Proportional directional spool valve type PSL, PSM, and PSV according to the Load-Sensing principle size 5 (valve bank design)

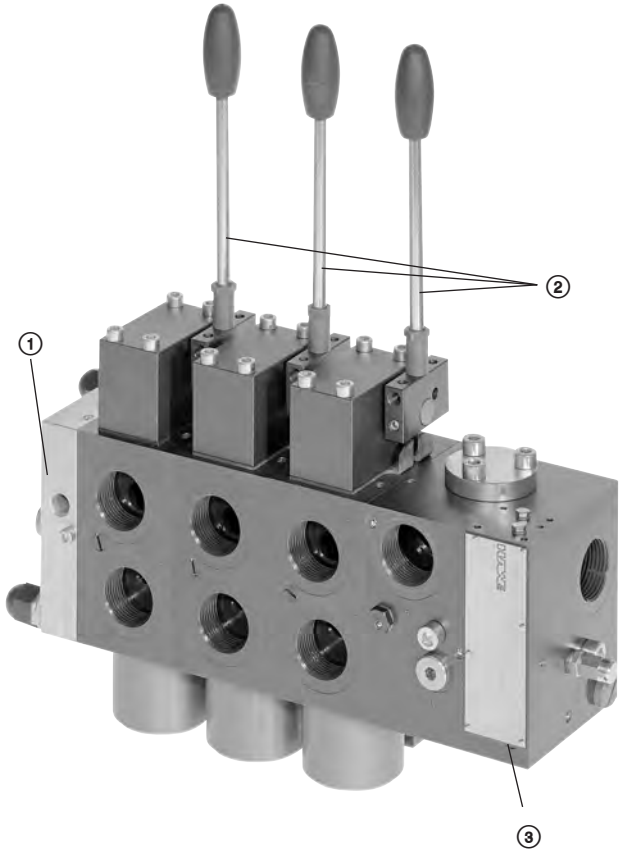
1. General

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. The proportional spool valves of this pamphlet are designed as valve banks and consist of three functional groups:

Basic data

Design	Proportional directional spool valve according to the Load-Sensing principle
Versions	Valve bank design
Pressure p_{max}	400 bar
Flow Q_{max}	160 (240) lpm

Table of contents



Further technical information:

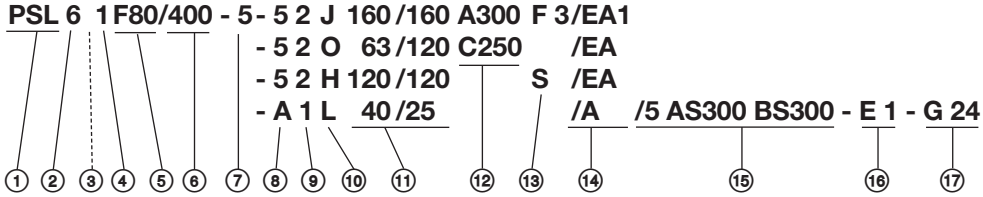
Size	Design	Pamphlet
2	Valve bank design	D 7700-2
2	Valve bank design (CAN onboard))	D 7700 CAN
3	Valve bank design	D 7700-3
3, 5	Manifold mounting design	D 7700-F
7	Manifold mounting design	D 7700-7F

Mounting

① End plate
② Directional spool valve
③ Connection block

2. Type coding, overview

Order example: (For additional examples, see also sect. 6.2)



A total of max. 10 valve sections, in one or more valve bank(s), can be connected in series via the internal LS-duct. External piping is required, if more are requested (see also note at sect. 6.1g).

① Basic type code for the connection block (for more details see sect. 3.1)

- **PSL** Supply with pressurized oil by means of constant delivery pump (open center).
- **PSV** Supply with pressurized oil by means of variable displacement pump with a delivery /flow controller (closed center), as a second, separate unit, or if both valve banks are connected to a constant pressure system.
- **PSM** Supply of pressurized fluid either via constant delivery or variable displacement pump. For external circuitry, see sect. 3.1)

② Ports at the connection block for P and R

- **5** G 1 (ISO 228/1) (BSPP)
- **6** G 1 1/4 (ISO 228/1) (BSPP)
- **UNF 6** 1 5/8-12 UN-2B (SAE-20, SAE J 514)

③ Additional elements (see table 2 and 4 in section 3.1)

- (no coding) Basic version
- **S, W** Additional damping device in gallery LS
- **B, B 4...7** Orifice in gallery LS
- **G** Restrictor check valve
- **H** Raised circulation pressure of the 3-way flow controller (approx. 14 bar, type PSL)
- **U, UH** Automatic reduction of the pump idle circulation pressure by means of a by-pass valve (only type PSL)
- **Y, YH** Separate, pressure resistant port for the excess oil from the 3-way flow controller (type PSL)
- **N** function integrated for the P gallery, (only type PSV)

④ Control oil supply (see table 7, sect. 3.1.4)

- (no coding) Without pressure reducing valve, if control oil is supplied externally (min. 20 bar up to max. 40 bar)
- **1** With integrated pressure reducing valve for the internal supply with control oil
- **2** With integrated pressure reducing valve for the internal supply with control oil (control pressure approx. 40 bar).

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
- **F, Z, ZM** De-energized open = Idle pump circulation when valve is de-energized (with valve WN 1F or EM 21 DSE)
- **D, V** De-energized closed = Idle pump circulation when valve is energized (with valve WN 1 D or EM 21 DE)
- **F...** or **D** If a pressure is specified, with pressure limiting valve which can be activated as a second pressure stage (e.g. F80)
- **PA, PB, PD** Prop. pressure limiting valve with various pressure ranges

⑥ Tool adjustable, piloted pressure limiting valve (main pressure limitation) in the connection block (see table 9, sect. 3.1.4)

- (no coding) Without pressure limiting valve (only type PSV)
- **/...** Pressure limiting valve, factory set to ... bar

⑦ Size (dep. on the hole-pattern of the mounting area for the spool valves to be added)

- **5** Size 5 (for size 2, see D 7700-2) (for size 3, see D 7700-3)

⑧ Ports at the directional spool valve for A and B

- **5** G 1 (ISO 228/1)
- **A** Suited for mounting of ancillary blocks acc. to ⑮ or

Add-on intermediate plates (see sect. 3.2.2) Position ⑨ ... ⑭ are omitted

- **ZPL 5 S(V)/H** Hydraulically actuated shut-off valve
- **ZPL 5 S(V)/E** Solenoid actuated shut-off valve
- **ZPL 5 P6 R6** Additional pump and return port G 1 1/4 (BSPP)
- **ZPL 55/9** Spacer plate 9 mm
- **ZPL 50 T..** Blocking intermediate plate

⑨ Directional spool valve (see table 13, sect. 3.2.1)

- **2** (standard) Spool valve with inflow controller for each consumer
- **1** Spool valve without inflow controller, suitable for consumers, which are actuated individually and successively but not simultaneously (no additional functions possible)
- **5, 7** Inflow controller with enforced spring for higher flow
- **8, 81** 4/3-way directional spool valve (pre-selector spool valve)
- **R 2, R 5, R 7** like 2, 5, 7 but with check valve function

⑩ Coding for the flow pattern (see sect. 3.2.1, table 14)
L, M, F, H, J, B, R, O, Y, I, Z, G, V, W

⑪ Flow coding for ports A and B (see table 15, sect. 3.2.1)

- **.../...** Coding for port A or B (independently selectable) **16, 25, 40, 63, 80, 120, 160**

⑫ LS-pressure limitation (deviating from the main pressure setting, lower pressure for the connected consumer) no shock valves (see sect. 3.2.1, table 16) (doesn't apply to spool valve types without inflow controller)

- (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 ⑬ **F.** or **S.**)

⑬ Functional cut-off (see table 17, sect. 3.2.1), doesn't apply to spool valve types without inflow controller,

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	External load pressure pick-up via control port X (common for A and B)

⑭ Types of actuation (see sect. 3.2.1, table 20)

/A	Manual actuation
/E	Electro-hydraulic actuation
/EA	Electro-hydraulic and manual actuation
/E0A	Like /EA, however without actuation solenoid (prepared for retrofitting)
/H	Hydraulic actuation
/H UNF	Like /H, however with port thread 7/16-20 UNF-2B SAE-4 (conf. SAE J 514)
/HA, /HEA, /FA	Hydraulic, (solenoid) and manual actuation
/HA UNF	Like /HA, however with port thread 7/16-20 UNF-2B SAE-4 (conf. SAE J 514)
/C, AR	Detent (stepless), 3-step detent
/ER, /EAR	Electrical, 3-step detent
/P	Pneumatic actuation
/PA	Pneumatic and manual actuation
/K	Mechanical joy-stick (2-axis)

/... Suffix	**1** without hand lever
WA, WA-EX	Integrated travel indicator
U	Lift monitoring (side indication)

⑮ Ancillary blocks (acc. to table 19 in sect. 3.2.1), into combination with coding A of ⑧

/5, /UNF 5	Ancillary blocks without additional functions
/5 AS.. BS..,	Ancillary blocks with shock valves at A
/UNF 5 AS.. BS..	and B (routed to the opposing side), with pressure specification (bar)
/5 AN.. BN..	Ancillary blocks with shock and suction
/UNF 5 AN.. BN..	valves at A and B, with pressure specification (bar)
/4 ASN.. BSN..,	With shock and suction valves A or B
/5 AN.., /5 BN..	
/5 AL..	Ancillary blocks with over-center valves at A, with pressure specification (bar)
/5 BL..	Ancillary blocks with over-center valves at B, with pressure specification (bar)
/5 VV(VX, XV)	Ancillary blocks with blocking function via EM 42 V
/UNF 5 VV(VX, XV)	Ancillary blocks with shut-off valves EM 42 V acc. to D 7490/1 (one or both sided) blocking the consumer with zero leakage (Q_{max} approx. 160 lpm)
/5 DRH, **/UNF 5 DRH**	Ancillary blocks with releasable check valves
/54 DFA, **/54 DFB**	Ancillary blocks for re-generative circuit
/54 DEA, **/54 DEB**	Ancillary blocks switch able regenerative circuit
/5 R VV	Ancillary blocks with Bypass-valves

Intermediate plates (acc. to table 11, sect. 3.2.1)

/Z 30	Spacer plate

⑯ End plate (see sect. 3.1.5, table 11)

E.	Ports conf. ISO 228/1 (BSPP)
E. UNF	Ports conf. SAE-4 acc. to SAE J 514
E 1	With T-port for external control oil return to the tank (standard)
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	Like E 1, however internal return control oil return, max. pressure 10 bar!
E 5	Like E 2, however internal return control oil return, max. pressure 10 bar!
E 6	Like E 3, however internal return control oil return, max. pressure 10 bar!
E 7 with **E 16**	Variations, see table 11, sect. 3.1.5
E 7 A 1(2)	Like E 1, however with additionally integrated pressure reducing valve (control pressure: **1** = approx. 20 bar, **2** = approx. 40 bar) similar connection block, see table 6 in sect. 3.1.3
E 8 A 1(2)	Like E2, however with additionally integrated pressure reducing valve (control pressure: **1** = approx. 20 bar, **2** = approx. 40 bar) similar connection block, see table 6 in sect. 3.1.3
E 1(E 4) PSV 56 **E 1(E 4) PSL 56**	(Additional) inlet section instead of the end plate

ZPL 53, **ZPL 53 RB**	Adapter plate enables combination with valve sections size 3 acc. to D 7700-3
ZPL 52	Adapter plate enables combination with valve sections 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, conforming
G 24 TEX 70	24V DC, explosion-proof version, conforming (ambient temperature 70°C)
G 24 MSHA	24V DC, explosion-proof version, conforming, fire-damp protected (mining)
G 24 M2 FP	24V DC, explosion-proof version, conforming, fire-damp protected (mining) (Australien)
G 12 IS	12V DC, explosion-proof version, conforming, fire-damp protected (mining)
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 (acc. to 3.1.3)

Order coding for a connection block as individual section (examples): **PSL 61 F/250 - 5 - G 24**
(**Attention:** Size specification absolutely necessary, here **-5**) **PSV 51 - 5**

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

Order example: **PSL 5** 1 F 0/350-5 -...- E 1 - **G 24**
PSL 6 U H 1 F/300-5 -...- E 1 - **G 24**

see table 2 — see table 10

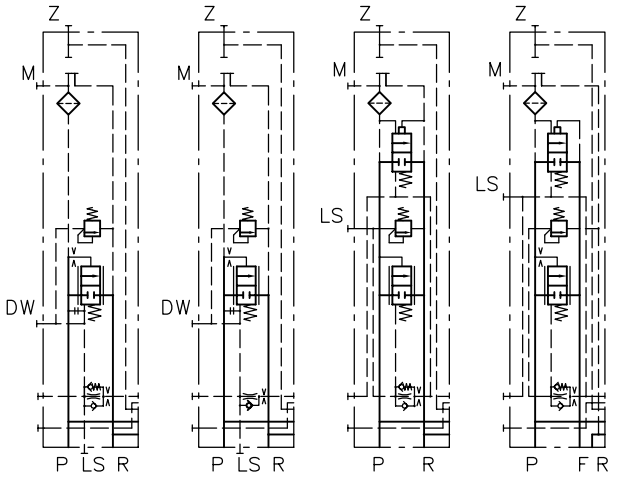
Table 1: Basic type and port size

Coding	Port P and R conf. ISO 228/1 (BSPP) or SAE J 514	Max. pump delivery flow (lpm)	Description
PSL 5	G 1	250	**Standard**, integrated 3-way flow controller, can be converted in a version for variable displacement pumps (corresponding type PSV) any time, see sect. 6.3.3
PSL 6	G 1 1/4	300	
PSL UNF 6	1 5/8-12 UN-2B (SAE-20)	300	
PSL 5 U	G 1	250	Automatic reduction of the idle pump circulation pressure by means of a by-pass valve (see also sect. 6.1a, $Q_{pu} \geq 150$ lpm with solenoid actuation)
PSL 6 U	G 1 1/4	300	
PSL 6 Y	G 1 1/4	300	Additional pressure resistant port for excess of from the 3-way flow controller (see also sect. 6.1a). This version also includes the by-pass valve like with type PSL 5(6) U
Note:	A spacer plate type SL 5-ZPL 55/9 (see table 22, sect. 3.2.2) has to be installed right after the connection block whenever type PSL 5(6), PSV 5(6) and PSM 6 is combined with a valve section with ancillary block (coding SL 5-A.. acc. to table 12 and 19) as otherwise it is not possible to mount a fitting in port R.		

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

Coding	Description
no coding	**Standard** Featuring a combination of orifice, check valve, pre-load valve (pre-load pressure approx. 25 bar)
W	Like standard, but with increased throttle effect
G	Restrictor check valve (without sequence valve), increased throttling effect
H	Coding for 3-way flow controller with raised circulation pressure (see sect. 4.2), otherwise similar flow pattern symbol as the standard version. Intended e.g. for valve spools with increased flow (coding 5 acc. to table 15)

Flow pattern symbols
(see also sect. 3.1.4)



PSL 5(6)./..
PSL UNF 6./..
PSL..G./..
PSL 5(6)U./..
PSL 6 Y./..

3.1.2 Connection blocks for variable displacement pump systems / constant pressure system or for other more separately, parallel connected directional spool valve banks type PSV

Order example: **PSV 6 S** 1 - 5 -...- E 1
PSV 5 1 F/300 - 5 -...- E 1 - **G 24**

- G 24 — Nominal voltage, see table 10
- 1 F/300 — see table 4
- PSV 5 / PSV 6 S — see table 3

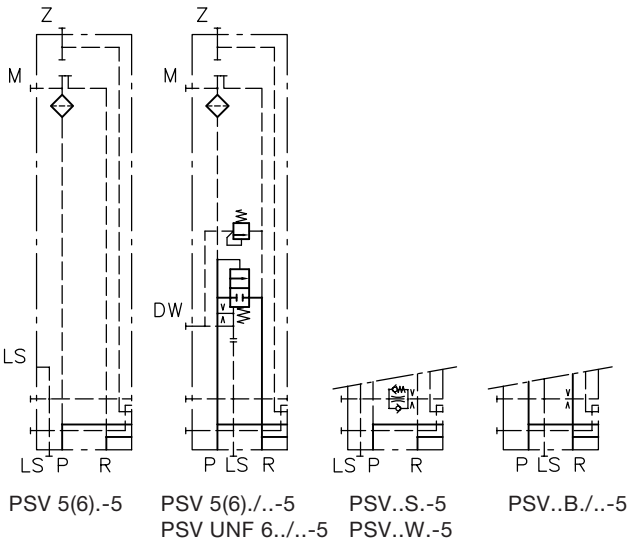
Table 3: Basic type and port size

Coding	Port P and R conf. ISO 228/1 (BSPP) or SAE J 514	Max. pump delivey flow (lpm)
PSV 5	G 1	approx. 250
PSV 5 N	G 1	approx. 300
PSV 6	G 1 1/4	approx. 300
PSV UNF 6	1 5/8-12 UN-2B (SAE-20)	approx. 300

The connection blocks type PSV 5, PSV 6 and PSV UNF 6 featuring a pressure limiting valve, may be converted any time into type PSL (standard) see pos. 6.3.3

Note: A spacer plate type SL 5-ZPL 55/9 (see table 22, sect. 3.2.2) has to be installed right after the connection block whenever type PSL 5(6), PSV 5(6) and PSM 6 is combined with a valve section with ancillary block (coding SL 5-A.. acc. to table 12 and 19) as otherwise it is not possible to mount a fitting in port R or LS (PSV 5 N).

Symbols (see also sect. 3.1.3)



PSV 5(6).-5 | PSV 5(6)./..-5 PSV UNF 6../..-5 | PSV..S.-5 PSV..W.-5 | PSV..B./..-5

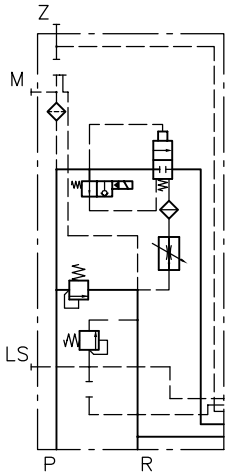
Divergent type coding at type PSV 5 N

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

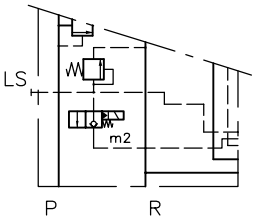
- 350/310 — LS-pressure limitation (bar)
- 300/270 — Main pressure limiting valve (bar)
- Z — LS-relief, arbitrarily activated, (see table 3a)
- S — table 7
- S — Damping device (acc. to table 4) necessary

Symbols

PSV 5 N..-



PSV 5 N..V.../...



PSV 5 N..Z.../...

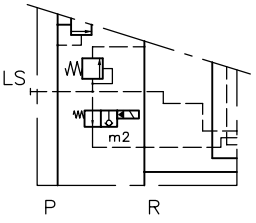


Table 3 a: LS-relief

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.

Table 4: Codings for features within the LS-signal duct to dampen the 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). See also note at table 8 !

Coding	Description
no coding	**Standard,** no additional feature
S	Integrated combination of orifice, check valve, pre-load valve (pre-load pressure approx. 25 bar); like standard with type PSL
W	Like S, however increased throttle effect
B	Orifice ∅ 0.8 mm within LS-duct (to limit control oil flow).
B 4, B 5, B 6, B 7	Orifice ∅ 0.4 mm, 0.5 mm, 0.6 mm or 0.7 mm within 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.

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

Order example: **PSM 6.**1 F/200 - 5 -...- E 5 - **G 24**

see table 6 — see table 10

Table 5: Basic type and port size

Coding	Ports P and R acc. to ISO 228/1 (BSPP) or SAE J 514	Max. pump delivery flow (lpm)
PSM 6	G 1	approx. 300
PSM UNF 6	1 5/8-12 UN-2B (SAE-20)	approx. 300

Note: A spacer plate type SL 5-ZPL 55/9 (see table 22 sect. 3.2.2) has to be installed right after the connection block whenever type PSM 6 is combined with a valve section with ancillary block (coding SL 5-A.. acc. to table 12 and 19) as otherwise it is not possible to mount a fitting in port R.

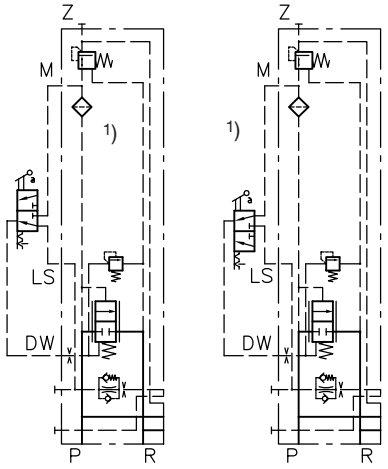
Table 6: Coding for additional elements

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)

Flow pattern symbols (see also sect. 3.1.4)

Connection appropriate for constant delivery pump systems

Connection appropriate for variable displacement pump systems



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

3.1.4 Additional elements for the connection blocks

Order example:

PSL 6. **1 F 100 /380** - 5 - ... - E 1 - G 24
PSV 5. **1 F /350** - 5 - ... - E 1 - G 24

see table 10
see table 9
see table 8
see table 7

Table 7: Coding for control oil supply (for symbol, see sect. 3.1.1, 3.1.2 and 3.1.3)

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 5 N..-5** !

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
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

Coding	Description
PA, PB, PD	Prop. pressure limiting valve enables variable adjustment of the system pressure range: 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, 3.1.2 and 3.1.3).

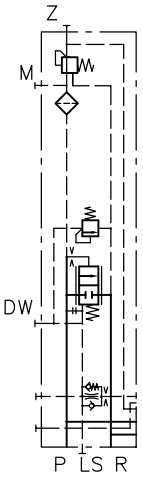
Coding	Description
no coding	Version without pressure limiting valve (only type PSV)
/...	With pressure limiting valve at PSL and PSV, if pressure specification in bar is added non piloted: PSV 5 N piloted: All others

Table 10: Solenoid voltage and version

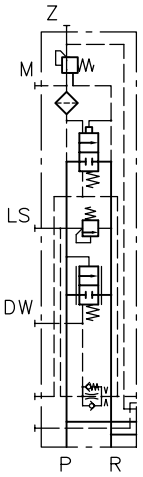
Coding	Description
G 12 . **G 24T** └ without **T** **TH** **H 4**	Electr. connection conf. EN 175 301-803 A, via plug (MSD 3-309) Suffix: Applies only to the solenoid actuation coding E, EA, HEA, FEA (table 20) and the functional cut-off (coding F, FP, table 17), see also sect. 4.3 Actuation solenoid 3-pin (standard) Manual emerg. actuation (standard with functional cut-off F., FP., see table 17) Manual emerg. actuation with pushbutton (standard with functional cut-off FPH.., FP., see table 17) Actuation solenoid 4-pin (only 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** **TEX** **EX4** **TEX4**	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 (fire-damp protected), 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) with cable length 3 m (no coding) or 10 m
G 24 M2 FP **G 24 M2 FP-10 m**	For use in mines and its on-surface systems, where a IEC or ANZE (Australien) approval is mandatory. Protection class I M2 Ex d I (fire-damp protected) with cable length 3 m (no coding) or 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 M2 FP.
- 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 5 S(V)E (table 22), end plates E 3, E 6 (table 11), 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)

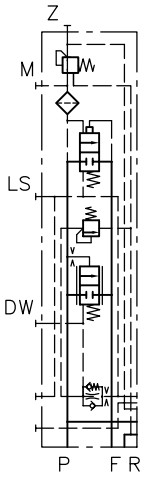
Symbole



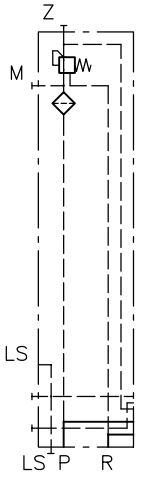
PSL 5(6).1./..-5
PSL UNF 6.1./..-5



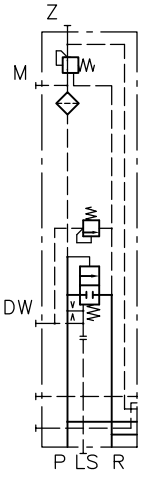
PSL 5(6)U.1./..-5



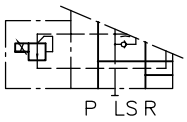
PSL 6 Y.1./..-5



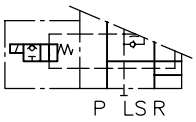
PSV 5(6).1.-5



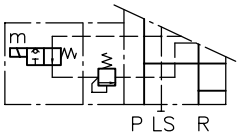
PSV 5(6).1./..-5
PSV UNF 6.1./..-5



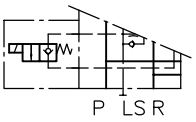
PSL(V)..PA(PB, PD)



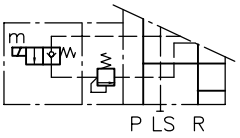
PSL(V)..F
PSL(V)..Z
PSL(V)..ZM



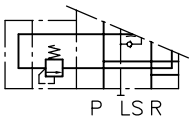
PSL(V)..F..



