

Proportional directional spool valve type PSL, PSM, and PSV according to the Load-Sensing principle size 3 (valve bank design)

1. General information

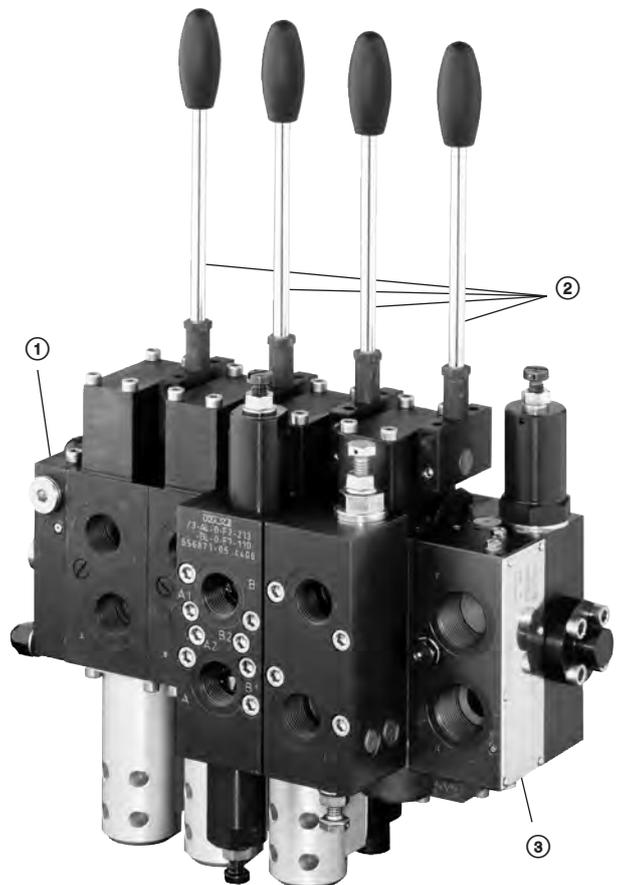
The directional spool valves types PSL and PSV serve to control both, the direction of movement and the load independent, stepless velocity of the hydraulic consumers. In this way several consumers may be moved simultaneously, independently from each other at different velocity and pressure ratings, as long as the sum of the partial flows needed for this is within the total delivery supplied by the pump.

Basic data

Design	Proportional directional spool valve according to the Load-Sensing principle
Versions	Valve bank design
Pressure p_{max}	420 bar
Flow Q_{max}	80 (120) lpm

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2.1

Further technical information:

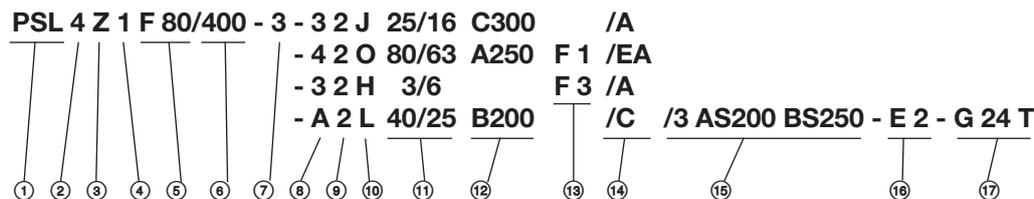
Size	Design	Pamphlet
2	Valve bank design	D 7700-2
2	Valve bank design (CAN onboard)	D 7700-CAN
5	Valve bank design	D 7700-5
3, 5	Manifold mounting design	D 7700-F
7	Manifold mounting design	D 7700-7F

Mounting

- ① End plate
- ② Directional spool valve
- ③ Connection block

2. Type coding, overview

Order coding example: (for additional examples, see also sect. 6)



A total of max. 12 spool valves, in one or more valve bank(s), can be connected in series via the internal LS-duct. External piping is necessary (see also note at sect. 6.1 g) if more are requested.

- | | |
|--|---|
| <p>① Basic type code for the connection block (for detailed information, see sect. 3.1)</p> <p>PSL Supply with pressurized oil by means of constant delivery pump (open center)</p> <p>PSV Supply with pressurized oil by means of variable displacement pump (closed center) with a delivery flow controller, or as a second, separate unit if both valve banks are connected to a constant pressure system</p> <p>PSM For arbitrary supply with pressurized oil either by means of a constant delivery pump or a variable displacement pump</p> <p>(ZPL 53) Adapter plate enables combination with valve sections size 5 acc. to D 7700-5</p> <p>② Tapped ports P and R conf. ISO 228/1 (BSPP) or SAE J 514:</p> <p>3 G 1/2 UNF 4 1 1/16-12 UN-2B (SAE-12)</p> <p>4 G 3/4 UNF 44 1 1/16-12 UN-2B (SAE-12, type PSV)</p> <p>5, 55 G 1 (55 only type PSV)</p> <p>6 G 1 1/4 (only type PSV)</p> <p>③ Additional elements (see section 3.1.1 and 3.1.2) (no coding) Basic version</p> <p>S, W Additional damping device in gallery LS</p> <p>B, B 4...7 Orifice in gallery LS</p> <p>G Restrictor check valve</p> <p>Z, K Restrictor check valve + release valve (type PSL)</p> <p>H Raised circulation pressure of the 3-way flow controller (approx. 14 bar with type PSL)</p> <p>U, UH Automatic reduction of the pump idle circulation pressure by means of a by-pass valve (only type PSL 5.)</p> <p>Y, YH Separate, pressure resistant port for the excess flow from the 3-way flow controller (only type PSL)</p> <p>N Integrated shut-off of the pump gallery (type PSV)</p> <p>④ Control oil supply (table 7, sect. 3.1.4) (no coding) Without pressure reducing valve in case of an external control oil supply (min. 20 bar up to max. 40 bar)</p> <p>1 With integrated pressure reducing valve for the internal supply of control oil (control pressure approx. 20 bar)</p> <p>2 With integrated pressure reducing valve for the internal supply of control oil (control pressure approx. 40 bar)</p> <p>⑤ Optional 2/2-way solenoid valve for arbitrary idle pump circulation (see table 8, sect. 3.1.4.) (no coding) Without directional valve, but prepared for retrofitting</p> <p>F, Z, ZM De-energized = idle pump circulation when open valve is de-energized</p> <p>D, V De-energized = idle pump circulation when closed valve is energized</p> <p>F.. or D.. If a pressure is specified, with pressure limiting valve which can be activated as a second pressure stage (e.g. F 50)</p> <p>PA, PB, PD Prop. pressure limiting valve with various pressure ranges</p> | <p>⑥ Tool adjustable pressure limiting valve (main pressure limitation) in the connection block (see table 9, sect. 3.1.4) (no coding) Without pressure limiting valve (type PSV only) /... Pressure limiting valve factory set to ... bar</p> <p>⑦ Size (acc. to the hole-pattern of the mounting area for the spool valves to be added)</p> <p>3 Size 3 (Size 2 see D 7700-2, Size 5 see D 7700-5)</p> <p>Valve section</p> <p>⑧ Ports at the directional spool valve for A and B</p> <p>3 G 1/2 (ISO 228/1) (BSPP) UNF 3 7/8-14 UNF-2B (SAE-10 acc. to SAE J 514)</p> <p>4 G 3/4 (ISO 228/1) (BSPP) UNF 4 1 1/16-12 UN-2B (SAE-12)</p> <p>A Suited for mounting of ancillary blocks acc. to ⑩</p> <p>or</p> <p>Add-on intermediate plates (see sect. 3.2.2). No. ⑨ ... ⑭ are omitted</p> <p>ZPL 3 VQ.. Priority flow divider</p> <p>ZPL 3 S(V)/H Hydraulically actuated shut-off valve</p> <p>ZPL 3 S(V)/E Solenoid actuated shut-off valve</p> <p>ZPL 3 P/... With pressure limiting valve (joint pressure limitation for all subsequent functions)</p> <p>ZPL 3 D(S) Enables arbitrary flow reduction</p> <p>ZPL 3 D(S)/... Enables arbitrary flow reduction, safe-guarded by a pressure limiting valve</p> <p>ZPL 33/5, ZPL 33/15,
ZPL 33, ZPL 33-Z 3 Spacer plate</p> <p>A1 RR.. Valve section for single acting consumers</p> <p>⑨ Basic directional spool valve unit (table 13, sect. 3.2.1)</p> <p>2, 23, 24 Spool valve with inflow controller for each consumer</p> <p>1 Spool valve without inflow controller, suitable for consumers, which are actuated individually and successively but not simultaneously (no additional functions possible)</p> <p>5, 54, 7, 74 Inflow controller with enforced spring for higher flow</p> <p>26, 56 Inflow controller with additional rebound damping</p> <p>8 4/3-way directional spool valve (pre-selector valve)</p> <p>R 2, R 5, R 7 like 2, 5, 7 but with check valve function</p> <p>⑩ Coding for the flow-pattern (for additional information, see sect. 3.2, table 14 and sect. 6.1 c)</p> <p>L, M, F, H, J, B, R, O, P, A, Q, K, T, N, I, Y, Z, V, G, W, X</p> |
|--|---|

- ⑪ Flow coding for outlet A and B (see table 15, sect. 3.2.1)
 .../... Flow coding for outlet A or B (independently selectable) **3, 6, 10, 16, 25, 40, 63, 80**
- ⑫ LS-pressure limitation (deviating from the main pressure setting, lower pressure for the connected consumer) no shock valves (see table 16, sect. 3.2.1), doesn't apply to spool valve types without inflow controller, coding 1 ⑨ or table 13 (no coding) No LS-pressure limitation
A... Only for consumer port A
B... Only for consumer port B
A...B... For consumer ports A and B
C... Joint for consumer port A and B (not in conjunction with **F**. or **S**)
- ⑬ Functional cut-off (see table 17, sect. 3.2.1), doesn't apply to spool valve types without inflow controller, coding 1 ⑨ or table 13 (no coding) No functional cut-off
F 1 Electrical cut-off, consumer port A
F 2 Electrical cut-off, consumer port B
F 3 Electrical cut-off, consumer port A and B
FP 1(2, 3) Like F 1(2, 3), however with electro-proportional pressure limitation
FPH 1(2, 3) Like FP 1(2, 3), however with additional push-button for manual emergency actuation
S, S 1 External hydraulic load signal pick-up from the control signal port U (consumer port A) and W (consumer port B)
X, SB External load signal pick-up from control signal port X (joint for consumer port A and B) or W (connection side B)
- ⑭ Types of actuation (see table 20, sect. 3.2.1)
/A Manual actuation
/E Electro-hydraulic actuation
/EA Electro-hydraulic and manual actuation
/E0A Like /EA, however without actuation solenoid (prepared for retrofitting)
/H, /HA, /F, /FA Hydraulic actuation with/without manual actuation
/HEA Hydraulic, electric and manual actuation
/C, /AR Detent (stepless), 3-step detent
/ER, /EAR, Electrical, 3-step detent (with/without manual actuation)
/P, /PA Pneumatic actuation with/without manual actuation
/K Mech. joy-stick (2-axis)
 /... Suffix
1 without hand lever
2 short lever
G Reinforced version
N, N1 Proximity switch
V, VA, VB, VC, VCHO, VCHC, VCHOC Contact switch monitoring the spool elevation
WA, WA-EX Position sensor
U Spool monitoring (side indication)
- ⑮ Ancillary blocks (acc. to table 19 in sect. 3.2.1), in combination with codings A of ⑨
/3, /4, /UNF 3 Ancillary block without additional functions
/3 AS.. BS.., Ancillary block with shock valves for A and B
/31 AS..BS.., (routed to the opposing side), with pressure specification (bar)
/4 AS..BS, /UNF 3 AS.. BS..
/3 AN... BN..., Ancillary blocks with shock and suction
/31 AN... BN..., valves at A and B, with pressure specification (bar)
/4 AN... BN..., /UNF 3 AN... BN...
- /4 AN BN, /UNF 3 AN BN** Ancillary blocks with suction valves at A and B
/4 AN..., /4 BN... Ancillary blocks with shock at A or B and suction valves at B or A, with pressure specification (bar)
/3 AL... BL..., /3 AL..., /3 BL... Ancillary blocks with over-center valves at A and/or B, with pressure specification (bar)
/3 VV(VX, XV), /UNF 3 VV(VX, XV) Ancillary blocks with shut-off valves EM 32 V acc. to D 7490/1 (one or both sided) blocking the consumer with zero leakage (Q_{max} approx. 80 lpm)
/3 DRH, /UNF 3 DRH Ancillary blocks with releasable check valves
/43 DFA, /43 DFB Ancillary blocks for regenerative circuit
/3 DW., /4 DW., /UNF 4 DW. Ancillary blocks with flow control valve for 3/3-way directional spool valve flow pattern symbol N
/4. AS.. Like /4 DW., with additional shock valve for A
/4. HPR.. Like /4 DW., with additional releasable check valve
- Intermediate plates (see table 19 a, sect. 3.2.1)
/ZDR, /ZDS Short-circuit valve between A and B
/Z AL... BL... Spacer plate with over-center valve an A and B with pressure specification (bar)
/ZDRH Spacer plate with releasable check valves
/Z 40.. Spacer plate
/Z AN BN Intermediate plate with suction valves
- ⑯ End plate (see table 11, sect. 3.1.5)
E 1, E 1 UNF With T-port for control oil return externally to the tank (basic type)
E 2 Like E 1, with additional port Y for connection to the LS-port of a further, separately located PSV spool valve
E 3 Like E 1, with additional 3/2-way directional solenoid valve for arbitrary shut-off of pump circulation during idle position of the valve spools
E 4, E 4 UNF Like E 1, however internal control oil return, max. pressure 10 bar!
E 5 Like E 2, however internal control oil return, max. pressure 10 bar!
E 6 Like E 3, however internal control oil return, max. pressure 10 bar!
E 17... E 20, E 17... E 20 UNF Variations, see table 11 in sect. 3.1.5
EF 30, EF 41, EF 42 see section 3.2.3
E 35... see section 3.1.5
ZPL 32 Adapter plate enables combination with directional spool valves size 2 acc. to D 7700-2
- ⑰ Solenoid voltage and version (see table 10, sect. 3.1.4)
G 12.. 12V DC, connection conf. EN 175 301-803 A
G 24.. 24V DC, connection conf. EN 175 301-803 A
G 24 EX 24V DC, explosion-proof version
G 24 TEX 70 24V DC, explosion-proof version (ambient temperature 70°C)
G 24 MSHA 24V DC, explosion-proof version (fire-damp protected (mining))
G 24 M2FP 24V DC, explosion-proof version (fire-damp protected (mining)) (Australia)
G 12 IS 12V DC, explosion-proof version, (fire-damp protected (mining)), intrinsically safe
AMP 12 K 4 12V DC, connection via AMP Junior Timer
AMP 24 K 4 24V DC, connection via AMP Junior Timer
S 12.. 12V DC, electr. connection via quarter turn plug
S 24.. 24V DC electr. connection via quarter turn plug
DT 12 12V DC electr. connection via plug
 Co. DEUTSCH
DT 24 24V DC electr. connection via plug
 Co. DEUTSCH

3. Available versions, main data

3.1 Connection blocks and end plates

There are three basic variations of connection blocks:

- Connection blocks with integrated 3-way flow controller, suitable for a constant delivery pump system (open-center) - type PSL (see sect. 3.1.1)
- Connection blocks suited for a variable displacement pump system (closed center), a constant pressure systems, or if a second or more separately located directional spool valve banks are fed in parallel - type PSV (see sect 3.1.2)
- Connection blocks for arbitrary supply with pressurized oil either by means of constant delivery pump or variable displacement pump (external connection) - type PSM (Pos. 3.1.3)

Order coding for a connection block as single section (examples):
(Attention: Size specification absolutely necessary, here -3)

PSL 41 F/250 - 3 - G 24
PSV 51 -3

3.1.1 Connection blocks for constant delivery pump systems (with integrated 3- way flow controller) type PSL

Order example:

PSL 4 . 1 F/300 - 3 - ... - G 24



Solenoid voltage and version table 10
 Coding for additional elements table 2
 Basic type and port size table 1

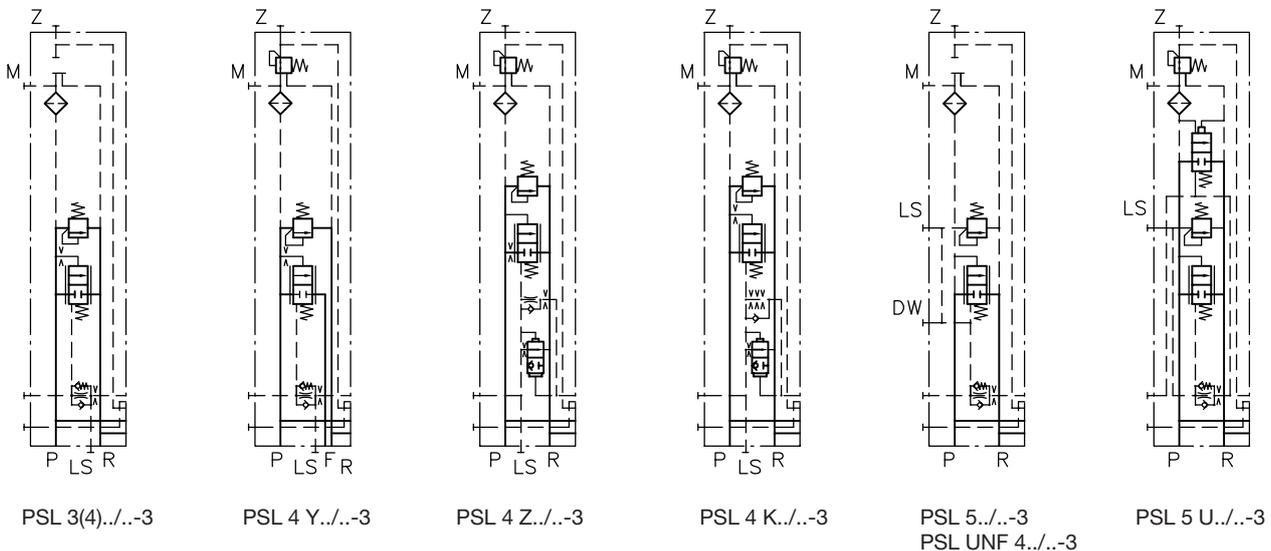
Table 1: Basic type and port size

Coding	Ports P and R conf. ISO 228/1 (BSPP) or SAE J 514	Max. pump delivery flow (lpm)	Description
PSL 3	G 1/2	80	Standard , integrated 3-way flow controller
PSL 4	G 3/4	100	
PSL 4 Y	G 3/4	100	Separate, pressure resistant port for the excess flow from the 3-way flow controller (see also sect. 6.1 a)
PSL 4 Z	G 3/4	100	PSL 4 Z Version with restrictor check valve (no pre-load valve) with additional un-loading valve for a specific dampening characteristic (quick de-pressurization at idle position of all spool valves)
PSL 4 K	G 3/4	100	PSL 4 K Version with gap type throttle with rather temperature independent dampening characteristic
PSL 5	G 1	200	Standard, integrated 3-way flow controller, can be converted any time for use with variable displacement pumps (similar to type PSV 55.. and PSV UNF 44), see sect. 6.3.3
PSL 45	G 3/4 and G 1		
PSL UNF 4	1 1/16-12 UN-2B (SAE-12)		
PSL 5 U	G 1	200	Automatic reduction of the idle pump circulation pressure by means of a by-pass valve (see also sect. 6.1 a, with solenoid actuation $Q_{pu} \geq 80$ lpm)
PSL 45 U	G 3/4 and G 1		

Note: A spacer plate type SL 3-ZPL 33/5 (see sect. 3.2.2) has to be installed right after the connection block whenever type PSL 5, PSV 55 or PSM 5 is combined with a valve section with ancillary block (coding SL 3-A.. acc. to table 12 and 19) as otherwise it is not possible to mount a fitting in port R.

Flow pattern symbols

(see also sect. 3.1.4)



PSL 3(4)../..-3

PSL 4 Y../..-3

PSL 4 Z../..-3

PSL 4 K../..-3

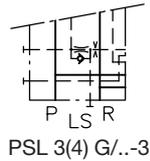
PSL 5../..-3
 PSL UNF 4../..-3

PSL 5 U../..-3

Table 2: Coding for additional elements (for notes and descriptions, see sect. 6.1 a)

Coding	Description
no coding	Standard (integrated combination of orifice, check valve, pre-load valve pre-load pressure approx. 25 bar)
W	Like standard, but with increased throttle effect, not available for type PSL 4 K and PSL 4 Z
G	Restrictor check valve (without sequence valve), increased throttling effect, not avail. with type PSL 4 K, PSL 4 Z, PSL 5
H	Coding for 3-way flow controller with increased idle circulation pressure (see sect. 4.2). Intended for valve spools with increased flow (coding 5 acc. to table 15), pre-selector spool valve coding 8 (see table 13), or add-on intermediate plates coding ZPL 3 P/... (see sect. 3.2.2)
T	Provision for locking the 3-way flow controller to enable use with variable pump systems. Only available for type PSL 3, PSL 4, PSL 4 K(Z)
TR	Like T, manually adjustable

Flow pattern symbols
(see also sect. 3.1.4)



3.1.2 Connection blocks for variable displacement pump systems / constant pressure system or for a second and all other separately parallel connected directional spool valve banks type PSV

Order example:

PSV 5 . 1 F/300 - 3 -... - E 1 - G 24

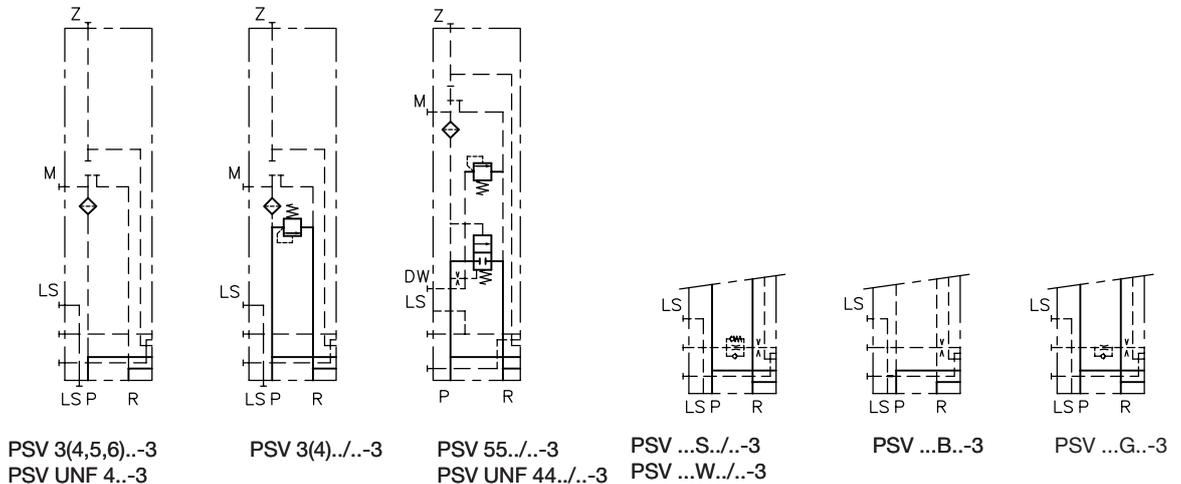


Solenoid voltage and version table 10
Coding for additional elements table 4
Basic type and port size table 3

Table 3: Basic type and port size

Coding	Port P and R conf. ISO 228/1 (BSPP) or SAE J 514	Max. pump delivery flow (lpm)	Note: A spacer plate type SL 3-ZPL 33/5 (see sect. 3.2.2) has to be installed right after the connection block whenever type PSL 5, PSV 55 or PSM 5 is combined with a valve section with ancillary block (coding SL 3-A.. acc. to table 12 and 19) as otherwise it is not possible to mount a fitting in port R. Type PSV 5, PSV 6, and PSV UNF 4, is not available with pressure limiting valve. For alternative see PSV 55 or PSV UNF 44 Type PSV 55 and PSV UNF 44, like converted type PSL 5 or PSL UNF 4 acc. to sect. 3.1.1
PSV 3	G 1/2	approx. 80	
PSV 4	G 3/4	approx. 100	
PSV UNF 4	1 1/16-12 UN-2B (SAE-12)	approx. 130	
PSV UNF 44	1 1/16-12 UN-2B (SAE-12)	approx. 200	
PSV 5	G 1	approx. 130	
PSV 55	G 1	approx. 200	
PSV 5 N	G 1	approx. 150	
PSV UNF 5 N	1 5/16-12 UN-2B (SAE-16)	approx. 150	
PSV 6	G 1 1/4	approx. 200	

Flow pattern symbols (see also sect. 3.1.4)



Divergent type coding at type PSV 5 N or PSV UNF 5 N

Order example: **PSV 5 N S 1 300/270 - 3**
PSV 5 N S 2 V 250/210 - 3
PSV 5 N S Z 350/310 - 3

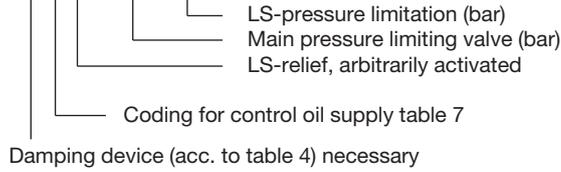


Table 3 a: LS-relief

Coding	Description
no coding	Without arbitrary relief, prepared for retrofitting of a directional seated valve type EM 11 S(V) acc. to D 7490/1
V	With 2/2-directional seated valve type EM 11 V acc. to D 7490/1 (closed when deenergized)
Z	With 2/2-directional seated valve type EM 11 S acc. to D 7490/1 (open when deenergized)

The high control pressure of variable displacement pump controllers may lead to unintentional movements of consumers with low load pressure even while the respective valve is in its idle position. The pump gallery is completely blocked with type PSV 5 N to ensure a definitive separation of pump and consumer circuit. This takes place by means of a solenoid valve. The LS-gallery together with the LS-controller may be additionally relieved via a separate 2/2-way directional seated valve.

Flow pattern symbols

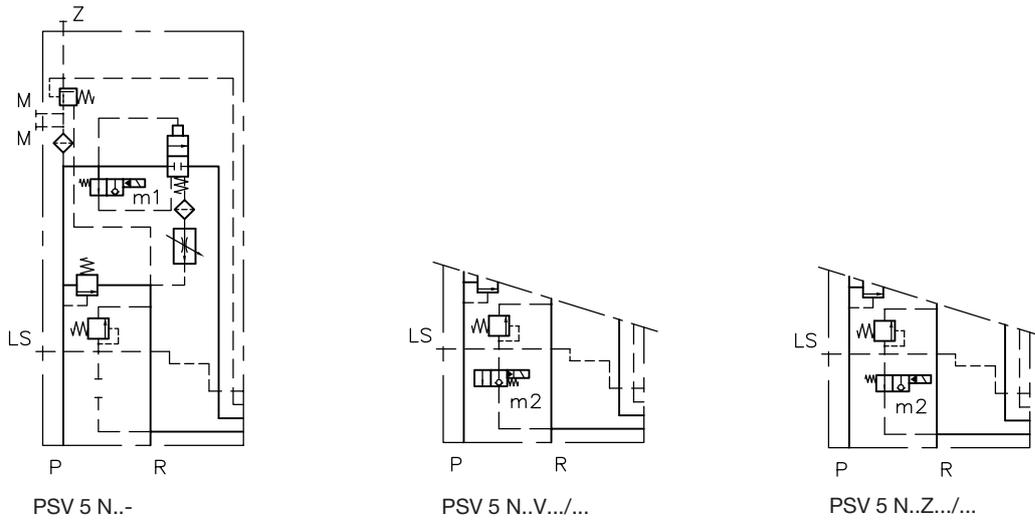


Table 4: Coding for features within the LS-signal duct for the damping of pump flow controllers (for notes and explanation, see sect. 6.1 a)
 Additional features only suitable where variable displacement pumps are used (limitation of the control oil flow) Observe note at table 9!

Coding	Description
no coding	Standard , without additional elements
S	With integrated combination of orifice, check valve, pre-load valve (pre-load pressure approx. 25 bar); like standard element of type PSL
W	Like S, but with increased throttle effect
B	With orifice \varnothing 0.8 mm within LS-duct (to limit control oil flow)
B 4, B 5, B 6, B 7	With orifice \varnothing 0.4 mm, 0.5 mm, 0.6 mm or 0.7 mm at the LS-duct

3.1.3 Connection block type PSM

The connection block can be used either for a constant delivery pump or for variable displacement pump system by appropriate external connection.

Order example: **PSM 5 . 1 F/320 - 3 - ... - E 5 - G 24**

Table 5: Basic type and port size

Coding	Port P and R conf. ISO 228/1 (BSPP) or SAE J 514	Max. pump delivery flow (lpm)
PSM 5	G 1	approx. 200
PSM UNF 4	1 1/16-12 UN-2B (SAE-12)	approx. 200
PSM 5L	G 1	approx. 200

Note: A spacer plate type SL 3-ZPL 33/5 (see sect. 3.2.2) has to be installed right after the connection block whenever type PSL 5, PSV 55 or PSM 5 is combined with a valve section with ancillary block (coding SL 3-A.. acc. to table 12 and 19) as other-wise it is not possible to mount a fitting in port R.

Table 6: Coding for additional elements

Coding	Description
no coding	Standard (damping like type PSL)
H	Coding for 3-way flow controller with increased idle circulation pressure (see sect. 4.2) otherwise identical to the standard version, e.g. suited for valve spools with increased flow rating (coding 5, see table 15)

3.1.4 Additional elements for the connection blocks

Order example: PSL 4. **1 F 100 /380** - 3 - ... - E 1 - G 24
 PSV 5. **1 F /350** - 3 - ... - E 1 - G 24

Table 7: Coding for control oil supply (for symbol, see sect. 3.1.1 and 3.1.2)

Coding	Description
no coding	Without pressure reducing valve for actuation A, C or P acc. to sect. 3.2 table 17 or in the case of external control oil supply (20-40 bar) for other actuations
1	With integrated pressure reducing valve for internal control oil supply for actuations H(HA), HEA).. and E(EA).. or as pick-up for other control valves (max. permissible control oil flow approx. 2 lpm)
2	Control pressure: Coding 1: approx. 20 bar (+ return pressure at R) Coding 2: approx. 40 bar (+ return pressure at R)

Table 8: Arbitrary idle pump circulation of all consumers by means of 2/2-way solenoid valve type WN 1 acc. to D 7470 A/1, 2/2-way solenoid valve type EM 21 DE (DSE) acc. to D 7490/1 E and prop. pressure limitation. Doesn't apply to **PSV 6...-3** and **PSV 5 N...-3** !

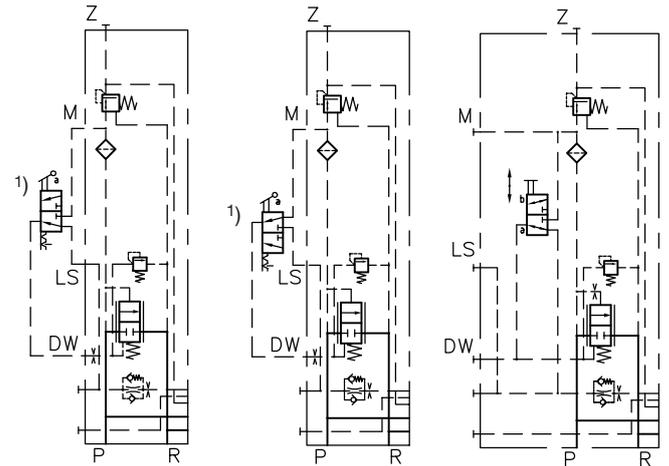
Coding	Description
no coding	If not required
F	With WN 1 F, idle pump circulation if valve is de energized (emergency stop)
D	With WN 1 D, idle pump circulation if valve is energized
F... or D...	With pressure limiting valve, which can be activated as a second pressure stage (specify pressure in bar) (pre-set pressure, tool adjustable from 50 to 400 bar) Example: type PSL 41 F 100/350-3.. De-energized p_{max} 100 bar Energized p_{max} 350 bar

This connection is to be customer furnished. The required pipes and fittings are not part of the delivery.

