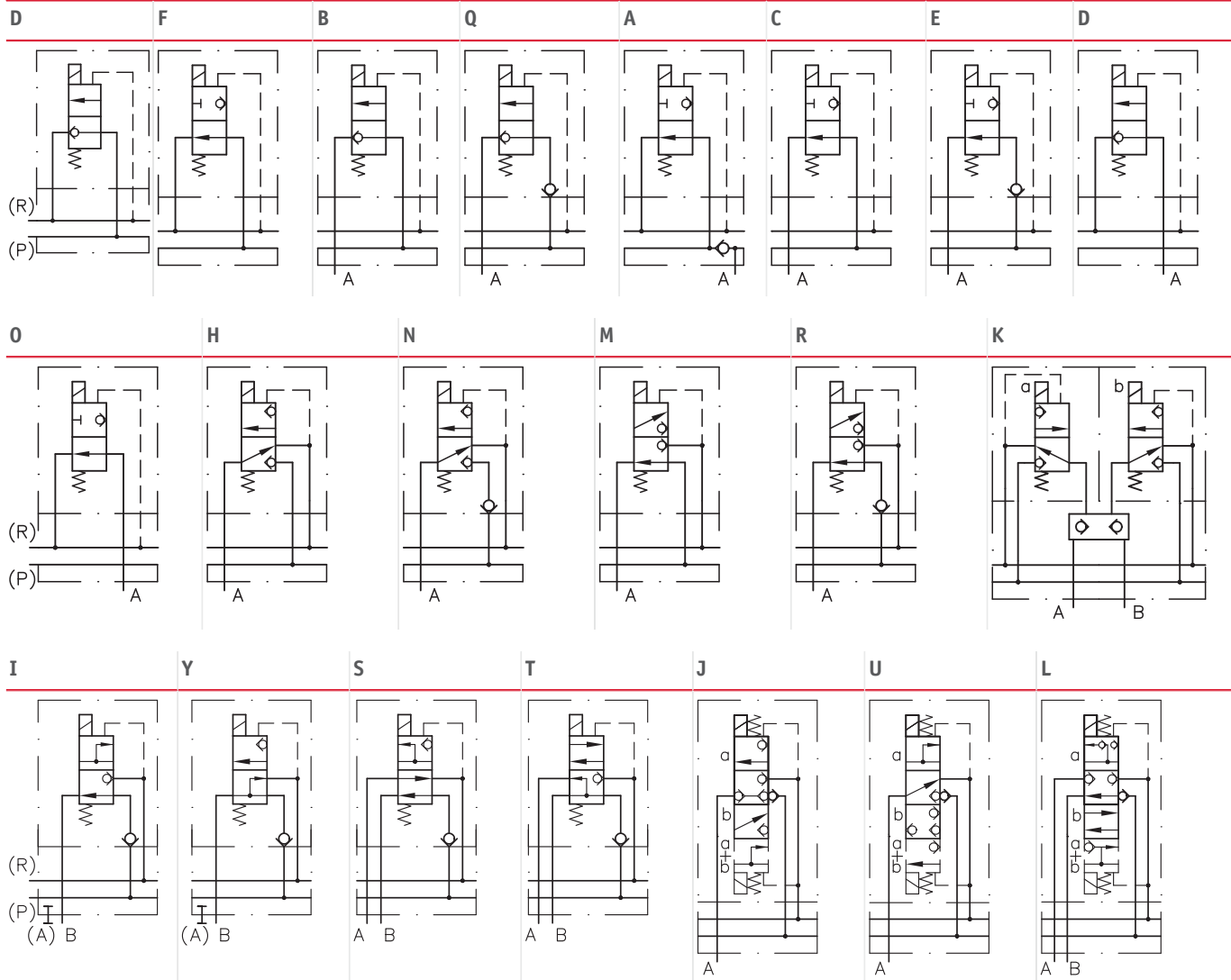
F



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

Valve sections:

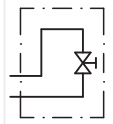
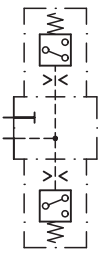
2/2-way directional seated valves



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.

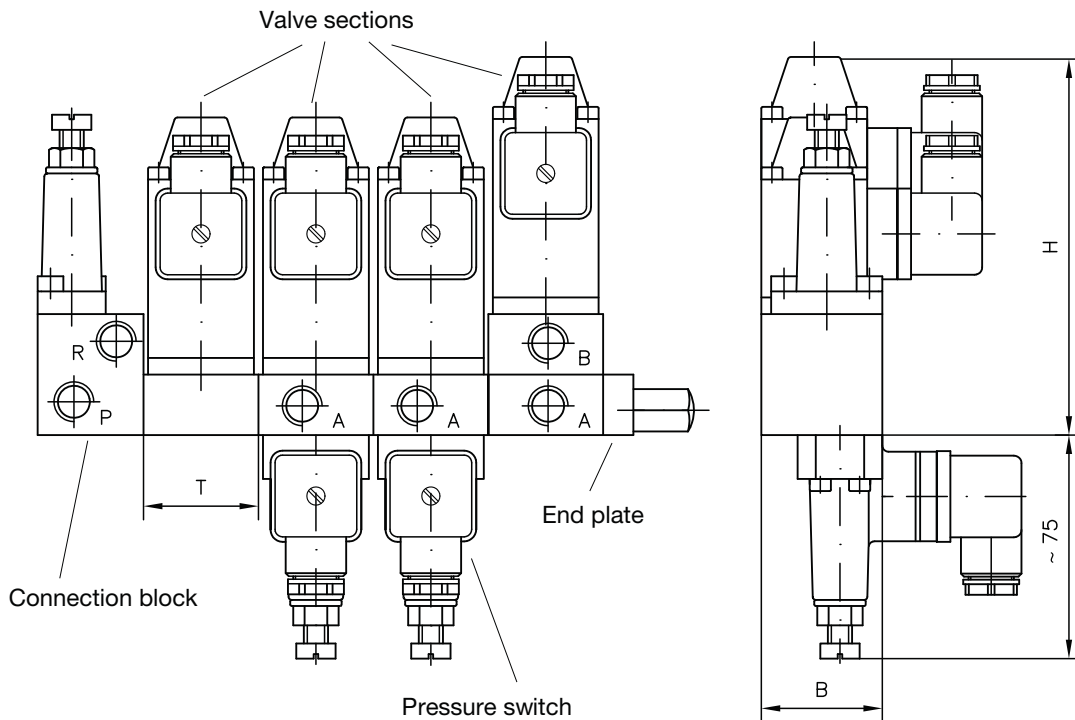
End plates:

1	2	3../3..
 (R) (P)		
Standard end plate	End plate with accumulator drain valve	End plate with one or two pressure switches connected to the P gallery

General parameters and dimensions

BWH

For pipe connection:



	$Q_{\max}$ [lpm]	$p_{\max}$ [bar]	Ports P, R, A, B (BSPP)	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
BWH 4	60	350	G 1/2	158 ... 213	70	92	4.1 ... 6.1

- Mass [kg] per valve section: + 0,3 kg with added pressure switch

Circuit example:

HC 24/0,64 - A2/400

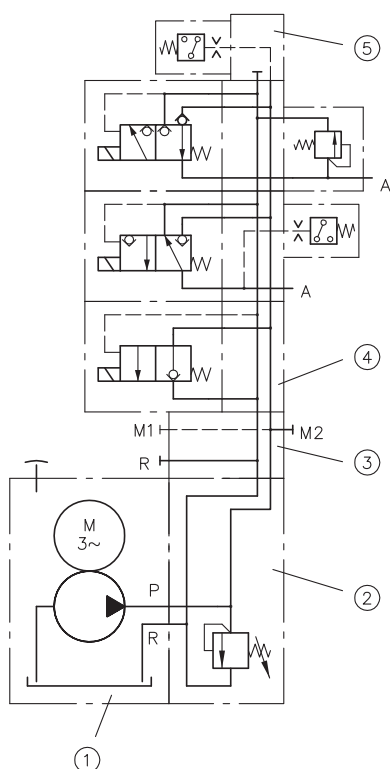
Hydraulic power pack type HC, size 2, connection block with pressure limiting valve (manually adjustable)

- BWH1F1 - D H5 R/150 - 36 - 1 - G24

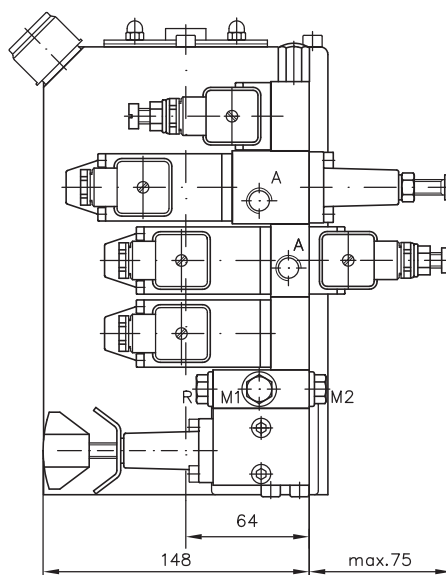
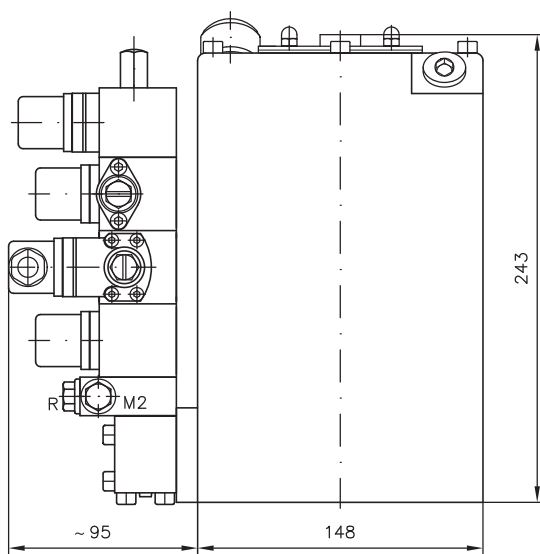
Valve bank type BWH, size 1 with three valve sections and end plate with pressure switch

Main parameter of the circuit example:

- $Q_{pu} = 0.64 \text{ lpm}$ (at 1450 rpm)
- $p_{max pu} = 700 \text{ bar}$
- $p_{system} = 400 \text{ bar}$ (setting of the pressure limiting valve)
- $V_{usable} = \text{approx. } 1.5 \text{ l}$



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



Associated publications:

- Directional seated valve banks type BWN1, BWH: [D 7470 B/1](#)
- Directional seated valves type WN1, WH: [D 7470 A/1](#)

Connection block:

- Type A: [Page 32](#)

Compact hydraulic power packs:

- Type HC, HCW, HCG: [Page 14](#)
- Type HK, HKF, HKL: [Page 26](#)

- Type NPC: [Page 12](#)
- Type KA, KAW: [Page 18](#)

Hydraulic power packs:

- Type R: [Page 46](#)

Hydraulic accessories:

- Pressure switches type DG 3.., DG 5E: [Page 266](#)
- Pressure-reducing valves type CDK: [Page 196](#)

Seated valves

2.2

Directional seated valves type VZP

These type VZP use spring-loaded balls or cones as valve elements and therefore do not show any leakage.

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 pairing, these valves can fulfil either one 4/4-, 4/3-, 3/3-way function or two independent 3/2- and 2/2-way functions. When compared with individual valves for manifold mounting of conventional layout, the twin design is more advantageous due to lower spatial requirements and the possibility to directly mount pressure switches for monitoring the consumer pressure. This compact design offers particular advantages in type BVZP valve banks consisting of several valves of this type connected in parallel.

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



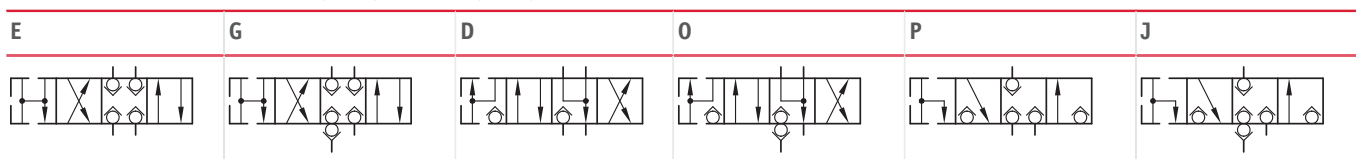
Nomenclature:	Directional seated valve, zero leakage
Design:	Individual valve, manifold mounting
Actuation:	Solenoid
p _{max} :	250 ... 450 bar
Q _{max} :	5 ... 15 lpm

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		

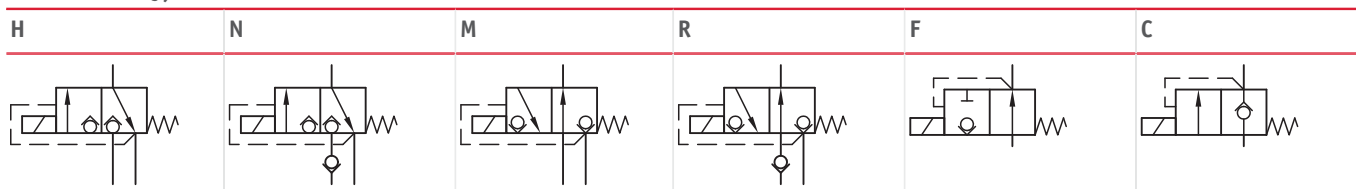
Function

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



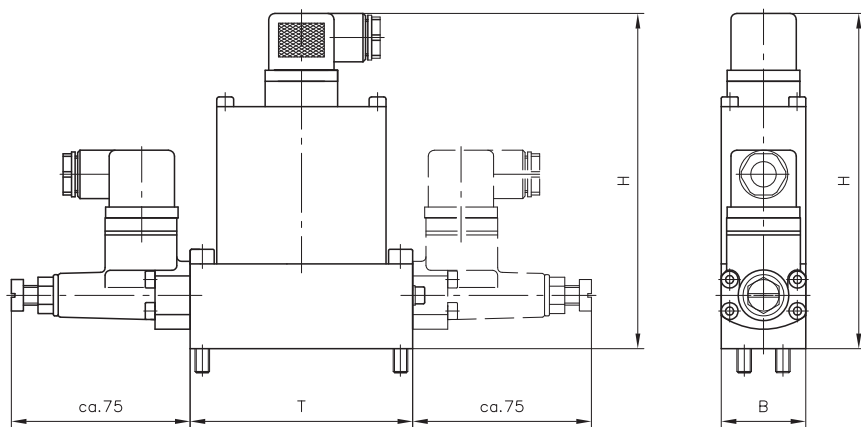
- The 4. shifting position illustrates mode, when both solenoids are energized

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



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 valves type VZP: [D 7785 A](#)

Valve banks:

- Type BVZP: [Page 146](#)

Accessories:

- Pressure switches type DG 3.., DG 5E: [Page 266](#)

Plugs:

- With LEDs or to support the EMV etc.: [D 7163](#)

Seated valves

2.2

Directional seated valve bank type BVZP

The valve bank type BVZP consist of a connection block (with ports P and R), the directional seated valves type VZP installed on sub-plates and connected in parallel plus the end plate. The whole valve bank is held together with two tension rods. Depending on the type, the sub-plate feature optional functions e.g. restrictor check valves and/or pressure reduction valves covering only the corresponding valve section. Connection blocks with or without pressure-limiting valve can be mounted for pipe connection. Combination with hydraulic power packs (type HK, HC, MP, MPN and KA) and other directional valve types is achieved using appropriate adapter plates. Various end plates (e.g. with and without pressure switch in the P gallery) extend the range of possible applications. Particularly in conjunction with hydraulic power packs, the compact design enables complete hydraulic control systems with low spatial requirements to be achieved.

Features and benefits:

- Excellent price/performance ratio
- Max. operating pressure 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 (chipping and non-chipping)
- Mining (incl. oil production)
- Clamping equipment, punching tools, jigs
- Rubber and plastics machinery



Nomen-clature:	Directional seated valve, zero leakage
Desing:	Valve bank ■ For pipe connection ■ Combination with hydraulic power packs
Actuation:	Solenoid
p _{max} :	450 bar
Q _{max} :	15 lpm

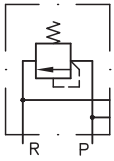
Design and order coding example

BVZP1	A-1/400	- G33/22	- 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 (BSPP) End plate ■ With/without pressure switch or prepared for retro-fitting of a pressure switches ■ Adapter plates for adding other valve banks (type BWN(H)1/BWH 2) Valve sections ■ 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) ■ Pressure reducing valve for gallery P Additional elements ■ Pressure switch in consumer port ■ Pressure-reducing valve in the consumer port Connection block/adaptor plates ■ For pipe connection ■ Pressure limiting valve (manually of tool adjustable) ■ Drain valve (for discharging the accumulator) ■ Pressure switch ■ For direct mounting at compact hydraulic power packs with connection block with/without prop. 3-way flow controller and optional pre-load valve in gallery R					
Basic type, size	Type BVZP, size 1				

Function

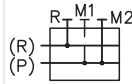
Connection blocks:

A 1



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

F

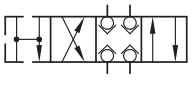


For direct mounting onto hydraulic power packs with connection block (type KA, HC, MP, MPN and HK), prepared for retrofitting of one or two pressure switches connected to gallery P

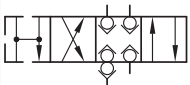
Valve sections:

Cone seated valves with 4/3- or 3/3-way function up to 400 bar

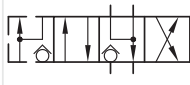
E



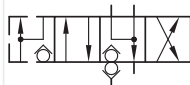
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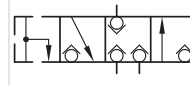
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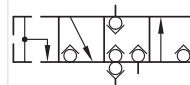
O



P



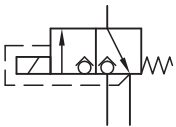
J



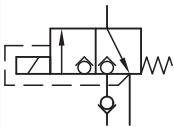
- The 4. shifting position illustrates mode when both solenoids are energized

Ball seated valves with 3/2- or 2/2-way function up to 450 bar

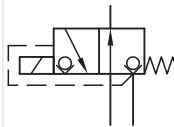
H



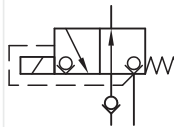
N



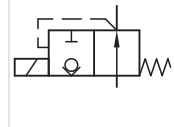
M



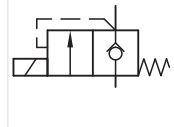
R



F

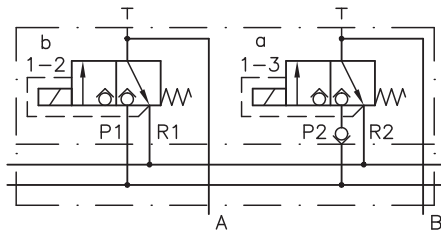


C

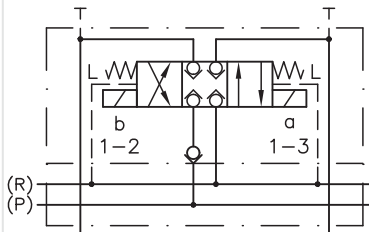


Valve sections

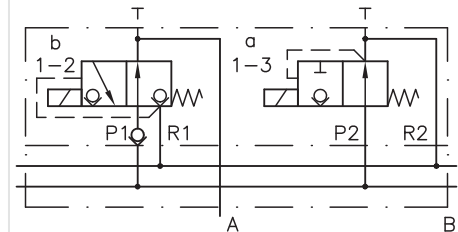
Example: -G22/0



Example: -H2N2/0



Example: -R2F2/0



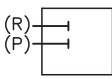
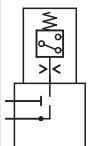
Options for the valve section:

- Sub-plate with throttle and restrictor check valves in the consumer port
- Valve section with 4/2-way function, directional spool valve
- Pressure reducing valve reducing the pressure for one valve section only (connected in parallel)
- Pressure reducing valve reducing the pressure for all subsequent valves (connected in series)
- Pressure reducing valve with orifice/throttle and by-pass check valve in the consumer port

Additional versions:

- Individual valve with orifice in the gallery P and/or return pressure stop in the return gallery
- Individual valve type WH with sub-plate, may be integrated in a valve bank
- Sub-plate for 4/3-way valves with ancillary blocks at the consumer side featuring a pressure reducing valve with tracked pressure switch and throttles

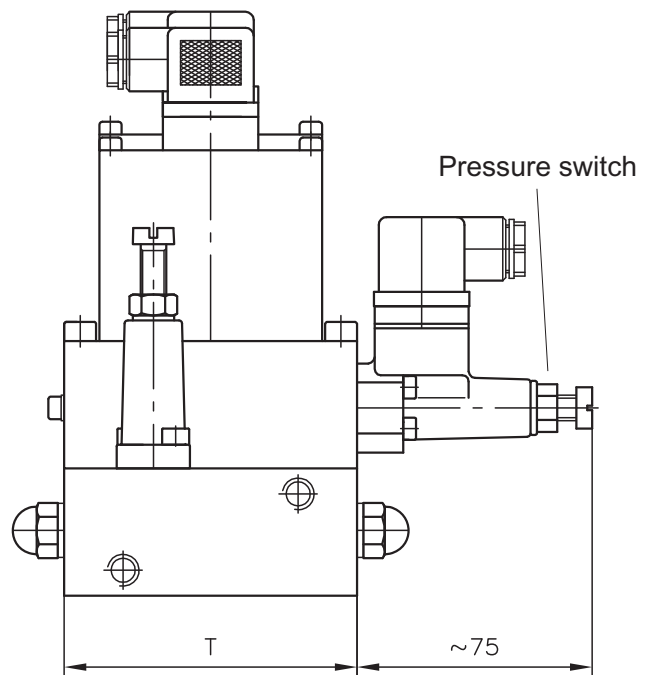
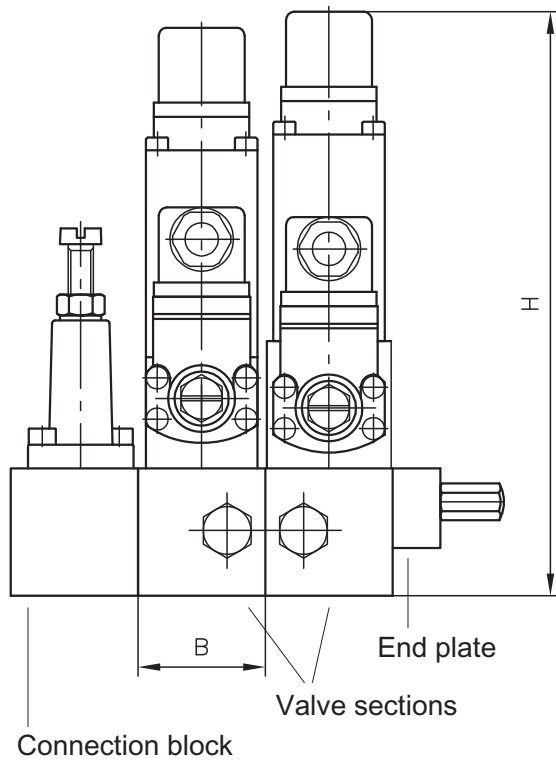
End plates:

1	32	33 to 37
		
Standard end plate	End plate prepared for retrofitting of a pressure switch type DG 3..	End plate with pressure switch type DG 3..

General parameters and dimensions

BVZP 1

Example: BVZP1 A-1/200 - G 52/22 - R5 M2/0 - 1 - 1 - G24



	Q_{max} [lpm]	p_{max} [bar]	Ports (BSPP)	Dimensions [mm]			m [kg]
			A, B, P, R, M	H	B	T	Valve section
BVZP 1	15	450	G 1/4	max. 182	40	92	2.9 - 3.2

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

Circuit example:
HK 448/1 - H7,0 - AS1/150

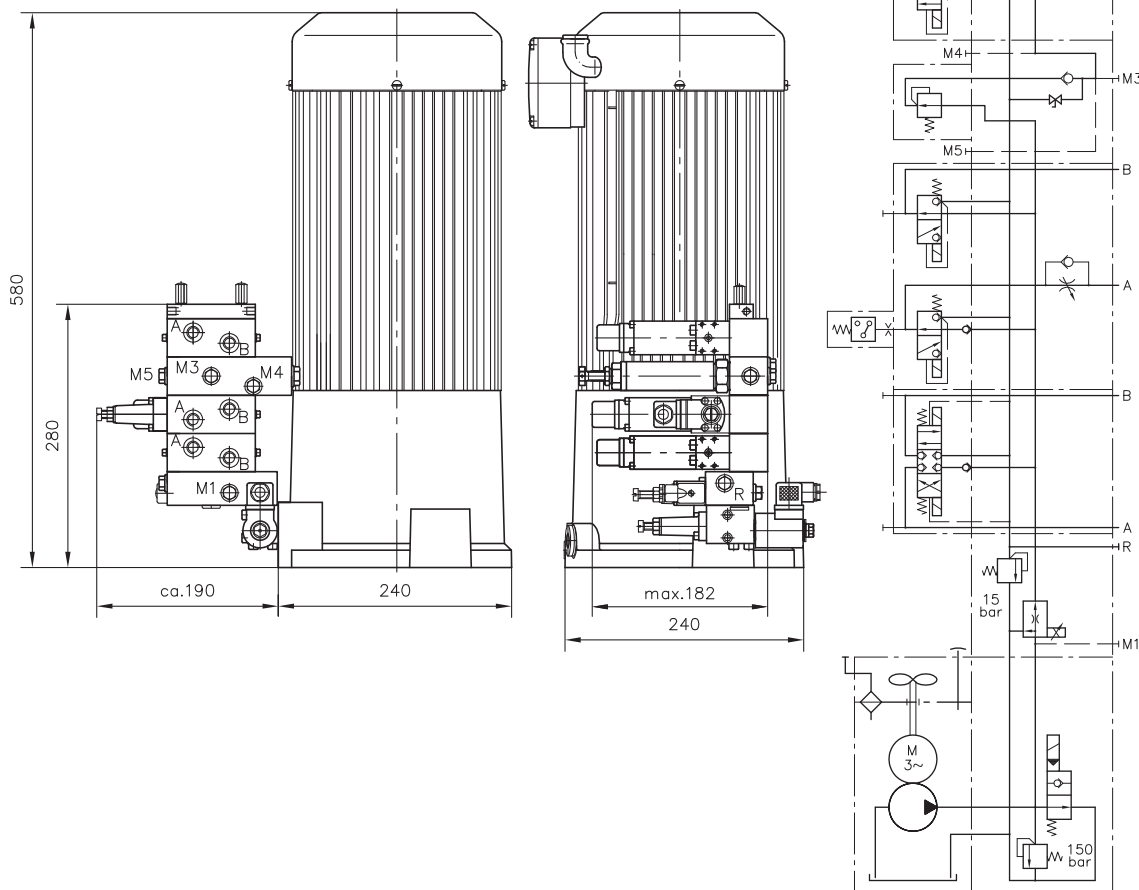
Hydraulic power pack type HK, size 4;
 connection block with integrated idle
 circulation valve and pressure limiting
 valve

BVZP1 FEH10F V15/G12 - G22/0 - R5 M2/20 - CZ5/80/5R - H12 H12/0 - 1 - 1 - G24

Valve bank type BVZP with 5 individually controlled valve functions housed in 3 valve sections, two functions are supplied with reduced pressure (pressure reducing valve section). The flow can be arbitrarily adjusted via a prop. flow control valve

Main parameter of the circuit example:

- $Q_{pu} = 7.0 \text{ lpm}$ (at 1450 rpm)
- $p_{max pu} = 215 \text{ bar}$
- $p_{system} = 150 \text{ bar}$ (setting of the pressure limiting valve)
- $V_{consum} = \text{approx. } 3.7 \text{ l}$


Associated technical data sheets:

- Valve banks type BVZP: [D 7785 B](#)

Products:

- Directional seated valves type VZP1: [Page 144](#)
- Valve banks type BWN1, BWH: [Page 138](#)
- Pressure-reducing valves type CDK and DK: [Page 196](#)
- Slot-type throttles type Q, QR, QV: [Page 232](#)

Accessories:

- Pressure switches type DG 3.., DG 5E: [Page 266](#)

Plugs:

- With LEDs or to support the EMV
 or with economy circuit etc.: [D 7163](#)

Directional seated valves

2.2 2/2-way directional seated valve cartridges type EM, EMP and EMC

These 2/2-way ball seated directional valves are either directly or pilot actuated by a solenoid. With the directly actuated version the valve passage is opened or closed by a cone whereas with the piloted a piloting duct of a stepped piston is opened or closed generating a pressure difference at the opposing facial areas of the piston forcing it in the open or closed position. Type EMP is a proportional valve, acting like a throttle but with zero leakage in blocked position. The dampened version will increase the switching time for on/off controls (hydraulic ramp). The wet armature solenoids for the valve actuation are pressure resistant, where all moving internal parts are flushed by oil. There is a wide range of connection blocks either for pipe connection or for banjo bolt mounting, which may feature optional elements such as drain valve, by-pass throttle, pressure switch, 2-way flow control valve etc.

Features and benefits:

- Zero leakage in blocked state
- Directly switching up to approx. 3 lpm and piloted up to 160 lpm
- Minimized back pressure even at high flows
- Long service life due to hardened valve seats

Intended applications:

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

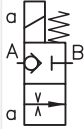
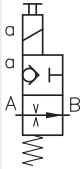
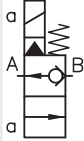
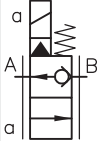
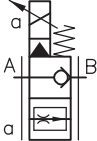
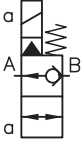
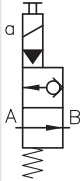
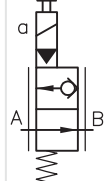
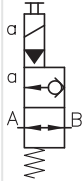


Nomenclature:	Directional seated valve, zero leakage
Design:	Screw-in valve Combination Combination with connection block for pipe connection Combination with connection block for swivel fitting Combination with connection block for manifold mounting
Actuation:	Solenoid
p _{max} :	450 bar
Q _{max} :	1 ... 160 lpm

Design and order coding example

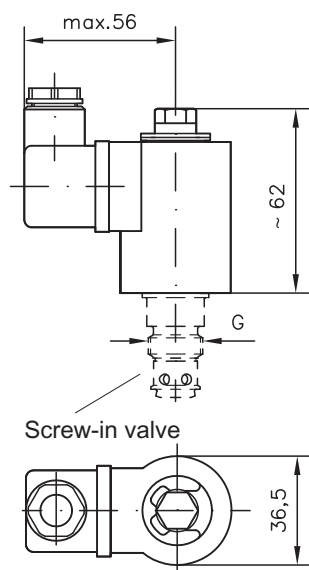
EM 21	V	- 3/8	- G24
			Solenoid voltage
			12V DC, 24V DC, 110V AC, 230V AC
			Versions with
			■ Versions with M12-plug and 8-Watt solenoid
			■ Quarter-turn plug, plugs of Co. KOSTAL or AMP
		Connection blocks	Versions with
			■ Drain valve
			■ Drain valve and drop-rate braking valve
			■ Drain valve 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: ON/OFF-valve, size 1 to 4
			■ Type EMP: Prop. valve, size 1 to 4
			■ Type EMC: proportional valve, load compensated, size 3

Function

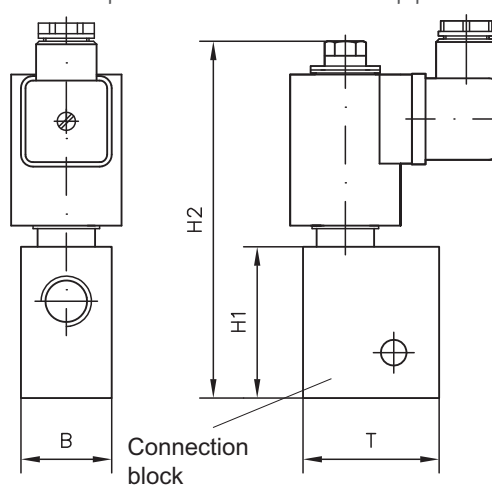
	Flow in arrowed direction				Arbitrary flow direction	Flow in arrowed direction				Arbitrary flow direction
	Energized open					Energized closed				
Directly actuated	EM .1 D 					EM .1 DS 				
Pilot actuated	EM .1 V 	EMP .1 V 	EMC .31 V 	EM .2 V 		EM .1 S 	EMP .1 S 	EM .2 S 		

General parameters and dimensions

Screw-in valve



Valve compl. with connection block for pipe connection



			Screw-in valve		Valve with connection block					
	Q _{max} [lpm]	p _{max} [bar]	G	m [kg]	Ports (BSPP)	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	

- 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. iron, light alloy).

Example circuit:

KA 442 LFK/HH 13.1/13.1

-SS-A 1 F 3/200

-BA 2

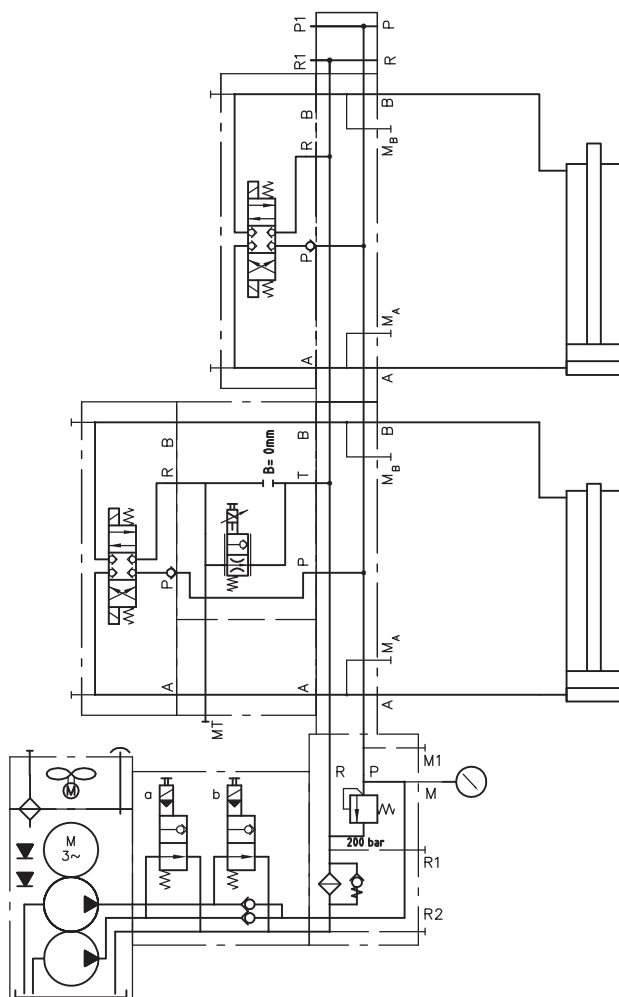
-NBVP 16 G/R-GM/NZP 16 TSPG/TB 0/3

-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 104](#)
- Lifting/lowering valves type HSV: [Page 162](#)
- Lifting modules type HST, HMT etc.: [Page 166](#)

Associated technical data sheets:

- Directional seated valves type EM, EMP: [D 7490/1](#), [D 7490/1E](#)

Accessories:

- Pressure switches type DG 3.., DG 5E: [Page 266](#)
- Drop rate braking valve type SB, SQ, SJ: [Page 222](#)
- Suitable prop. amplifier type EV1M2 (module), EV1G1 (module) and EV1D (module): [Page 276](#)

Plugs:

- With LED etc.: [D 7163](#)
- With economy circuit: [D 7813](#), [D 7833](#)

See also section "Devices for special applications"

- Screw-in valves and installation kits

Seated valves

2.2

Directional seated valves type BVG, BVE, BVP and NBVP

The group of directional seated valves type BVG, BVE and BVP includes 2/2- and 3/2-way directional valves in two sizes. Size 1 valves feature a version with standard connection diagram NG 6 (type NBVP) and a version with 4/3-way function. They are designed as zero-leakage, cone seated valves. All ports are equally pressure-resistant due to an internal static pressure balance. The valves can be connected via pipes (type BVG), screwed onto self-manufactured base plates (type BVP) and industrial standard connection plates (type NBVP) or screwed into self-manufactured valve blocks as a screw-in valve (type BVE). The various actuation modes (type BVE with solenoid actuation only) enable use of these valves in a wide range of applications. Additional elements for ports P, R, A and B (e.g. orifices, check valves and restrictor check valves) can be incorporated in the valve block to tailor the range of possible applications to the special requirements of the customer.

By retracting the spring, the zero or neutral position is automatically adopted when in a non-actuated state. With solenoid actuation, the detented version adopts the home or switching position via a brief control impulse from the solenoid located opposite.

