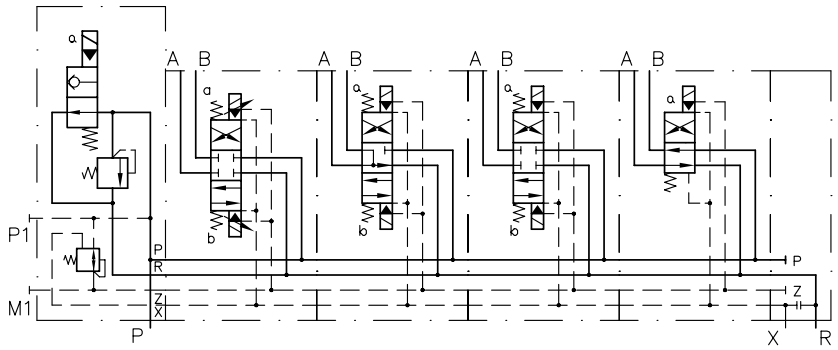
Directional spool valve banks type HSR

electro-hydraulically actuated, for oil-hydraulic systems

Operating pressure p_{max} = 400 bar
Flow Q_{max} = 80 and 160 lpm

Additional versions:
Individual directional spool valve type HSF for manifold mounting D 7493 E
Individual directional spool valve type HSL for pipe connection D 7493 L

Order example acc. to photo
HSR 3/B 31 C - G1 DGW - 2 - G 24 - 250



2.1

1. General

The type HSR directional spool valves are generally used for controlling the connected hydraulic consumers' direction of movement. Operation is indirect and electro-hydraulic via the built-on 3/2-way solenoid seated valves. The use of zero leakage seated valves actuated by wet armature solenoids as pilot valves and strong return springs for the valve spool ensure safe function even when being actuated for prolonged periods (no jamming because of micro contamination).
It is common knowledge that high volume consumers or long pipes have a fairly great accumulator effect, which always bears the risk of switching and decompression surges, due to the oil elasticity. This is particularly pronounced at higher operating pressure. In order to avoid such surges and to obtain soft switching, it is possible to adjust the switching speed of the valve via optional thread-type throttles to meet local requirements (switching time adjustment). This allows individual adjustment of the active period of the decompression grooves. This switching time adjustment becomes particularly effective and accurate, when the control pressure is at a low level. In addition, a pressure control valve, which is built into the connection block and limiting the control pressure is also optionally available. See detailed notes in section 2.

2. Types available, type coding

Ready to connect directional spool valve bank

For order coding of indiv. components, see sect. 5.2

Order example:

HSR 3/B 31 C - G1 DGW - 2 - G 24 - 250

- HSR 3/B: Basic type and size (table 1)
- 31: Connection blocks (table 2a, 2b)
- C: Directional spool valve (table 3)
- G1: End plate (table 4)
- DGW: Nom. voltage for pilot and circulation valve (table 5)
- 2: Desired setting of the pressure limiting valve (applies only too connection blocks B...)
- G 24: Nom. voltage for pilot and circulation valve (table 5)
- 250: Desired setting of the pressure limiting valve (applies only too connection blocks B...)

Table 1: Basic type and size

Coding	Flow Q_{max} (lpm)	Pressure p_{max} (bar)	Tapped ports DIN ISO 228/1 (BSPP)	Control pressure (bar)
HSR 3	80	400	G 1/2	Optimum 25 to 40; min.10, max. 160; 1) 2) 3)
HSR 4	160		G 3/4	

Table 2a: Connection block basic version for HSR 3(4)

Coding	Control oil supply	Control pressure limitation
A 1	Internally via gallery P 1)	None
A 2	Externally via P1 2)	
A 3	Internally via gallery P 1)	Internally to approx. 30 bar by pressure reducing valve
A 4	Externally via P1 2)	

Symbols

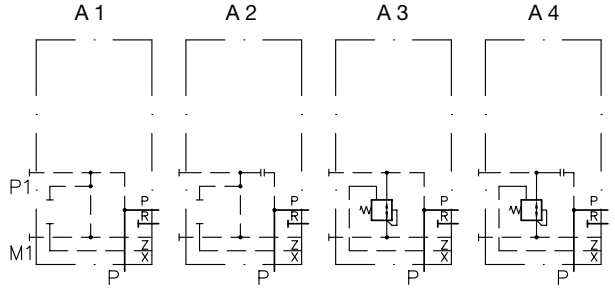
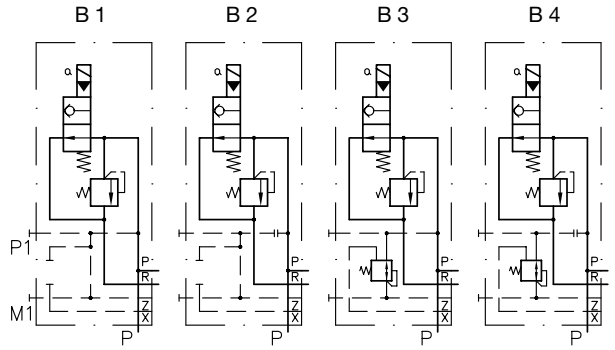