Solenoid voltage and version (see table 10)

Flow pattern symbols (see also sect. 3.1.4)

Coding PSM 5	PSM 5	PSM 5L
PSM UNF 4	PSM UNF 4	
Connection appropriate for constant delivery pump systems	Connection appropriate for variable displacement pump systems	



1) 3/2-way directional valve not scope of delivery

Solenoid voltage and version (see table 10)
 Tool adjustable pressure limiting valve for the main pressure table 9
 Arbitrary idle pump circulation table 8
 Coding for control oil supply table 7

Note: To limit the control oil flow, when using the idle pump circulation with type PSV an additional element coding S, W or B 4, B 5, B 6 acc. to table 4 is required.

Attention: Observe note in sect. 6.1 a when using the valves for an emergency stop function!

Coding	Description
PA, PB, PD	Prop. pressure limiting valve enables variable adjustment of the system pressure ranges: PA 100...320 bar, PB 15...250 bar, PD 18...400 bar
Z	Prop. pressure limiting valve type EM 21 DSE, open when deenergized
ZM	Like Z, but with lead sealed wing screw for emergency operation
V	Prop. pressure limiting valve type EM 21 DE, closed when deenergized
X...	Additional LS pressure limitation (50...400 bar) Not suited to compensate pressure peaks on the consumer side.

Table 9: Tool adjustable pressure limiting valve for the main pressure. Adjustable from 50 up to 420 bar, after slackening the lock-nut (for symbol, see sect. 3.1.1 and 3.1.2).

Coding	Description
no coding	Version without pressure limiting valve (only type PSV)
/...	With pressure limiting valve at PSL and PSV, if pressure specification in bar is added; non piloted: PSL(V) 3, PSL(V) 4 and PSV 5 N piloted: PSL 5, PSV 55, PSL UNF 4, PSV UNF 44 and PSM 5 Not available with type PSV 6..- 3!

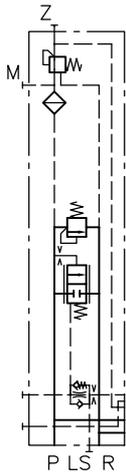
Table 10: Solenoid voltage and version

Coding	Description
G 12 . G 24 T without T TH H 4	Electr. connection conf. EN 175 301-803 A, via plug (MSD 3-309) Suffix: Applies only to the solenoid actuation coding E, EA, HEA, FEA (table 20) and the functional cut-off (coding F, FP, table 17), see also sect. 4.3 Actuation solenoid 3-pin (standard) Manual emergency actuation (standard with functional cut-off F., FP., see table 17) Manual emergency actuation with pushbutton (standard with functional cut-off FPH., FP., see table 17) Actuation solenoid 4-pin (only G 24 V DC)
G 24 C 4	Electr. connection conf. EN 175 301-803 C, via plug (MSD 6-209), 4-pin actuation solenoid
X 12 . X 24 .	Electr. connection conf. EN 175 301-803 A, without plug. For options, see coding G...
S 12 . S 24 T without T	Electr. connection via quarter turn type plug (Bayonet PA 6, Co. SCHLEMMER D-85586 Poing, suited for taper with bayonet 10 SL), 3-pin actuation solenoid Suffix: Manual emergency actuation (standard with functional cut-off FP., table 17)
AMP 12 K 4 AMP 24 K 4	Vertical connection via plug AMP Junior Timer, solenoid features 4 terminals
AMP 24 H 4 T	Lateral connection via plug AMP Junior Timer, solenoid features 4 terminals and manual emergency actuation
DT 12 DT 24	Connection via plug Co. DEUTSCH DT 04-4P, suited for socket DT 06-4S
G 24 EX G 24 EX-10 m EX T EX EX4 T EX4	For use in areas with explosion hazardous atmosphere. Suited for category 2 and 3, zone 1, 21, 2, 22. Protection class EEx m II 120° (T4), with cable length 3 m (no coding) or 10 m 3-pin actuation solenoid 3-pin actuation solenoid with manual emergency actuation 4-pin actuation solenoid 4-pin actuation solenoid with manual emergency actuation
G 24 TEX 70 G 24 TEX 70-10 m	Like G 24 EX ..., but for ambient temperature < 70°C
G 12 IS G 12 IS-10 m	For use in mines and its on-surface systems, which can be endangered by fire damp and/or combustible dust. Protection class I M2 Ex d ib I , intrinsic safe), with cable length 5 m (no coding) or 10 m
G 24 MSHA G 24 MSHA-10 m	For use in mines and its on-surface systems, where a ATEX (EU), IEC, MSHA (USA) or MA (China) approval is mandatory. Protection class I M2 Ex d I (fire-damp protected), intrinsic safe), with cable length 5 m (no coding) or 10 m
G 24 M2FP G 24 M2FP-10 m	Intended for use in mining and related machinery below and above ground, where an approval conforming IEC or ANZE (Australia) is mandatory. Protection class I M2 Ex d I (fire-damp protected) with connection line 3m (std.) or connection line 10 m

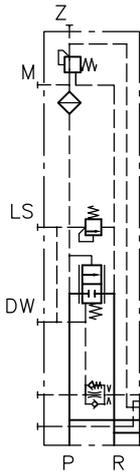
Note:

- Solenoids of explosion-proof design are only available for actuation E, EA or HE(A) (table 20).
- An intermediate plate ZPL 33/5 (see table 22) has to be provided between the valve sections when using solenoids G 12 IS..., G 24 MSHA... and G 24 M2FP.
- Coding G 24 C4 (X 24 C4) is only available for solenoids of the electrical actuation (table 20) where there is no manual emergency actuation.
- Coding AMP..., DT not available for idle circulation valves coding D, F, PA, PB, PD (table 8), intermediate plates ZPL 3 S(V)E (table 22), end plates E 3, E 6 (table 11), intermediate plates /ZDS, /ZDR (table 19a), functional cut-off coding F. (table 17)
- Coding S.: Not available for functional cut-off coding F. (table 17) and comparator coding U (table 21)

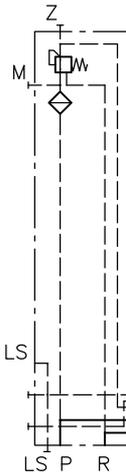
Flow pattern symbols



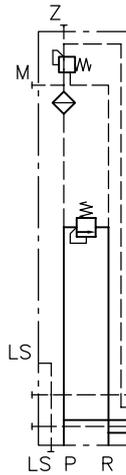
PSL 3(4).1./..-3



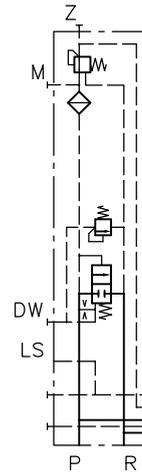
PSL 5.1./..-3
PSL UNF 4.1./..-3



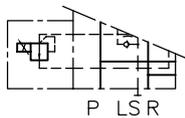
PSV 3(4,5,6).1...-3
PSV UNF 4.1...-3



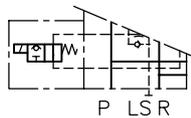
PSV 3(4).1./..-3



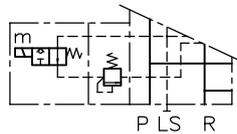
PSV 55.1./..-3
PSV UNF 44.1./..



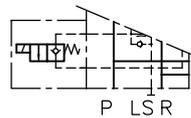
PSL(V)..PA(PB, PD)



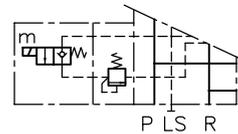
PSL(V)..F
PSL(V)..Z
PSL(V)..ZM



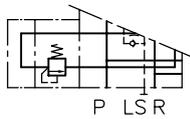
PSL(V)..F..



PSL(V)..D
PSL(V)..V



PSL(V)..D..



PSL(V)..X

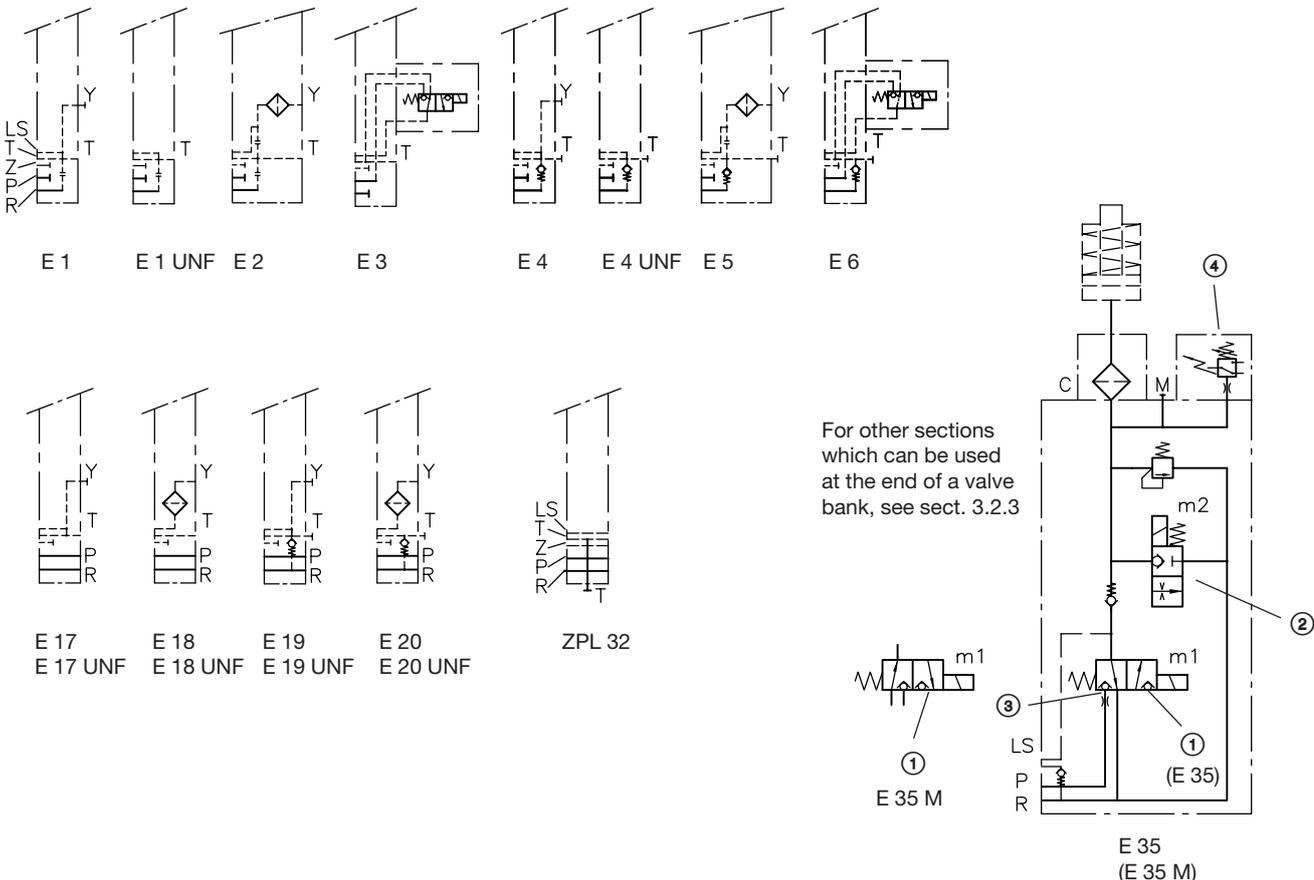
3.1.5 End plates

Order example: PSL 41 F 100/380 - 3 - ... - **E 1** - G 24

Table 11: End plates

End plate		Port size	Description Order coding of an end plate as separate part (example): SL 3 - E 1 SL 3 - E 6 - G 24 SL 3 - ZPL 32
external port T (separate return pipe to the tank)	internal control oil return gallery		
E 1 E 1 UNF	E 4 E 4 UNF	ISO 228/1 (BSPP): T, Y = G 1/4 P and R = G 3/4	Standard end plate
E 2	E 5		With additional inlet port Y e.g. for connecting the LS-control pipe of a subsequent PSV spool valve bank
E 3	E 6	SAE J 514 (E.. UNF): T = 7/16-20 UNF-2B (SAE-4) P and R = 7/8-14 UNF-2B (SAE-10)	Possibility for arbitrary shut-off of the idle pump circulation by means of a directly mounted 3/2-way directional seated valve WN 1 H conf. D 7470 A/1
E 17 E 17 UNF	E 19 E 19 UNF		Like E 1/E 4, but with additional port P and R
E 18 E 18 UNF	E 20 E 20 UNF		Like E 2/E 5, but with additional port P and R
	E 35 . /60 /45 E 35 M 7/320/...	C, M = G 1/4 (BSPP)	Activation of clamping cylinders or brakes (open / close) additionally part of the system by means of leakage free directional seated valves e.g. engaging or releasing the clamping of a rudder of a ship. The flow via the 3/2-way directional seated valve ① is limited by an orifice ③. A pressure switch ④ monitors whether the clamping pressure is reached and maintained. The consumer is released by means of the 2/2-way directional seated valve ②. Integrated individual valves: Q_{max} : 6 lpm, p_{max} : 60 bar (100 bar with orifice diameter 1 mm) (260 bar with orifice diameter 0.8 mm) (420 bar with orifice diameter 0.7 mm)
ZPL 32		T = G 1/4 (BSPP)	Adapter plate from size 3 to size 2

Order example

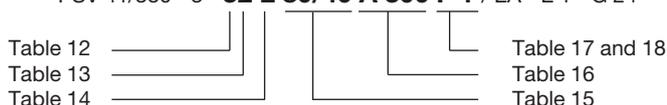


Note: The internal control oil return gallery is to be used only in systems where the return pressure is below 10 bar.

3.2 Add-on spool valves

3.2.1 Directional spool valve

Order example: PSV 41/380 - 3 - **32 L 80/40 A 300 F 1** / EA - E 1 - G 24



Order code for single section (examples):

Directional spool valve **SL 3-32 J 80/40 F 2/EA-G 24**

Valve spools (separate) **SL 3 - J 80/40**

Note: Size specification absolutely necessary SL 3! The valve spools are subsequently interchangeable, e.g. if a different flow rating than initially planned becomes necessary (see sect. 6.3.4)

Table 12: Port size A and B

Coding	Port conf. ISO 228/1 (BSPP) or SAE J 514 (SAE-10)	Note
3	G 1/2	
4	G 3/4	Attention: Run-out version, don't use for new systems!
UNF 3	7/8-14 UNF-2B	Coding UNF 3 (table 12) only with electrical actuation (coding E, E0A, EA acc. to table 20) and only as optional function „no coding“, A.. B.., A..B..., A.. B.. F.(FP.), A..B... S 1 or X (table 16 and 17)
UNF 4	1 1/16-12 UN-2B	Coding UNF 4 only in combination with coding 8 acc. to table 13
A	With ancillary blocks conf. table 19 Note: A spacer plate type SL 3-ZPL 33/5 (see sect. 3.2.2) has to be installed right after the connection block whenever type PSL 5, PSV 55 or PSM 5 is combined with a valve section with ancillary block (coding SL 3-A.. acc. to table 12 and 19) as otherwise it is not possible to mount a fitting in port R.	

Table 13: Directional spool valve, basic unit

Coding	Description	
2	Standard , with inflow controller, for simultaneous load compensated moving of several consumers (3/3-, 4/3-way spool valve, standard type)	
1	Without inflow controller intended for singly / successively actuated functions. Additional functions on the consumer side are not possible. For the max. consumer flow of the indiv. consumer, see table 15 and sect. 6.1 b)	
5	With inflow controller (for symbol, see coding 2) but with reinforced spring at the 2-way flow controller (control pressure approx. 9 bar). Only usable in conjunction with connection block type PSL.H./... or type PSV with variable displacement pump / constant pressure system (for note, see sect. 6.1a and b).	
7	With inflow controller (like coding 2) but enforced 2-way controller spring (control pressure approx. 13 bar). Only available in combination with connection block type PSV and variable displacement pump/constant pressure system (for note, see sect. 6.1b).	
23, 24 53, 54 73, 74	With inflow controller (for symbol, see coding 2) but with additional dampening (orifice 0.3 mm or 0.4 mm)	
26 56	With inflow controller coding 2 or 5, and additional rebound damping; Especially suited for oscillation inducing consumers (e.g. hydraulic motors with a low number of pistons)	
8	4/3-way directional spool valve, utilized as pre-selector (also, see symbol page 15), only available with ports G 1/2*, G 3/4* and UNF 4 (conf. table 12) coding. -38, -48 and -UNF 48. This version is only recommended with flow coding L and max. flow. Only usable in conjunction with connection block type PSL.H./... or type PSV with variable displacement pump / constant pressure system. (For note, see sect. 6.1 b) (* = BSPP)	
R 2 R 5 R 7	Like coding 2, 5, 7, but with additional check valve functionality (spool valve = slight leakage), see sect. 6.1 b Only usable in conjunction with connection block type PSL.H./... or type PSV with variable displacement pump / constant pressure system.	

Table 14: Order example

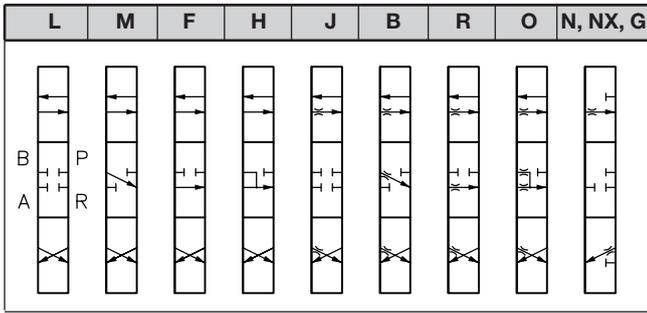


Table 15: Max. flows P → A(B) conf. the coding

Valve spool coding conf. table 13	Coding for consumer flow $Q_{A, B}$ (lpm) at ports A and B							
	3	6	10	16	25	40	63	80
2, 26	3	6	10	16	25	40	63	80
1	4	9	14	22	34	54	85	107
Valid for PSL (integrated 3-way flow controller: $\Delta p \sim 9$ bar) otherwise as guide line $Q_{A, B} \approx Q_{nom} \sqrt{0.2 \cdot \Delta p_{controller}}$ Q_{nom} - Nom. flow with coding 2 $\Delta p_{controller}$ Stand-By-pressure of the pump controller Example : $Q_{nom} = 25$ lpm, $\Delta p_{controller} = 14$ bar $Q_{A, B} \approx 42$ lpm								
5, 56	4	9	14	22	34	54	85	107
7	5	10	15	24	37	59	93	118
8	See coding 1 (only for port A)							

The flow ratings for the consumer ports A and B can be selected freely, e.g. 63/40, 40/80. Thereby enabling optimal adaptation to the respective consumer while exploitation the full functional lift of the spool. In addition there is the possibility of stroke limitation.

Table 17: Functional cut-off or prop. pressure limitation (only available for spool valves with inflow controller, coding 2, 5 and 7 conf. table 15!)
Not in combination with flow pattern symbol N!

Coding	Description
no coding	Without additional cut-off
F 1, F 2	Electric functional cut-off at A or B
F 3	Electric functional cut-off at A and B
FP 1, FP 2, FP 3 FPH 1, FPH 2, FPH 3	Prop. pressure limitation for A or B resp. A and B Version FPH. with additional emergency actuation (no tools needed)
S, S 1	Load signal ports U and W (G 1/8 (BSPP)) for external piping
X, SB	Common load signal port (coding X) or load signal B (coding SB) for external piping (G 1/8 (BSPP)) Only available in combination with coding 3 and UNF 3 (table 12)

There remains a residual pressure when the LS gallery is relieved. When the return line is depressurized the residual pressure will be: $p_{relieved} = \Delta p_{block} + \Delta p_{controller}$ ($\Delta p_{controller}$ = control pressure of the inflow controller acc. to table 13)

Coding F., FP., X. SB : $\Delta p_{block} = 10$ bar
Coding S, S 1 : $\Delta p_{block} = 5$ bar
Coding X (at UNF 3): $\Delta p_{block} = 1$ bar

J, B, R, O, I, Y, Z, V	Spool with return flow throttling to support the oscillation damping, see sect. 6.1 c
A, K, P, Q, T	Valve spool with positive overlapping, see sect. 6.1 c
N, NX, G	3/3-way directional spool valve type SL 3-A. N./... without additional functions (see table 16) Type SL3-A. NX./... only in combination with add. function A.. or K...X (acc. to table 16) Observe note in sect.. 6.1 c !
W	4/2-way spool valve, see sect. 6.1 c
JE, LE	Valve spool with minimized internal leakage, can not be retrofitted; increased hysteresis
HW, OW	Valve spool with wider fitting to prevent spool sticking - intended for contamination prone systems
X	2/2-way directional spool valve for hydraulic motors, see sect. 6.1 e

Table 16: LS-pressure limiting valves, no shock valves (only available with for sections with inflow controller coding 2, 5 and 7 acc. to table 15! In combination with symbol NX only A.. or K... (see page 14!))

Coding	Description
no coding	Without pressure limitation
A...	Pressure limitation at A with pressure specification
K...X	Pressure limitation for A and pressure specification (bar), additionally with LS-pressure ports K and X (see sect. 6.1 c) Only in combination with symbol NX!
B...	Pressure limitation at B with pressure specification
A... B...	Pressure limitation at A and B with pressure specification
C...	Common pressure limitation for A and B with pressure specification

Pressure limitation $p_{min} = 50$ bar; $p_{max} = 400$ bar
Example: SL 3-32 H 63/40 **A 250 B 200/A**

Coding UNF 3 (table 12) only with electrical actuation (coding E, EOA, EA acc. to table 20) and only as optional function „no coding“, A..., B..., A...B..., A...B... F.(FP.), A...B... S 1 or X (table 16 and 17).

Table 18: Combination possibilities for additional functions flow pattern symbols, see page 15

Pressure limitation	Functional cut-off			
	no coding	S S 1	X SB	F 1, F 2, F 3 FP 1, FP 2, FP 3 FPH 1, FPH 2, FPH 3
no coding	●	●	●	●
A or B A and B	●	●	●	●
C	●	--	--	--

Additionally: **F 1 ... F 3** or **FP(H) 1 ... FP(H) 3** may be combined with **X**

Table 19: Ancillary blocks
 Port size: /3.. = G 1/2, /4.. = G 3/4, /UNF 3.. = 7/8-14 UNF-2B (SAE-10), /UNF 4.. = 1 1/16 UNF/2B (SAE/12)
 Observe note in table 1, 3 and 5

Coding	Brief description	Symbols
/3 /UNF 3 /4	Without additional functions	
/3 AS... BS... /31 AS... BS... /UNF 3 AS... BS... /4 AS... BS...	With shock valves at A and B (routed to the opposing side), with pressure specification (bar)	
/3 AN... BN... /31 AN... BN... /UNF 3 AN... BN... /4 AN... BN...	With shock and suction valves at A and B, with pressure specification (bar)	
/4 AN BN /UNF 3 AN BN	With suction valves at A and B	
/4 AN...	With shock and suction valves at A or B, with pressure specification (bar)	
/4 BN...		
/3 AL... /3 BL... /3 AL... BL... /3 AC... BC...	With over-center valves at A and/or B. type /3 AC... BC... load independent version (For more details, see D 7918 type LHT 3)	

- 6 - A 7 - 250

Pressure setting (bar)

Flow (lpm) / Release ratio

Coding	A 7	B 7	C 7	D 7	E 7	F 7
(lpm)	130	85	55	35	20	10

Bypass-orifice D2

Coding	0	4	5	6	7	8
(∅ mm)	plugged	0.4	0.5	0.6 (std.)	0.7	0.8
Release ratio	1:7	1:4.96	1:3.5	1:2.28	1:1.28	1:0.93

Example:

PSL 41/300 - 3

- A 2 H 40/40 C 200/EA /3 AS 220 BS 220 / EA - ... - G 24

Valve section suited for mounting of an ancillary block

Ancillary block

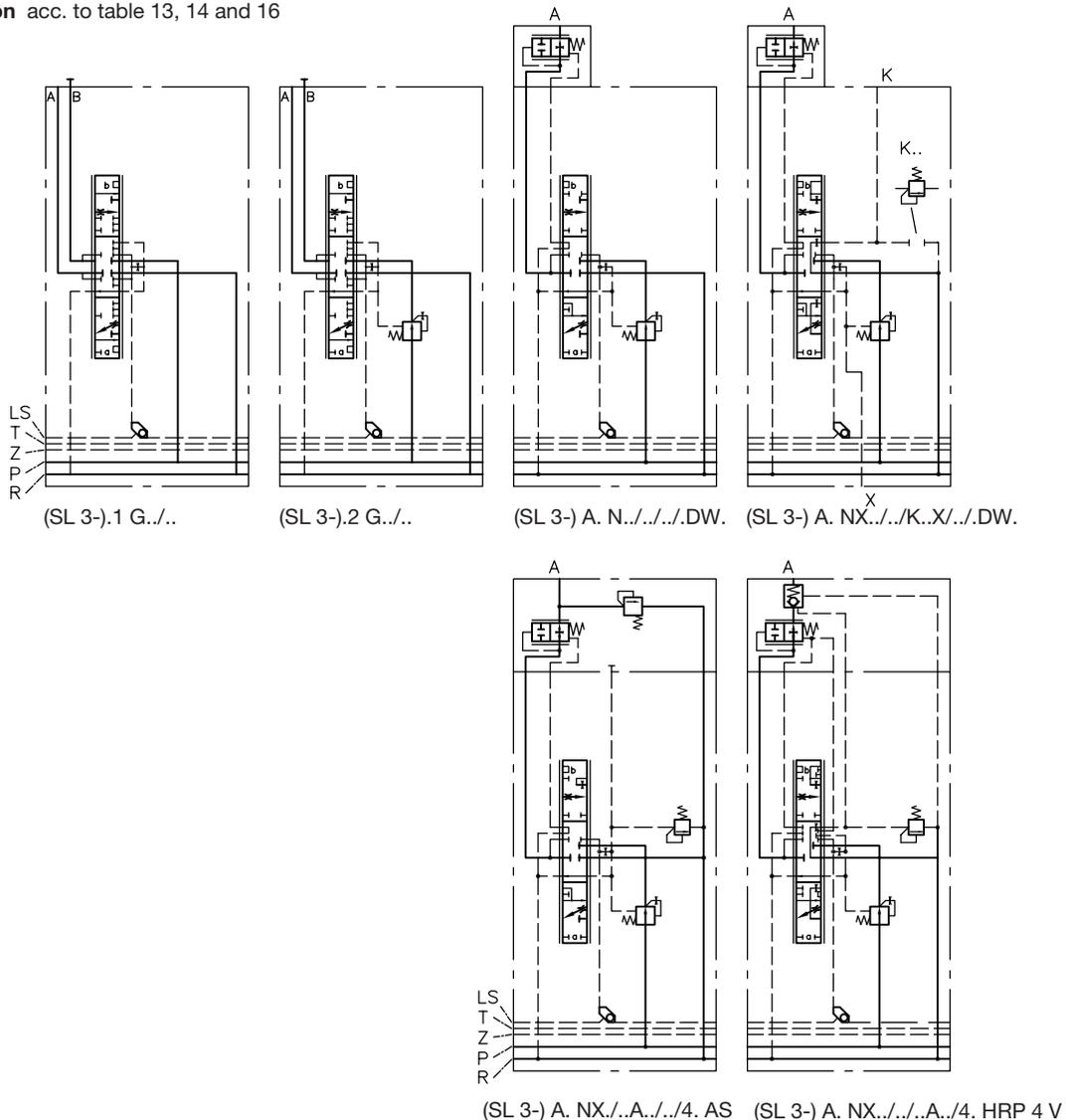
Coding	Brief description	Symbols
/43 DFA	For regenerative circuit piston side connected at A (type /43 DFA) or piston side connected at B (type /43 DFB)	
/43 DFB	Attention: Not suitable for the use with dragging loads!	
/3 VV /UNF 3 VV	With shut-off valves EM 32 V acc. to D 7490/1 (one or both sides) blocking the consumer with zero leakage (Q _{max} approx. 80 lpm)	
/3 VX /UNF 3 VX		
/3 XV /UNF 3 XV		
/3 DRH /UNF 3 DRH	Releasable check valves in A and B (release ratio 1:2.5) For additional version with pre-relieve coding /3 DRH VV, see D 6110 type DRH 3	
/3 DW 2 /4 DW 2 /UNF 4 DW 2	Outflow controller for proportional and load independent lowering (consumer → return) of single acting cylinders, only in combination with 3/3-way directional spool valve, symbol NX and with additional functions A (pressure limitation for A, table 16) like	
/42 AS..	Outflow controller for proportional and load independent lowering (consumer → return) of single acting cylinders, only in combination with 3/3-way directional spool valve, symbol NX and with additional functions A (pressure limitation for A, table 16), otherwise like /4 DW.	
/42 HRP 4 V	With zero leakage check valve. For details, see D 5116 type HRP 4 V, only in combination with 3/3-way directional spool valve, symbol NX and with additional functions A (pressure limitation for A, table 16 = limitation of the open-up pressure), otherwise like /4 DW.	