Features and benefits:

- Zero-leakage, cone seated construction
- Pressure switch can be directly mounted
- Complete system solution with compact hydraulic power packs made from the modular system
- ATEX-compliant version

Intended applications:

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



Nomenclature:	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... 300 lpm

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

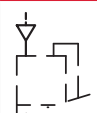
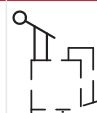
Function

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

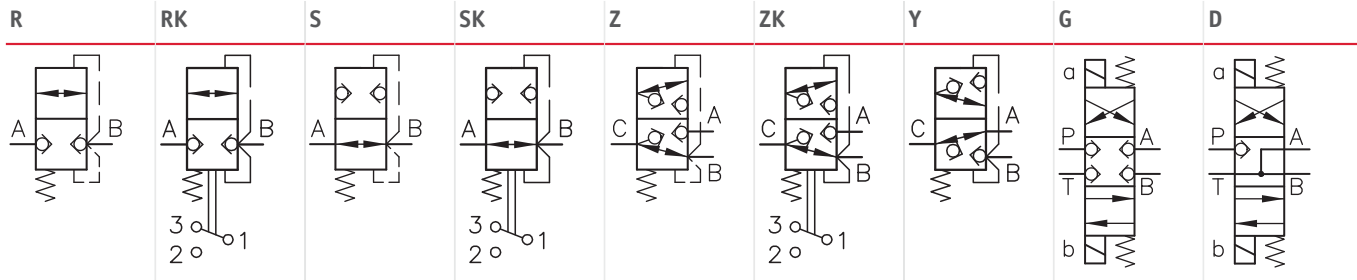
Basic type, size

Type BVG and BVP, size 1 and 3
 Type BVE, size 1, 3 and 5
 Type NBVP (with standard connection diagram NG 6), size 1

Actuations:

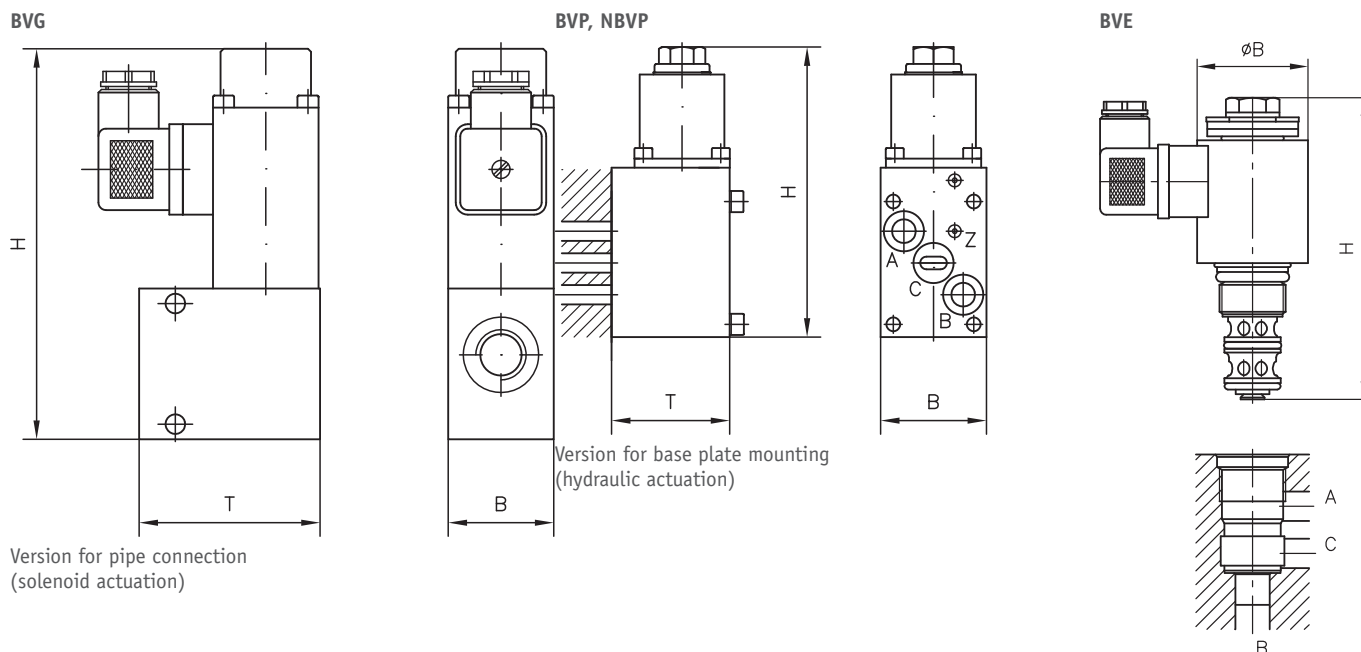
Solenoid	Hydraulic	Pneumatic	Manual
 Solenoid voltages: 12V DC, 24V DC, 110V AC, 230V AC ■ BVP 1, NBVP16 also available in ATEX-compliant version ■ Version with M12 plug and 8-watt solenoid	 Control pressure: $p_{\text{contr. min}} = 24 \text{ bar}$ $p_{\text{contr. max}} = 320 \text{ bar}$	 Control pressure: $p_{\text{contr. min}} = 2 \dots 3.5 \text{ bar}$ $p_{\text{contr. max}} = 15 \text{ bar}$	 Actuation torque: approx. 1.5... 3 Nm

Function



- Additional flow pattern symbols available
- **G, D:** only type NBVP16

General parameters and dimensions



	Q_{max} [lpm]	p_{max} [bar]	Ports (BSPP)	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
BVG 3	50	320	G 1/2	145	80	50	3.3
BVP 3				155	50	76	2.4
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

¹⁾ with solenoid actuation GM.. and WGM

- BVE 3: screw-in valve, also available with connection block for pipe connection

Associated technical data sheets: Directional seated valves

- Type BVG, BVP: [D 7400](#)
- Type BVG1, BVP1: [D 7765](#)
- Type BVE: [D 7921](#)
- Type NBVP: [D 7765 N](#)

Products:

- Type BA: [Page 34](#)
- Type NZP: [Page 34](#)
- Type BVH: [Page 40](#)

Plugs:

- With LED etc.: [D 7163](#)
- With economy circuit: [D 7813](#), [D 7833](#)

Seated valves

2.2

Directional seated valves type VP

Type VP 1 valves are designed as zero-leakage, cone-seated valves and can be used as 2/2-, 3/2- and 4/2-way directional valves. The internal pressure balance enables free selection of the flow direction and maximum pressure resistance of all ports. Due to the air-switching actuation, there is no risk of interaction between actuation elements and the medium used. No sticking or resinification as a result of increased temperatures is possible.

The preferred area of application is hydraulic lubrication systems that use high-viscosity grease or oils. Other fluids in the relevant viscosity range can also be considered provided they have the appropriate seal compatibility.

Features and benefits:

- Freely selectable flow direction
- No interaction between actuation elements and medium
- No sticking or resinification as a result of increased temperatures is possible.

Intended applications:

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



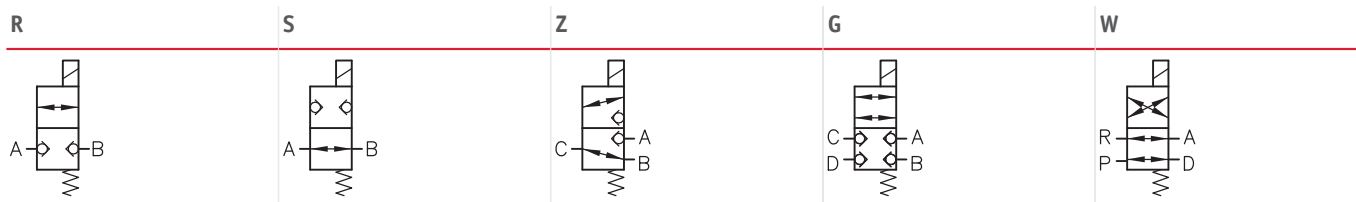
Nomenclature:	Directional seated valve, zero leakage
Design:	Manifold mounting
Actuation:	Solenoid Hydraulic Pneumatic
p _{max} •	400 bar
Q _{max} •	15 lpm

Design and order coding example

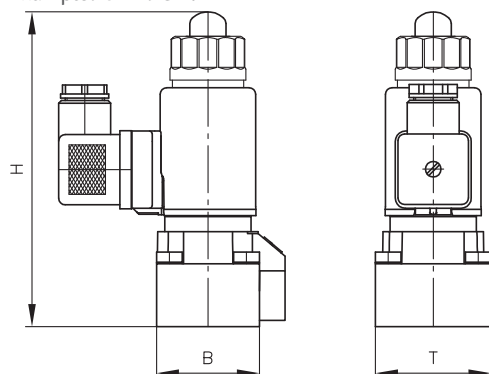
VP1	- R	- 3/4	- G24
			Actuation ■ Solenoid ■ Mechanical: roller, feeler ■ Manual: lever, turn-knob
			Optional connection block For direct pipe connection
	Function	2/2-way directional seated valve (R, S) 3/2-way directional seated valve (Z) 4/2-way directional seated valve (W, G)	
Basic type, size	Type VP, size 1 ■ Versions conforming ATEX		

Actuation:

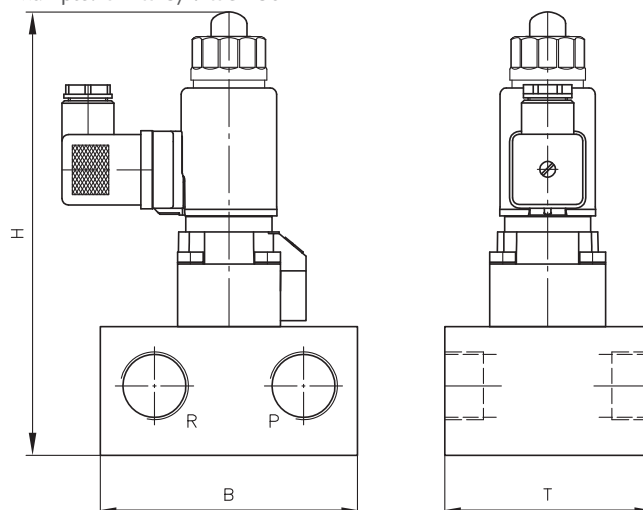
Solenoid	Hydraulic	Pneumatic
		
Solenoid voltage: 12V DC; 24V DC; 110V AC, 230V AC	Control pressure: p _{control min} = 24 bar p _{control max} = 320 bar	Control pressure: p _{control min} = 2 ... 3.5 bar p _{control max} = 15 bar

Function

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 (BSPP)	Dimensions [mm]			m_{max} [kg]
				H_{max}	B_{max}	T_{max}	
VP 1	15	400	A, B, C 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} : Figures apply to solenoid actuation

Associated technical data sheets:

- Directional seated valves type VP: [D 7915](#)

Similar products:

- Directional seated valves type BVG1, BVP1, BVE, NBVP16:
[Page 156](#)

Plugs:

- With LEDs or
 to support the EMV etc.: [D 7163](#)
- With economy circuit: [D 7813](#), [D 7833](#)

Seated valves

2.2

Lifting/lowering valves type HSV

The lifting/lowering valves type HSV are preferentially used for controlling lifting equipment with single-acting cylinders. The valve block combines the functions of a 2/2-way directional seated valve with solenoid actuation for lowering the raised load. It is optionally available with an adjustable throttle to limit the lowering speed or a 2-way flow control valve to guarantee the lowering speed is as load-independent as possible. A pressure-limiting valve is incorporated to limit the permissible load. An additionally installed check valve prevents uncontrolled lowering of the load. Flange-mounting on self-manufactured connection plates is possible.

Features and benefits:

- Optimal 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 construction
- Mining machinery



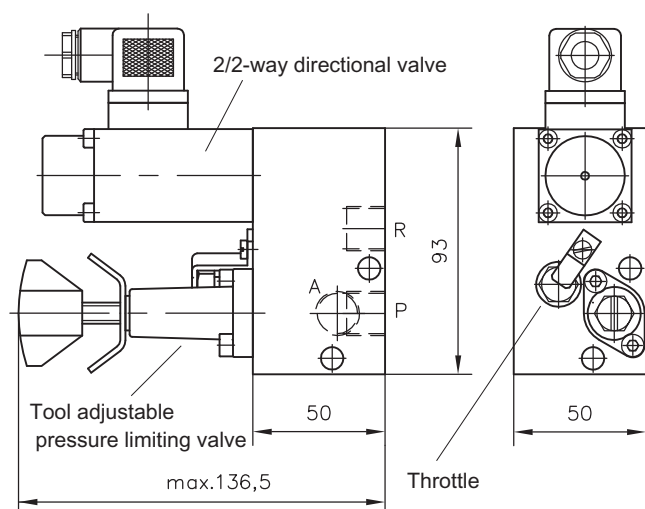
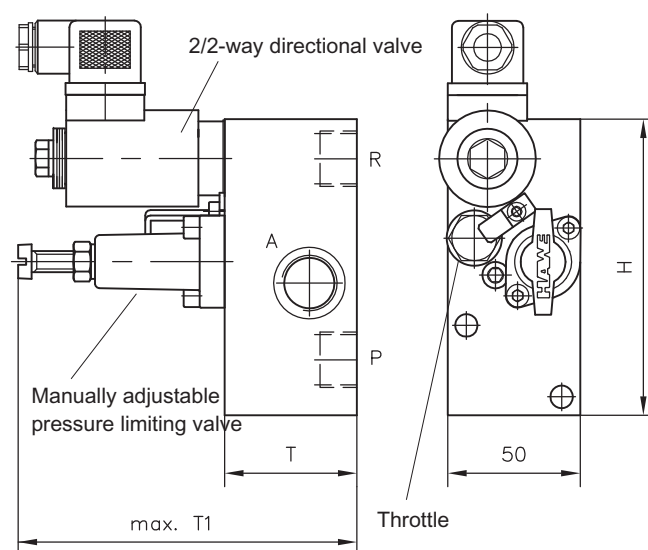
Nomenclature:	Valve combination consisting of: ■ 2/2-way directional seated valve, solenoid actuated ■ Pressure-limiting valve ■ Check valve optional ■ Throttle or 2-way flow control valve
Design:	Individual valve for pipe connection
Actuation:	Solenoid
p _{max} :	315 ... 400 bar
Q _{max} :	20 ... 120 lpm

Design and order coding example

HSV41	- R1	- R-150	- G24
			Solenoid voltage
			12V DC, 24V DC, 110V AC, 230V AC
			HSV 21 and HSV 22 version conforming ATEX
		Pressure limiting valve	Manually or tool adjustable, pressure setting in bar
	Function		
Basic type, size	Type HSV, size 2, 4, 6 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 41 HSV 61 HSV 71						

General parameters and dimensions
HSV 21 and HSV 22

HSV 41 and HSV 71


	Q_{max} [lpm]	p_{max} [bar]	Ports (BSPP)		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 41	40	400	G 1/2	G 1/2	112	50	140	2.2
HSV 61	60	350	G 1/2	G 1/2	100	63	166.5	2.5
HSV 71	120	315	G 3/4	G 3/4	100	80	160	3.1

Associated technical data sheets:

- Lifting/lowering valves type HSV, HZV: [D 7032](#)

Plugs:

- With LEDs or to support the EMV etc.: [D 7163](#)
- With economy circuit: [D 7813](#), [D 7833](#)

Seated valves

2.2

Switch units (press control valves) type CR

The switch units type CR, available in three sizes, are intended for the control of bottom and top ram presses, which are driven by dual stage pumps. They consist of a 2/2-way ball seated directional valve, a ball type check valve and pressure valves. Low pressure and high pressure circuit are joined during rapid transverse, as soon as the set pressure is achieved or exceeded the low pressure circuit is switched in idle circulation mode, whereas the high pressure circuit continues feeding the press cylinder. An automatic pre-release ensures decompression without pressure surges. These switch units are designed for direct mounting onto our hydraulic power packs type MP and RZ.

Features and benefits:

- Optimized for the controls of bottom ram 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

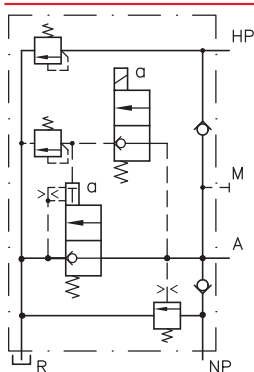
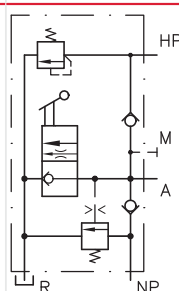


Nomenclature:	Valve combination consisting of: ■ 2/2-directional seated valve ■ Ball-type check valve ■ Pressure valve
Design:	Individual valve for pipe connection
Actuation:	Solenoid Manual
p _{max} :	HP 400 bar LP 30 ... 60 bar
Q _{max} :	HP 8 ... 20 lpm LP 80 ... 160 lpm A → R 160 ... 300 lpm

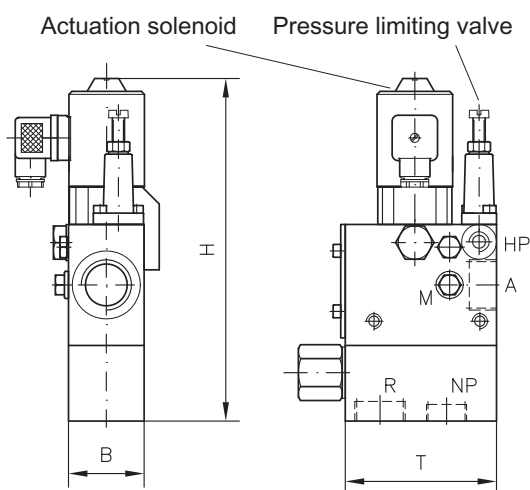
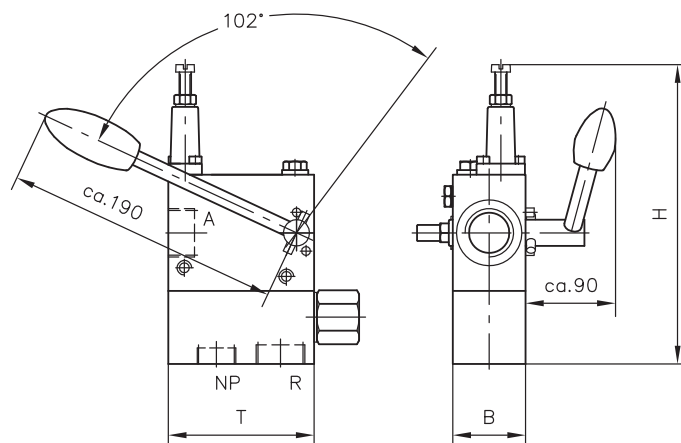
Design and order coding example

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 and CR 5M

CR 4H


General parameters and dimensions

CR 4M

CR 4H


	Q_{max} [lpm]			p_{max} [bar]		Ports (BSPP)				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	30 ... 60	G 1	G 1/4	G 3/4	G 1/4	max. 247.5	50	100	5.2
CR 4H	8	80	200	400	30 ... 60	G 1	G 1/4	G 3/4	G 1/4	max. 202	50	100	4.7
CR 5M	20	160	300	400	30 ... 60	G 1 1/4	G 3/8	G 1	G 1/4	max 277.5	63	135	10.0

Associated technical data sheets:

- Switch units type CR: [D 7150](#)

Similar products:

- Two-stage valves type NE: [Page 206](#)

Hydraulic power packs:

- Hydraulic power packs type RZ: [Page 62](#)
- Compact hydraulic power packs type MP, MPN, MPNW, MPW: [Page 22](#)

Plugs:

- With LEDs or to support the EMV etc.: [D 7163](#)

See also section "Devices for special applications"

- Press controls
- Devices for up to 700 bar

Seated valves

2.2

Lifting modules and lifting/lowering valves type HMB, HMC, HMT, and HSV, HZV etc.

They are a combination of different valves (flow control valves, throttles, directional valves) for main lift and, in some cases, other additional functions. The lifting modules and lifting/lowering valves are for controlling lifting devices, especially high-rack stackers, order pickers, reach trucks and mobile lifting units. The design of the internal control system is extremely flexible. This enables solutions that are not only precisely tailored to the relevant drive concept (fixed or variable displacement pump) and the customer-specific application, but also affordable.

Control systems for secondary or additional functions can be achieved using directional seated valves or directional spool valves (type SWR or SWS). These valves are directly flange-mounted to the main valve in the form of mounting blocks, therefore making the whole valve combination extremely space-saving.

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 construction



Nomenclature:	Valve combination according to type consisting of: ■ 3-way flow control valves ■ 2-way flow control valves ■ 2-way seated valves ■ Directional spool functions
Design:	Valve bank
Actuation:	Solenoid
p _{max} :	315 bar
Q _{max} :	120 lpm

Design and order coding example

HMT34	- 1/200	- FH5N5	- 30EP12/G24	
			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		Diverse intermediate blocks for rotating/extending fork for high rack stackers; Function rotating/stifting/lifting/lowering 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 ■ With flow divider ■ With/without pressure limiting valve ■ With shut-off valve for P and H (lift)
Basic type	Lift modules and lifting/lowering valves			

Drive concept an field of application:

	Drive concept			Application					
	1	2	3	Scissor lift	Miniature stacker, Walkie stacker	Counter balance truck	Reach truck	Order picker (warehouse)	
								no man aloft	man aloft
HSV	x			x	x				
HZV	x			x	x				x
HSN			x					x	x
HST	x	x			x	(x)		x	x
HMB	(x)	x			(x)			x	x
HMC	x				(x)				x
HMT		x				x	x	x	x
HMS	x	x	x					x	x
HMF	x	x	x					x	x
HMR		x	x					x	x
SWR..SE	x	x					x	x	x
HSW	x				x				

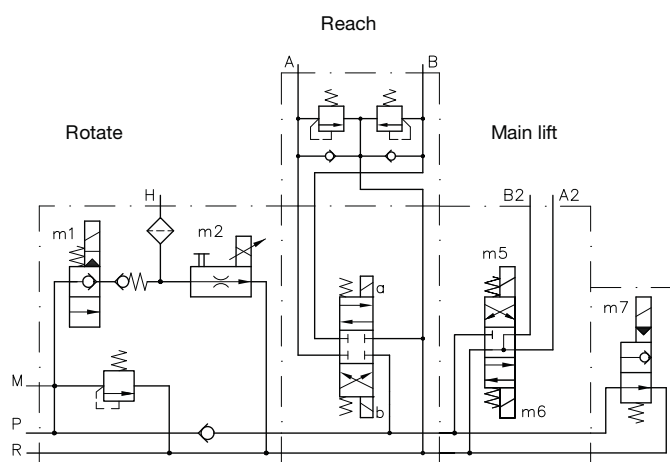
Drive concept:

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

Circuit examples:

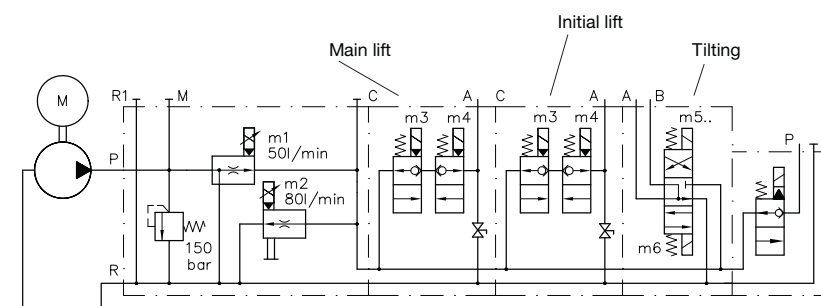
HMT 34-1/200-70F -G/M/0/2 AN40 BN130 -D/M/0/02 -30E-P12/G 24

Lifting module type HMT, size 3, port size 4 with pressure limiting valve (set for 200 bar), outflow controller with 70 lpm metering throttle (blocked in idle position); section G with shock and suction valves is part of the ancillary block (settings 40 and 130 bar); end plate with idle circulation valve (open in idle position), proportional-solenoid voltage for the flow control valve 12V DC, solenoid voltage for directional spool valve and directional seated valves 24V DC



HMC 33-1/150-50/80F-T3 T3/D-20E-G 24

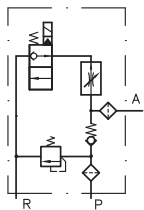
Lifting module type HMC, size 3, port size 3 (G 3/4 (BSPP)) with pressure limiting valve (set for 150 bar), 3-way flow control valve with metering throttle up to 50 lpm, 2-way flow controller up to 80 lpm (blocked in idle position), two intermediate blocks type T3 with seated valves and one directly added directional spool valve section type SWR 2 flow pattern D, end plate with additional port P and R as well as a shut off valve for port P, solenoid voltage 24V DC



Function

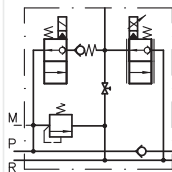
Single devices:

HSV

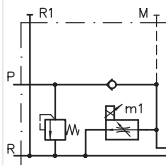


Lifting modules and connection blocks:

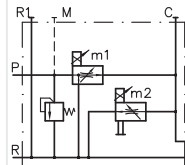
HST



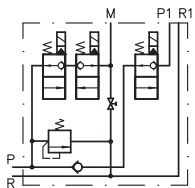
HMB



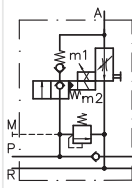
HMC



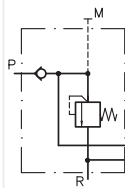
HSN



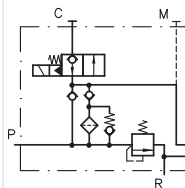
HMT



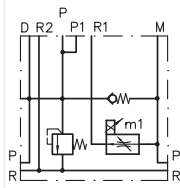
HMS



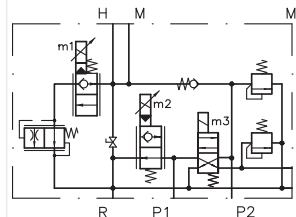
HMF



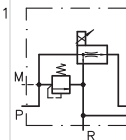
HMR



HSW



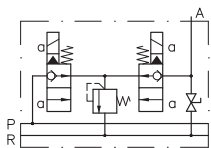
SWR



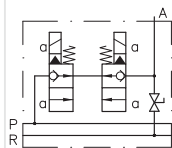
Intermediate blocks (main and initial lift):

Size 2

T 23

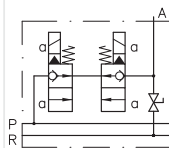


T 2

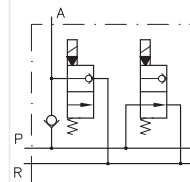


Size 3

T 3, T 34, T 44



T 25



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

End plates:

Size 1 and 2

1



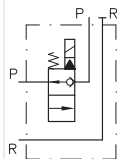
Size 1 and 2

2



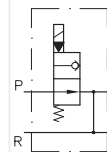
Size 2

20E



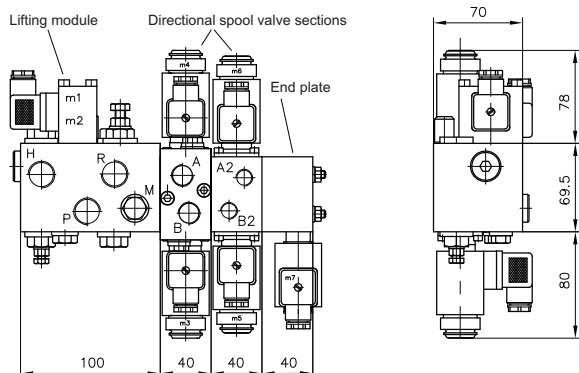
Size 2

30E

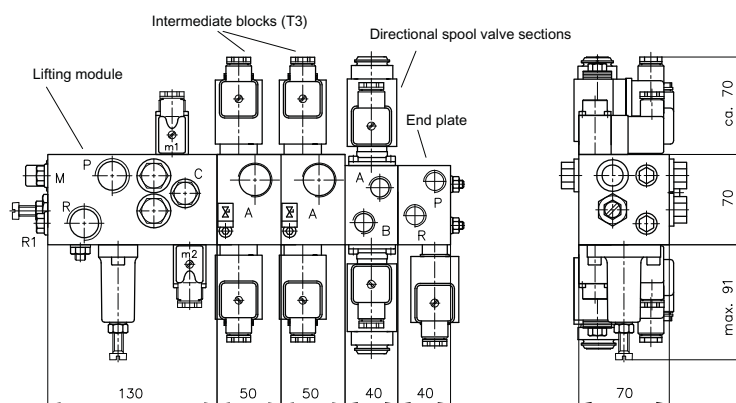


General parameters and dimensions

HMT 34 ...



HMC 33 ...



	Q _{max} [lpm]	p _{max} (bar)	Note	Ports (BSPP)
HSV 21	20	315 ... 400	Individual device	P, R, A = G 3/8
HSV 22	30			P = G 3/8; A, R = G 1/2
HSV 41	40			P, R, A = G 1/2
HSV 61	60			P, R, A = G 1/2
HSV 71	160			P, R, A = G 3/4
HSN	50 -100			H, R = G 3/4; P1 = G 3/8; P = (flange connection)
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
HMB 2	30			P, R = G 1/2; M = G 1/4
HMB 33	90			P, R = G 3/4; M, R1 = G 1/4
HMC 2	30			P, R, A = G 1/2; M = G 1/8
HMC 3 (33)	90			P, R = G 3/4; M, R1 = G 1/4; C = 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
HMS 4	100			R = G 3/4; C, R1 = G 3/8; M = G 1/4
HMF 4	100			R = G 3/4; C, R1 = G 3/8; M = G 1/4
HMR 4	100			P, R1, R 2 = G 3/4; P1, D = G 3/8; M = G 1/4
HSW 2	25			H, R = G 1/2; P1, P 2 = G 3/8; M = G 1/8
SWR 1 SE	12			P, R, R1 = G 1/4; M = G 1/8
SWR 2 SE	25			P, R = G 3/8; M = G 1/4

- HMB 2, HMC 2, SWR 1 SE: Hole pattern SWR 1, T2; adaptor plates from X12 to SWR 2
- SWR 1 SE, SWR 2 SE: also for external additional functions

Associated technical data sheets:

- Type HMC: [D 7650](#)
- Type HMT: [Sk 7758 HMT](#)
- Type HMB: [Sk 7650 B2](#), [Sk 7650 B33](#)
- Type HST: [Sk 7650 HST ff](#)
- Type HSW: [Sk 7650 HSW](#)
- Type HTML: [Sk 7982 HTML](#)

Information on additional lifting modules on inquiry

Similar products:

- Type SWR, SWS 2: [Page 88](#)
- Connection blocks type HMPL and HMPV: [Page 104](#)

Plugs:

- With LED's and others: [D 7163](#)
- With economy circuit: [D 7813D 7833](#)

See also section "Devices for special applications"

- Devices for industrial trucks and hoists

Seated valves

2.2

Directional seated valves type VH, VHR and VHP

The directional seated valves types VH, VHR and VHP operate leakage free and are available in two different sizes. They are operated via a hand lever on an eccentric shaft transferring the switching moment to an actuation pin acting on the valve elements (balls). The actuation either features a detent or is self returning to its idle position. Valve banks type VHR are also available, featuring individual valves (type VH) connected in parallel and held together with tension rods. Valves type VHP size 1 is also available as individual manifold mounting version.

Features and benefits:

- Max. pressure 700 bar (manual actuation)
- 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

- Machines for construction and construction material
- Offshore and marine technology
- Process engineering systems
- Oil hydraulics and pneumatics



Nomenclature:	Directional seated valve, zero leakage
Design:	Individual valve for pipe connection Individual valve, manifold mounting, bankable
Actuation:	Manual
p _{max} :	500 ... 700 bar
Q _{max} :	12 ... 25 lpm

Design and order coding example

VH 1	H1
VHR 1	G1/N1/E1

Function/valve sections with actuation

Hand lever with automatic return (1) or detent (2)

Additional versions:

- Actuation with idle position monitoring via contact switch, available either as indiv. valve or valve bank

Basic type, size

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

Actuations:

Return spring	Detent	
		Symbol type VHR..

- Return spring: The automatic return is limited to operating pressure of 50 bar. The hand lever has to be returned manually at operating pressure between 50 ... 700 bar.

Function

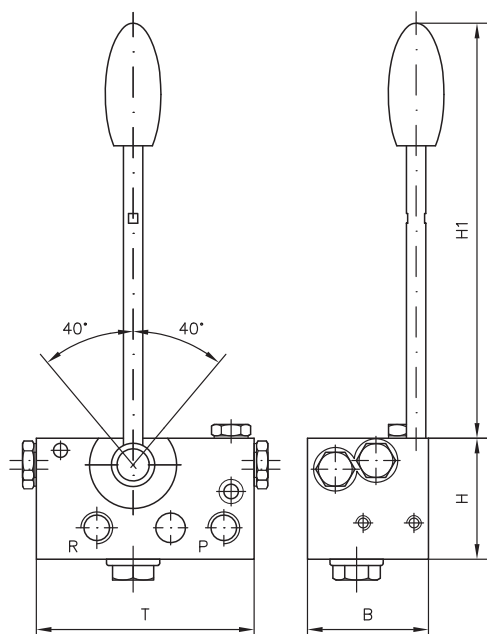
Basic symbols

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

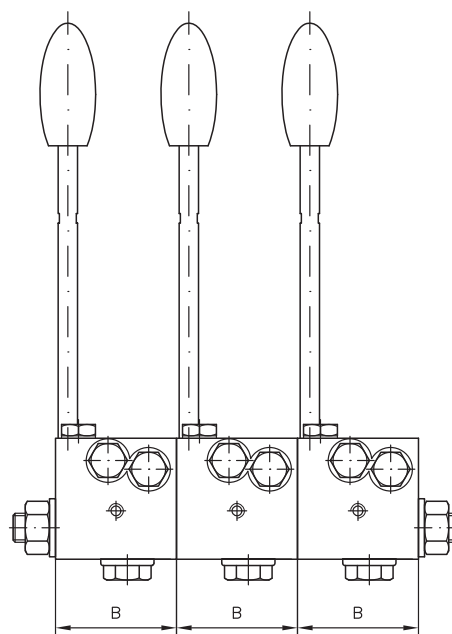
- Max. 7 or 5 valves for type VHR, (size 1 or 2) may be combined
- Type L and S individual valve only, not for type VHR

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	approx. 172	50	90	1.6
VH 2, VHR 2	25	500	G 3/8	60	approx. 162	60	120	3

Associated technical data sheets:

- Directional seated valves type VH, VHR, VHP: [D 7647](#)

Similar products:

- Directional seated valves type BVG 1, BVP 1, NBVP 16: [Page 156](#)
- Shut-off valves type DA, EA: [Page 172](#)

See also section "Devices for special applications"

- Devices for up to 700 bar

Seated valves

2.2

Shut-off valves type DA and EA

The shut-off valves types DA and EA are of ball seated design and are available in two sizes. They are used in hydraulic systems for blocking the flow in one or both directions. They are available with hand lever or with eccentric shaft for customer furnished hand lever. Both versions can be ordered either with or without detent.