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



PSL(V)..D..



PSL(V)..X

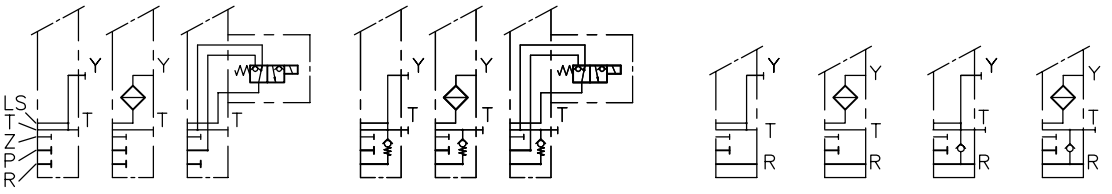
3.1.5 End plates

Order example: PSL 51 F 100/380 - 5 - 52.. - **E 1** - G 24

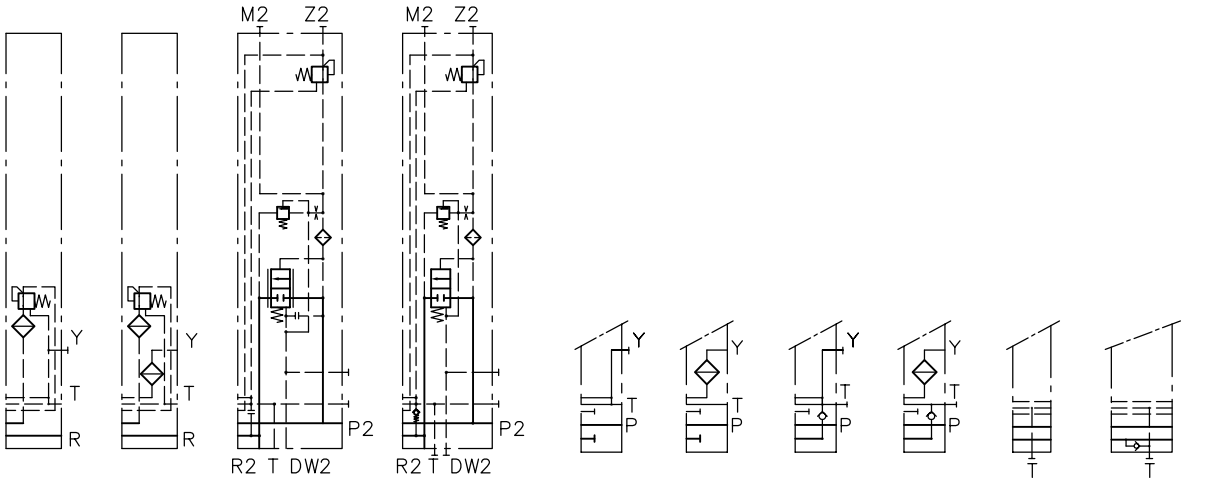
Table 11: End plates

End plate: External port T (separate return pipe to the tank)	End plate: Internal control oil return gallery	Ports	Description Order coding of an end plate as individual part (example): **SL 5 - E 1** **SL 5 - E 6 - G 24** **SL 5 - ZPL 52**
E 1 **E 1 UNF**	**E 4** **E 4 UNF**	ISO 228/1 (BSPP): T, Y = G 1/4 P = G 1 R = G 1 1/4 SAE J 514 (E.. UNF): T, Y = 7/16-20 UNF-2B (SAE-4) P, R = 1 5/16-12 UN-2B (SAE-16)	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**		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 acc. to D 7470 A/1
E 7	**E 9**		Like E 1/E 4, but with additional port R
E 8	**E 10**		Like E 2/E 5, but with additional port R
E 13 **E 13 UNF**	**E 15** **E 15 UNF**		Like E 1/E 4, but with additional port P
E 14 **E 14 UNF**	**E 16** **E 16 UNF**		Like E 2/E 5, but with additional port P
E 7 A 1 **E 7 A 2** **E 8 A 1** **E 8 A 2**	**---**		E 7 A. like E 1 and E 8 A. like E 2, but with additionally integrated pressure reducing valve (control pressure: **1** = approx. 20 bar, **2** = approx. 40 bar). Intended for applications where the control pressure has to be maintained (e.g. to achieve a defined trigger pressure). The control pressure is influenced by the backpressure in the return with the standard version (control oil supply via the connection block).
ZPL 53	**ZPL 53 RB**	T = G 1/4	Adapter plate to continue a prop. direct. valve bank size 5 with sections of size 3
ZPL 52	**---**		Adapter plate to continue a prop. direct. valve bank size 5 with sections of size 2
E 1 PSL 56.. **E 1 PSV 56..**	**E 4 PSL 56../..** **E 4 PSV 56../..**	P_2 = G 1 R_2 = G 11/4	End plate with additional connection block functionality, see table 1 and 3, sect. 3.1.1 and sect. 3.1.2. Intended as additional inlet section or as dual circuit when combined with intermediate plate ZPL 50 T.. acc. to table 22, the LS-signal has to be routed externally from the connection block (type E. PSL 56) or the intermediate plate (type ZPL 50 T) to port DW 2.
Note: The internal control oil return line has to be used only at systems where the return pressure does not exceed 10 bar			

Symbole



E 1 E 2 E 3 E 4 E 5 E 6 E 7 E 8 E 9 E 10
E 1 UNF E 4 UNF



E 7 A 1 E 7 A 2 E 8 A 1 E 8 A 2 E 1 PSL 56 E 4 PSV 56 E 13 E 13 UNF E 14 E 14 UNF E 15 E 15 UNF E 16 E 16 UNF ZPL 53 ZPL 52 ZPL 53 RB

3.2 Add-on spool valves

3.2.1 Directional spool valve

Order example: PSV 61/380 - 5 - **5 2 L 160/80 A300 F 1** /EA - E 1- G 24

- see table 12
- see table 13
- see table 14
- see table 15
- see table 16
- see table 17 and 18

Order code for single section (examples):

Directional spool valve **SL 5-52 J 80/40 F 2/EA-G 24**

Valve spool (individual) **SL 5 - J 120/40**

Note: Size specification absolutely necessary, here SL 5 ! 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	Ports
5	G 1 (ISO 228/1) (BSPP)
A	With ancillary blocks acc. to table 19
Note:	A spacer plate type SL 5-ZPL 55/9 (see table 22, sect. 3.2.2) has to be installed right after the connection block whenever type PSL 5(6), PSV 5(6) or PSM 5(6) is combined with a valve section with ancillary block (coding SL 5-A.. acc. to table 12 and 19) as otherwise it is not possible to mount a fitting in port R.

Table 13: Spool valve; basic unit

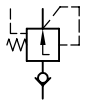
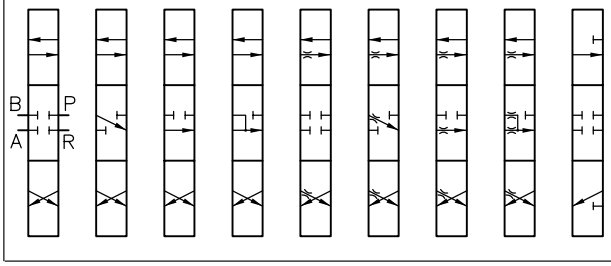
Coding	Features, description
2	**Standard,** with inflow controller, for simultaneous load compensated moving of several consumers (3/3-, 4/3-way spool valve, standard type)
1	Without inflow controller intended for singly / successively actuated functions. Additional functions on the consumer side are not possible. For the max. consumer flow of the indiv. consumer, see table 15, and sect. 6.1b)
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 (for symbol, see coding 2) but with reinforced spring at the 2-way flow controller (control pressure approx. 13 bar). Only usable in combination with connection block type PSV with variable displacement pump / constant pressure system. (For note, see sect. 6.1b)
8	4/3-way directional spool valve, utilized as pre-selector (also, see symbol page 13), only available with ports G 1*, (acc. to table 12) coding -58. This version is only recommended with flow coding L or H and max. flow. Only usable in conjunction with connection block type PSL.H../... or type PSV with variable displacement pump / constant pressure system. (* = BSPP) (For note in sect. 6.1c)
81	Like coding 8, but without LS-input from consumer port B to the main LS-gallery (For note in sect. 6.1b)
82	Like coding 8, but without shuttle valve. The LS-signal for subsequent valve sections is gnerated at the P-gallery (For note in sect. 6.1b).
R 2 **R 5** **R 7**	Like coding 2, 5, 7, but with additional check valve functionality (spool valve = slight leakage), (For note in sect. 6.1b) Only usable in conjunction with connection block type PSL.H./... or type PSV with variable displacement pump / constant pressure system. 

Table 14: Symbole

L	M	F	H	J	B	R	O	G



J, B, R, O, I, Y, Z, V	Spool with return flow throttling to support the oscillation damping (observe note in sect. 6.1c)
G	3/3-way spool valve (observe note in sect. 6.1c)
W	4/2-way spool valve (observe note in sect. 6.1c)
HW, OW	Valve spool with wider fitting to prevent spool sticking - intended for contamination prone systems

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

Valve spool coding acc. to table 13	Flow coding $Q_{A,B}$ (lpm) at consumer port A and B [1]						
	16	**25**	**40**	**63**	**80**	**120**	**160**
2	16	25	40	63	80	120	160
1	20	32	51	80	110	150	210
	Valid for PSL (integrated 3-way flow controller Δp ~ 9 bar) otherwise as guide line $Q_{A,B} \approx Q_{nom} \cdot \sqrt{0.2 \cdot \Delta p_{controller}}$ Q_{nom} - Nom. flow with coding 2 $\Delta p_{controller}$ Stand-by-pressure of the pump controller Example: Q_{nom} = 120 lpm, $\Delta p_{controller}$ = 14 bar $Q_{A,B} \approx$ 200 lpm (guideline)						
5	20	32	51	80	110	150	210
7	23	37	60	95	130	175	240
8, 81, 82	like coding 1 (only for port A)						

The consumer flow for ports A and B can be selected freely and independently e.g. 63/40, 40/80. This allows tailoring the flow exactly to the respective requirements while still maintaining the full functional stroke. Additional there is the possibility of a stroke limitation.

Table 16: LS-pressure limiting valves, no shock valves (only availably for spool valves featuring a inflow controller, coding 2, 5 and 7 acc. to table 13 !)

Coding	Description
no coding	Without pressure limitation
A...	Pressure limitation at A with pressure specification
B...	Pressure limitation at B with pressure specification
A...B...	Pressure limitation at A and B with pressure specification
C...	With manual short-cut valve between A and B as well as drain valve for A or B to the tank

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

Table 18: Possible combinations of the additional functions, see page 12

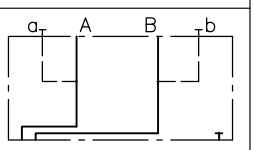
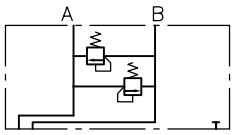
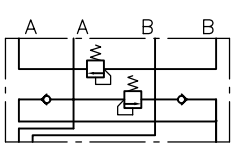
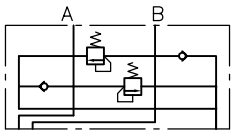
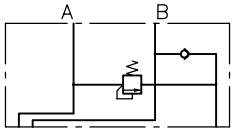
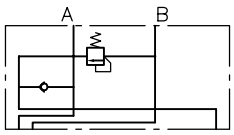
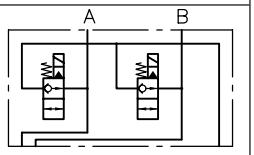
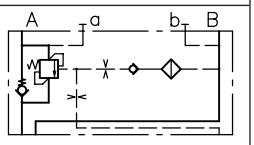
Pressure limitation	Functional cut-off			
	no coding	**S S 1**	**X**	**F 1, F 2, F 3 FP 1, FP 2, FP 3 FPH 1, FPH 2, FPH 3**
no coding	●	●		●
A or B A and B	●	●	●	●
C	●	--	--	--

Tabelle 17: Functional cut-off (only avail. for spool valves with inflow controller coding 2, 5 and 7 acc. to table 13!) Not in combination with flow pattern symbol N!)

Coding	Description
no coding	Without functional cut-off
S, S 1	Load signal ports U and W (G 1/8) (BSPP) for external piping
X	Common load pressure signal port (G 1/8) (BSPP) for an external activation, only in combination with coding 5 (G 1 (BSPP), table 12)
FP 1, FP 2, FP 3 FPH 1, FPH 2, FPH 3	Like F1, F2, F3 but add. prop. pressure limitation at A or B as well as A and B, version FPH. with additional pushbutton for manual emergency actuation without tool
F 1, F 2	Electric functional cut-off at A or B
F 3	Electric functional cut-off at A and B

There remains a residual pressure when the LS gallery is relieved. When the return line is depressurized the residual pressure will be:
prelieved = Δp_{block} + $\Delta p_{controller}$ ($\Delta p_{controller}$ = control pressure of the inflow controller acc. to table 13)
Coding F., FP. : Δp_{block} = 10 bar
Coding S, S 1 : Δp_{block} = 5 bar
Coding X : Δp_{block} = 1 bar

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

Coding	Brief description	Symbols
/5 **/UNF 5**	Without additional functions	
/5 AS... BS... **/UNF 5 AS... BS...**	With shock at A and B, with pressure specification (bar)	
/4 ASN.. BSN..	With shock valves at A and B (routed to the opposing side), with pressure specification (bar)	
/5 AN.. BN.. **/UNF 5 AN... BN...**	With shock and suction valves at A or B, with pressure specification (bar)	
/5 AN..	With shock and suction valves at A and B, with pressure specification (bar)	
/5 BN..		
/5 R VV	With by-pass valves type EM 22 V acc. to D 7490/1 for arbitrary customer relieve. **Note:** Q_{max} = 40 lpm	
/5 AL.. **/5 BL..**	With over-center valves at A or B. (For more details, see D 7918 type LHT 5)	

- 6 - A 6 - 250 -

Pressure setting (bar)

Flow (lpm) / Release ration

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

Bypass-throttle D2

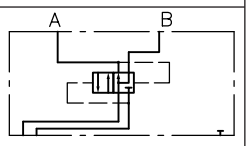
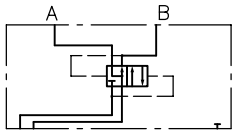
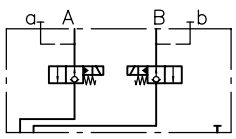
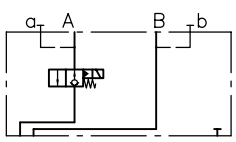
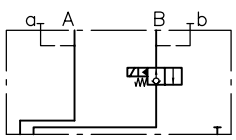
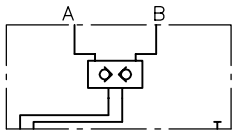
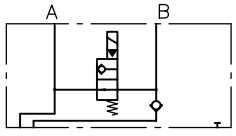
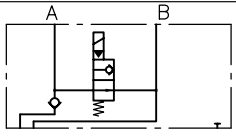
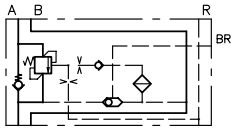
Coding	**0**	**4**	**5**	**6**	**7**	**8**
(∅ mm)	plugged	0.4	0.5	0.6 Serie	0.7	0.8
Release ratio	1:6	1:4.26	1:3	1:1.95	1:1.56	1:0.79

Example:

PSL 51 F/300 - 5 **- A** 2 H 40/40 C200/EA **/5 AS220 BS220** - E 4 - G 24

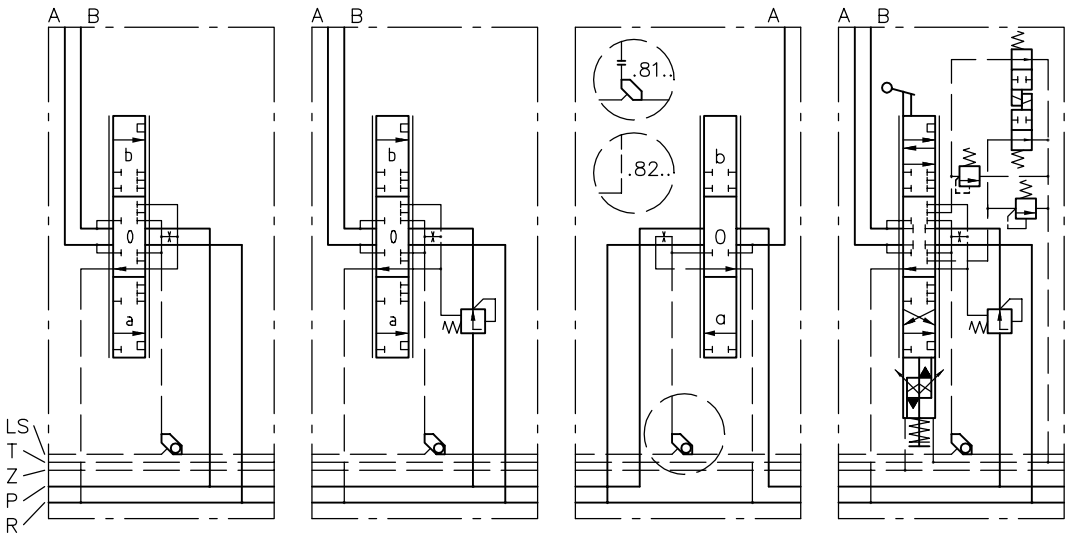
Valve section suited for mounting of an ancillary block

Ancillary block

Coding	Brief description	Symbols
/54 DFA	For regenerative circuit piston side connected at A (type /54 DFA) or piston side conected at B (type /54 DFB) **Note:** Not suitable for the use with dragging loads!	
/54 DFB		
/5 VV **/UNF 5 VV**	With shut-off valves EM 42 V acc. to D 7490/1 (one or both sides) blocking the consumer with zero leakage (Q_{max} approx. 160 lpm)	
/5 VX **/UNF 5 VX**		
/5 XV **/UNF 5 XV**		
/5 DRH **/UNF 5 DRH**	Releasable check valves in A and B (release ratio 1: 2.5) For additional version with prerelieve coding /5 DRH VV, see D 6110 type DRH 5	
/54 DEA	With switchable regenerative circuit functionality via 2/2-way valve type EM 41 S	
/54 DEB		
Intermediate plates for parallel connection		
/Z 30	Spacer plate 30 mm to compensate height differences between differing ancillary blocks or to prevent collisions of neighboring ancillary blocks when combined with other intermediate plates	
/Z ALW-.. **/Z BLW-..**	With over-center valve for A or B and add. shuttle valve. For type coding, see coding /5 AL or /5 BL	

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 illustrated in table 12 or 19 or 20, see also example in table 19 and sect. 6.



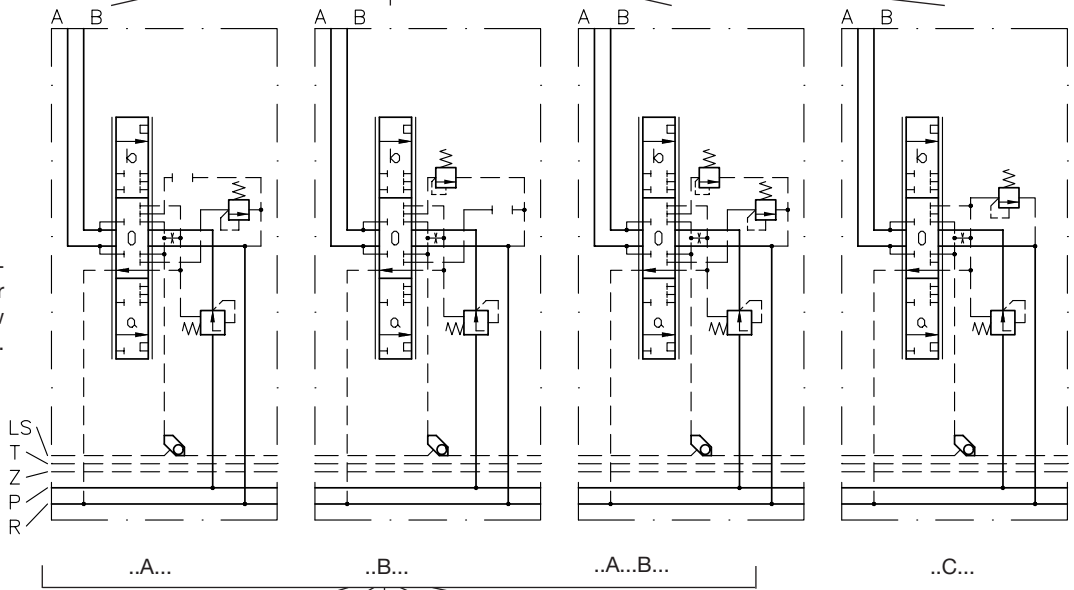
4/3-way directional spool valve without inflow controller .1...

4/3-way directional spool valve with inflow controller .2... (.5...)

4/3-way directional spool valve utilized as pre-selector. 8...

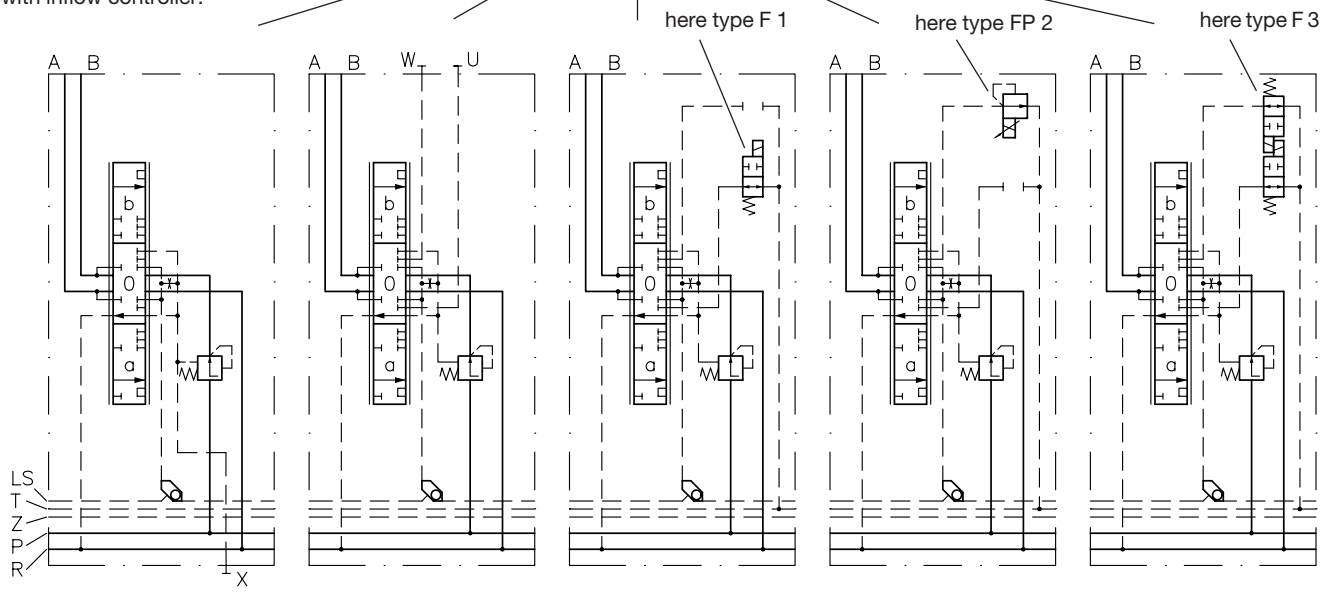
Example: SL 5-52 L 160/80 A300 B200 F 3/ EA-G 24

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



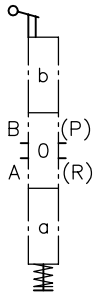
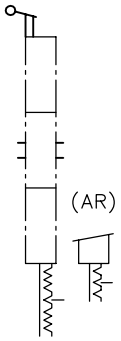
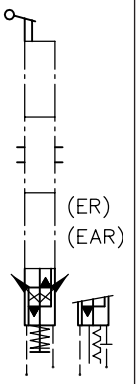
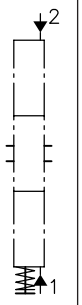
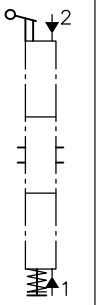
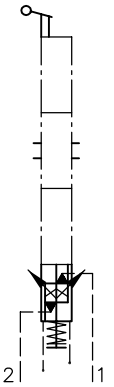
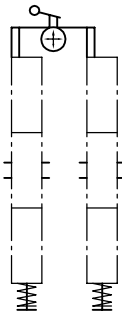
..A... ..B... ..A...B... ..C...