Table 19 a: Intermediate plates for parallel connection

Coding	Brief description	Symbols
/ZDR	Intermediate plate with short-circuit valve between A and B (floating function) for volumetric interchange $Q_{max} = 20 \text{ lpm}$	
/ZDS		
/ZDRH	Releasable check valves in A and B (release ratio 1:2.5) For additional version with pre-relieve coding /ZDRH VV, see D 6110 type DRH 3	
/ZAL... - BN... /ZBL... - AN...	Over-center valve at A or B and shock valve incl. pressure spec. at A or B. For type coding of the over-center valve, see coding /3 AL... BL... Shock valve (bar)	

Coding	Brief description	Symbols
/ZAL... BL...	With over-center valves at A and B. For codings, see /3 AL... BL... or pamphlet D 7918 type LHT 3	
/Z 40 /Z 40 M /Z 40 M UNF	Spacer plate 40 mm to compensate height differences between differing ancillary blocks or to prevent collisions of neighboring ancillary blocks when combined with other intermediate plates	
/Z AN BN	With suction valves at A and B	

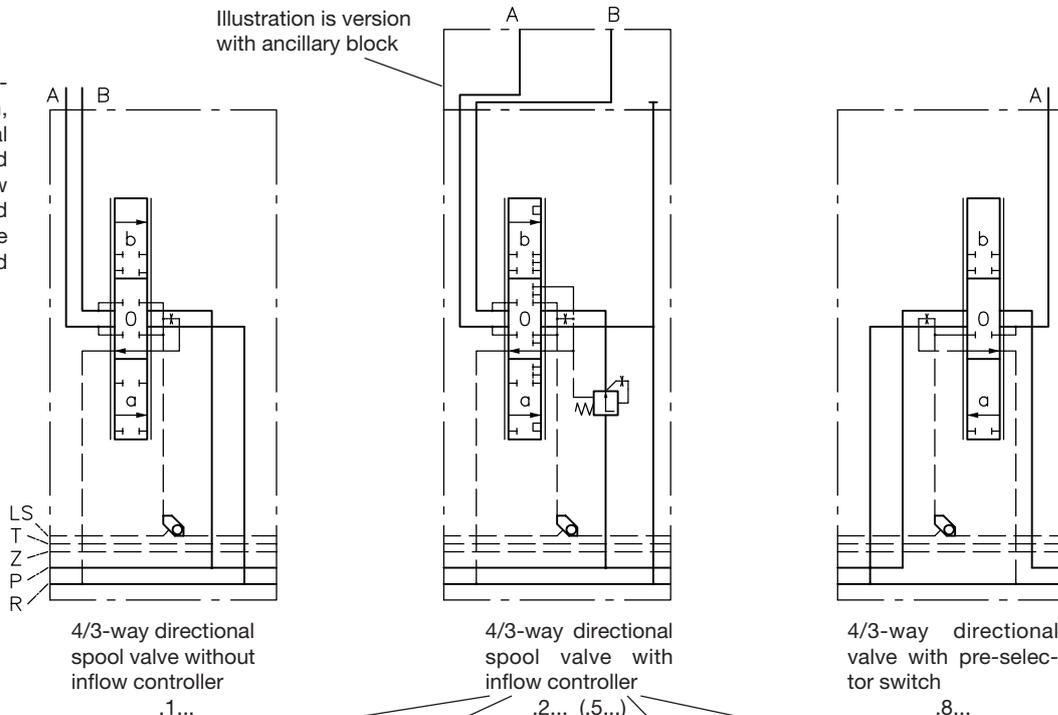
Standard version acc. to table 13, 14 and 16



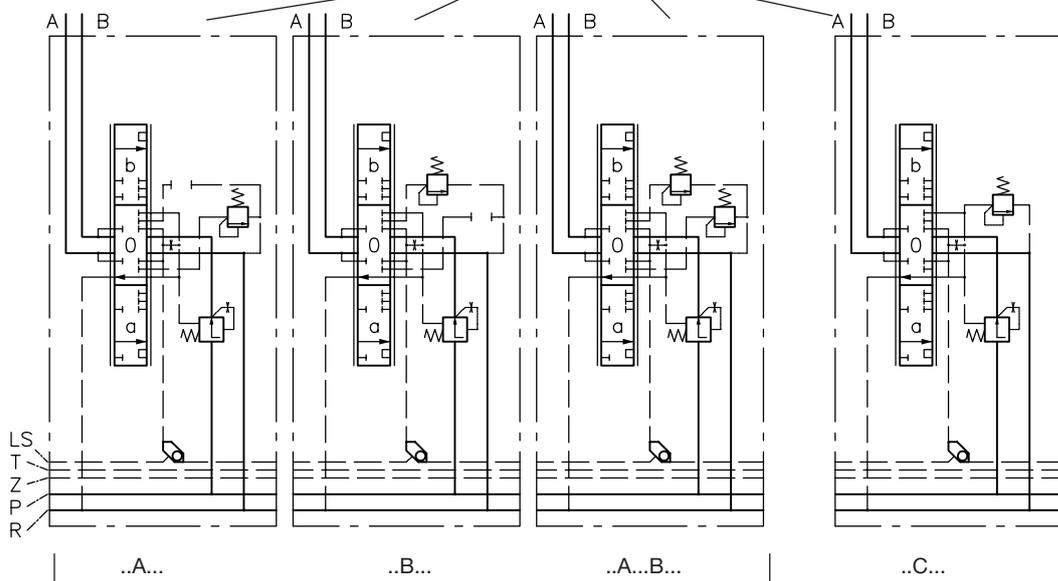
**Standard version
acc. to table 13**

With respect to flow configuration and actuation, these symbols are neutral and must be supplemented by the corresponding flow pattern symbols displayed in table 14, 19 or 20, see also example in table 19 and sect. 6.

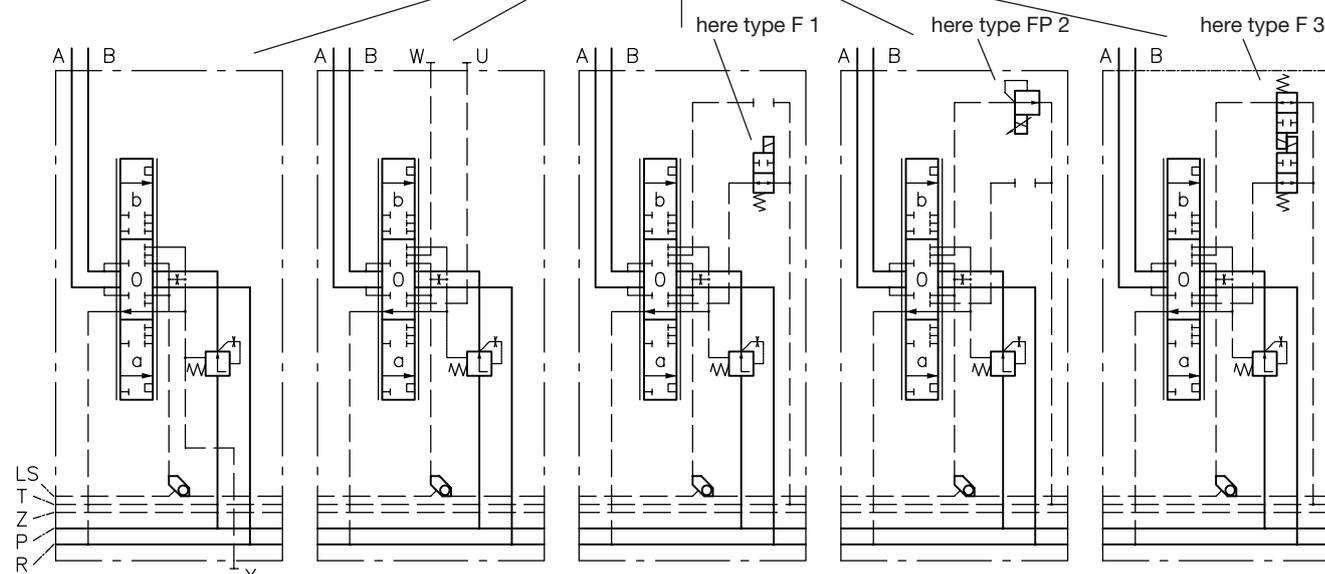
Illustration is version with ancillary block



Additional function:
Ls- pressure limitation
acc. to table 16 for spool valves with inflow controller (no shock valve!)



Functional cut-off, acc. to table 17, for spool valves with inflow controller



Possible combinations:	.X	..S	..F 1, FP 1, FPH 1 (X)	..F 2, FP 2, FPH 2 (X)	..F 3, FP 3, FPH 3 (X)
	A..X	A..S	A..F 1, FP 1, FPH 1 (X)	A..F 2, FP 2, FPH 2 (X)	A..F 3, FP 3, FPH 3 (X)
	B..X	B..S	B..F 1, FP 1, FPH 1 (X)	B..F 2, FP 2, FPH 2 (X)	B..F 3, FP 3, FPH 3 (X)
	A..B..X	A..B..S	A..B..F 1, FP 1, FPH 1 (X)	A..B..F 2, FP 2, FPH 2 (X)	A..B..F 3, FP 3, FPH 3 (X)

Table 20: Types of actuation (for further explanations, see sect. 4.3)

Nomenclature	Manual actuation		Electro-hydraulic actuation		Hydraulic actuation ¹⁾			Pneumatic actuation	Mechanical joystick
	Spring return	Detent	Only purely electro-hydraulic	Comb. with manual actuation	Only purely hydraulic	Comb. with manual actuation	Comb. with solenoid and manual actuation		
Coding	A E0A	C E0C AR E0AR	E EI ER	EA EAR	H H UNF F F UNF	HA HA UNF FA FA UNF	HEA HEA UNF FEA FEA UNF (HE, FE)	P PA	K KE K 12
Symbols									
Manipulated variables	Actuation angle min. approx. 5° max. approx. 30°		Control current ratio I / I _N min. approx. 0.2 max. approx. 1		Control pressure (bar) min. approx. 5 max. approx. 18 max. perm. 50 bar			Control press. min. approx. 2.5 bar max. approx. 7 bar	Actuation angle approx. 5...19°

- Note:**
- Approximate values for start of flow at A or B (= min) up to max. consumer flow according to the flow coding table 15, see curves sect. 4.2.
 - Hydraulic actuation type F.. has to be selected when combined with ancillary blocks!
Difference between actuation H.. and F.. is the position of the control line ports.
With actuations HE(A) or FE(A) observe also notes and circuit examples in sect. 6.1 i
 - Type E0A, E0C, E0AR is prepared for retrofitting solenoid actuations
 - Type AR, ER and EAR come with detent in the end positions, stroke limitation not possible
 - Type EI - Version without stroke limitation
 - Type EM and EAM: Version with pressure gauge ports at the actuation heads
 - Type K12 with thread M12, no without hand lever available
 - Type A 8 Actuation torque like with EA; Type E 9, E 9 A: Actuation torque like with H, HA

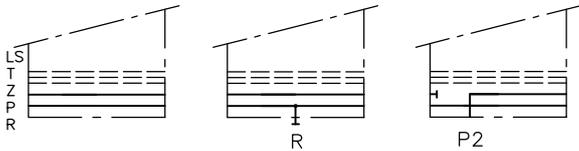
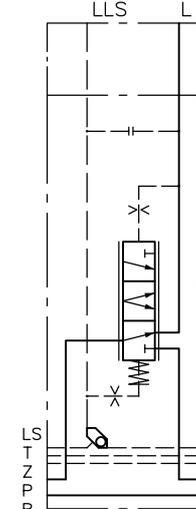
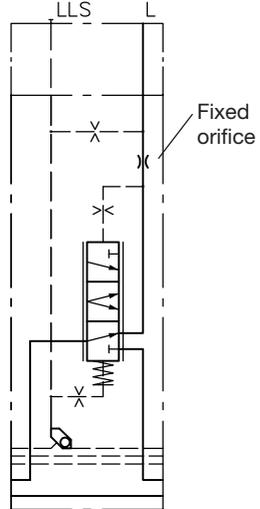
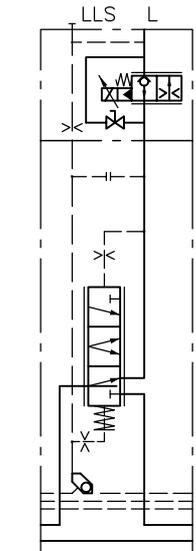
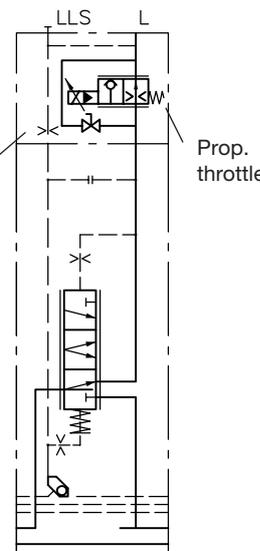
Table 21: Additional features for actuators

Type of actuation / coding	Suffix	Description	Example	Symbols
A, EA, HA, PA, C	1	Manual actuation without hand lever	EA 1, C 1	
A, EA, HA, PA, C	2	Manual actuation with short hand lever (for dimensions, see sect. 5.3)	EA 2, A 2	
A, EA, HA, C	V VA VB VC VCHO VCHC	Micro switch (mechanical), for monitoring the spool's idle position (not sided) (for data of the switch, see sect. 4.3) V - Signal with start of movement, direction A or B (no side indication) VA - Signal with start of movement, direction A VB - Signal with start of movement, direction B VC - Signal with start of movement, direction A and B (separate side indication) VCHO - Signal with start of movement, direction A and B separate (2xNO-contact) VCHC - Signal with start of movement, direction A and B separate (2xNC-contact)	EA VA, A 1 VB, C VC	
A, EA, C	N, N1	Proximity switch, for monitoring the spool's idle position (not side indication) (for data of the switch, see sect. 4.3) Type N1- only support: The transducer (8x8x33 centered sensor area) is customer furnished	EA N, A 1 N 1	
A, EA, C, PA, K, H, HA	WA WA-EX WA-M2FP	Integrated position sensor (Hall-sensor) with analogous signal output (lift monitoring). Version WA-EX n, explosion-proof version. Coding WA-M2FP, with fire-damp protected version (mining)	EA WA, A 1 WA	
A, EA, C, PA, K	U	Integrated spool monitoring for side indication (comparator, triggered signal: ON / OFF)	EA U	
A, C, E, E0A	G	Reinforced version of the spring cover, suitable if high pressure surges are expected in the gallery T	ET 1 G, CG, A 1 G	

3.2.2 Add-on intermediate plates

Order example: PSL 41/250 - 32 H 63/40 /EA
 - **ZPL 3 S/H**
 - 32 L 25/16/EA - E 4 - G 24

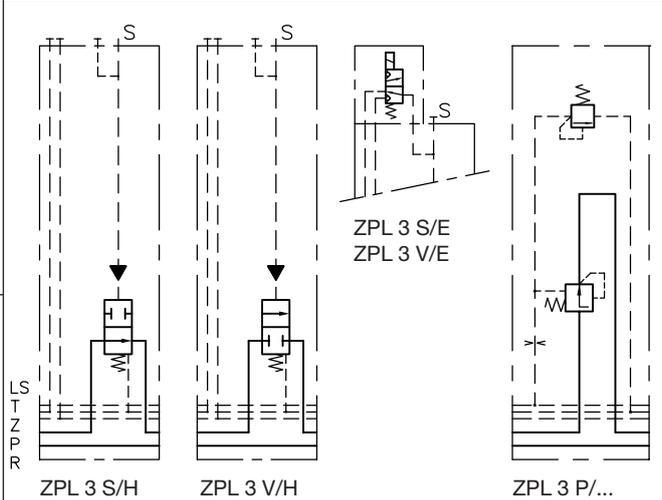
Table 22: Add-on intermediate plates

Coding	Brief description	Symbols	
<p>ZPL 33/5 ZPL 33/15 ZPL 33</p> <p>ZPL 3-Z 3</p>	<p>Adapter plate (5 mm, 15 mm or 49.5 mm) see also note table 1, 3, 10 and 12</p> <p>Intermediate plate with additional port P for second pump circuit</p>	 <p>ZPL 33/5 ZPL 33/15</p> <p>ZPL 33</p> <p>ZPL 3-Z 3</p>	
<p>ZPL 3 VQ 2-5/3 Q ZPL 3 VQ 3-X/3 QV-6</p> <p>Dampening orifice 5 - Ø 0.5mm 6 - Ø 0.6mm 7 - Ø 0.7mm</p> <p>Ancillary blocks /3 Q Without additional functions; /UNF 3 Q The necessary load signal has to be generated either internally via a fixed throttle (coding 2...6) or fed externally via port LLS (without fixed throttle, coding X)</p> <p>/3 QV With prop. directional seated valve type EMP 31 V (coding /3 QV), EMP 31 V 80 V /3 QS (coding /3 QV 80) or EMP 31 V 80 V /UNF QV /UNF 3 QV 80 S (coding /3 QS) only available without fixed throttle (coding X) /UNF QS</p> <p>Fixed throttle for constant flow X - no throttle 2 - Ø 2 mm, Q_L approx. 8 lpm 3 - Ø 3 mm, Q_L approx. 18 lpm 4 - Ø 4 mm, Q_L approx. 30 lpm 5 - Ø 5 mm, Q_L approx. 40 lpm 6 - Ø 6 mm, Q_L approx. 60 lpm</p> <p>Basic setting 1 - $Q_{Lmax} \leq 20$ lpm 2 - $Q_{Lmax} \leq 50$ lpm 3 - $Q_{Lmax} > 50$ lpm</p>		<p>Version without throttle</p>  <p>ZPL 3 VQ.-X/3 Q ZPL 3 VQ.-X/UNF 3 Q</p>	<p>Version with fixed throttle</p>  <p>ZPL 3 VQ.-/3 Q ZPL 3 VQ.-/UNF 3 Q</p>
<p>Version with prop. throttle (closed when deenergized)</p>  <p>ZPL 3 VQ .-X/3 QV ZPL 3 VQ/3 QV 80 ZPL 3 VQ .-X/UNF 3 QV ZPL 3 VQ/UNF 3 QV 80</p>	<p>Version with prop. throttle (open when deenergized)</p>  <p>ZPL 3 VQ .-X/3 QS ZPL 3 VQ .-X/UNF 3 QS</p>		

ZPL 3 S/H
ZPL 3 V/H

ZPL 3 S/E
ZPL 3 V/E

The shut-off valve can arbitrarily block the pump gallery for all subsequent consumers. The switching signal can be either hydraulically (/H) or electrical (/E). The connection to all subsequent valve sections can be either open (S) or blocked (V) if not actuated.
The main application is with circuits where it is necessary to lock (block) one or more consumers due to functional or safety reasons.



ZPL 3 P/...

Pressure limiting valve to the limitation of the operation pressure for all subsequent valve sections (consumers).

Ranges of application:

- Simple realization of two pressure levels within one valve bank (Pressure of the main pressure limiting valve in front of the intermediate plate, pressure of the pressure limiting valve in the intermediate plate onwards)
- Pressure limitation for valves sections without inflow controller (like additional function "C" acc. to table 16)

Example: ... - ZPL 3 P/180 - ...

Attention:

- An raised idle circulation pressure has to be selected with type PSL (coding H, Table 2) to compensate the increased pressure drop.
- Subsequent valve sections are not available with inflow controller coding 5 (table 13) or flow coding 80 (table 15).
- $p_{min} = 40$ bar

ZPL 3 D
ZPL 3 DS

ZPL 3 D/...
ZPL 3 DS/...

Arbitrary flow (velocity) reduction for all subsequent consumers. The velocity control for all these consumers is still retained over the full elevation of the valve spool.

Limits:

- $Q_{max pu} = 60$ lpm
- $Q_{reduc.} = 0 \dots 20$ lpm

These figures applies only to type PSL, but they are dependent on the control pressure of the pump with type PSV.

Versions:

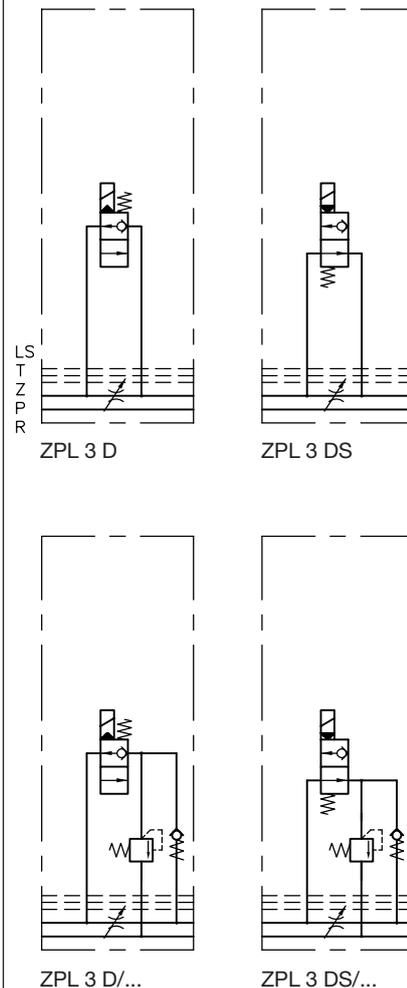
- D, reduced velocity when de-energized
- DS, nom. velocity when en-energized
- Without additional pressure limiting valve
- With additional pressure limiting valve (only active with nom. velocity)

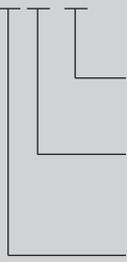
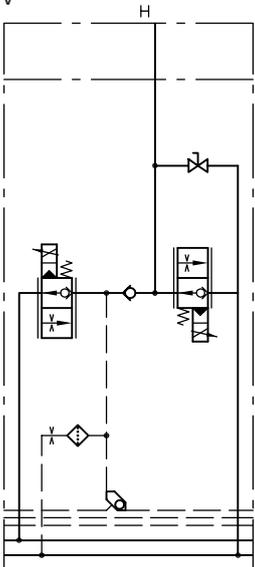
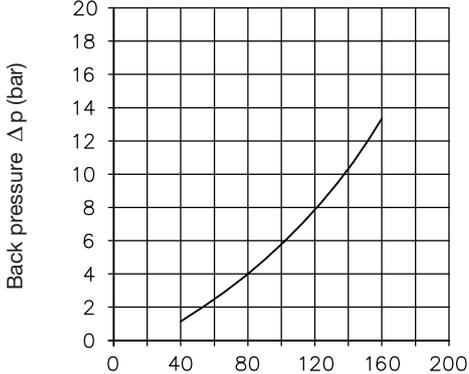
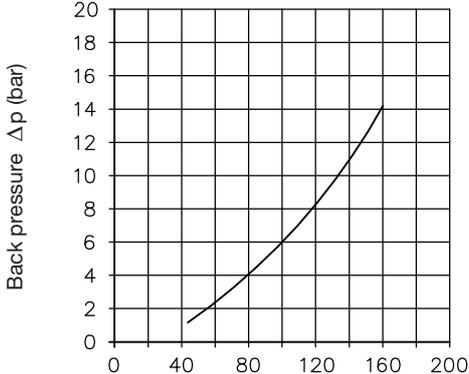
Applications:

- Reduced velocity for the boom of cranes e.g. if a working platform is manned Recommended type: ZPL 3 D
- Increased load at reduced speed (safety)
- Nom. velocity safe-guarded by additional pressure limiting valve (lower pressure setting)
- Reduced speed safe-guarded by pressure limiting valve in the connection block (higher pressure setting)

Recommended type: ZPL 3 DS/...

(Example: PSL 41/350-3-...-ZPL 3 DS/180-...)



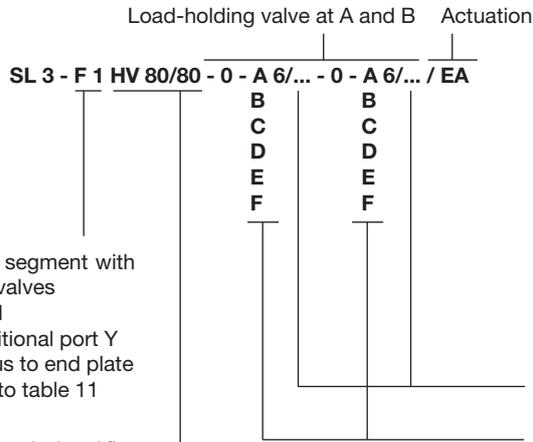
Coding	Brief description	Curves
<p>A1 RR PVPV / 5</p> 	<p>Valve section for the control of single acting consumers, e.g. lifting / lowering with industrial trucks (stackers) $Q_{max} = 160 \text{ lpm}$</p> <p>Ancillary block /5 Port G 1 Control valve for lowering, for details see D 7490/1 PV - Prop. Directional spool valve type EMP 41 V Control valve for lifting, for details see D 7490/1 PV - Prop. Directional spool valve type EMP 41 V</p> 	<p>$\Delta p \text{ P} \rightarrow \text{H}$ (lifting)</p>  <p>$\Delta p \text{ H} \rightarrow \text{P}$ (lowering)</p> 

3.2.3 Valve segment with load-holding valves

This valve segment **can be used as the last valve section** in a valve bank and is equipped with load-holding valves in the consumer ports A and B. The consumer ports are integrated in an especially designed end plate. It also may incorporate optionally a differential connection (for rapid movement) which can be arbitrarily activated or a pressure switch to supply a an enabling signal.

This combination is suitable e.g. for the control of the swivel cylinders at though tipping trucks. The flow pattern symbol „HV“ illustrated at the order example is a variation of the standard version „H“. It enables activation of the differential circuit incorporated in the end plate SL 3-EF 31 just before full travel in direction a (position a) is achieved.

Order example: Valve segment with load-holding valve



Version valve segment with load-holding valves
F 1 Standard
F 5 with additional port Y analogous to end plate E 5 acc. to table 11

Flow pattern symbol and flow coding according to table 14 and 15 (specific flow rating for valve spool coding 1 in table 15). See notes to flow pattern symbol HV above!

Pressure setting load-holding valve

Flow rate and opening ratio (1:6)

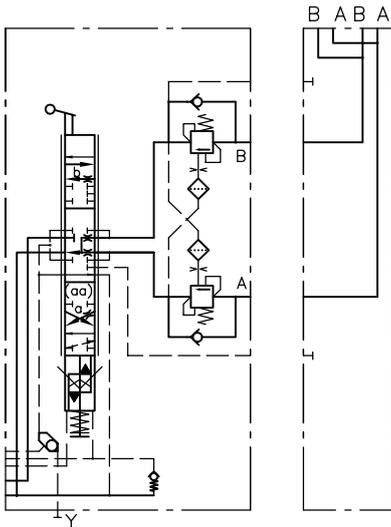
Coding	A 6	B 6	C 6	D 6	E 6	F 6
(lpm)	250	200	150	100	50	25

Order example: End plate for valve segment above

- SL 3-EF 30** End plate with consumer port of A and B (G 1/2 (BSPP))
- SL 3-EF 41** End plate with consumer port of A and B (G 1/4 or G 3/4 (BSPP))
- SL 3-EF 42** End plate with consumer port of A and B (G 1/4 or G 3/4 (BSPP))

Type SL 3-F 1
 Type SL 3-F 5

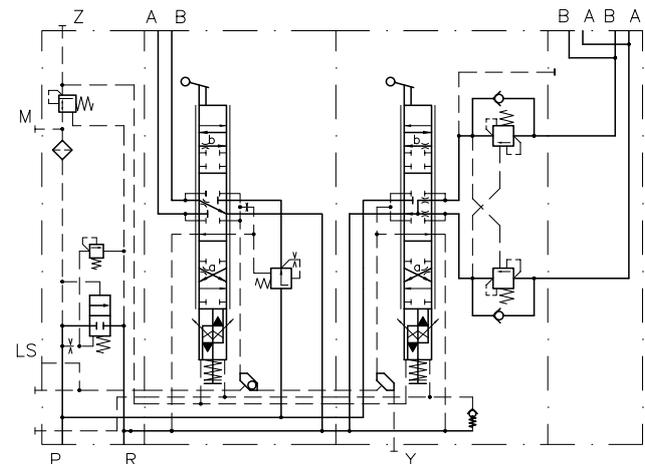
Type SL 3-EF 30
 SL 3-EF 41
 SL 3-EF 42



Blocked and without shuttle valve at type SL 3-F 1

Example

Type PSV 551/275 - 3 - 32 B 40/63/EAB
 - F 1 O 80/80 - 0 - B 6/280 - 0 - C 6/280/EAB
 - EF 30 - G 24



4. Characteristic data

4.1 General and hydraulic

Type coding	PSL, PSV or PSM see sect 3.1																																																																																					
Design	Spool valve of block design, up to 12 spool valves, all-steel																																																																																					
Mounting	Tapped holes: M8; see dimensions sect. 5 ++																																																																																					
Installation position	Arbitrary																																																																																					
Ports	<table border="0"> <tr> <td>P</td><td>= Pressure inlet (pump) / lead-on</td> <td>M</td><td>= Pressure gauge connection (pump side)</td> </tr> <tr> <td>R</td><td>= Return</td> <td>Z</td><td>= Pilot pressure connection (20...40 bar inlet, 20 or 40 bar outlet)</td> </tr> <tr> <td>A, B, L</td><td>= Consumer ports</td> <td>T</td><td>= Control oil return port</td> </tr> <tr> <td>U, W, X</td><td>= Load-signal outlet at the indiv. spool valve section</td> <td>Y</td><td>= Load-signal inlet port (end plate E 2, E 5, E 18 and E 20)</td> </tr> <tr> <td>LS, DW</td><td>= Load-signal outlet e.g. connection of pump metering valve at PSV.</td> <td></td><td></td> </tr> </table> <p>Attention: No pressure input!</p>		P	= Pressure inlet (pump) / lead-on	M	= Pressure gauge connection (pump side)	R	= Return	Z	= Pilot pressure connection (20...40 bar inlet, 20 or 40 bar outlet)	A, B, L	= Consumer ports	T	= Control oil return port	U, W, X	= Load-signal outlet at the indiv. spool valve section	Y	= Load-signal inlet port (end plate E 2, E 5, E 18 and E 20)	LS, DW	= Load-signal outlet e.g. connection of pump metering valve at PSV.																																																																		
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Surface coating	All surfaces corrosion-inhibiting, gas nitrided Solenoid at actuation E.. and additional functions F 1...F 3, FP 1...FP 3, FPH 1...FPH 3 gal. zinc-plated and olive-green anodized. Solenoids at actuation EB zinc galvanized EN 12329-Fe/Zn12c Housing with actuation P and PA: anodized.																																																																																					
Mass (weight) approx. 1) + 0.6 kg at version with WN 1 F(D), PA PD	<table border="0"> <tr> <td>Connection block: PSV 3, 4, 5</td><td>= 3.6 kg 1)</td> <td>End plates: E 1, E 2, E 4, E 5</td><td>= 1.0 kg</td> </tr> <tr> <td>PSV 6</td><td>= 3.3 kg</td> <td>E 1(4) UNF</td><td>= 1.0 kg</td> </tr> <tr> <td>PSL 3, 4</td><td>= 3.8 kg 1)</td> <td>E 3, E 6</td><td>= 1.6 kg</td> </tr> <tr> <td>PSL 5, PSM 5, PSV 55</td><td>= 4.3 kg 1)</td> <td>E 17, E 18, E 19, E 20</td><td>= 2.1 kg</td> </tr> <tr> <td></td><td></td> <td>E 17 UNF... E 20 UNF</td><td>= 2.1 kg</td> </tr> </table>		Connection block: PSV 3, 4, 5	= 3.6 kg 1)	End plates: E 1, E 2, E 4, E 5	= 1.0 kg	PSV 6	= 3.3 kg	E 1(4) UNF	= 1.0 kg	PSL 3, 4	= 3.8 kg 1)	E 3, E 6	= 1.6 kg	PSL 5, PSM 5, PSV 55	= 4.3 kg 1)	E 17, E 18, E 19, E 20	= 2.1 kg			E 17 UNF... E 20 UNF	= 2.1 kg																																																																
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				/3 DW.., /4 DW.., /UNF 4 DW..	= 0.8 kg																																																																																	
Pressure fluid	Hydraulic fluid acc. to DIN 51524 table 1 to 3; ISO VG 10 to 68 acc. to DIN 51519 Viscosity range: min. approx. 4; max. approx. 1500 mm ² /s Optimal operation range: approx. 10...500 mm ² /s Also suitable are biologically degradable pressure fluids of the type HEPG (Polyalkylenglycol) and HEES (synth. Ester) at operation temperatures up to approx. +70°C. HETG (e.g. rape seed oil) or water based fluids e.g. HFA or HFC must not be used!																																																																																					
Temperature	Ambient: approx. -40 ... +80°C ; Oil: -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 consequent running is at least 20K higher. Biological degradable pressure fluids: Pay attention to manufacturer's information. With regard to the compatibility with sealing materials do not exceed +70°C. Restrictions with explosion-proof solenoids																																																																																					
Required cleanliness	ISO 4406 20/18/15																																																																																					
Operating pressure	<p>$p_{max} = 420$ bar; Ports P, P1, A, B, LS, M, Y</p> <p>The max. pressure achievable at the consumer side of the spool valves is lowered by the amount equivalent internal control pressure drop at the 3-way flow regulator of the PSL (see curves "Connection block PSL" on next page) or at the pump flow regulator (PSV). Return port R(R1) ≤ 50 bar; port T pressureless with separate pipe (e.g. 6x1) to the tank. It is recommended to employ end plate E 1, E 2, E 3, etc. with an additional leakage port, in case higher return pressure is anticipated. Port Z approx. 20 or 40 bar (acc. to coding, see table 7) (outlet); ≤ 40 bar (inlet)</p>																																																																																					
Control circuit	For control pressure, see Q-I-characteristics. The internal control oil circuit is sufficiently protected against malfunctions caused by contamination via a disk filter.																																																																																					
Flow	Max. consumer flow 3...80 (120) lpm or acc. to table 15 sect. 3.2.1.																																																																																					