Features and benefits:

- Zero leakage blocking of a hydraulic line
- Pressures up to 500 bar manually switchable
- Flows up to 150 lpm
- Single or double-blocking

Intended applications:

- Rolling mill equipment
- Shipbuilding
- Construction and construction materials machinery
- Mining machinery



Nomen-clature:	Directional seated valve, zero leakage
Design:	Individual valve for pipe connection
Actuation:	Manual
p _{max} :	500 bar
Q _{max} :	60 ... 150 lpm

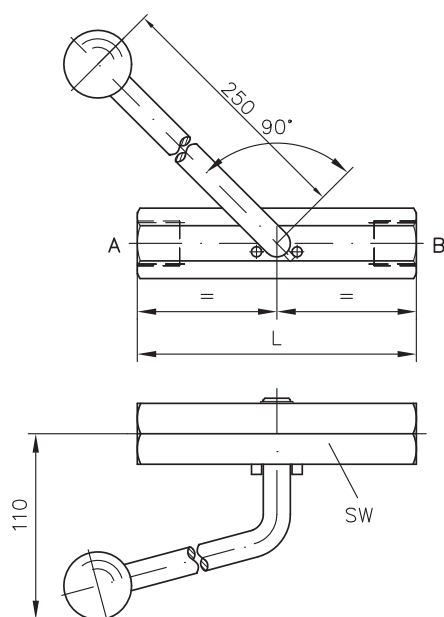
Design and order coding example

EA 3

Basic type, size Type DA (doppeltwirkend) size 2, 3, Typ EA (einfachwirkend), size 2, 3

Function

DA 2	EA 2	DA 2B	EA 2B	DA 3	EA 3
	With hand lever		Without hand lever		Hand lever with detent

General parameters and dimensions
DA 3


	$Q_{\max}$ [lpm]	$p_{\max}$ [bar]	Ports (BSPP)	Dimensions [mm]		m [kg]
			A, B	L	SW = a/f	
DA 2, EA 2	60	500	G 3/4	165	SW 36	1.3 - 1.5
DA 2B, EA 2B	60	500	G 3/4	165	SW 36	1.3 - 1.5
DA 3, EA 3	150	500	G 1	200	SW 50	3.0 - 3.2

Associated technical data sheets:

- Shut-off valves type DA, EA: [D 1741](#)

Similar products:

- Directional seated valves type VH, VHR, VHP: [Page 170](#)

2.3 Pressure valves

Directly controlled pressure limiting and sequence valves type MV, SV	178
Pressure limiting valves type CMV and CSV	182
Piloted pressure limiting valves type DV, AS etc.	184
Sequence valves with check valve type VR	186
Proportional pressure limiting valves type PMV and PDV	188
Miniature pressure reducing valves type ADC, AM etc.	190
Pressure reducing valves type ADM and VDM	192
Pressure-reducing valves type CDK, CLK, DK, DLZ and DZ	196
Miniature proportional pressure reducing valves type PM	200
Proportional pressure reducing valves type PDM	202
Circulation valve type CNE	204
Two stage valves type NE	206
Shut-off valves type LV and ALZ	208
Pressure controlled shut-off valves type DSV and CDSV	210
Load holding valves type LHK, LHDV, and LHT	212



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}	Q _{max}
MV, SV	■ Individual valve for pipe connection or manifold mounting ■ Screw-in valve, assembly kit	- Tool adjustable - Manually adjustable	700 bar	5... 160 lpm
CMV(Z), CSV(Z)	■ Screw-in valve ■ Directly controlled	- Tool adjustable - Manually adjustable	500 bar	60 lpm
DV, AS	■ Individual valve for pipe connection or manifold mounting	- Tool adjustable - Manually adjustable	420 bar	120 lpm
VR	■ Insert valve ■ Version with housing	- Tool adjustable	315 bar Δp _{max} : 15 bar	120 lpm
PMV, PDV	■ Individual valve for pipe connection or manifold mounting	- Electro-proportional	700 bar	120 lpm

Pressure-reducing valves (also proportional)

Type	Design	Adjustability	p _{max}	Q _{max}
ADC, AM	■ Screw-in valve ■ for pipe connection	- Tool adjustable	p _{max P} : 300... 400 bar p _{max A} : 15... 100 bar	2... 10 lpm
ADM, VDM	■ Individual valve for pipe connection or manifold mounting ■ Directly controlled or piloted	- Tool adjustable - Manually adjustable	p _{max P} : 300 - 400 bar p _{max A} : 250 - 400 bar	120 lpm
CDK, CLK, DK, DLZ, DZ	■ Screw-in valve (2-way principle) ■ Combination with connection block	- Tool adjustable - Manually adjustable	500 bar	22 lpm
PM	■ Assembly kit ■ Individual valve for manifold mounting	- Electro-proportional	p _{max P} : 40 bar p _{max A} : 19 bar	approx. 2 lpm
PDM	■ Individual valve for pipe connection or manifold mounting	- Electro-proportional	p _{max P} : 400 bar p _{max A} : 5 - 350 bar	120 lpm

Externally pressure-controlled relief valves (switch-off, follow-up valves)

Type	Nomenclature/Design	Adjustability	p _{max}	Q _{max}
CNE 2	■ 2-way idle circulation valve ■ Screw-in valve	- Tool adjustable	500 bar p _{max} adjust: 450 bar	30 lpm
NE	■ Two-stage valve (high-pressure/low-pressure stage) ■ Individual valve for pipe connection	- Tool adjustable	500... 700/ 30...80 bar	25/ 180 lpm
LV, ALZ	■ Shut-off valve (idle circulation valve, directly controlled or piloted) ■ Individual valve for pipe connection or manifold mounting	- Tool adjustable - Manually adjustable	350 bar	120 lpm
DSV, CDSV	■ Individual valve for pipe connection or manifold mounting ■ Screw-in valve	- Tool adjustable - Manually adjustable	600 bar	60 lpm

Load-holding valves

Type	Nomenclature/Design	p _{max}	Q _{max}
LHK, LHDV, LHT	Load-holding valve, over centre valve ■ Individual valve for pipe connection or manifold mounting ■ Screw-in valve, version for banjo bolt mounting	360... 450 bar	250 lpm

Pressure valves

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

Pressure valves influence the pressure in hydraulic systems. Pressure-limiting valves (safety or overpressure valve) safeguard the system against excessive pressure or limit the operation pressure. Sequence valves generate a constant pressure difference between the inlet and outlet flow. A damping device is fitted as standard in the directly controlled valves to ensure quiet operation, but an undamped variant is also available for special operating conditions. Pressure-limiting valves with unit approval and CE mark (type MV.X) are also available.

Features and benefits:

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

Intended applications:

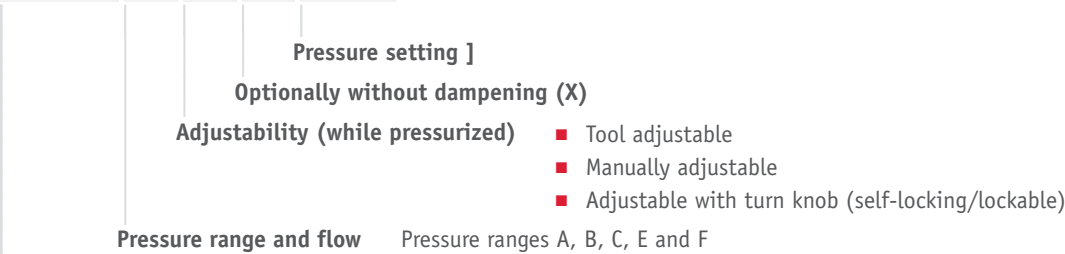
- General hydraulic systems
- Test benches
- Hydraulic tools



Nomenclature:	Pressure limiting valve, sequence valves (directly controlled)
Design:	Individual valve for pipe connection Screw-in valve Individual manifold mounting valve Assembly kit
Adjustment:	Tool adjustable Manually adjustable
p_{max}:	700 bar
Q_{max}:	5 ... 160 l/min

Design and order coding example

MVS 52 B R X - 650

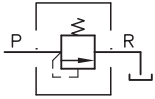
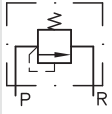
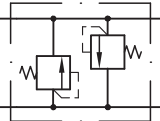
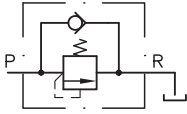


Basic type, size Type MV.., DMV.. and SV..

Additional versions

- Multiple pressure limiting valves (2, 3, 4, 5 valves in parallel)
- 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)

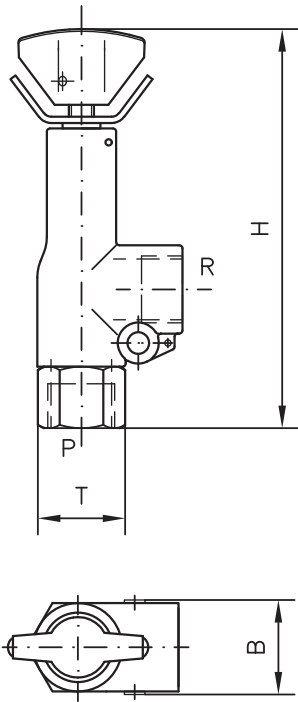
Function

	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 return flow 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

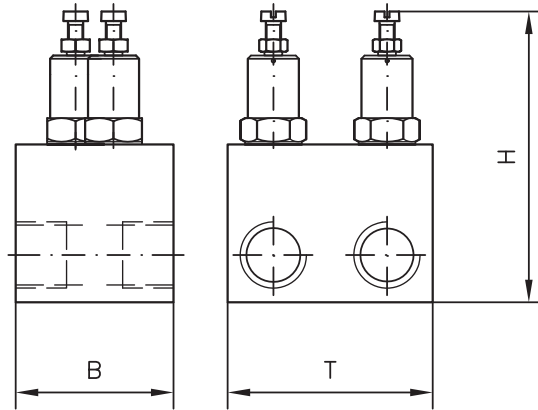
- 1) Only size 4, 5, 6, and 8
 Type MVG and MVGC only size 13 and 14

General parameters and dimensions

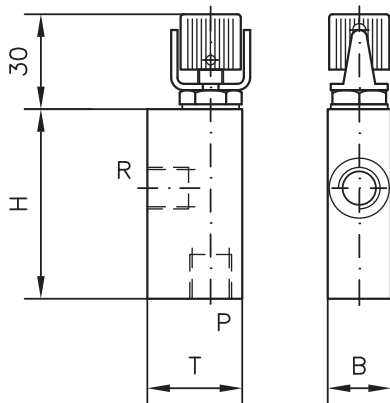
MV, MVS



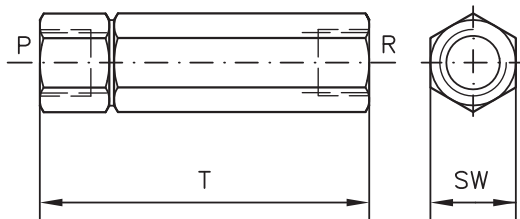
DMV



MVG



SV, SVC



See following table for dimensions

	Size	Dimensions [mm]			m [kg]	Size	Pressure range/ Flow	Ports (BSPP) 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	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 valves type MV etc.: [D 7000/1](#)
- Miniature pressure limiting valves type MVGetc.: [D 3726](#)
- Pressure limiting valves (assembly kits) type MV: [D 7000 E/1](#)
- Multiple pressure limiting valves type MV: [D 7000 M](#)
- Pressure limiting valves with type approval (TÜV) type MVX etc.: [D 7000 TÜV](#)

Similar products:

- Screw-in pressure valves type CMV, CSV: [Page 182](#)
- Piloted pressure valves type DV: [Page 184](#)
- Piloted pressure valves type A: [Page 184](#)

See also section "Devices for special applications":

- Devices for up to 700 bar

Pressure valves

2.3

Pressure limiting valves type CMV and CSV

Pressure valves influence the pressure in hydraulic systems. Pressure-limiting valves (safety or overpressure valve) safeguard the system against excessive pressure or limit the operation pressure. Sequence valves generate a constant pressure difference between the inlet and outlet flow, where the flow in the opposite direction (return flow) is free via a bypass check valve.

One advantage of the valves described here is the easily produced mounting hole (see dimensions). Type CMV is also available as a CE-marked pressure-limiting valve with unit approval, e.g. as a safety valve for accumulators in accordance with Pressure Equipment Directive 97/23 EC. Types CMVZ and CSVZ are not influenced by the pressure conditions downstream and are therefore suitable for use in loss-free sequence control systems.

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



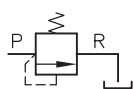
Nomenclature:	Pressure limiting valve, sequence valves (directly controlled)
Design:	Screw-in valve
Adjustment:	Tool adjustable Manually adjustable
p _{max} :	500 bar
Q _{max} :	60 lpm

Design and order coding example

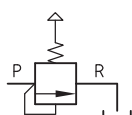
CMV 3	F	R	- 200	- 1/4
				Indiv. connection block for pipe connection
				Pressure setting [bar]
				Adjustability (while pressurized) Tool or manually adjustable
				Pressure range Pressure ranges B, C, E and F
Basic type, size	Type CMV (pressure limiting valve), size 1 to 3 Type CSV (pressure difference valve), size 2 to 3			
	Additional versions:			
	■ Sequence valves CMVZ or CSVZ			
	■ Version with unit approval type CMVX			
	■ Undamped version (CMV)			

Function

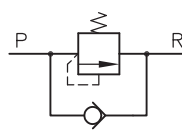
CMV



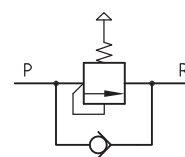
CMVZ



CSV



CSVZ

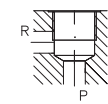
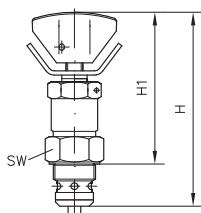


Pressure limiting valve (port R pressure resistant)

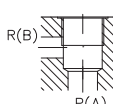
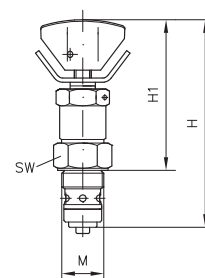
Sequence valves with by-pass check valve

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-limiting valves type CMV, CSV: [D 7710 MV](#)
- Pressure-limiting valves with unit approval type CMVX:
[D 7710 TÜV](#)

Similar products:

- Pressure-limiting valves type MV, SV etc.: [Page 178](#)
- Miniature pressure-limiting valves type MVG etc.: [Page 178](#)

- Piloted pressure valves type DV: [Page 184](#)
- Piloted pressure valves type AS: [Page 184](#)

See also section "Devices for special applications"

- Screw-in valves and installation kits
- Devices for up to 700 bar

Pressure valves

2.3

Piloted pressure limiting valves type DV, AS etc.

Pressure valves influence the pressure in hydraulic systems. Pressure-limiting valves (safety or overpressure valve) safeguard the system against excessive pressure or limit the operation pressure. Sequence valves generate a constant pressure difference between the inlet and outlet flow. Follow-up valves (release valves) block the flow until a set pressure value is reached (free flow once this value is exceeded). Compared with pressure valves of the type DV, the types AS and AE have an additional check valve in the consumer port.

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

- Intended applications:**
- General hydraulic systems
 - Test benches



Nomenclature:	Pressure limiting valve Sequence valve Follow-up valve (piloted)
Design:	Individual valve for pipe connection Individual valve manifold mounting
Adjustment:	Tool adjustable Manually adjustable
p _{max} :	420 bar
Q _{max} :	120 lpm

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

Tool adjustable 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



Pressure limiting,
sequence valve



Follow-up valve



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)



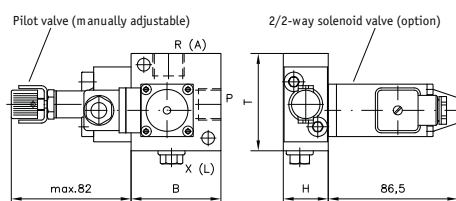
Pressure limiting
valve



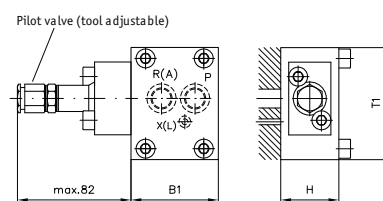
Release valve (remote
controlled), combined
function as pressure
limiting valve possible
(type ASE)

General parameters and dimensions

DV..G



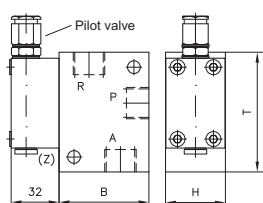
DV...P



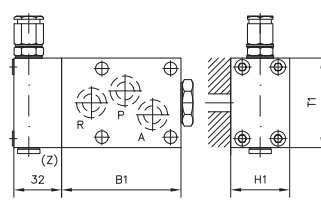
Type, size	Q _{max} [lpm]	Pressure range: p _{max} [bar]	Ports (BSPP)	Dimensions [mm]					m [kg] ¹⁾
DV, DVE, DF				H	B	B1	T	T1	
3	50	N: 100 H: 420	G 1/2	30	60	-	66	-	1,1 / -
4	80		G 3/4	40	65	60	71	78	1,5 / 2,0
5	120		G 1	50	80	88	73	81	2,0 / 2,5

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

A..G



A...P



Type, size	Q _{max} [lpm]	Pressure range: p _{max} [bar]	Ports (BSPP)	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:

- Piloted pressure valves type DV: [D 4350](#)
- Piloted pressure valves type AS, AE: [D 6170](#)

Similar products:

- Pressure limiting valves type MV, SV etc.: [Page 178](#)
- Miniature pressure limiting valves type MVG etc.: [Page 178](#)
- Pressure limiting valves type CMV(Z): [Page 182](#)

Pressure valves

2.3 Sequence valves with check valve type VR

Pressure valves influence the pressure within a hydraulic system. The type illustrated below is a sequence valves which generates a constant pressure difference between inlet and outlet of the flow. The flow in opposite direction (reflow) is unhindered via a by-pass check valve. This valve shows minor leakage like other spool valves in flow direction V → F.

These pre-load valves are used, for example, as drop protection in fork lift trucks, safeguarding the lifting cylinder during lowering to prevent continued travel if the fork accidentally gets caught (accident protection), or preventing undesired oscillations by increasing the back pressure when used as pre-load valve in return pipes.

Features and benefits:

- Compact screw-in valve

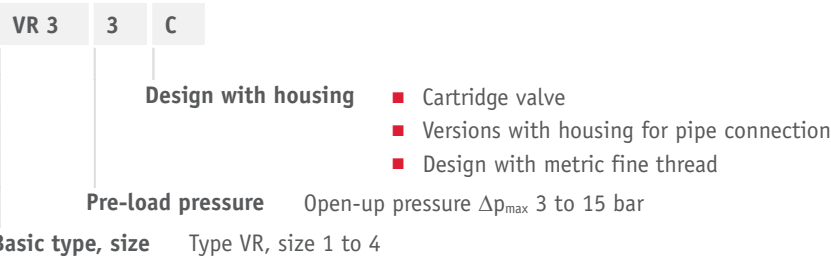
Intended applications:

- Industrial trucks
- Lifting devices



Nomenclature:	Sequence valve
Design:	Screw-in valve Combination with housing for pipe connection
Adjustment:	Fixed (non-adjustable)
p _{max} :	315 bar
Δp _{max} :	15 bar
Q _{max} :	120 lpm

Design and order coding example

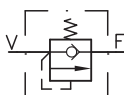


Function

VR



Screw-in valve

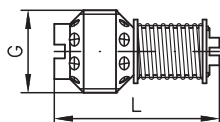


Version with housing for pipe connection

General parameters and dimensions

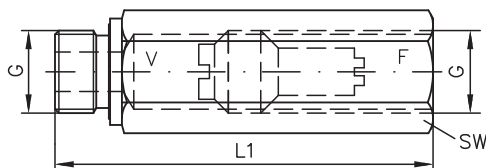
VR 3 3 C

Insert valve



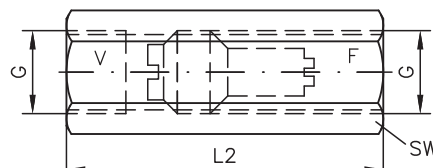
VR 4 9 E

Version with housing



VR 1 15 G

Version with housing



	$Q_{\max}$ [lpm]	$\Delta p_{\max}$ [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 be altered

2) Individual valve/design with housing

Associated technical data sheets:

- Sequence valves type VR: [D 7340](#)

Similar products:

- Pressure limiting valves type MV, SV etc.: [Page 178](#)
- Miniature pressure limiting valves MVG etc.: [Page 178](#)
- Piloted pressure valves type DV: [Page 184](#)
- Pressure limiting valves type CMV: [Page 182](#)

See also section "Devices for special applications":

- Industrial trucks
- Screw-in valves and installation kits

Pressure valves

2.3

Proportional pressure limiting valves type PMV and PDV

These pressure limiting valves are electrically remote controlled and rule the hydraulic pressure within the system. These pressure limiting valves are electrically remote controlled and safe guard the system against an excessive pressure whose value can be altered.

The valve series described here are directly controlled (type PMV) or piloted (type PDV). A minimum pressure of 3 bar or more is required for proper functioning of the integrated prop. pressure-reducing valve.

Features and benefits:

- Max. operating pressure 700 bar

Intended applications:

- General hydraulics
- Test benches



Nomenclature:	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 lpm

Design and order coding example

PDV4G	H	- G24
PMVP4	- 44	- G24

Nominal voltage of proportional solenoid 12V DC, 24V DC
Controls via prop. amplifier or PLVC

Pressure range [bar]

- Basic type, connection size Type PMV (pipe connection), type PMVP (manifold mounting)
- Optionally with separate control oil supply, i.e. pressure reduction right above 0 bar, no leakage in the main pump circuit (type PMVS, PMVPS)
- Type PDV
- Additionally with 2/2-way solenoid valves for arbitrary idle circulation

Function

PMV, PDV



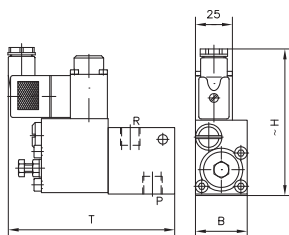
Pipe connection



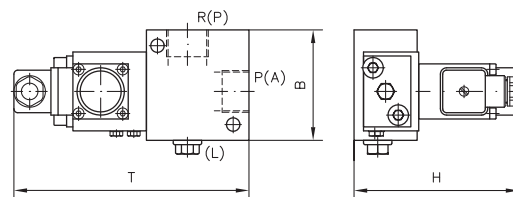
Manifold mounting valve

General parameters and dimensions

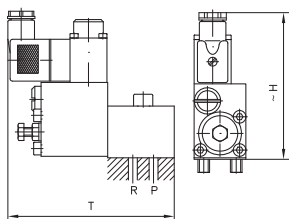
PMV



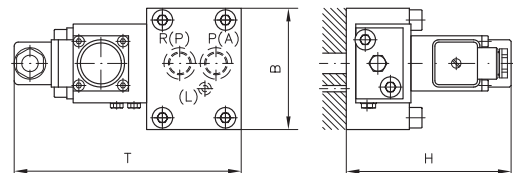
PDV..G



PMVP



PDV..P



	Size	Q _{max} [lpm]	Pressure range p _{max} [bar]	Ports (BSPP) 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	16... 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	60... 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	G 1/2	96	66	150	1.8
	4	80	M: 200	G 3/4	99.5	71/78	155/150	2,2/2,7
	5	120	H: 350	G 1	104.5	73/81	170/178	2.7/3.2

1) For pipe connection versions only

Associated technical data sheets:

- Prop. pressure limiting valves type PMV(S), PMVP(S): [D 7485/1](#)
- Prop. pressure valves type PDV: [D 7486](#)
- Type NPMVP: [D 7485 N](#)
- Type NZP: [D 7788 Z](#)

Electronic accessories:

- Prop. amplifier (module) type EV1M2: [Page 276](#)
- Prop. amplifier (module) type EV1D1: [Page 276](#)
- Prop. amplifier (card version) type EV 22K2: [Page 276](#)
- Programmable logic valve control type PLVC: [Page 278](#)

See also section "Devices for special applications"

- Proportional valves
- Devices for up to 700 bar

Pressure valves

2.3

Miniature pressure reducing valves type ADC, AM etc.

The task of pressure-reducing valves is to maintain a largely constant outlet pressure despite a higher and changing inlet pressure. These valves are used when a secondary circuit has to be fed with a lower but constant pressure level by a main (primary) oil circuit with a higher and varying pressure level. The valves mentioned here are suitable for the supply of control circuits with low oil consumption. There is a design-related permanent leakage flow, which has to be led back to the tank in a de-pressurized line via port R. A reversal of the flow direction is possible up to approx. 30% of Q_{max} . A bypass check valve has to be provided for higher reversed flow. These pressure-reducing valves feature an override compensation, i.e. acting like a pressure-limiting valve, if the pressure on the secondary side exceeds the set pressure e.g. due to external forces.

Features and benefits:

- Compact design
- Numerous configurations

Intended applications:

- For control oil supply in pilot circuits



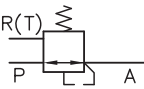
Nomenclature:	Pressure reducing valve
Design:	Screw-in valve Valve for pipe connection
Adjustment:	Fixed (non-adjustable)
$p_{max} P$:	300 ... 400 bar
$p_{max} A$:	15 ... 100 bar
Q_{max} :	2 ... 10 lpm

Design and order coding example

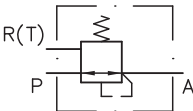
ADC 1	- 25	- 1/4
	Design	■ Cartridge valve ■ Design with housing for direct pipe connection ■ Version with housing for manifold mounting (type AM 11)
	Pressure downstream	Pressure at port A [bar]
Basic type	Type ADC, AM Type ADM, ADME ■ Type ADM 1 adjustable version available	

Function

ADC, AM, ADM, ADME



Screw-in valve

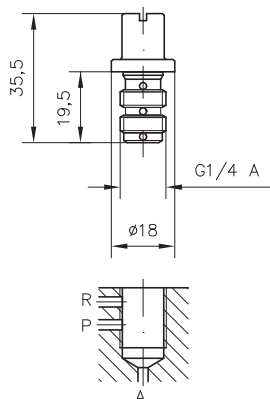


Pipe installation

General parameters and dimensions

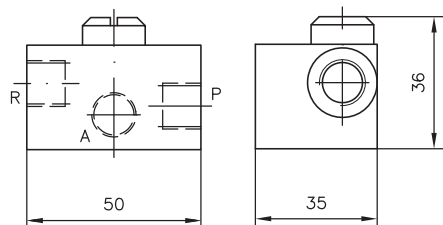
ADC 1-.25

Pressure reducing valve type ADC 1, screw-in valve, pressure at A approx. 25 bar

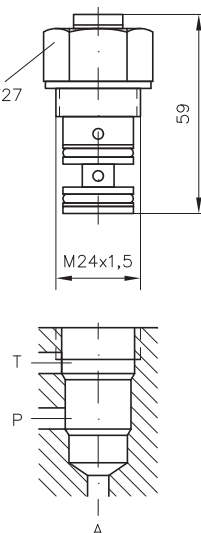


AM 1 - 20 -1/4

Pressure-reducing valve type AM 1, version for pipe connection (ports G 1/4 (BSPP)), pressure at A approx. 20 bar

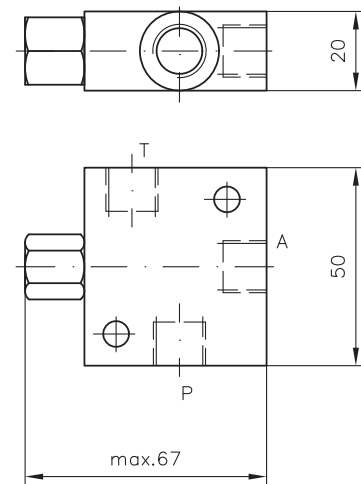


ADME 1-...



ADM 1-70

Pressure-reducing valve type ADM 1, version for pipe connection, pressure at A approx. 70 bar



	$Q_{\max}$ [lpm]	$p_{\max}$ [bar]	Outlet pressure [bar] at A	Ports (BSPP) 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:

- Miniature pressure-reducing valves type ADC etc.: [D 7458](#)

Similar products:

- Pressure-reducing valves type ADM, VDM: [Page 192](#)
- Pressure-reducing valves type CDK: [Page 196](#)

- Prop. pressure-reducing valves type PDM: [Page 202](#)
- Miniature prop. pressure-reducing valves type PM, PMZ: [Page 200](#)

See also section "Devices for special applications"

- Screw-in valves and installation kits

Pressure valves

2.3

Pressure reducing valves type ADM and VDM

The task of pressure reducing valves in a hydraulic circuit is to maintain a rather constant outlet pressure despite a higher and changing inlet pressure. These valves are usually used when a secondary circuit has to be fed with a lower but constant pressure level by a main (primary) circuit with a higher and varying pressure level. These valves are either directly controlled (type ADM) or hydraulically piloted (type VDM). There is a design related permanent leakage flow apparent at L, which has to be led back to the tank via a de-pressurized line. A reversal of the direction of flow is possible up to approx. 50% of Q_{max} . A by-pass check valve has to be provided for higher reversed flow. The pressure reducing valves type ADM feature an override compensation i.e. acting like a pressure limiting valve, if the pressure on the secondary side exceeds the set pressure e.g. due to external forces.

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 piloted)
Design:	Individual valve for pipe connection Individual valve Manifold mounting
Adjustment:	Tool adjustable Manually adjustable
$p_{max} P$:	300 ... 400 bar
$p_{max} A$:	250 ... 400 bar
Q_{max} :	120 lpm

Design and order coding example

ADM 22D R - 250

Pressure setting [bar]

Adjustability in operation

- Tool adjustable (-)
- Manually adjustable (R)
- Adjustable with turn knob (self-locking -V/lockable -H)

Pressure rangePressure ranges for outlet pressure at A

Basic type, sizeType ADM (non-piloted), size 1 to 3

VDM 5H R - 250

Pressure setting [bar]

Adjustability in operation

- Tool adjustable (-)
- Manually adjustable (R)

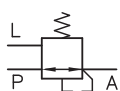
Pressure rangePressure ranges for outlet pressure at A

Basic type, sizeType VDM (hydraulically piloted), size 3 to 5

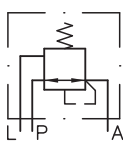
- Hydraulically piloted pressure-reducing valve type VDX (pressure-limiting valve at port L)

Function

ADM..

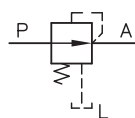


Valve for pipe connection

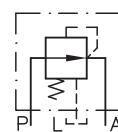


Manifold mounting valve

VDM..



Valve for pipe connection



Manifold mounting valve

General parameters and dimensions

ADM 22 DR

Directly controlled pressure reducing valve type ADM size 2, for pipe connection

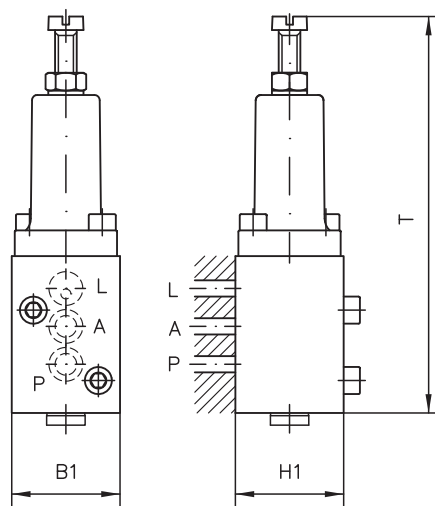
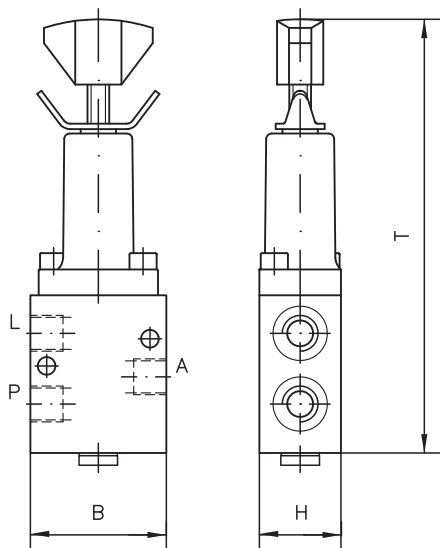
(tapped ports G 3/8 (BSPP), coding 2),
 pressure range 30 to 120 bar (coding D),
 pressure manually adjustable (coding R)

Directly controlled pressure-reducing valve type ADM, size 2 for pipe connection

(ports G 3/8 (BSPP), coding 2),
 Pressure range 30 to 120 bar (coding D),
 Manually adjustable pressure (coding R)

ADM...P

Manifold mounting valve

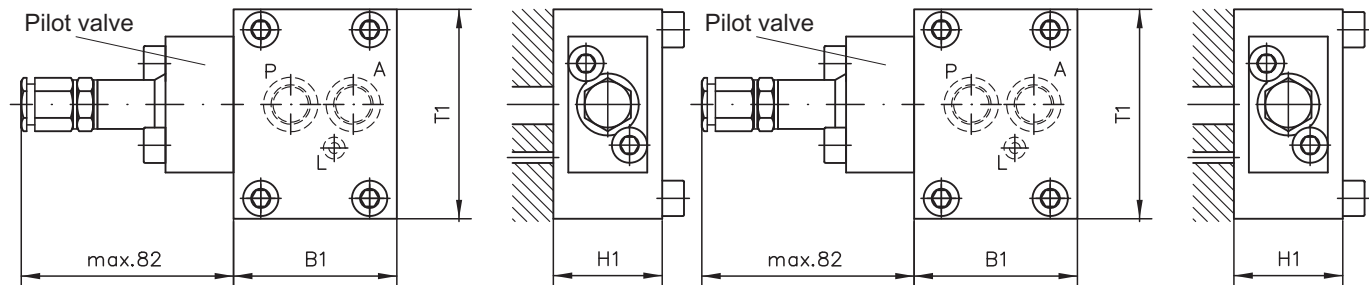


VDM...G

Valve for pipe connection

VDM 5 PH - 250

Piloted pressure reducing valve type VDM size 5, manifold mounting (coding P), pressure range 10 to 400 bar (coding H), pressure tool adjustable to 250 bar
 Piloted pressure-reducing valve type VDM, size 5 for manifold mounting (coding P), pressure range 10 to 400 bar (coding H), tool adjustable pressure to 250 bar



	$Q_{\max}$ [lpm]	$p_{\max}$ [bar]	$p_{\max A}$ [bar]	Ports (BSPP) 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	approx. <0.05	30	35	45	35	141	-	0.6/0.6
ADM 2..	25			G 1/4, G 3/8	approx. <0.05	30	40	50	40	162	-	0.7/0.85
ADM 3..	60			G 3/8, G 1/2	approx. <0.07	30	40	50	40	174	-	1.0/1.1
VDM 3..	40	400	N: 100 H: 400 ¹⁾	G 1/2	approx. <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 is 300 bar between inlet and outlet

2) Design for pipe connection

3) Version for pipe connection / manifold mounting

Example circuit:

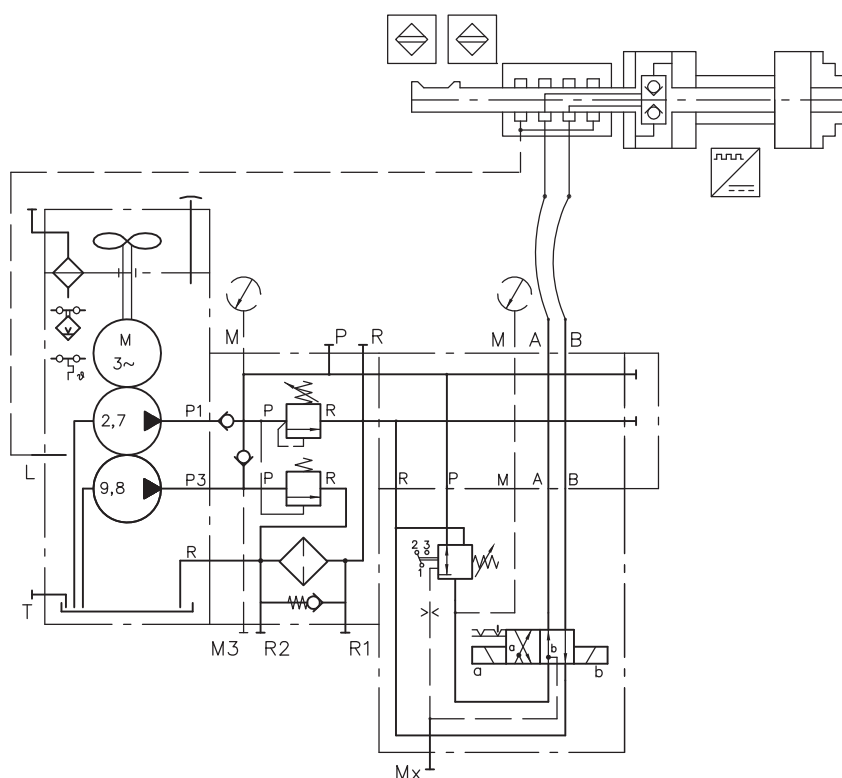
HK 43 LDT/1 M - ZZ 2.7/9.8

-AN 21 F 2-D45-F50

-BA 2

-NSMD 2 K/GRK/0

-1-G 24


Associated technical data sheets:

- Pressure-reducing valves type ADM: [D 7120](#)
- Pressure-reducing valves type VDM, VDX: [D 5579](#)

Similar products:

- Miniature pressure-reducing valves type ADC etc.: [Page 190](#)
- Miniature prop. pressure-reducing valves type PM, PMZ: [Page 200](#)

- Pressure-reducing valves type CDK: [Page 196](#)
- Prop. pressure-reducing valves type PDM: [Page 202](#)

Pressure valves

2.3

Pressure-reducing valves type CDK, CLK, DK, DLZ and DZ

The task of pressure-reducing valves is to maintain a largely constant outlet pressure despite a higher and changing inlet pressure. These valves are used when a secondary circuit has to be fed with a lower but constant pressure level by a main (primary) oil circuit with a higher and varying pressure level. The valve described here is directly controlled. Compared with conventional, piston-type pressure-reducing valves suffering from leaking oil, where an additional drain port is required, this type is designed according to the 2-way principle, i.e. it has zero leakage when in a closed state. Type CLK has an additional override compensation. A reversal of the flow direction is possible up to approx. $2 \times Q_{max}$.

Features and benefits:

- Zero leakage in closed state
- Version with integrated overpressure function
- Easily produced mounting hole

Intended applications:

- General hydraulic systems
- Jigs
- Test benches



Nomenclature:	Pressure reducing valve (2-way valve)
Design:	Screw-in valve combination with a connection block for ■ Pipe connection ■ Manifold mounting
Adjustment:	Tool adjustable Manually (adjustable)
p _{max} :	500 bar
Q _{max} :	22 lpm

Design and order coding example

CDK 3 -2

R

- 250

Pressure setting [bar]

Adjustment

■ Tool adjustable (-)

■ 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

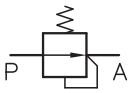
■ Version with connection block for manifold mounting with/without pressure-limiting valve

■ In intermediate plate design NG6 (type NZP)

DK 2	R	/160	/4R
Additional elements Orifice/throttle			
Pressure setting [bar]			
Adjustment ■ Tool adjustable (-) ■ 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			

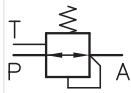
Function

CDK

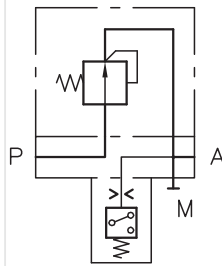


Screw-in valve

CLK

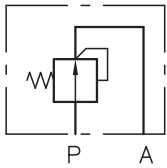


CDK 3. ...-1/4-DG3.