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



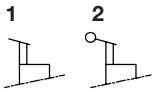
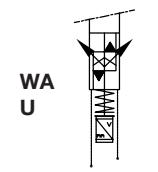
	..X	..S (S 1)	..F 1, FP 1, FPH 1 (X)	..F 2, FP 2, FPH 2 (X)	..F 3, FP 3, FPH 3 (X)
Possible combinations:	A..X	A..S	A..F 1, FP 1, FPH 1 (X)	A..F 2, FP 2, FPH 2 (X)	A..F 3, FP 3, FPH 3 (X)
	B..X	B..S	B..F 1, FP 1, FPH 1 (X)	B..F 2, FP 2, FPH 2 (X)	B..F 3, FP 3, FPH 3 (X)
	A..B..X	A..B..S	A..B..F 1, FP 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			Pneumatic actuation	Manual 2-axis joy-stick
	Spring return	Detent	Purely electro-hydraulic	In comb. with manual actuation	Purely hydraulic	In comb. with manual actuation	In comb. with solenoid and manual actuation		
Coding	**A E0A**	**C E0C AR E0AR**	**E EI ER**	**EA EAR**	**H H UNF**	**HA HA UNF FA**	**HEA HEA UNF FEA (HE, FE)**	**P PA**	**K**
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			Control pressure (bar) min. approx. 2.5 max approx. 7	Actuation angle approx. 5...19°

Note:
- Approximate figures for start of flow (= min) at A or B up to the max. consumer flow according to the flow coding table 15, see curves in sect. 4.2.
- Hydraulic actuation type F.. acc. to D 7700 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. 6.1i!
- 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
- Order example for type K, see sect. 6.1 h
- Type EM and EAM: Version with pressure gauge ports at the actuation heads
- Type E 9, E 9 A: Actuation torque like with H, HA

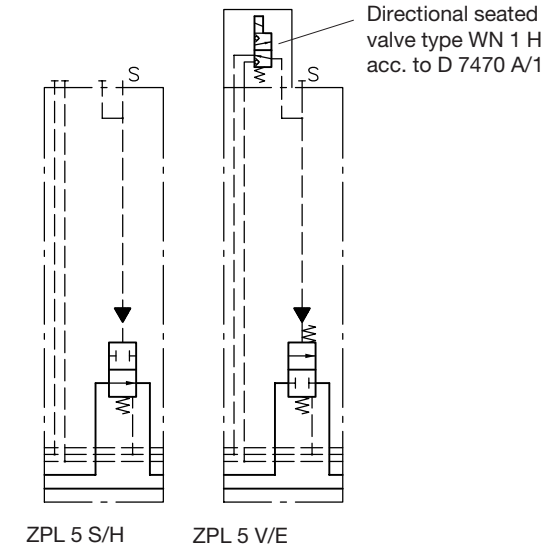
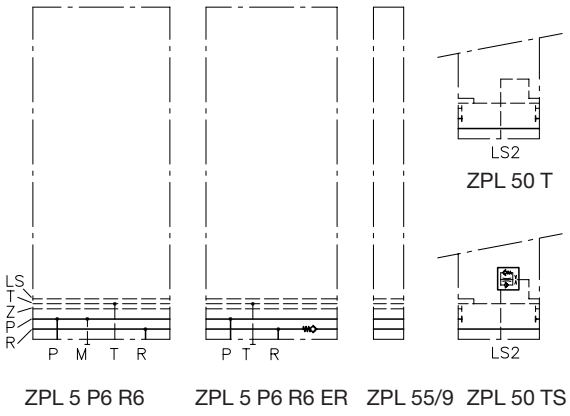
Table 21: Additional features for the actuations

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, C, PA, K, H, HA	**WA** **WA-EX** **WA-M2 FP**	Integrated position sensor (Hall-sensor) with analogous signal output (lift monitoring) Version WA-EX, explosion-proof version Coding WA-M2 FP with fire-damp protected version (mining)	EA WA, A 1 WA	
A, EA, C, PA, HA, HEA, FA, FEH	**U**	Integrated spool monitoring for side indication (Comparator triggered signal: ON / OFF)	EA U	
A, C, E, E0A	**(G)** no coding	Reinforced version of the spring cover, intended when high pressure surges are expected in the T-line.		

3.2.2 Add-on intermediate plates

Order example: PSL 51/250-5 -32 H 63/40 /EA
-ZPL 5 S/H
-32 L 25/16 /EA-E 4-G 24

Table 22: Add-on intermediate plates

Coding	Brief description	Symbols
ZPL 5 S/H **ZPL 5 V/H** **ZPL 5 S/E** **ZPL 5 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. $p_{switch} \geqq 12$ bar ($p_{max\ S}$ = 400 bar)	
ZPL 5 P6 R6	Additional pump and return port G 1 1/4	
ZPL 5 P6 R6 ER	Like ZPL 5 P6 R6 , but with additional check valve in gallery R and additional tank port T. It can be only used when ZPL 52 (see table 11) is mounted subsequently.	
ZPL 55/9	Spacer plate (9 mm) between connection block and first valve section, necessary when this section is equipped with an ancillary block (acc. to table 19). Observe note intable 1, 3 an 5.	
ZPL 50T S	Intermediate plate separating two systems working individually (in combination with end plate E 1 (PSL) or E 4 (PSV) 56 acc. to table 11 **Note:** The LS-signal from port LS 2 has to be routed externally from the connection block (type E. PSL 56) to port DW 2. Coding for add. element in the LS signal line, see table 4.	

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 10 spool valves, all-steel

Mounting
Tapped holes: M10; see dimensions sect. 5++

Installation position
Arbitrary

Ports

P = Pressure inlet (pump) / lead-on
R = Return
A ,B = Consumer ports
F = Pressure resistant return
U, W, X = Load-signal outlet at the indiv. spool valve section
LS, DW = Load-signal outlet e.g. connection of pump metering valve at PSV.
Attention: no pressure input!
M = Pressure gauge connection (pump side)
Z = Pilot pressure connection (20 ... 40 bar inlet, 20 or 40 bar outlet)
T = Control oil return port
Y = Load-signal inlet port (end plate E 2, E 5, E 8, E 10, E 14 (UNF) and E 16 (UNF)

Ports

P, R, A, B, F = Acc. to type coding (see sect. 3.1)
M, LS, Z, T, Y, DW = G 1/4 (ISO 228/1 (BSPP)) or 7/16-20 UNF-2B (SAE-4, SAE J 514)
U, W, X = G 1/8 (ISO 228/1 (BSPP))

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 galvanisch verzinkt und oliv passiviert
Solenoids at actuation EB zinc galvanized EN 12329-Fe/Zn12c
Housing with actuation P and PA: anodized

Mass (weight) approx.

Connection block:

PSV 5(6)	= 4.5 kg [1]
PSV 5(6)./..	= 7.7 kg [1]
PSM 6	= 4.5 kg [1]
E 1(E 4) PSL(V) 56	= 7.7 kg [1]

[1]) + 0.6 kg at version with WN 1 F(D), PA ... PD

End plates:

E 1, E 2, E 4, E 5	= 2.5 kg
E 1(4) UNF	= 2.5 kg
E 3, E 6	= 3.1 kg
E 7 bis E 16 UNF	= 3.0 kg
E 7 A 1(2), E 8 A 1(2)	= 2.5 kg

4/3- and 3/3-way directional spool valves:

		Standard version	With additional functions	
			A .. C, S	A .. B .. F(P, PH) 1(2,3)
Actuations	A, E, H, P, E0A	3.7 kg	3.7 kg	4.1 kg
	EA, HA, PA	4.1 kg	4.1 kg	4.5 kg
	HEA	4.6 kg	4.6 kg	5.0 kg

Intermediate plates:

ZPL 5 S/H	= 5.0 kg
ZPL 5 V/E	= 5.0 kg
ZPL 5 P6 R6	= 5.9 kg
ZPL 53	= 2.6 kg
ZPL 52	= 2.6 kg
ZPL 55/9	= 0.7 kg
ZPL 50 T..	= 2.6 kg

Ancillary blocks:

/(UNF) 5	= 1.5 kg
/(UNF) 5 AS.. BS..	= 2.4 kg
/(UNF) 5 AN.. BN..	= 2.3 kg
/5 AL... /5 BL..	= 3.4 kg
/5 VV(VX, XV)	= 2.4 kg
/(UNF) 5 DRH	= 2.3 kg
/DFA, DFB	= 2.4 kg
/DEA, DEB	= 2.8 kg
/5 R VV	= 2.4 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.
Observe restrictions for versions with ex-proof solenoid!

Required cleanliness
ISO 4406 20/18/15

Operating pressure
p_{max} = 400 bar; ports P, P1, A, B, LS, M, Y
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. 8x1) 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 bar (acc. to coding, see table 7) (outlet); ≤ 40 bar (inlet)

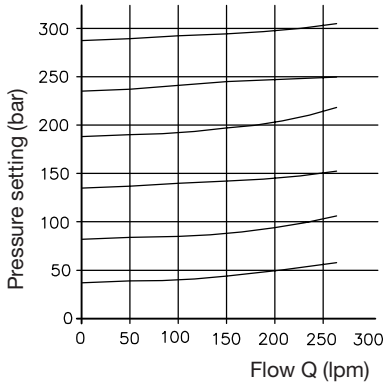
Control circuit
For control pressure, see Q-I-characteristics.
The internal control oil circuit is sufficiently protected against malfunctions caused by contamination by means of a disk filter.

Perm. flow
Max. consumer flow 16...160 (240) lpm or acc. to table 15 sect. 3.2.1.

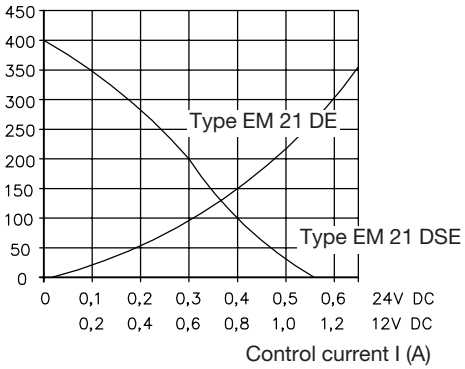
4.2 Curves

Pressure limiting valve

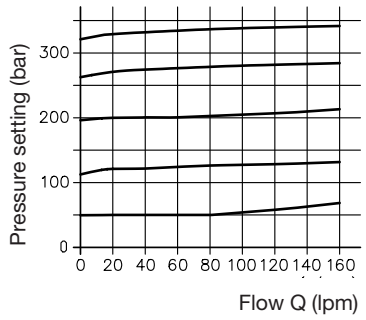
Connection block



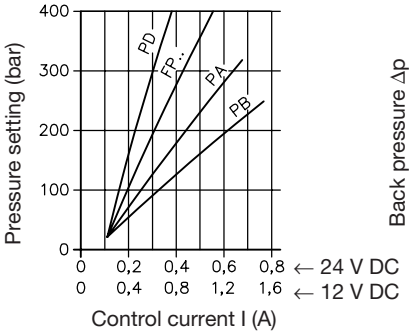
Prop. pressure limitation at the connection block
type PSL (PSV) ..V (Z, ZM)



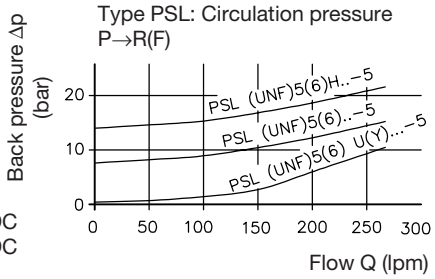
Secondary pressure limiting valves
(Coding A.. B..; C.. acc. to table 16
in sect. 3.2.1)



Proportional pressure limiting valve
Coding PA ... PD acc. to table 9, pos. 3.1.4, sect. FP(H) 1,
FP(H) 2, FP(H) 3 acc. to table 17, sect. 3.2.1

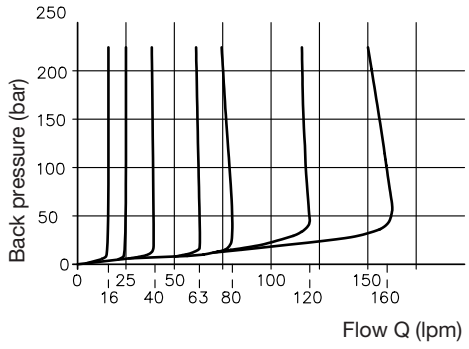


Type PSL: Circulation pressure
P→R(F)

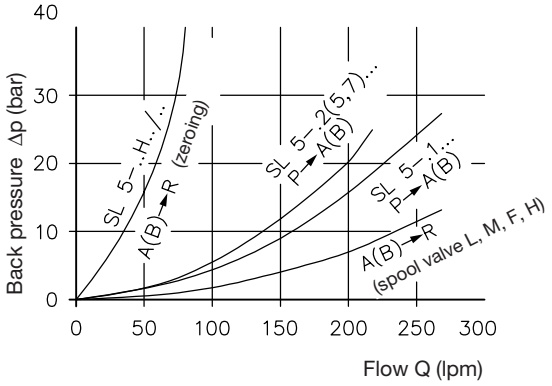


Directional spool valve section

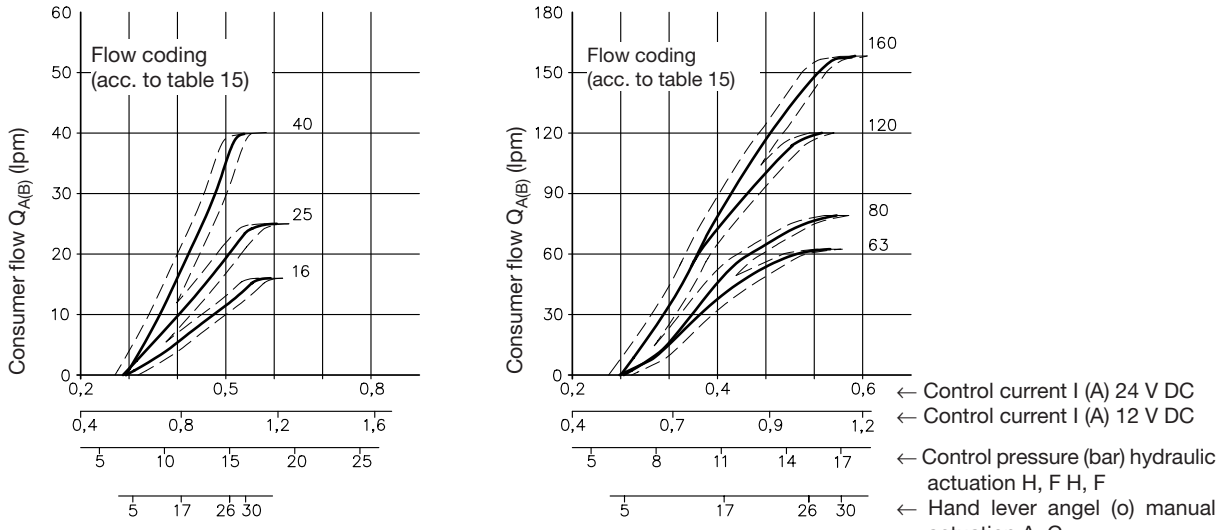
2-way inflow controller



Back pressure (full elevation)



Input / consumer flow curve
(Guideline, example directional spool valve with inflow controller type SL 5-52../..)



Oil viscosity during measurement approx. 60 mm²/s

4.3 Actuations

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

Actuation A

	Actuating moment (Nm) Idle position	End position
Version A	approx. 3.0	approx. 7.5
Version HA, HEA, PA	approx. 5.0	approx. 16.5
Version EA, E0A	approx. 3.0	approx. 12.0

Actuation C

Version with detent, fixation of the valve spools at any desired position (idle position with special notch)

AR, ER, EAR

Version with detent, fixation of the valve spool at idle and both end positions
Pulse duration for the switching process approx. 1 sec.

Actuation E, EA, HE(A)

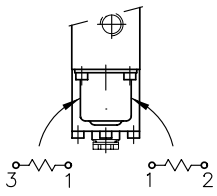
Proportional solenoid, manufactured and tested acc. to DIN VDE 0580
Twin solenoid with armature chambers sealed to the outside and internally connected to the return duct. Thereby the armature is maintenance-free lubricated and protected against corrosion by the hydraulic fluid.

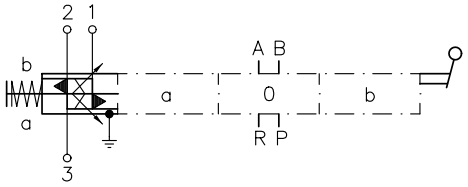
Additional notes:
See also Sk 7814, as well as for additional components sect. 6.1 j !

Specifications apply to all solenoid versions if not stated otherwise.

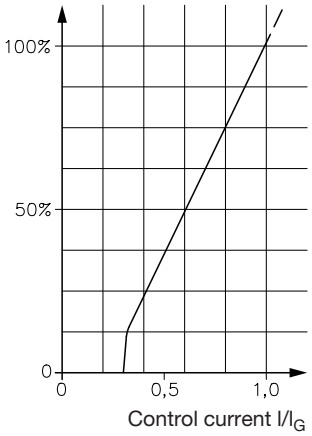
	24 V DC	12 V DC
Rated voltage U_N		
Coil resistance cold R_{20}	26.6 Ω	6.3 Ω
Current,cold I_{20}	0.9 A	1.9 A
Lim. current I_G (I_{lim})	0.63 A	1.26 A
Cut-off energy W_A	≤ 0.3 Ws	≤ 0.3 Ws
Rel. duty cycle	S 1	S 1
(reference temp. ϑ_{11} = 50°C)		
Required dither frequency	40...70 Hz (best 55 Hz)	
Dither amplitude [1]	20% ≤ A_D ≤ 35%	

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





I - stroke- curve

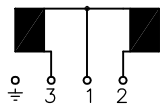


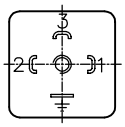
Oil viscosity during measurement approx. 60 mm²/s

Electr. connection

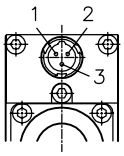
Circuitry for coding -G 12 -G 24
EN 175 301-803 A
3-pin
IP 65 (IEC 60529)

Coil a Coil b

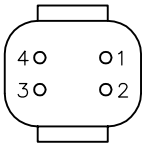




Circuitry for coding -S 12 -S 24
3-pin
IP 67 (IEC 60529)

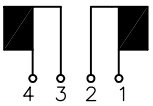


Circuitry for coding -DT 12 -DT 24
4-pin
IP 67 (IEC 60529)

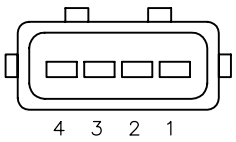


Circuitry for coding -AMP 12 K 4 -AMP 24 K 4
AMP Junior Timer,
4-pin
IP 65 (IEC 60529)

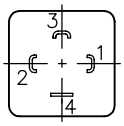
Coil a Coil b



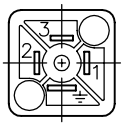
3 1 2 4 (with coding ...H 4 and ...C 4)



Circuitry for coding -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)



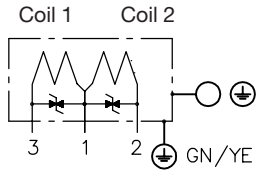
The IP-specification only applies when the plug is mounted as specified.

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

Attention:
Additionally observe operating manuals
B 01/2002 and B ATEX

Protect against direct 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	TÜV-A 02 ATEX 0007 X
Ex-proof level	⟨Ex⟩ II 2 G Ex mb II 120°C (T4)
	⟨Ex⟩ II 2 D Ex mbD 21 T120°C
Duty cycle (ED)	S 1, one coil energized per solenoid housing
Protection class	IP 67 (IEC 60529)
Nom. voltage U_N	24 V DC
Coil resistance cold R_{20}	26.6 Ω
Current, cold I_{20}	0.88 A
Lim. current I_G	0.63 A
Residual ripple	15% of the supply voltage
Conditions of use:	
Ambient temperature	-35 ... +40°C
max. fluid temperature	+70°C
Fuse	I_F < 1.8 A each solenoid must be safe guarded against overload and short-cut by fuse conforming IEC 60127 medium
Surface coating	Housing galvanically zinc coated Coil and connection cavity are moulded
Electrical design and testing	conforming EN 60079, VDE 0170/0171 T 1 and T 9
Electrical connection	4 x 0.5 mm²
Cable length	3 m or 10 m (cable ÖLFLEX-440P ® Co. LAPP, D-70565 Stuttgart)

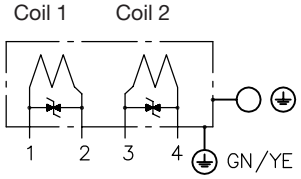
For connection scheme, see “Actuation E, EA” (standard version)

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

Attention:
Additionally observe operating manuals
B 01/2002 and B ATEX

Protect against direct sunlight.

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



Letter of conformity ATEX	TÜV-A 02 ATEX 0007 X
Ex-proof level	⟨Ex⟩ II 2 G Ex mb II 120°C (T4)
	⟨Ex⟩ II 2 D Ex mbD 21 T120°C
Duty cycle (ED)	S 1, one coil energized per solenoid housing
Protection class	IP 67 (IEC 60529)
Nennspannung U_N	24 V DC
Coil resistance cold R_{20}	26.6 Ω
Nom. voltage I_{20}	0.88 A
Current, cold I_G	0.63 A
Residual ripple	15% of the supply voltage
Conditions of use:	
Ambient temperature	-35 ... +40°C
max. fluid temperature	+70°C
Fuse	I_F < 1.8 A each solenoid must be safe guarded against overload and short-cut by fuse conforming IEC 60127 medium
Surface coating	Housing galvanically zinc coated Coil and connection cavity are moulded
Electrical design and testing	conforming EN 60079, VDE 0170/0171 T 1 and T 9
Electrical connection	4 x 0.5 mm²
Cable length	3 m or 10 m (cable ÖLFLEX-440P ® Co. LAPP, D-70565 Stuttgart)

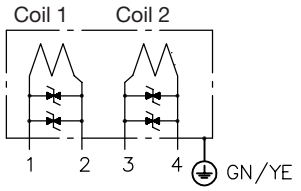
For connection scheme, see “Actuation E, EA” (standard version)

Actuation suffix E, EA, HE(A)
Explosion-proof version of actuation
(fire-damp protected (mning), intrinsic save)
Voltage specification **G 24 TEX 70**

Attention:
Additionally observe operating manuals
B 09/2006 and B ATEX

Protect against direct sunlight.