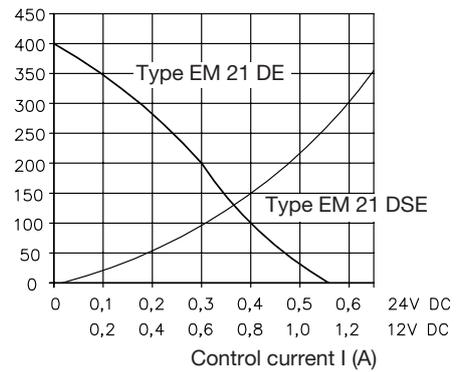
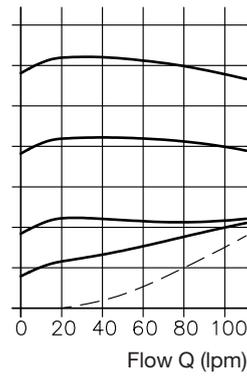
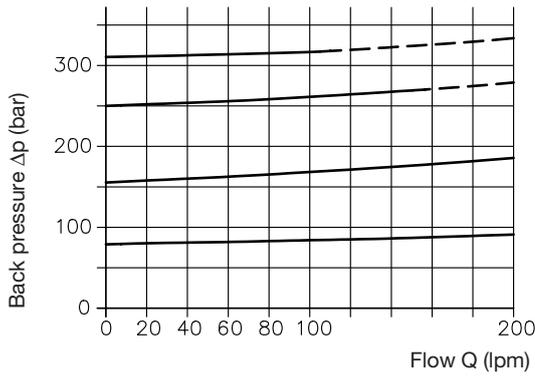
4.2 Curves

Oil viscosity during measurement approx. 60 mm²/s

Pressure limiting valve in the connection block type PSL 5.../...-3 (pilot operated)

Pressure limiting valve in the connection block type PSL 3(4).../...-3 (direct operated)

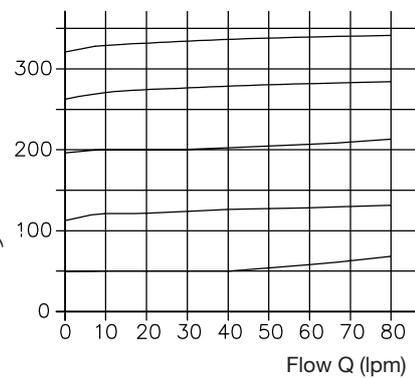
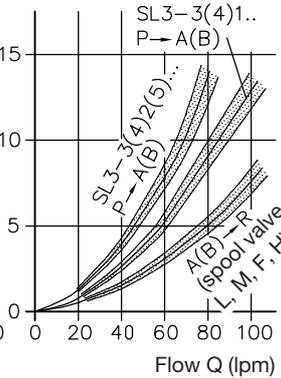
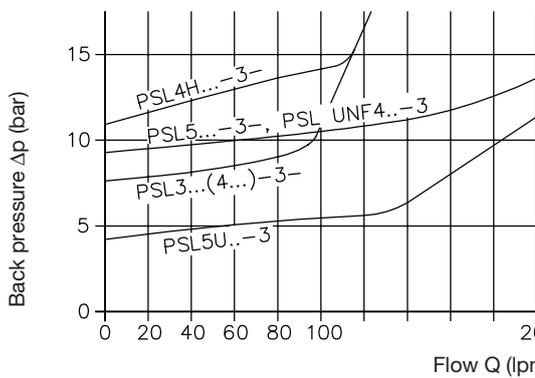
Prop. pressure limitation at the connection block type PSL (PSV) ..V(Z, ZM)



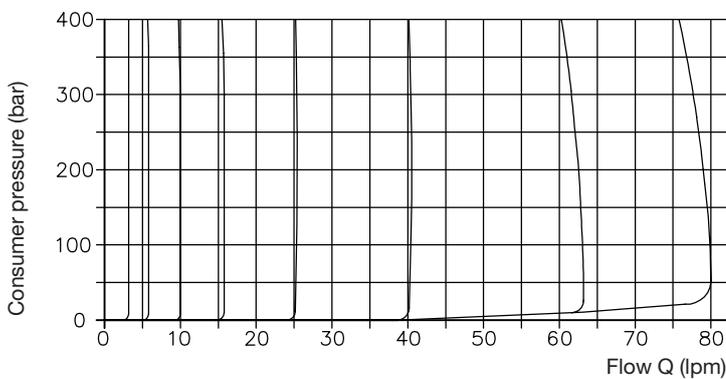
Connection block type PSL...
Circulation pressure P→R

Directional spool valve
P→A(B), A(B)→R

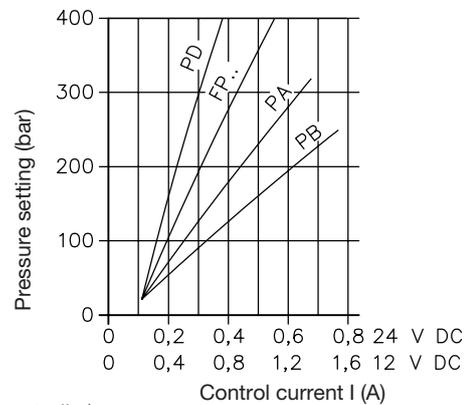
Ls- pressure limiting valves
Coding A...B...; C... acc. to table 16, sect. 3.2.1



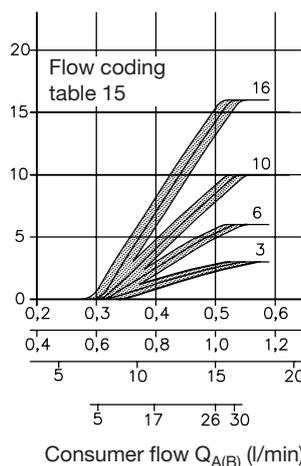
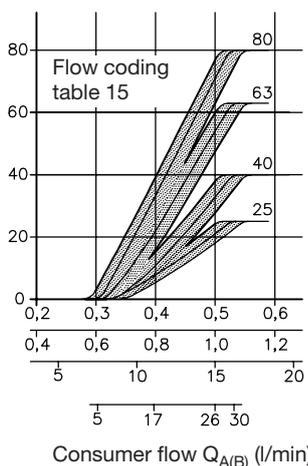
2-way inflow controllers



Prop. pressure limitation
Coding PA ... PD acc. to table 8, sect. 3.1.4
Coding FP(H) 1(2,3), table 17, sect. 3.2.1



Control curve for consumer flow
(guide line, example for directional spool valve type SL 3-2... with inflow controller)



- ← Control current I (A) 24V DC
- ← Control current I (A) 12V DC
- ← Control pressure (bar) hydr. actuation H, F
- ← Angle at hand lever (°) manual actuation A, C

4.3 Actuators

For other data such as coding, symbols etc., see sect. 3.2

Actuation A, K

	Actuating moment (Nm)	
	Idle position	End position
Actuation A	approx. 2.3	approx. 3.4
Actuation HA, HEA, FA, FEA, PA	approx. 2.9	approx. 8.0
Actuation EA, EOA	approx. 2.4	approx. 6.0

Actuation C

AR, ER, EAR

Version with detent, fixation of the valve spools at any desired position (idle position with special notch)
 Version with detent, fixation of the valve spool at idle and both end positions
 Required pulse duration for switching: approx. 1 sec

Actuation E, EA, HE(A), KE

Prop.-Solenoid, manufactured and tested acc. to VDE 0580
 Twin solenoid with anchor chambers sealed on the outside and connected to the return duct, the anchors are thereby maintenance-free lubricated and protected against corrosion by the hydraulic fluid.

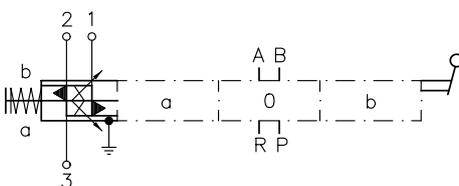
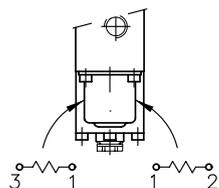
See also:

Notes at Sk 7814 as well as for optional components section 7.6.1!

Specifications apply to all solenoid versions if not stated otherwise

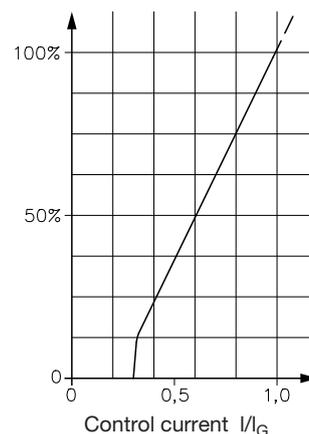
Rated voltage U_N	24V DC	12V DC
Coil resistance cold R_{20}	26.6 Ω	6.3 Ω
Current, cold I_{20}	0.9 A	1.9 A
Lim. current $I_G (I_{lim})$	0.63 A	1.26 A
Cut-off energy W_A	≤ 0.3 Ws	≤ 0.3 Ws
Rel. duty cycle	S 1	S 1
(reference temp. $\vartheta_{11} = 50^\circ\text{C}$)		
Required dither frequency	40...70 Hz	
	(best. 55 Hz)	
Dither amplitude 1)	20% $\leq A_D \leq$ 50%	

$$1) A_D (\%) = \frac{I_{\text{peak-peak}}}{I_G} \cdot 100$$



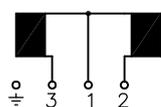
Oil viscosity during measurement approx. 60 mm²/s

I - stroke- curve

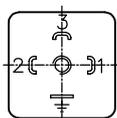


Electr. connection

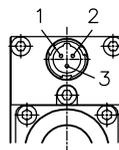
3-pin
Coil a (1) Coil b (2)



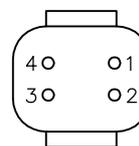
Circuitry for coding -G 12, -G 24
-X 12, -X 24
EN 175 301-803 A
3-pin
IP 65 (IEC 60529)



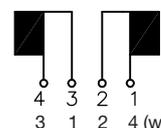
Circuitry for coding -S 12
-S 24
3-pin
IP 67 (IEC 60529)



Circuitry for coding -DT 12
-DT 24
4-pin
IP 69 K (IEC 60529)

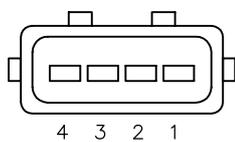


4-pin
Coil a (1) Coil b (2)

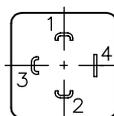


3 1 2 4 (with coding
...H 4 and ...C 4)

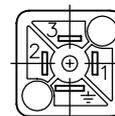
Circuitry for coding -AMP 12 K 4
-AMP 24 K 4
AMP Junior Timer,
4-pin
IP 67 (IEC 60529)



Circuitry for coding -G 12 H 4
-G 24 H 4
4-pin
IP 65 (IEC 60529)



Circuitry for coding -G 24 C 4,
EN 175 301-803 C
4-pin
IP 65 (IEC 60529)



The IP-specification only applies when the plug is mounted as specified.

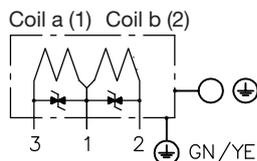
Explosion-proof version of actuation E, EA, HE(A)
Voltage specification **G 24 EX, G 24 TEX**

Attention:

Additionally observe operating manuals
B 01/2002 and B ATEX

Protect against sunlight.

Not available in combination with other solenoids at the connection block (table 3a and 8), ancillary blocks (table 19), intermediate plates (table 22), end plates (table 11) and functional cut-off F.. (table 17).



Letter of conformity ATEX
Ex-proof level

Duty cycle (ED)
Protection class
Nom. voltage U_N
Coil resistance cold R_{20}
Current, cold I_{20}
Lim. current I_G
Residual ripple

Conditions of use:
Ambient temperature
max. fluid temperature
Fuse

Surface coating

Electrical design and testing
Electrical connection
Cable length

For connection scheme, see "Actuation E, EA" (standard version)

TÜV-A 02 ATEX 0007 X
Ⓢ II 2 G Ex mb II 120°C (T4)
Ⓢ II 2 D Ex mbD 21 T120°C

S 1, one coil energized per solenoid housing
IP 67 (IEC 60529)
24V DC
26.6 Ω
0.88 A
0.63 A
15% of the supply voltage

-35 ... +40°C
+70°C
 $I_F < 1.8$ A each solenoid must be safe guarded against overload and short-cut by fuse conforming IEC 60127 medium

Housing galvanically zinc coated
Coil and connection cavity are moulded conforming EN 60079, VDE 0170/0171 T 1 and T 9
4 x 0.5 mm²
3 m or 10 m (cable ÖLFLEX-440P ® Co. LAPP, D-70565 Stuttgart)

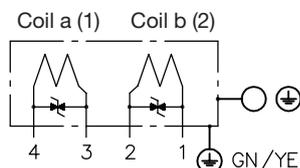
Explosion-proof version of actuation E, EA, HE(A)
Voltage specification **G 24 EX 4, G 24 TEX 4**

Attention:

Additionally observe operating manuals
B 01/2002 and B ATEX

Protect against sunlight.

Not in combination with functional cut-off F(FP).. (table 17) or all other solenoids mounted on connection blocks (table 3a and 8), ancillary blocks (table 19), intermediate plates (table 22) and end plates (table 11)



Letter of conformity ATEX
Ex-proof level

Duty cycle (ED)
Protection class
Nom. voltage U_N
Coil resistance cold R_{20}
Current, cold I_{20}
Lim. current I_G
Residual ripple

Conditions of use:
Ambient temperature
max. fluid temperature
Fuse

Surface coating

Electrical design and testing
Electrical connection
Cable length

For connection scheme, see "Actuation E, EA" (standard version)

TÜV-A 02 ATEX 0007 X
Ⓢ II 2 G Ex mb II 120°C (T4)
Ⓢ II 2 D Ex mbD 21 T120°C

S 1, one coil energized per solenoid housing
IP 67 (IEC 60529)
24V DC
26.6 Ω
0.88 A
0.63 A
15% of the supply voltage

-35 ... +40°C
+70°C
 $I_F < 1.8$ A each solenoid must be safe guarded against overload and short-cut by fuse conforming IEC 60127 medium

Housing galvanically zinc coated
Coil and connection cavity are moulded conforming EN 60079, VDE 0170/0171 T 1 and T 9
4 x 0.5 mm²
3 m or 10 m (cable ÖLFLEX-440P ® Co. LAPP, D-70565 Stuttgart)

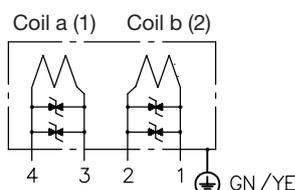
Explosion-proof version of actuation E, EA, HE(A)
Voltage specification **G 24 TEX 70**

Attention:

Additionally observe operating manuals
B 09/2006 und B ATEX

Protect against sunlight.

Not in combination with functional cut-off F(FP).. (table 17) or all other solenoids mounted on connection blocks (table 3a and 8), ancillary blocks (table 19), intermediate plates (table 22) and end plates (table 11)



Letter of conformity IEC
Letter of conformity ATEX
Ex-proof level

Duty cycle (ED)
Protection class
Nom. voltage U_N
Power, cold R_{20}
Lim. current I_G
Residual ripple

Conditions of use:
Ambient temperature
max. fluid temperature
Fuse

Surface coating

Electrical design and testing
Electrical connection
Cable length

For connection scheme, see "Actuation E, EA" (standard version)

IEC Ex IBE 09.0005 X
IBExU07ATEX 1089 X
Ⓢ II 2 G Ex d IIB T4
Ⓢ II 2 D Ex tD A21 T135°C

S 1, one coil energized per solenoid housing
IP 67 (IEC 60529)
24V DC
80 Ω
0.24 A
15% of the supply voltage

-20 ... +70°C
+70°C
 $I_F < 0.5$ A each solenoid must be safe guarded against overload and short-cut by fuse conforming IEC 60127 medium

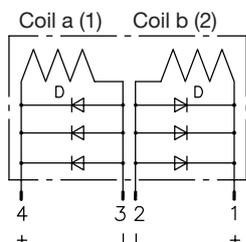
Housing galvanically zinc coated
Coil and connection cavity are moulded conforming EN 60079, VDE 0170/0171 T 1 and T 9
4+1 x 0.5 mm²
3 m or 10 m (cable ÖLFLEX-440P ® Co. LAPP, D-70565 Stuttgart)

Explosion-proof version of actuation E, EA (fire-damp protected (mining), intrinsic safe)
Voltage specification **G 12 IS**

Attention:

Additionally observe operating manuals B 04/2005 und B ATEX

Not in combination with functional cut-off F(FP).. (table 17) or all other solenoids mounted on connection blocks (table 3a and 8), ancillary blocks (table 19), intermediate plates (table 22) and end plates (table 11)



Attention: Observe polarity!

Note: Due to the utilized clamp diodes at the pulsed prop. amplifier PWM it is not possible to measure the coil current during operation. Readings will usually be too low and are additionally dependent on the supply voltage and the coil resistance.

Letter of conformity IEC	IEC Ex IBE 09.0006 X
Letter of conformity ATEX	IBExU05ATEX 1116 X
Ex-proof level	Ⓢ I M1 Ex d ia I Ⓢ I M2 Ex d ib I
Duty cycle (ED)	S 1, one coil energized per solenoid housing
Protection class	IP 67 (IEC 60529)
Nom. voltage U_N	12V DC
I_l	1.7 A
Lim. current I_G	0.4 A
Power, cold R_{20}	22 Ω
Conditions of use:	
Ambient temperature	-20 ... +40°C
max. fluid temperature	+70°C
Surface coating	Housing galvanically zinc coated Coil and connection cavity are moulded
Electrical design and testing	conforming EN 60079-0 (general requests), EN 60079-25 (intrinsic safe "i"), EN 60079-1 (pressure resistant encapsulation "d")
Electrical connection	4 x 0.5 mm ²
Cable length	3 m or 10 m (cable ÖLFLEX-EB ® Co. LAPP, D-70565 Stuttgart) Coded leads: 1-4, insulation color: fair blue)
The complete circuit has to be designed and get approved acc. to EN 60079-25.	

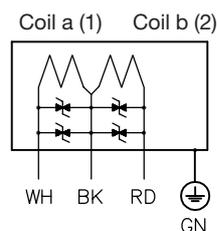
Explosion-proof version of actuation E, EA (fire-damp protected (mining))
Voltage specification **G 24 MSHA**

Attention:

Additionally observe operating manuals B 05/2006 and B ATEX

Not available in combination with other solenoids at the connection block (table 3a and 8), ancillary blocks (table 19), intermediate plates (table 22), end plates (table 11) and functional cut-off F(FP) .. (table 17).

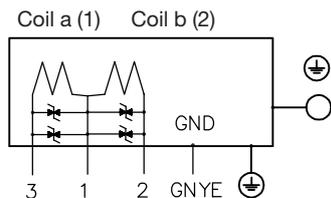
Exception: A combination with functional cut-off FP.. (table 17) together with intermediate plate 7709 090 is available.



MSHA-approval (USA)	18-NXA 05 0003-0
MA-approval (China)	J2007101
Letter of conformity IEC	IEC Ex IBE 09.0004 X
Letter of conformity ATEX	IBExU05ATEX 1115 X
Ex-proof level	Ⓢ I M2 Ex d I
Duty cycle (ED)	S 1, one coil energized per solenoid housing
Protection class	IP 67 (IEC 60529)
Nom. voltage U_N	24V DC
Coil resistance cold R_{20}	26.6 Ω
Lim. current I_G	0.63 A
Current, cold I_{20}	0.9 A
Conditions of use:	
max. ambient temperature	-20 ... +40°C
max. fluid temperature	+70°C
Fuse	I = max. 3x I_G , each solenoid must be safe guarded against overload and short-cut by fuse conforming IEC 60127-2 UL 248
Surface coating	Housing galvanically zinc coated Coil and connection cavity are moulded
Electrical design and testing	conf. EN 60079-0 (general requests), EN 60079-1 pressure resistant encapsulation "d")
Electrical connection	4 x 18 AWG (approx. 0.8 mm ²)
Cable length	3 m or 10 m
Leads	BK, WH, RD, GN; Item-Nr. 40003, General Cable

Explosion-proof version of actuation E, EA, HE(A) (fire-damp protected (mining))
Voltage specification **G 24 M2FP**

Letter of conformity ATEX	IBEx U05 ATEX 1115 X
Letter of conformity ANZEX	ANZEx 10.3019X
Electrical connection	4 x 0.75 mm ² , shielded connection line
For additional information	see coding G 24 MSHA



Actuation suffix H, HA, HEA

Control pressure approx. 5 bar (start of stroke)
approx. 18 bar (full elevation) max. permissible pressure 50 bar.
The remote control lines to the control port 1 and 2 have to be piped externally. Supply is via proportional piloting valve e.g. type FB 2/18 etc. or KFB 2/18 (both acc. to D 6600).

Actuation suffix P, PA

Control pressure approx. 2.5 bar (start of stroke)
approx. 7 bar (full elevation)

Actuation suffix V, VA, VB, VC

The idle position of the valve spool is monitored by a contact switch from Co. BURGESS type V 4 NS ® with lever AR 1
 Switch compressed at idle position
 Protection class IP 67 (IEC 60529)
 Circuit-breaking capacity up to 30 V DC = 5 A
 Inductive load = 3 A
 Cables 3 x 0.5 mm² leads PVC coated; length 50 mm
 black = inlet
 blue = NO-contact
 green = NC-contact

The switch is highly protected by a sheet cover against exterior physical damage.

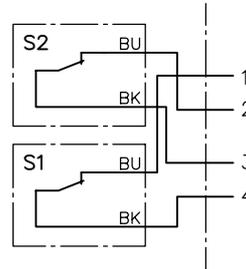
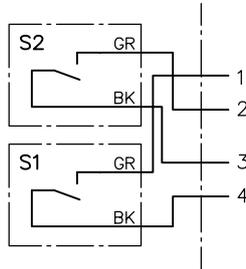
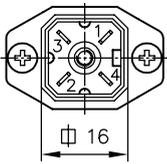
Actuation suffix VCHO, VCHC

The idle position of the valve spool is monitored by a contact switch from Co. BURGESS type V 4 N 4 Sk 2 ® with lever AR 1
 Switch compressed at idle position
 Electr. connection via plug, e.g. type G 4 W 1 F ® Co. HIRSCHMANN, www.hirschmann.com
 Protection class IP 65 (IEC 60529)
 Circuit-breaking capacity up to 30V DC = 5 A
 Inductive load = 3 A

Circuitry

VCHO

VCHC



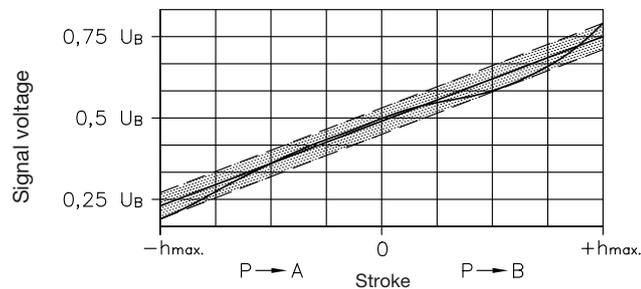
Switch function
 S 1 - direction A
 S 2 - direction B

Actuation suffix N

Supervision of the idle position of the valve spool via a transducer
 Design 8x8x40mm, with LED-display, e.g. NC-contact, conducting to plus an even type IFFM 08P/37O1/02L ®
 Manufacturer: Co. BAUMER Electric GmbH D-61169 Friedberg
 Connection cable Ø3 mm, 3 leads PVC coated
 Operating voltage 10 up to 30V DC
 Current consumption without load up to 10 mA
 Max. load current 200 mA
 Operating temperature -25°C up to 80°C
 Protection class IP 67 (IEC 60529)
 The switch is highly protected by a sheet cover against exterior physical damage.

Actuation suffix WA, WA-EX

Position sensor supervision of the valve spool stroke via a Hall-sensor

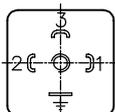


U_B = Supply voltage
 U_{B max} = 76%
 U_{B min} = 24%
 Accuracy ± 9% (U_B)

Circuitry

The DC supply voltage must be stabilized and smoothened.
Attention: Any strong magnetic field will destroy the transducer!

Coding G...



2 = +U_B operating voltage (5 up to 10 V)
 1 = U_{output}
 3 = GND

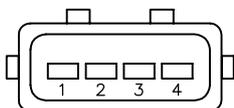
Actuation suffix WA
 Electr. connection acc. to the coding, see table 10

Actuation suffix WA-EX
 Letter of conformity ATEX
 Ex-proof level

IBEx U09 ATEX 1001X
 Ⓜ II 2 G Ex d IIB T 4,
 Ⓜ II 2 D Ex td A21 IP 6x T 135°C
 Ⓜ I M2 Ex d I
 -30 ... +40°C

Coding AMP...

Coding S...



Ambient temperature
 Cable length

3 m or 10 m
 (cable ÖLFLEX-440 @ with shielding and YE/GN ground (protectne conductor) Co. LAPP, D-70565 Stuttgart)

Attention: Operating manual B ATEX and B 10/2008 have to be additionally observed!

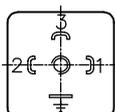
Actuation suffix WA-M2FP
 Ex-proof level
 Ambient temperature
 Cable length

IECEX IBE 11.0004X
 see WA-EX
 -30 ... +40°C
 3 m or 10 m

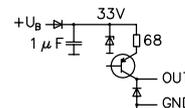
Actuation suffix U

Circuitry

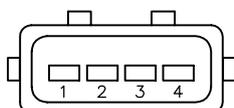
Coding G...



Pin	Signal	Description	
1	OUT _A	PNP-Transistor (connecting to +)	Open-Collector: I _{max} = 10 mA Short-circuit proof
2	OUT _B	PNP-Transistor (connecting to +)	
3	+U _B	10 ... 32V DC	Residual ripple ≤ 10%
4/GND	GND	0V DC	



Coding AMP...



Signal table			
Ident. No.	Spool movement	OUT _A	OUT _B
1	Idle position middle	ON	ON
2	P → B	OFF	ON
3	P → A	ON	OFF

4.4 Functional cut-off, prop. pressure limitation

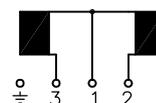
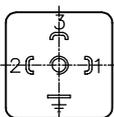
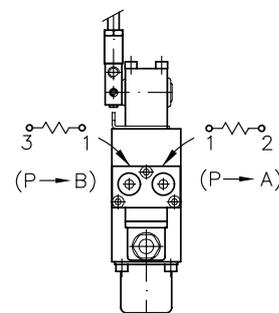
Functional cut-off

On/Off solenoid with manual emergency actuation

Rated voltage U _N	24V DC	12V DC
Coil resistance R ₂₀	34.8 Ω	8.7 Ω
Current, cold I ₂₀	0.69 A	1.38 A
Rated current I ₇₀	0.48 A	0.97 A
Cut-off energy W _A	≤ 0.3 Ws	≤ 0.3 Ws
Rel. duty cycle ¹⁾	S 1	S 1
(reference temp. ϑ ₁₁ = 50°C)		
Electr. connection	EN 175 301-803 A	
Protection class (assembled)	IP 65 (IEC 60529)	

Circuitry

Coil b Coil a



¹⁾ **Note:** The duty cycle refers to one coil only of each twin solenoid. The perm. duty cycle is only 50%, when both coils are energized simultaneously

Prop.-pressure limitation

Prop.-solenoid with manual emergency actuation. For connection pattern, see functional cut-off for electrical data, see actuation E, EA

4.5 Other solenoid valves

Electrical data	<ul style="list-style-type: none"> - Connection blocks coding Z, ZM, V - Add-on intermediate plates coding ZPL 3 D(DS) - Ancillary blocks coding /3 VV(VX, XV), /UNF 3 VV(VX, XV) - End plates coding E 35 (valve 2) - End plates coding EF 31D 		<ul style="list-style-type: none"> - Connection blocks coding F, D - Add-on intermediate plates coding ZPL 3 S(V) / E - End plates coding E 3, E 6, E 35 (valve 1) 		<ul style="list-style-type: none"> - Connection blocks coding PA, PB, PD 	
Additional documentation	D 7490/1, D 7490/1 E (type EM)		D 7470 A/1 (type WN 1, WH 1)			
Nom. voltage U_N	24V DC	12V DC	24V DC	12V DC	24V DC	12V DC
Nom. power P_N	21 W	21 W	24.4 W	24.4 W	21 W	21 W
Nom. current I_N	0.63 A	1.2 A	1 A	2 A	0.63 A	1.26 A
	<ul style="list-style-type: none"> - Add-on intermediate plates coding ZPL 3 VQ..., /3 QV(3 QS) 		<ul style="list-style-type: none"> - Ancillary blocks coding /ZDR, /ZDS 			
Additional documentation	D 7490/1 (type EMP)		D 7765 (type BVG 1)			
Nom. voltage U_N	24V DC	12V DC	24V DC	12V DC		
Nom. power P_N	30 W	30 W	27.6 W	29.4 W		
Nom. current I_N	1.25 A	2.5 A	1.1 A	2.2 A		

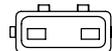
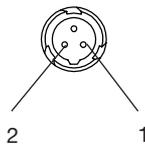
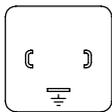
Electr. connection

Circuitry with coding -G 12, -G 24, -X 12, -X 24
EN 175 301-803 A
IP 65 (IEC 60529)

Circuitry with coding -S 24
Plug Co. SCHLEMMER
Type SL-10
IP 67 (IEC 60529)

Circuitry with coding -AMP 24
AMP Junior Timer
2-pin
IP 65 (IEC 60529)

Circuitry with coding PA, PB, PD -G 12, -G 24 -X 12, -X 24
Slim design industrial standard contact clearance 11 mm IP 65 (IEC 60529)

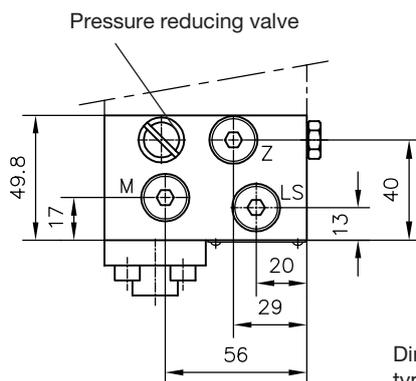


5. Unit dimensions

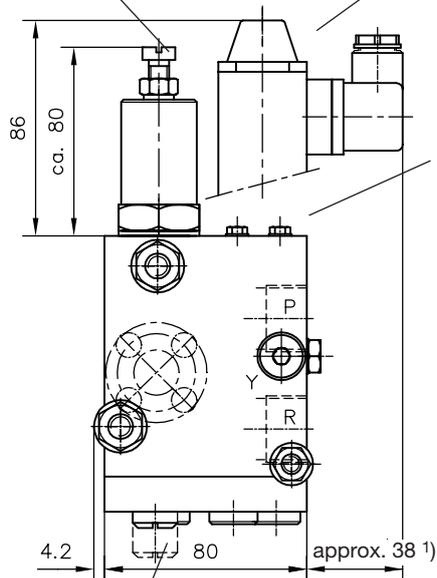
All dimensions are in mm and are subject to change without notice !