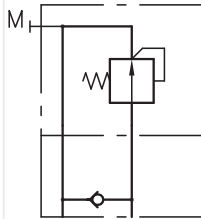
Version for pipe connection, a pressure switch type DG 3. May be installed as option, additional port for pressure gauge

CDK 3. ...-P



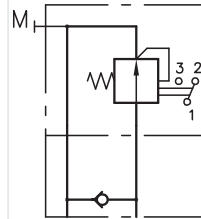
Manifold mounting valve

DZ, DLZ



Manifold mounting valve, optional with orifice/throttle and bypass check valve

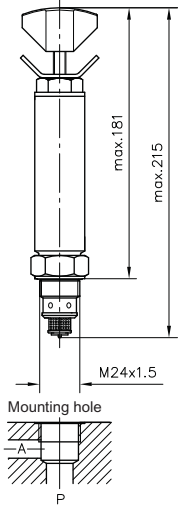
DK



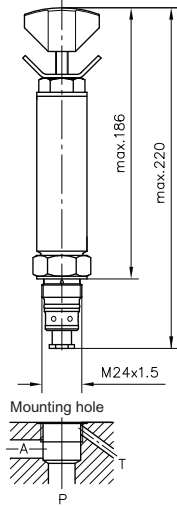
Manifold mounting valve with tracked pressure switch

General parameters and dimensions

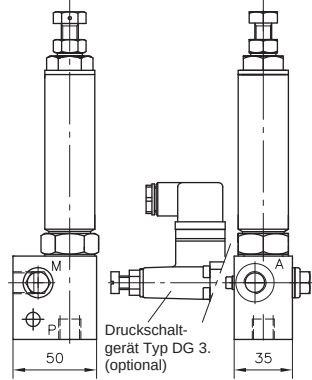
CDK 3..



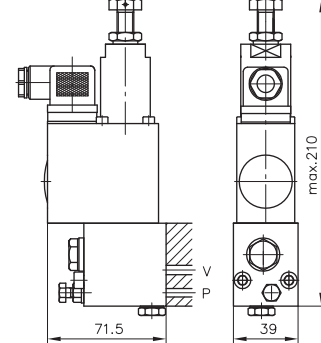
CLK 3..



CDK 3. ...-1/4-DG3.



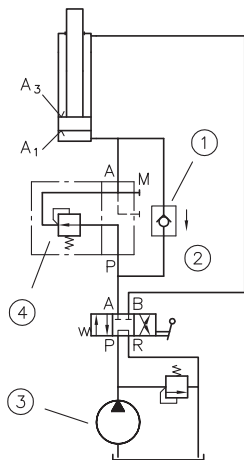
DK 2.



	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

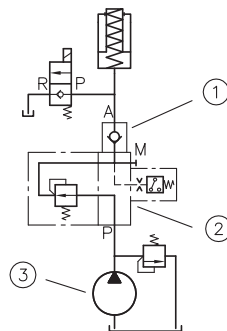
Example of a version
 with large flows $Q_{A \rightarrow P}$
 Example: $Q_P = 15 \text{ lpm}$ [formula]



Application example for large flows

1. e.g. type RK 2G in acc. with D 7445
2. $Q_{\text{return}} = 45 \text{ lpm}$
3. $Q_P = 15 \text{ lpm}$
4. Type CDK 3-2-1/4

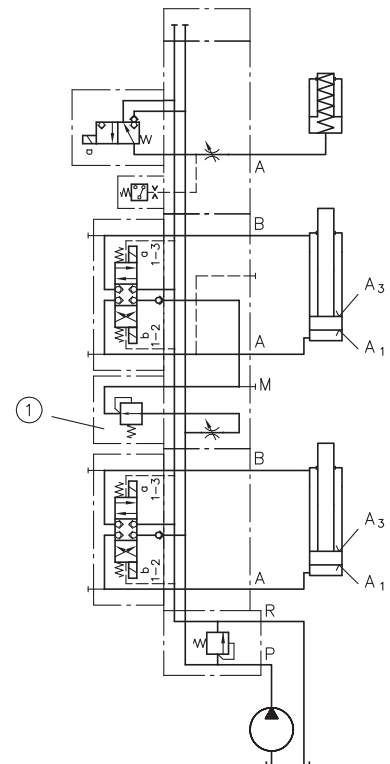
Example of a version
 with undesired return flow



Application example for undesired return flow

1. e.g. type RK 1E in acc. with D 7445 (shown here screwed into port 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 in acc.
 with D 7785 B
 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 valves type CDK: [D 7745](#)
- Pressure-reducing valves type CLK: [D 7745 L](#)
- Pressure reducing valve with tracked pressure switch type DK, DZ: **D 7941**

Similar products:

- Pressure-reducing valves type ADM, VDM, VDX: [Page 192](#)
- Miniature pressure-reducing valves type ADC etc.: [Page 190](#)
- Prop. pressure-reducing valves type PDM: [Page 202](#)

Intermediate plates:

- Intermediate plate NG 6 type NZP: [D 7788 Z](#)

Accessories:

- Pressure switches type DG 3., DG 5 E: [Page 266](#)

See also section "Devices for special applications"

- Screw-in valves and installation kits

Pressure valves

2.3

Miniature proportional pressure reducing valves type PM

These proportional pressure reducing valves are used for circuits, where other devices i.e. directional spool valves should be controlled with a low flow and varying pressure. The pressure on the secondary side (port A) can be adjusted, independently from the pressure on the primary side, according to an electrical signal. The reduced pressure at port A will change proportional to alternation of the electrical input signal. There is a design related permanent leakage flow apparent at R, which has to be led back to the tank via a depressurized line. These pressure reducing valves feature a override compensation i.e. acting like a pressure limiting valve, if the pressure on the secondary side exceeds the set pressure e.g. due to external forces.

Features and benefits:

- Compact design
- Numerous configurations

Intended applications:

- For control oil supply in piloting circuits



Nomenclature:	Prop. pressure reducing valve
Design:	Assembly kit Individual valve Manifold mounting
Adjustment:	Electro-proportional
p _{max} P:	40 bar
p _{max} A:	19 bar
Q _{max} :	approx.. 2 lpm

Design and order coding example

PM 1

- 11

B 0,6

- G24

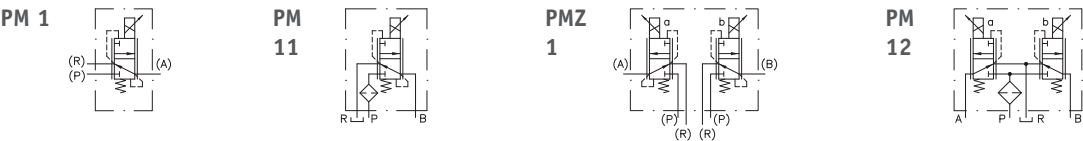
Nominal voltage of proportional solenoid Controls via prop. amplifier or PLVC
Type PMZ also available in ATEX-compliant version

- Additional elements
- Orifice for oscillation damping in A and B
 - Return pressure stop in R

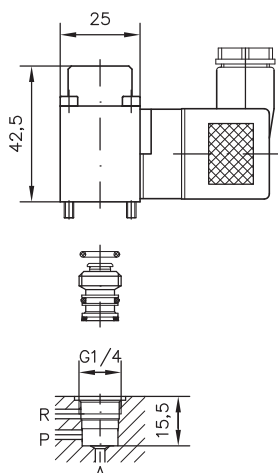
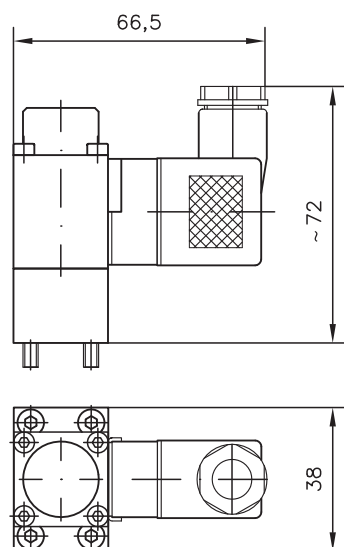
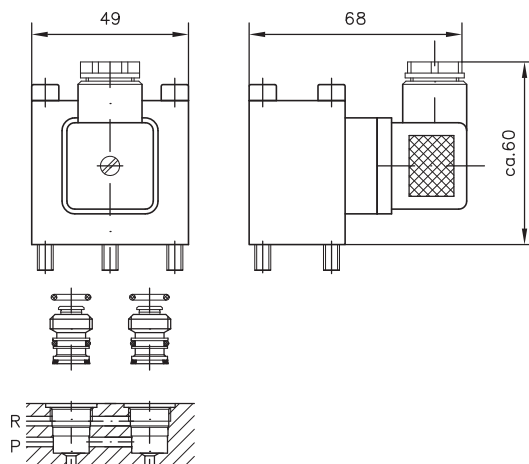
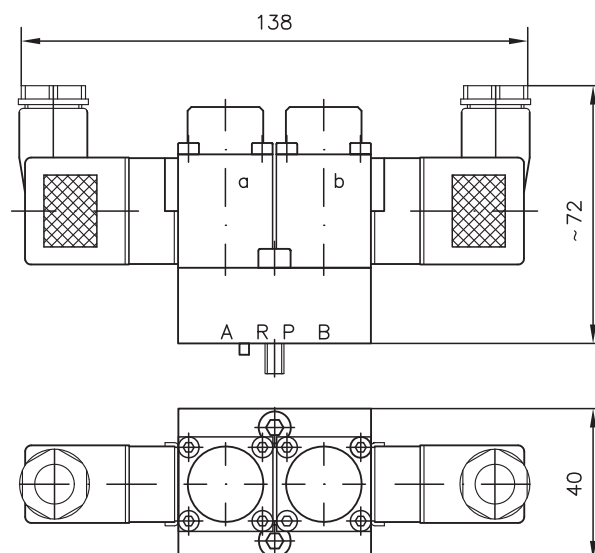
Prop. adjustable nominal pressure difference [bar]

- 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



General parameters and dimensions

PM 1

PM 11

PMZ 1

PM 12


	Design		Pressure range (prop. adjustable nom. pressure difference $\Delta p = p_A - p_R$) [bar]
PM 1	Assembly kit	Individual valve	0... 9
PMZ 1, PMZ 01		Twin valve	0... 4.5 and 0... 11.5
PM 11	Valve for manifold mounting	Individual valve	0... 5.5 and 0... 14
PM 12		Twin valve	0... 7.5 and 0... 19

Associated technical data sheets:

- Miniature prop. pressure reducing valves type PM, PMZ: [D 7625](#)

Similar products:

- Prop. pressure reducing valves type PDM: [Page 276](#)

Prop. amplifier:

- Type EV1M (module): [Page 276](#)
- Type EV1G (module): [Page 276](#)

- Type EV1D (module): [Page 276](#)

- Type EV22K (card version): [Page 276](#)

Additional electrical components:

- Programmable logical valve control type PLVC: [Page 278](#)

See also section "Devices for special applications":

- Proportional valves

Pressure valves

2.3

Proportional pressure reducing valves type PDM

The task of proportional pressure reducing valves in a hydraulic circuit is to maintain a rather constant outlet pressure (port A) despite a higher and changing inlet pressure (port P). They are used when an hydraulic circuit with a higher pressure level (primary side) is to supply another circuit with a lower pressure level (secondary side), without affecting the higher pressure in the primary circuit. There is a design related permanent leakage flow apparent at L, which has to be led back to the tank via a de-pressurized line. A reversal of the direction of flow is possible up to approx. 50% of Q_{max} . A by-pass check valve has to be provided for higher reversed flow. The pressure reducing valves size 11 and 21/22 feature an override compensation i.e. acting like a pressure limiting valve, if the pressure on the secondary side exceeds the set pressure e.g. due to external forces.

Features and benefits:

- With safety valve function

Intended applications:

- General hydraulics
- Jigs
- Test benches



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
$p_{max} A$:	5 ... 350 bar
Q_{max} :	120 lpm

Design and order coding example

PDMP 2		
PDM 4 G	- 43	- G24

Nom. voltage prop. solenoid 12V DC, 24V DC, controls via prop. 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)

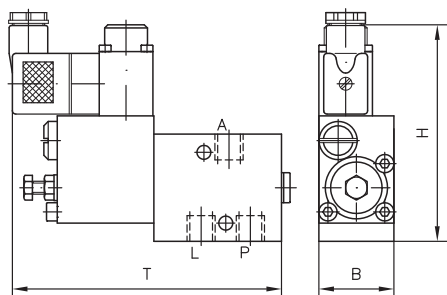
Function

PDM		Piloted	Piloted
Valve for pipe connection:		Manifold mounting valve:	

General parameters and dimensions

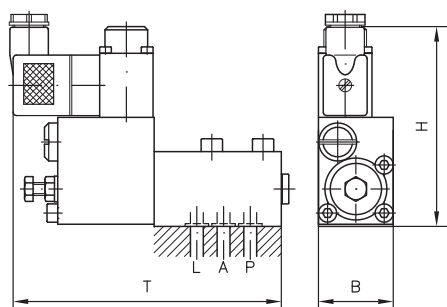
PDM 11, PDM 21, PDM 22

Valve for pipe connection

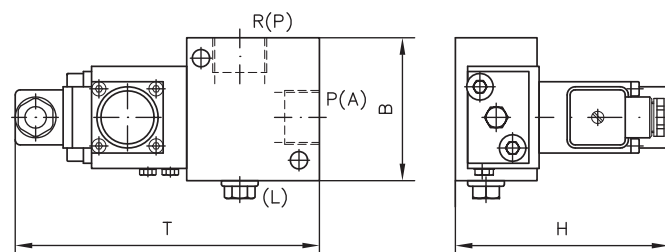


PDMP 11 and PDMP 22

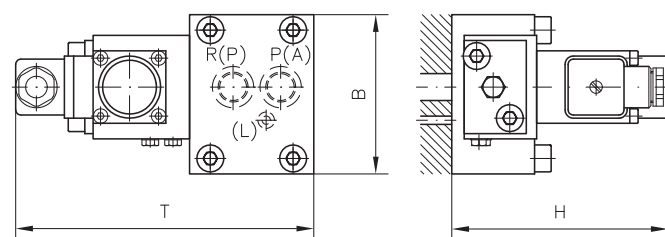
Manifold mounting valve



PDM 3 to 5



PDM 4P and PDM 5P



		$Q_{\max}$ [lpm]	Pressure range $p_{\max A}$ [bar]	Ports (BSPP) ¹⁾	Leakage flow Q_{leak} [lpm]	Dimensions [mm]			m [kg]
						H	B	T	
PDM 11	Directly controlled	12	41: 80	G 1/4	< 0.5	113	35	135	1.5
PDMP 11			42: 130 43: 200 44: 320	-		108	35	135	1.4
PDM 21/22		20	41: 45	G 1/4, G 3/8	< 0.5	113	35	142	1.6
PDMP 22			42: 70 43: 110 44: 180	-		108	40	142	1.3
PDM 3 G	Piloted	40	N: 130	G 1/2	< 0.8	96	66	150	1.8
PDM 4 G		70	M: 200	G 3/4		99.5	71	155	2.2
PDM 5 G		120	H: 350	G 1		104.5	73	170	2.7
PDM 4 P		70		-	-	99.5	78	150	2.7
PDM 5 P		120		-	-	104.5	81	178	3.2

1) Version for pipe connection

Associated technical data sheets:

- Prop. pressure reducing valves type PDM: [D 7486](#), [D 7584/1](#)

Similar products:

- Miniature prop. pressure reducing valves type PM, PMZ: [Page 200](#)

Prop. amplifier:

- Type EV1M (module): [Page 276](#)
- Type EV1G (module): [Page 276](#)

- Type EV1D (module): [Page 276D 7831 D](#)

- Type EV22K (card version): [Page 276](#)

Additional electrical components:

- Programmable logical valve control type PLVC: [Page 278](#)

See also section "Devices for special applications":

- Proportional valves

Pressure valves

2.3

Circulation valve type CNE

The pressure controlled 2-way directional valve automatically switches one (low pressure) of two circuits feeding a hydraulic system into idle circulation as soon as the adjusted pressure is achieved or exceeded by the high pressure circuit. The valve is retained in this shifting position, enabling idle circulation, via the higher pressure being picked up and transmitted by a control oil duct. This valve also serves as a pressure limiting valve for the low pressure circuit. Contrary to version CNE 2, CNE 21 features an additional thread seal and CNE 22 and 23 a thread seal plus a piston seal. The idle circulation valves type CNE are screw-in valves where the mounting hole can be easily manufactured.

Features and benefits:

- Compact design
- Easily produced mounting hole

Intended applications:

- Accumulator charged systems
- Jigs



Nomen-clature:	2-way circulation valve
Design:	Screw-in valve
Adjustment:	Tool adjustable
p _{max} •	500 bar
p _{max adjust} •	450 bar
Q _{max} •	30 lpm

Design and order coding example

CNE 2	C	- 50
-------	---	------

Pressure setting [bar]

Pressure range

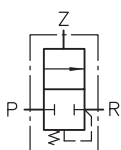
Basic type, size Pressure controlled 2-way valve type CNE

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)

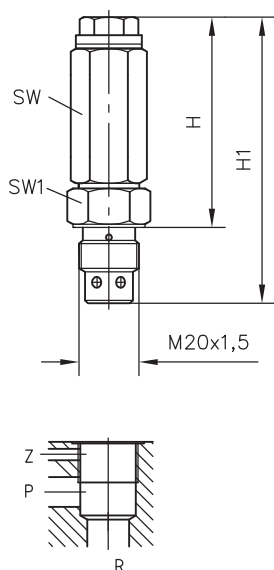
Function

CNE



General parameters and dimensions

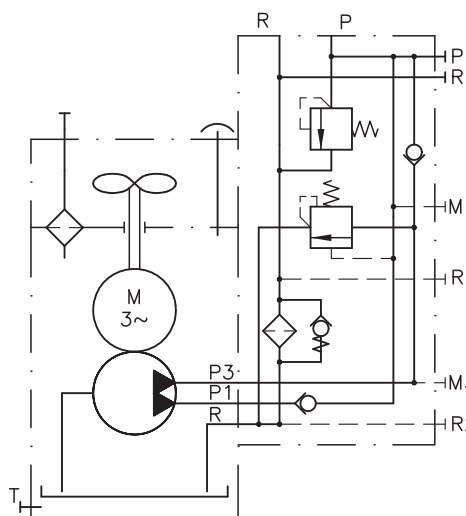
CNE 2



Order example:

HK448/1-HH..-AN21F2

Circulation valve integrated in connection block type AN 21 F2 for compact hydraulic power packs type HK with two pump circuits



	$Q_{\max}$ [lpm]	Oper. pressure $p_{\max}$ [bar] with		Dimensions [mm]			
		P	Z	H	H1	SW = a/f	SW1
CNE 2	30	E: 30	500	70	96	22	24
CNE 21		D: 45					
CNE 23		C: 60					
		B: 75					
	30	A: 90	500	120	147	30	27
		M: 120					
		L: 150					
CNE 22		C: 320					
		B: 450					

Associated technical data sheets:

- Idle circulation valves type CNE: [D 7710 NE](#)

Similar products:

- Two-stage valves type NE: [Page 206](#)
- Switch units type CR: [Page 164](#)
- Shut-off valves type LV, ALZ: [Page 208](#)
- Switching valves type AE: [Page 184](#)

Connection blocks:

- Two-stage connection blocks type NA: [D 6905 A/1](#)
- Connection blocks type AN, AL: [D 6905 A/1](#)

See also section "Devices for special applications"

- Screw-in valves and installation kits and devices for up to 700 bar

Pressure valves

2.3

Two stage valves type NE

Two stage valves are used for hydraulic systems fed by two stage pumps (low and high pressure). They unit the flow from both pumps, automatically switch the low pressure circuit to idle circulation as soon as the adjusted pressure is achieved or exceeded by the high pressure circuit and safeguard both pumps from excessive pressure above the set figures. These valves are intended for use together with 3/3- or 4/3-way directional valves controlling hydraulic cylinders. Bottom ram presses and single acting hydraulic cylinders are better controlled by switch units type CR.

Features and benefits:

- Max. operating pressure 700 bar
- Direct mounting to hydraulic power packs
- Direct combination with valve control

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:	Tool adjustable
p _{max} :	500 ... 700 (HP) / 30 ... 80 (LP) bar
Q _{max} :	25 (HP) / 180 (LP) lpm

Design and order coding example

NE 20

- 650/20

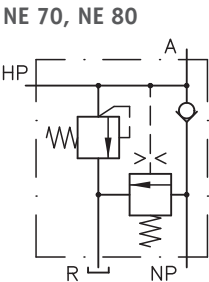
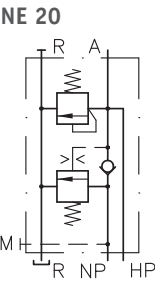
Pressure setting [bar] High- /low pressure

Basic type NE 20, 70 and 80

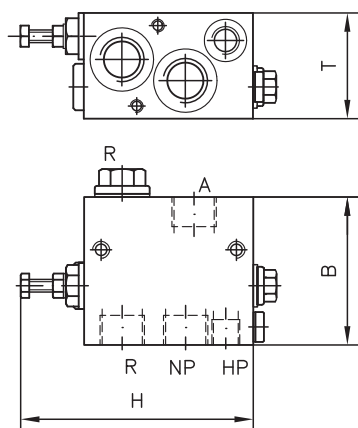
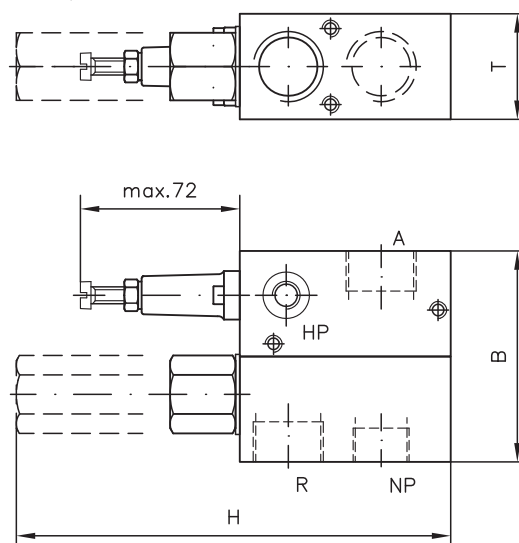
Additional versions:

- Direct mounting at hydraulic power packs type MP and RZ
- Valve banks type BV can be directly mounted (type NE 21)

Function



General parameters and dimensions

NE 20

NE 70, NE 80


	$Q_{\max}$ [lpm]		$p_{\max}$ [bar]		Ports (BSPP)			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 valves type NE: [D 7161](#)

Pumps:

- Compact hydraulic power packs type MP, MPN, MPW, MPNW: [Page 22](#)
- Dual-stage pump type RZ: [Page 62](#)

Similar products:

- Idle circulation valves type CNE: [Page 204](#)
- (Press) switch units type CR: [Page 164](#)
- Directional seated valves type VB: [Page 130](#)

See also section "Devices for special applications":

- Press control
- Devices for up to 700 bar

Pressure valves

2.3 Shut-off valves type LV and ALZ

These shut-off valves automatically switch the pump delivery flow into idle circulation as soon as the adjusted pressure is achieved. There is a check valve upstream of the consumer port A preventing any return flow via the port R . The idle circulation switching position is interrupted as soon as the pressure in the consumer port drops approx. 13% under the set pressure figure. The self controlled valves type LV do not require any flow pulsation whereas type ALZ is a piloting valve. Both types are mostly used as accumulator charge valves, and should be installed as near to the pump as possible.

Features and benefits:

- Various means of adjustment
- Various additional functions

Intended applications:

- General hydraulics
- Test benches



Nomenclature:	Shut-off valve (idle circulation valve, direct controlled or piloted)
Design:	Individual valve for pipe connection Individual valve Manifold mounting
Adjustment:	Tool adjustable manually adjustable
p _{max} :	350 bar
Q _{max} :	120 lpm

Design and order coding example

LV 10 P	D	- 180
ALZ 3 G	CR	- 250

Pressure setting [bar]

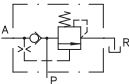
- Pressure range
- Tool adjustable (-)
 - Manually adjustable (R)

- 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)
 - Arbitrary idle pump circulation via 2/2-way solenoid valve

Function

LV, ALZ

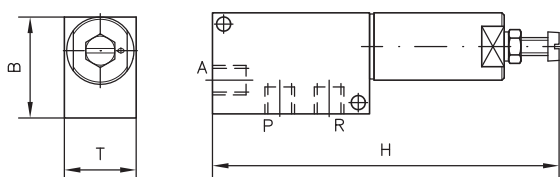
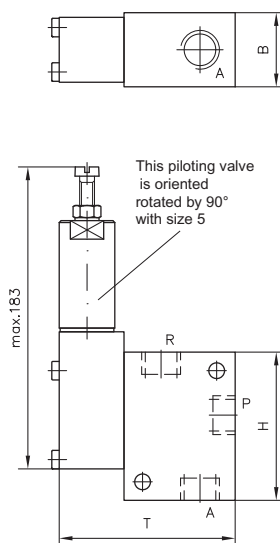
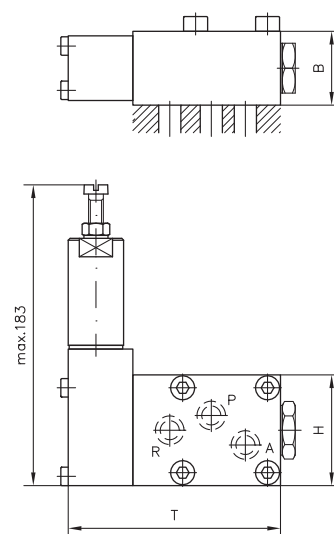
For pipe connection:



Manifold mounting valve:



General parameters and dimensions

LV..

ALZ..G..

ALZ..P..


	Control	Q _{max} [lpm]	Pressure range: p _{max} [bar]	Ports (BSPP) 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, LV25		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 valves type LV: [D 7529](#)
- Shut-off valves type ALZ: [D 6170-ALZ](#)
- Shut-off valves type AL: [D 6170](#)

Similar products:

- Release valves type AE: [Page 184](#)
- Connection blocks type AL: [Page 32](#)

Pressure valves

2.3

Pressure controlled shut-off valves type DSV and CDSV

These pressure-controlled shut-off valves in the seated valve version block the flow to consumers located downstream without any leakage as soon as the set pressure value is reached or exceeded in the consumer line B. The valves will open again if the pressure on the inlet side A drops below the set value defined by the spring tension. While type DSV is designed for manifold mounting or pipe connection, type CDSV is a screw-in valve with easily machined mounting holes. It is frequently used to safeguard pressure gauges, for example.

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

- Intended applications:**
- General hydraulic systems
 - Test benches
 - (Pressure gauge) protection valve

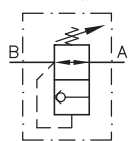
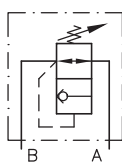


Nomen-clature:	Shut-off valve
Design:	Individual valve for pipe connection Manifold mounting Screw-in valve
Adjustment:	Tool adjustable manually adjustable
p _{max} :	600 bar
Q _{max} :	60 lpm

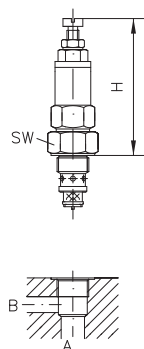
Design and order coding example

CDSV 1	A	- 1/4	- 400
		Design	Pressure setting [bar] with connection block (-1/4) Cartridge valve (-)
		Pressure range	Tool adjustable (-) or manually adjustable (R)
Basic type, size		Type CDSV (cartridge valve), size 1	

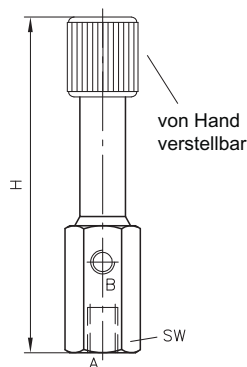
DSV 21-1	B	- 200
		Pressure setting [bar]
	Pressure range	Tool adjustable (-) or manually adjustable (R)
Basic type, size	Type DSV (pipe connection), type DSV (manifold mounting), size 1, 2, 3	

Function
CDSV 1, DSV 2

DSVP 2

General parameters and dimensions
CDSV 1

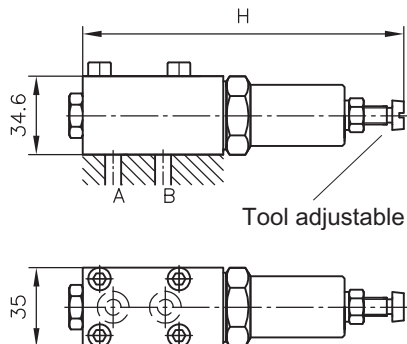
Screw-in valve


DSV 2-2

Version for pipe connection


DSVP 21-1

Manifold mounting valve



	Design	Size	Q _{max} [lpm]	p _{max} [bar]	Ports (BSPP)	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 2¹⁾	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 2¹⁾	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:

- Shut-off valves type DSV, DSVP: [D 3990](#)
- Shut-off valves type CDSV: [D 7876](#)

See also section "Devices for special applications":

- Screw-in valves and installation kits
- Devices for up to 700 bar

Pressure valves

2.3

Load holding valves type LHK, LHDV, and LHT

Load-holding valves are pressure valves that always act on the outlet side of double-acting consumers. They block the outlet duct with their set pressure (pressure setting approx. 15% above the max. load pressure), generating a counter force to a pushing (negative) load. Therefore the pump will have to feed the inflow side with residual pressure in order to drop the load.

Type LHK valves are intended for use in applications that are not particularly prone to oscillations.

Load-holding valves of type LHT and type LHDV featuring special damping properties are especially well suited for applications together with prop. directional spool valves ("Load Sensing" directional spool valves) e.g. type PSL/PSV.

Many additional options are available such as shock valves and shuttle valves with or without restrictor check valve (delayed release of hydraulic brakes) etc.

Features and benefits:

- Operating pressures up to 420 bar
- Various adjustment options
- Various configurations

Intended applications:

- Cranes
- Construction machinery
- Lifting devices



Nomenclature:	Load holding valve (over center valve, for one sided or alternating load direction) Single or twin valve
Design:	Individual valve for pipe connection Individual valve Manifold mounting Screw-in valve Version for banjo bolt mounting
p _{max} :	360 ... 450 bar
Q _{max} :	250 lpm

Design and order coding example

LHK44	G	- 11	- 160
			Pressure setting load-holding pressure [bar]
		Design	Various housing designs available
		Dampening	Without/with, or with restrictor check valve
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

Flow

Additional elements

- With shock- and suction valves
- With shuttle valves for brakes
- With restrictor check valve

Basic type, size

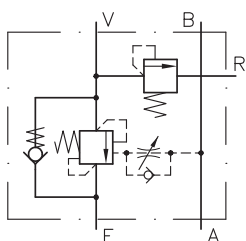
Type LHDV (with tailored dampening characteristics), size 3
Type LHT, size 2, 3 and 5

Additional versions:

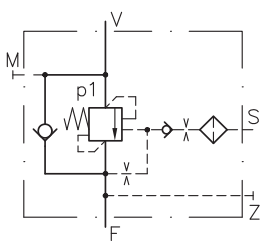
- Cartridge valve versions
- Type LHT
- Type LHTE, with discharge pressure compensation

Function

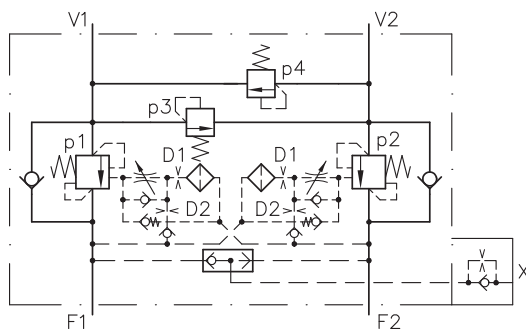
LHK 33 G-15-...



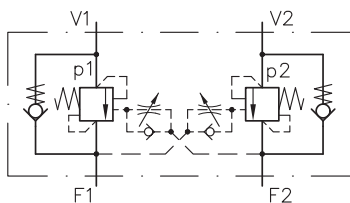
LHT 33 P-11-...



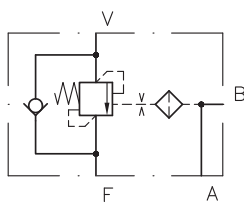
LHDV 33 G-25WD-...



LHK 44 G-21-...



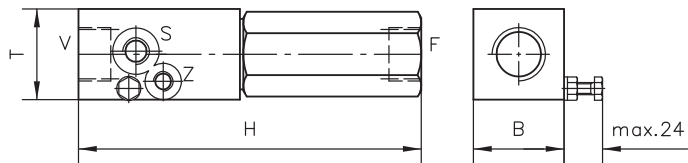
LHT 21 H-14-...



General parameters and dimensions

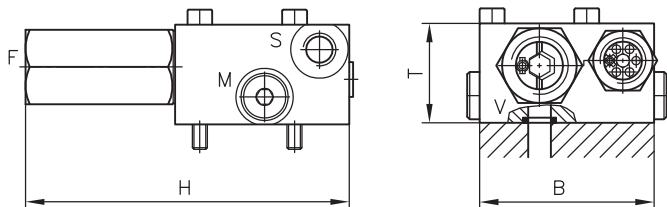
LHK 44 G - 11 - 160

Individual valve



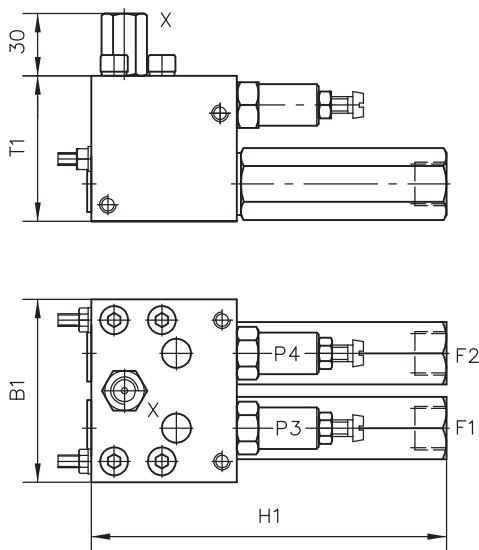
LHT 33 P - 15

Individual valve



LHDV 33 - 25 WD - B 6 - 200/200 - 240/240

Twin valve



	Design	Q _{max} [lpm]	p _{max} [bar]	Release ratio	Ports (BSPP)	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!

2.4 Metering valves

Flow control valves type SF, SD, SK, and SU	218
2-way flow control valves type SB, SQ and SJ	222
Flow control valves type SE and SEH with electro-proportional actuation	224
Flow dividers type TQ and TV	228
Orifices and restrictor check valves type EB, BE, and BC	230
Throttles type Q, QR, QV, and FG	232
Throttles and restrictor check valves type ED, RD, and RDF	234
Throttles and restrictor check valves type CQ, CQR, and CQV	236
Throttle and shut-off valves type AV, AVT, and CAV	238



Flow control valves

*with electro-proportional
actuation type SE and SEH*



*Throttles
type Q, QR, QV and FG*

Flow control valves

Type	Nomenclature/Design	Adjustability	p _{max}	Q _{max}
SF, SD, SK, SU	2-way and 3-way flow control valve - Individual valve for pipe connection - Manifold mounting valve	- Mechanical - Solenoid	315 bar	0,3 ... 130 l/min
SB, SQ, SJ	2-way metering valve, lowering brake valve - Insert valve - Version with housing for pipe connection	- Tool adjustable	315 bar	0,25 ... 400 l/min
SE, SEH	2-way and 3-way flow control valve - Individual valve for pipe connection - Manifold mounting valve	- Electro-proportional	315 bar	0,1 ... 120 l/min

Flow dividers

Type	Nomenclature/Design	Adjustability	p _{max}	Q _{max}
TQ, TV	Flow divider with or without priority division - Individual valve for pipe connection - Manifold mounting valve	- Non-adjustable	300 ... 350 bar	7,5 ... 200 lpm nom. total flow

Orifices, restrictor check valves

Type	Nomenclature/Design	p _{max}	Q _{max}
EB, BE, BC	Orifice, restrictor check valve - Plug-in valve - Insert valve - Version with housing for pipe connection	400 ... 700 bar	0,5 ... 120 l/min

Throttles and throttle shut-off valves

Type	Nomenclature/Design	Adjustability	p _{max}	Q _{max}
Q, QR, QV, FG	Throttle, restrictor check valve - Screw-in valve - Individual valve for pipe connection - Angle valve - Banjo bolt - Swivel fitting	- Tool adjustable	300 ... 400 bar	0 ... 80 lpm
ED, RD, RDF	Throttle, restrictor check valve Individual valve for pipe connection	- Tool adjustable, - Manually adjustable	500 bar	12...130 lpm
CQ, CQR, CQV	Throttle, restrictor check valve Screw-in valve	- Tool adjustable	700 bar	50 l/min
AV, AVT, CAV	Throttle and shut-off valve - With and without bypass check valve - Individual valve for pipe connection - Screw-in valve	- Tool adjustable, - Manually adjustable	500 ... 630 bar	50 l/min

Metering valves

2.4

Flow control valves type SF, SD, SK, and SU

The flow control valves type SF, SD, SK and SU are available in 2 and 3-way versions. They enable continuous adjustment of the oil flow settings in oil-hydraulic systems. With the type SU, a choice can be made between two constant flows. The flow rate is kept constant within a close tolerance regardless of the system pressure and viscosity of the hydraulic oil. Additional control functions (pressure-limiting valve and idle circulation valve integrated in the valve or implemented externally via Z control port) enable adjustment to specific requirements. The 2-way flow control valves are available with bypass check valve and bridge circuit for free selection of the flow direction. The various actuation modes make these flow control valves suitable for a broad range of applications.