Table 2b: Connection block for HSR 3.. with circulation and pressure limiting valve

Coding	Control oil supply	Control pressure limiting
B 1	Internally via gallery P 1)	None
B 2	Externally via P1 2)	
B 3	Internally via gallery P 1)	Internally to approx. 30 bar by pressure reducing valve
B 4	Externally via P1 2)	

Pressure limiting valve	**1**	Tool adjustable
	2	Manually adjustable
Pressure range (bar)	**B**	(30) ... 400
	C	(20) ... 315
	E	(10) ... 160

Symbols

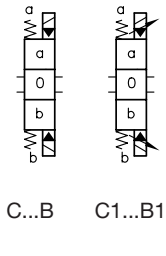
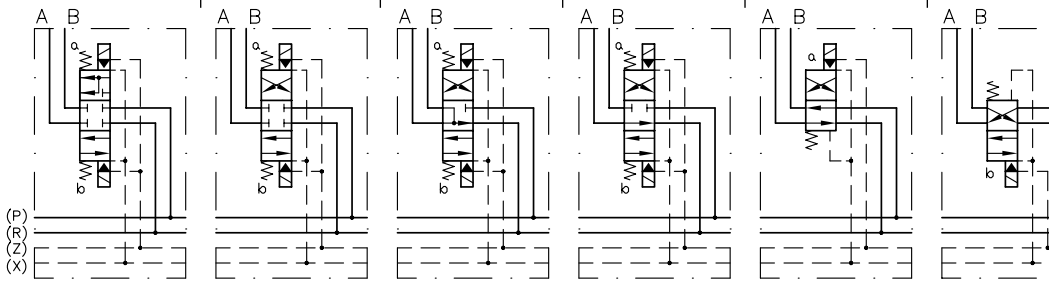


1) The simplest way of control oil supply is internal, when picked up from the main circuit (gallery P) e.g. when no separate control circuit is available. In the case of connection block A1 or B1... the control pressure is like the operating pressure in gallery P. This is suitable up to approx. 160 bar (max. permissible control pressure). Type A 3 or B3.. with control pressure limitation to approx. 35 bar via the built-in pressure reducing valve should be used for pressure over 160 bar, larger consumer volumes and long pipes. This provides softer, surge-free valve switching in general and good switching time adjustability via the throttle screws in the case of valves C1 to B1 (table 3).

2) External control oil inlet at P 1, when a separate own control circuit from the pump is available (delivery flow e.g. < 2 lpm). A 2 or B 2.. suitable, whenever the control circuit can be limited at a lower pressure, e.g. in the range of 15 ... 40 bar. A 4 or B4.. with control pressure limitation (via a built-in pressure reducing valve), is necessary when the control circuit is operated at higher pressure (> 160 bar), e.g. when it is also used to supply pressurized oil for other consumers.

3) Only for HSR 3: Valve EM 31S (D 7490/1) for relieving the pump gallery, e.g. for idle pump circulation when the valve spool is in neutral and the pump is not switched off. Note that the consumer side A (B) is also depressurized, in the case of spools W and B,. The minimum control pressure required for the valve is 10 bar. Travel from the neutral position starts at approx. 2 ... 3 bar. Very soft switching (consumer start) is therefore also achievable, when the valve is only switched with circulation pressure (Δp_L), i.e. the EM 31S is switched slightly delayed after the servo valve via a time-delay relay. This is only possible with a pump outlet flow of more than approx. 40 lpm (Δp_L > 3 bar).

Table 3: Directional spool valve (valve section)

Switching time adjustment	Coding (for notes and detailed symbols see sect. 5.1)					
Without [2]	**C** [1]	**G**	**D**	**E**	**W**	**B**
With [3]	**C 1** [1]	**G 1**	**D 1**	**E 1**	**W 1**	**B 1**
Symbols	 C...B C1...B1					

[1]) Differential valve for controlling double-action hydraulic cylinders with uneven piston surface areas (differential cylinders). Connect piston side to port A, rod side to port B. Differential cylinders should be always connected to the first valve directly after the connection block (table 2a or 2b), all other valves are added subsequently, see sect. 5.

[2]) Normal, standard version. Usually sufficient for most applications and for operating pressure up to approx. 200 bar. See also notes on HSR 3 with circulation valve, table 2b.

[3]) Advantageous for high operating pressure, long pipes, and high volume consumers. Optimum adjustability at low control pressure (pressure reducing valves, connection blocks A 3, A 4, B 3.., B 4.., tables 2a and 2b).
Retrofitting is possible, see dimensional drawings.