5.1 Connection blocks

Connection blocks type PSL and PSM acc. to sect. 3.1.1 and 3.1.3



Pressure limiting valve

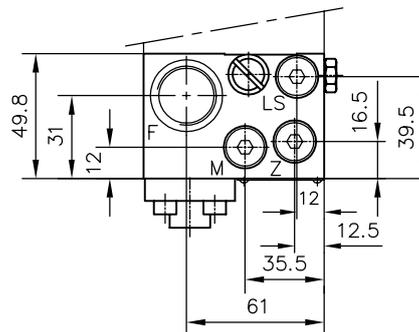


With coding 2 acc. to table 7

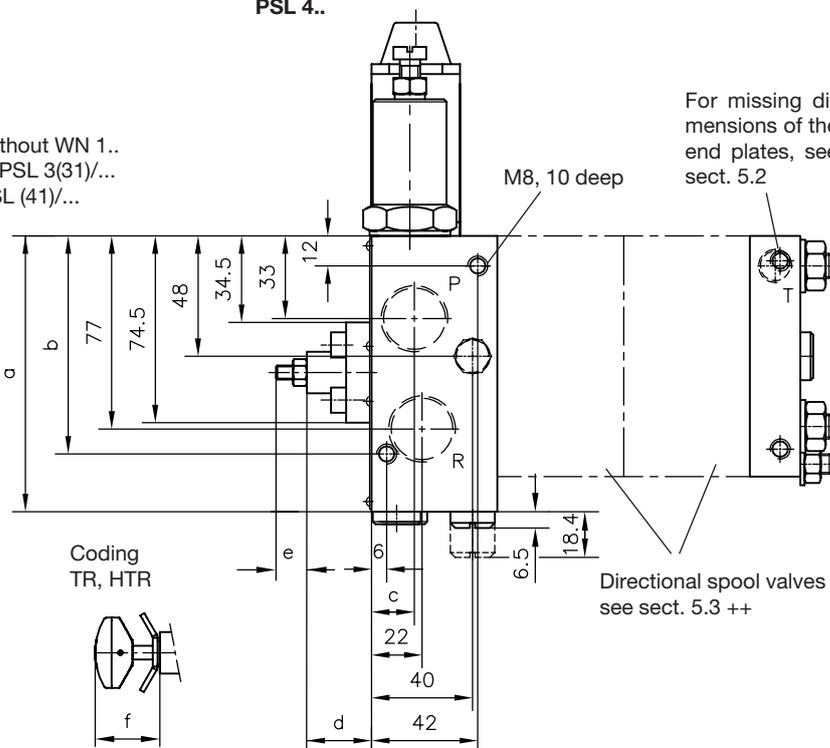
1) This dimension (plug) depends on the make and may be up to 50 mm acc. EN 175 301-803 A

	Ports			ISO 228/1 (BSPP)
	P	R	LS, Z, M	
PSL 3..	G 1/2	G 1/2	G 1/4	
PSL 4..	G 3/4	G 3/4	G 1/4	
PSL 4 Y..	G 3/4	G 3/4	G 1/4	

Type PSL 4 Y



Type PSL 3..
PSL 4..



For missing dimensions of the end plates, see sect. 5.2

Directional spool valves see sect. 5.3 ++

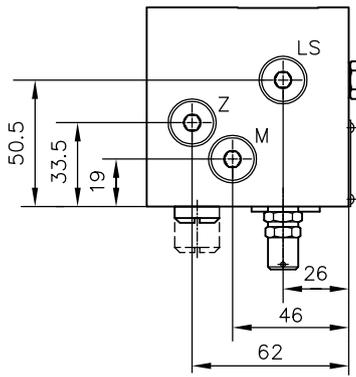
	a	b	c
PSL 3	110	87	18
PSL 4	110	87	21
PSL 4 Y	123	111.5	21

	d
PSL 3(4)	22
PSL 3(4) T (TR)	35
PSL 3(4) H	40
PSL 3(4) HT (HTR)	53

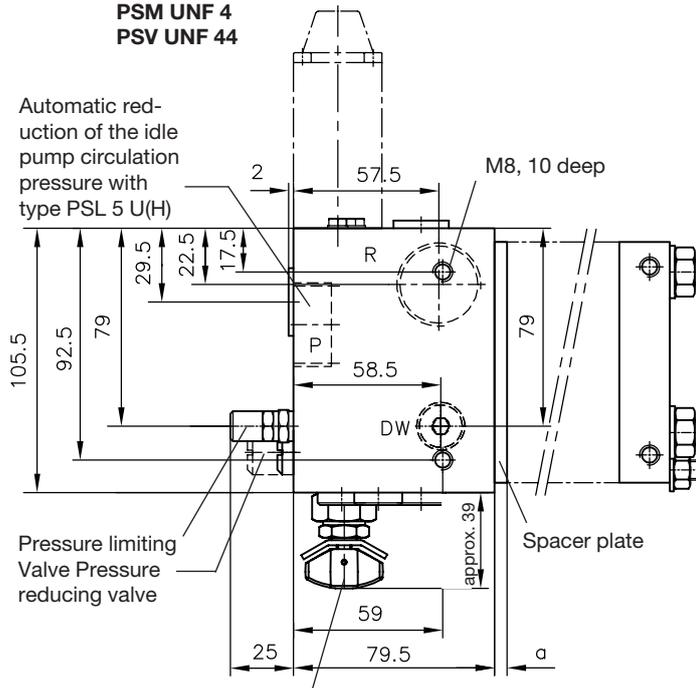
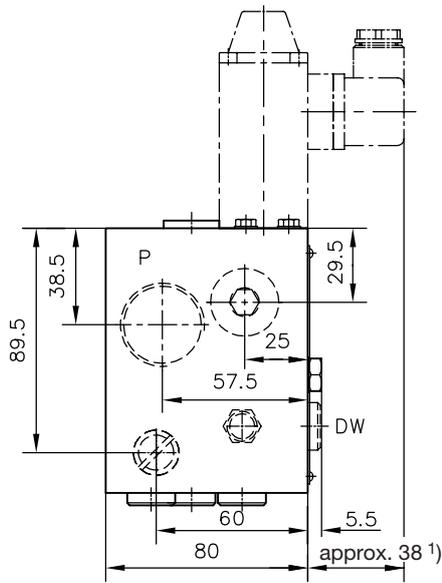
e ≈ 8 with type PSV (blocked controller)
> 11 with type PSL

f ≈ 28 with type PSV (blocked controller)
> 31 with type PSL

to 5.1 connection blocks



Type PSL 5..
 PSL 45..
 PSL 5 U(H)..
 PSL 45 U(H)..
 PSV 55..
 PSM 5..
 PSL UNF 4
 PSM UNF 4
 PSV UNF 44



Pressure limiting Valve Pressure reducing valve

Switch-over valve type PSM 5 L

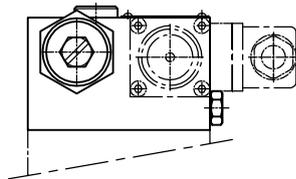
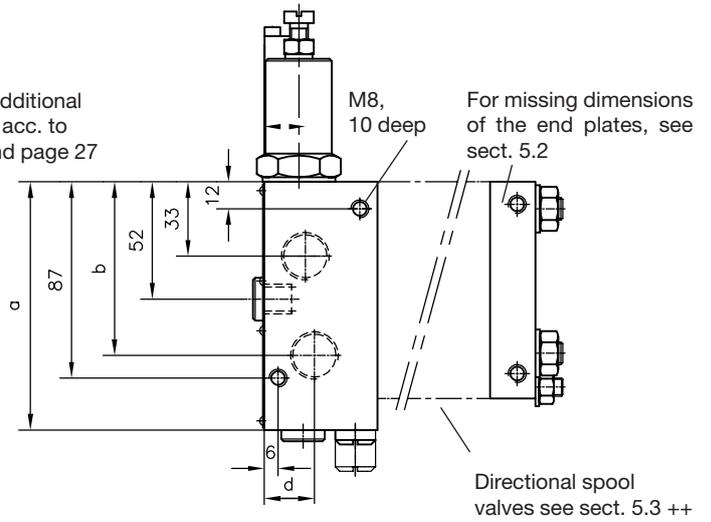
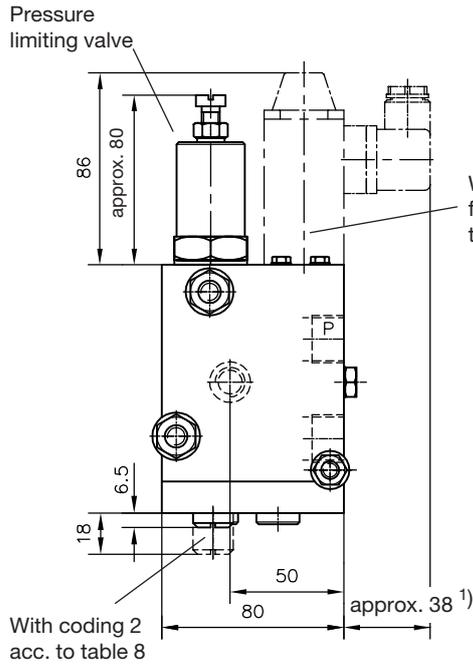
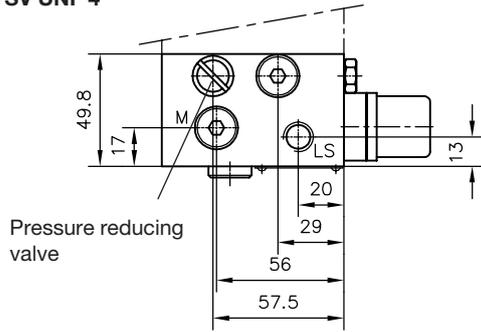
Spacer plate	a
Type ZPL 33/5	5
ZPL 33/15	15
ZPL 33	49.8

1) This dimension (plug) depends on the make and may be up to 50 mm acc. EN 175 301-803 A

	Ports			
	P	R	LS, Z, M, DW	
PSL 45..	G 3/4	G 1	G 1/4	
PSL 45 U(H)..	G 3/4	G 1	G 1/4	ISO 228/1
PSL 5..	G 1	G 1	G 1/4	(BSPP)
PSL 5 U(H)..	G 1	G 1	G 1/4	
PSL UNF 4..	1 1/16-12 UN-2B (SAE-12)	1 1/16-12 UN-2B (SAE-12)	7/16-20 UNF-2B (SAE-4)	SAE J 514
PSV 55..	G 1	G 1	G 1/4	ISO 228/1 (BSPP)
PSV UNF 44..	1 1/16-12 UN-2B (SAE-12)	1 1/16-12 UN-2B (SAE-12)	7/16-20 UNF-2B (SAE-4)	SAE J 514
PSM 5..	G 1	G 1	G 1/4	ISO 228/1 (BSPP)
PSM 5 L..	G 1	G 1	G 1/4	
PSM UNF 4..	1 1/16-12 UN-2B (SAE-12)	1 1/16-12 UN-2B (SAE-12)	7/16-20 UNF-2B (SAE-4)	SAE J 514

Connection blocks type PSV acc. to pos. 3.1.2

Type PSV 3(4, 5)
PSV UNF 4



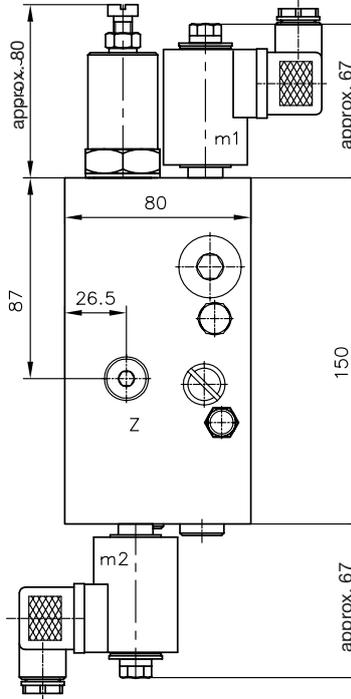
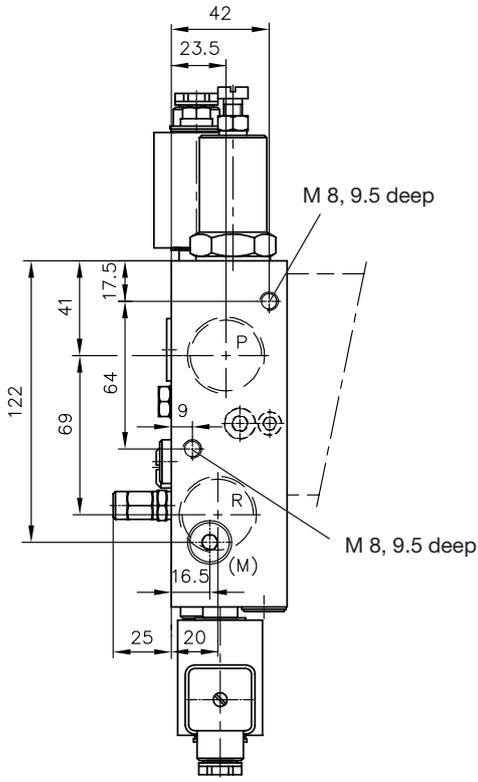
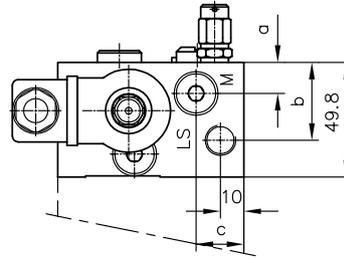
1) This dimension (plug) depends on the make and may be up to 50 mm acc. EN 175 301-803 A

	Ports			
	P	R	LS, Z, M	
PSV 3..	G 1/2	G 1/2	G 1/4	ISO 228/1 (BSPP)
PSV 4..	G 3/4	G 3/4	G 1/4	
PSV 5..	G 1	G 1	G 1/4	
PSV UNF 4..	1 1/16-12 UN-2B (SAE-12)	7/16-20 UNF-2B (SAE-4)		SAE J 514

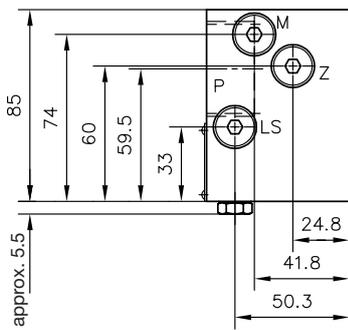
	a	b	c	d
PSV 3..	110	77	18	22
PSV 4..	110	77	21	22
PSV 5..	128	98	21	21

Type PSV 5 N

	a	b	c
PSV 5 N	13.5	33.8	20.5
PSV UNF 5 N	14.5	32.5	24

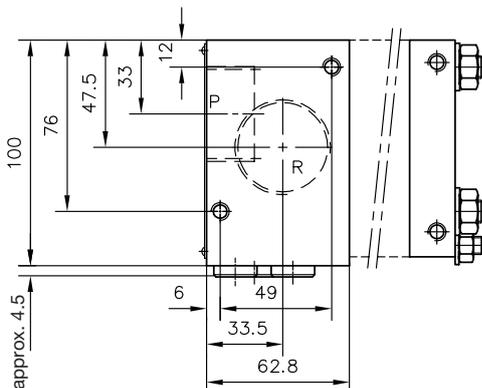


Type PSV 6

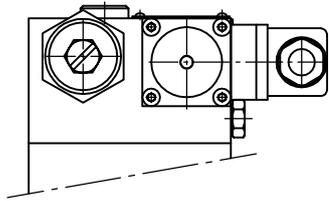
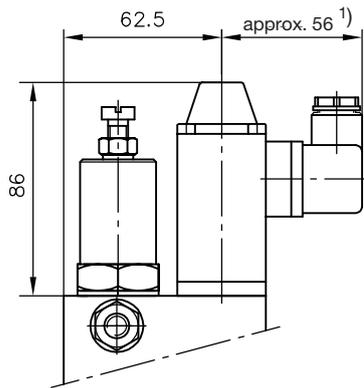


	Ports			
	P	R	LS, Z	
PSV 5 N	G 1	G 1	G 1/4	ISO 228/1 (BSPP)
PSV UNF 5 N	1 5/16-12UN-2B (SAE-16)	1 5/16-12UN-2B (SAE-16)	7/16-20UNF-2B (SAE-4)	SAE J 514
PSV 6	G 1 1/4	G 1 1/4	G 1/4	ISO 228/1 (BSPP)

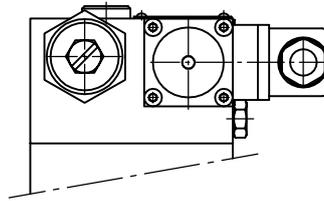
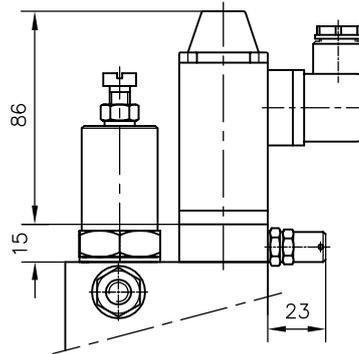
	Ports		
	M	(M)	
PSV 5 N	G 1/4	G 1/8	ISO 228/1 (BSPP)
PSV UNF 5 N	7/16-20UNF-2B (SAE-4)	--	SAE J 514
PSV 6	G 1/4	--	ISO 228/1 (BSPP)



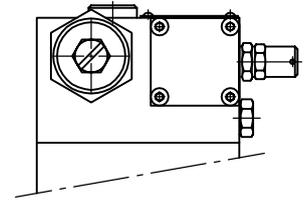
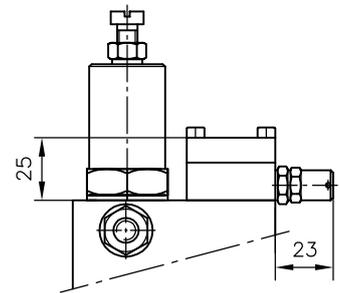
**Type PSL..F(D)/...
PSV..F(D)
PSV..F(D)/...**



**Type PSL..F(D)/...
PSV..F(D)/...**

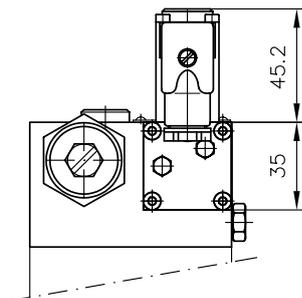
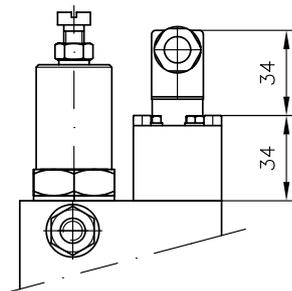


Type PSV...X...

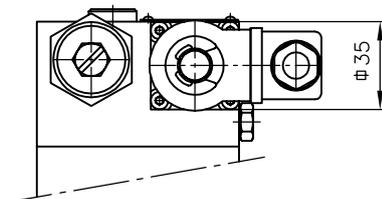
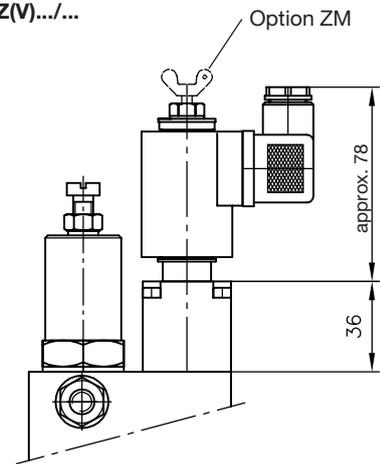


1) This dimension (plug) depends on the make and may be up to 68 mm acc. EN 175 301-803 A

**Type PSL..PA(PB, PD)/...
PSV..PA (PB, PD)**

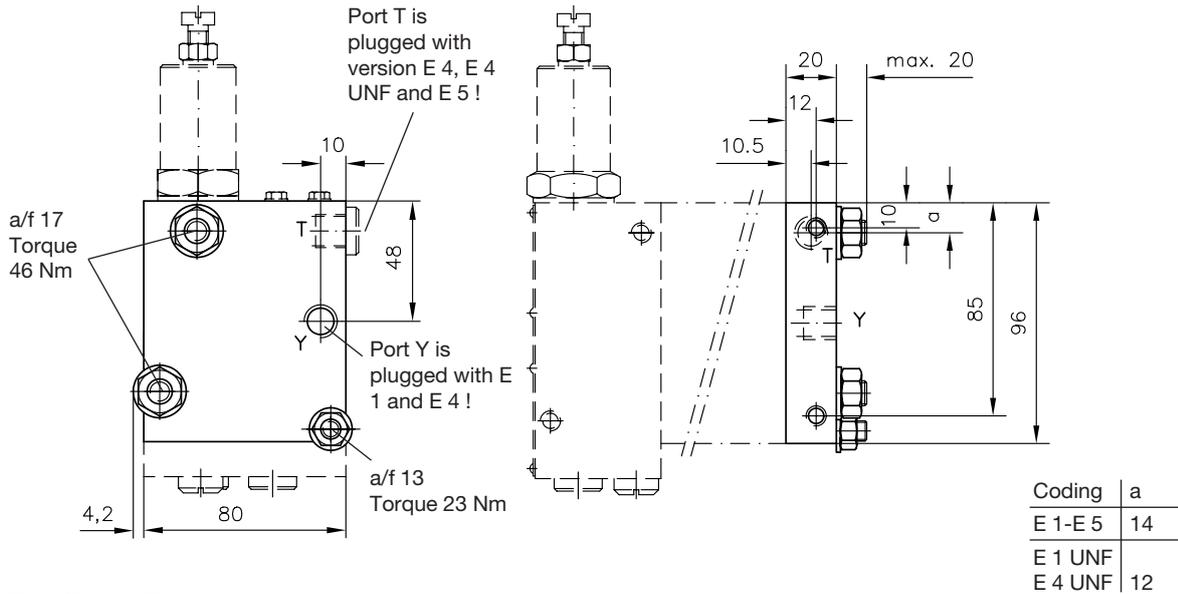


**Type PSL..Z(V).../
PSV..Z(V).../...**

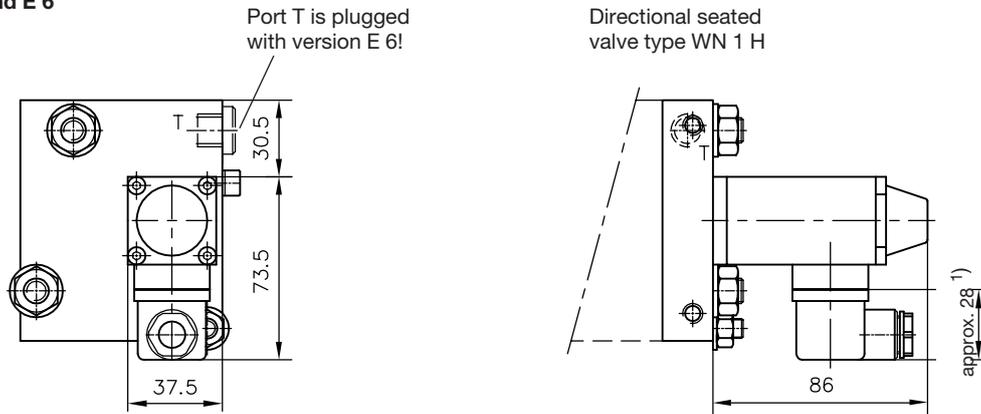


5.2 End plates

Type E 1, E 2, E 4 and E 5 E 1 UNF and E 4 UNF

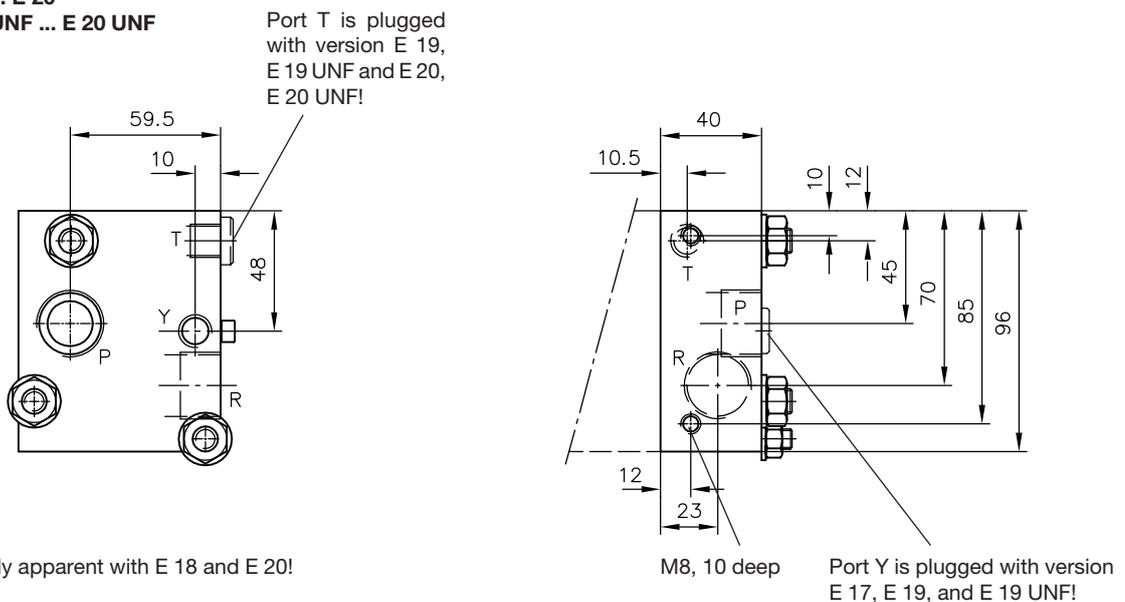


Type E 3 and E 6



For missing specifications, see above!

Type E 17 ... E 20 E 17 UNF ... E 20 UNF

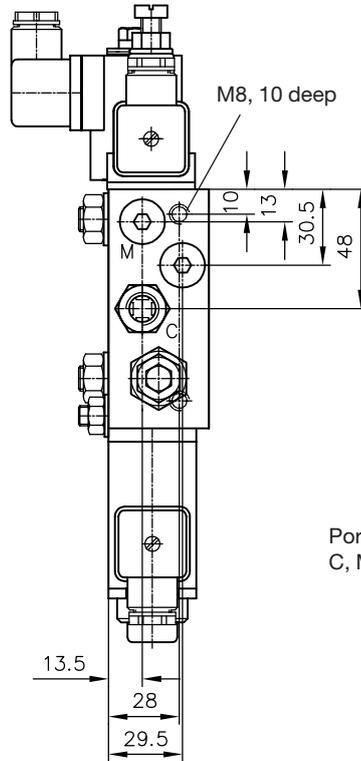
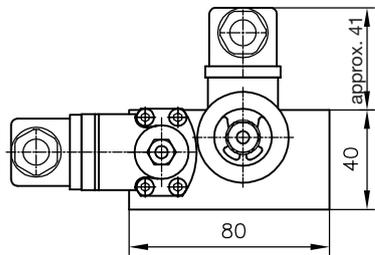
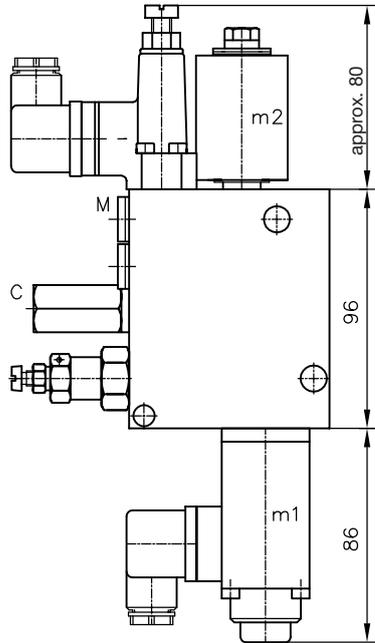
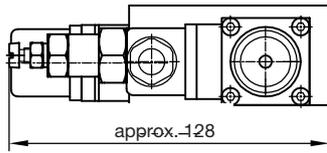


Ports conforming ISO 228/1 (BSPP):
T and Y = G 1/4
P and R = G 3/4

acc. to SAE J 514 (E.. UNF)
T and Y = 7/16-20 UNF-2B (SAE-4)
P and R = 7/8-14 UNF-2B (SAE-10)

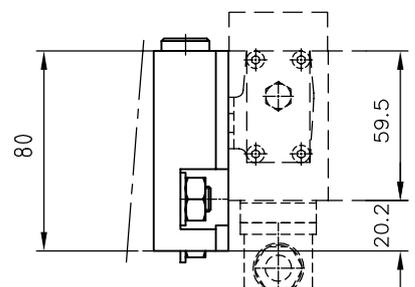
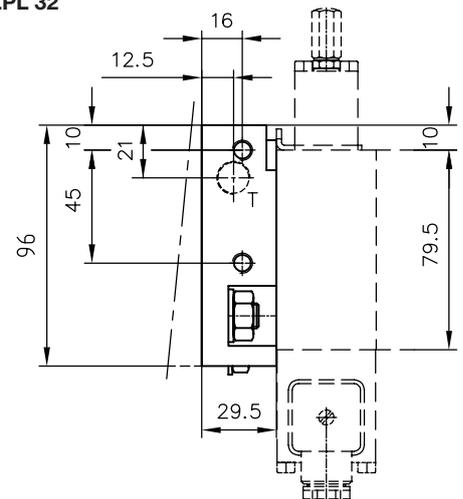
For missing specifications, see above!
1) This dimension (plug) depends on the make and may be up to 40 mm acc. EN 175 301-803 A

Type E 35/.../...



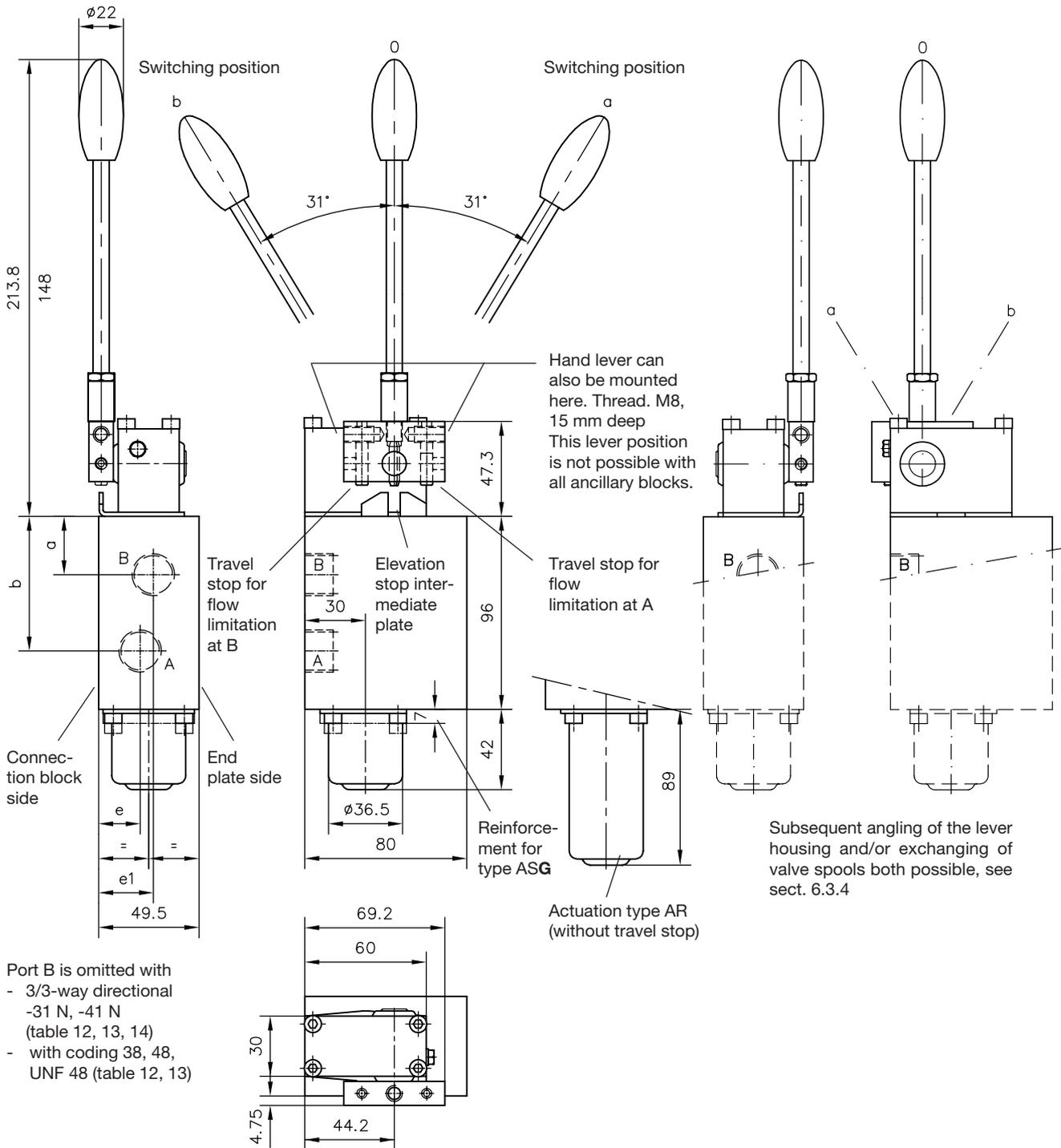
Ports conf. ISO 228/1 (BSPP):
C, M = G 1/4

Type ZPL 32



5.3 Directional spool valves with manual actuation A, C

Lever housing will be installed rotated by 180°, when stated in uncoded text.