Features and benefits:

- Various actuation modes
- Also in combination with bypass check valves

Intended applications:

- Construction machinery
- Machine tools
- General hydraulic systems



Nomenclature:	2-way flow control valve
	3-way flow control valve
Design:	Individual valves for pipe mounting Manifold mounting
Adjustment:	Mechanical ■ Adjusting knob ■ Roller actuation ■ Adjusting screw
	Solenoid (switching between two constant consumer flows)
p _{max} :	315 bar
Q _{max} :	0,3 ... 130 lpm

Design and order coding example

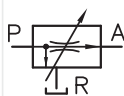
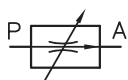
SF 3 - 3	/15	- S	- G24	- 120
Pressure setting [bar] of the pressure limiting valve (S) Solenoid voltage G 12, G 24, WG 110 and WG 230 Mounting and add. valve ■ Pipe connection (no coding) ■ Manifold mounting (P) ■ Valve with bypass check valve (R, PR) ■ Check valve bridge circuit (B) ■ Pressure-limiting valve (S) ■ Pressure-limiting and circulation valve (S-WN1F, S-WN1D)				
Flow Flow steps via orifices Q_{max} : 3, 6, 15, 36, 50, 60, 70, 90, 130 lpm				
Basic type, design, size ■ Type SD, with turn-knob ■ Type SD with adjusting knob actuation ■ Type SK with roller actuation (open version) ■ Type SU, solenoid actuation, switching between to fixed values (only size 3 and only with pipe mounting design) ■ Version as 2-way- (-2) and 3-way- (3) flow control valve ■ Size 3 to 5 ■ Size 3 to 5				

Function

2-way

3-way

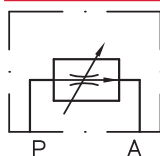
Pipe mounting



2-way

3-way

Manifold mounting valve


Actuations:

SF ...

SD ...

SK ...

SKR ...

SU


 Set screw SW 10
 adjustment travel
 5 mm

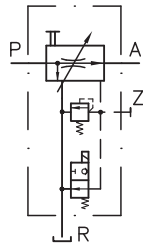
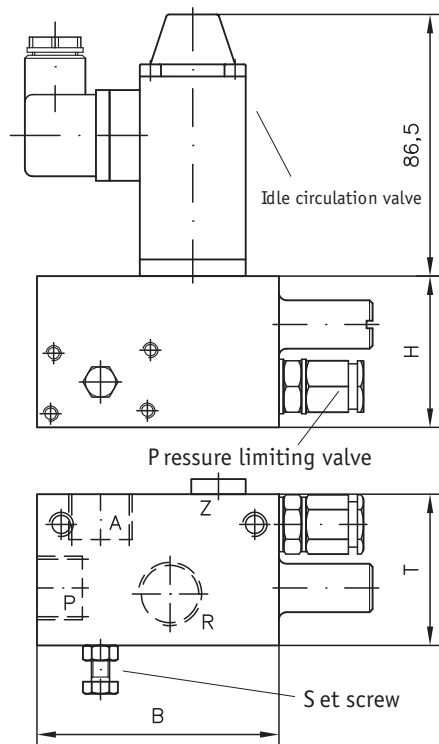
 Adjusting knob,
 adjustment travel
 3.8 turns

 Roller actuation
 Unshielded version (SK), Shielded version (SKR)
 Actuation travel 15,5 ... 17 mm,
 Actuation force 30 ... 70 N

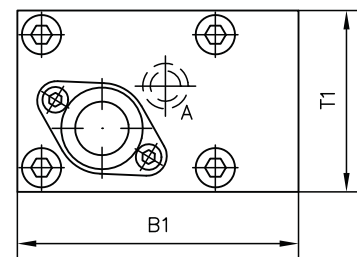
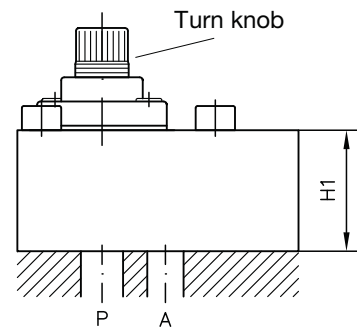
 Solenoid
 12V DC, 24V DC, 110V AC, 230V AC

General parameters and dimensions

Version for pipe connection



Manifold mounting valve



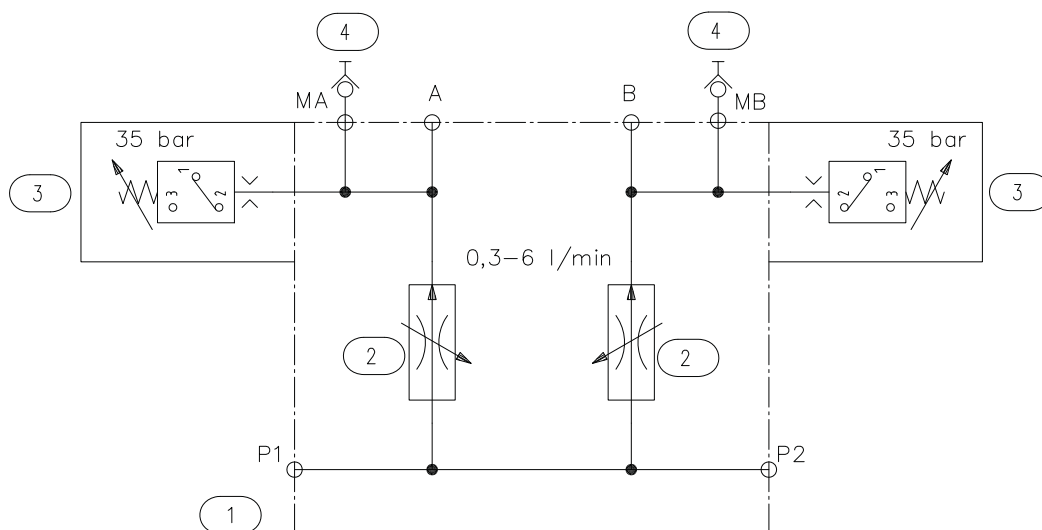
		Q_{max} [lpm] ¹⁾	Ports (BSPP) ²⁾	Dimensions [mm]						m [kg] ³⁾
2-way	3-way			H	H 1	B	B 1	T	T1	
S. 2-3	S. 3-3	0,3 ... 60	G 1/2	50	40	80	60	50	60	1,4 ... 2,1
				50	40	80	93	50	60	1,4 ... 2,1
S. 2-4	S. 3-4	0,6 ... 90	G 3/4	60	50	88	70	60	70	2
				60	50	88	100	60	70	2,0 ... 2,6
S. 2-5	S. 3-5	1,0 ... 130	G 1	70	50	100	80	70	80	3,1
				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 actuators

Item	Number	Description
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:

- 2-way and 3-way flow control valves type S: [D 6233](#)

Similar products:

- Drop rate braking valves type SB, SQ: [Page 222](#)
- Prop. flow control valves type SE, SEH: [Page 224](#)

Plugs:

- With LED etc.: [D 7163](#)

Metering valves

2.4

2-way flow control valves type SB, SQ and SJ

The 2-way metering valves (lowering brake valves) type SB or SQ are preferentially used for flow control tasks of single-acting cylinders. In doing so, the lowering speed is largely kept constant regardless of the size of the load. The integrated sliding metering orifice enables completely free flow in the opposite direction. While with type SB, there is a slight load dependence preventing the occurrence of oscillations (e.g. required for fork lift trucks), type SQ has largely load-independent Δp -Q characteristics.

These flow control valves are preferentially used to limit control flows in pilot circuits. The DSJ version for flow limitation in both flow directions is intended for double-acting consumers.

The valve is characterized in particular by its low hysteresis range and its easily machined mounting hole. It can be adjusted from the outside using a tool. The main flow is channelled to other consumers or is fed away as throttling loss to the tank via the pressure-limiting valve.

Features and benefits:

- Oscillation damping or load-independent
- Compact screw-in valve

Intended applications:

- General hydraulic systems
- Industrial trucks
- Lifting equipment



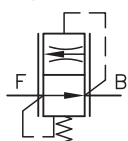
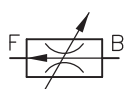
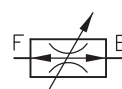
Nomenclature:	2-way flow control valve (drop rate braking valve)
Design:	Screw-in type with housing for in-line installation
Adjustment:	Fixed (pre-set) Tool adjustable from outside
p _{max} :	315 bar
Q _{max} :	0,25 ... 400 lpm

Design and order coding example

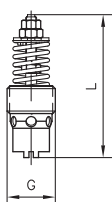
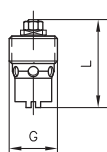
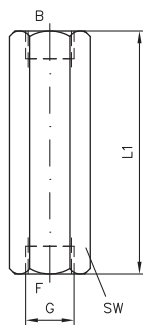
SB 2	1	C	- 30
------	---	---	------

	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 or 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 (without one-way orifice), size 0 to 5	
	Type DSJ (Q _{max} = 20 lpm, p _{max} = 300 bar) Flow control function in both directions e.g. for double acting cylinders	

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 (BSPP)	Dimensions [mm]			m [g]
	1	3	5	7	9	90		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 0¹⁾								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	-		94	160	50	300
DSJ 1	1.0...21.0						G 1 1/4 (A)	39	78	19	30

1) Type SJ 0 without coding: adjust. range 0.25 ... 1.2 lpm

2) Not for type SQ..

Associated technical data sheets:

- Lowering brake valves type SB, SQ: [D 6920](#)
- 2-way flow control valves type SJ: [D 7395](#)
- 2-way flow control valves type CSJ: [D 7736](#)
- Double-acting 2-way flow control valves type DSJ: [D 7825](#)

See also "Devices for special applications":

- Industrial trucks
- Screw-in valves and installation kits

Metering valves

2.4

Flow control valves type SE and SEH with electro-proportional actuation

The flow control valves type SE and SEH are used for continuous adjustment of the operating speed of connected hydraulic consumers regardless of pressure. They can be used as 2-way or 3-way flow control valves and are available with proportional electrical, directly actuated (type SE) or proportional electro-hydraulic, piloted (type SEH) control orifice adjustment (each available with normal position as open or closed). They help to achieve fully automated operating cycles with individually preselected acceleration and deceleration phases.

A piloted pressure-limiting valve and an electrically switchable circulation valve (3-way controller) or a bypass check valve and check valves in a bridge circuit for free selection of the flow direction (2-way controller) can be selected as additional elements.

Features and benefits:

- Electrical control of consumer operating speeds
- Automation of operating cycles

Intended applications:

- Construction machinery
- Machine tools
- General hydraulic systems



Nomenclature:	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} :	0,1 ... 120 lpm

Design and order coding example

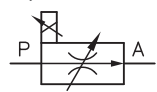
SE 2-3	/30F	- P	- G24
Basic type, size	Solenoid voltage		
	Prop. solenoid		
	■ 12 V DC, 24 V DC		
	■ Controls via prop. amplifier or PLVC		
	Design and port size		
Flow [lpm]	■ Pipe connection		
	■ Manifold mounting (P)		
	Nom. flow of the metering orifice		
	■ Deenergized open		
	■ Deenergized closed (coding F		
Basic type, size	Orifice steps Q _{max} : 3, 6, 10, 15, 22, 30, 36, 50, 70, 90, 120 lpm		
	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

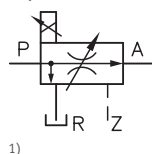
2-way

Pipe connection



3-way

Pipe connection



No Z port with type SEH 3-2

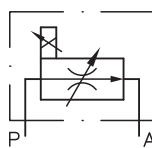
Additional functions for flow control valves:

2-way flow control valve

- Version with bypass check valve
- Version with check valve in bridge circuit for free selection of the flow direction

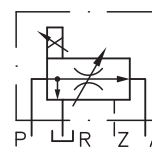
2-way

Manifold mounting valve



3-way

Manifold mounting valve



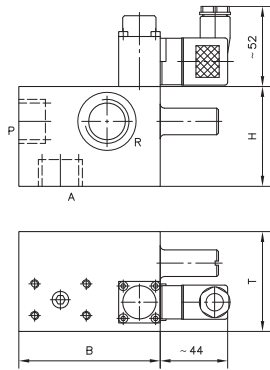
3-way flow control valve

- 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

General parameters and dimensions

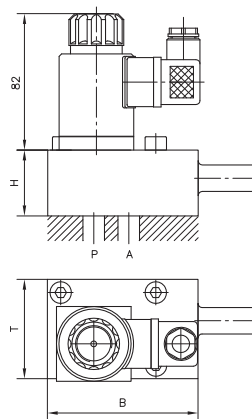
SEH

Version for pipe connection



SE

Manifold mounting valve



Basic type and size

			Q_{max} [lpm] ¹⁾	p_{max} [bar]	Ports (BSPP) 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	-		0,6 ... 70	315	G 3/4	120 ... 130	85 ... 100	60 ... 70	2,2
-	SE 3-4		0,6 ... 90	315	G 3/4				
SEH 2-2	SEH 3-2	Hydraulically piloted	0,1 ... 30	315	G 3/8	115	55 ... 70	40	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

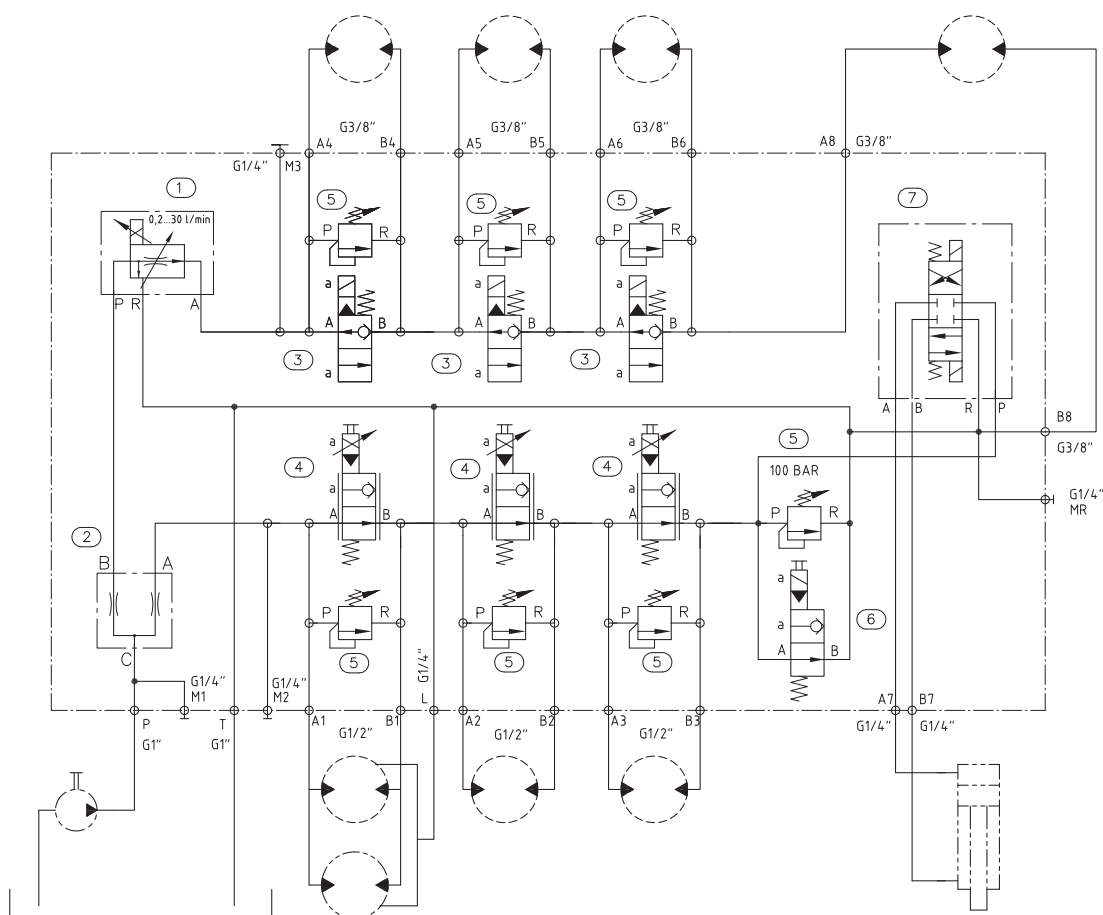
1) Different Q_{max} available, see Design and order coding example: "Orifice steps"

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 valves type SE, SEH: [D 7557/1](#)

Similar products:

- Flow control valves type SD etc.: [Page 218](#)

Proportional amplifier:

- Type EV1M (module): [Page 276](#)
- Type EV1G (module): [Page 276](#)

- Type EV22K2 (card version): [Page 276](#)

- Programmable logical valve control type PLVC: [Page 278](#)

See also section "Devices for special applications":

- Proportional valves

Metering valves

2.4

Flow dividers type TQ and TV

The flow dividers type TQ divide (collect) total flow entering (exiting) at port C. The distribution is independent of working pressure at ports A and B, and may be divided equally or unequally in predetermined portions.

Type TV flow dividers feature privilege division. A variable flow entering at port C is divided into a partial flow Q_A , which is kept constant, and a residual flow Q_B . As soon as one consumer's movement is stopped, the flow to the other is either reduced to a minimal flow (type TQ) or completely reduced to leakage flow (type TV). It is possible to overcome this design feature by simulating flow via a pressure-limiting valve. These valves are used for applications where one pump is required to supply two unevenly loaded hydraulic consumers, which must be driven simultaneously and independently (type TQ) or if one consumer simply requires a constant flow (type TV).

Features and benefits:

- Accurate flow division

Intended applications:

- Steering systems
- Synchronized cylinder movement



Nomenclature:	Flow dividers with or without priority division
Design:	Individual valve for pipe mounting Manifold mounting
Adjustment:	Non-adjustable
p _{max} :	300 ... 350 bar
Q _{max} :	7,5 ... 200 lpm (nom. total flow)

Design and order coding example

TV3P	- A	- 2,0
TQ 32		- 3

Coding Flow indicator

Design (A – equal division ratio)

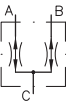
Basic type, size

- Pipe connection (no coding)
- Manifold mounting (P)

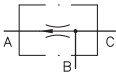
Type TQ, size 2 to 5
Type TV, flow divider with privilege division, size 3

Function

TQ
Pipe connection



TV



TQ.P
Manifold mounting valve



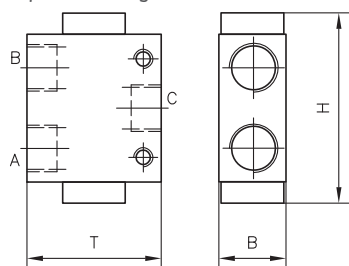
TV.P



General parameters and dimensions

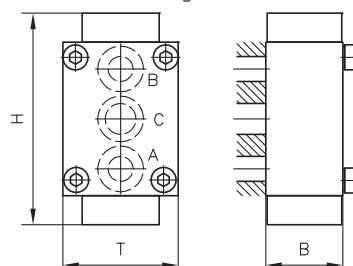
TQ...

Pipe mounting



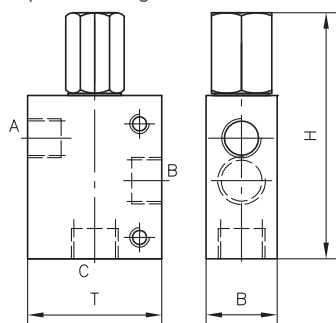
TQ .P

Manifold mounting



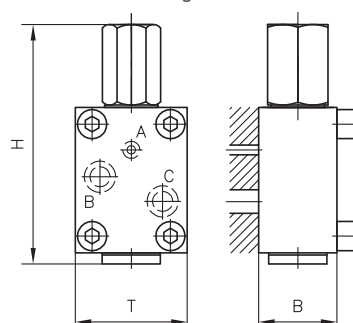
TV 3..

Pipe mounting



TV 3P

Manifold mounting



	Q _{max} [lpm]	p _{max} [bar]	Ports (BSPP) 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
TV 3..	60	300	G 3/8	G 1/2	G 1/2	109	30	60	1.0
TV 3P	60	300	-	-	-	106	35	50	1.0

1) For pipe mounting versions only

Associated technical data sheets:

- Flow dividers type TQ: [D 7381](#)
- Flow dividers type TV: [D 7394](#)

Metering valves

2.4

Orifices and restrictor check valves type EB, BE, and BC

The orifice inserts type EB are part of the flow valves, whereas the restrictor check valves type BE and BC are a combination of a flow and check valve. These valves are preferentially used to limit flows when switching directional valves (e.g. flow limitation to Q_{max} and avoidance of excessively rapid accumulator draining). The restrictor check valves type BC and BE are designed as a hole or slot orifice and enable free flow in the direction $F \rightarrow B$ and throttle function in the opposite direction.

Type BC is spring loaded and can be screwed into normal threaded holes (point angle 118°).

Type EB orifice inserts can be used in the P gallery of manifold mounting valves, for example.

- Features and benefits:**
- Max. 700 bar
 - Simple design and installation
- Intended applications:**
- General hydraulics
 - Winch controls
 - Hydraulic pilot systems

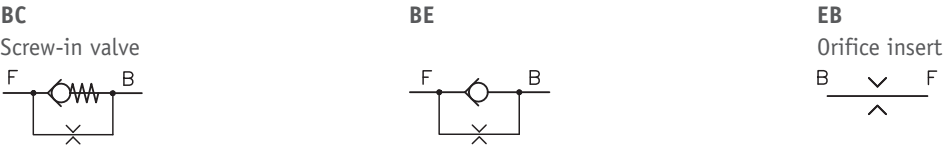


Nomenclature:	Orifice
	Restrictor check valve
Design:	Orifice insert
	Screw-in valve
	Version with housing for in-line installation
p _{max} :	400 ... 700 bar
Q _{max} :	0,5 ... 120 lpm

Design and order coding example

BC1	- 0,8	G
Basic type, size	Orifice	Design with housing For pipe connection, type BC, BE (E; F, G)
		Hole or slot type orifice, diameter in mm
		Type BC, size 1 to 3
	Additional versions	
	■ With/without metric thread (type BC and BE)	

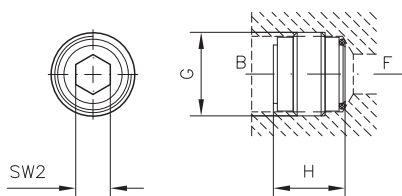
Function



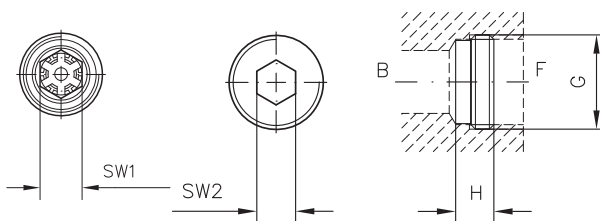
General parameters and dimensions

BC..

Screw-in valve

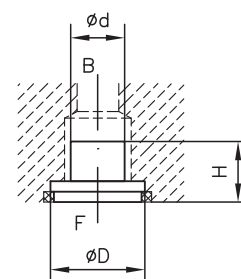


BE ..



EB..

Orifice insert



	$Q_{\max}$ [l/min]	$p_{\max}$ [bar]	Thread	Dimensions				m [g]
				H [mm]	G / D	SW = a/f 1/ød	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	70	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 valves type BC: [D 6969 B](#)
- Restrictor check valves type BE: [D 7555 B](#)
- Orifice inserts type EB: [D 6465](#)

Similar products:

- Insert check valves type RK, RB, RC, RE, ER: [Page 242](#)

- Screw-in flow valves type BSE, QSE, MSE: [D 7121](#)
- Restrictor check valves type RD, ED, RDF: [Page 234](#)

See also section "Devices for special applications":

- Screw-in valves and installation kits

Metering valves

2.4 Throttles type Q, QR, QV, and FG

Throttles are a type of metering valve. The valve types Q, QR and QV are subdivided into five sizes and are used to limit the flow in accumulator and control circuits. They are designed as slot-type throttles (complete stroke) and are therefore impervious to micro-contaminants (no edge filter effect).

The precision throttle valves type FG are preferentially used for adjusting the switching time of directional valves, preventing pressure surges and damping oscillations. The throttle effect is achieved via the effective thread length.

The settings can only be adjusted using tools.

Features and benefits:

- Different installation options
- Simple design

Intended applications:

- General hydraulic systems



Nomenclature:	Throttle Restrictor check valves
Design:	Cartridge Individual valve for pipe mounting ■ Corner housing ■ Banjo bolt ■ Swivel fitting
Adjustment:	Tool adjustable
p_{max}:	300 400 bar
Q_{max}:	0 ... 80 lpm

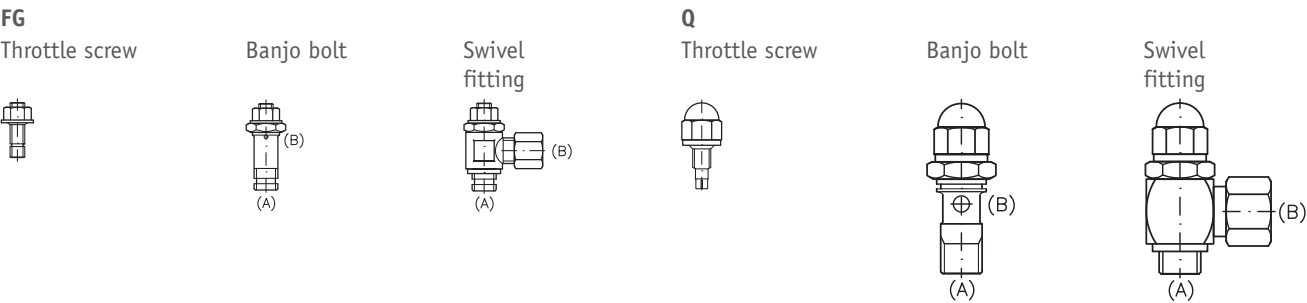
Design and order coding example

QR 20		
FG 1	- H 6	

- 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:

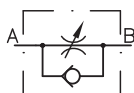


Function

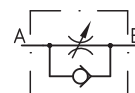
FG, Q



FG 1, QR

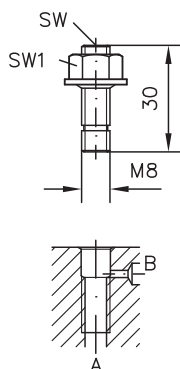


FG2, QV

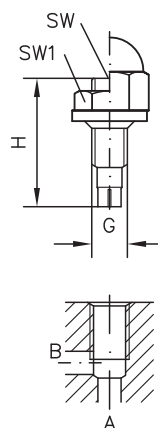


General parameters and dimensions

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) These figures apply for valves fully opened (observe red indicator) with a back pressure of approx. 50 bar (throttled direction of flow)

Associated technical data sheets:

- Throttles type Q, QR, QV: [D 7730](#)
- Precision throttles type FG: [D 7275](#)

Similar products:

- Throttles type CQ, CQR, CQV: [Page 236](#)
- Throttle and restrictor check valves type ED, RD and RDF: [Page 234](#)

- Restrictor check valves and orifice inserts type EB, BE, BC: [Page 230](#)

See also chapter "Equipment for special applications":

- Screw-in and insert valves

Metering valves

2.4

Throttles and restrictor check valves type ED, RD, and RDF

The throttles type ED, RD and RDF are metering valves and are used to influence the flow in single and double-acting consumers. The two smallest sizes are designed as a combination of a slot-type and annular gap throttle to improve adjustability. The larger sizes are pure annular gap throttles. With RD restrictor check valves, the check valve function is performed by a shim that responds to the smallest oil flow movement. With the restrictor check valves type RDF, a nozzle or orifice disc takes on the check valve function. The type ED is designed as a pure throttle.

- Features and benefits:
- Sensitively adjustable
 - Wear-resistant
- Intended applications:
- General hydraulic systems

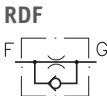


Nomenclature:	Throttle
	Restrictor check valves
Design:	Individual valve for pipe mounting Screw-in valve
Adjustment:	Manually adjustable (handle, adjusting knob)
	Tool adjustable
p _{max} :	500 bar
Q _{max} :	12...130 lpm

Design and order coding example

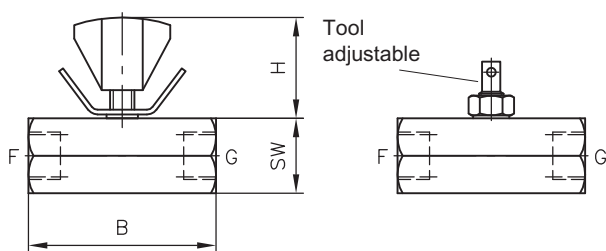
RD 11		- K
RDF 21	/1,0	
Adjustability		
■ Type ED and RD only		
■ Without labelling = manually (wing bolt/lock nut)		
■ K = tool adjustable (setting spindle/lock nut)		
Fixed throttles		
Diameter in mm, type RDF		
■ 0.4 - 0.6 (in increments of 0.1)		
■ 0.8 - 2.0 (in increments of 0.2)		
■ 2.5 - 5.5 (in 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

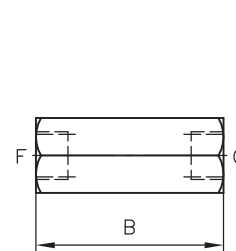


General parameters and dimensions

ED.. and RD..



RDF..



1)	$Q_{\max}$ [lpm] ²⁾	$p_{\max}$ [bar]	Ports (BSPP)	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 can be 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 and RDF: [D 7540](#), [D 2570](#)

Similar products:

- Throttles type Q, QR, QV, FG: [Page 232](#)
- Restrictor check valves type CQ, CQR, CQV: [Page 236](#)
- Restrictor check valves type EB, BE, BC: [Page 230](#)

See also section "Devices for special applications":

- Devices up to 700 bar

Metering valves

2.4

Throttles and restrictor check valves type CQ, CQR, and CQV

The throttles type CQ, CQR and CQV are metering valves and are used to influence the flow in single and double-acting consumers. The throttles described here are designed as slot-type throttles and are therefore impervious to micro-contaminants (no edge filter effect). The check valve function of types CQR and CQV is performed by a shim that guarantees short response times. The double spindle seal enables leakage-free adjustment, even under pressure.

Features and benefits:

- Leak-free adjustment under pressure
- Operating pressure up to 700 bar

Intended applications:

- Speed regulation in hydraulic lifting devices



Nomenclature:	Throttle Restrictor check valves
Design:	Screw-in valve
Adjustment:	Tool adjustable Manually
p _{max} :	700 bar
Q _{max} :	50 lpm

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 = tool adjustable
- 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

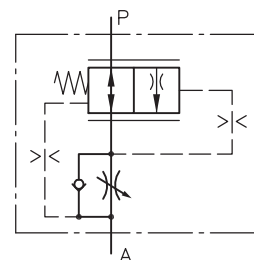
- Version with precision control range (size 22)
- Version with pressure compensator (flow control function)

Function

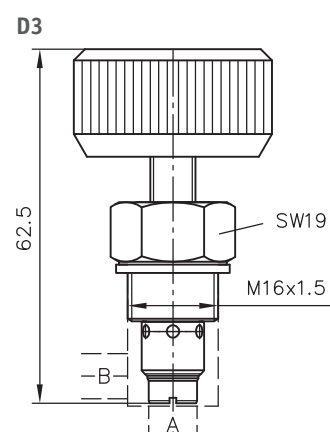
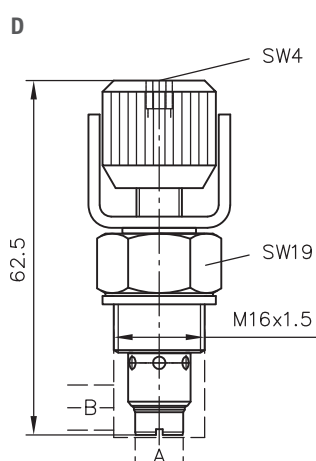
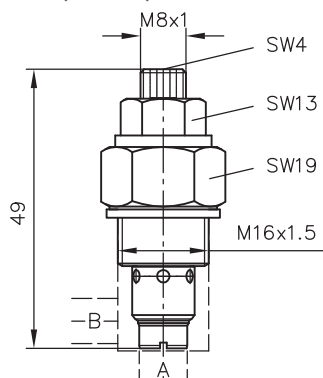
CQ 2, CQ 22

CQR 2, CQR 22

CQV 2, CQV 22

CQ 2 - P - DW


General parameters and dimensions

CQ 2., CQR 2., CQV 2.


	$Q_{\max}$ [lpm]	$p_{\max}$ [bar]
CQ 2 / CQ 22	50 / 20	700
CQR 2 / CQR 22		
CQV 2 / CQV 22		

Associated technical data sheets:

- Throttle and restrictor check valves
type CQ, CQR, CQV: [D 7713](#)

Similar products:

- Throttle and restrictor check valves
type ED, RD and RDF: [Page 234](#)
- Throttles type Q, QR, QV, FG: [Page 232](#)

See also section "Devices for special applications":

- Devices for up to 700 bar

Metering valves

2.4

Throttle and shut-off valves type AV, AVT, and CAV

The throttle and shut-off valves type AVT, AV and CAV (in various sizes) are metering valves and are designed as screw-in valves in the versions AV...E and CAV. They help to generate a pressure difference between the inlet and outlet side to regulate the speed of cylinders in accumulator circuits and the flow in control circuits, or to completely shut off a consumer line (e.g. to safeguard a pressure gauge). With AV valves, the throttle effect is caused by an annular gap, which is created by a valve cone entering a valve seat hole (needle valve). CAV valves create the variably adjustable pressure difference by means of a slot (slot-type throttle, sensitively adjustable and impervious to micro-contaminants). Versions with an integrated check valve enable free flow in one direction.

Features and benefits:

- Various configurations
- Sensitive adjustment and complete shut off possible

Intended applications:

- General hydraulic systems



Nomenclature:	Throttle and shut-off valve with/without by-pass check valve
Design:	Individual valve for pipe mounting Screw-in valve
Adjustment:	Manually adjustable (handle, adjusting knob) Tool adjustable
p _{max} •	500 ... 630 bar
Q _{max} •	50 ... 100 lpm

Design and order coding example

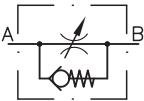
AV 3AVT 10 CAV 1V	- K	- 1/4
	Thread size	Version with connection block for pipe connection (type CAV)
	Means of adjustment	Tool adjustable Manually (adjustable)
Basic type, size	Type AV, size 2, 3 Type AVT, size 6... 16 Type CAV, size 1, 2	

Function

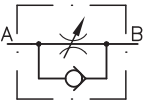
AV, AV.E, AVT, CAV



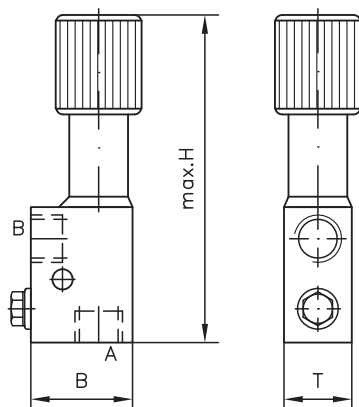
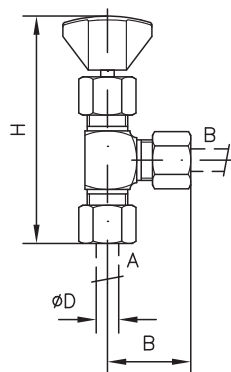
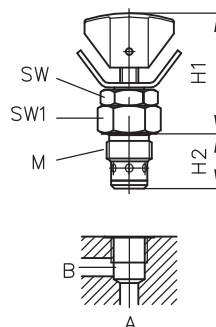
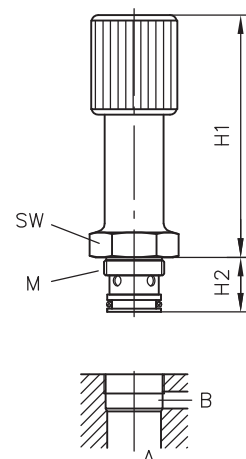
CAV..R



CAV..V, AV..R, AV..RE



General parameters and dimensions

AV..
 Valve for pipe connection

AVT..