Table 4: End plate

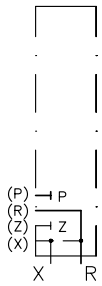
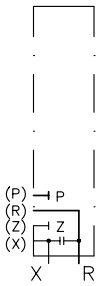
Coding	**1**	**2**
Symbols, notes	 Internal control oil return (R) Normally sufficient in conjunction with internal control oil supply (connection blocks A 1, A 3 or B1.., B3..)	 External control oil return (X) Appropriate, when the control oil supply is also external via P1 and restricted to very low pressure and when higher return pressure (line resistance) or pressure surges are expected at port R.

Table 5: Nom. voltage for pilot and circulation valve

Solenoid actuated pilot valve type WN1H acc. to D 7470 A/1
and circulation valve type EM 31S acc. to D 7490/1.
For additional information see respective pamphlets.

Standard, with plug	Without plug	With featuring plug LED's	Nom. voltage U_N	Nom. power P_N	
				WN1H	EM 31S
G 12	**X 12**	**L 12**	12V DC	24.4 W	21 W
G 24	**X 24**	**L 24**	24V DC		
G 98	**X 98**	---	98V DC		
G 205	**X 205**	---	205V DC		
WG 110	---	---	110V AC 50 / 60 Hz		
WG 230	---	---	230V AC		

3. Characteristic data

Type and version

Directional spool valve, full steel design.
Housing zinc galvanized, giving a good resistance to corrosion.
Valve spool hardened, ground, polished and deburred. An exactly circular sealing gap with a minimum leakage rate is achieved by the diamond-honed and polish-deburred housing bore.
Built-on pilot valves: WN1H in accordance with D 7470 A/1, seated ball valves, leakage zero. See sect. 1 for advantages.

Installation position

Any

Ports
DIN ISO 228/1 (BSPP)

		HSR 3	HSR 4
P	= Pump inlet	G 1/2	G 3/4
A, B	= Consumer	G 1/2	G 3/4
R	= Return	G 1/2	G 3/4

P1	= External control valve inlet	G 1/4
X	= External control valve outlet	G 1/4
M1	= Measuring port, control circuit	G 1/4

Overlapping

Zero

Switching times (guide line)

Without switching time adjustability (non throttled)

HSR 3: t_{on} = 30...40 ms; t_{off} = 70...100 ms
HSR 4: t_{on} = 50...60 ms; t_{off} = 110...140 ms

Mass (weight) approx. kg,,

Type	Connection bock, coding A 1 to A 4	Connection bock, coding B 1 to B 4	Directional spool valve, coding C(C1) to E(E1)	Directional spool valve, coding B(B1) and W(W1)	End plate, coding 1 and 2
HSR 3	1.0	2.8	2.5	2.0	0.7
HSR 4	2.4	--	4.2	3.7	4.2

Flow Q_{max}

HSR 3 ≈ 80 lpm; HSR 4 ≈ 160 lpm; note total back pressure (see below)

Operating presure

P, A, and B = 400 bar; R and X = 12 bar; M1 and P1 = 160 bar

Control volume

HSR 3 approx. 1.8 cm^3; HSR 4 approx. 5 cm^3

Hydraulic fluid

Hydraulic oil conf. DIN 51524 table 1 to 3; ISO VG 10 to 68 conf. DIN 51519
Viscosity range: min. approx. 4; max. approx. 1500 mm^2/sec. Optimal operation range: approx. 10...500 mm^2/sec. Also suitable are biologically degradable pressure fluids of the type HEPG (Polyalkylenglycol) and HEES (synth. Ester) at operation temperature up to approx. +70°C.
Other pressure media only if the NBR seals are compatible and if aforementioned viscosity range is kept to.

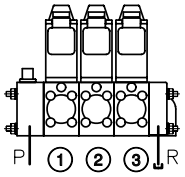
Temperatures

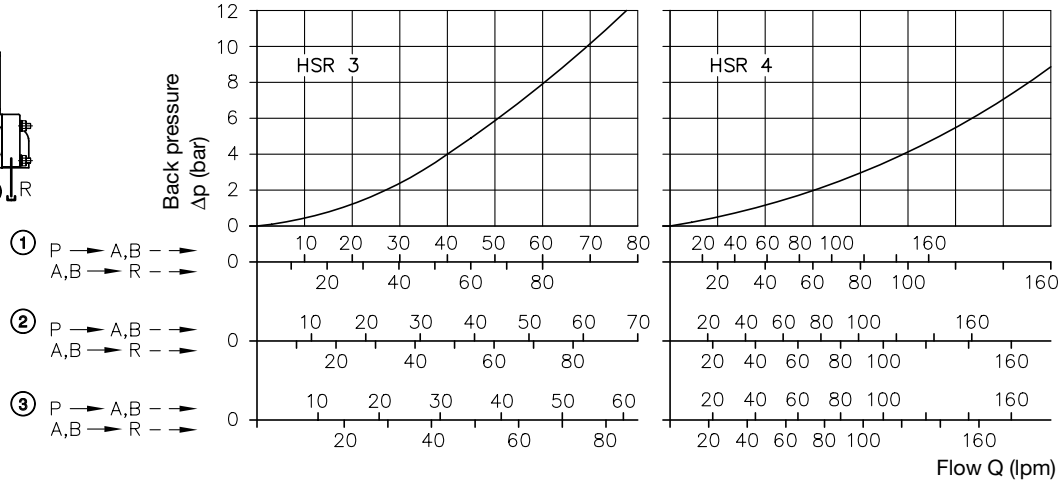
Ambient: approx. -40 ... +80°C. Fluid: -25 ... +80°C, pay attention to the viscosity range!
Start temperature down to -40°C are allowable (Pay attention to the viscosity range during start!), as long as the operation temperature during subsequent running is at least 20 K (Kelvin) higher.
Biological degradable pressure fluids: Pay attention to manufacturer's information. With regard to the compatibility with sealing materials do not exceed +70°C.