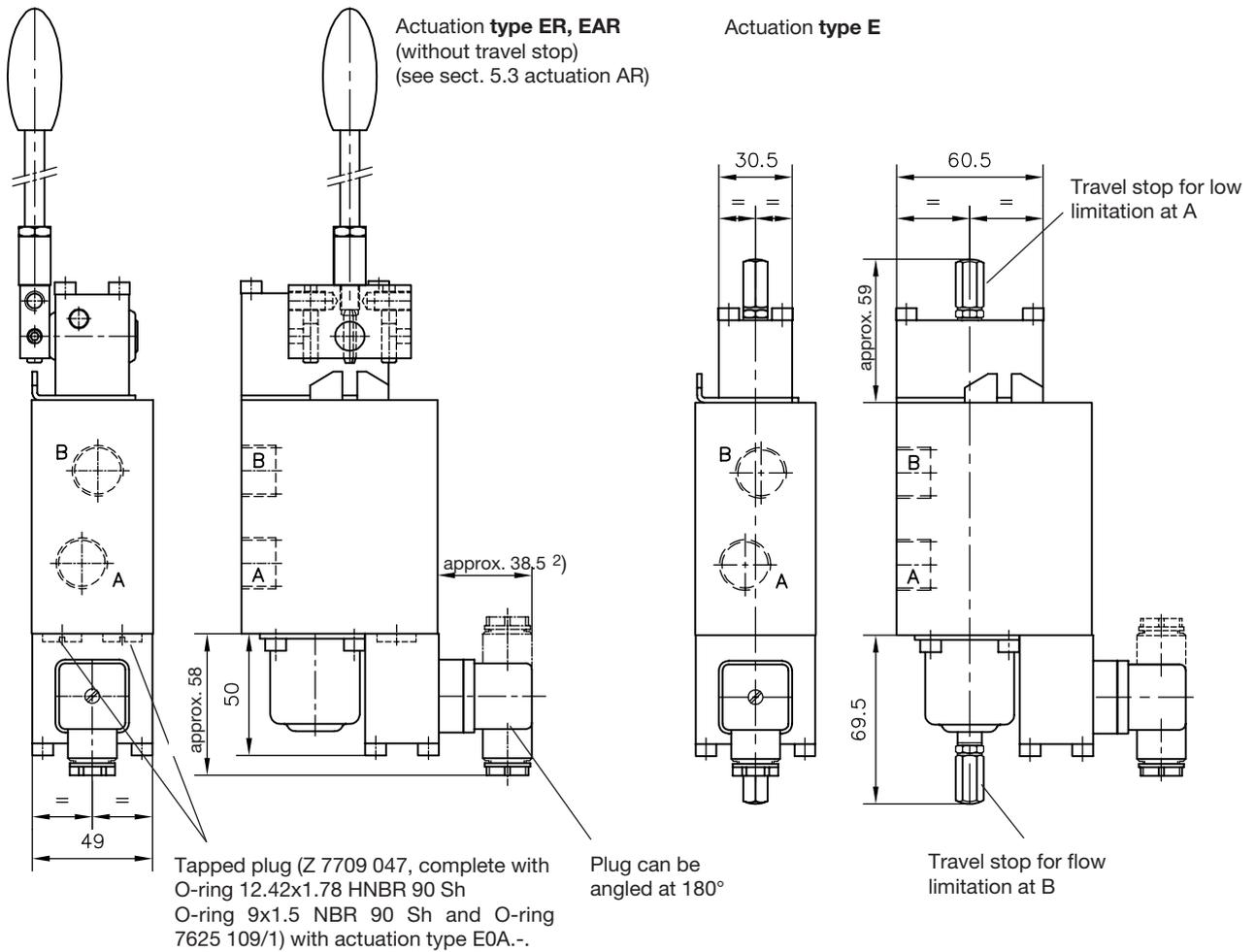
Port B is omitted with
 - 3/3-way directional
 -31 N, -41 N
 (table 12, 13, 14)
 - with coding 38, 48,
 UNF 48 (table 12, 13)

Port size	Ports A and B conf. ISO 228/1 (BSPP)				
		a	b	e	e1
3	G 1/2	29	67	20.5	27
4	G 3/4	27	69	21.5	31.5
UNF 3	7/8-14 UNF-3B (SAE-10)	29	67	20.5	27
UNF 4	1 1/16-12 UN-2B (SAE-12)	-	69	-	-

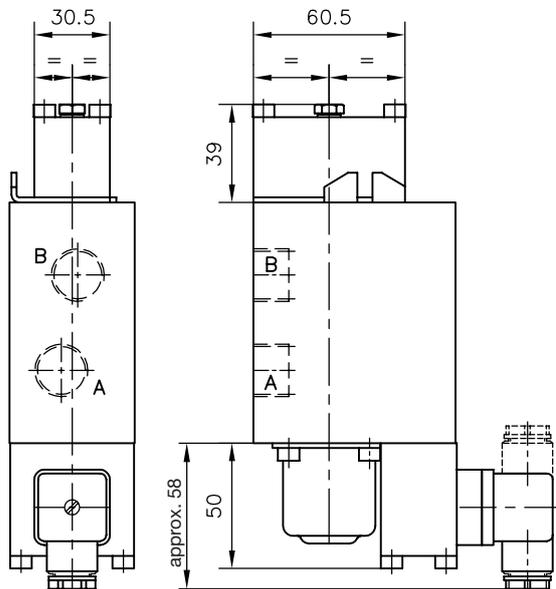
The stroke stops for flow limitation at A and B allow the consumer flow Q_{max} of the built in spool to be smoothly reduced to intermediate values down to Q_{max} of the spool with the next smallest flow coding (table 15, sect. 3.2).

5.4 Spool valves with actuation EA, E0A, E, EI, ER, EAR

Actuation type EA, E0A ¹⁾

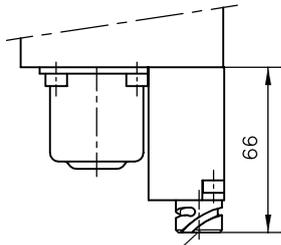


Actuation type EI



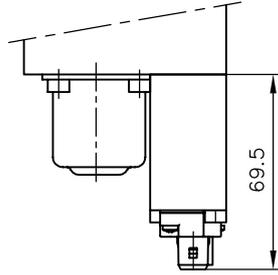
Additional solenoid versions

Coding **-S 12**
-S 24
-S 12 T
-S 24 T

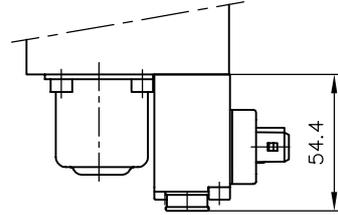


Quarter turn type
 plug (Bayonet) PA 6

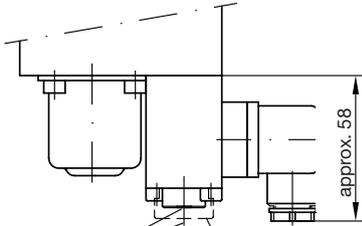
Coding **-AMP 12 K 4**
-AMP 24 K 4



Coding **-AMP 24 H 4 T**

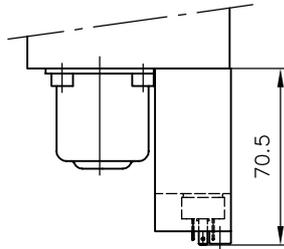


Coding **-G(X) 12 T**
-G(X) 24 T

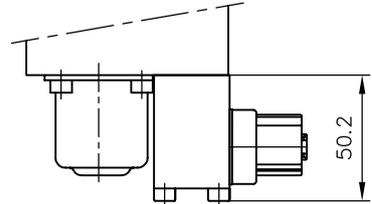


Manual emergency
 operation Pushbutton coding **TH**

Coding **-G(X) 24 C 4**



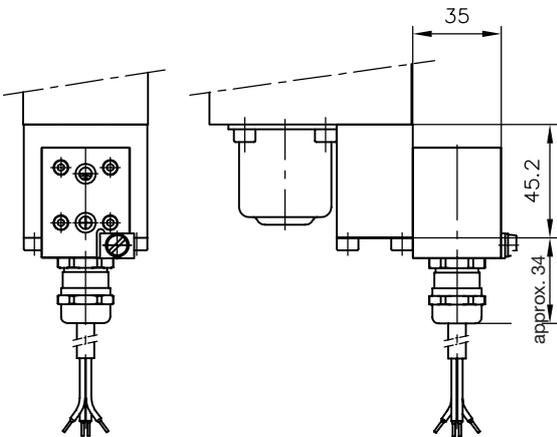
Coding **-DT 12**
-DT 24



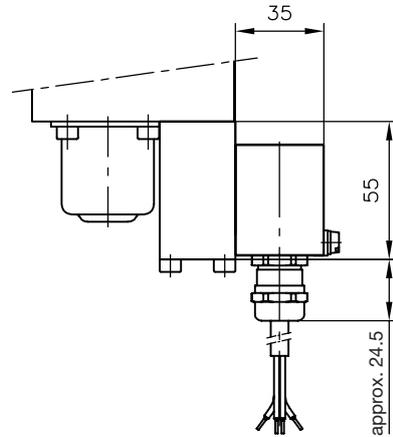
1) Lever housing at EA(1) and HA(1) can be angled at 180° in the same manner as described at sect. 6.3.4

2) This dimension (plug) depends on the make and may be up to 50 mm acc. EN 175 301-803 A

Coding **-G 24 EX**
-G 24 EX 4

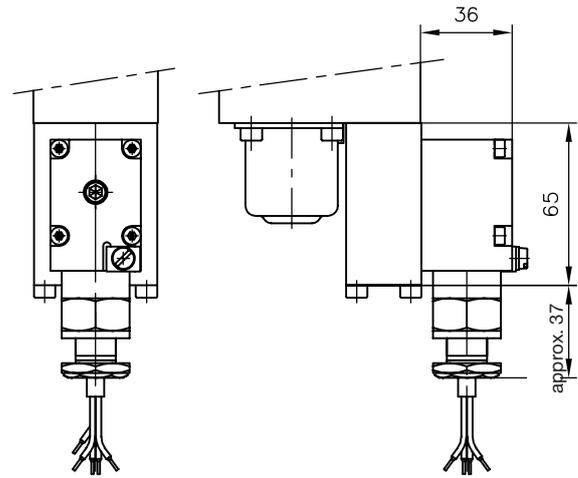
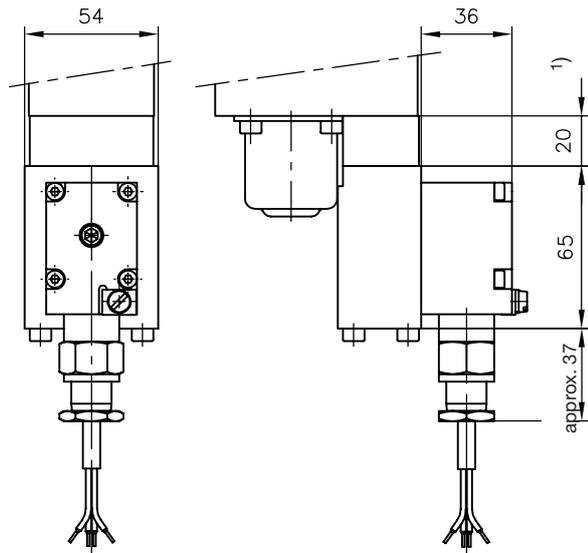


Coding **-G 24 TEX**
-G 24 TEX 4



Coding -G 12 IS
 -G 24 MSHA
 -G 24 M2FP

Coding -G 24 TEX 70

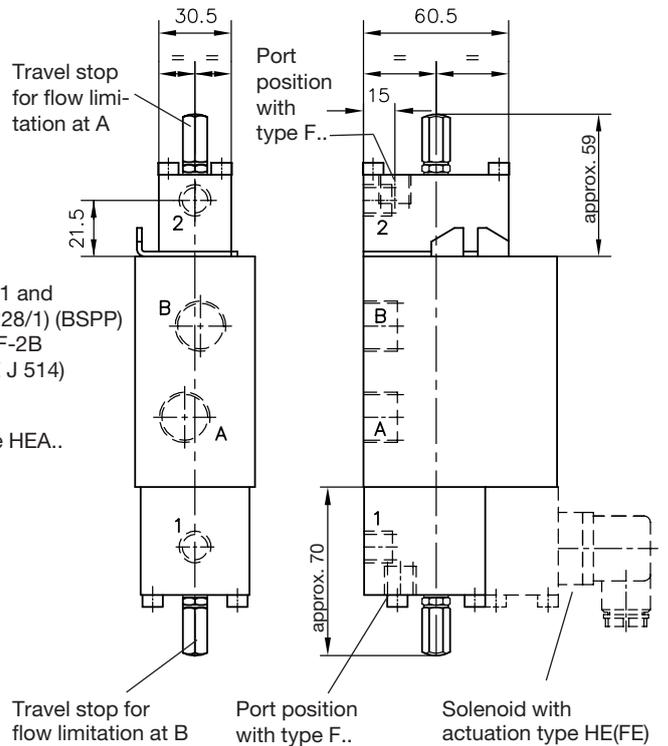
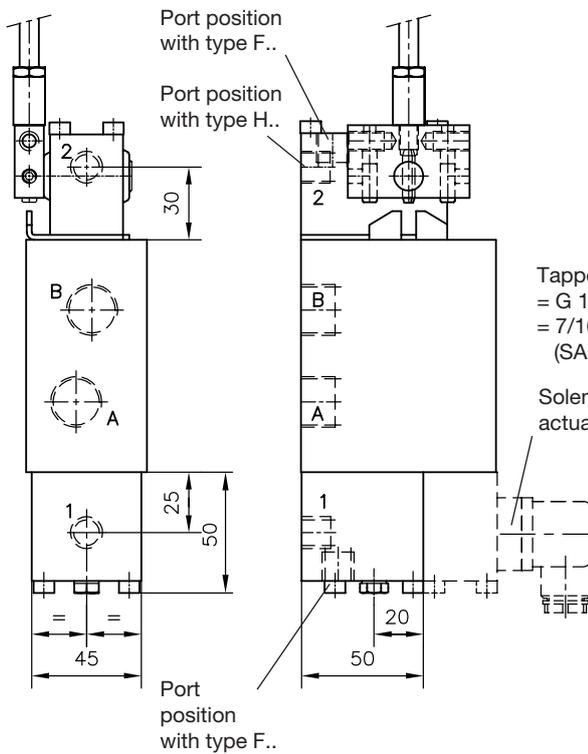


1) Intermediate plate only in combination with actuation ER and EAR

5.5 Spool valves with actuation HA, H, HEA, FA, F, FEA

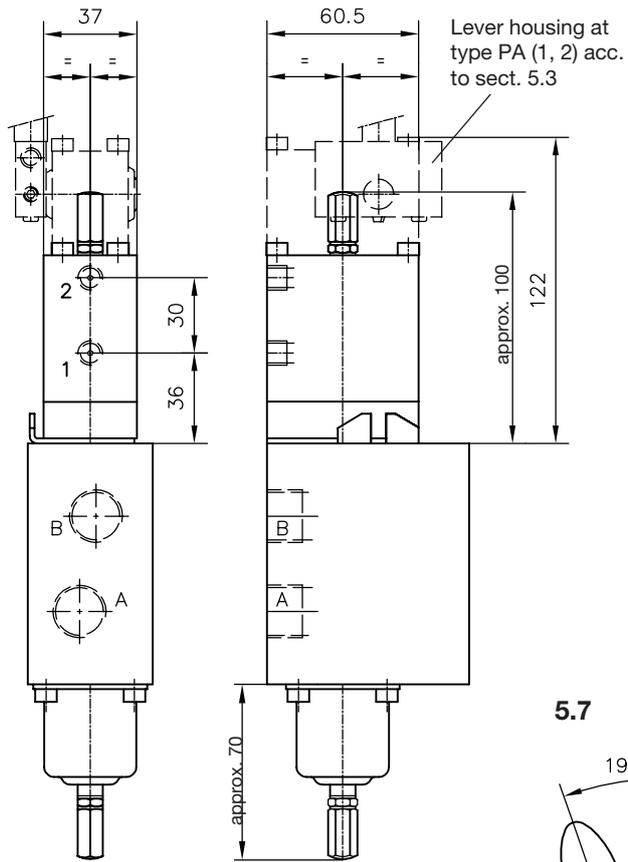
Actuation type HA, FA, HEA, FEA ²⁾

Actuation type H, HE, F, FE



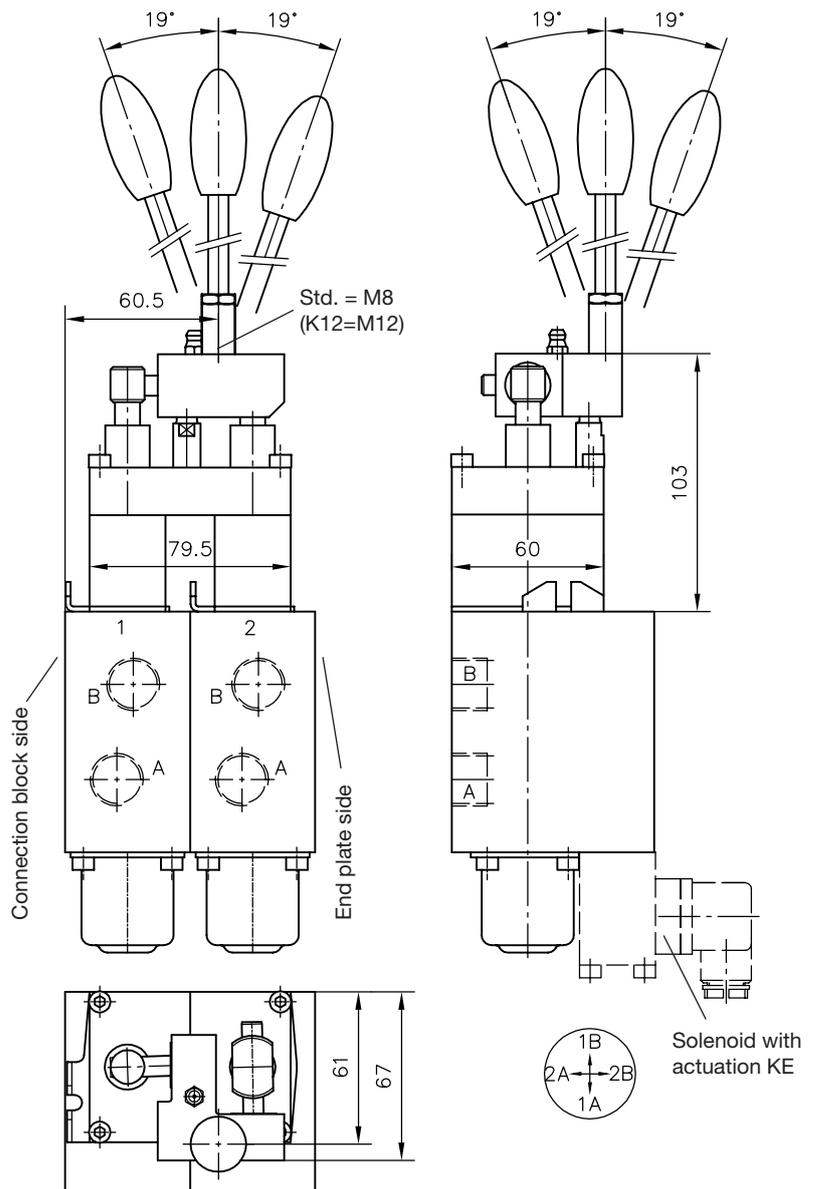
²⁾ Lever housing at EA and HA (FA) can be angled at 180° in the same manner as described at sect. 6.3.4

5.6 Spool valves with actuation P and PA



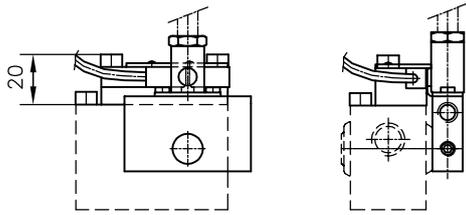
Ports conforming ISO 228/1 (BSPP):
1, 2 = G 1/8

5.7 Spool valves with actuation K and KE

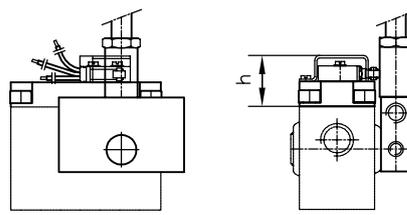


5.8 Elevation monitoring

Type ...N (1)

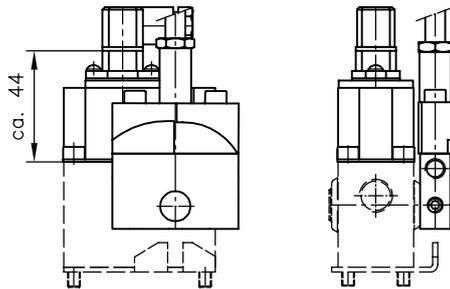


Type ... V

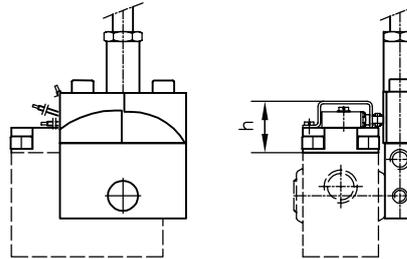


Type	h
... V (VA, VB)	20.5
... VC	27

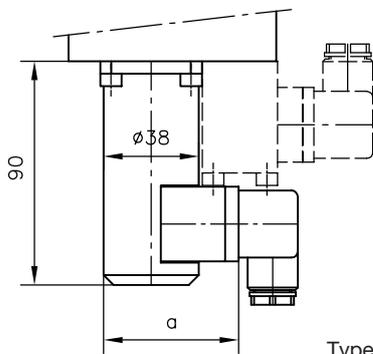
Type VCH0 (VCHC)



Type ... VA, VB, VC

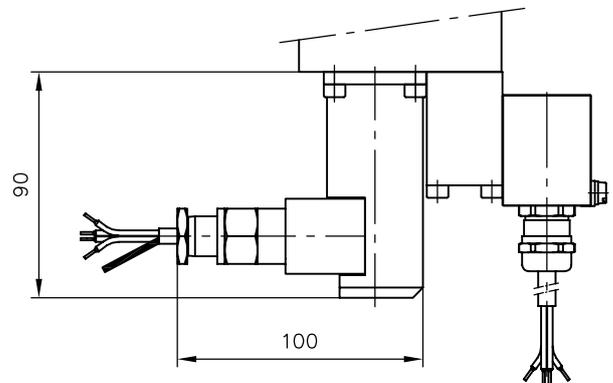


Type ... WA, U

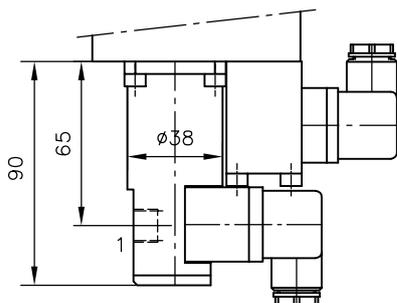


Type	a
WA	39
U	53

Type ...WA-EX
...WA-EX-M2FP



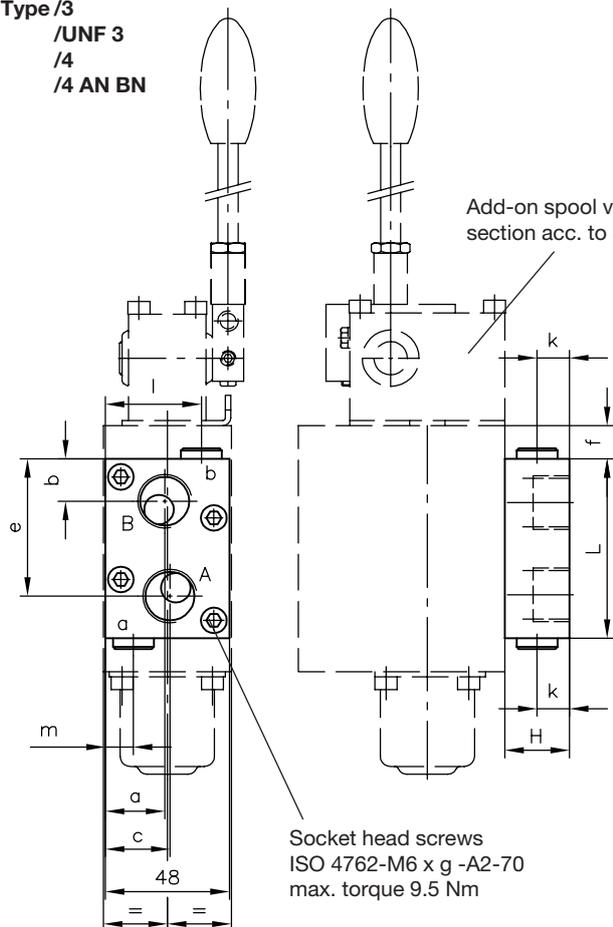
Type H.WA



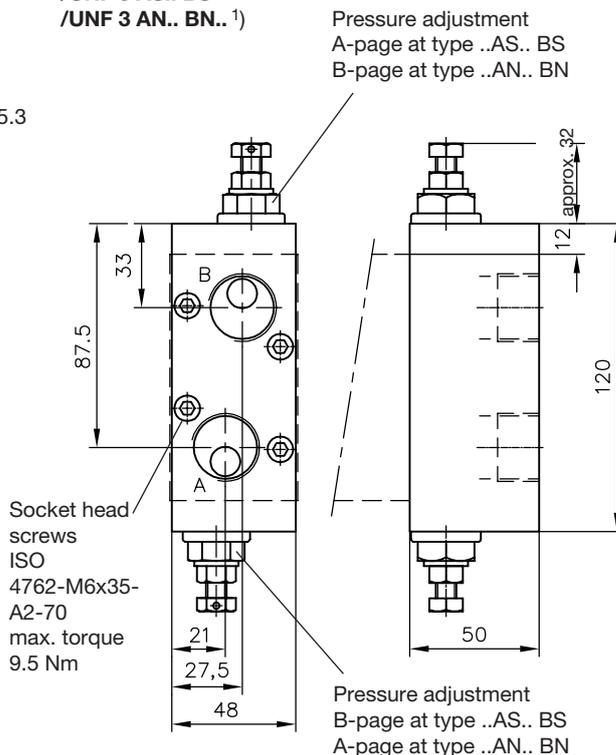
Port conf. ISO 228/1 (BSPP):
1 = G 1/4

5.10 Ancillary blocks

Type /3
/UNF 3
/4
/4 AN BN



Type /3 AS.. BS..
/3 AN.. BN..
/4 AS.. BS..
/4 AN.. BN..
/UNF 3 AS.. BS
/UNF 3 AN.. BN.. 1)



Type	H	L	a	b	c	e	f	g	k	l	m
/3	25	84	23	23.5	25	60.5	6	25	12.5	35	13
/UNF 3	30	96	26.25	23.75	21.75	72.25	--	30	17	13.5	34.5
/4	30	105	27.25	25.25	20.75	79.75	4.5	30	16	12	36
/4 AN BN	30	105	27.25	25.25	20.75	79.75	4.5	30	16	12	36

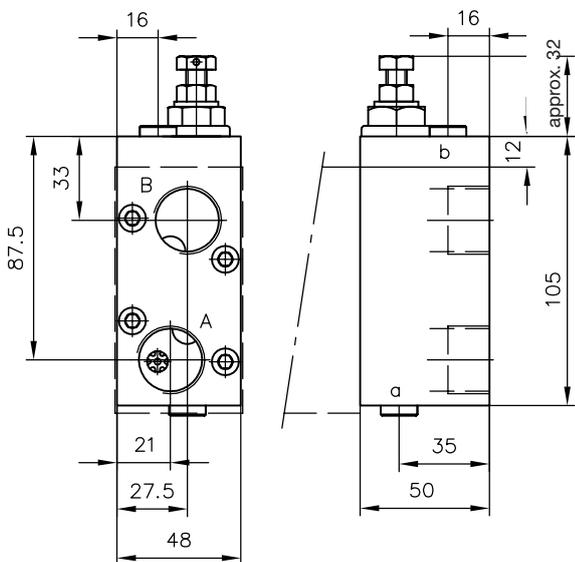
Port A and B (all versions):

	ISO 228/1 (BSPP)	SAE J 514 (SAE-10)
/3.., /31..	G 1/2	---
/UNF 3..	---	7/8-14 UN-2B
/4..	G 3/4	---

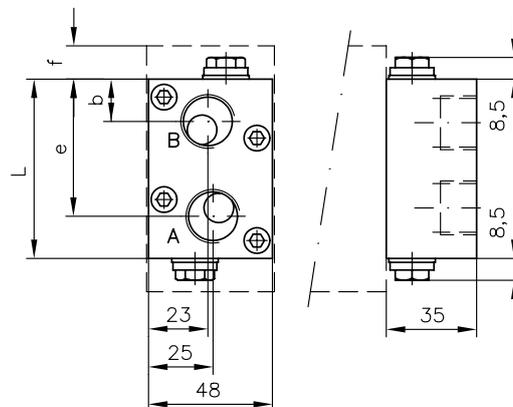
Port a and b conf. ISO 228/1 (BSPP):

/3, /4	G 1/4	---
/4 AN.., /4 BN..	G 1/8	---

Type /4 AN..
/4 BN.. 1)



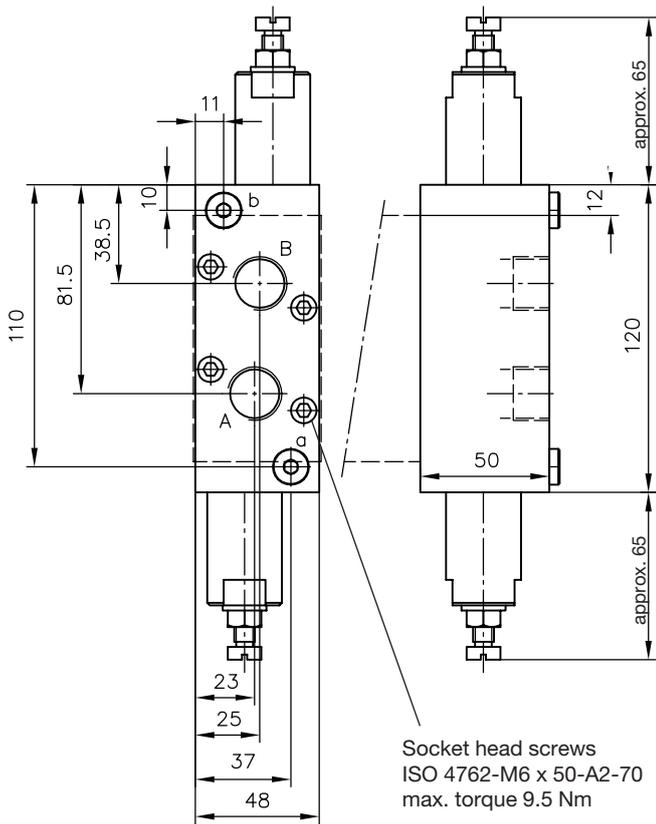
Type /31 AS.. BS..
/31 AN.. BN..