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

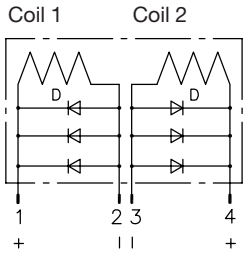


Letter of Conformity IEC	IEC Ex IBE 09.0005 X
Letter of conformity ATEX	IBEx U07 ATEX 1089 X
Coding	⟨Ex⟩ II 2 G Ex d IIB T4
	⟨Ex⟩ II 2 D Ex tD A21 T135°C
Duty cycle (ED)	S 1, one coil energized per solenoid housing
Protection class	IP 67 (IEC 60529)
Nom. voltage U_N	24 V DC
Power, cold R_{20}	80 Ω
Lim. current I_G	0.24 A
Residual ripple	15% of the supply voltage
Conditions of use:	
Ambient temperature	-20 ... +70°C
max. fluid temperature	+70°C
Fuse	I_F < 0.5 A each solenoid must be safe guarded against overload and short-cut by fuse conforming IEC 60127 medium
Surface coating	Housing galvanically zinc coated Coil and connection cavity are moulded
Electrical design and testing	conforming EN 60079, VDE 0170/0171 T 1 and T 9
Electrical connection	4+1 x 0.5 mm²
Cable length	3 m or 10 m (cable ÖLFLEX-440P ® Co. LAPP, D-70565 Stuttgart)

Actuation suffix E, EA, HE(A)
Explosion-proof version of actuation
(fire-damp protected (mining), intrinsic save)
Voltage specification **G 12 IS**

Attention:
Additionally observe operating manuals
B 04/2005 and B ATEX

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



Attention: Take polarity into account!

Letter of Conformity IEC	IEC Ex IBE 09.0006 X
Letter of conformity ATEX	IBEx U05 ATEX 1116 X
Ex-proof level	⟨Ex⟩ I M1 Ex d ia I ⟨Ex⟩ 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_I	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 save "i"), EN 60079-1 (pressure resistant encapsulation "d")
Electrical connection	4 x 0.5 mm²
Cable length	3 m or 10 m (cable ÖLFLEX-EB ® Co. LAPP, D-70565 Stuttgart) Coded leads: 1-4, insulation color: fair blue)

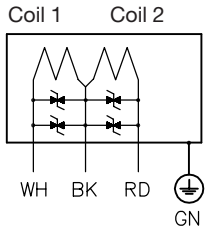
The complete circuit has to be designed and get approved acc. to EN 60079-25.

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.

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

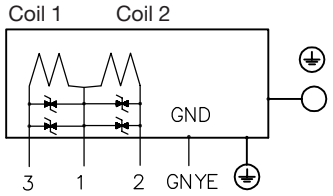
Attention:
Additionally observe operating manuals
B 05/2006 and B ATEX

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	IBEx U05 ATEX 1115 X
Ex-proof level	⟨Ex⟩ 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:	
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 mm²)
Cable length	3 m or 10 m
Leads	BK, WH, RD, GN; Item-Nr. 40003, General Cable

Actuation suffix E, EA, HE(A)
Explosion-proof version of actuation
(fire-damp protected (mining))
Voltage specification **G 24 M2 FP**



Letter of conformity ATEX	IBEx U05 ATEX 1115 X
Letter of conformity ANZEx	ANZEx 10.3019X
Electrical connection	4 x 0.75 mm², shielded cable
For add. specifications	see coding G 24 MSHA

Actuation suffix H, HA, HEA

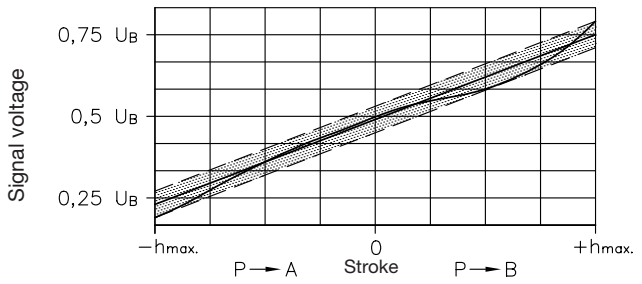
Control pressure approx. 5 bar (start of stroke)
approx. 18 bar (End position), max. perm. pressure 50 bar
The remote control lines to the control port 1 and 2 have to be piped externally. Supply is via proportional piloting valve e.g. type FB 2/18 etc. or KFB 2/18 (both acc. to D 6600).

Actuation suffix P, PA

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

Actuation suffix WA, WA-EX

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

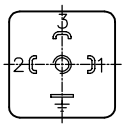


U_B = Supply voltage
$U_{B\,max}$ = 76%
$U_{B\,min}$ = 24%
Accuracy
± 9%(U_B)

Circuitry

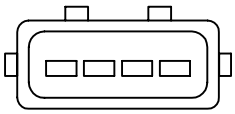
The DC supply voltage must be stabilized and smoothened.
Attention: Any strong magnetic field will destroy the sensor!

Coding G...



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

Coding AMP...



Coding S...

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

Actuation suffix WA-EX

Letter of conformity ATEX	IBEx U09 ATEX 1001X
Coding	Ⓔx II 2 G Ex d IIB T 4, Ⓔx II 2 D Ex td A21 IP 6x T 135°C Ⓔx I M2 Ex d I
Ambient temperature	-30 ... +40°C
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!

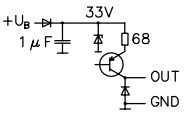
Actuation suffix WA-M2 FP

Letter of conformity ATEX	IBEx U09 ATEX 1001 X
Letter of Conformity ANZEx	ANZEx 11.3007 X
Electrical connection	4 x 0.75mm², shielded cable
For add. specifications	see coding G 24 MSHA
Ex-proof level	see WA-EX
Ambient temperature	-30 ... +40°C
Cable length	3 m or 10 m

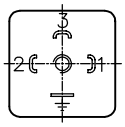
Actuation suffix U

Comparator
(stroke monitoring / side indication)

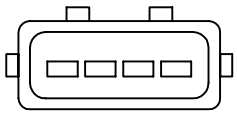
Circuitry

Pin	Signal	Description	
1	OUT_A	PNP-transistor (switched on high-side)	Open-Collector: I_{max} = 10 mA short-cut resistant 
2	OUT_B	PNP-transistor (switched on high-side)	
3	+U_B	10 ... 32 V DC	Residual ripple ≤ 10%
4/GND	GND	0 V DC	

Coding G...



Coding AMP...



Electr. connection acc. to coding, see table 10

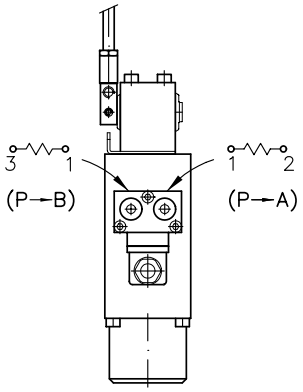
Signal table			
Ident. No.	Spool movement	OUT_A	OUT_B
1	Idle position middle	ON	ON
2	P → B	OFF	ON
3	P → A	ON	OFF

4.4 Functional cut-off, prop. pressure limitation

Functional cut-off

On/Off solenoid with manual emergency actuation

Rated voltage U_N	24 V DC	12 V 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	1.38 A
Cut-off energy W_A	≤ 0.3 Ws	≤ 0.3 Ws
Rel. duty cycle [1]	S 1	S 1
(reference temp. $\vartheta 11$ = 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

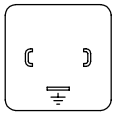
4.5 Other solenoid valves

Electrical data	- Connection blocks coding Z, ZM, V - Ancillary blocks coding /5 R VV		- Connection blocks coding F, D - Add-on intermediate plates coding ZPL 5 V(S)/E - End plates coding E 3, E 6		- 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	24 V DC	12 V DC	24 V DC	12 V DC	24 V DC	12 V 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

	- Ancillary blocks coding /5 VV(VX, XV), /UNF 5 VV (VX, XV), /5 DEA(DEB)	
Additional documentation	D 7490/1 (type EM 4)	
Nom. voltage U_N	24 V DC	12 V DC
Nom. power P_N	30 W	30 W
Nom. current I_N	1.25 A	2.5 A

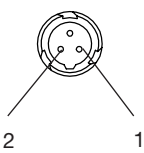
Electrical connection

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



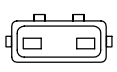
Circuitry
with coding -S 24
Plug Co. SCHLEMMER
type SL-10

IP 67 (IEC 60529)

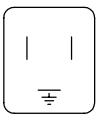


Circuitry
with coding -AMP 24
AMP Junior Timer

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)

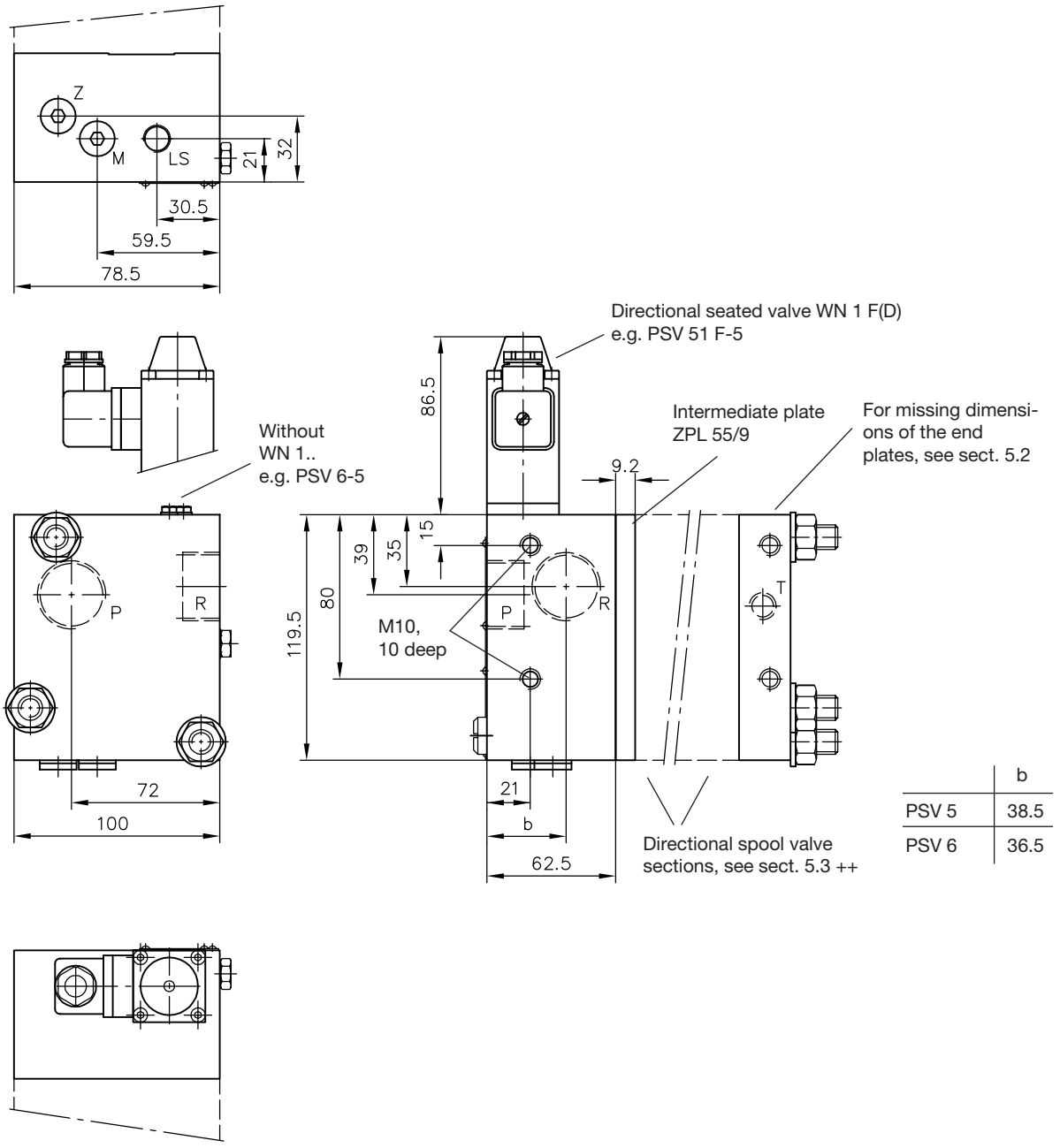


5. Unit d imensions

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

5.1 Connection blocks and end plates

Type PSV 5. (F, D)-5
PSV 6. (F, D)-5



	b
PSV 5	38.5
PSV 6	36.5

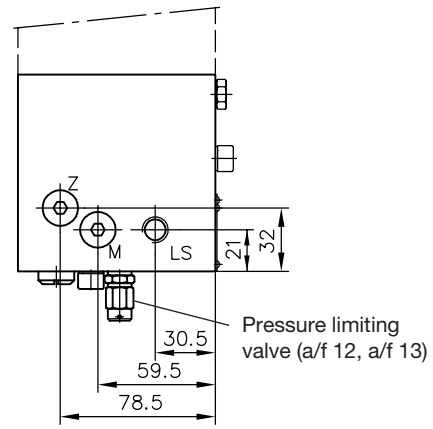
Ports

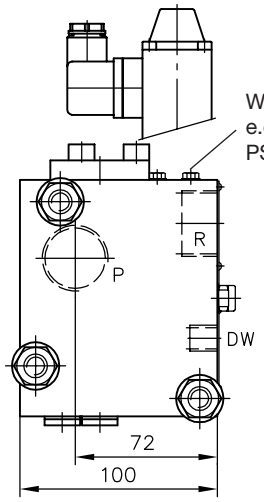
	P	R	LS, Z, M	
PSV 5	G 1	G 1	G 1/4	ISO 228/1
PSV 6	G 1 1/4	G 1 1/4	G 1/4	(BSPP)
PSV UNF 6	1 5/8-12 UN-2B (SAE-20)		7/16-20 UNF-2B (SAE-4)	SAE J 514

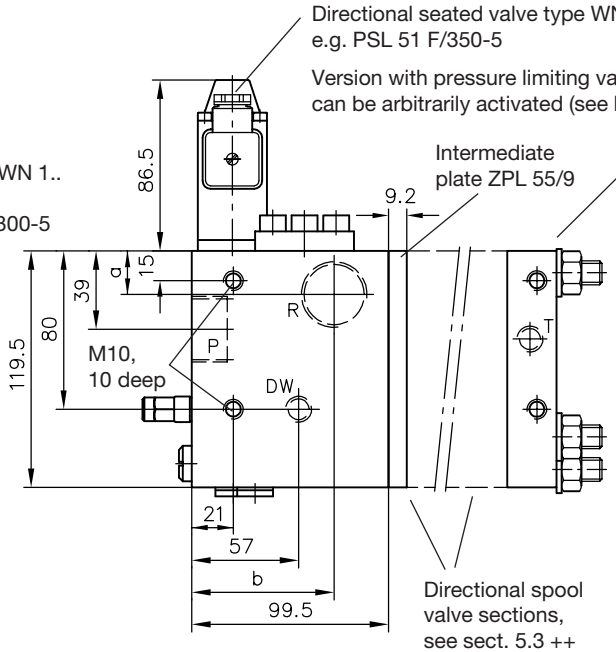
Type PSV 5(6) ../.. -5, PSL 5(6). (F, D)/...-5, PSM 6. (F, D)/...-5

Ports ISO 228/1 (BSPP)

	P, R	LS, Z, M, DW	
PSL 5../.. PSL 6../.. PSL UNF 6../..	G 1 G 1 1/4 1 5/8-12 UN-2B (SAE-20)	G 1/4 G 1/4 7/16-20 UNF-2B (SAE-4)	ISO 228/1 ISO 228/1 SAE J 514
PSV 5../.. PSV 6../.. PSV UNF 6../..	G 1 G 1 1/4 1 5/8-12 UN-2B (SAE-20)	G 1/4 G 1/4 7/16-20 UNF-2B (SAE-4)	ISO 228/1 ISO 228/1 SAE J 514
PSM 6../.. PSM UNF 6../..	G 1 1/4 1 5/8-12 UN-2B (SAE-20)	G 1/4 7/16-20 UNF-2B (SAE-4)	ISO 228/1 SAE J 514

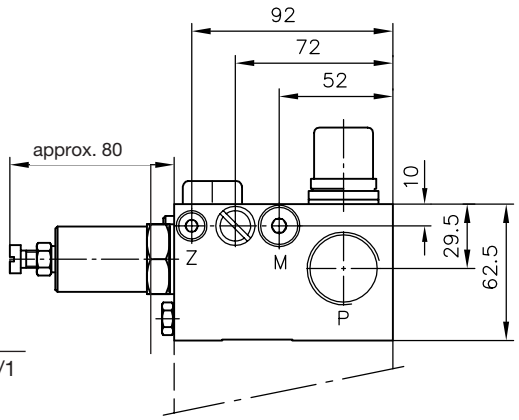






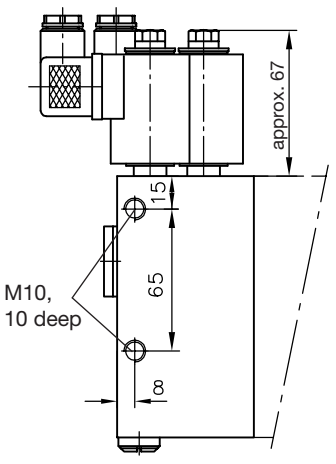
	a	b
PSV 5./., PSL 5./.	22	75
PSV 6./., PSL 6./. PSM 6./.	26	74
PSV UNF 6./. PSL UNF 6./. PSM UNF 6./.	26	72

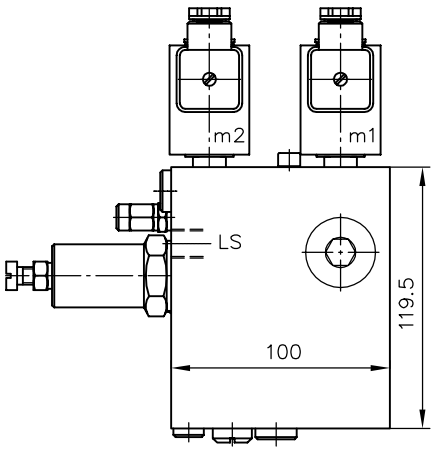
Type PSV 5 N

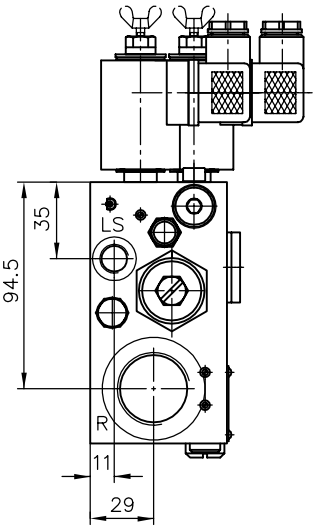


Ports ISO 228/1 (BSPP)

	P, R	LS, Z	M	
PSV 5	G 1	G 1/4	G 1/8	ISO 228/1





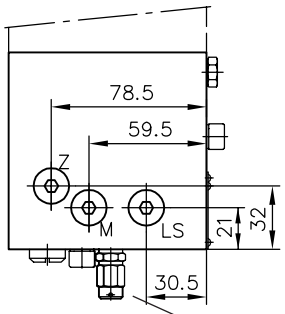


Type PSL 5(6) U..(F, D)/..-5
PSL 5(6) UH..(F, D)/..-5

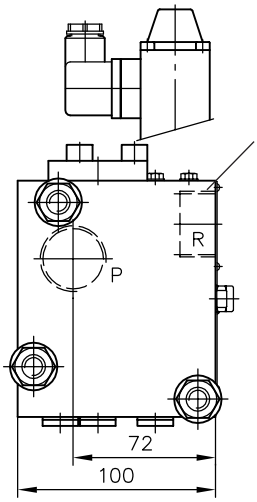
Ports

	P, R	LS, Z, M	
PSV 5 U../..	G 1	G 1/4	ISO 228/1
PSL 6 U../..	G 1 1/4	G 1/4	(BSPP)

	a	b
PSL 5 U	22	75.5
PSL 6 U	26	74



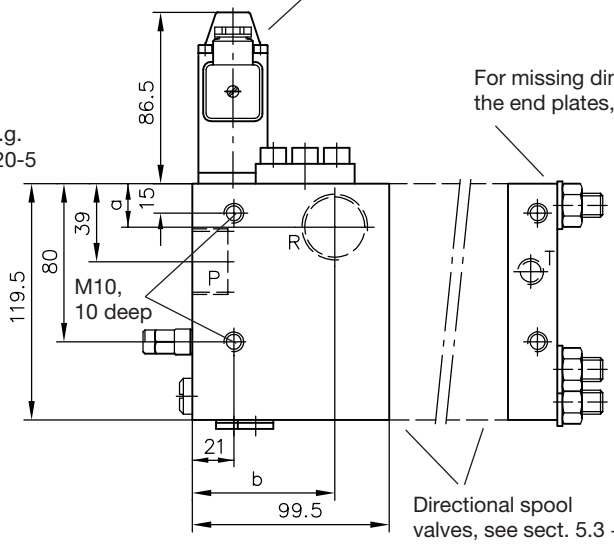
Pressure limiting valve
(a/f 12, a/f 13)



Without WN 1.. e.g.
e.g. PSL 5 U 1/320-5

Directional seated valve WN 1 F(D)
e.g. PSL 6 UH 1 F

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

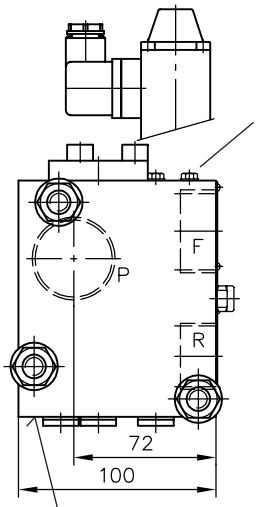


Directional spool
valves, see sect. 5.3 ++

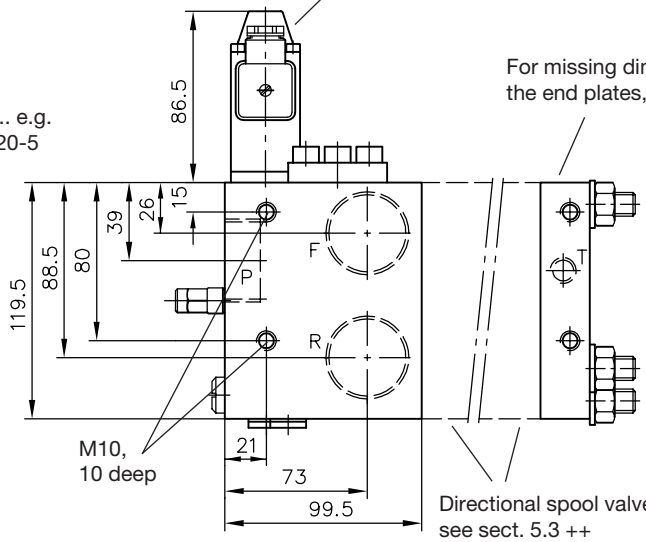
Type PSL 6 Y ..(F, D)/..-5
PSL 6 YH ..(F, D)/..-5

Directional seated valve WN 1 F(D)
e.g. PSL 6 Y 1 F/380-5

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



Without WN 1.. e.g.
PSL 6 YH 1/320-5



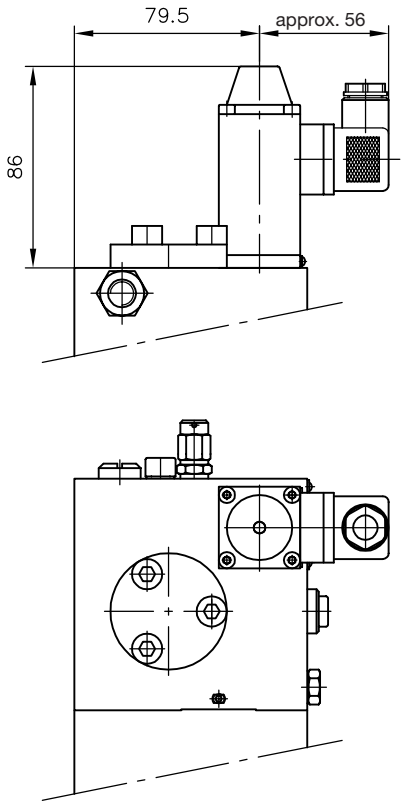
Directional spool valves,
see sect. 5.3 ++

View from bottom is
like illustrated above !