Pilot valves

Not over 60% duty cycle if the ambient temperature is 60°C and not over 35% duty cycle if the ambient temperature is 80°C. Heat generation of the solenoid can be reduced by reducing the supply voltage. This gives a temperature reserve as a balance for increased ambient temperatures and greater safety under normal conditions and if the ambient temperatures are changing.
Control pressure ≦ 160 bar (connection block A 1, A 2, B 1, B 2)
$U_{reduc.}$ = 0.75 U_{Nom}, permissible ambient temperature ≦ 60°C
Control pressure = 35 bar (connection block A 3, A 4, B 3, B 4)
$U_{reduc.}$ = 0.50 U_{Nom}, permissible ambient temperature ≦ 80°C

Δp-Q-curves



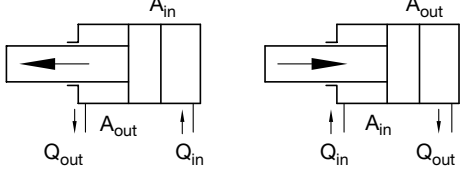


Oil viscosity during the measurement approx. 60 mm^2/sec

In the case of 4/3-way directional spool valves, the total back pressure Δp_{total}, measured at inlet P, is made up of the proportion $\Delta p_{P \rightarrow A,B}$ on the onflow side and the proportion $\Delta p_{A,B \rightarrow R}$ on the outlet side. In the case of valve banks with several valves, the position of the valve in the block also has an influence. Note that in the case of consumers with an unequal surface ratio (diff. cylinder) the reflux Q_{out}, for which $\Delta p_{A,B \rightarrow R}$ is to be determined, can be lower or higher than Q_{in} depending on the direction of movement.

Symbol C: The flow $Q_{in\ total} = Q_{in} \cdot \frac{A_{in}}{A_{in} - A_{out}}$ can be used to determine $\Delta p_{P \rightarrow A}$ for differential extension.

$$\Delta p_{total} = \Delta p_{P \rightarrow A,B} + \Delta p_{A,B \rightarrow R} \cdot \frac{A_{out}}{A_{in}}$$

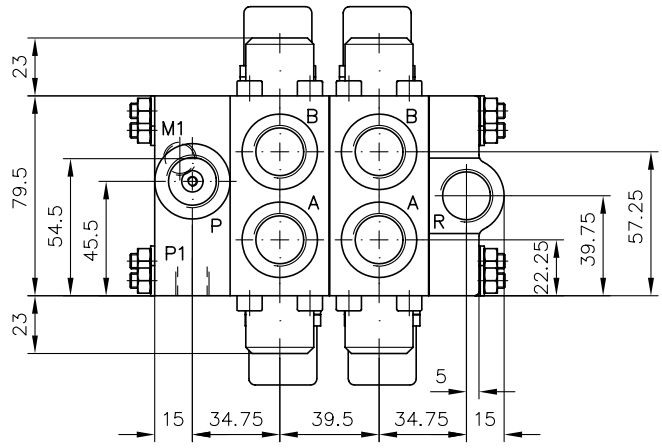


$$Q_{out} = Q_{in} \frac{A_{out}}{A_{in}}$$

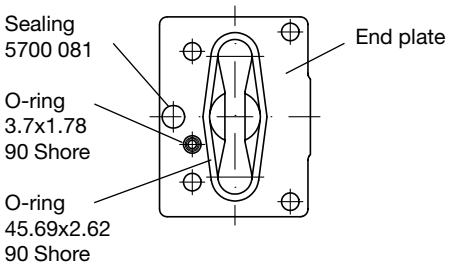
4. Dimensions of units

All dimensions are in mm, subject to change without notice!