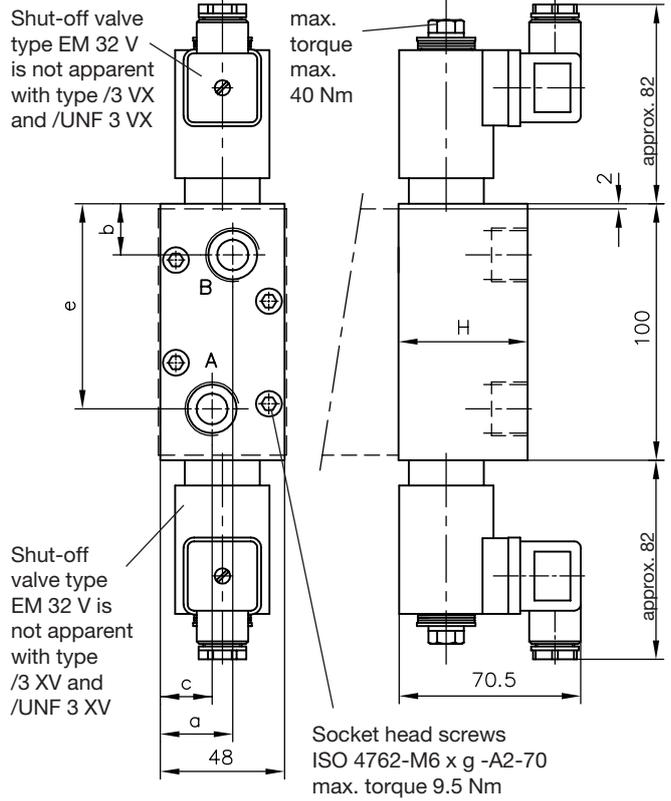
Type	L	b	e	f
/31 AS.. BS..	70	16.5	53.5	13
/31 AN.. BN..	100	31.5	68.5	2

1) Note: Not all lever positions are possible.

Type /3 AL.. BL.. 1)



**Type /3 VV(VX, XV)
UNF 3 VV(VX, XV) 1)**



Port A and B:

/3.. = G 1/2 (ISO 228/1) (BSPP)

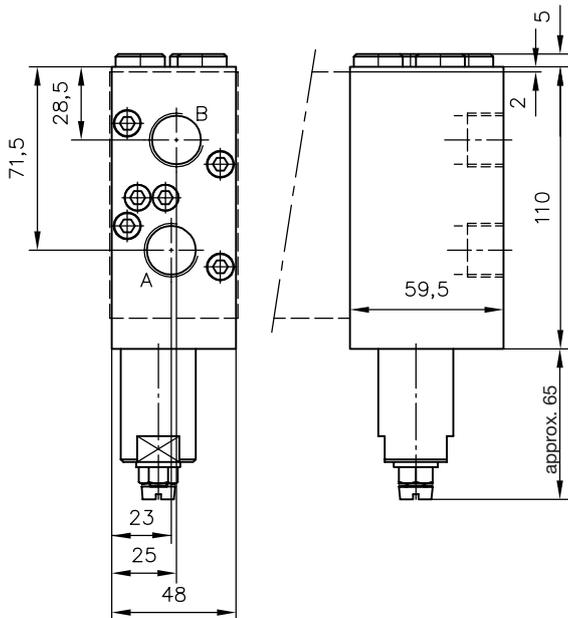
/UNF 3.. = 7/8-14 UN-2B (SAE J 514, SAE-10)

Port a and b:

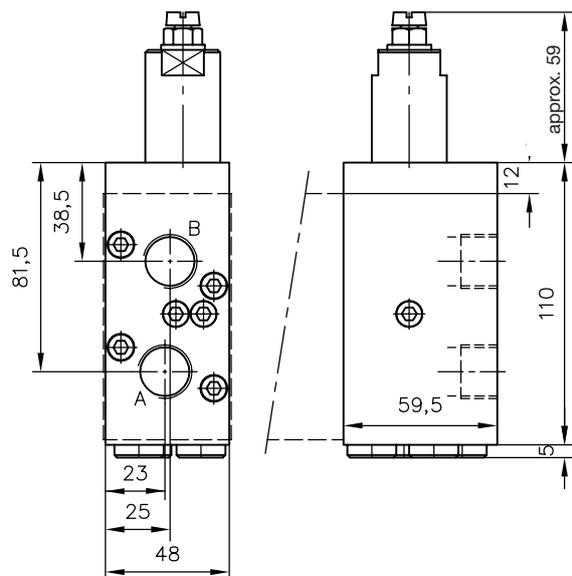
/3.. = G 1/8 (ISO 228/1) (BSPP)

Type	H	a	b	c	e	g
/3 VV(VX, XV)	50	25	20	23	80	50
/UNF 3 VV						
/UNF 3 VX	55	27.5	22.5	21	78	55
/UNF 3 XV						

Type /3 AL.. 1)

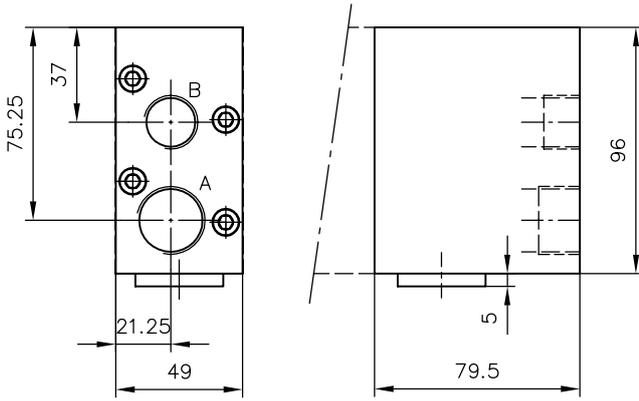


Type /3 BL.. 1)

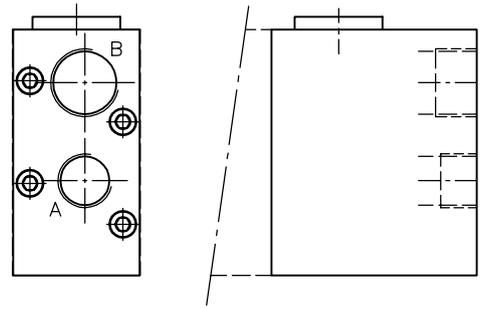


1) **Note:** Not all lever positions are possible.

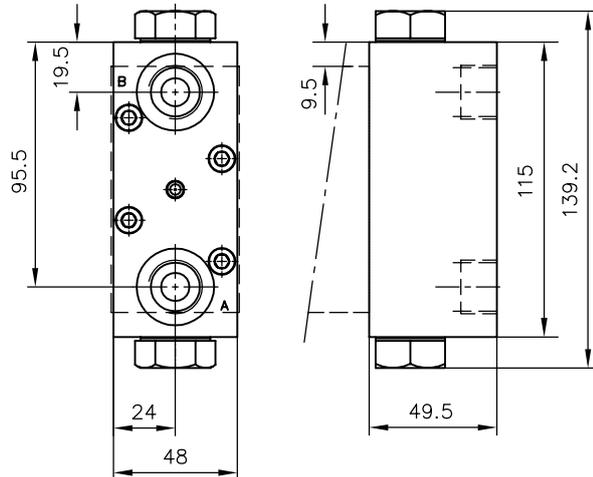
Type /43 DFA 1)



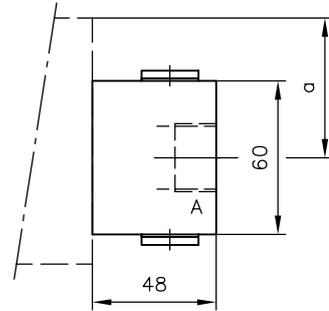
Type /43 DFB 1)



**Type /3 DRH
/UNF 3 DRH 1)**



**Type /3 DW.
/4 DW.
/UNF 4 DW.**

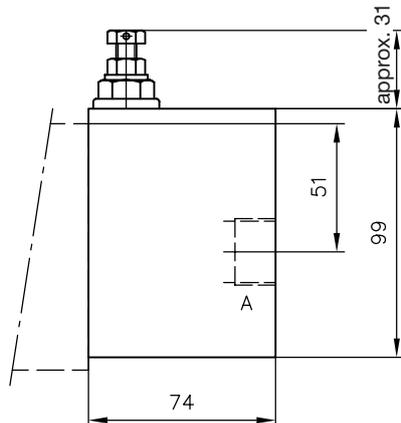


	a
/3 DW.	53.5
/4 DW.	56.5
/UNF 4 DW.	56.5

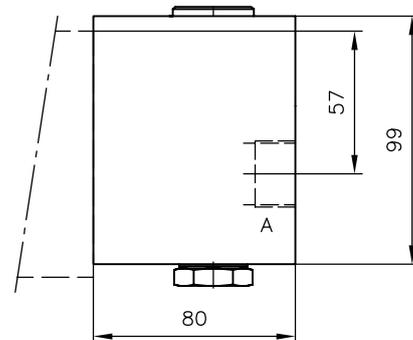
Port A and B:
 /3.. = G 1/2 (ISO 228/1) (BSPP)
 /4.. = G 3/4 (ISO 228/1) (BSPP)
 /UNF 3.. = 7/8-14 UN-2B (SAE J 514, SAE-10)
 /UNF 4.. = 1 1/16-12 UNF-2B (SAE J 514, SAE-12)

1) **Note:** Not all lever positions are possible.

Type /4 AS..

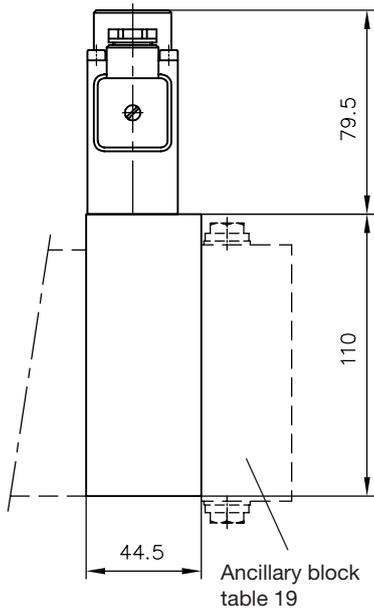


Type /4 HRP 4..

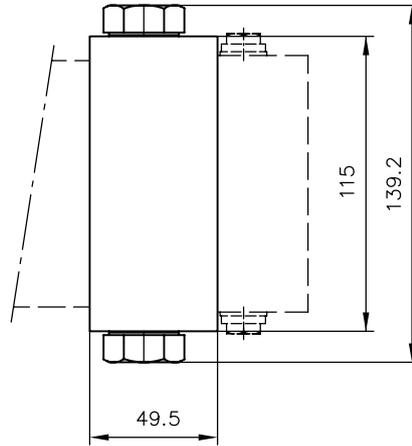


Referring to sect. 5.10 Ancillary blocks
Intermediate plates for parallel connection

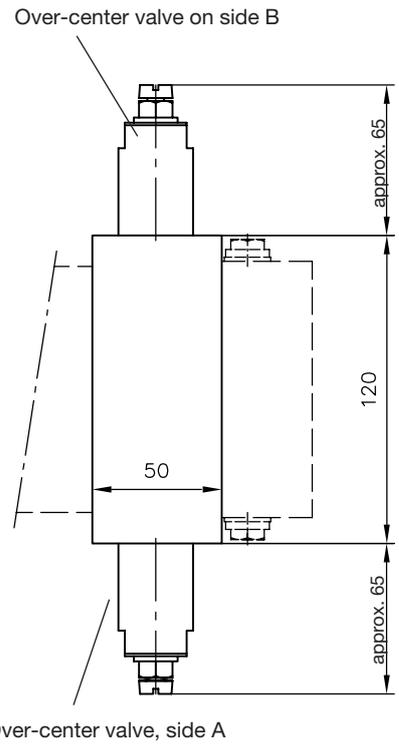
Type /ZDR
/ZDS 1)



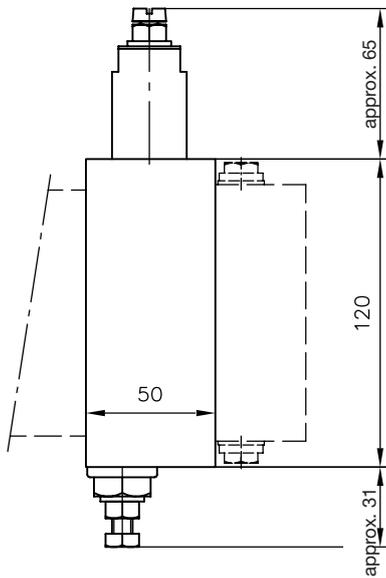
Type /ZDRH



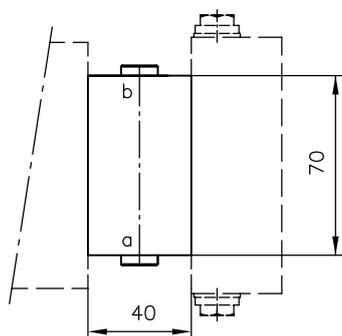
Type /ZAL..BL.. 1)



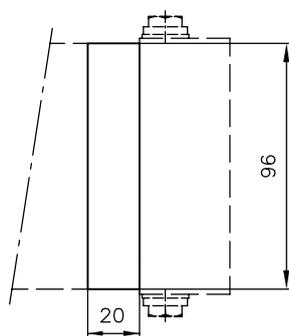
Type /ZAL... BN...
/ZBL... AN... 1)



Type /Z 40
/Z 40 M
/Z 40 M UNF 1)



Type /Z AN BN 1)



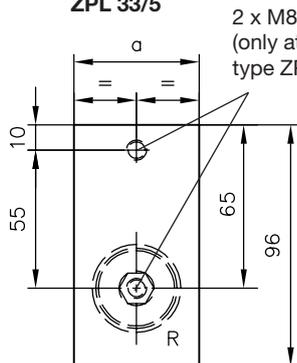
Port a and b:

	ISO 228 (BSPP)	SAE J 514
/Z 40 M	G 1/4	---
/UNF 3..	---	7/16 - 20 UNF - 2B

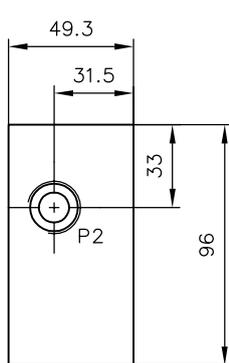
1) **Note:** Not all lever positions are possible.

5.11 Add-on intermediate plates ZPL 3...

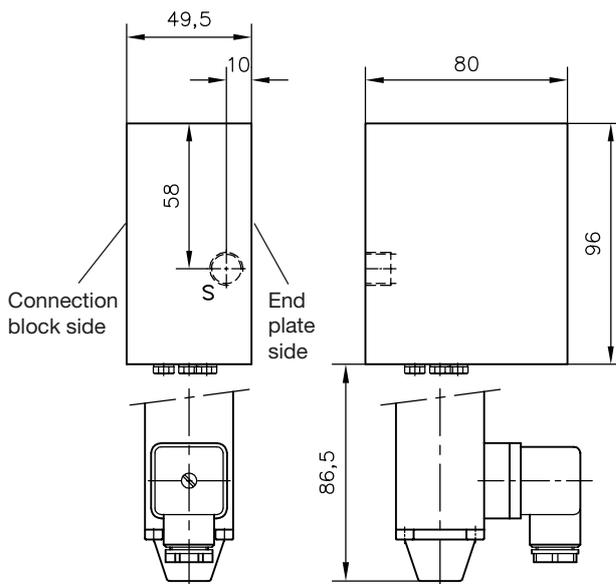
Type ZPL 33
ZPL 33/15
ZPL 33/5



Type ZPL 3 - Z 3



Type ZPL 3 S/H
ZPL 3 V/H



Type	a
ZPL 33	49.5
ZPL 33/15	15
ZPL 33/5	5

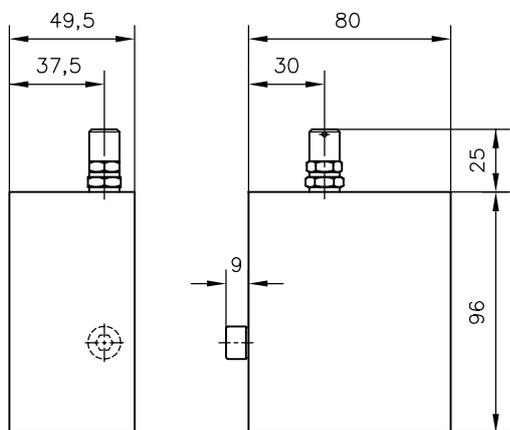
Ports conforming
ISO 228/1 (BSPP):
P2 = G 1/2
R = G 3/4 (only type ZPL 33)

Type ZPL 3 S(V)/E

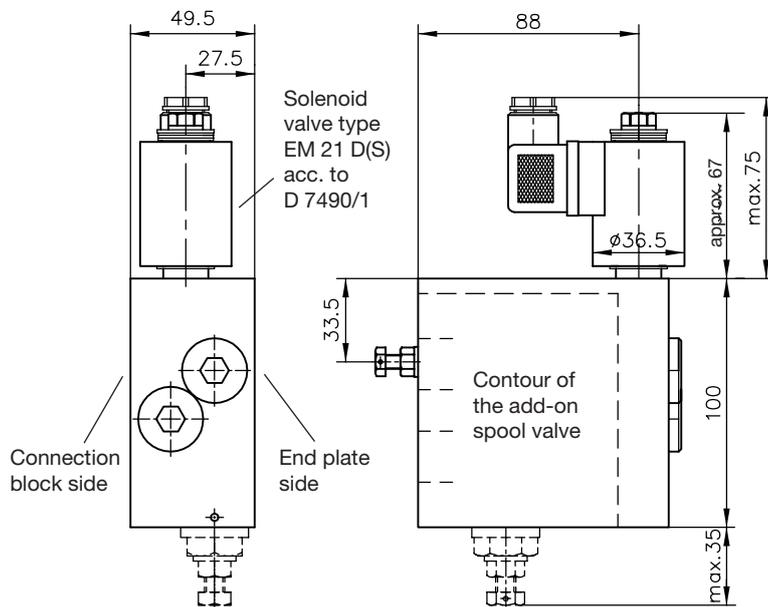
Port S = G 1/4 (ISO 228/1) (BSPP)
(plugged with type ZPL 3 (V)/E)

also add-on intermediate plates

Type ZPL 3 P

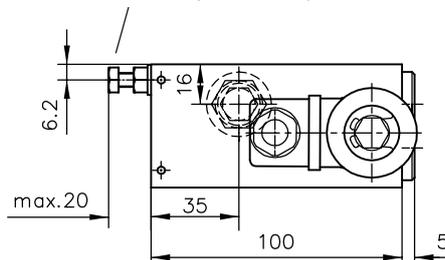


Type ZPL 3 D(S)
ZPL 3 D(S)/..



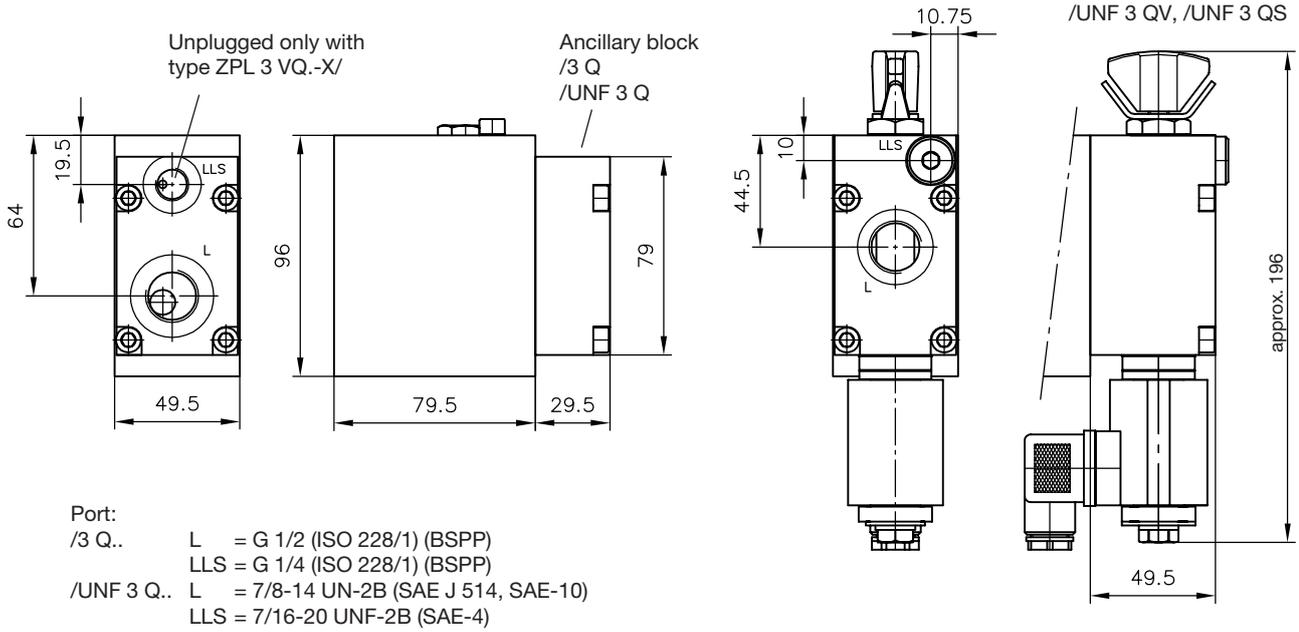
Adjustment screw a/f 13 for the pressure limiting valve
(only at type ZPL 3 D(S)/... 1)

Set screw a/f 10
for second speed rate 1)



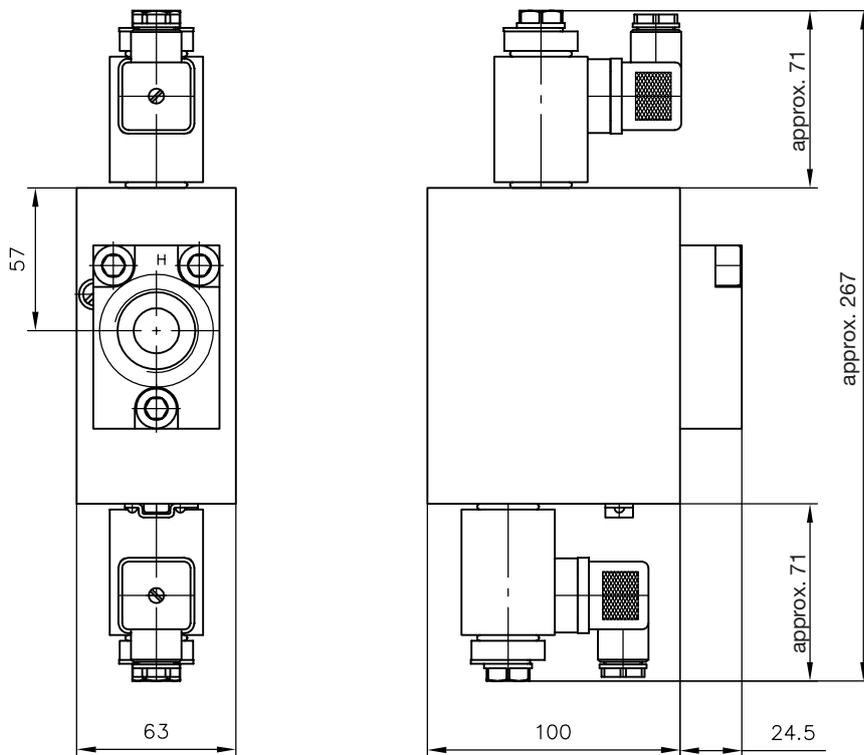
1) It is necessary to loosen the lock-nut sufficiently before adjusting the throttle screw to prevent damage of the vulcanized seal ring!

Type ZPL 3 VQ.-./3 QV(QS)
ZPL 3 VQ.-./3 Q



in series intermediate plates

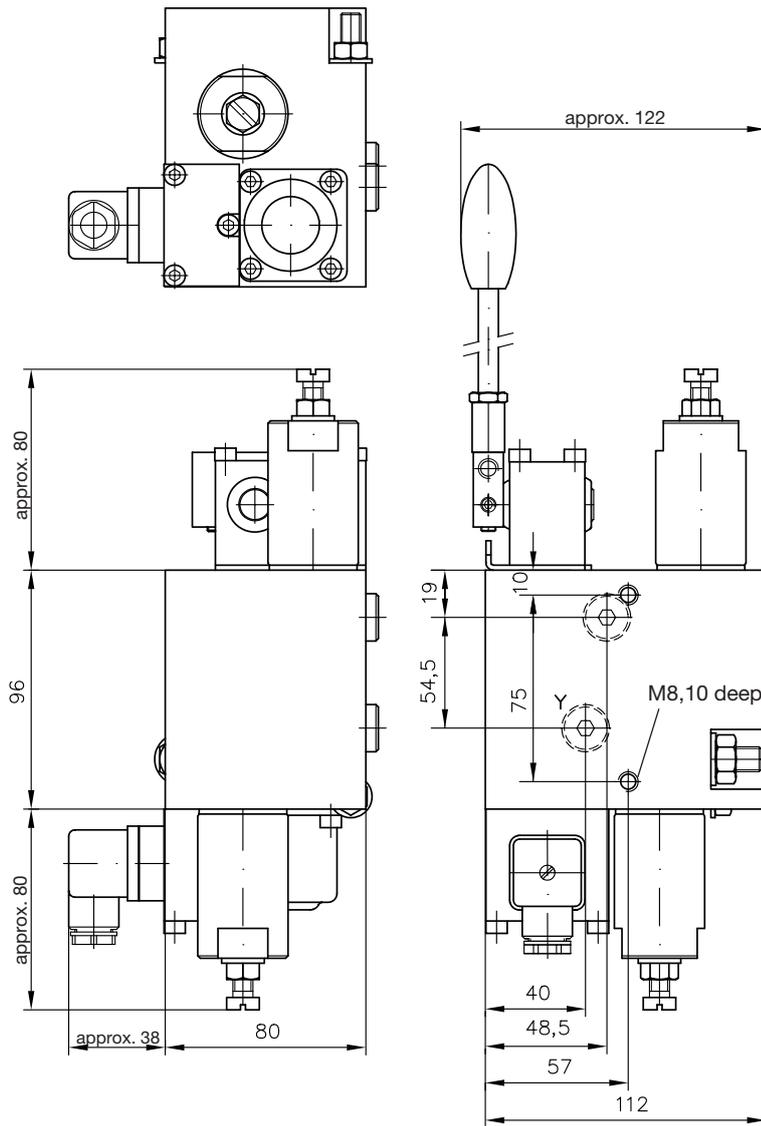
Type A1 RR...



Port conf. ISO 228/1 (BSPP):
 /5 = G 1

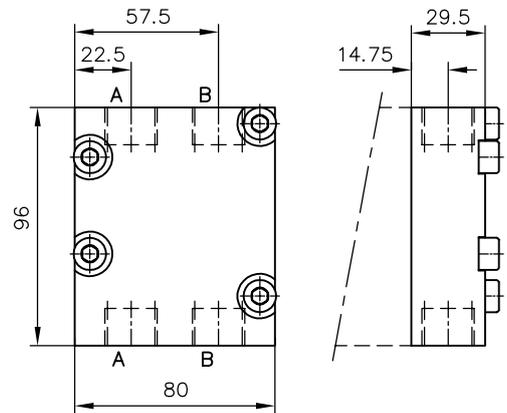
5.12 Valve sections with over-center valves

Type SL 3-F 1... and SL 3-F 5...



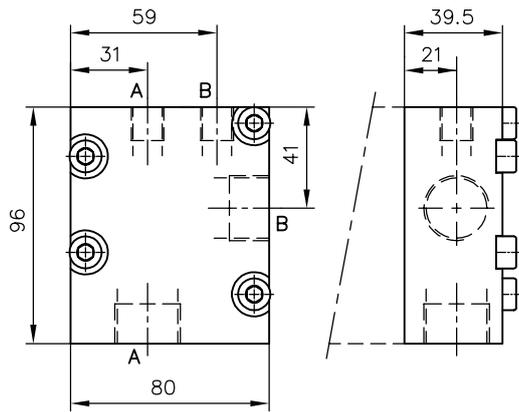
Port conforming ISO 228/1 (BSPP);
Y = G 1/4

Type SL 3-EF 30

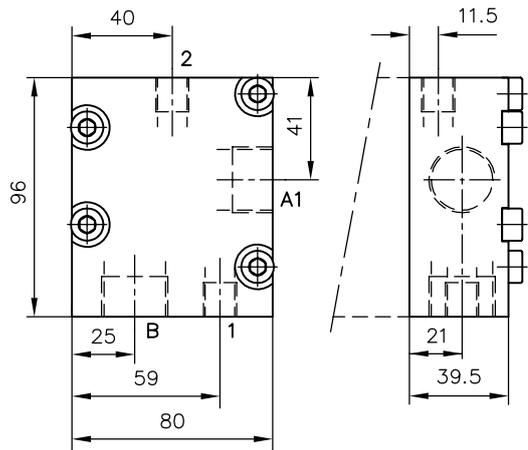


Ports conforming ISO 228/1 (BSPP);
A and B = G 1/2

Type SL 3-EF 41



Type SL 3-EF 42



Ports conforming ISO 228/1 (BSPP):

A, A 1 and B = G 3/4

a and b, 1 and 2 = G 1/4

6. Appendix

6.1 Notes for selection and lay-out

a) Connection block

There are, apart from the standard versions acc. to sect. 3.1.1 and 3.1.2. additional damping variations for the LS-signal duct listed in tables 2 or 4. These are required, if strong (load-) oscillations are externally induced on the control circuit. A general rule concerning the use of one or other variation can however not be given.

Coding Z and K

In this version a limiting to the return duct is opened as soon as the pressure level in the LS-duct drops below approx. 1/3 of the pressure level in the spring cavity of the 3-way flow controller. This ensures a quick response in spite of good damping characteristics during operation (at least one valve spool elevated). The main field of application is in connection with load-holding valves (types LHDV) and systems with a high tendency to oscillate.

Coding U (or UH)

The pump idle circulation pressure is reduced by means of an additional by-pass valve, if all directional spool valves are in idle position (see also curves in sect. 4.2). The valve opens automatically if the upcoming load pressure (LS pressure) drops below 25% of the (still remaining) pump pressure.

Attention: A minimum pump delivery flow of approx. 80 lpm must be maintained for electro-hydraulic actuation with internal control oil supply. The control pressure (Δp pump circulation pressure) is not sufficient for elevating the spool at lower delivery flows. The load pressure must be at least 20 bar.

Coding UH

The control pressure of the 3-way flow controller must be raised by approx. 15 bar to ensure a pressure difference between 2- and 3-way flow controller if at least one directional spool valve coding 5 (increased circulation pressure) is used due to the necessary consumer velocity. An increased dissipation power of the control system is of course obliged with this. The by-pass valve (see coding U) is therefore integrated as standard to minimize pressure losses during idle pump circulation.

Coding Y and YH

The additional port F (excess fluid of the 3-way controller) is fully pressure resistant. This enables feeding of an subsequent valve bank and connected consumers, depending on the excess flow).

When connecting two valve banks type PSL in series, it is necessary to employ version YH for the first one to maintain a sufficient pressure drop required for a flawless control function.

Coding G

This version lacks the sequence valve at the damping element which is apparent at the standard version to enable quick depressurization down to the pre-load pressure during idle position of the valve spool. This results in a stronger damping effect than with the standard version, as all fluid from the spring cavity of the 3-way flow controller must pass the thread type throttle. Main application is with consumers prone to low-frequent oscillations - drawback is the delayed depressurization down to the pre-load pressure during idle position of the valve spool (pro-longed run-down).