CAV..
 Screw-in valve

AV..E


	$Q_{\max}$ [lpm] ¹⁾	$p_{\max}$ [bar]	Connection size M	Dimensions [mm]							m [kg]
				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
AVT 16	100	400	16 mm	123	-	-	43	-	-	-	0.44
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) This figures do apply with a back pressure of approx. 10 bar (throttled flow direction)

Associated technical data sheets:

- Shut-off valves type AVT: [D 7690](#)
- Throttle and shut-off valves type AV: [D 4583](#)
- Throttle and shut-off valves type CAV: [D 7711](#)

Similar products:

- Throttle and restrictor check valves
type ED, RD and RDF: [Page 234](#)
- Throttles type Q, QR, QV, FG: [Page 232](#)

See also section "Devices for special applications":

- Screw-in valves and installation kits
- Devices for up to 700 bar

2.5 Check valves

Check valves type RK/RB, RC, RE, and ER	242
Check valves type CRK and CRB	244
Check valves type B	246
Screw-in check valves with hydraulic release type CRH and RHC	248
Check valves with hydraulic release type HRP	250
Check valves with release type RH and DRH	252
Check valves and pre-fill valves type F	254
Line rupture safety valves type LB	256
Shuttle valves type WV and WVC	258



*Check valves
type RK/RB, RC, RE and ER*



*Check valves
and pre-fill valves type F*

Check valves

Type	Design	p _{max}	Q _{max}
RK/RB, RC, RE, ER	Check valve ■ Insert valve ■ Plug-in valve ■ Version with housing for pipe connection	400 ... 700 bar	6 ... 320 lpm
CRK, CRB	Check valve ■ Screw-in valve	500 bar	30 .. 80 lpm
B	Check valve ■ Individual valve for pipe connection	500 bar	15 ... 160 lpm

Releasable check valves

Type	Design	Actuation	p _{max}	Q _{max}
CRH, RHC	Check valve with hydraulic release ■ Insert valve ■ Screw-in valve	- Hydraulic	500 ... 700 bar	8 ... 200 lpm
HRP	Check valve with hydraulic release ■ Manifold mounting valve	- Hydraulic - Electro-hydraulic	700 ... 500 bar	20 ... 400 lpm
RH, DRH	Check valve with hydraulic release, twin check valve ■ Individual valve for pipe connection ■ Manifold mounting valve	- Hydraulic	700 ... 400 bar	15 ... 160 lpm

Pre-fill valves

Type	Design	Actuation	p _{max}	Q _{max}
F	Check valve with hydraulic release (pre-fill valve) ■ Valve in wafer design	- Hydraulic	400 bar	100 ... 7000 lpm

Line rupture safety valve, shuttle valves

Type	Design	Adjustability	p _{max}	Q _{max}
LB	Line rupture safety valve ■ Insert valve ■ Version with housing for pipe connection	- Tool adjustable	700 bar	4 ... 160 lpm
WV, WVC	Shuttle valve ■ Individual valve for pipe connection ■ Insert valve ■ Screw-in valve		700 bar	6 ... 150 lpm

Check valves

2.5

Check valves type RK/RB, RC, RE, and ER

Check valves type RK, RB, RC, RE and ER are used to block the flow in one direction and enable free flow in the opposite direction. RK/RB check valves are spring-loaded, sturdily designed and dirt-resistant ball seated valves.

The screw-in check valves type RC may be installed in both directions with the spring-loaded valve shim enabling rapid switching sequences. The check valve type RE is a shim-type check valve without spring pre-load. This enables a very compact and simple method of blocking the oil flow in one direction. This valve can be used as a "foot valve" in the suction pipe of pumps, for example.

The mounting hole for all screw-in check valves can be easily machined with a standard twist drill (point angle 118°).

The insert check valves type ER feature a spring-loaded, ball seated design and are primarily used in manifold-mounted versions of seated valves.

- Features and benefits:**
- Operating pressures up to 700 bar
 - Easily machined mounting holes
 - Sturdy

- Intended applications:**
- General hydraulic systems
 - Hydraulic pre-loading



Nomenclature:	Check valve
Design:	Screw-in valve Valve insert With housing for in-line installation
p _{max} :	400...700 bar
Q _{max} :	6...320 lpm

Design and order coding example

RC 2- E

Design with housing

For pipe connection (E, F, G), type RK, RB and RC

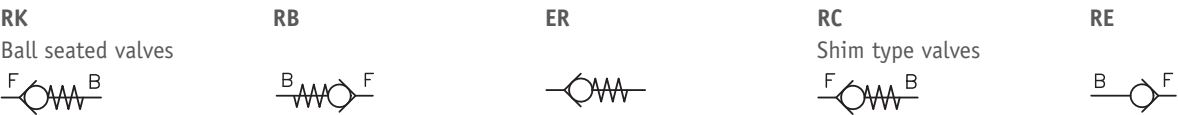
Basic type, size

Screw-in check valve
Type RK, RB, size 0 ... 4
Type RC, size 1 ... 3
Type RE, size 0 ... 4
Type RE, ER (check valve insert), size 0 to 4

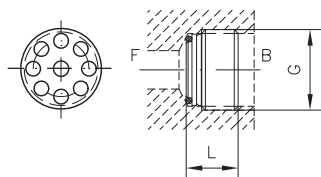
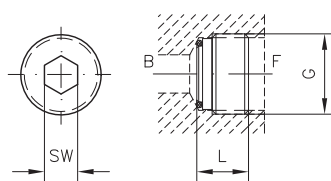
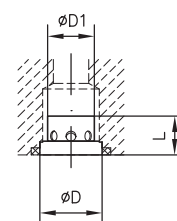
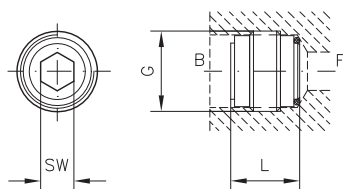
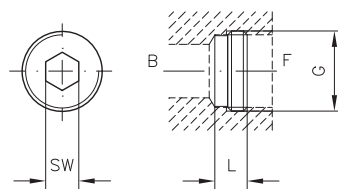
Additional versions:

■ Type RK with increased open-up pressure
■ Type ER, stainless (size 01 ... 31)
■ Type RK, RB, RC and RE with metric thread

Function



General parameters and dimensions

RK..

RB..

ER..

RC..

RE..


	Q_{max} [lpm]	p_{max} [bar]	Ports (BSPP)	Dimensions [mm]		m [g]
RK 0/RB 0	10	700	G 1/8 A	7.2/7.9	SW 5	5
RK 1/RB 1	20	700	G 1/4 A	9/10.3	SW 7	5
RK 2/RB 2	50	700	G 3/8 A	11.2/11.7	SW 6	15
RK 3/RB 3	80	500	G 1/2 A	13.5/13.2	SW 8	15/20
RK 4/RB 4	120	500	G 3/4 A	17.5/17.5	SW 12	35/40
RK 6	320	300	G 1 1/4	55	-	135
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:

- Insert check valves type ER: [D 7325](#)
- Check valves type RE: [D 7555 R](#)
- Check valves type RC: [D 6969 R](#)
- Check valves type RK, RB: [D 7445](#)

Similar products:

- Check valves type CRK, CRB: [Page 244](#)
- Check valves type B: [Page 246](#)

- Restrictor check valves type EB, BE, BC: [Page 230](#)

See also section "Devices for special applications":

- Screw-in valves and installation kits
- Devices for up to 700 bar

Check valves

2.5

Check valves type CRK and CRB

The check valves type CRK and CRB are used to block the flow in one direction and allow free flow in the opposite direction.
The mounting hole can be closed with a simple tapped plug or with a locking tapped plug if necessary.

- Features and benefits:**
- Cartridge valves
- Intended applications:**
- General hydraulics



Nomenclature:	Check valve
Design:	Screw-in valve
p _{max} :	500 bar
Q _{max} :	30 ... 80 lpm

Design and order coding example

CRK 2

- 1/4

Individual connection block for pipe connection

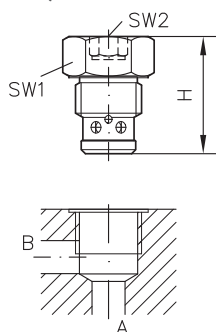
- Basic type
- Check valves type CRK and CRB, size 1 to 3
- With/without tapped plug
 - With/without tapped blockage/plug combination

Function

CRK

CRB


General parameters and dimensions

CRK, CRB


	$Q_{\max}$ [lpm]	$p_{\max}$ [bar]	Ports (BSPP)	Dimensions			m [g]
				H [mm]	SW = a/f 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 valves type CRK, CRB: [D 7712](#)

Similar products:

- Check valves type RK, RB, RC, RE, ER: [Page 242](#)

See also section "Devices for special applications":

- Screw-in valves and installation kits
- Devices for up to 700 bar

Check valves

2.5

Check valves type B

These check valves type B are available in three housing designs with internal and/or external thread, enabling in-line installation for any requirement.
Use as a foot valve for the suction pipes of pumps is possible due to the low opening pressures.

Features and benefits:

- Max. flow 160 lpm
- Pipe installation

Intended applications:

- General hydraulics



Nomenclature:	Check valve
Design:	Individual valve for in-line installation
p _{max} •	500 bar
Q _{max} •	15 ... 160 lpm

Design and order coding example

B 1 - 2

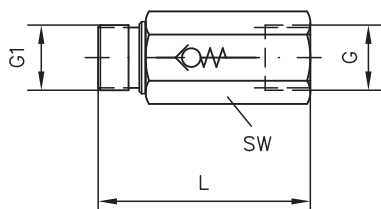
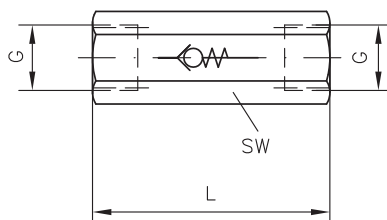
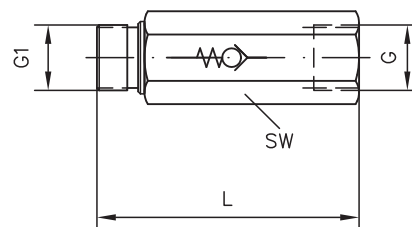
Basic type, with housing, size

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 (BSPP)		Dimensions		m [kg]
				G	G1	L [mm]	SW = a/f	
B 1	-1	15	500	G 1/4	G 1/4 A	50 ... 60	SW 19	0.11
B 2	-2	20		G 3/8	G 3/8 A	58 ... 67	SW 24	0.16
B 3	-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 242](#)

See also section "Devices for special applications"

- Devices for up to 700 bar

Check valves

2.5

Screw-in check valves with hydraulic release type CRH and RHC

The screw-in check valves with hydraulic release type CRH and RHC are used in hydraulic circuits together with design related, leaking directional valves, as a hydraulically actuated drain, or idle circulation valves.

The valves type RHC with and without pre-release (for high pressures and large consumer volumes) are designed as insert valves. The mounting hole (also sealing surface) is to be machined with a standard twist drill (point angle 118°).

Different variants extend the range of applications.

The type CRH is a screw-in valve for very easily machined mounting holes.

Features and benefits:

- Cartridge valve
- Pressures up to 700 bar
- Flows up to 200 lpm
- Sturdy

Intended applications:

- Industrial hydraulics
- Construction machinery



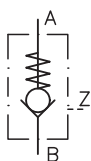
Nomenclature:	Check valve with hydraulic release
Design:	Valve insert Screw-in valve
Actuation:	Hydraulic
p _{max} :	500 ... 700 bar
Q _{max} :	8 ... 200 lpm

Design and order coding example

CRH 3	V	
	Function	Without pre-release (-) With pre-release (V)
Basic type, size	Screw-in check valve with hydraulic release Type CRH, size 1 to 3 and Type RHC, size 1 to 6	
	Additional versions:	
	■ With increased release ratio (approx. 4.2 : 1)	
	■ With sealed tapped journal and control piston	
	■ With hydraulic relieve of the control piston (type RHCE)	

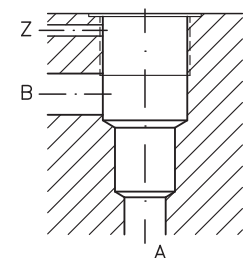
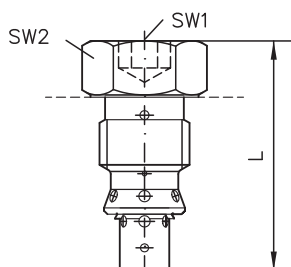
Function

CRH, RHC

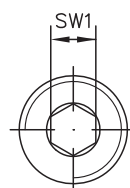
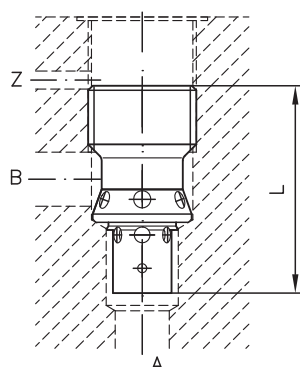


General parameters and dimensions

CRH



RHC



	Q_{max} [lpm]	p_{max} [bar]	Release ratio p_a / p_z	Ports (BSPP)	Dimensions			m [g]
					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: Check valves with hydraulic release type:

- Type CRH: [D 7712](#)
- Type RHC: [D 7165](#)

Similar products:

- Type RHV: [D 3056](#)
- Type HRP: [Page 250](#)
- Type RH: [Page 252](#)

See also section "Devices for special applications":

- Screw-in valves and installation kits
- Devices for up to 700 bar

Check valves

2.5

Check valves with hydraulic release type HRP

The check valves type HR with hydraulic release, are designed as manifold mounting valves and are available in six sizes. These valves are used in hydraulic circuits with design related, leaking directional valves, as hydraulically actuated drain, or idle circulation valves. The check valve type HRP can be ordered also with a pre-release to suppress decompression surges for circuits with high pressure and high consumer flows.

This valve is extremely tolerant to residual pressure in the return duct (port B), as the rear side of the actuation piston is de-pressurised via a drain port. Another option allows opening of the check valve via the load pressure on the consumer side, controlled by a flange-mounted solenoid valve.

Features and benefits:

- Manifold mounting valve for max. pressure 700 bar
- Flows up to 400 lpm
- Electrically controlled
- With pre-release for smooth switching

Intended applications:

- Industrial and mobile hydraulics



Nomenclature:	Check valve with hydraulic release
Design:	Manifold mounting valve
Actuation:	Hydraulic Electro-hydraulic
p _{max} •	700 ... 500 bar
Q _{max} •	20 ... 400 lpm

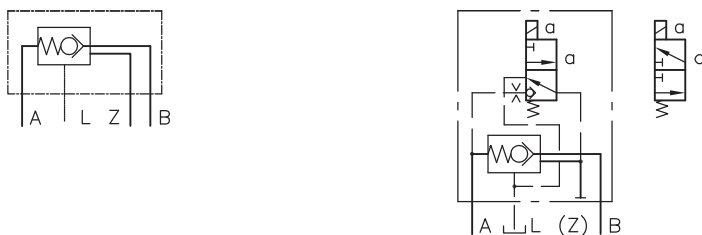
Design and order coding example

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			

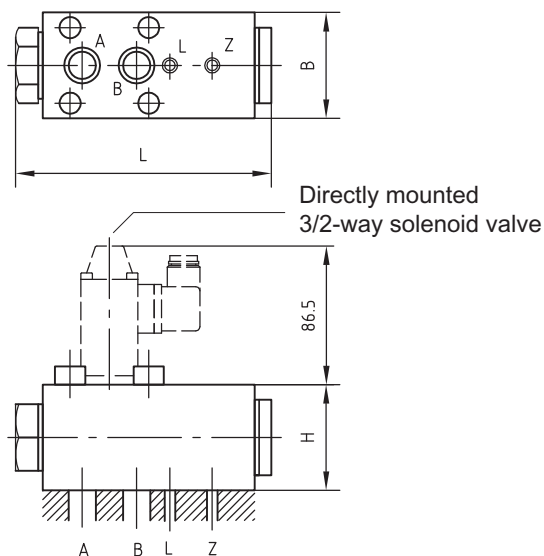
Function

HRP



General parameters and dimensions

HRP



	$Q_{\max}$ [lpm]	$p_{\max}$ [bar]	Release ratio p_A / p_Z	Dimensions [mm]			m [kg]
				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 valves type HRP: [D 5116](#)

Similar products:

- Releasable check valves type RH: [Page 252](#)
- Releasable check valves type RHV: [D 3056](#)
- Releasable check valves type CRH, RHC: [Page 248](#)
- Releasable twin check valve type DRH: [Page 252](#)

See also section "Devices for special applications":

- Devices for up to 700 bar

Check valves

2.5

Check valves with release type RH and DRH

Check valves with hydraulic release are used to block one or both hydraulic consumer pipes or as a hydraulically actuated drain or circulation valve. The valves type RH and DRH are also available with pre-release for one or both sides of the connection to suppress decompression surges for circuits with high pressures and high consumer flows.

Features and benefits:

- Pressures up to 700 bar
- With pre-release for smooth switching

Intended applications:

- Blocking of leak-free hydraulic cylinders in connection with a directional spool valve control suffering from leaking oil
- Return flow relief if return oil flows that are greater than the permissible flow for the directional valve are experienced due to the surface ratio, when introducing a double-acting hydraulic cylinder
- Hydraulically actuated drain or circulation valve



Check valve with hydraulic release or releasable double check valve	Check valve with hydraulic release or twin check valve
Design:	Individual valve for ■ Pipe connection ■ Manifold mounting
Hydraulic	Hydraulic
400...700 bar	400...700 bar
15...160 lpm	15...160 lpm

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

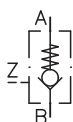
Pre-charge pressure [bar]

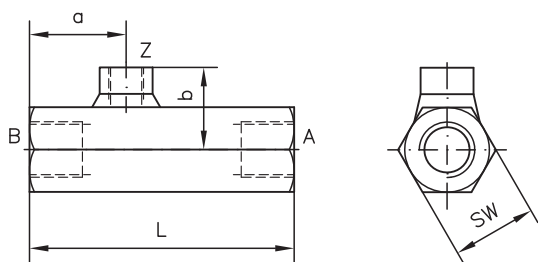
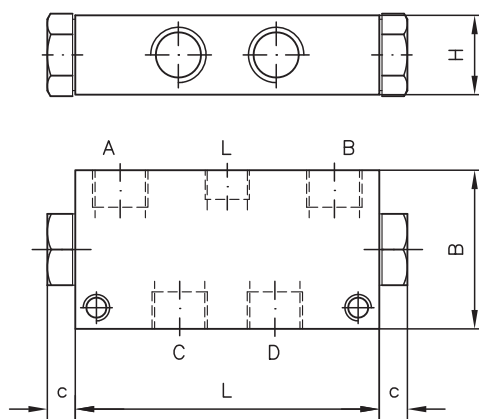
Pressure setting [bar]

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 $p_{A(B)}/p_Z$	Tapped ports (BSPP)		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 valves type RH: [D 6105](#)
- Releasable twin check valves type DRH: [D 6110](#)

Similar products:

- Type RHV: [D 3056](#)
- Type CRH and RHC: [Page 244](#)
- Type HRP: [Page 250](#)

See also section "Devices for special applications":

- Devices for up to 700 bar

Check valves

2.5

Check valves and pre-fill valves type F

Check valves and pre-fill valves type F are check valves. They are designed as spring-loaded disc seat valves. The check valves type F enable free flow in one direction and block flow in the opposite direction.

As a pre-fill valve (check valve with hydraulic release), they are used for example in top ram presses for draining and replenishing press cylinders during opening and closing in rapid traverse mode.

The smaller sizes may be optionally equipped with a pre-release device (decompression at high pressures via the valve) to prevent decompression surges.

Features and benefits:

- Wafer design
- Extremely large flows, up to 7000 lpm

Intended applications:

- Press control systems
- Injection moulding machines



Nomenclature:	Check valve Check valve with hydraulic release (pre-fill valve)
Design:	Intermediate section between pipe flanges
Actuation:	Hydraulic
p _{max} :	400 bar
Q _{max} :	100 ... 7000 lpm

Design and order coding example

F25

Basic type, size Check valve type F, size 25 to 200

F80B-36 V

Additional versions: Without pre-release (-)
 With pre-release (V), size 25 to 80

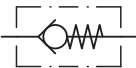
Basic type, size Pre-fill valves type F, size 25 to 200

Additional functions

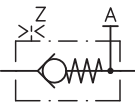
- With holes in the mounting flange (B)
- For fluids type HFA type F125-60-HFA

Function

Check valve

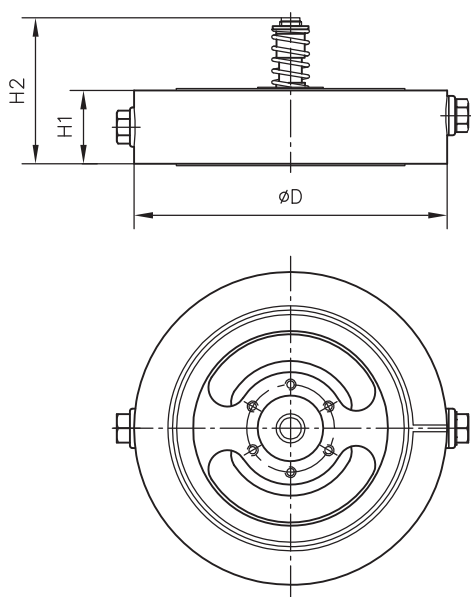


Pre-fill valve

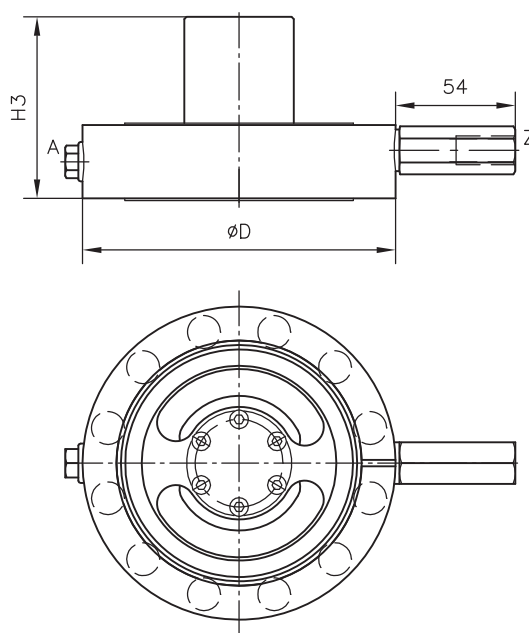


General parameters and dimensions

Check valve



Pre-fill valve



Basic type and size		$Q_{\max}$ [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(B)-30	630		4.2	143	33.5	69	83	2.8	3.4
F 80	F 80(B)-36	1000		4.5	169	38.5	83	97.5	4.4	5.2
F 100	F 100(B)-45	1600		4.3	212	44	97	118	9.9	11.7
F 125	F 125(B)-60	2500		4.3	248	51	127	155	15.8	19.6
F 160	F 160-76	4000	320	4.3	310	70	182	233	43	50
F 200	F 200-100	7000		4.0	420	150	250	300	114	120

Associated technical data sheets:

- Check valves and pre-fill valves type F: [D 6960](#)

See also section "Devices for special applications":

- Press controls

Check valves

2.5

Line rupture safety valves type LB

The line rupture safety valves type LB are check valves. They are available as insert valves or with housing for pipe connection.

The line rupture safety valve, which is generally mounted directly on the consumer (cylinder) serves to block a consumer in the event of a break in a pressurised pipe, i.e. if the hydraulic counter pressure subsides. It therefore prevents an uncontrolled decline in the load. A flow in excess of the setpoint results in a shim that has been lifted off the valve seat with spring force being pressed onto the housing seat by the flow forces, and consequently the valve closes.

Two versions – one for completely stopping the load and one with an orifice hole for a slow decrease – enable this valve to be used for various requirements.

- Features and benefits:**
- Pressures up to 700 bar

- Intended applications:**
- Industrial trucks
 - Lifting devices

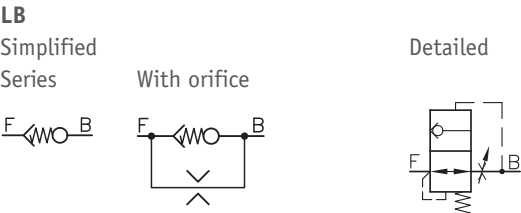


Nomen-clature:	Line rupture safety valve
Design:	Valve insert with housing for in-line installation
Adjustment:	Tool adjustable
p _{max} :	700 bar
Q _{max} :	4 ... 160 lpm

Design and order coding example

LB 2	G	1,0	- 25
		Response flow [lpm]	Response flow Q _A
		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		
	■ Design with metric thread ■ Design with UNF thread		

Function

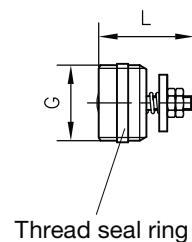
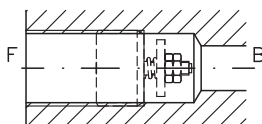
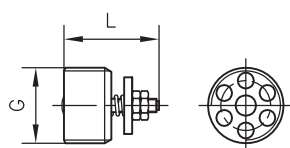


General parameters and dimensions

LB ..C

Screw-in valve

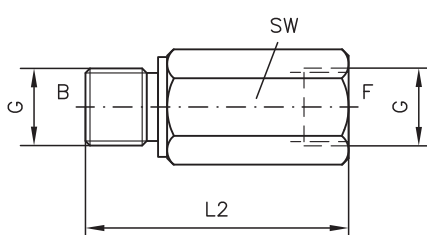
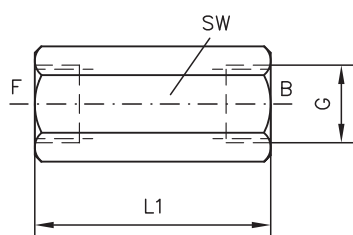
LB 11(21)C



LB ..G

Valve with housing

LB ..F



	$Q_{\max}$ [lpm]	$p_{\max}$ [bar]	Ports (BSPP)	Dimensions [mm]			SW = a/f	m [g] ²⁾
				L	L1	L2		
LB 1 (C, G, F)	4 ... 25	500	G 1/4 (A)	17.5	48	50	a/f 19	6 / 70
LB 11 C¹⁾	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 C¹⁾	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

1) The mounting thread is sealed additionally.

2) Mass for screw-in valve versions with housing

Associated technical data sheets:

- Line rupture safety valves type LB: [D 6990](#)
- Line rupture safety valves type LB.E as a screw joint: Sk 6990 E

See also section "Devices for special applications"

- Industrial trucks
- Hydraulics for mobile applications
- Screw-in valves and installation kits

Check valves

2.5

Shuttle valves type WV and WVC

Shuttle valves are stop valves with two inlets and one outlet. There is a ball in the inside of the valve, which can travel from one inlet to the other. It will automatically block the one inlet with the lower pressure. This way the higher inlet pressure is automatically led to the outlet port.

The version for pipe connection is incorporated in a T-fitting. The WVC version is designed as an insert valve.

Features and benefits:

- Max. pressure 700 bar
- Insert and housing versions

Intended applications:

- For Load-Sensing systems
- Often in mobile hydraulics



Nomenclature:	Shuttle valve
Design:	Individual valve for pipe mounting Valve insert Screw-in valve
p _{max} :	700 bar
Q _{max} :	6 ... 150 lpm

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 cartridge valve, size 1

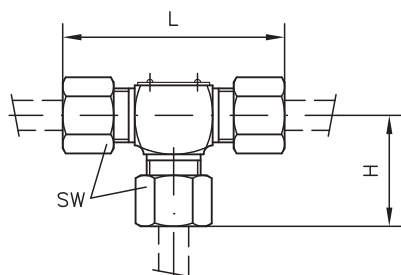
Function

WV, WVC, WVH

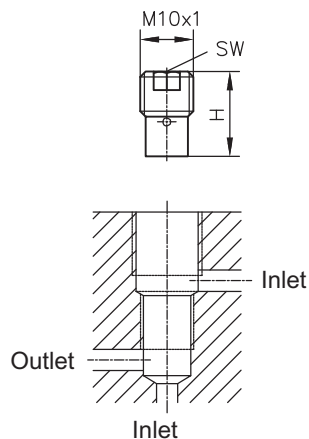


General parameters and dimensions

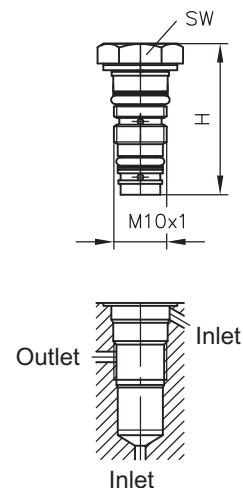
WV..



WVC 1



WVH 1



	Q _{max} [lpm]	p _{max} [bar]	External pipe Ø [mm]	Mounting thread	Dimensions [mm]			m [g]
					L	H	SW = a/f	
WV 6 - S	6	315	6	-	62	31	SW 17	120
WV 8 - S	15		8		64	32	SW 19	170
WV 10 - S	25		10		68	34	SW 22	225
WV 12 - S	40		12		76	38	SW 24	290
WV 14 - S	60		14		80	40	SW 27	320
WV 16 - S	100		16		86	43	SW 30	390
WV 18 - L	150		18		80	40	SW 32	340
WVC 1	6	315	-	M 10 x 1	--	16	SW 5	7
WVH 1	3	700	-	M 10 x 1	--	28,5	SW 14	10

Associated technical data sheets:

- Shuttle valves type WV and WVC: [D 7016](#)

Similar products:

- Shuttle valves type WVH: **Sk 7962**

See also section "Devices for special applications":

- Screw-in valves and installation kits

Hydraulic cylinders

Hydraulic clamps type HSE and HSA

262



*Hydraulic clamps
type HSE and HSA*

Hydraulic cylinders

Type	Nomenclature/Design	$p_{\max}$	$F_{\max}$
HSE, HSA	Hydraulic clamps ■ Screw-in version ■ Manifold mounting	500 bar	60000 N

Hydraulic cylinders

3

Hydraulic clamps type HSE and HSA

Hydraulic clamps type HSE and HSA are single-acting power elements equipped with return springs, which are used in hydraulic fixtures where only a very restricted space is available for the generation of high forces with limited piston movement. The type HSE is designed as a screw-in cylinder whereas type HSA is manifold mounting. These clamps are available, depending on application with piston diameters between 12 and 40 mm and strokes between 2 and 25 mm. They are mainly used for clamping work pieces, slides and guides, indexing round tables and for bending punching and cutting purposes.

Features and benefits

- Compact
- Operating pressure up to 500 bar

Intended applications:

- Clamping systems
- Securing systems



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

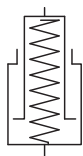
- 15

Stroke [mm] Stroke H

Basic type, piston diameter [mm] Screw-in version type HSE
Manifold mounting version type HSA

Function

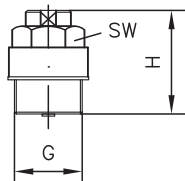
HSE, HSA



General parameters and dimensions

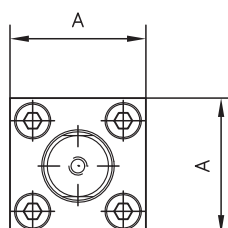
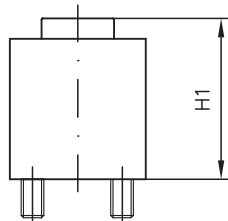
HSE ..

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](#)

See also section "Devices for special applications":

- Hydraulics for clamping

Hydraulic accessories

Pressure switches type DG	266
Hydraulic miniature accumulators type AC	268
Piston type accumulator type HPS	270
Hydraulic accessories	272



*Pressure switches type DG
and analogous pressure sensors*

Type	Nomenclature/Design	Capacity	p _{max}	Piston diameter
DG	Spring-loaded piston-type pressure switch, electronic pressure switch ■ Manifold mounting ■ Screw-in version ■ Version for pipe connection		0 ... 700 bar 0... 1000 bar	
AC	Hydraulic accumulator ■ Screw-in version	V ₀ : 0,013 ... 2.8 dm ³	500 bar	
HPS	Piston-type accumulator ■ Basic type HPS	V ₀ : 0,4 ... 80 dm ³	p _{operation} : 415 bar	80 ... 250 mm
Hydraulic accessories	Reducing connector, connection fitting, screen filter, wire mesh filter, pressure gauge ■ Screw-in version ■ Version for pipe connection		350 ... 700 bar	

Hydraulic accessories

4

Pressure switches type DG

Pressure switches close or open electrical contacts when under pressure. They are used to issue an electrical switching command or signal for further operations when a predefined pressure value is reached.

Different versions (with pressure setting on an adjusting knob, main and secondary switch, screw-on pressure switch) enable their use in a wide range of applications. A design-related difference (hysteresis) of 8... 20% is to be expected between the upper and lower switching point in piston-type pressure switches.

In contrast to this, the type DG5E and DG6 electronic pressure switches provide the option to select two independent pressure switching points and/or program or adjust the hysteresis.

Type DT is an analogous pressure sensor.

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 Pressure transducer
Design:	Screw-in version Manifold mounting Designed for pipe fittings
Pmax:	0... 1000 bar

Design and order coding example

DG 1	RF	
DG 35	V	-YS 8

Hydraulic connection

- With various tapped journals or to be mounted at fittings (type DG 3..)
- Combination with various fittings

Means of adjustment, mounting

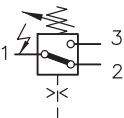
- Manually adjustable (R) or Turn-knob (V, H = with lock) (type DG 3..)
- Design with bezel for installation in control panels (F)

Basic type

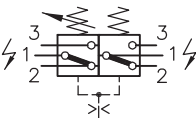
Pressure switch type DG
Type DG 1, 3, 8 (spring loaded piston type switch)
Type DG 5, DG 6 (Electronic pressure switch with two switch points)
Operating voltage 12 V DC, 24 V DC, 110 V AC, 230 V AC
Analogous pressure transducer type DT
Type DT 11
Type DT 2

Function

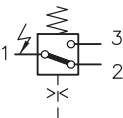
DG 1 R



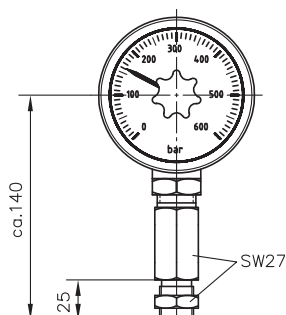
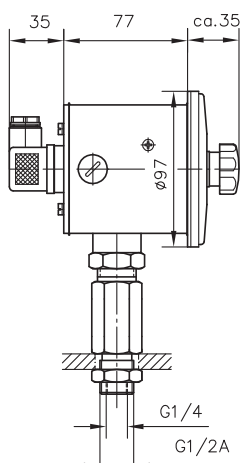
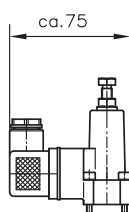
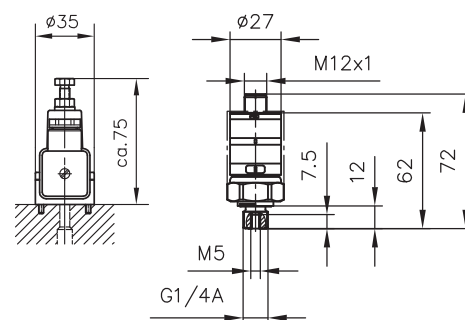
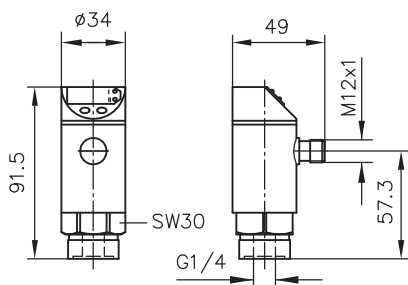
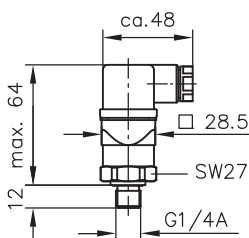
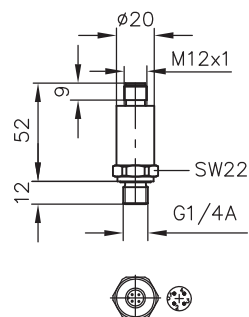
DG 8



DG 3...



General parameters and dimensions

DG 1 R

DG 8

DG 3 ..

DG 6..

DG 5 E

DT 11

DT 2


	Brief description	Adjustable pressure p_{max} [bar] ¹⁾	Ports (BSPP)	m [kg]
DG 1 R	Adjustment via turn-knob at the dial	20 ... 600	G 1/2 or G 1/4 A	1,3
DG 8	Version with two pressure switches Main switch: Adjustment via turn-knob at the dial Secondary switch: Adjustment via set screw	20 ... 600 and 20 ... 180	G 1/2 or G 1/4 A	1,35
DG 3..	Compact design for manifold mounting Adjustment via set screw	4 ... 700	G 1/4 or G 1/4 A ²⁾	0,3
DG 5 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	Analogous pressure sensor	0 ... 1000	G 1/4	0,08
DT 2		0 ... 600	G 1/4	0,7

1) The max. operation pressure of 700 bar is not influenced by the max. set pressure

2) For versions with adapter only

Associated technical data sheets:

- Pressure switches type DG: [D 5440](#)
- Electronic pressure switch type DG 5 E: [D 5440 E/1](#)
- Electronic pressure switch type DG 6: [D 5440 F](#)

Hydraulic accessories:

- Fittings type X, X 84: [Page 272](#)

Similar products:

- Analogous pressure sensor type DT 11: [D 5440 T/2](#)
- Analogous pressure sensor type DT 2: [D 5440 T/1](#)

See also section "Devices for special applications":

- Hydraulics for clamping purposes
- Press controls
- Devices for up to 700 bar

Hydraulic accessories

4

Hydraulic miniature accumulators type AC

The hydraulic accumulators type AC are available in two categories. The hydraulic miniature accumulators with a capacity of 0.013 dm³ and 0.040 dm³ are used for applications including clamping hydraulics for volume compensation in the event of temperature fluctuations, covering possible oil losses due to leakage or oscillation damping of functional parts activated by pressure difference.

The diaphragm accumulators with a capacity of up to 3.5 dm³ are primarily used as a source of pressure oil for supporting/increasing the pump delivery flow and storing pressure energy, in order to achieve an accumulator charging circuit, for example. Various fittings enable the integration of a hydraulic system in different installation positions and at different installation points.