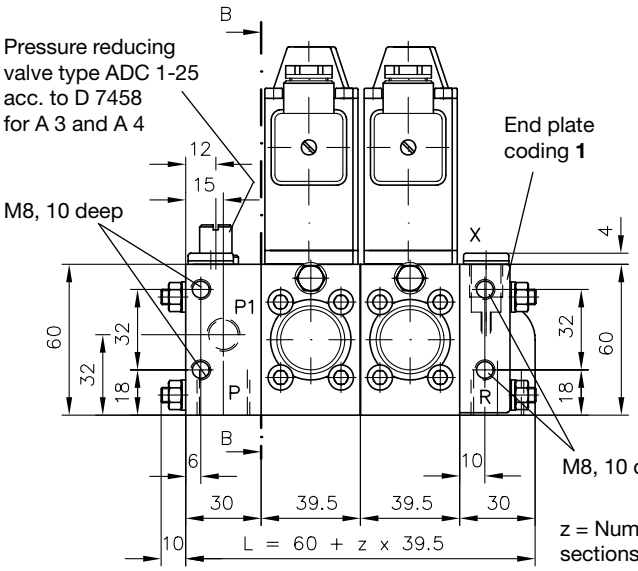
4.1 Type HSR 3 with connection block A1 to A 4



View A - A

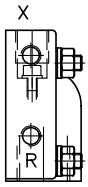


Ports conf. DIN ISO 228/1 (BSPP):
P, A, B, and R = G 1/2
P1, M1, and X = G 1/4

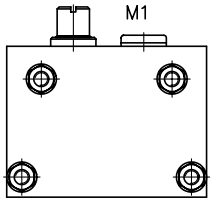


End plate coding **1**

End plate coding **2**
(for missing dimensions see coding 1)

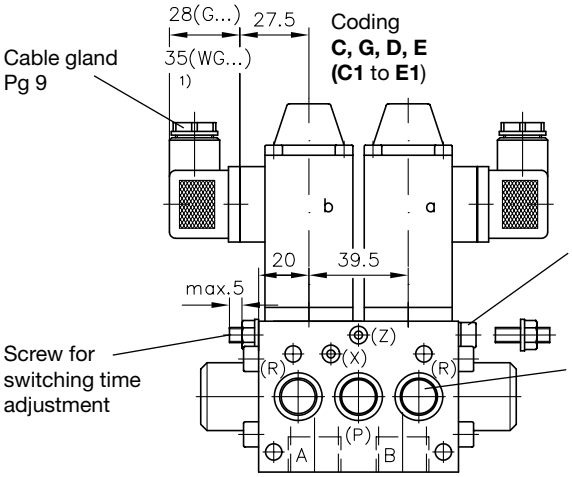


Side view
of connection block

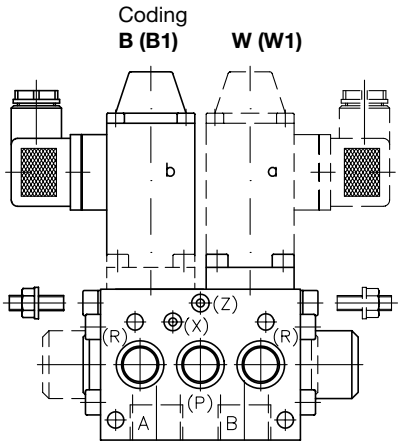


Measuring port M1 for control pressure is blocked with tapped plug DIN 908 - G 1/4 A-St and seal ring A 14x18x1.5 DIN 7603-St

z = Number of valve sections (max. 8)



View B - B

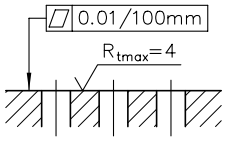


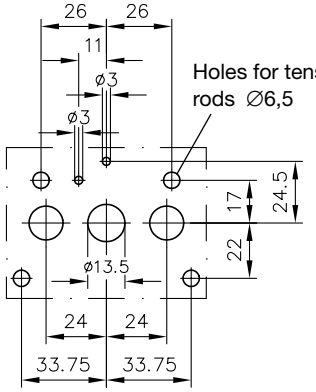
Sealing of ports:
P and R with O-ring 15.5x1.78 90 Shore
X and Z with O-ring 3.7x1.78 90 Shore

Hole pattern, valve housing:

The holes ∅3 and ∅13.5 are max. ∅ for control and main ports at customer furnished manifolds.