Coding H

If on account of the required consumer velocity at least one spool valve with reference number 5 (raised circulation pressure) is utilized, then, in order to maintain the necessary pressure difference between 2- and 3-way flow controller, the circulation pressure of the 3-way flow controller must be raised to approx. 14 bar. This means, of course, greater power dissipation.

Coding Z, ZM, V and PA, PB, PD (see table 8)

When using these valves for an emergency stop function, it has to be taken into account that there will be a certain min. residual pressure during pushing load while a valve spool is elevated!

Dampening screw acc. to table 2 and 5 Coding	Residual pressure at load induced pressure of	
	250 bar	350 bar
S, G, W, B	125	150
B 4	60	70
B 5	75	80
B 6	85	95
B 7	100	120

Viscosity $\leq 60 \text{ mm}^2/\text{s}$

b) Spool valve sections

Coding 1 (example SL 3-31 L 6/16...)

On the one hand, there is a higher consumer flow with directional spool valves without an inflow controller (coding 1) in comparison with one having a 2-way flow controller (code no 2, 5), as the flow is then directly dependent on the control pressure of either the connection block's 3-way flow controller (approx. 10 bar) in type PSL, or the metering valve of a variable displacement pump (approx. 14 to 20 bar), in type PSV. On the other hand, the load-independence is lost, if several consumers are actuated simultaneously, because the consumer with the highest load pressure rules the pressure level of the LS-signal given to the 3-way flow controller and so defines the available oil flow in the system. When another valve with lower pressure is now actuated, the flow can only be regulated by throttling, which means if the highest load pressure varies, the spool elevation (= throttling) of the second consumer has to be reset to maintain a constant delivery flow to the consumer. This consumer flow can be calculated approx. by ($Q_{A, B}$ = expected consumer flow, Q_{nom} = rated consumer flow for a valve with inflow controller coding 2, $\Delta p_{\text{controller}}$ = pressure difference at the flow controller of the connection block or pump).

$$Q_{A, B} \approx Q_{\text{nom}} \cdot \sqrt[3]{0.2 \cdot \Delta p_{\text{controller}}}$$

Coding 2 (example SL 3-32 O 16/25...)

The standard version of the spool valve comes with load compensation. Due to the control pressure of the inflow controller (approx. 6 bar), it regulates a constant flow related only to the spool elevation, making its delivery independent of other consumers or system pressure: $Q \approx \sqrt{\Delta p_{\text{controller}}} \cdot A_{\text{valve spool}}$

Coding 26 and 56 (example SL 3-326 J 40/25...)

Symptoms of resonance (audible knocking of the 2-way flow controllers) can be sometimes caused if pulsating consumers e.g. radial or axial piston motors with a low number of pistons are connected.

This is prevented by use of a restrictor check valve combination which delays the closing of the inflow controller. This doesn't harm the characteristic of the functional cut-off or the pressure limiting valves.

Coding 5 (example SL 3-35 H 80/40...)

This version has an increased control pressure enabling higher consumer flows (see also above coding 1 and 2). The pressure of the flow controller is 10 bar resulting in a 1.3 higher flow compared to the standard version (coding 2).

Coding 7 (example SL 3-A 7 J 80/40)

Like coding 5, due to the necessary pressure drop only in combination variable displacement pump / constant pressure system i.e. basically type PSV.

Coding 8 (example SL 3-38 L 63/80...)

To ensure max. flow for all subsequent valve sections, the highest flow rating (80) must be selected for the B side (continuation of P).

Coding R 2, R 5 and R 7

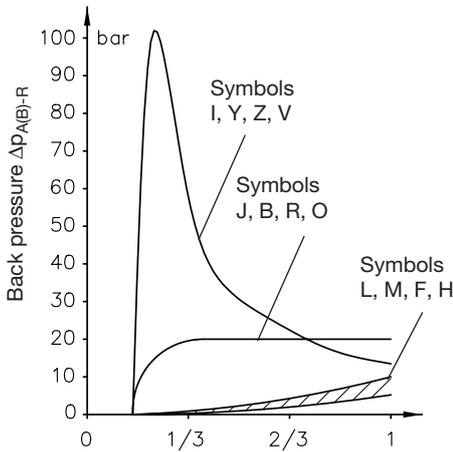
The flow controller acts additionally like a check valve. Thus preventing a reversal of the flow direction in case of starving pump delivery.

c) Flow-pattern variations

Flow pattern symbol J, B, R, O and I, Y, Z, V

Oscillations may occur depending on application during start (e.g. winches) or during normal operation (e.g. crane booms). They can be caused by the natural frequency of the hydraulic motors or external load variations e.g. swinging load. The flow coding (table 15) of the respective spool should correspond to the cylinder ratio as far as possible.

Symbol	Description	Application
J, B, R, O	Creation of a back pressure of approx. 20 bar at 1/3 spool lift and more.	When combined with over-center valves e.g. for boom controls
I, Y, Z, V	Creation of a back pressure of approx. 100 bar for up to 1/3 spool lift	Hydraulic motors (because of pressure rise due to area ratio 1:1), e.g. with cabin slewing



Flow pattern symbol W

This 4/2-way directional spool valve is intended for applications where a constant velocity is required e.g. blower or generator drives. The ability of prop. speed control is restricted, but load independency is ensured via the inflow controller (table 13).

Flow pattern symbol X

This 2/2-way directional spool valve is intended for hydraulic motors (e.g. fan drives) and features maximum speed in idle position. The speed can be reduced proportionally down to dead-halt by energizing the side „b“. The load-independence is provided when combined with an inflow controller (table 13).

Symbols		Available versions:	
X	W	SL 3-W 50/50	
		Coding acc. to table 13	$Q_{max A, B}$ (lpm)
		2	50
		(1)	(67)
5	67		
		SL 3-X 80	
		Coding acc. to table 13	$Q_{max A, B}$ (lpm)
		2	80
(1)	(107)		
5	107		

Flow pattern symbol P, A, T, Q, K

These spools show positive overlap. Type P overlaps in both switching directions, i.e. during elevation of the spool the connection $P \rightarrow A(B)$ is opened before of connection $B(A) \rightarrow R$. This results in an undesired pressure intensification at cylinders (area ratio $\neq 1$), therefore we recommend type A, T, Q or K as these have a one-sided overlapping only. They are intended for consumers such as hydro-motors / double acting cylinders (area ratio 1:1) with righting moments / -forces, as well as at cylinders with drawing loads (area ratio $\neq 1$). A short-term preloading prevents „lowering jolts“ and „running empty“. These valve spools can substitute load-holding valves to a limited extent. It should be taken into account, that a short-term working against the max. system pressure takes place.

Symbols				Available versions:	
I	Y	Z	V	SL 3 - I 6/6	
				I 10/10	
				I 16/16	
				I 25/25	
				I 30/30	
				I 40/40	
				SL 3 - V 6/6	
				V 10/10	
				V 16/16	
				V 25/25	
				V 40/40	
				V 63/63	
				V 80/80	
				SL 3 - Y 45/45	
				Y 60/60	
				SL 3 - Z 25/25	
				Z 45/45	
				Z 60/60	

Symbols				
P	A	T	Q	K

Cylinder area ratio A_{piston}/A_{rod}	Valve spool coding		Example
	Piston side		
= 1		P...	P 40/40
$\neq 1$	connection A	A, T	T 25/16
	connection B	Q, K	Q 40/63

The flow coding for A should be selected higher than for B with spool codings A and T to prevent unintended pressure intensifications (for spool codings Q and K $Q_{nom A} < Q_{nom B}$)

Flow pattern symbol N, NX, G

3/3-way directional spool valve for single acting cylinders

Restrictions:

- there is no load signal triggered via the LS-line
- not ideally suited for solenoid actuated systems fed by constant delivery pump (type PSL), min. pump circulation pressure approx. 11 bar
- Version without outflow controller
- The flow while lowering is only throttled (no flow control functionality) and therefore load-dependent. It is therefore necessary (safety!) to limit the drop rate by a drop rate braking valve e.g. type SB acc. to D 6920

- Available versions: - Symbol N ($Q_A = Q_B$)
(SL 3-) A 2 N 63/63 /EA /4 DW 2 - G 24

(SL 3) - N 3/3

Ancillary block
acc. to table

N 80/80

New type coding and alternatives

Old	New
(SL 3-) 34 N/..	(SL 3-) A 2 N/.. /3 DW ..
(SL 3-) 44 N/..	(SL 3-) A 2 N/.. /4 DW ..

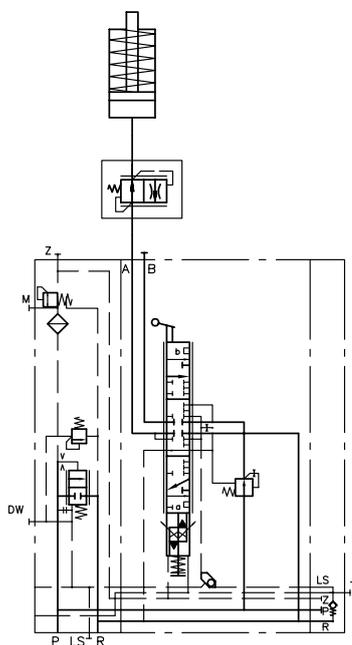
Old	New
(SL 3-) 31 N/..	(SL 3-) 31 G/.. /
(SL 3-) 41 N/..	(SL 3-) 41 G/.. /
(SL 3-) 32 N/..	(SL 3-) 32 G/.. /
(SL 3-) 42 N/..	(SL 3-) 42 G/.. /

- Available versions: - Symbol NX
(SL 3) - NX 25/10
NX 40/16

- Available versions: - Symbol G ($Q_A \geq Q_B$)
(SL 3) - G 3/3

G 80/40

Note: Observe the restrictions regarding symbol G.

**d) Variations for special operation conditions or-requirements****Operation at potentially explosive areas**

Electro-hydraulic actuation (type E or EA) version G 24 EX..., see sect. 3.1.4 table 10 and sect. 4.3

Monitoring of the spool elevation (safety- / switching function)

With contact- or proximity switch for monitoring the idle position of the valve spool (suffix to the types A, C, EA, HA, HEA, PA acc. to sect. 3.2.1 tables 20 and 21 and sect. 4.3)

Maritime climate

The aggressive sea atmosphere requires sufficient corrosion protection of all moving part of the actuators with hand lever. The actuation shaft in the hand lever housing is therefore made of stainless steel as standard. All other parts are either corrosion inhibiting gas nitrated or made of stainless steel. Exception: Housing of pneumatic actuation P or PA which is made of anodized light alloy.

Pressure surges in the return line

Minor leakage may appear at the spring domes of actuators type A, C, E, EA and E0A when excessive pressure peaks (>150 bar) do occur in the return line. This can be prevented by use of enforcement flanges (suffix **G** acc. to table 21 in sect. 3.2.1)

Note: The perm. pressure in the return line is limited to approx. 50 bar (see sect. 4.1). The functionality of the actuation solenoids could be harmed in case of excessive pressure.

e) Use of variable displacement pumps

With Load-sensing controls in alliance with variable displacement pumps, the LS-signal duct for the pump pressure-flow controller (Load-Sensing metering valve) is relieved, to minimize circulation losses during idle position (no consumer flow). This limiting takes place via the proportional spool valves. Without this decompression the pump would have to work during no-lift position with all the remaining flow against the pressure set at the safety valve of the pressure regulator.

As there exist spool valves without this limiting possibility, some brands of pressure-flow controllers have a internal bypass orifice or throttle between LS-signal entrance and decompressed leakage outlet.

In case of the prop. spool valves type PSV this is not necessary and can even cause malfunctions due to lost control oil. The control oil flow is for functional reasons consciously limited (approx. 2 lpm) (slow-motion of the consumer).

Note: Care must therefore be taken, to ensure that a possible bypass orifice in the pressure-flow regulator is plugged!

f) Combination with load-holding valves

It can happen due to exterior variations of load and resonance that the control system starts to oscillate, if three regulation devices, the 3-way flow controller in the pump or the connection block, the 2-way flow controller at the spool valve section plus load holding insert are connected in series. This can be effectively suppressed by systematic use of a bypass orifice and throttle-, check-, pre-load valve combination within the control oil circuit at the load-holding valve type LHDV acc. to D 7770. A similar behavior can be achieved with use of the over-center valves type LHT acc. to D 7918.

g) Combination of more than 12 spool valves

Through the consecutive connection of the LS-signal duct, a total of max. 12 spool valves can be linked. Whether the spool valves are arranged in one or more valve banks is irrelevant. This restriction results from the only limited available oil flow (ensuring slow-motion movements). If more than 12 spool valves in separated directional spool valve banks are to be coupled via the LS-signal, a chaining via external shuttle valves is to be used.

h) Manual 2-axis joy-stick actuation (in preparation)

With one hand lever two adjacent located functions can be actuated simultaneously

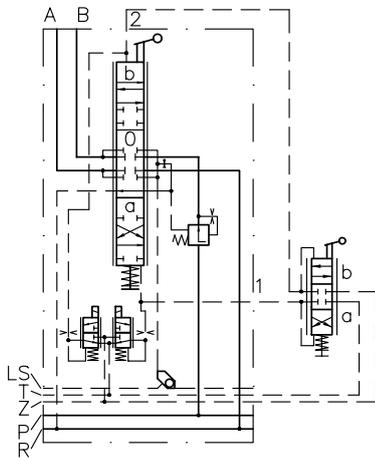
Order designation: PSL 41/250 - 3
- 32 L 80/40/K } joint
- 32 H 80/63/K } actuation
- 32 L 40/25/A-E 1

(combination of manual joy-stick actuation along with a electro-hydraulic actuation on inquiry)

i) Indications of actuation HEA

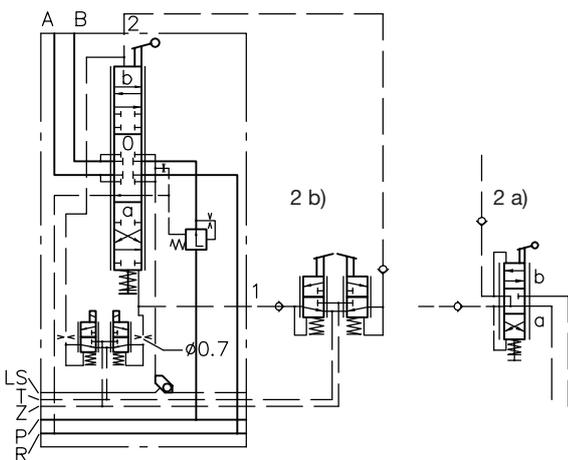
The following notes to the connection of the valve bank have to be observed to ensure a flawless function of the electric and hydraulic actuation.

Combination with hydraulic control devices similar (circuitry acc. to example 1)

Examples 1

Combination with common hydraulic joy-sticks or hydraulic control devices type FB and KFB acc. to D 6600 and D 6600-01 (circuitry acc. to example 2)

The pressure reducing valves integrated in the joy-sticks open the consumer line to the tank during idle position. The control oil flow would escape via this bypass when a valve is simultaneously solenoid actuated. Therefore it is a must to provide check valves for the control lines at this kind of circuitry. The same applies to hydraulic actuations. The used throttles however limit the bypass leakage. The control oil supply must be dimensioned so that this leakage can be compensated (> 0.7 lpm per actuated valve section plus the internal leakage of the hydraulic joy-stick).

Examples 2**j) Optional components****For Electro-hydraulic actuations**

1. Plugs MSD 3-309 standard, belongs to the scope of delivery SVS 296107 Plug with LED's for functional cut-off acc. to sect. 3.2 table 17 (for more details, see D 7163)
2. Electric amplifier EV 22 K2-12(24) acc. to D 7817/1 One board can control two directional valves.
3. Electric amplifier EV 1 M2 acc. to D 7831/1 EV 1 D acc. to D 7831 D A remote control potentiometer with direction switches is required additionally (see detailed information in D 7831/1 sect. 5.2).
4. Logic valve control type PLVC acc. to D 7845 ++
5. joy-stick type EJ 1, EJ 2 and EJ 3 acc. to D 7844
6. Radio controls are accepted, if they fulfill the requirements of SK 7814.

(Approved brands:

Co. HBC-ELEKTRONIK in D-74564 Crailsheim,
Co. HETRONIK Steuer-Systeme in D-84085 Langquaid,
Co. NBB-Nachrichtentechnik in D-75248 Ölbronn-Dürrn,
Co. SCANRECO Industrieelektronik AB, Box 19144,
S-5227 Södertälje, Sweden)

Load-holding valves

Load-holding valves type LHT acc. to D 7918 or type LHDV acc. to D 7770 and note sect. 6.1 f, type LHK acc. to D 7100 only with „very stiff“ systems and directional spool valves without inflow controller (coding 1 acc. to table 15, sect. 3.2.1)

Other valves

Proportional spool valve type PSL(V) size 2 acc. to D 7700-2 (can be combined via intermediate plate ZPL 32 with size 3)
Proportional spool valve type PSL(V) size 5 acc. to D 7700-5 (can be combined via intermediate plate ZPL 53 with size 3)
Proportional spool valve type PSL(V) F size 3 and 5 acc. to D 7700-3 F (manifold mounting spool valves)
Proportional pressure reducing valve type PMZ acc. to D 7625
Hydraulic joy-stick type KFB01 acc. to D 6600-01

k) Connection Block PSV 5../. (previous design)**Attention: Do not use for new system layout!**

The previous version featured a directly actuated pressure limiting valve.

For dimensions, see sect. 5.1 Type PSV 5...!

Alternative: Use type PSV 55..; see table 4 and sect. 5.1 (5.2)

6.2 Circuit examples

The diagrams show a typical valve bank for cranes with hydraulic control.

Example:

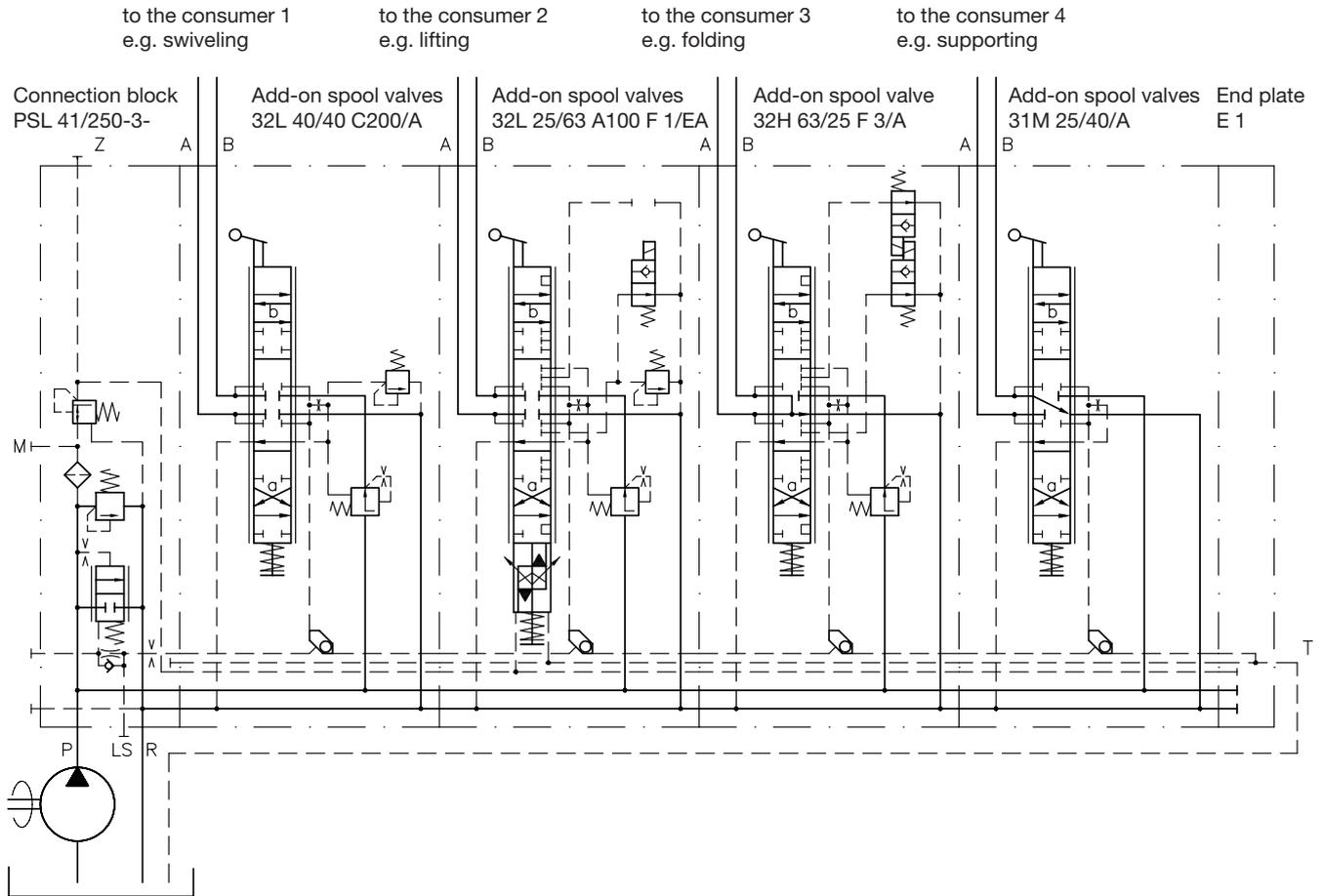
Control by PSL; supply of pressurized oil
by constant delivery pump

PSL 41/250 - 3 - 3 2 L 40/40 C 200/A

- 3 2 L 25/63 A 100 F 1/EA

- 3 2 H 63/25 F 3/A

- 3 2 M 25/40 /A - E 1 - G 24



Example:

Supply with pressurized fluid via variable displacement pump.
Combination of two valve banks installed a differing spots.

PSV 55 S 1/315 - 3

- ZPL 3 V Q 2 - X/3 QV

- A 2 O 63/40 A 220 B 150/EA/3 AL - 6 B 7/250

- A 2 L 80/63/EA/3 AN 320 BN 320

- A 2 H 16/10/EA/3 DRH

- E 5 - G 24

PSV 4 S 1 - 3

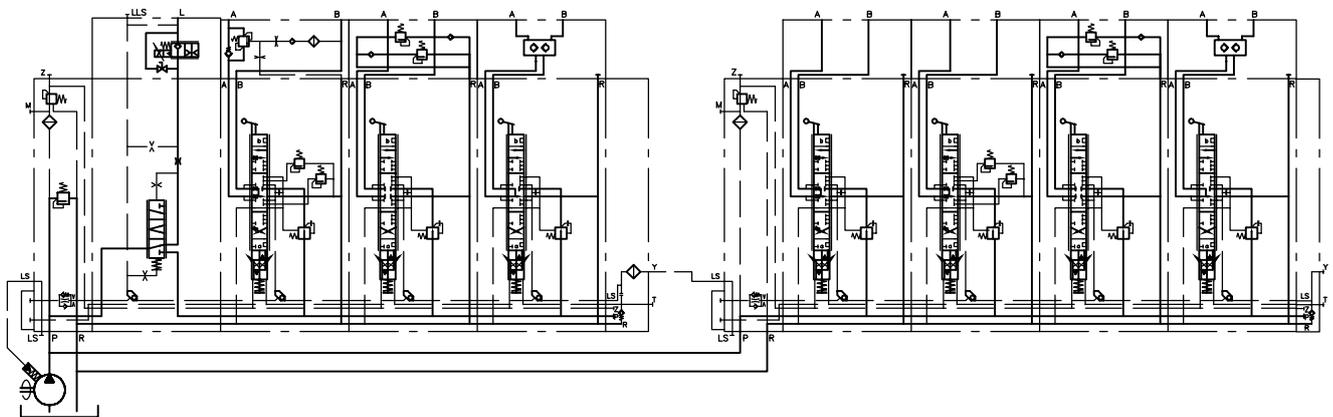
- A 2 O 63/409/EA/3

- A 2 O 63/40 A 260 B 170/EA/3

- A 2 L 25/16/EA/3 AN 320 BN 320

- A 2 H 40/40/EA/3 DRH

- E 4 - G 24



6.3 Notes regarding assembly, installation and conversion

All installation, set-up, maintenance and repairs must be performed by authorized and trained staff.
 The use of this product beyond the specified performance limits, use of non specified fluids and/or use of not genuine spares will cause the expiration of the guarantee.

6.3.1 Mounting

The mounting of the valve bank must be performed in such a way that no stress is induced.
 Three screws and elastic washers between valve assembly and frame are recommended for fastening.
 Silent-bloc A 2510 55WR (M8x20)
 Co. FREUDENBERG Deutschland
 Part No. 509067

6.3.2 Piping

All fittings used must utilize deformable seal materials.
 Do not exceed the specified torque!

6.3.3 Notes for converting the connection block

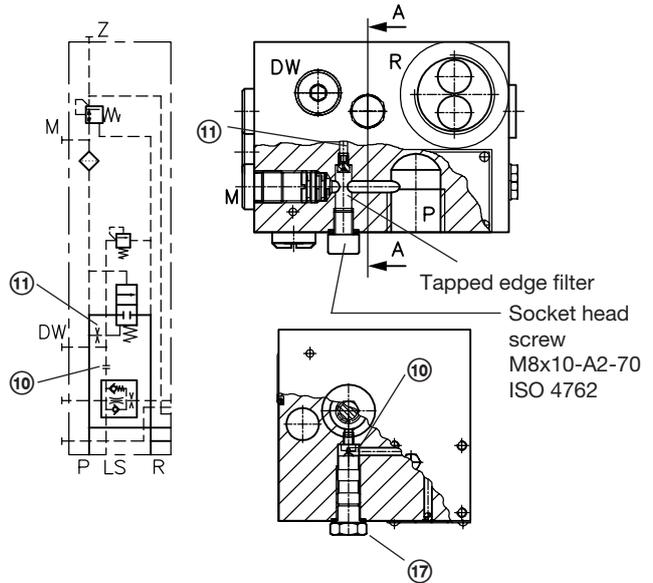
The connection block type PSL 5...-3 or PSL UNF 4...-3 can be converted any time into a connection block for variable displacement pump systems (correct type then PSV 55 S...-3 or PSV UNF 344 S...-3). This requires replacing the parts listed below.
 Does not apply to type PSV 5 N

Attention: The screw (parts No. 6380 013) ⑩ or carburetor jet M4x0.6 ⑪ are secured with liquid screw lock, which must be applied again when replacing these parts.

This conversion cannot be carried out at the type PSL 5 U(H) since the integrated free switching valve forbids a combination with variable displacement pump systems.

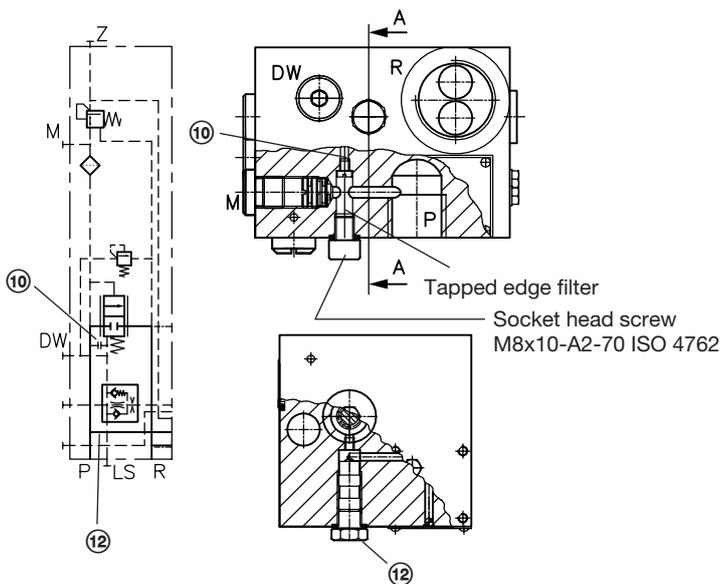
It is necessary to replace the tapped plug (parts No. 7778 036) by the damping screw S (parts No. 7778 301) ⑫, while converting a type PSV to type PSL (does not apply to type PSV 55 S...-3 and PSV UNF 44 S...-3; as these are already equipped with it).

Type PSV 55 S 1./...-3



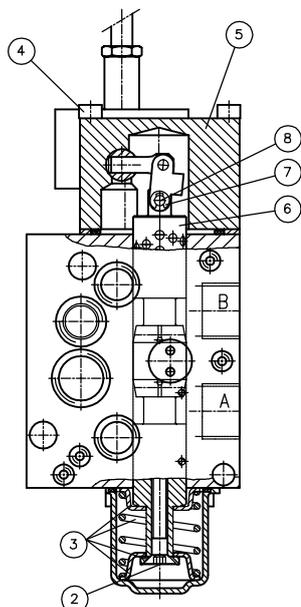
- ⑩ The screw (parts No. 6380 013)
- ⑪ Carburetor jet M4x0.6
- ⑫ Dampening screw (parts No. 7778 301)
- ⑰ Tapped plug G 1/8 A NBR

Type PSL 5./...-3



6.3.4 Notes on changing the spool

The valve spools are not mated to one spool housing. Therefore valve spools can be changed at any time to adapt to changing consumer consumption. The following routine is to be followed particularly:



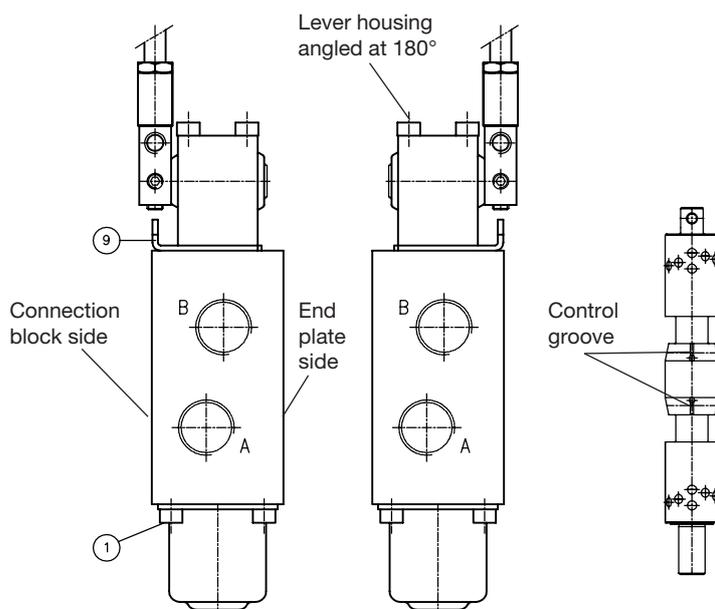
Indications for angling the lever housing by 180° (inversion of the shifting mode)

As set out in 1. - 7. above, however instead of a new valve spool the existing one has to be disconnected, angled at 180° and remounted (see above mentioned note). The intermediate plate ⑨ together with the lever housing, have to be angled at 180°.

All lever housings of the valve bank have to be rotated!

6.3.5 Seal kits

Connection block	DS 7700-31
Valve section	DS 7700-32
In addition for pneumatic actuation	DS 7700-33
Intermediate plate ZPL 32	DS 7700-22



Advice on changing the valve spool

1. Slacken screws ① (ISO 4762-M5x8-8.8-A2K), remove spring cover
2. Remove screw ② (M 6x40, machined flat head screw drawing No. 7709 042)
3. Remove spring assembly including spring cap ③
4. Slacken screws ④ (ISO 4762-M5x50-8.8-A2K)
5. Lift lever housing including spool out of spool housing, drawing ⑤ ⑥
6. Remove circlip DIN 6799 3,2 and remove bolt ⑦ ⑧
7. Assemble with (new) spool in reverse sequence

Attention: The control grooves of the valve spool should always be installed towards the end plate!
Exception: Valve spools with flow coding 80 do not show control grooves.