- 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



Nomenclature:	Hydro-pneumatic accumulator
Design:	Screw-in version
p _{max} :	500 bar
V _{max} :	1,95 dm ³

Design and order coding example

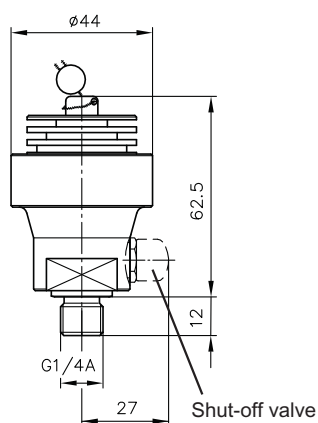
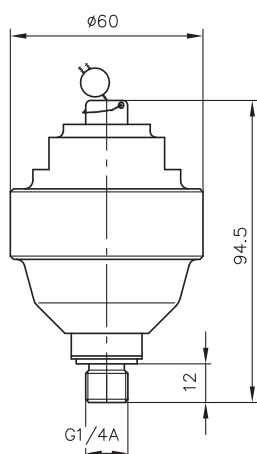
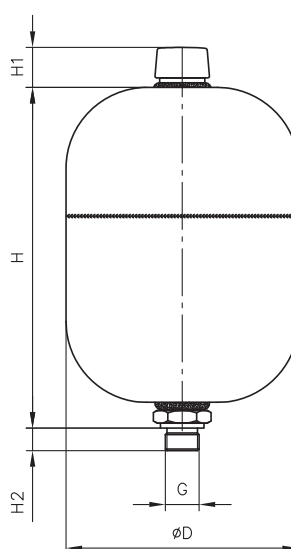
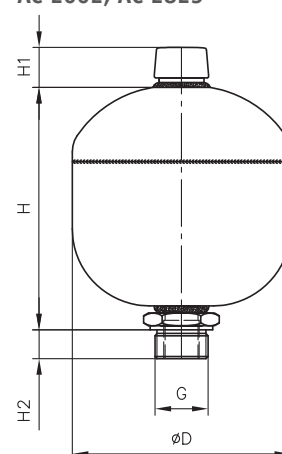
AC 2001	/90	/3A
Basic type, size		
Hydraulic accumulator type AC		
Connection thread (hydraulic side)		
Gas pre-charge pressure [bar]		

AC 40	- 1/4	- 200	
ACS 13	- 1/4	- 50	/110
Basic type, nom. volume			
Hydraulic miniature accumulator type AC and type ACS with shut-off valve, nom. volume in cm ³			
Setting shut-off valve [bar]			
Gas pre-charge pressure [bar]			
Connection thread			

Function



General parameters and dimensions

AC(S) 13 - 1/4

AC 40 - 1/4

AC 0725, AC 202, AC 322

**AC 603, AC 1002, AC 1414,
AC 2002, AC 2825**


	V ₀ [dm³]	p _{max} [bar]	Max. gas filling pressure p ₀ [bar]	Ports (BSPP)	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 202/3	0.16	250	130	G 3/8 A	102	26.5	-	74	0.8
AC 322/3A	0.32	210	140	G 1/2 A	101.5	25	12	92.5	1.4
AC 603/3	0.6	330	200	G 1/2	149	23	-	115	3.3
AC 1002/22	1.0	210	140	M 22 x 1,5	151	25	18	136	3.5
AC 1414/2A	1.4	140	120	G 3/8 A	162	25	18	147	4.2
AC 2002/4	1.95	250	140	G 3/4	229	25	-	155	7.5
AC 2825/2AW	2.8	250	130	G 3/8 A	246	26.5	18	167	8.2

Associated technical data sheets:

- Hydraulic miniature accumulators type AC: [D 7571](#)
- Diaphragm accumulator type AC: [D 7969](#)

Hydraulic accessories:

- Fittings type X84: [Page 272](#)

Similar products:

- Piston type accumulator type HPS: [Page 270](#)

See also section "Devices for special applications":

- Hydraulic clamping systems

4

Piston type accumulator type HPS

In many mobile and stationary applications, a modern hydraulic system includes reliable and powerful hydraulic accumulators. They are especially useful when energy is to be stored, pressure surges are to be damped, leakage is to be compensated or high flows are to be delivered in a short time. There is usually no faster or easier solution to do so than with a piston-type accumulator. The freely moving piston separates the compressible gas cushion and the hydraulic fluid. High-quality and thoroughly tested piston sealings guarantee a reliable separation of gas and oil even under extreme conditions.

To enable any arrangement of the piston-type accumulator, the accumulators are available with the appropriate mounting clips.

- Features and benefits:**
- Compact design
 - Option of integration into the HAWE modular system

- Intended applications:**
- Accumulator charging systems
 - Construction machinery
 - Wind turbine systems



Basic type:	HPS
Nomenclature:	Piston accumulator
Operation pressure:	415 bar
Capacity:	0,1 - 80 dm³
Internal piston diameter:	80 - 250 mm

Design and order coding example

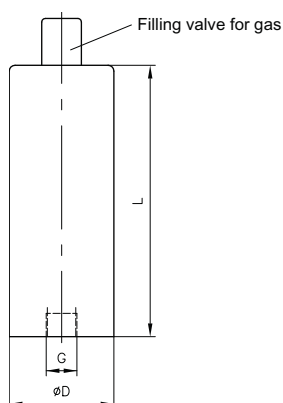
HPS 11	- 250	- 160	- 0050
			Nom. volume V ₀ [dm³]
			Int. diameter [mm]
			max. operating pressure [bar] Pressure ratings 250 bar, 350 bar, 415 bar
Basic type	Piston type hydraulic accumulator type HPS		

Function



General parameters and dimensions

HPS



	Nom. volume V_0 [dm ³]	$p_{\max}$ [bar]	Ports (BSPP)	Dimensions [mm]	
				D	L
HPS 11 - 250 - 080	0.4 ... 4.0	250	G 3/4	90	233 ... 949
HPS 11 - 250 - 100	2.0 ... 10.0		G 1	110	439 ... 1458
HPS 11 - 250 - 160	5.0 ... 30.0		G 1 1/2	180	436 ... 1680
HPS 11 - 250 - 200	8.0 ... 50.0		G 2	229	233 ... 1840
HPS 11 - 250 - 250	10.0 ... 80.0		G 2	275	465 ... 1886
HPS 11 - 350 - 080	0.4 ... 4.0	350	G 3/4	95	254 ... 970
HPS 11 - 350 - 100	2.0 ... 10.0		G 1	115	457 ... 1475
HPS 11 - 350 - 160	5.0 ... 30.0		G 1 1/2	185	458 ... 1702
HPS 11 - 350 - 200	8.0 ... 50.0		G 2	225	513 ... 1849
HPS 11 - 350 - 250	10.0 ... 80.0		G 2	280	491 ... 1917
HPS 11 - 415 - 080	0.4 ... 4.0	415	G 3/4	95	254 ... 970
HPS 11 - 415 - 100	2.0 ... 10.0		G 1	115	469 ... 1488
HPS 11 - 415 - 160	5.0 ... 30.0		G 1 1/2	185	458 ... 1702
HPS 11 - 415 - 200	8.0 ... 50.0		G 2	230	522 ... 1859
HPS 11 - 415 - 250	10.0 ... 80.0		G 2	290	491 ... 1917

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

Associated technical data sheets:

- Piston-type accumulator type HPS: [D 7969 HPS](#)

Similar products:

- Diaphragm accumulator type AC: [Page 268](#)

Hydraulic accessories

4

Hydraulic accessories

Hydraulic systems use measuring instruments () for pressure monitoring, command devices for pressure-controlled switching (pressure switches) and hydraulic accumulators. Using the various fittings, these devices can be connected to the pressure pipes of HAWE hydraulic power packs as well as valves in a wide range of installation situations.

help to combine devices. Other accessories, such as screen and wire mesh filters protect hydraulic devices from larger, stray impurities that occasionally occur. These are available in two versions: as screen filters and wire mesh filters (wire mesh filters preferentially used in control circuits without a significant current flow).

Features and benefits:

- Compact design
- Option of integration into the HAWE modular system
- Operating pressures up to 700 bar

Intended applications:

- General hydraulic systems



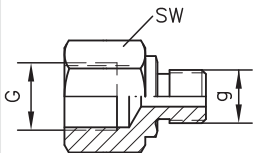
Nomenclature:	Reducing connector Connection fitting Screen filter Wire mesh filter Pressure gauge
Design:	Screw-in version for pipe connection
p _{max} :	350... 700 bar

Designs

Reducing connectors (various dimensions)

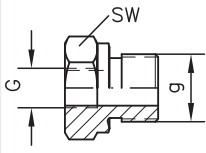
G - g

- Internal thread - external thread
- BSPP thread - metric thread
- BSPP thread - BSPP thread
- Metric thread - metric thread
- Metric thread - BSPP thread



SW 19 - 55

Example: G 1/2A - M 16 x 1.5



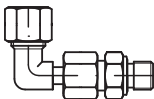
Example: G 1/2 - G 1A

Fittings

- Connection fitting with tapped journal G 1/4
- Connection fitting with fastening nut and internal port G 1/4
- Connecting pieces for attaching the cutting ring for external pipe diameter 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

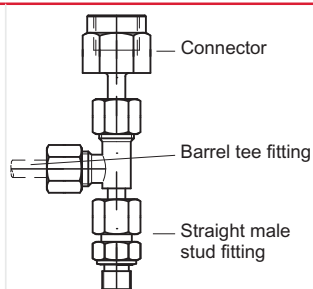
Symbol:



Fitting combinations

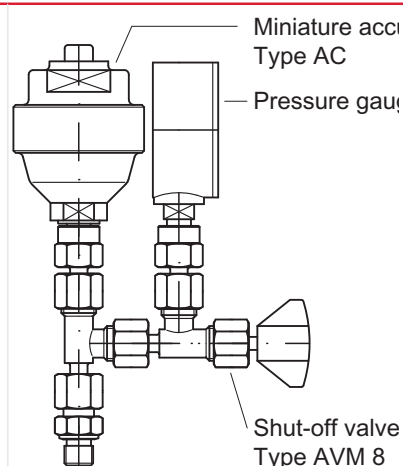
Consisting of:

- Connecting pieces
- Straight screw-in fitting
- Swivel fitting
- L-connecting pieces
- Elbow fitting
- AVM 8 shut-off valve
- Locking element



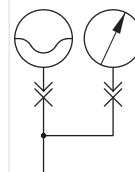
Example: X 84T

Symbol:



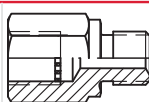
Example: X 84U - AC 40/100-9/400

Symbol:



Screen and wire mesh filters

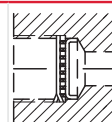
- BSPP thread
- Metric thread
- Screw-in strainer type HFC (hole $\varnothing$ 0.63 mm)
- Screw-in wire mesh filter disc type HFC.. F (filter fineness approx. 100 μ m)
- Also available with housing



Example:

HFE 3/8

Strainer with housing (hole $\varnothing$ approx. 0.5 mm), with connection thread G 3/8(A)



Example:

HFC 1/4 F

Screw-in wire mesh filter disc for port G 1/4, filter fineness approx. 100 μ m

Symbol:



Associated technical data sheets:

- Reducing connectors: [D 845D 845](#)
- Fittings type X: [D 7065](#)
- Fitting combination type X84: [D 7077](#)
- Screen and wire mesh filters: [D 7235](#)
- Shut-off valves type AVM 8: [Page 238](#)

See also chapter "Equipment for special applications":

- Clamping hydraulics

Electronic accessory components	276
Type PLVC programmable logic valve control	278



*Programmable logic valve controls
type PLVC*

Electronic accessory components

Type	Nomenclature	Designs
Accessory component	■ Plugs with no special feature (standard) - With rectifier circuit, - With clamp diode, - With LED with economy circuit ■ Amplifier units for proportional solenoids ■ Power supply units	■ Plugs ■ Modules with screw terminals ■ Cards with terminal strip

Programmable logic valve controls

Type	Nomenclature/Design
PLVC	Programmable logic valve control ■ Modular system with - Basic modules - Extension modules - CAN bus nodes - Display - Software
CAN-IO	CAN node ■ Programmable

5

Electronic accessory components

A range of electronic accessory components is available in various versions for the control of common on/off and proportional solenoids. These include electronic amplifiers in the form of modules and cards and versions integrated in the plug for single and twin solenoids, as well as for pressure switches. A power supply unit for 24V DC solenoid valves is also available. All of these components are tailored to HAWE solenoid valves.

Features and benefits:

- Compact design
- Functions tailored to HAWE products

Intended applications:

- For control of all types of proportional valves
- Plug for visual operation control, prolonging the service life of the solenoid etc.



Nomenclature:	■ Plugs with no special feature (standard) With rectifier circuit With clamp diode With LED with economy circuit ■ Amplifier units for proportional solenoids ■ Power supply units
Design:	Plugs Modules with screw terminals Cards with terminal strip

Designs

Plug for solenoid valves (single and twin solenoid)

Brief description	Application
No special feature (standard)	For all applications with no special requirements
Version with LED	Visual operation control 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	Increased functional security and prolonged service life of the solenoids by reducing the voltage (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	Enables use of DC solenoids when a power supply of 110V AC, 230V AC is available

Plugs with no special feature (DC voltage supply) or the version with rectifier circuit for power supply of 110V AC, 230V AC are included as standard in the scope of delivery of the solenoid valve.

Proportional amplifier

Features:

- Constant current control (regardless of the power supply and changes in resistance of the solenoid due to heating effects)
- Improved EMC properties
- Use in a broad temperature range

Adjustable parameters:

- $I_{\max}$ and $I_{\min}$ setting
- Setting for ramp time up to 10 sec
- Reference voltage for potentiometric setpoint generator available
- Option to set dither amplitude and frequency

Type	Brief description	Application
EV 1 M EV 1 G EV 1 D	Module version (board only or built-in housing)	Suitable for installation in switch cabinets, secured with screw terminals
EV 22 K	Card version	Card suitable for control of two proportional solenoids. Use in card holder for one, or in a module rack for max. 3 amplifier cards

Power supply units for solenoid valves

Type	Brief description	Application
MNG	Power supply unit for input voltage 230V AC and output voltage 24V DC, max. power rating 5A	Power supply for solenoid-actuated hydraulic valves or electrical amplifiers for proportional solenoids

Associated technical data sheets:

Please check whether correct links are inserted

Plugs:

- [Socket connectors \(type overview\): D 7163](#)
- Economy circuits for WG 230 actuating solenoids: [Directional seated valves: D 7831](#)
- [Economy circuit plug type MSE 28026 with adjustable economy voltage: D 7832](#)
- [Type MSD 4 P55 line connector with economy circuit for 24 VDC: D 7833](#)

Electronic amplifiers:

- [Type EV1M 2-12/24 and EV1M 2-24/48 electronic amplifier: D 7831/1](#)
- [Electronic amplifier type EV1D: D 7831 D](#)
- [Electronic amplifier type EV1G1-12/24: D 7837](#)
- [Electronic amplifier type EV22K2-12/24: D 7817/1](#)

Power supply units:

- [Power supply unit type MNG 2,5-230/24 and MNG 5-230/24: D 7835](#)

Further information:

- Possible combinations of valves and electronic accessories: **P 7163**
- [Joysticks type EJ: D 7844](#)

Programmable logic valve controls:

- Type PLVC 21: [Page 278](#)
- Type PLVC 41: [Page 278](#)
- Type PLVC 8: [Page 278](#)

CAN node

- Type CAN-IO 14: [Page 278](#)

Suitable products:

Lifting modules:

- Type HMT etc.: [Page 166](#)

Prop. pressure valves:

- Type PM, PMZ: [Page 200](#)
- Type PMV, PDV: [Page 188](#)
- Type PDM: [Page 202](#)

- Prop. directional seated valves type EMP: [Page 152](#)
- Prop. directional spool valves type PSL, PSV: [Page 104](#)
- Prop. flow control valves type SE, SEH: [Page 224](#)

Electronic pressure sensors:

- Type DT 11 and DT 2: [Page 266](#)

See also chapter "Equipment for special applications":

- Proportional valves

5 Type PLVC programmable logic valve control

The type PLVC programmable logic valve control is intended for the actuation of complex hydraulic systems. Any movement sequences with pressure, speed and acceleration profiles can be implemented and saved in pre-defined limit areas. Analogue and digital components as well as components linked to CAN bus (e.g. valves, pressure sensors, joystick) can be used via cable or remotely to control tasks. This type of control can also be described as PLC with integrated prop. amplifiers.

High flexibility via:

- Modular systems with extension 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 machinery
- Crane systems
- Complex lifting devices
- Machines for forestry purposes
- Machine tools and press construction



Nomenclature:	Programmable logic valve control
Version:	Modular concept with ■ Basic modules ■ Expansion modules ■ CAN bus nodes ■ Display ■ Software

Basic types and general parameters

	PLVC 41	PLVC 21	PLVC 8	CAN-IO 14
Number of inputs ¹⁾				
Digital	27 (3 / 24)	13 (5 / 8)	17 (10 / 7)	1
Analogue	28 (4 / 24)	12 (4 / 8)	23 (11 / 12)	6 (10)
Frequency	3 (3 / -)	3 (3 / -)	3 (3 / -)	-
Emergency stop	x	x	x	-
Number of outputs ¹⁾				
Digital	16 (- / 16)	16 (8 / 8)	13 (- / 13)	4
Analogue (PWM)	16 (4 / 16)	4 (4 / -)	16 (16 / -)	4
Analogue (0 ... 10V)	1 (1/-)	--	--	-
Relay	8 (3 / 8)	4 (- / 4)	--	-
Auxiliary voltage	1 (5V DC)	--	--	-
Interfaces				
RS 232	x	x	x	x
CAN bus	x	x (- / x)	x (x / x)	x
Profibus	--	x	--	-
Voltage supply (10 ... 30V DC)	5A (10A)	5A	5A	10A

1) Always max. number of inputs and outputs, figures in brackets apply to basic modules and expansion modules

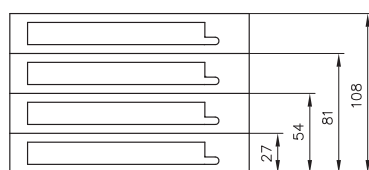
Software function packs (examples):

- Position measurement
- CAN bus communication
- Position and volumetric flow control
- Fault detection
- Controller for closed control circuits
- Ganging
- Electronic volumetric flow distribution
- Stability
- Limit load control
- Pressure control

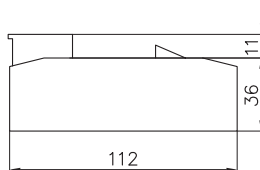
Furthermore, the system allows customers to use the aforementioned PLC programming to very quickly make individual adaptations using structured texts (ST).

Dimensions

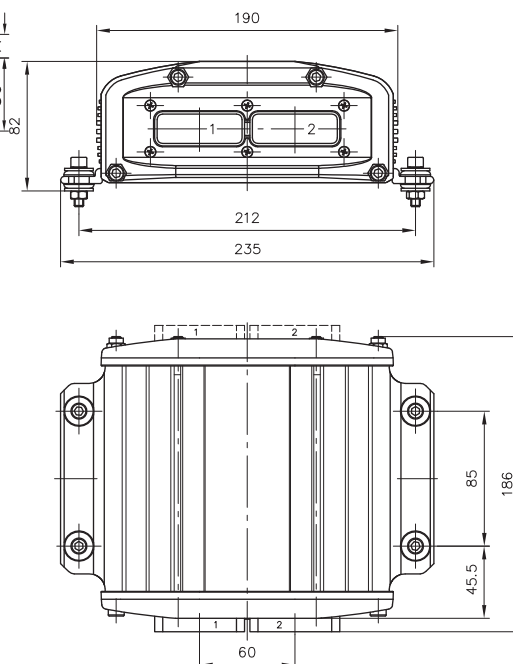
PLVC 41



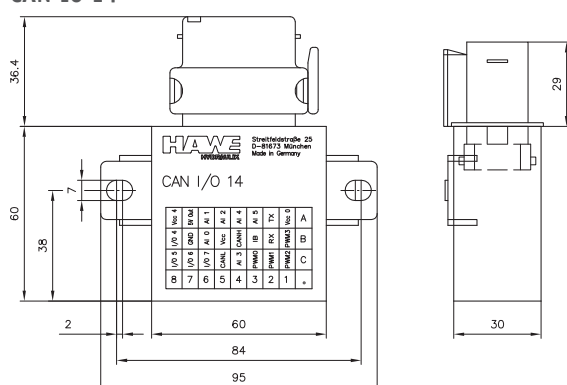
PLVC 21



PLVC 8



CAN-IO 14



Programmable logic valve control:

- Type PLVC 21: [D 7845-21](#)
- Type PLVC 41: [D 7845-41](#)
- Type PLVC 8: [D 7845 M](#)
- Type CAN-IO 14: [D 7845 IO](#)
- Type PM, PMZ: [Page 200](#)
- Type PMV, PDV: [Page 188](#)
- Type PDM: [Page 202](#)

Prop. pressure valve:

- Including type HMT lifting modules: [Page 166](#)
- Type PSL, PSV prop. directional spool valves: [Page 104](#)
- Type SE, SEH prop. flow control valves: [Page 224](#)

See also chapter "Equipment for special applications":

- Industrial trucks
- Mobile hydraulics
- Prop. valve technology

Appendix

Pressure fluids – notes for selection	281
Devices for special applications	286
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Adresses of Offices and Representatives	302
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6 Pressure fluids – notes for selection

The performance of a hydraulic system depends to a large extent on the quality of the pressure fluid used.

The pressure fluid should essentially be selected according to the operating conditions, such as

- Temperature (see viscosity classes)
- Device type (possible ban on certain pressure fluids due to undesired reactions with metals, seals etc.)
- Usage type (e.g. environmentally compatible pressure fluids)
- Surroundings (use of existing pressure fluids)

	The following viscosity ranges and temperature ranges apply to HAWE devices:
Temperature range:	Surrounding area: approx. -40...+80 °C (attention: +5...+80 °C for type LP air-driven pumps) Pressure fluid: -25...+80 °C Please observe viscosity range and any additional restrictions.
Permissible temperature during start:	down to -40 °C (observe start-viscosity!), 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 optimum service approx. 10...500 mm ² /s

Mineral oils

Pressure fluid	Characteristics	Unusual features / restrictions
■ Pressure fluids HLP (DIN 51524 part 2)	Mineral oil with additives improving corrosion, oxidation and wear protection	Common hydraulic oil
■ Pressure fluids HL (DIN 51524 part 1)	Mineral oil without wear protecting additives	No wear protection additives therefore not suitable for gear pumps. HAWE-pumps type: Z, RZ, MP..-Z, HK..Z Observe manufacturer's specifications for other devices!
■ Pressure fluids HVL (DIN 51524 part 3)	Mineral oil with same additives as HLP, but with increased viscosity index for use in higher temperature ranges	Additives improving the viscosity index show drawbacks concerning e.g. shear strength (viscosity drop during load by 30%), fall out of water and air. Use only, if temperature range requires this. Observe fluid manufacturer's specification !
■ Undoped oil H e.g. - lubricating oils (DIN 51517 part 1) - white oil (e.g. USDA H1)	Mineral oil without additives	Only for systems for intermittent service (S2 or S3 operation), due to the missing additives (low lubricating characteristic). White oil is mainly used in systems for food processing.
■ Special fluids for aviation (MIL H-5606) for off-shore applications (NATO H 540)	Mineral oils are based as a rule on naphthenic based oil with wide temperature range	Seals made of fluor rubber FPM might be required, depending on pressure fluid. Consult the oil manufacturer!
■ Other mineral oils Engine oils type HD (e.g. DIN 51511) Automatic transmission fluid type ATF(AQA Suffix A) Diesel fuel Test oil for diesel injection pumps	Mineral oils which basically were developed for other application purposes.	More or less well suited pressure fluids. Observe whether it contains additives preventing corrosion and oxidation as well as material compatibility (especially with seals). Attention: increased leakage with directional spool valves. Consult the oil manufacturer!

Ecologically compatible pressure fluids VDMA 24568 and 24569

Pressure 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 strength (< 60...70°C)	Not suited for oil immersed hydraulic power packs type HC, MP, FP, HK, all valves with wet armature solenoids as well as control systems utilizing many throttles. Fluids type HETG show a tendency to gum, aging, and sticking at higher temperature (> 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 Polyethyleneglycol (PAG) Similar qualities i.e. service life, lubricating characteristics and pressure resistance, like mineral oil	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 ■ Is not suitable for pumps type HC, MP, FP, HK, RZ, Z and connection blocks with filter type A.F., AF, BF, EF, FF
■ Synthetical ester HEES (carbon acid ester, diester, polyester)	Similar qualities i.e. service life, lubricating characteristics and pressure resistance, like mineral oil	No restrictions with regard to the operation behavior. Contact with PVC should be avoided.

Fire inhibiting pressure fluids conforming DIN 51502

Pressure fluid	Characteristics	Unusual features / restrictions
■ HFA (pressurized water, emulsions)	Emulsion, oil solved in water (water content > 80%) max. temp. range approx. 60°C	There is the danger of corrosion and cavitation due to the high water content, therefore only devices intended for it, should be used (some pump versions of type R, directional seated valves acc. to D 7300). Max. oper. pressure of the pump 50...60% (danger of cavitation) Min. oil content > 4% ■ No use of oil immersed hydraulic power packs – danger of short-cuts-applies to pumps type HC, MP, FP, HK ■ No cellulose filters – danger of clogging
■ HFC	Glycol / water solution (water content < 35%) max. temp. range approx. 60°C	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 ■ Is not suitable for pumps type HC, MP, FP, HK, RZ, Z and connection blocks with filter type A.F., AF, BF, EF, FF
■ HFD HFDR phosphoric ester HFDS chlorinated hydrocarbon HFDT blend of HFDR and HFDS HFDU other composition	Fluids without water content, similar qualities like mineral oil	No restrictions with regard to the operation behavior, but it ■ Requires seals out of FPM (FKM) (see also section "Seals")

Special fluids

Pressure fluid	Characteristics	Unusual features / restrictions
AT-Brake fluid	Brake fluid based on glycol (DOT 4)	No restrictions with regard to the operation behavior, but devices must be equipped with EPDM or SBR-seals when operated with brake fluid (see also section "Seals") No compact hydraulic power packs type HC, MP, FP, HK

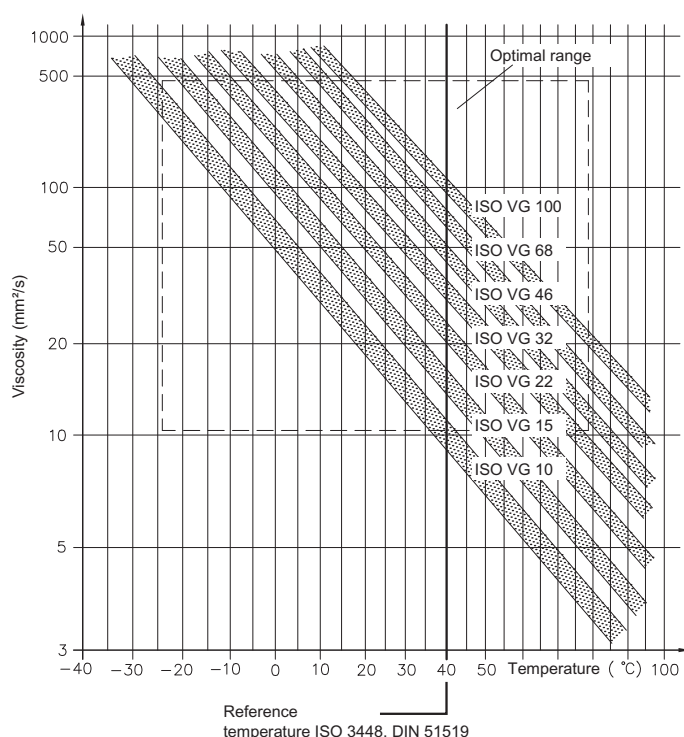
Selection of the viscosity

The industrial standard "ISO Viscosity classification for liquid lubricants" (ISO 3448, DIN 51519) lists 18 viscosity classes, but only the viscosity classes ISO VG10 to ISO VG68 are of common interest for hydraulic systems. The index No. behind ISO VG informs about the nom. viscosity at 40°C. The temperature behavior illustrated in the curve applies to mineral oil only. The behavior of HVLP and environmentally friendly fluids is less temperature dependent i.e. the curve is less steep.

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 (estimated or demanded) temperature (to ensure sufficient service life of the seals not above 80°C!)

Temperature / viscosity curve



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 application (for use in the open, operation in summer only)
- VG46, VG68**
 Systems in tropical conditions at ambient temperatures up to 40°C or closed rooms

Filtration

Major malfunctions of a hydraulic system can be caused by contamination like fine wear particles and dust or bigger particles e.g. swarf, rubber from tubing or seals. Therefore the following filtration is recommended (after a thorough initial flushing):

Recommended purity of the pressure fluid			Recommended filter fineness	Devices	
ISO 4406 : 1999	NAS 1638	SAE T 490			
21/18/15...19/17/13	12 ... 8	≥6	$\beta_{16...25} \geq 75$	Radial piston and gear pumps, valves, cylinders (use in general mechanical engineering)	The purity degree of the pressure fluid is especially important for the repeatability accuracy with proportional valves. It should be noted that new pressure fluid "from the barrel" does not necessarily fulfil the highest cleanliness requirements.
20/17/14...18/15/12	11 ... 6	5 ... 3	$\beta_{6...16} \geq 75$	Prop. pressure and flow control valves	

Lower limits must be applied for pressure above 250 bar

Service life

The aging of pressure 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 pressure 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, pressure fluids with low water content) Avoid higher temperatures – Service life reduction – (+10K corresponds to half service life)
- Circulation ratio of the pressure fluid $\frac{Q_{pump}[lpm]}{V_{circuit}[l]}$ (guideline)
 - approx. 0.2...0.4/min for conventional hydraulic power packs
 - approx. ...1/min for mobile hydraulics
 - approx. ...4/min for hydraulic power packs operated on/off or with idle circulation
- Control of the pressure fluid on a regular base (fluid level, contamination, coloring index, neutralization value etc.)
- Change of the pressure fluid on a regular base (depending on fluid type and application conditions)
Guideline:
 - approx. 4000 ... 8000 h (mineral oil)
 - approx. 2000 h (other pressure fluids)
 - or at least annually
 Take into account notes of the fluid manufacturer!

Change of the pressure fluid

Mixing different kinds of pressure fluid sometimes can cause unintended chemical reactions such as sludging, gumming etc.

Therefore the relevant manufacturers should be consulted when switching between different pressure fluids.

In all cases, the whole hydraulic system must be rinsed thoroughly.

Seals

Any question about the compatibility with seal material should be settled with the fluid manufacturer always before using a certain pressure 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 following 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 (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)

Storage of hydraulic components

The storage conditions for hydraulic components depend primarily on the seals used and the test bench oil with which the parts are moistened. The storability of rubber materials is generally influenced by the following factors:

- Warmth, light, humidity, oxygen, ozone

The storing conditions for hydraulic components mainly depend on the used seal material and the test rig fluid which is on all internal parts. The storability of rubber materials is generally influenced by the following factors:

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/BS3F68:1977, MIL-HDBK-695C, MIL-STD- 1523A, DIN 9088.

Hydraulic oils 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. In addition, a functional test (emergency manual override, dry switching) should be carried out on the device at least once a year to ensure operation when required.

With safety-related components, a six-monthly functional test on site and a regular factory inspection including seal replacement every 2 years are recommended.

The risk of corrosion of hydraulic components that are stored as described above is low, as most external parts are coated with a protective layer (galvanised, gas-nitrated) and moistened with oil.

6 Devices for special applications

The complexity of the selection of the proper pump, valves and other components is increasing as the number of products available is rising and as the devices are getting more specialized. We have listed the devices on the following pages according to their function or their intended purpose. This selection should be used only as a rough guide for general applications and do not include all HAWE products available. A brief description for most of these products may be found in the main sections of this product catalogue. More detailed information is contained in the corresponding supplemental pamphlets listed, which may be ordered via our sales offices, representatives or directly from HAWE in Germany.

Devices intended for the following applications:

- Hydraulics for clamping
- Press control systems
- Industrial trucks
- Mobile hydraulics
- Systems for potentially explosive atmospheres, ATEX-compliant
- Use with HFA, emulsions or press water

Devices with the following characteristics:

- Proportional valves
- Devices for system pressure from 500 to 700 bar
- Cartridge and screw-in valves
- Devices with unit approval or special listing (TÜV, GL, automotive industry)
- (TÜV, GL, automotive sector)

Devices for clamping at machine toll, jigs etc.

Nomenclature	Q _{max} [lpm]	p _{max} [bar]	Pamphlet	Page
Compact hydraulic power packs type NPC	1.36	750	D 7940	12
Compact hydraulic power packs type HC, HCW and HCG	12.9	700	D 7900, D 7900 G	14
Pumps complete with motor and hydraulic power packs type MP and MPN	14.8/108	700/150	D 7200, D 7200 H, D 7207	22
Compact hydraulic power packs type HK, HKF and HKL	12.9/16	700/150	D 7600-4, D 7600-3, D 7600-3L, D 7600-2	26
Compact hydraulic power packs type KA and KAW	6.2/10.3	700/150	D 8010	18
Connection blocks some with return or pressurized filter type A, B and C, (for hydraulic power packs type HC, MP, MPN, FP, HK, KA)	18	700	D 6905 A/1, D 6905 B, D 6905 C, D 6905 TÜV	32
Two stage connection block type NA		700/120	D 6905 A/1	32
Solenoid actuated directional spool valve type SW, SWR, SWS, SWP and NSWP	25	315	D 7450, D 7451, D 7451 N, D 7951	88
Directional seated valves with different actuations type G, WG, H, P, K, T, F and D	120	700	D 7300	124
Directional seated valves with different actuations type of NG, NWG, NH, NP, NK, NT, NF and ND (connection hole pattern NG 6)	12	500	D 7300 N	124
Directional seated valve banks type VB	120	700	D 7302	130
Directional seated valves type WH and WN	60	450	D 7470 A/1	136
Valve banks type BWH and BWN	60	450	D 7470 B/1	138
Directional seated valves type VZP	15	450	D 7785 A	144
Valve banks type BVZP	15	450	D 7785 B	146
Valve banks type BA	20	400	D 7788	34
Valve banks type BVH	20	400	D 7788 BV	40
Intermediate plates NG 6, type NZP	20	400	D 7788 Z	34
2/2- , 3/2- and 4/3-way directional seated valves type BVG, BVP, NBVP	50	400	D 7400, D 7765, D 7765 N	156
Directional seated valves type VP	20	400	D 7915	160
4/3- and 3/3-way directional seated valves type VH, VHR, and VHP	25	700	D 7647	170
Directly controlled pressure valves type MV, MVS, MVE, MVP, SV, SVC, MVCS, DMV and DMVN, assembly kits type MVF, MVH etc.	160	700	D 7000/1, D 7000 E/1	178
Pressure limiting valve type CMV(Z) and CSV(Z), for mounting in simple tapped holes	60	500	D 7710 MV	182

Nomenclature	Q _{max} [lpm]	p _{max} [bar]	Pamphlet	Page
Pressure limiting valves with unit approval type CMVX, for mounting in simple, tapped holes	28	500	D 7710 TÜV	182
Pressure reducing valves type CDK and CLK, for mounting in simple, tapped holes	15	500	D 7745, D 7745 L	196
Pressure reducing valves with tracked pressure switch type DK	15	400	D 7941	196
Prop.-pressure limiting valves type NPMVP	16	700	D 7485 N	188
Idle circulation valves type CNE, for mounting in simple, tapped holes	30	75	D 7710 NE	204
Switch-off valves type LV	25	350	D 7529	208
Fine throttle type FG	< 1	300	D 7275	232
Slot type throttle type Q, QR, and QV	80	400	D 7730	232
Slot type throttle type CQ, CQR and CQV, for mounting in simple, tapped holes	50	700	D 7713	236
Prop. throttle type PB	20	300	D 7557/1	224
Hydraulic clamps type HSE and HSA		800	D 4711	262
Electro-hydraulic pressure switches type DG		1000	D 5440, D 5440 E/1, D 5440 F	266
Pressure sensor type DT11 and DT2		500	D 5440 T/1, D 5440 T/2	266
Hydraulic miniature accumulators type AC		330	D 7571	268
Hydraulic miniature accumulators type AC			D 7969	268
Fittings type X 84			D 7077	272
Device connectors with LED and clamp diode etc. type MSD, SVS, MSE and MSUD			D 7163	276
Economy circuit type MSD4 P53 and MSD4 P63 for solenoid valves with actuation solenoids type WG 230/115, 50/60 Hz			D 7813	276
Economy circuit type MSE 28026			D 7832	276
Economy circuit type MSD 4 P55 for solenoid valves with actuation solenoids type G 24 V DC			D 7833	276
Mains supply type MNG			D 7835	276
Programmable logical valve control type PLVC			D 7845-2, D 7845-4, D 7845 HMI, D 7845 M	278
CAN node type CAN-IO 14			D 7845 IO	278

Hydraulics for clamping especially for chucks of lathes or other consumers with design related leakage

Nomenclature	Q _{max} [lpm]	p _{max} [bar]	Pamphlet	Page
Compact hydraulic power packs type HK, HKF and HKL	12.9/16	700/150	D 7600-4, D 7600-3, D 7600-3L, D 7600-2	26
Connection blocks some with reflow or pressurized filter type A		700	D 6905 A/1	32
Valve banks type BA	25	500	D 7788	34
Intermediate plates NG 6, type NZP	20	400	D 7788 Z	34
Solenoid actuated directional spool valve type SWP and NSWP	25	315	D 7450, D 7451, D 7451 N	84
Clamping modules type NSMD	25	100	D 7787	116
2/2- , 3/2- and 4/3-way directional seated valves type NBVP	20	400	D 7765 N	156

Press controls (top or bottom acting ram presses, or presses for laboratories, injection molds)

Nomenclature	Q _{max} [lpm]	p _{max} [bar]	Pamphlet	Page
Two stage connection block type NA		700/120	D 6905 A/1	32
Pumps complete with motor and hydraulic power packs type MP, MPW, and MPN	14.8/108	700/150	D 7200, D 7200 H, D 7207	22
Hydraulic pumps type R and RG	91.2	700	D 6010, D 6010 H, D 6010 D, D 6010 DB, D 6010 S	46
InLine variable displacement axial piston pump type V30D and V30E	365	350 (420)	D 7960, D 7960 E	50
Hydraulic pumps type RZ	91.2/135	700/150	D 6910, D 6910 H	62
Air driven hydraulic pumps type LP	12	1500	D 7280, D 7280 H	68
Hand pumps type H, HD, HE, and DH		600	D 7147/1	74
Directional seated valves with different actuations type G, WG, H, P, K, T, F and D	120	700	D 7300, D 7300 Ex, D 7300 H	124
Directional seated valves with different actuations type of NG, NWG, NH, NP, NK, NT, NF and ND (connection hole pattern NG 6)	12	500	D 7300 N	124
Valve banks type VB	120	700	D 7302	130
Lift monitored seated valves	120	400	D 7300 H	124
Switch units type CR	20/160	500/60	D 7150	164
Directly controlled pressure valves type MV, MVS, MVE, MVP, SV, SVC, MVCS, DMV and DMVN, ssembly kits type MVE, MVH etc., multiple pressure limiting valves	160	700	D 7000/1, D 7000 E/1, D 7000 M, D 7000 TÜV	178
Piloted pressure valve type DV, DVE, and DF	120	420	D 4350	184
Piloted pressure valve with check valve type AL, AE, and AS	120	350	D 6170	184
Prop. pressure limiting valve type PMV	120	700	D 7485/1	188
Prop. pressure valves type PDV	120	350	D 7486	188
Shut-off valve type LV	25	350	D 7529	208
Idle circulation valves type CNE, for mounting in simple, tapped holes	30	450	D 7710 NE	204
Pressure reducing valve with tracked pressure switch type DK	15	400	D 7941	196
Two stage valves type NE	25/180	700/60	D 7161	206
Slot type throttle type CQ, CQR, and CQV, for mounting in simple, tapped holes	50	50	D 7713	236
Blocking valves with pre-release type RHV	200	500	D 3056	248
Check valves and pre-fill valves type F	4000	400	D 6960	254
Electro-hydraulic pressure switches type DG		800	D 5440, D 5440 E/1, D 5440 F	266

Nomenclature	Q _{max} [lpm]	p _{max} [bar]	Pamphlet	Page
Hydraulic miniature accumulators type AC		330	D 7969	268

Devices for industrial trucks and lifting equipment (e.g. stackers, lifting platforms etc.)