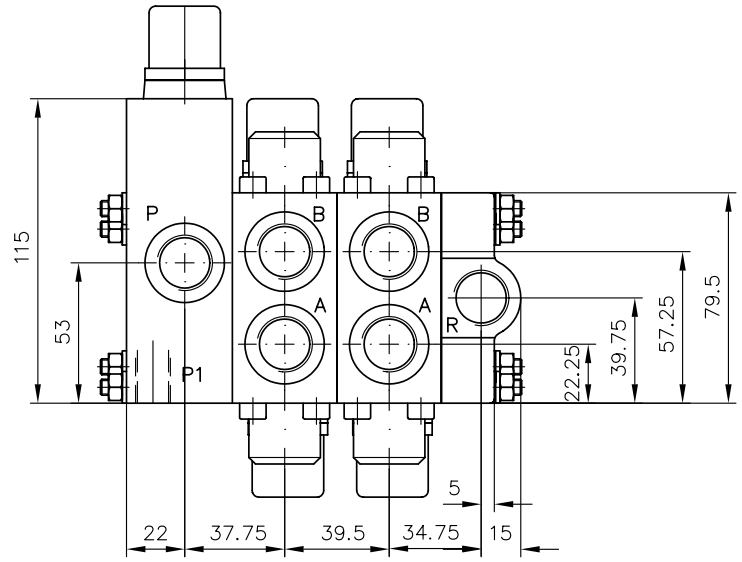
Mounting surface





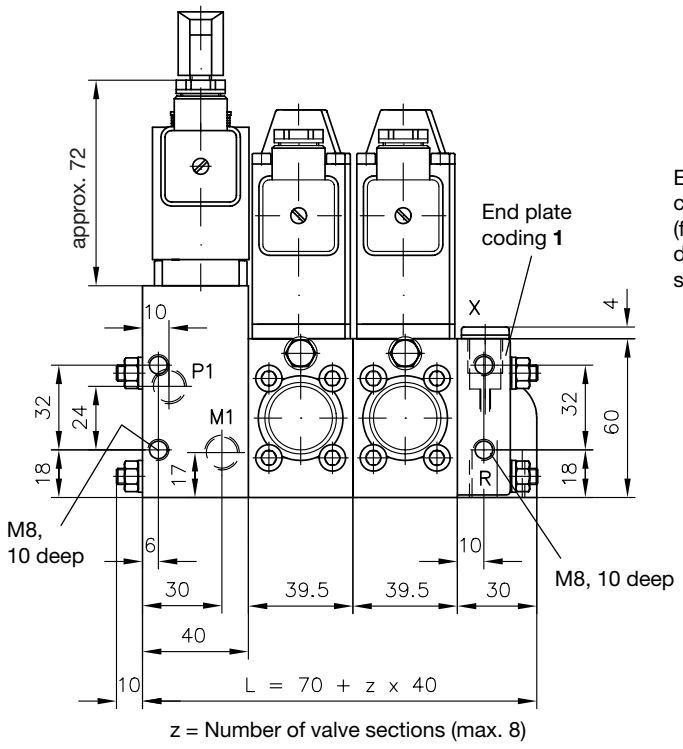
1) This dimension depends on the make and can be up to 40 mm according to DIN 43 650

4.2 Type HSR 3 with connection block B 1 to B 4



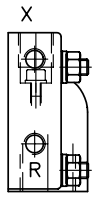
For missing data of directional spool valve and end plate, see sect. 4.1

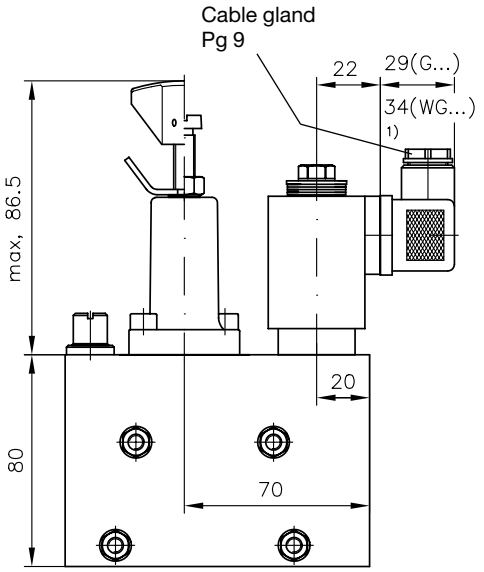
Ports conf. DIN ISO 228/1 (BSPP):
P, A, B, and R = G 1/2
P1, M1, and X = G 1/4



z = Number of valve sections (max. 8)

End plate coding **2** (for missing dimensions see coding 1)