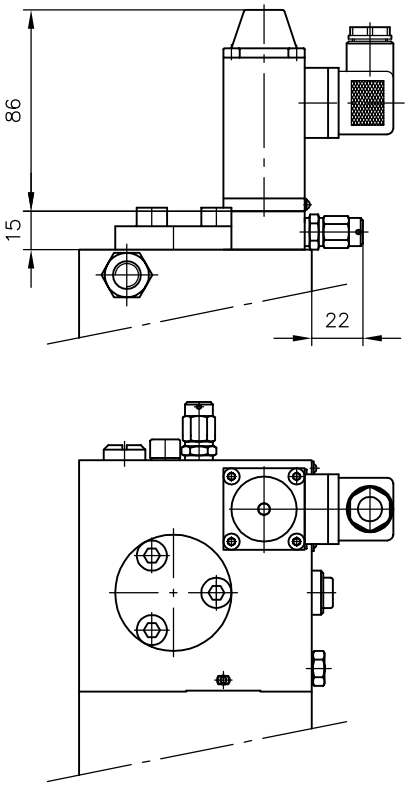
Ports

	P, R, F	LS, Z, M	
PSL 6 Y../..	G 1 1/4	G 1/4	ISO 228/1
			(BSPP)

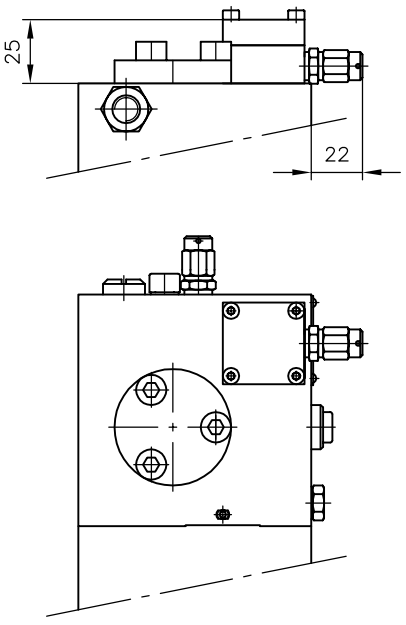
Type PSL.. F(D)/...
PSV.. F(D)
PSV.. F(D)/...



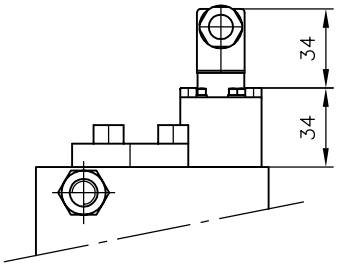
Type PSL.. F(D).../...
PSV.. F(D).../...

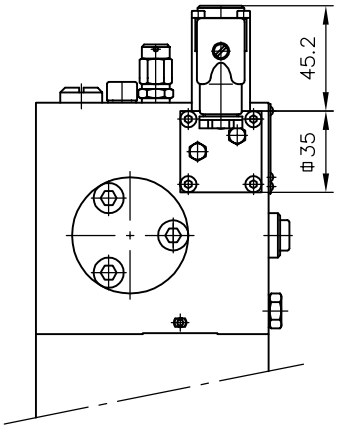


Type PSV.. X..

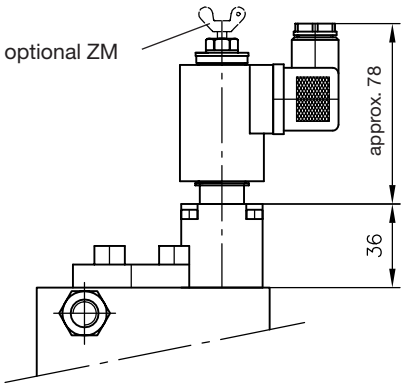


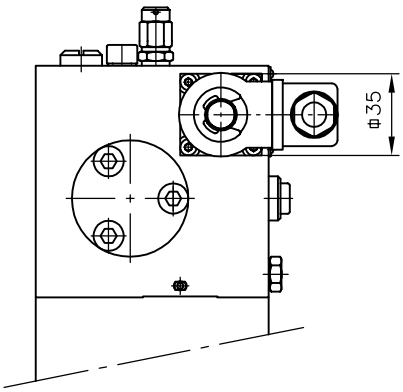
Type PSL.. PA(PB, PD)/...
PSV.. PA(PB, PD)





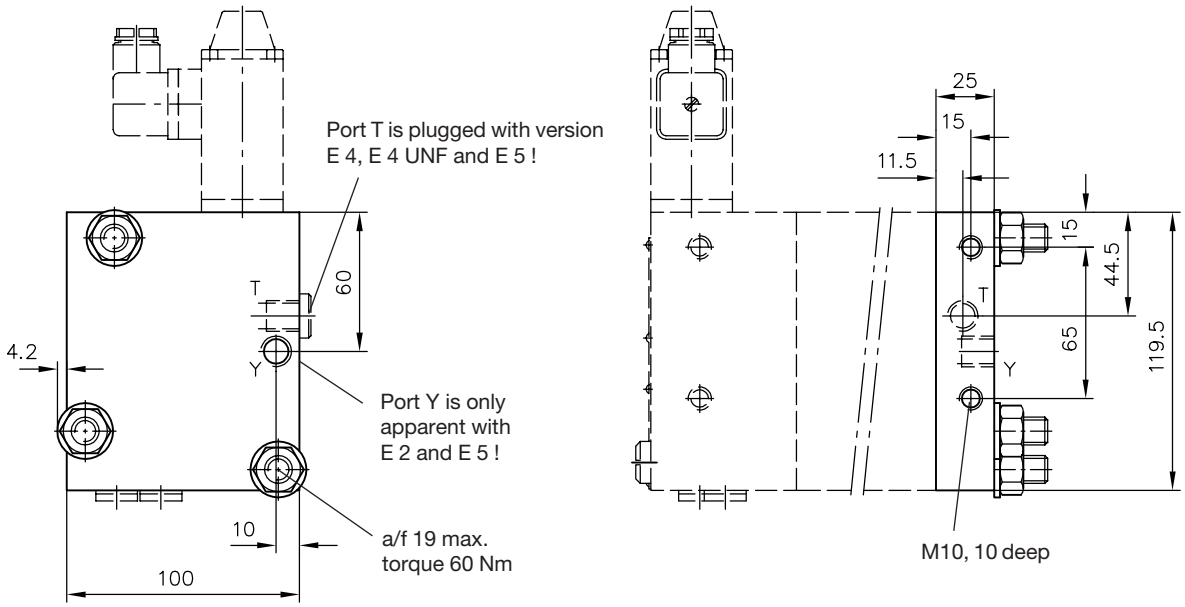
Type PSL.. Z(V).../...
PSV.. Z(V).../...



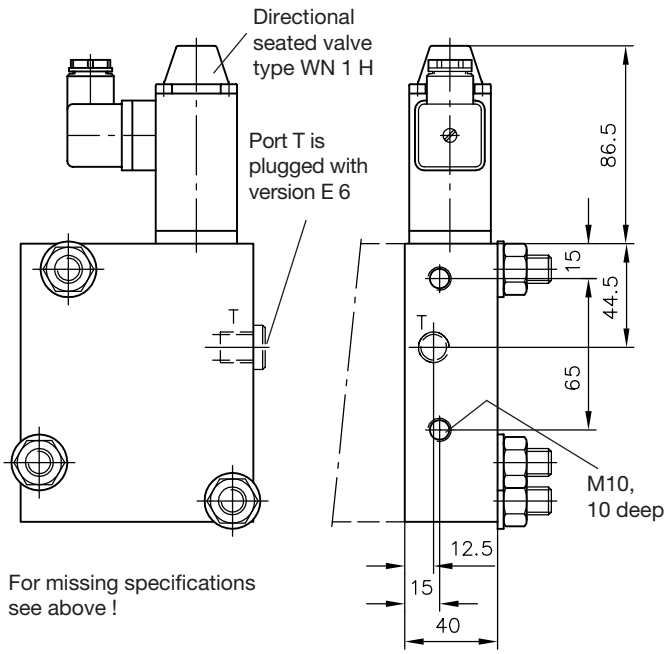


5.2 End plate

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

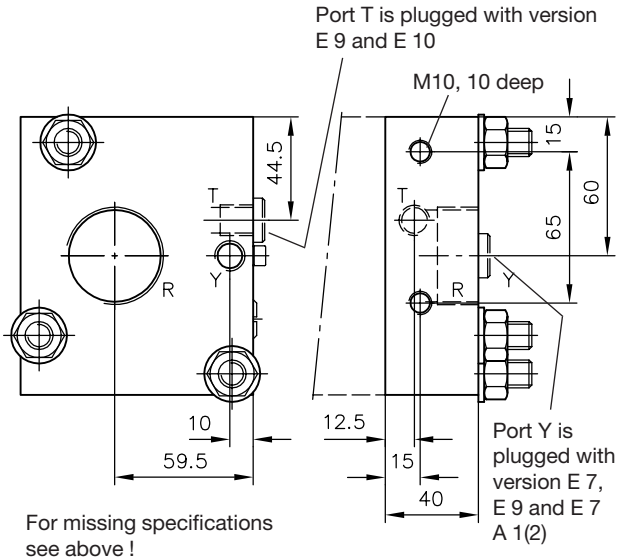


Type E 3 and E 6



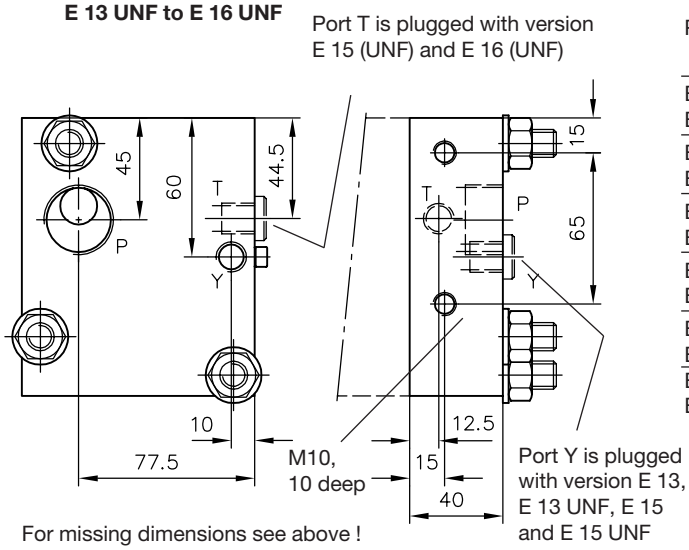
For missing specifications see above !

End plate E 7 to E 10
E 7 A 1, E 7 A 2
E 8 A 1, E 8 A 2



For missing specifications see above !

Type E 13 to E 16
E 13 UNF to E 16 UNF



For missing dimensions see above !

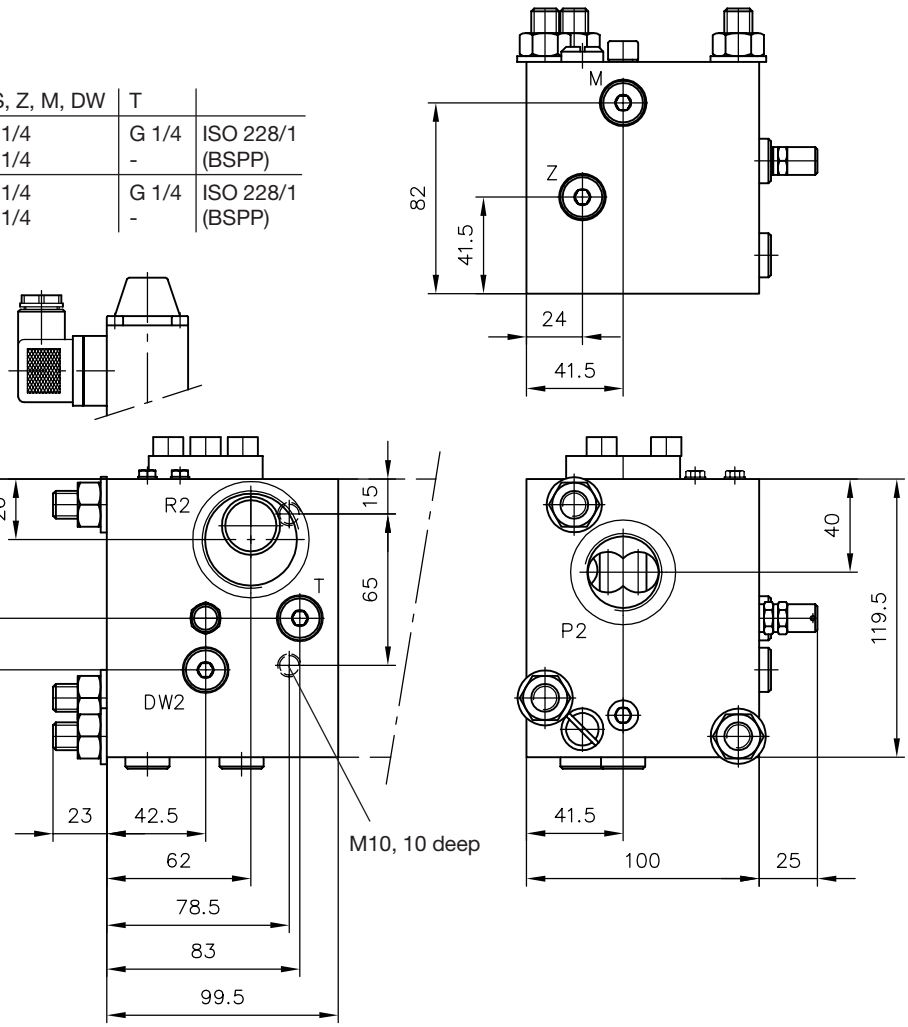
Ports ISO 228/1 (BSPP)

	P	R	T	Y	
E1, E3, E4, E6 E2, E5	- -	- -	G 1/4 G 1/4	- G 1/4	ISO 228/1
E1 UNF, E4 UNF	-	-	7/16-20 UNF-2B	-	SAE J 514
E7, E7 A., E9 E8, E8 A., E11	- -	G 1 1/4 G 1 1/4	G 1/4 G 1/4	- G 1/4	ISO 228/1
E13, E15 E14, E16	G 1 G 1	- -	G 1/4 G 1/4	- G 1/4	ISO 228/1
E13 UNF, E15 UNF	1 5/8-12 UN-2B	-	7/16-20 UNF-2B	-	SAE J 514
E14 UNF, E16 UNF	1 5/8-12 UN-2B	-	7/16-20 UNF-2B	7/16-20 UNF-2B	

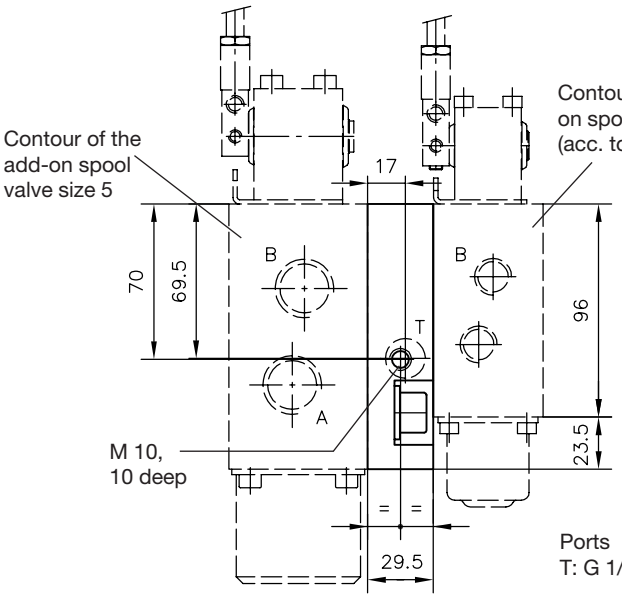
Type E 1(E 4) PSL 56../..
E 1(E 4) PSV 56../..

Ports

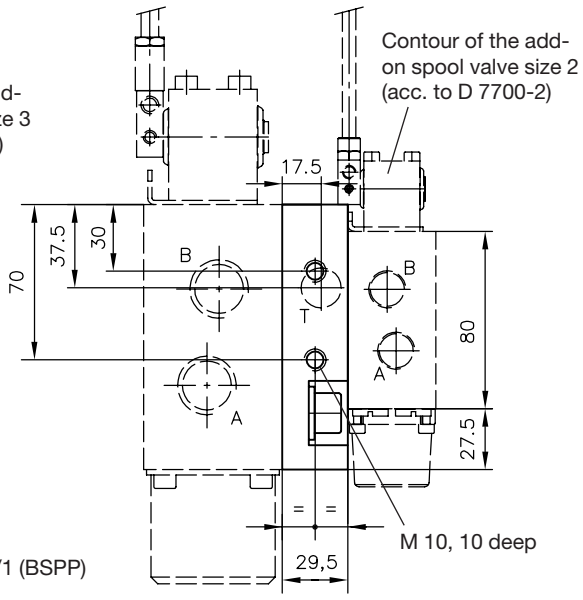
	P	R	LS, Z, M, DW	T	
E1 PSL 56	G 1	G 1 1/4	G 1/4	G 1/4	ISO 228/1
E4 PSL 56	G 1	G 1 1/4	G 1/4	-	(BSPP)
E1 PSV 56	G 1	G 1 1/4	G 1/4	G 1/4	ISO 228/1
E4 PSV 56	G 1	G 1 1/4	G 1/4	-	(BSPP)



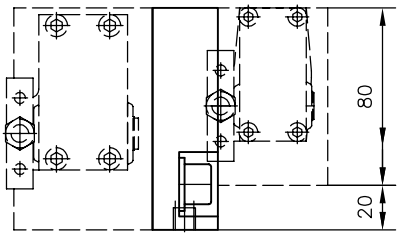
Adapter plate type ZPL 53
ZPL 53 RB

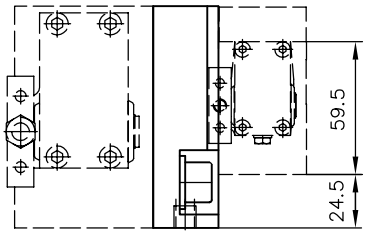


Adapter plate type ZPL 52

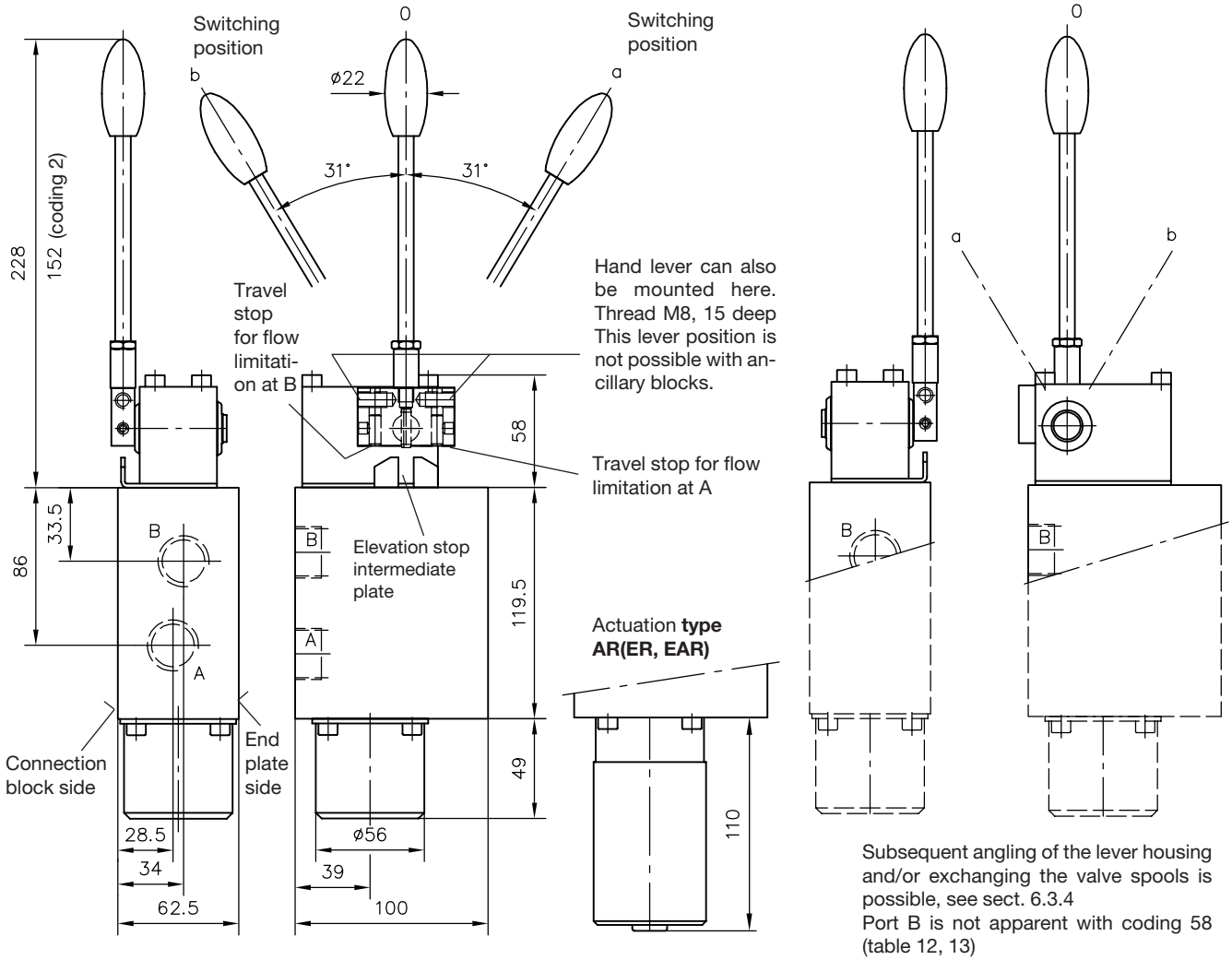


Ports
T: G 1/4 ISO 228/1 (BSPP)





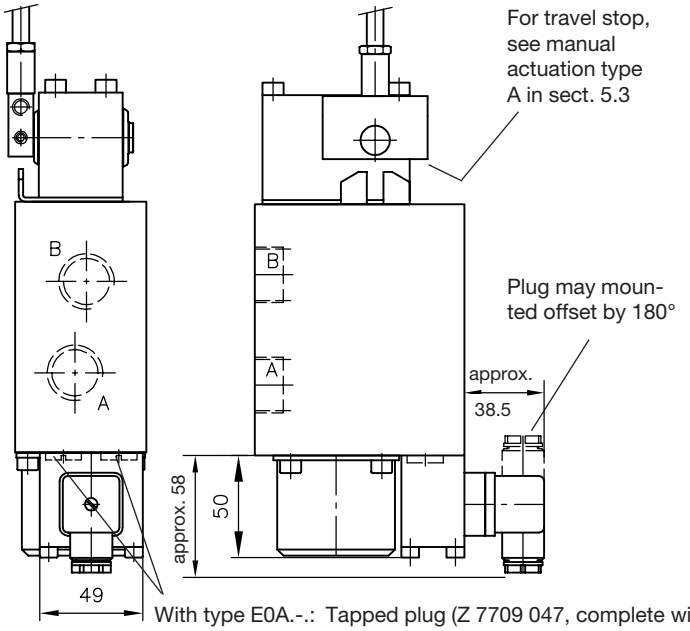
5.3 Directional spool valves with manual actuation A, C



Subsequent angling of the lever housing and/or exchanging the valve spools is possible, see sect. 6.3.4
Port B is not apparent with coding 58 (table 12, 13)

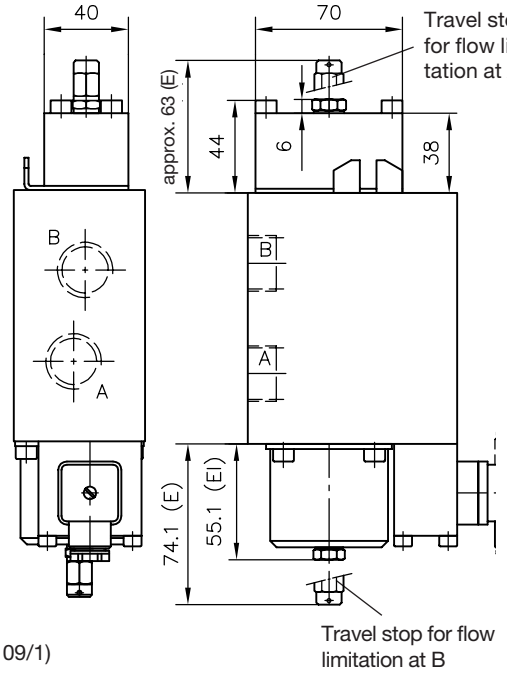
5.4 Directional spool valves with actuation EA, E0A, E

Actuation **type EA, E0A** [1)]



With type E0A.-.: Tapped plug (Z 7709 047, complete with
O-ring 12.42x1.78 HNBR 90 Sh
O-ring 9x1.5 NBR 90 Sh and O-ring 7625 109/1)