Nomenclature	Q _{max} [lpm]	p _{max} [bar]	Pamphlet	Page
Solenoid actuated directional spool valve type SW, SWR, SWP and SWS	25	315	D 7450, D 7451, D 7951	84
Directional spool valves type DL	90	315	D 7260	98
Proportional directional valves type HMPL and HMPV	160	420	D 7700 H	104
2/2-way directional seated valves type EM and EMP	160	450	D 7490/1	152
Lifting/lowering valves type HSV and HZV	120	315	D 7032	162
Lifting modules type HMB, HMC, and HST	90	315	D 7650, Sk 7650 B2, Sk 7650 B33, Sk 7650 HST	166
Lifting modules type HMT, HSN, HMS, HMF, HMR and HSW	90/100	315	Sk 7758 HMT etc.	166
Directly controlled pressure valves type MV, MVS, SV, SVC, MVCS, DMV and DMVN, assembly kits type MVF, MVH etc., multiple pressure limiting valves	160	700	D 7000/1, D 7000 E/1, D 7000 M	178
Pre-loaded check valves type VR	120	300/15	D 7340	186
Load-holding valves type LHK and LHT	250	400	D 7100, D 7918	212
2-way flow control valves (drop-rate braking valves) type SB	400	315	D 6920	222
2-way flow control valves type DSJ	25	315	D 7825	222
Emergency drain valve type BR		400	D 7854	
Line rupture safety valves type LB	160	500	D 6990	256
Prop. amplifiers type EV22K			D 7817, D 7817/1	276
Prop. amplifiers type EV1M			D 7831/1	276
Prop. amplifiers type EV1D			D 7831 D	276
Prop. amplifiers type EV1G			D 7837	276
Programmable logical valve control type PLVC			D 7845-2, D 7845-4, D 7845 HMI, D 7845 M	278
CAN node type CAN-IO 14			D 7845 IO	278

Devices for mobile applications (e.g. crane controls, ship building)

Nomenclature	Q _{max} [lpm]	p _{max} [bar]	Pamphlet	Page
InLine variable displacement axial piston pump type V30D and V30E	365	350/420	D 7960, D 7960 E	50
InLine variable displacement axial piston pump type V60N	240	350/420	D 7960 N	54
Variable displacement axial piston pumps type V40M	65	250/320	D 7961	58
Air driven hydraulic pumps type LP	12	1500	D 7280, D 7280 H	68
Hand pumps type H, HD, HE and DH		600	D 7147/1	74
Individual directional spool valves type SG and SP	100	400	D 5650/1	80
Directional spool valves type DL and DLS	90	315	D 7260	98
Prop. directional spool valves type PSL and PSV (valve bank via directly attached valve sections)	210	420	D 7700-2, D 7700-3, D 7700-5	104
Prop. directional spool valves type PSLF and PSVF (valve bank via manifold mounting valve sections)	500	420	D 7700-F	110
Directly controlled pressure valves type MV, MVS, MVE, MVP, SV, SVC, MVCS, DMV and DMVN, assembly kits type MVF, MVH etc., multiple pressure limiting valves	160	700	D 7000/1, D 7000 E/1, D 7000 M	178

Nomenclature	Q _{max} [lpm]	p _{max} [bar]	Pamphlet	Page
Pre-loaded check valves type VR	120	300/15	D 7340	186
Load-holding valves type LHK	100	400	D 7100	212
Load-holding valves type LHT	250	400	D 7918	212
Load-holding valves type LHDV	80	420	D 7770	212
Flow control valves type SD, SF, SK, SKR and SU	130	300	D 6233	218
2-way flow control valves (drop-rate braking valves) type SB and SQ	400	315	D 6920	222
2-way flow control valves type SJ	15	315	D 7395	222
Flow divider type TQ	200	350	D 7381	228
Flow divider with priority division type TV	60	300	D 7394	228
Pressure sensor type DT		1000	D 5440 T, D 5440 T/1	266
Prop. amplifiers type EV22K			D 7817, D 7817/1	276
Prop. amplifiers type EV1M			D 7831/1	276
Prop. amplifiers type EV1D			D 7831 D	276
Prop. amplifiers type EV1G			D 7837	276
Plugs type MSD, SVS, MSE, MSUD with LED and clamp diode etc.			D 7163	276
Programmable logical valve control type PLVC			D 7845-2, D 7845-4, D 7845 HMI, D 7845 M	278
CAN node type CAN-IO 14			D 7845 IO	278

Devices for explosion hazardous areas (ATEX-conform)

Nomenclature	Q _{max} [lpm]	p _{max} [bar]	Pamphlet	Page
Hydraulic pumps and power packs type R and RG	91.2	700	D 6010, D 6010 H, D 6010 D, D 6010 DB, D 6010 S	46
Hydraulic power packs type Z	135	150	D 6820	46
Dual stage pumps and power packs type RZ	91.2/135	700/150	D 6910, D 6910 H	62
Air-driven hydraulic pumps type LP	12	1500	D 7280, D 7280 H	68
Solenoid actuated directional spool valve type SW, SWR, SWS, SWP and NSWP	25	315	D 7450, D 7451, D 7451 N, D 7951	84
Directional spool valve type HSRL 3	80	400	Sk 7493 RL	94
Prop. directional spool valves type PSL and PSV (valve bank via directly attached valve sections)	210	420	D 7700-2, D 7700-3, D 7700-5	104
Prop. directional spool valves type PSLF and PSVF (valve bank via manifold mounting valve sections)	500	420	D 7700-F	110
Directional seated (size 1) type G and NG	12	700	D 7300, D 7300 N	124
Valve banks type VB, pneumatically actuated	12	700	D 7302	130
2/2- and 3/2-way directional seated valves type BVG, BVP and NBVP	20	400	D 7765, D 7765 N	156
2/2-, 3/2-, 4/2-way directional seated valves type VP	20	400	D 7915	160
Lifting/lowering valves type HSV 21(22)	30	315	D 7032	162
Pressure switch type DG 3		700	D 5440	266
Prop. pressure limiting valves type PMV and PMVP	16	700	Sk 7485 863	188
Prop. pressure reducing valves type PDMP	20	320	Sk 7584 350	202

All pure mechanical devices, i.e. also directional valves with hydraulic, pneumatic, or mechanical actuation can be supplied conforming ATEX.

Proportional valves

Nomenclature	Q _{max} [lpm]	p _{max} [bar]	Pamphlet	Page
Connection blocks type AP	16	700	D 6905 A/1	32
Solenoid actuated directional spool valve type SWS	25	315	D 7951	88
Prop. directional spool valves type PSL and PSV (valve bank via directly attached valve sections)	210	420	D 7700-2, D 7700-3, D 7700-5	104
Prop. directional spool valves type PSLF and PSVF (valve bank via manifold mounting valve sections)	500	420	D 7700-F, D 7700-7F	110
Valve banks type BVZP1FEH	15	450	D 7785 B	146
2/2-way directional seated valve with prop. throttle function type EMP	60	400	D 7490/1, D 7490/1E	152
Prop. pressure limiting valve type PMV	120	700	D 7485/1	188
Prop. pressure valves type PDV	120	350	D 7486	188
Prop. pressure reducing valves type PDM	120	400/350	D 7486, D 7584/1	202
Prop. pressure valves type PDVE	120	350	D 7486	188
Prop. pressure reducing valves type PM and PMZ	< 2	40/19	D 7625	200
Prop. flow control valves type SE and SEH	90	300	D 7557/1	224
Prop. throttle type PB	20	300	D 7557/1	224
Pressure sensor type DT11 and DT2		1000	D 5440 T/1, D 5440 T/2	266
Prop. amplifiers type EV22K			D 7817, D 7817/1	276
Prop. amplifiers type EV1M			D 7831/1	276
Prop. amplifiers type EV1D			D 7831 D	276
Prop. amplifiers type EV1G			D 7837	276
Programmable logical valve control type PLVC			D 7845-2, D 7845-4, D 7845 HMI, D 7845 M	278
CAN node type CAN-IO 14			D 7845 IO	278

Devices for HFA, emulsions and pressurized water

Nomenclature	Q _{max} [lpm]	p _{max} [bar]	Pamphlet	Page
Hydraulic pumps type R...HFA, RG...HFA	91.2	700	D 6010 ff	46
Directional seated valves with different actuations type G, WG, H, P, K, T, F and D (version for HFA)	120	500	D 7300, D 7300 Ex, D 7300 N	124
Valve banks type VB (version for HFA)	120	500	D 7302	130

Devices for operating pressure of 500 ... 700 bar

Nomenclature	Q _{max} [lpm]	p _{max} [bar]	Pamphlet	Page
Compact hydraulic power packs type NPC	1.36	750	D 7940	12
Compact hydraulic power packs type HC, HCG and HCW	12.9	700	D 7900, D 7900 G	14
Pumps complete with motor and hydraulic power packs type MP, MPW and MPN	14.8/108	700/150	D 7200, D 7200 H, D 7207	22
Pumps complete with motor and hydraulic power packs type HK, HKF and HKL	12.9/16	700/150	D 7600-4, D 7600-3, D 7600-3L, D 7600-2	26
Compact hydraulic power packs type KA and KAW	6.2/10.3	700/150	D 8010	18
Connection blocks some with return or pressurized filter type A, B, C (for hydraulic power packs type HC, MP, FP and HK)			D 6905 A/1, D 6905 B, D 6905 C	32
Two stage connection block type NA		700/120	D 6905 A/1	32

Nomenclature	Q _{max} [lpm]	p _{max} [bar]	Pamphlet	Page
Hydraulic pumps type R and RG	91.2	700	D 6010, D 6010 H, D 6010 D, D 6010 DB, D 6010 S	46
Hydraulic power packs type R with DC-motor	approx. 19	700	D 6010 G	46
Dual stage pumps type RZ	91.2/135	700/150	D 6910, D 6910 H	62
Dual stage pumps type RF (with 2-hole SAE flange suited for direct mounting of an additional pump)	30.4/...	700/...	D 7410	62
Air-driven hydraulic pumps type LP	12	1500	D 7280, D 7280 H	68
Hand pumps type HE		600	D 7147/1	74
Directional seated valves with different actuations type G, WG, H, P, K, T, F and D	25	700	D 7300, D 7300 Ex	124
Directional seated valves with different actuations type of NG, NWG, NH, NP, NK, NT, NF and ND (connection hole pattern NG 6)	12	500	D 7300 N	124
Directional seated valve banks type VB	25	700	D 7302	130
Switch units type CR	20/160	500/60	D 7150	164
4/3- and 3/3-way directional seated valves type VH, VHR and VHP	25	700	D 7647	170
Single and double acting shut-off valves type DA	150	500	D 1741	172
Single and double acting shut-off valves type MVG, MVE and MVP	8	700	D 3726	178
Directly controlled pressure valves type MV, MVS, MVE, MVP, SV, SVC, MVCS, DMV and DMVN, assembly kits type MVF, MVH etc.	70	700	D 7000/1, D 7000 E/1	178
Pressure limiting valve for manifold mounting type SVP	80	700	D 7722	178
Pressure limiting valve type CMV and CSV, for mounting in simple, tapped holes	60	500	D 7710 MV	182
Pressure limiting valve with unit approval type CMVX, for mounting in simple, tapped holes	28	500	D 7710 TÜV	182
Prop. pressure limiting valve type PMV	120	700	D 7485/1	188
Pressure reducing valve type CDK and CLK, for mounting in simple, tapped holes	15	500	D 7745, D 7745 L	196
Dual stage valve type NE	25/180	700/80	D 7161	206
Idle circulation valves type CNE, for mounting in simple, tapped holes	30	500/450	D 7710 NE	204
Pressure dependent shut-off valves type DSV	60	600	D 3990	210
Pressure dependent shut-off valves type CDSV, for mounting in simple, tapped holes	10	600	D 7876	210
By-pass check valves type BC	60	700	D 6969 B	230
Restrictor check valves and check valves type BE	120	500	D 7555 B	230
Throttle and shut-off valves type AV	100	500	D 4583	238
Shut-off valves type AVT .. and AVM	80	630	D 7690	238
Throttle and shut-off valves type CAV, for mounting in simple, tapped holes	50	500	D 7711	238
Slot type throttle type CQ, CQR, and CQV, for mounting in simple, tapped holes	50	700	D 7713	236
Check valves type RC	60	700	D 6969 R	242
Check valves inserts type ER and EK	120	500	D 7325	242
Check valves inserts type RK and RB	120	700	D 7445	242
Check valves inserts type RE	120	500	D 7555 R	242
Blocking valves type CRK, CRB, for mounting in simple, tapped holes	80	500	D 7712	244
Check valves with pre-release type RHV	200	500	D 3056	252

Nomenclature	Q _{max} [lpm]	p _{max} [bar]	Pamphlet	Page
Check valves type B	160	500	D 1191	246
Check valve inserts with hydraulic release type RHC and RHCE	200	500	D 7165	248
Check valves type CRH, for mounting in simple, tapped holes	55	500	D 7712	248
Check valves with hydraulic release type HRP	140	700	D 5116	250
Check valves with hydraulic release type RH	160	700	D 6105	252
Twin check valves with release type DRH	140	500	D 6110	252
Line rupture safety valves type LB	160	700	D 6990	256
Shuttle valves type WVH	3	700	D 7016, Sk 7962	258
Hydraulic clamps type HSE and HSA		500	D 4711	262
Electro-hydraulic pressure switches type DG and DG5E		800	D 5440, D 5440 E/1	266
Pressure sensor type DT11 and DT2		1000	D 5440 T/1, D 5440 T/2	266
Hydraulic miniature accumulators type AC		500	D 7571	268

Screw-in valves and installation kits

Nomenclature	Q _{max} [lpm]	p _{max} [bar]	Pamphlet	Page
Solenoid actuated 2/2-way directional seated cartridge valves type EM and EMP	160	450	D 7490/1	152
Solenoid actuated 2/2-, 3/2-way directional seated valve type BVE	60	400	D 7921	156
Miniature pressure limiting and sequence valves type MVE	8	700	D 3726	178
Directly controlled pressure valves type MVE, assembly kits type MV.	160	700	D 7000/1, D 7000 E/1	178
Pressure limiting valve type CMV and CSV, for mounting in simple, tapped holes	60	500	D 7710 MV	182
Pressure limiting valves type CMVX with unit approval, for mounting in simple, tapped holes	28	500	D 7710 TÜV	182
Miniature pressure reducing valves type ADC, AM, ADM and ADME	8	300/100	D 7458	190
Pressure reducing valves type CDK and CLK, for mounting in simple, tapped holes	15	500	D 7745, D 7745 L	196
Prop. pressure reducing valves type PM	< 2	40/19	D 7625	200
Idle circulation valves type CNE, for mounting in simple, tapped holes	30	500/450	D 7710 NE	204
Pressure dependent shut-off valves type CDSV, for mounting in simple, tapped holes	10	600	D 7876	210
Load-holding valves type LHK..E and LHT..E	120	420	D 7100, D 7918	212
2-way flow control valves (drop-rate braking valves) type SB and SQ	400	315	D 6920	222
2-way flow control valves type SJ	15	315	D 7395	222
2-way flow control valves type SJ	25	315	D 7825	222
2-way flow control valves type CSJ	10	315	D 7736	222
Screw-in flow valves type BSE, QSE, and MSE	26	315	D 7125	230
Orifice inserts type EB	120	500	D 6465	230
By-pass check valves type BC	60	700	D 6969 B	230
By-pass check valves type BE	120	500	D 7555 B	230
Throttle type FG	< 1	300	D 7275	232
Slot type throttle type Q, QR, and QV	80	400	D 7730	232
Slot type throttle type CQ, CQR, and CQV, for mounting in simple, tapped holes	50	700	D 7713	236

Nomenclature	Q _{max} [lpm]	p _{max} [bar]	Pamphlet	Page
Throttle and shut-off valves type AV.E	100	500	D 4583	238
Throttle and shut-off valves type CAV, for mounting in simple, tapped holes	50	500	D 7711	238
Check valves type RC	60	700	D 6969 R	242
Check valves inserts type ER and EK	120	500	D 7325	242
Check valves inserts type RK and RB	120	700	D 7445	242
Check valves inserts type RE	120	500	D 7555 R	242
Check valves type CRK, CRB, for mounting in simple, tapped holes	80	500	D 7712	244
Screw-in check valves with hydraulic release type RHC and RHCE	200	500	D 7165	248
Check valves with hydraulic release type CRH, for mounting in simple, tapped holes	55	500	D 7712	248
Line rupture safety valves type LB	160	500	D 6990	256
Shuttle valves type WVC and W VH	6	700	D 7016, Sk 7962	258
Hydraulic clamps type HSE		500	D 4711	262
Electro-hydraulic pressure switches type DG		800	D 5440, D 5440 E/1, D 5440 F	266
Pressure sensors type DT11 and DT2		1000	D 5440 T/1, D 5440 T/2	266
Hydraulic miniature accumulators type AC		500	D 7571	268
Hydraulic miniature accumulators type AC		330	D 7969	268

Devices with unit approval (TÜV-CE), specimen approval (German Lloyd), or for automotive industry

Nomenclature	Q _{max} [lpm]	p _{max} [bar]	Pamphlet	Page
Unit approved TÜV-CE marked units acc. to "Pressurized equipment guideline" Pressure limiting valve with unit approval in connection blocks type AX, ASX, AVX, and APX			D 6905 TÜV	32
Pressure limiting valves with unit approval type MV.X	100	450	D 7000 TÜV	178
Pressure limiting valves with unit approval type CMVX, for mounting in simple, tapped holes	28	500	D 7710 TÜV	182

Devices utilized by the automotive industry

		Chapter
BMW	Hydraulic power packs (tank < 40 l)	1.1, 1.2, 1.3, 1.4
	Radial piston pumps	1.2, 1.3
	Seated valves	2.2
MERCEDES-BENZ	Hydraulic power packs for high pressure	1.1, 1.2, 1.3, 1.4, 1.5
	Seated valves (NG 6)	2.2
	Check valves with release (type RH, DRH)	2.5
	Clamps (type HSA, HSE)	3
	Hydraulic power packs < 63 l-tank (type HC, MP, HK) Hydraulic power packs	1.1, 1.2
FIAT	Hydraulic power packs	1.1, 1.2, 1.3, 1.4
	Radial piston pumps	1.2, 1.3
OPEL	Valves for pipe connection	2.1, 2.2, 2.3, 2.4, 2.5
	Hydraulic power packs	1.1, 1.2, 1.3, 1.4
	Radial piston pumps	1.2, 1.3

		Chapter
FORD	Valves	2.1, 2.2, 2.3, 2.4, 2.5
	Hydraulic power packs	1.1, 1.2, 1.3, 1.4
	Radial piston pumps	1.2, 1.3
PEUGEOT, CITROEN	Seated valves	2.2
	Hydraulic power packs	1.1

HAWE Hydraulik is listed with Dun & Bradstreet (D&B) under D-U-N-S® (Data Universal Numbering System) number 316724384.

6 Formulas and units

Hydraulic system and circuit design is limited only by the creativity of the application engineer. All basic circuit design begins with the ultimate actuator functions in mind however.

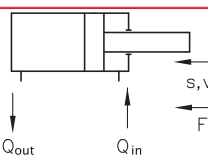
The most important condition for this is the definition or specification of relevant consumer variables, such as the loads (load forces, load torques or turning torques), motion functions (travel, speeds, rotational speeds, timing) etc.

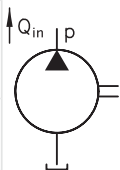
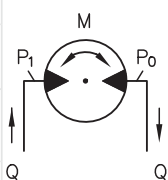
The following formulas and tables are intended to serve as guideline only and should help with the planning of your hydraulic system.

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.

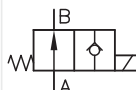
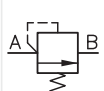
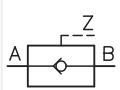
Equipment	Formulas and description		
General information	Basic equations (static, without any loss)		
	$Q = \frac{V}{t}$ $V = A \cdot s$ $F = p \cdot A$ $p = \frac{F}{A}$ $Q = A \cdot v$ $M = \frac{V \cdot p}{2 \pi}$ $v = \frac{s}{t}$	force volume A: Area Q: Flow v: Speed V: Volume torque Time s: Travel (stroke) M: Torque	
Equipment	Formulas and description		Symbol
Hydraulic cylinders ■ Single acting	$A [mm^2] = \frac{\pi}{4} d^2 [mm]$ $v [\frac{m}{s}] = \frac{s [mm]}{1000 t [s]}$ $F_s [N] = 0,1 p_B [bar] \cdot A [mm^2]$ $p_B [bar] = \frac{-10 F_s [N]}{A_1 [mm^2]}$ $Q_{in} [lpm] = 0,06 \cdot A [mm^2] \cdot v [\frac{m}{s}]$	d: piston diameter [mm] A: piston area [mm²] F _s : force [N] p _B : operating pressure [bar] v: Piston speed [$\frac{m}{s}$] Q _{in} : inflow [lpm] s: stroke [mm] t: time [S]	
■ Double acting	Extending Basic equations (balance of forces): $A_1 = \frac{\pi}{4} d_1^2 \approx 0,78 d_1^2$ $A_3 = \frac{\pi}{4} (d_1^2 - d_2^2)$ $p_1 \cdot A_1 = p_3 \cdot A_3 - F$ $p_1 = \frac{1}{A_1} (p_3 \cdot A_3 - F)$ $Q_{zu} = A_1 v$ $Q_{ab} = A_3 v$	Simplified: $p_1 [bar] = \frac{p_3 [bar] \cdot A_3 [mm^2] - 10 F [N]}{A_1 [mm^2]}$ $F [N] = \frac{-p_1 [bar] \cdot A_1 [mm^2] + p_3 [bar] \cdot A_3 [mm^2]}{10}$ p ₃ is the result of back pressure from pipes and valves for Q _{out} Attention: note possible pressure intensification!	
	Retracting Basic equations (balance of forces): $p_1 \cdot A_1 = p_3 \cdot A_3 + F$ $p_3 = \frac{1}{A_3} (p_1 \cdot A_1 - F)$	Simplified: $p_3 [bar] = \frac{p_1 [bar] \cdot A_1 [mm^2] - 10 F [N]}{A_3 [mm^2]}$	

Equipment	Formulas and description	Symbol
	$Q_{zu}=A_3 \cdot v$ $Q_{ab}=A_1 \cdot v$	
	$F[N]=\frac{p_1[\text{bar}] \cdot A_1[\text{mm}^2] - p_3[\text{bar}] \cdot A_3[\text{mm}^2]}{10}$ p₁ result of back pressure from pipes and valves for Q_{out}	
	A₁: piston area [mm²] A₃: rod side area [mm²] d₁: piston Ø [mm] d₂: rod Ø [mm] F: force [N]	Q_{in}: inflow [lpm] Q_{out}: outflow [lpm] p₁: pressure, piston side [bar] p₃: pressure, rod side [bar] s: stroke, travel [mm]

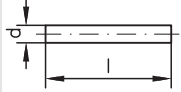
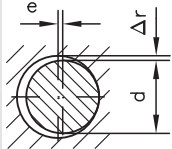
Equipment	Formulas and description		Symbol
Hydraulic pumps / hydraulic motors	Basic equations:	$\Delta p = p_1 - p_o^{1)}$	Simplified:
	Geometric volume per revolution (piston pumps):	$V = A \cdot h$	$V[cm^3] \approx \frac{A[mm^2] \cdot h[mm]}{1000}$
	Flow:	$Q = V \cdot n$	$Q[lpm] \approx \frac{V[cm^3] \cdot n[min^{-1}]}{1000}$
	Middle torque:	$M = \frac{V \cdot \Delta p}{2 \pi}$	$M[Nm] \approx \frac{V[cm^3] \cdot \Delta p[bar]}{62}$
	Power:	$P_{hydr} = \Delta p \cdot Q$	$P_{hyd}[kW] \approx \frac{\Delta p[bar] \cdot Q[lpm]}{612}$
	Power consumption (pump):	$P_{mech} = \frac{\Delta p \cdot Q}{\eta_T} = \frac{M \cdot 2 \pi n}{\eta_T}^{2)}$	$P_{drive}[kW] \approx \frac{\Delta p[bar] \cdot Q[lpm]}{500}$
	Power rating (motor):	$P_{max} = \Delta p \cdot Q \cdot \eta_T = M \cdot 2 \pi n \cdot \eta_T^{2)}$	$P_{out}[kW] \approx \frac{\Delta p[bar] \cdot Q[lpm]}{740}$ $\approx \frac{M[Nm] \cdot n[min^{-1}]}{12000}$
V: displacement [cm ³] A: effective piston area [mm ²] h: double stroke [mm] n: rev. rating [rpm] M: middle torque [Nm] p: pressure [bar] Δp: effective pressure [bar] Q: 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 flow of Q = 1 lpm with operating pressure p = 500 bar!	 Hydraulic pump  Hydraulic motor

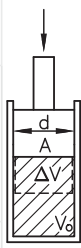
¹⁾ p_o result of back pressure from pipes and valves

²⁾ incl. degree of efficiency η_T ≈ 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: ■ Back pressure of valves ■ Back pressure of pipes ■ Back pressure due to geometric shape (elbows etc.) Pressure losses Δp in the valves that are caused by the 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: Directional 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: $Q \approx \alpha \cdot \frac{\pi}{4} d^2 \sqrt{\frac{2 \Delta p}{\rho}}$ Q: flow [lpm] Δp: back pressure between A and B [bar] d: orifice diameter [mm]	Simplified: $Q \approx 0.55 d^2 [mm] \cdot \sqrt{\Delta p [bar]}$ $d \approx 1.35 \cdot \sqrt{\frac{Q [lpm]}{\Delta p [bar]}}$

Equipment	Formulas and description		Symbol
	ρ: density (approx. 0.9 g/cm³) α: flow coefficient (approx. 0.78)	$\Delta p \approx \left(\frac{1.82 \cdot Q[lpm]}{d^2[mm]} \right)^2$	
Equipment	Formulas and description		Symbol
Pipes / hoses	The diameter of pipes and/or hoses should be selected in such a way that back pressure is minimized. Basic equations: $Re = \frac{v \cdot d}{\nu}$ $\lambda_R = \frac{64}{Re}$ $\Delta p = \lambda_R \cdot \frac{l}{d} \cdot \frac{\rho}{2} v^2$ λ_R: pipe back pressure coefficient Δp: back pressure [bar] l: pipe length [m] d: pipe diameter [mm] ν: cinematic viscosity [mm²/s] Q: flow [lpm] Re: Reynolds No. (< 2300) ρ: density (approx. 0.9 g/cm³) v: flow velocity [$\frac{m}{s}$]		
	Simplified: $Q[l/min] \leq 0,108 \cdot d[mm] \cdot v \left[\frac{mm^2}{s} \right]$ $d[mm] \geq \frac{9.2 \cdot Q[lpm]}{v \left[\frac{mm^2}{s} \right]}$ $\frac{\Delta p}{l} \left[\frac{bar}{m} \right] \approx \frac{6,1 \cdot v \left[\frac{mm^2}{s} \right] \cdot Q \left[\frac{l}{min} \right]}{d^4[mm]}$		
Equipment	Formulas and description		Symbol
Back pressure due to geometric shape (elbows etc.)	Basic equations: $\Delta p = \xi \cdot \frac{\rho}{2} v^2$ $v = \frac{Q}{A} = \frac{4Q}{\pi d^2}$ 90° elbow $\xi = 0,15$ straight pipe fitting $\xi = 0,5$ elbow fitting $\xi = 1,0$ Simplified: $\Delta p[bar] = 2,2 \cdot \xi \cdot \frac{Q^2[lpm]}{d^4[mm]}$ Δp: back pressure [bar] ξ: back pressure 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: $Q_L = \frac{\pi \cdot d \cdot \Delta p^3}{12 \cdot \nu \cdot \rho} \cdot \frac{\Delta p}{l} (1 + 1,5 \cdot \epsilon^2)$ 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)	Simplified: $Q_L = 1848 \cdot \frac{d \cdot \Delta r^3}{\nu} \cdot \frac{\Delta p}{l} (1 + 1,5 \cdot \epsilon^2) \quad \epsilon = \frac{e}{\Delta r}$	

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] Δ: volume alternation [l] β_p: compressibility Simplified: $\Delta V = 0,7 \cdot 10^{-4} \cdot V_o \cdot \Delta p$ (with $\beta_p \approx 0,7 \cdot 10^{-4} \frac{1}{\text{bar}}$)	
Volumetric losses (due to temperature rise)	Basic equation: $\Delta V = \beta_T \cdot V_o \cdot \Delta \vartheta$ mit $\Delta \vartheta = \vartheta_2 - \vartheta_1$	
	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: $\Delta V = 0,7 \cdot 10^{-3} \cdot V_o \cdot \Delta \vartheta$ (mit $\beta_T \approx 0,7 \cdot 10^{-3} \frac{1}{K}$)	
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. $\Delta \vartheta \approx 1K \Leftrightarrow \Delta p \approx 10\text{bar}$ 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)	$\Delta V = V_1 \left(1 - \frac{p_1}{p_2} \right)$
	adiabatic (quick)	$\Delta V = V_1 \left(1 - \left(\frac{p_1}{p_2} \right)^{0,71} \right)$
	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 $c \approx 75$ Surface with bad circulation $c \approx 120$ with fan ($v \approx 2$ m/s) $c \approx 40$ Oil/water radiator $c \approx 5$	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] $\vartheta_{ölmax}$: max. fluid temperature [°C] ϑ_{amb} : ambient temperature [°C] A: surface of the system (tank, pipes etc.) [m²]	

Conversion table

Nomenclature	Codings	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
Performance	P	1 PS, 1 hp	≈	0.74	kW
Area	A	1 ft ²	≈	92903	mm ²
		1 in ²	≈	645.16	mm ²
Volume	V	1 ft ³	≈	28.92	l
		1 in ³	≈	$1.64 \cdot 10^{-2}$	l
		1 UK gal	≈	4.55	l
		1 US gal	≈	3.79	l
Temperature	T, θ	5 (°F-32)/9	≈	1	°C
Mass	m	1 lb	≈	0.45	kg
Cinematic viscosity	v	1 cST	=	1	$\frac{mm^2}{s}$

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Appendix

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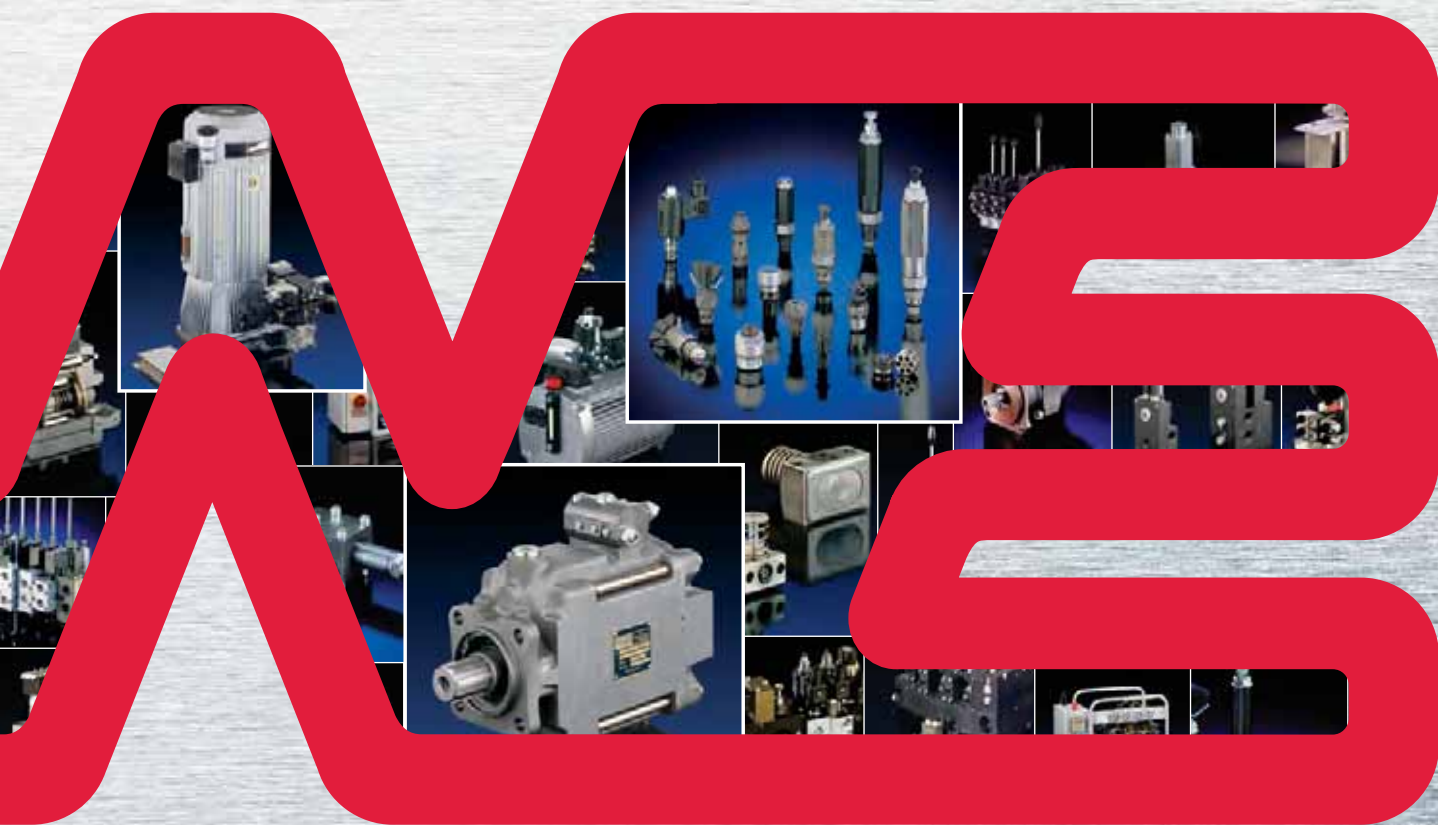
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