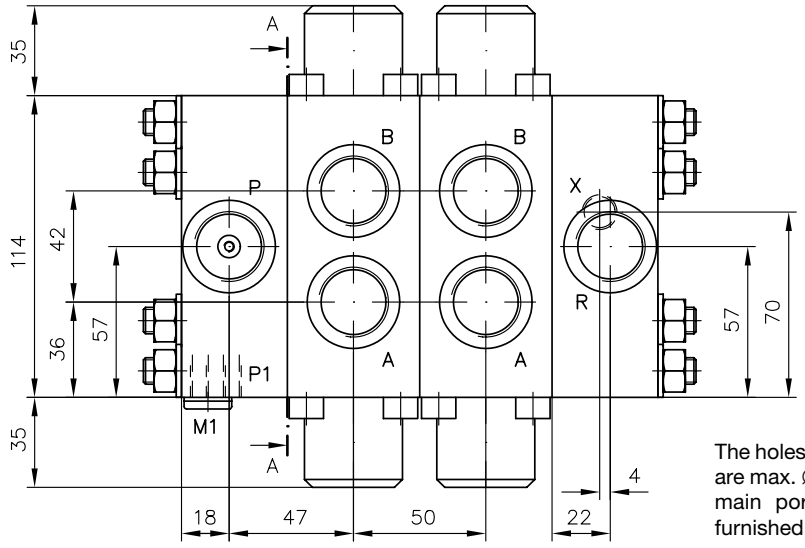




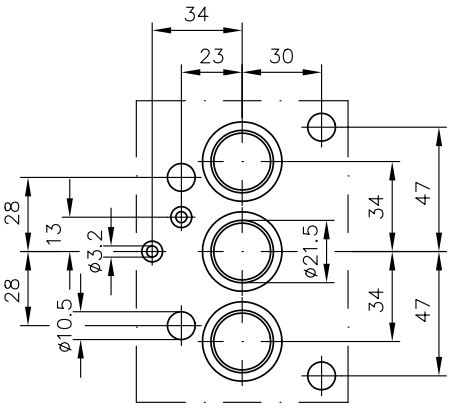
[1]) This dimension depends on the make and can be up to 40 mm according to DIN 43 650

Measuring port M1 for control pressure is blocked with tapped plug DIN 908 - G 1/4 A-St and seal ring A 14x18x1.5 DIN 7603-St

4.3 Directional spool valve bank type HSR 4, complete

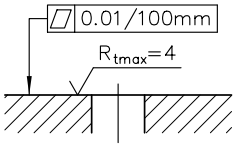


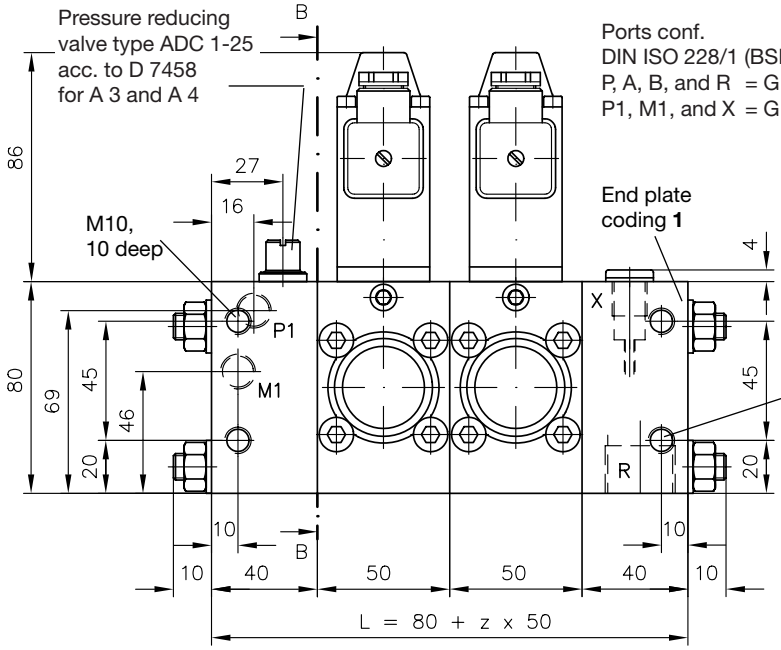
View A - A
Hole pattern, valve housing



The holes ∅3.2 and ∅21.5 are max. ∅ for control and main ports at customer furnished manifolds.

Mounting surface



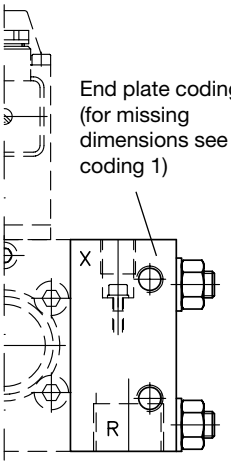


Ports conf.
DIN ISO 228/1 (BSPP):
P, A, B, and R = G 3/4
P1, M1, and X = G 1/4

End plate coding **1**

M10, 10 deep

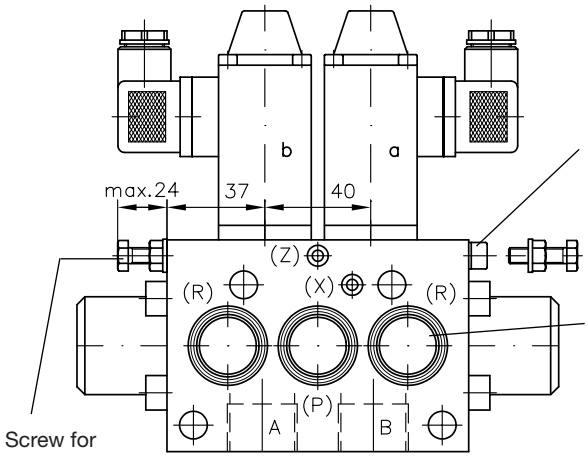
z = Number of valve sections (max. 8)



End plate coding **2** (for missing dimensions see coding 1)

Measuring port M1 for control pressure is blocked with tapped plug DIN 908 - G 1/4 A-St and seal ring A 14x18x1.5 DIN 7603-St

View B - B
Hole pattern applies also to end plate
Valve section coding **C (C1)** to **E (E1)**