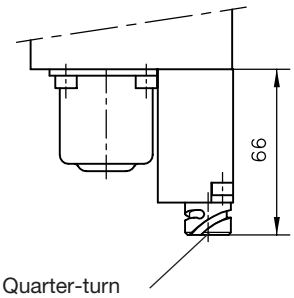
Actuation **type E, EI**



[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

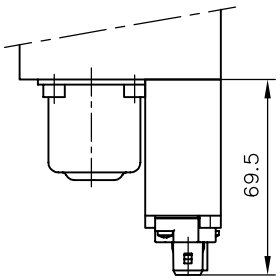
Additional solenoid versions

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

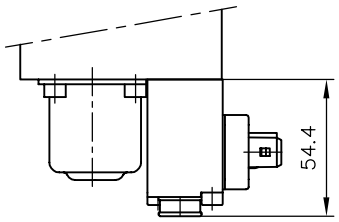


Quarter-turn
plug PA 6

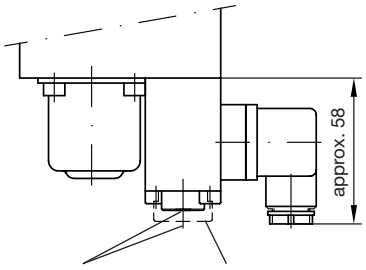
Coding **-AMP 12 K 4**
-AMP 24 K 4



Coding **-AMP 24 H 4 T**



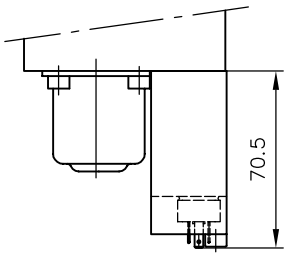
Coding **-G(X) 12 T**
-G(X) 24 T



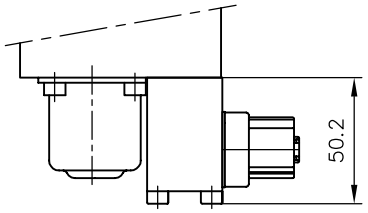
Manual emergency
actuation

Pushbutton
coding **TH**

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



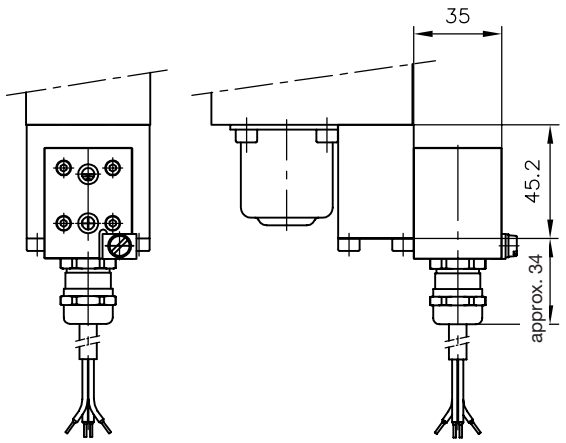
Coding **-DT 12**
-DT 24



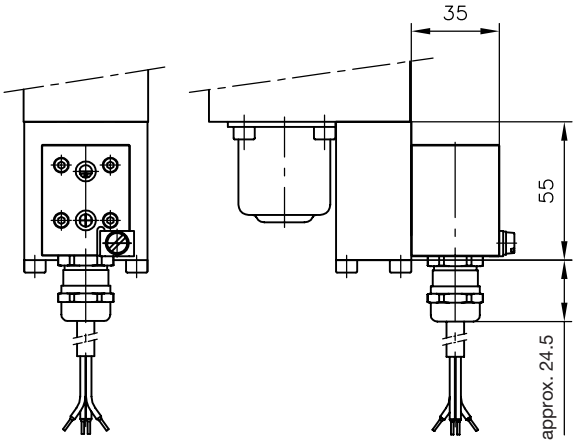
[1]) Lever housing at EA and HA (FA) can be angled at 180° in the same manner as described at sect. 6.3.4

[2]) This dimension depends on the manufacturer and may be up to 50 mm acc. to EN 175 301-803 A!

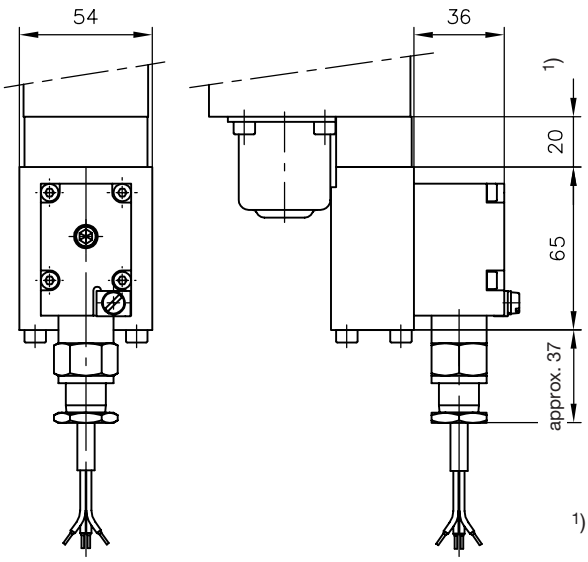
Coding **-G 24 EX**
-G 24 EX 4



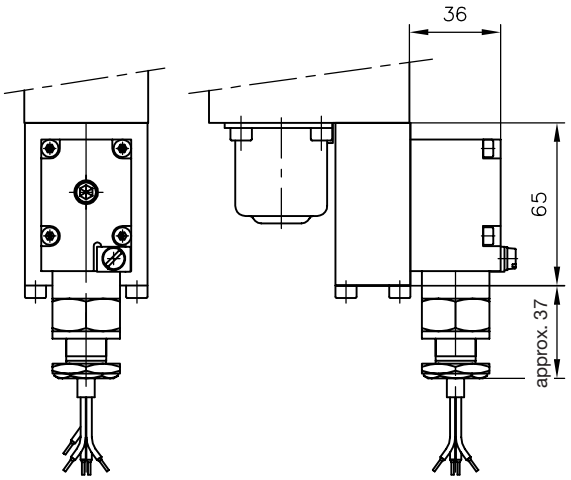
Coding **-G 24 TEX**
-G 24 TEX 4



Coding **-G 12 IS**
-G 24 MSHA
-G 24 M2 FP



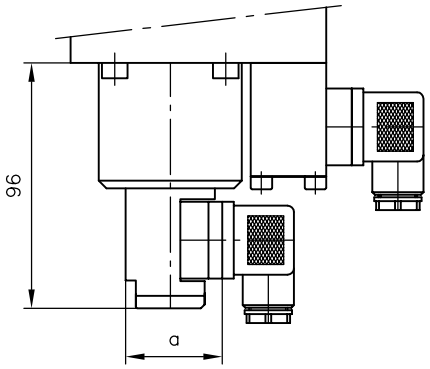
Coding **-G 24 TEX 70**



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

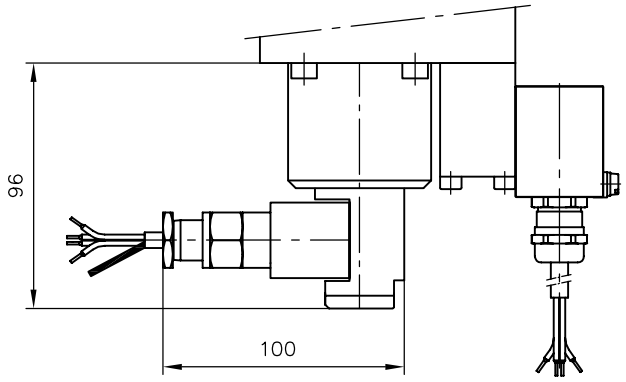
5.5 Lift monitoring

Type WA, U

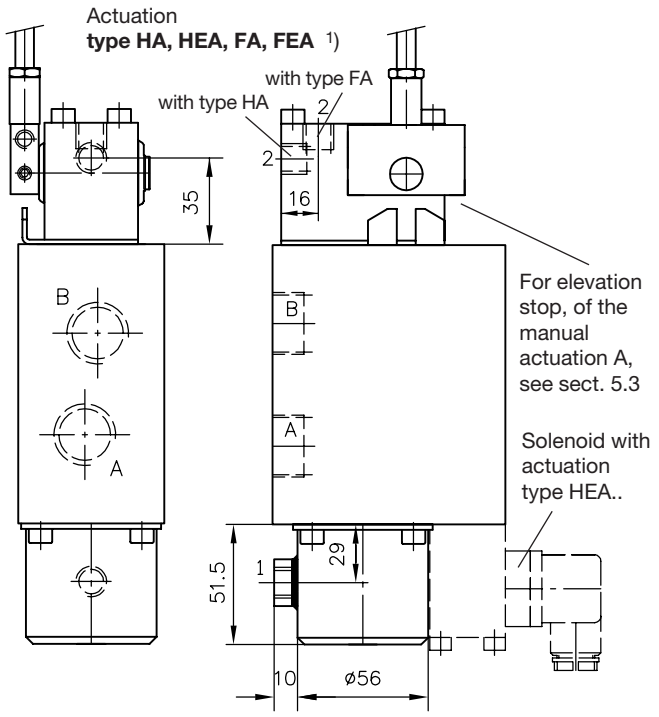


Type	a
WA	36.4
U	49.5

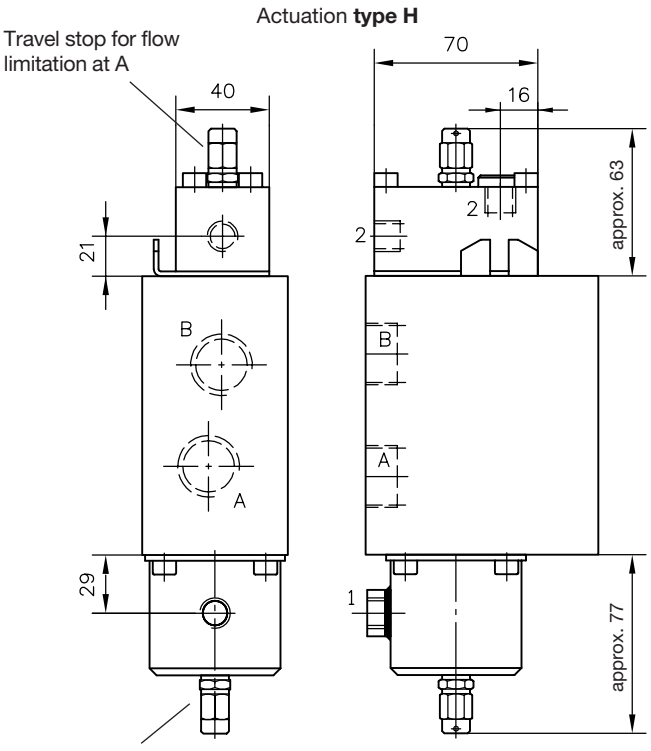
Type WA-EX
WA-M2 FP



5.6 Directional spool valves with actuation H, HA and HEA

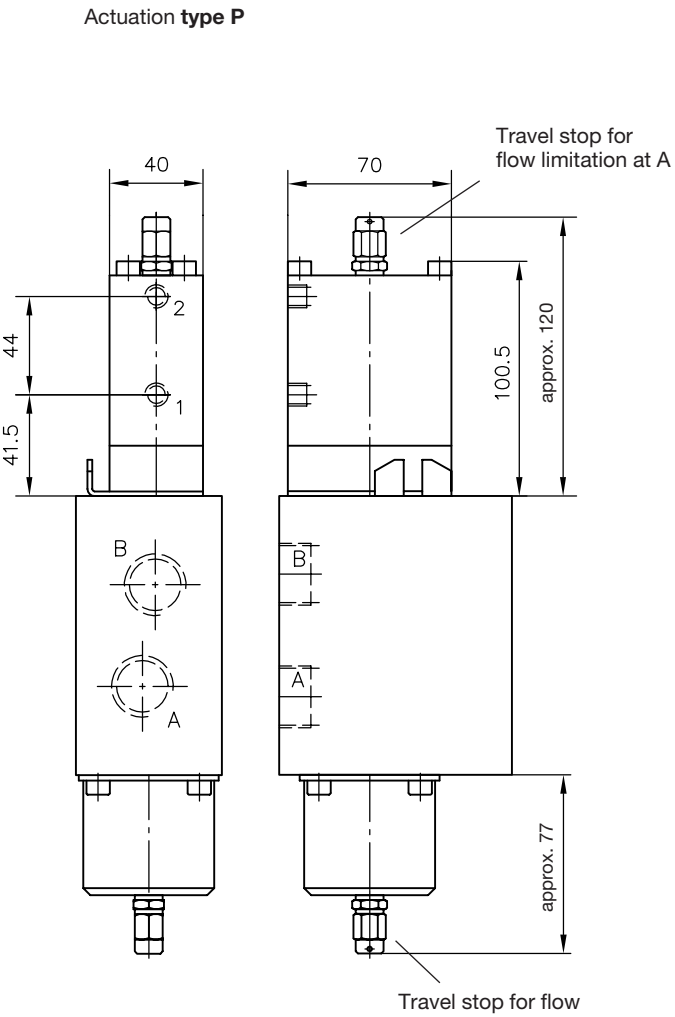


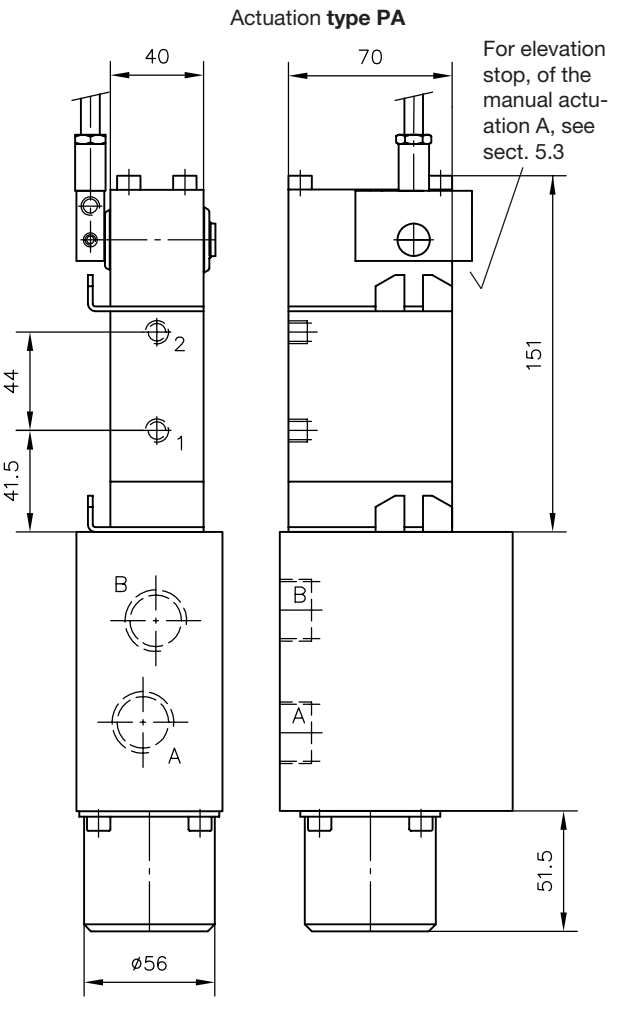
1) Lever housing at EA and HA (FH) can be angled at 180° in the same manner as described at sect. 6.3.4



Port 1 and 2:
= G 1/4 (ISO 228/1) (BSPP)
= 7/16-20 UNF-2B (SAE-4, SAE J 514)

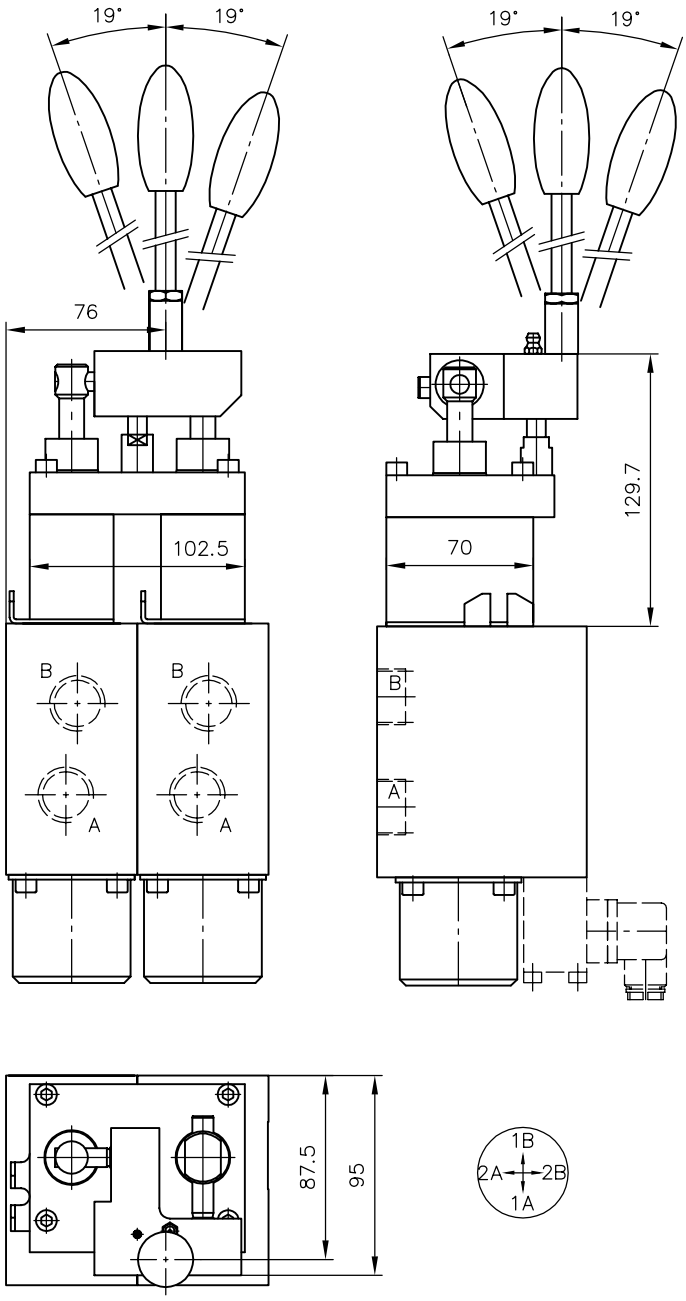
5.7 Directional spool valves with actuation P, PA





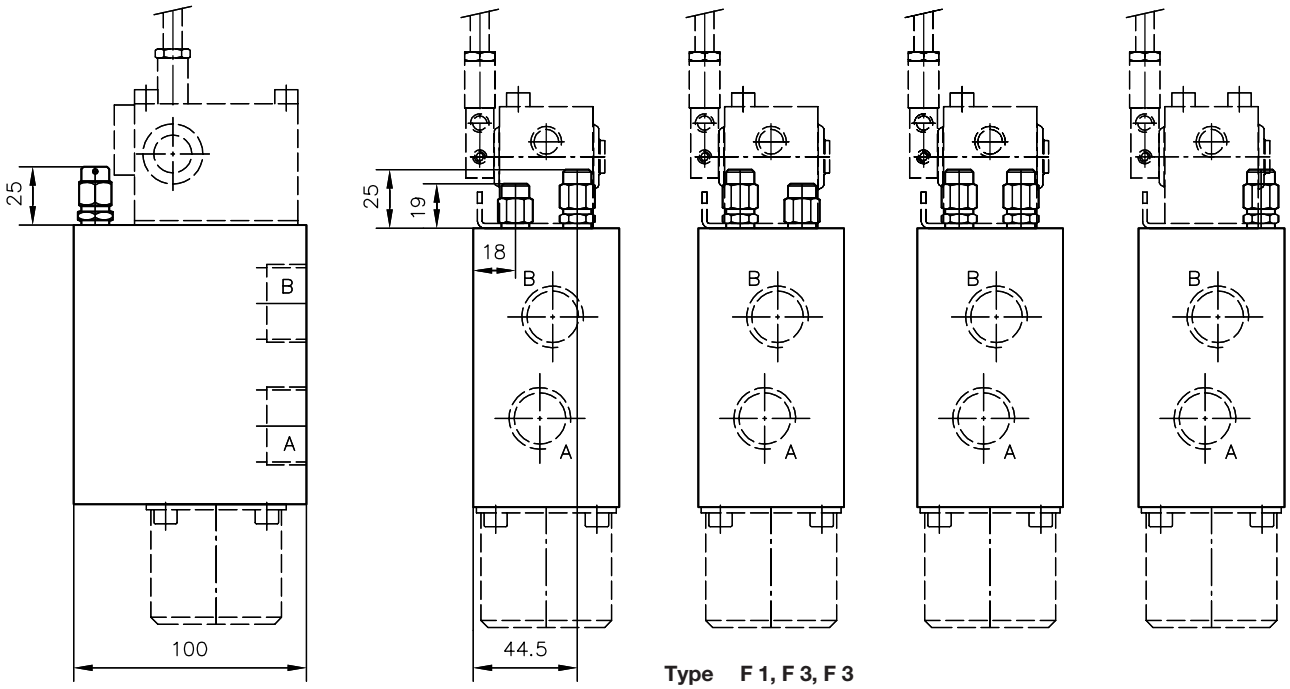
Ports conf. (ISO 228/1) (BSPP)
1, 2 = G 1/8

5.8 Mechanical 2-axis joy-stick



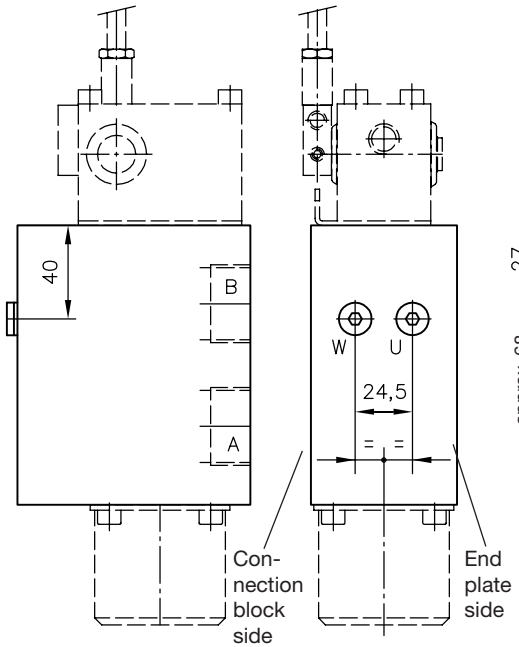
5.9 Spool valves with LS-pressure limitation, functional cut-off and prop. pressure limitation

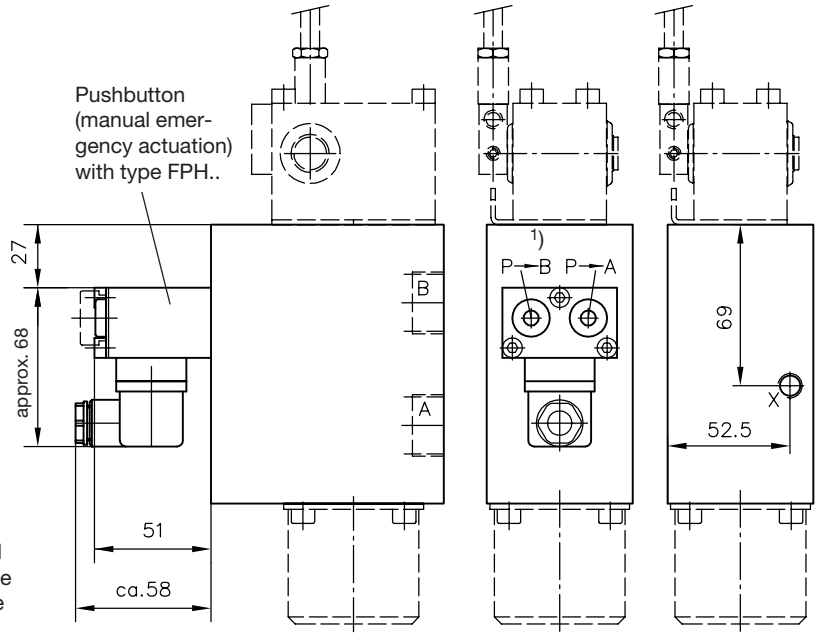
Type A... **Type B...** **Type A...B...** **Type C...**



Type **F 1, F 3, F 3**
FP 1, FP 2, FP 3
FPH 1, FPH 2, FPH 3

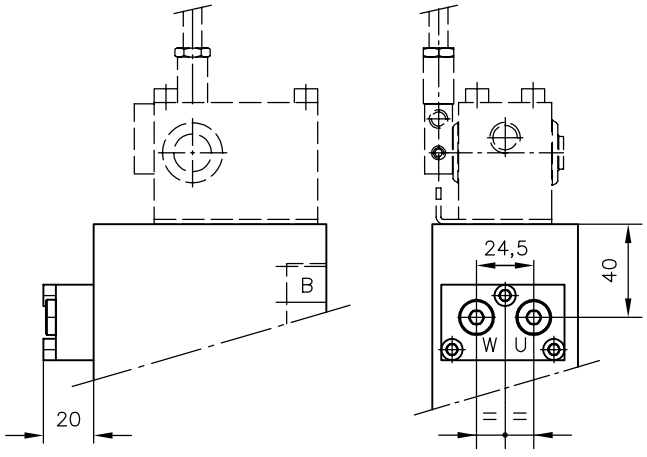
Type S





Type X

Type S 1



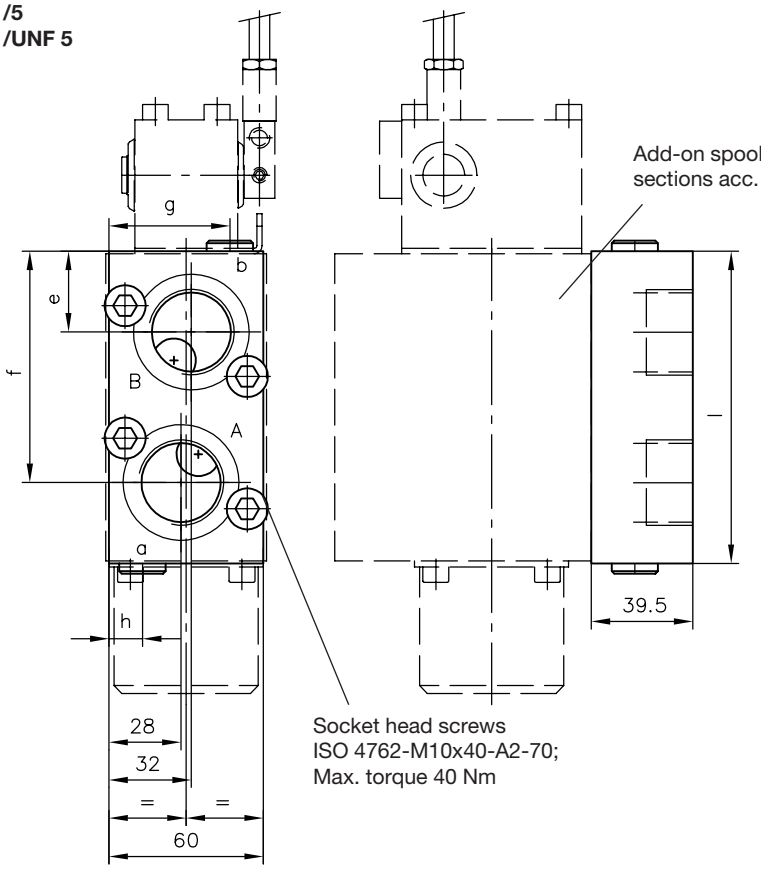
Ports conf. ISO 228/1 (BSPP):
U, W and X = G 1/8

For missing data (directional spool valves and actuations) see section 5.3 to 5.6!

[1]) Manual emergency actuation

5.10 Ancillary blocks

Type /5
/UNF 5

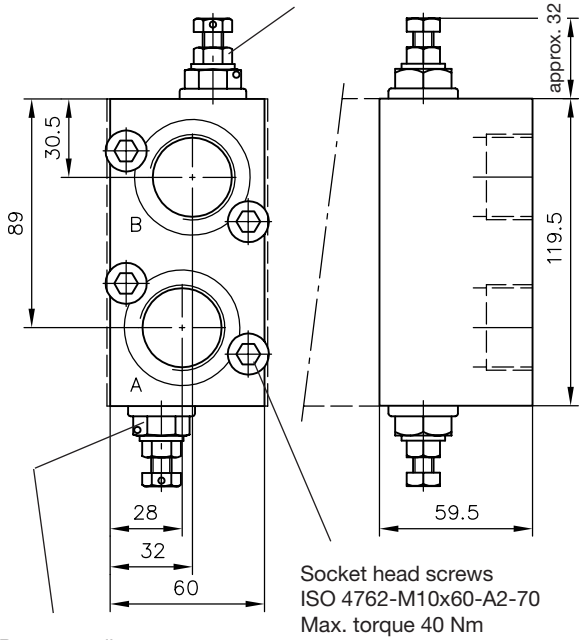


	l	e	f	g	h
/5	121.5	31.5	90	47	13
/UNF 5	119.5	30.5	89	19.5	40.5

Ports A and B :
/5.. = G 1 (ISO 228/1) (BSPP)
/UNF 5.. = 1 5/16-12 UN-2B (SAE-16, SAE J 514)

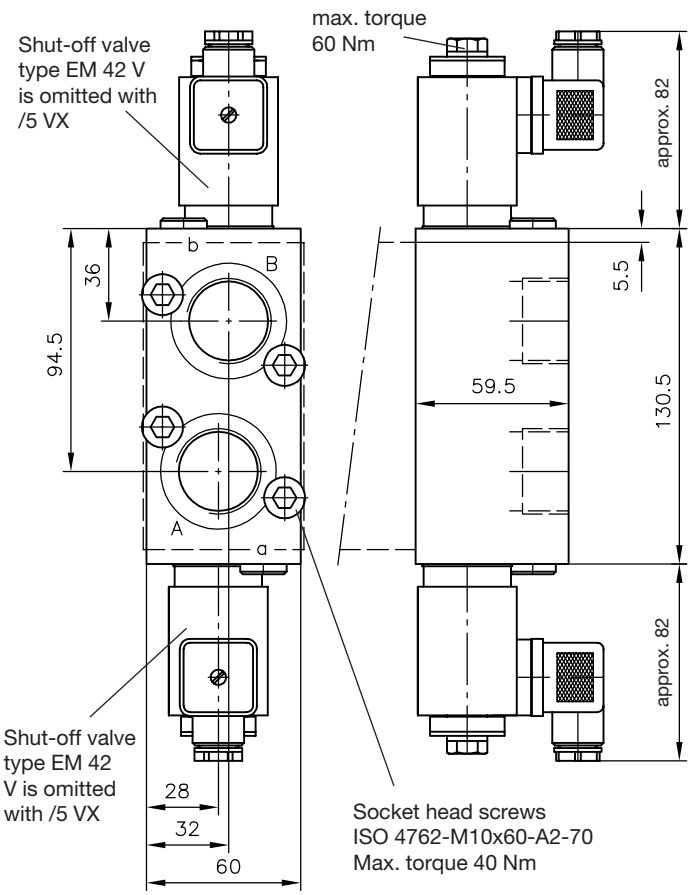
Ports a and b :
/5.. = G 1/4 (ISO 228/1) (BSPP)
/UNF 5.. = 7/16-20 UNF-2B (SAE-4)

Type /5 AS.. BS.. [1])
/UNF 5 AS.. BS..
/5 AN.. BN..
/UNF 5 AN.. BN..



Ports A and B :
/5.. = G 1 (ISO 228/1) (BSPP)
/UNF 5.. = 1 5/16-12 UN-2B (SAE-16, SAE J 514)

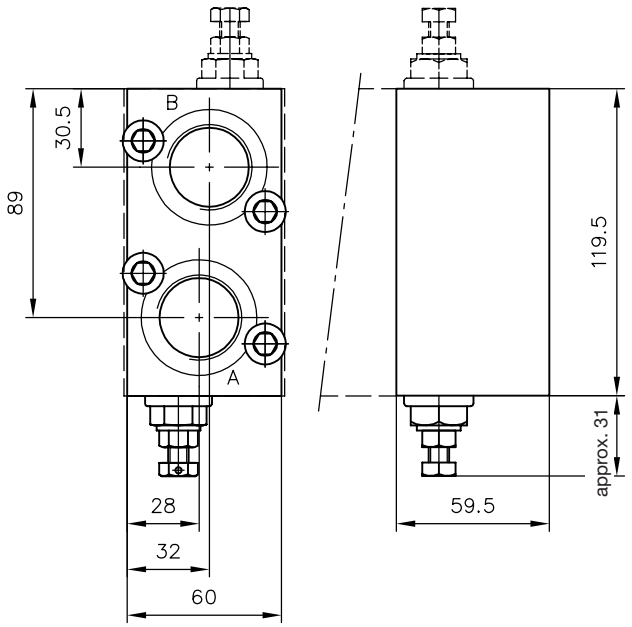
Type /5 VV(VX, XV) [1])



Ports a and b :
/5.. = G 1/4 (ISO 228/1) (BSPP)
/UNF 5.. = 7/16-20 UNF-2B (SAE-4)

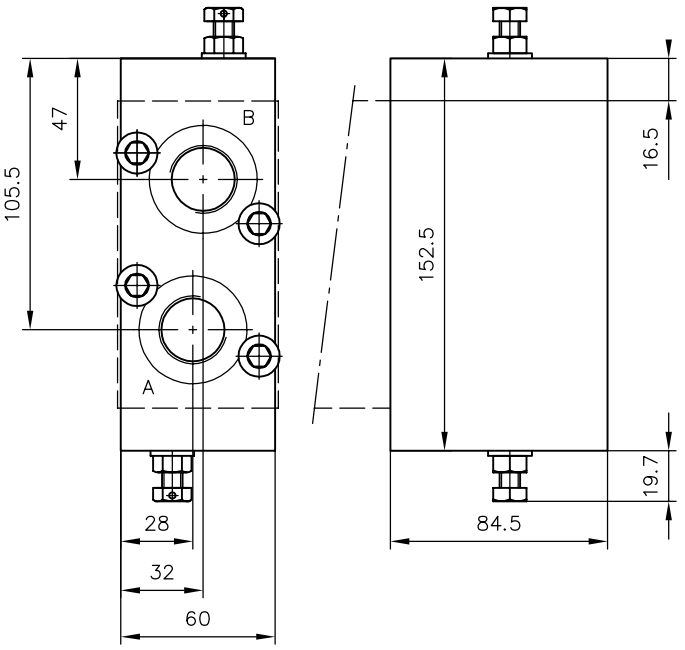
[1]) **Note:** Not all lever positions are possible.

Type /5 AN.. [1]
/5 BN..

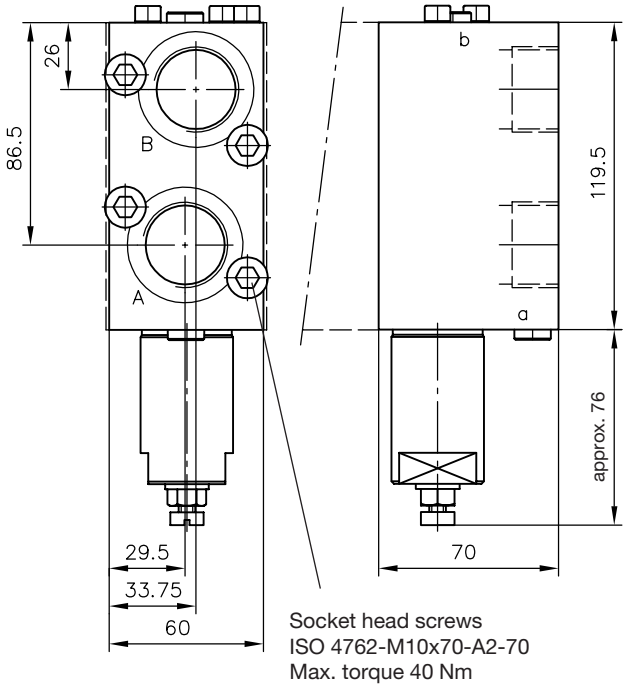


Ports A and B
/4.. = G 3/4 (ISO 228/1) (BSPP)
/5.. = G 1 (ISO 228/1) (BSPP)

Type /4 ASN.. BSN.. [1]

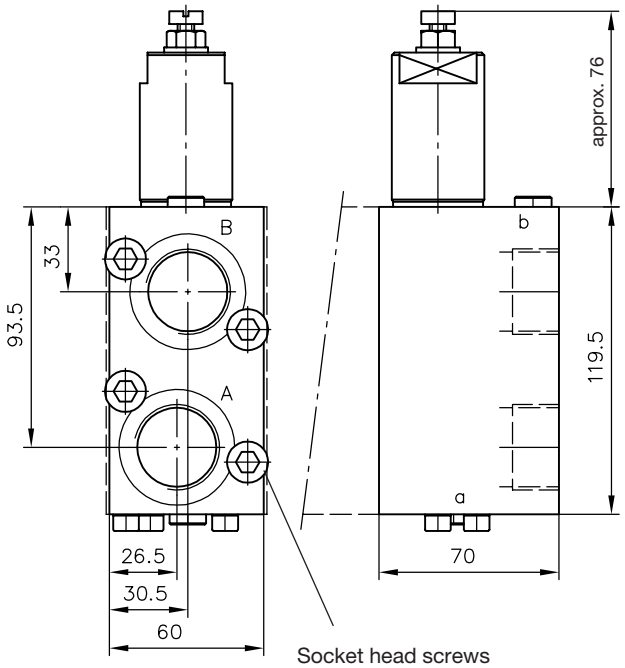


Typ /5 AL.. [1]



Socket head screws
ISO 4762-M10x70-A2-70
Max. torque 40 Nm

Type /5 BL.. [1]



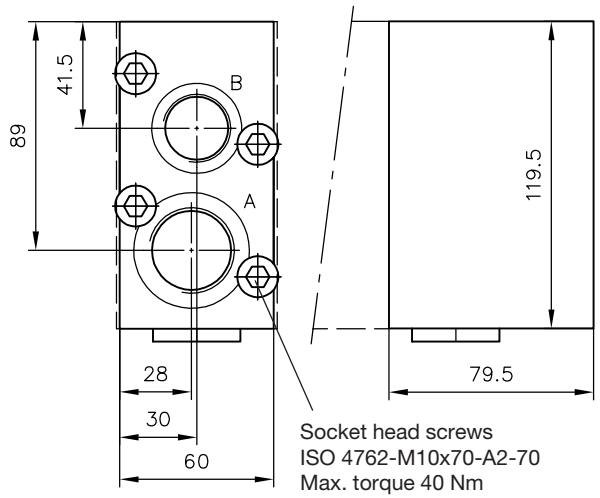
Socket head screws
ISO 4762-M10x70-A2-70
Max. torque 40 Nm

Ports a and b (ISO 228/1) (BSPP):
/5 AL.. = G 1/8
/5 BL.. = G 1/8

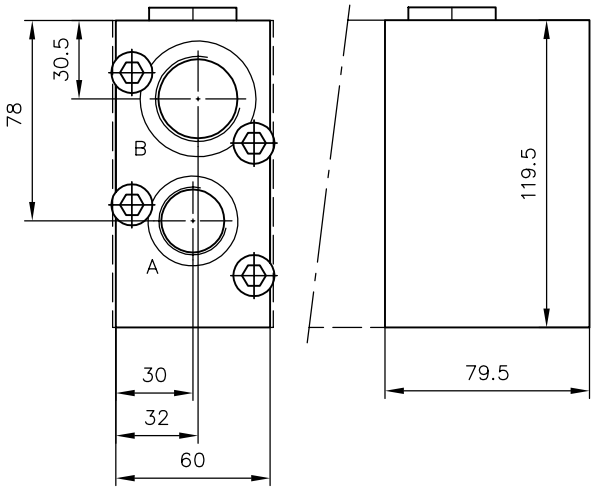
[1] **Note:** Not all lever positions are possible.

Continuation section 5.8. ancillary blocks

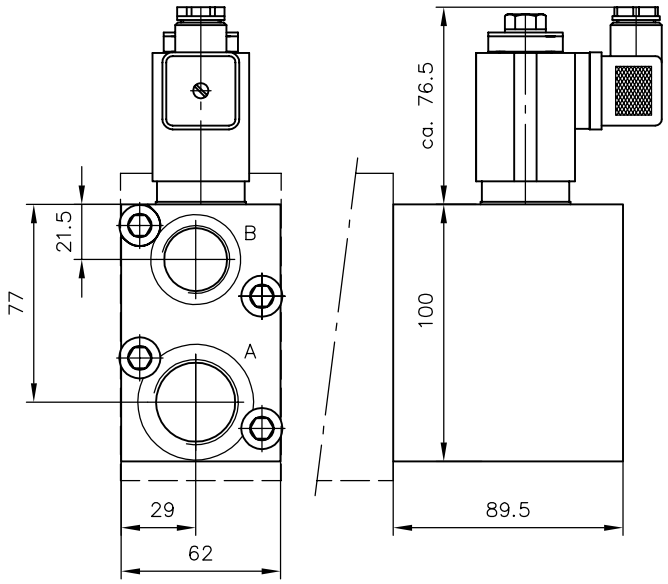
Type /54 DFA [1]



Type /54 DFB [1]

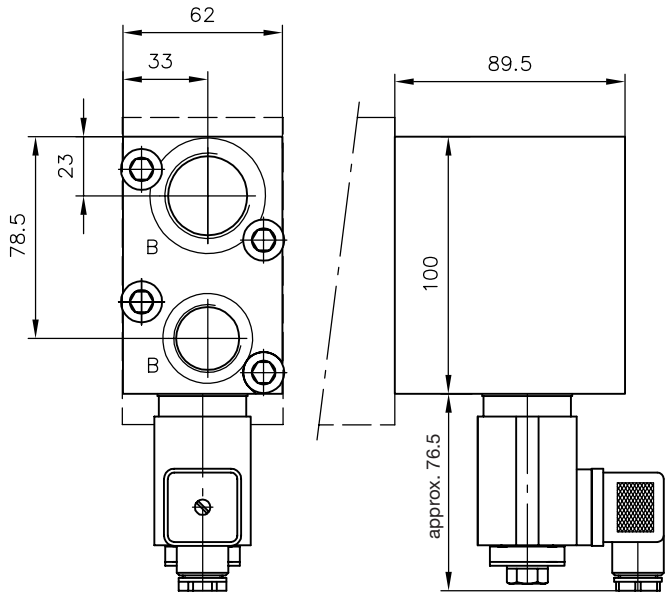


Type /54 DEA [1]



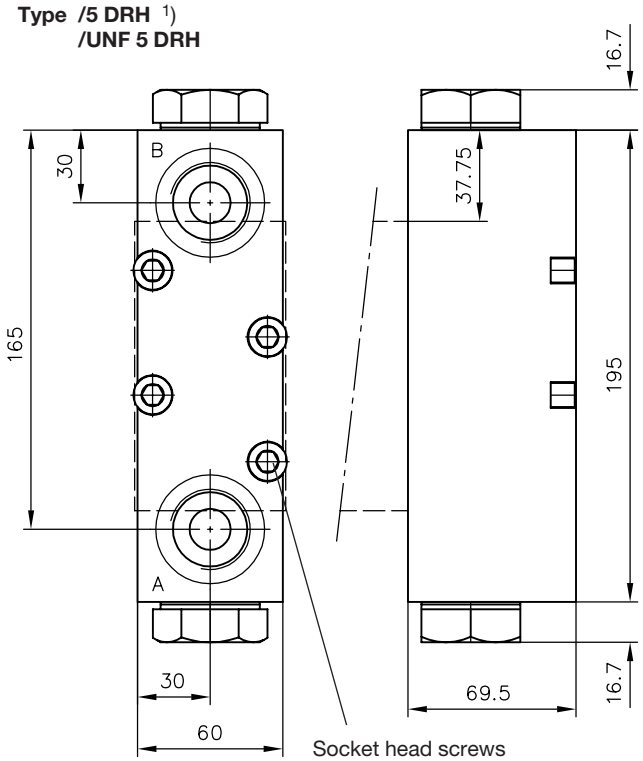
Ports A and B conf. (ISO 228/1) (BSPP)
/4.. = G 3/4
/5.. = G 1

Type /54 DEB [1]



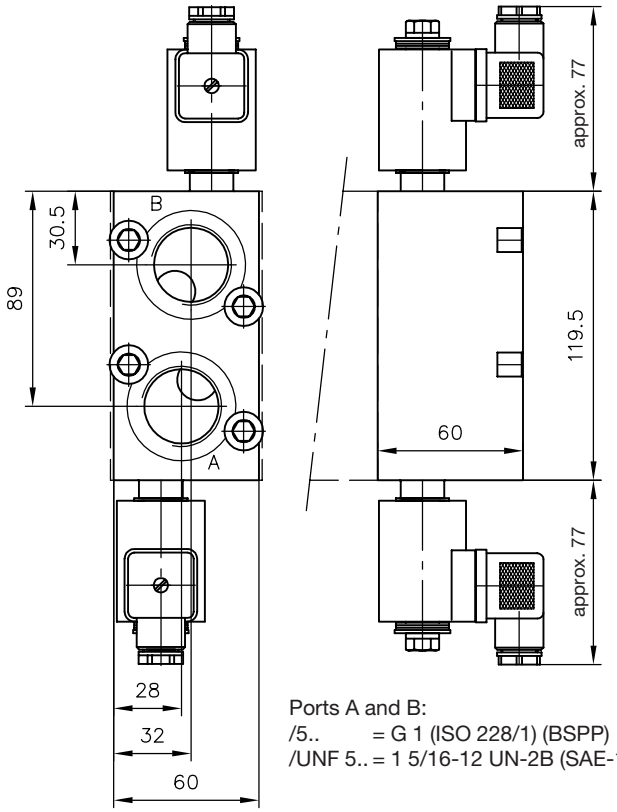
[1] **Note:** Not all lever positions are possible.

Type /5 DRH [1]
/UNF 5 DRH



Socket head screws
ISO 4762-M10x70-A2-70
Max. torque 40 Nm

Type /5 R VV [1]



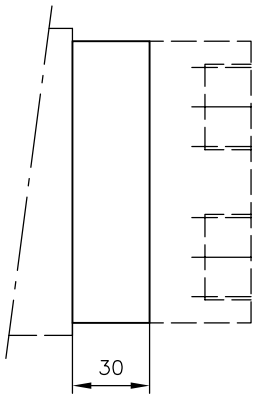
Ports A and B:
/5.. = G 1 (ISO 228/1) (BSPP)
/UNF 5.. = 1 5/16-12 UN-2B (SAE-16)

[1] **Note:** Not all lever positions are possible.