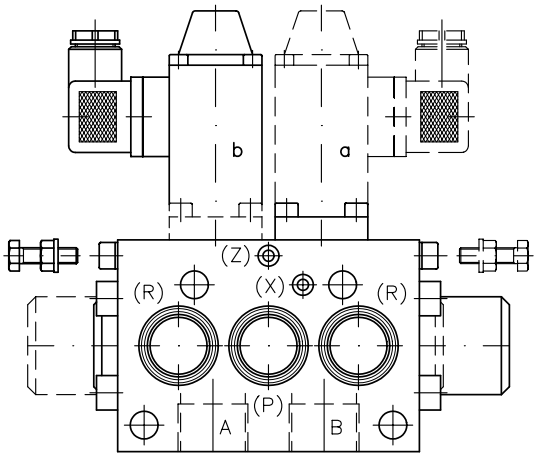
Screw for switching time adjustment

Tapped plug, when without switching time adjustment

This return port is not present with valve coding C(1)

For missing data, see sect. 4.1!

Directional control valve coding
B (B1) **W (W1)**



Sealing of ports:
P and R with O-ring 25.07x2.62 90 Shore
X and Z with O-ring 4.47x1.78 90 Shore

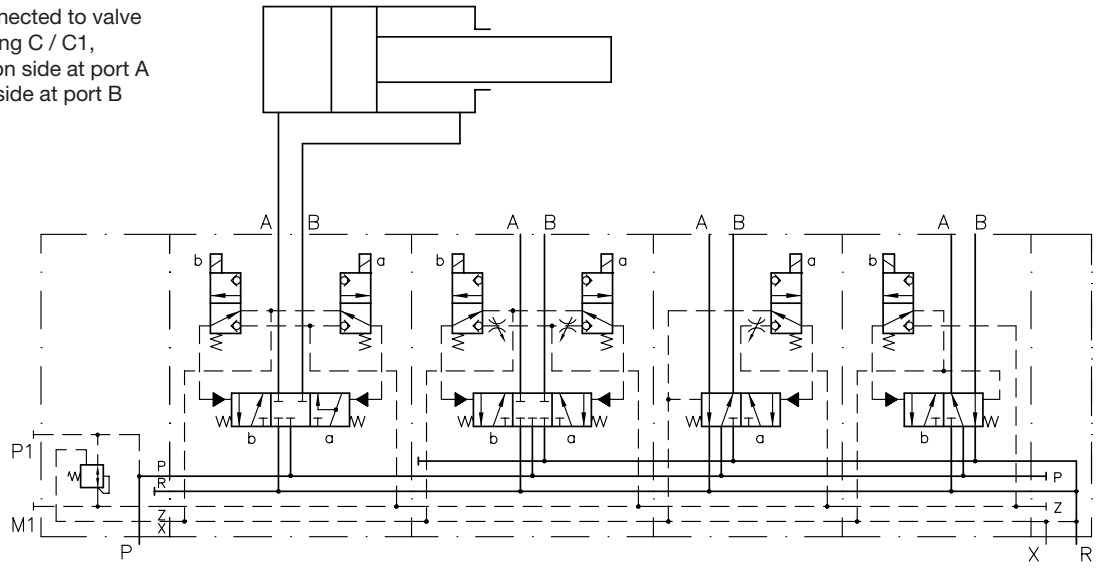
5. Appendix

5.1 Detailed illustration of the symbols from table 3, page 3

This detailed presentation is intended to make it easier to learn about the functional behavior and actual flow routes.
When using differential valves C or C1, ensure that they are always placed at the first location behind the connection block A.. or B.. sect. 2.1, since only one return gallery is present internally for design and functional reasons. Two return galleries are necessary in each case for all other flow diagrams. These galleries are not joined before port R in the end plate. If the C valves were arranged in any other way, one of them would be blocked.

Illustrated example: **HSR 3/A 3 - C G1 W1 B - 1 - G 24**

Connected to valve coding C / C1, piston side at port A rod side at port B



5.2 Individual components for the directional valve bank

For extension, replacement, own stocks etc.

	Connection block (table 1 and 2..)	Valve section (table 1, 3 and 5)		End plate (table 1 and 4)	Plus four tension rods DIN 940, depending on number of valves							
					1	2	3	4	5	6	7	8
Size 3	HSR 3-A 1 to HSR 3-B 42E	HSR 3-C to HSR 3-B 1	G 12 G 24 WG 230	HSR 3-1 or HSR 3-2	M6x 95	135	175	215	255	295	335	375
Size 4	HSR 4-A 1 to HSR 4-A 4	HSR 4 C to HSR 4-B 1		HSR 4-1 or HSR 4-2	M10x 130	180	230	280	330	380	430	480

In order to avoid misunderstandings, the terms connection block, valve section or end plate must be placed ahead of the order designation HSR... Examples: Connection block HSR 3-B 42 E
Valve section HSR 3 G - G 24
End plate HSR 4-1