Continuation of sect 5.9

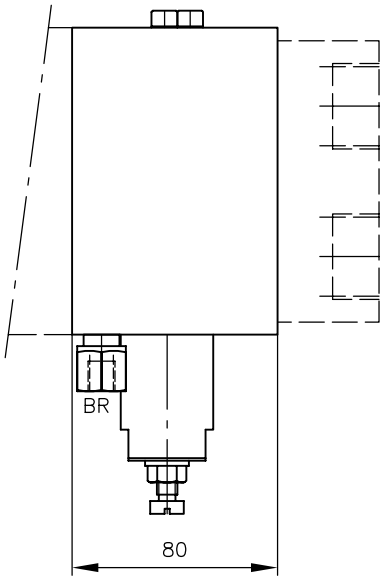
Ancillary blocks Intermediate plates for parallel connection

Type /Z 30

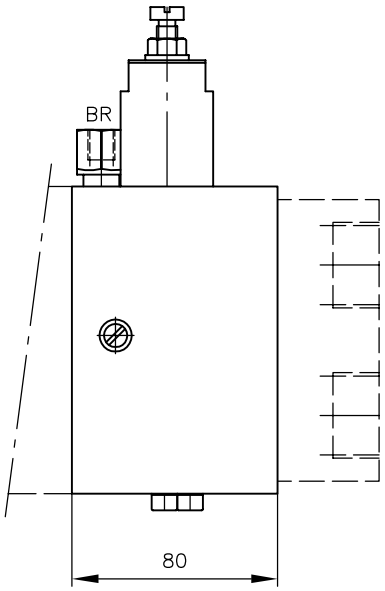


Port BR
G 1/8 (BSPP) or 7/16-20 UNF-2B

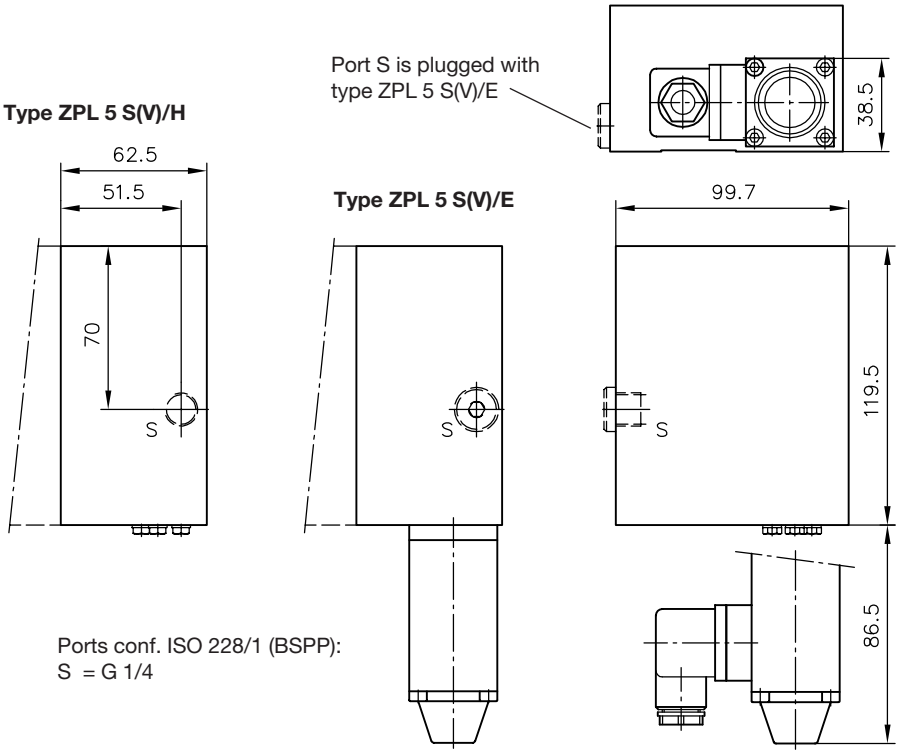
Type /Z ALW



Type /Z BLW

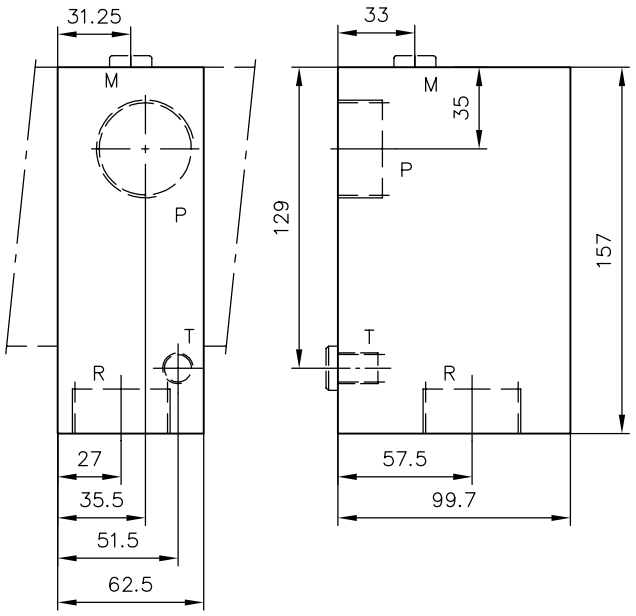


5.11 Add-on intermediate plates type ZPL 5...

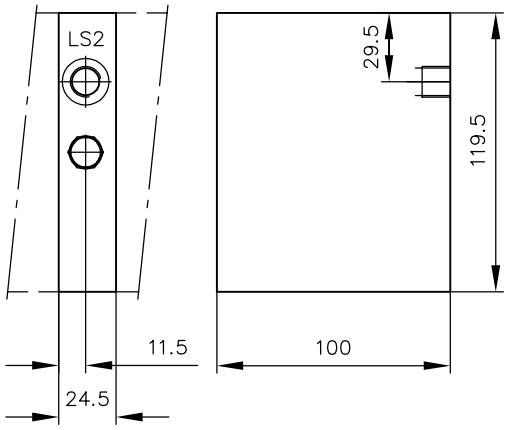


Ports conf. ISO 228/1 (BSPP):
S = G 1/4

Type ZPL 5 P6 R6
ZPL 5 P6 R6 ER



Type ZPL 50 T



Ports conf. ISO 228/1 (BSPP):
LS 2 = G 1/4
P and R = G 1 1/4

6. Appendix

6.1 Notes for selection and lay-out of

a) The connection block

There are additional damping variations available for the LS-signal duct listed in table 2 (apart from the standard versions acc. to sect. 3.1.1). These are required, if strong (load-) oscillations are externally induced on the control circuit. However, a general rule concerning the use of the one or the other variation can not be given. Both versions may be retrofitted any time.

To 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 occurring load pressure (LS pressure) drops below 25% of the (still remaining) pump pressure.

Attention: A minimum pump delivery flow of approx. 150 lpm must be maintained for electro-hydraulic actuation with internal control oil supply. The control pressure (≙ pump circulation pressure) is not sufficient for elevating the spool at lower delivery flows.

To coding Y and YH

Additional, pressure resistant port F for the excess oil from the 3-way flow controller. This enables to control separately located consumers by making use of the excess delivery flow not consumed by the prop. directional spool valve bank.
It is important that the pressure induced via port F is minimum 15 bar lower than the load pressure applied to the 3-way flow controller of the first valve bank, if a consumer connected to this valve bank is simultaneously operated. Otherwise the LS control system will fail, and the excess flow might be forced via the main pressure limiting valve.

To 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).

To coding H

When 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.

To 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	Residual pressure at load induced pressure of	
Coding	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 ≦ 60 mm^2/s

b) Spool valve sections

To coding 1 (example SL 5-5**1** L 120/63...)

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 (coding 2, 5), as the flow is then directly dependent on the control pressure of either the connection block's 3-way flow controller (type PSL approx. 10 bar), or the metering valve of a variable displacement pump (approx. 14 to 20 bar) for 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 therefore defines the available flow in the system. As soon as another valve with higher load pressure is actuated now, the flow for the first consumer can only be regulated by throttling, i.e. if the highest load pressure varies, the spool elevation (= throttling) of the first valve section has to be reset to maintain a constant delivery flow to the consumer. This consumer flow can be calculated approximately by:

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

To coding 2 (example SL 5-5**2** 0 63/63...)

The standard version of the spool valve section is load compensated and is equipped with an inflow controller (coding 2). Due to the control pressure of the inflow controller (approx. 6 bar), it regulates a constant flow related only to the spool elevation (groove edges at the spool act like a metering orifice), making its delivery independent of other consumers or system pressure:

$$Q \approx \sqrt{\Delta p_{controller} \cdot A_{valve\ spool}}$$

To coding 5 (example SL 5-A **5** H 160/160...)

This version features an increased control pressure enabling higher consumer flows (see also above coding 1 and 2). The pressure of this flow controller (coding 5) is approx. 10 bar resulting in a 1.3 higher flow when compared to the standard version (coding 2).

To coding 7 (example SL 5-A **7** H 160/160)

Like coding 5. To be used only together with variable displacement with connection block type PSV and variable displacement pump / constant pressure system because of the necessary pressure drop.

To coding R 2, R 5 and R 7

Beside its control function the flow controller acts also as a check valve. Thus preventing a possible flow reversal in case of insufficient supply from the pump.

To coding 8, 81, 82 (example SL 5-58 L 120/160...)

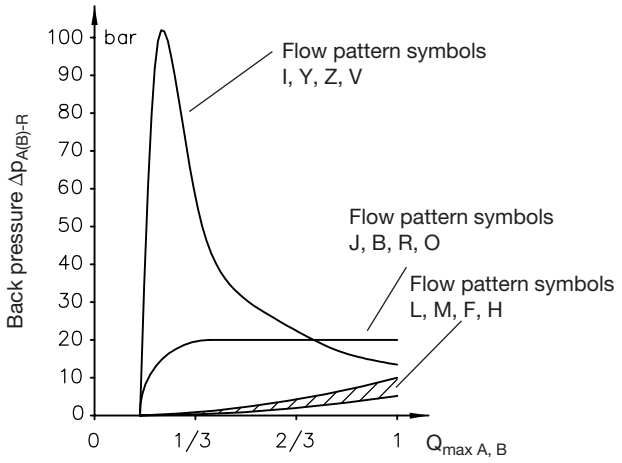
To ensure max. flow for all subsequent valve sections, the highest flow rating (.../160) must be selected for the B side (continuation of P).

c) Flow-pattern variations

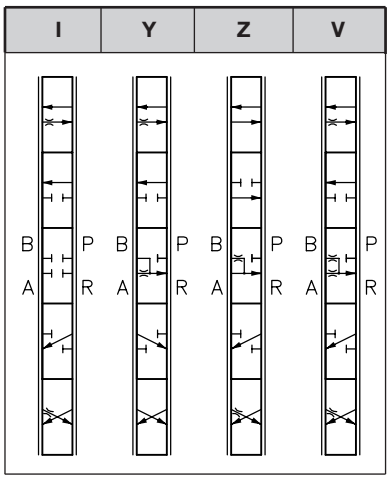
Flow-pattern symbol J, B, R, O and I, Y, Z, V

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 $\Delta p_{A(B)-R}$ 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 $\Delta p_{A(B)-R}$ 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



Symbole



Available versions:

SL 5 - I 25/25
I 120/120
I 140/140
I 160/160

SL 5 - Y 150/150

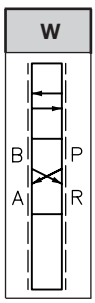
SL 5 - Z 80/80

SL 5 - V 25/25
V 120/120
V 140/140

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).

Symbol



Available versions:
SL 5 - W 120/120

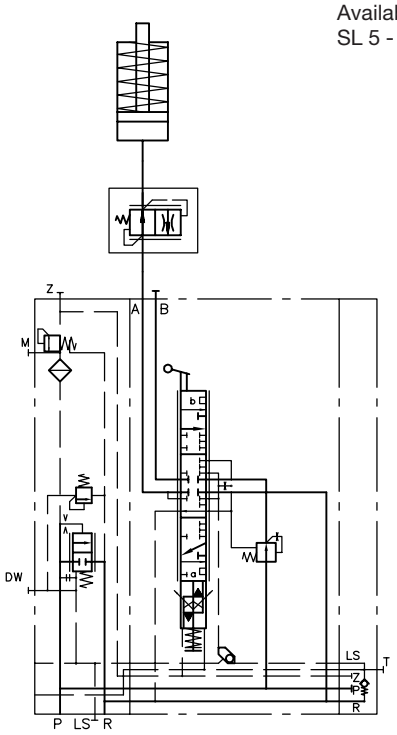
Coding acc. Table 13	$Q_{max\ A, B}$ (lpm)
2	120
(1)	150
5	150
7	175

Flow pattern symbol G

3-position 3-way-spool for single acting cylinder
Restrictions:

- No LS-Signal while lowering
- Therefore only usable at open center systems (type PSL) and electric actuation with restrictions – idle pump circulation pressure approx. 11 bar
- The lowering function is just a throttle valve function (load dependent lowering speed). The system needs to be protected by a separate flow control valve (to limit the max. speed e.g. with type SB acc. to D 6920).

Available versions:
SL 5 - G 160/160



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

Maritime ambient climate

The aggressive sea atmosphere requires sufficient corrosion protection of all moving part of the actuations 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 nitrided 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 actuations when excessive pressure peaks do occur in the return line (during rapid on/off of consumers). 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

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 10 spool valves

A total of max. 10 spool valves can be linked, via a consecutive connection of the LS-signal duct. It is irrelevant, whether the spool valves are arranged in one or more valve banks. This restriction is caused by the limited oil flow being available (ensuring slow-motion movements). A chaining via external shuttle valves is to be used, if more than 10 spool valves in separated directional spool valve banks are to be coupled via the LS-signal.

h) Mechanical 2-axis joy-stick

Two neighboring valve sections (functions) can be simultaneously actuated via hand lever

Order coding: PSL 51/250 - 5
- 52 L 160/80/K ┐
- 52 H 80/63/K ┘ joint actuation
- 52 L 120/63/A-E 1

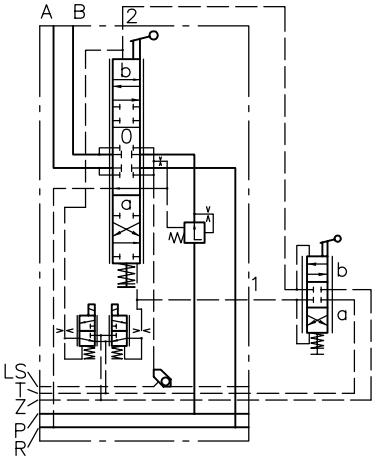
(It is possible to combine this mechanical 2-axis joy-stick with electro.-hydraulic actuation)

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.

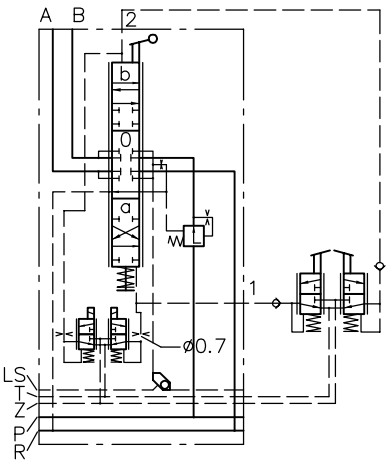
Combination with hydraulic control devices like type FB and KFB acc. to D 6600 and D 6600-01

These control devices can be directly connected, due to their function and low inner leakage.



Combination with common hydraulic joy-sticks

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 actuation. 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).



j) Recommended optional components
For electro-hydraulic actuations

1. Plugs — MSD 3-309 (standard, is 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 card can control two directional valves (including board holder).
3. Electric amplifier — EV 1 M2 acc. to D 7831/1
   EV 1 D acc. to D 7831 D
   A remote control joy-stick 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, Schweden)

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 5)
Proportional spool valve type PSL(V) size 3 acc. to D 7700-3
(can be combined via intermediate plate ZPL 53 with size 5)
Proportional spool valve type PSL(V)F size 3 and 5 acc. to D 7700-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

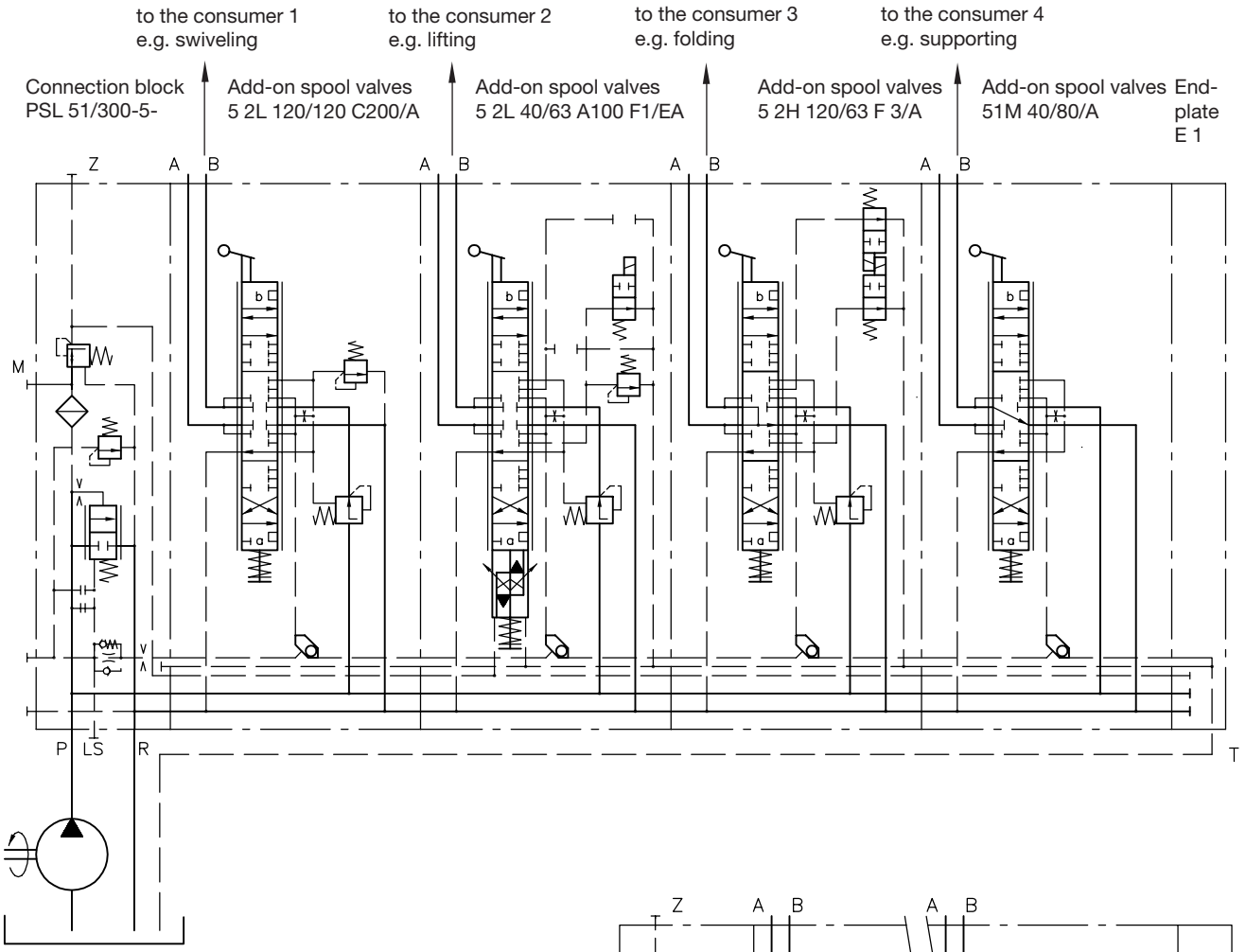
6.2 Schaltungsbeispiele

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

Example 1:

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

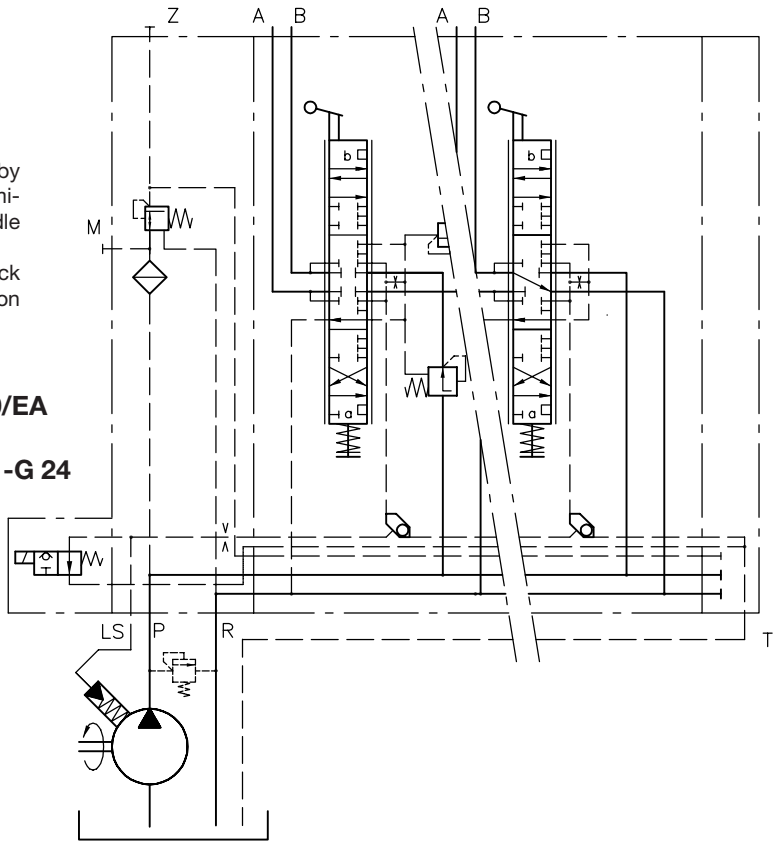
PSL 51/300 - 5 - 5 2 L 120/120 C 200 /A
- 5 2 L 40/63 A 100 F 1/EA
- 5 2 H 120/63 F 3/A
- 5 1 M 40/80 /A-E 1-G 24



Example 2:

ExampleControl by PSV; Pressurized oil supply by variable displacement pump without pressure limiting valve, but with solenoid valve for arbitrary idle pump circulation.
Only difference to example 1 is the connection block with similar versions and arrangement of the add-on valves.

PSV 51 F-5 - 5 2 L 120/120 C 200/A
- 5 2 L 40 /63 A 100/EA
- 5 2 H 120/63 F 3/A
- 5 1 M 40 /80/A-E 1-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.

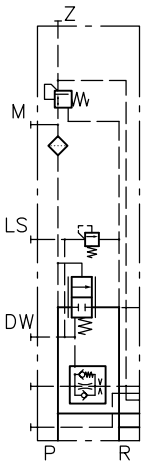
6.3.2 Piping

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

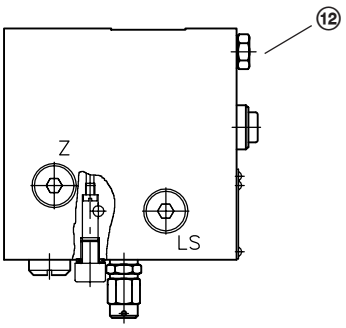
6.3.3 Notes for converting the connection block

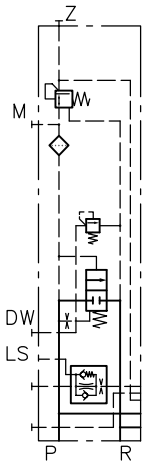
The connection blocks type PSL 5(6)...-5 and PSL UNF 6..-5 can be converted any time into a connection block for variable displacement pump systems (correct type then PSV 55 S../..-5 or PSV UNF 6 S). This requires replacing the parts listed below.

Attention: The screw (parts No. 6380 013) ⑩ Dor carburetor jet M4x0.6 ⑪ Eare 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(6) U(H) and PSL 6 Y since the integrated valve combination forbids a combination with variable displacement pump systems.
It is necessary to replace the tapped plug by the damping screw S ⑫ (7778 301), while converting a type PSV to type PSL (does not apply to type PSV 5(6) S..-5 and PSV UNF 6 S..-5; as these are already equipped with it).

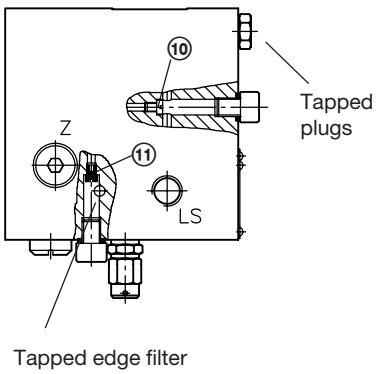


Type PSL 5(6)./...-5



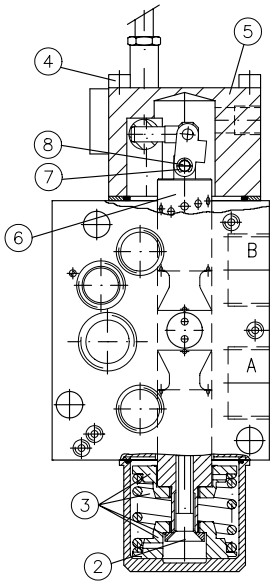


Type PSV 5(6) S./...-5



6.3.4 Notes on changing the spool

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



Advice on changing the valve spool

1. Slacken screws ① (ISO 4762-M6x8-8.8-A2K), remove spring cover
2. Remove screw ② (M8x40, machined flat head screw drawing DIN 7991)
3. Remove spring assembly including spring cap ③
4. Slacken screws ④ (ISO 4762-M6x60-8.8-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

Note: The control grooves of the valve spool should always be installed towards the end plate!
Exception: Valve spools with flow coding 160 do not show control grooves

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 7700-51
Valve section	DS 7700-52
In addition for pneumatic actuation	DS 7700-53
Intermediate plate ZPL 53	DS 7700-32
Intermediate plate ZPL 52	DS 7700-22