Throttle and shut-off valves type AV

for oil pressure systems

Pressure p_{max} = 500 bar
Flow Q_{max} = 100 lpm

Corner valve for direct pipe connection

Cartridge valve

1. General information

Type AV 2.. and AV 3.. are widely used as:

- As shut-off valve, closes completely sealed in shut condition.
- As drain valve for very gentle lowerin of single-acting weight-loaded hydr. cylinders.
- For precision-controlled relieving of high pressures, e.g. in test stands.
- To control working speeds by throttle.

Unit construct of all-steel with hardened, finish-ground and wear -resistant valve seat as well as hardened and finish-ground valve cone (needle valve), adjustable by screw spindle with precision thread. The valve cone projects into the valve seat hole which together form a ring-shaped aperture where the pressure drop needed for the throttling effect is produced. It must be remembered that the limited flow rate resulting from the throttle adjustment is dependent on the viscosity of the pressure oil. If for instance after a prolonged period of operation the oil viscosity becomes less on account of higher temperatures, the throughput of oil will increase with the aperture remaining the same. Consequently the working speed will increase. The throughput of oil malso changes in dependence on the differential pressure bat the throttling point with constant adjustment (e.g. if the back pressure changes). Therefore it is only practical to control the working speed by throttle if the speed is allowed to change in relationship to the load.
The viscosity-or differential pressure-controlled characteristics of the throttle valves are of no significance in the case of application as shut-off valve and sometimes also during simple lowering cycles.
Throttle control therefore is a method of loss control, since part of the flow of oil is carried away via the pressure limiting valve where its energy component is converted into heat. As a rule speed control should only be employed in case of small performance values.
It must be taken into account that in case of throttle control the oil always flows in the direction of A→B. If applied in the opposite direction, the valve cone could, in case of fine adjustment, be pulled onto the seat like a non-return valve and damaged owing to the play at the spindle fastening.

2. Available versions, main data

Version		Coding	Connection mode		Pressures p_{max}	Flow Q_{max} (lpm) [1]	Poids approx. (kg)	Symbol
Cartridge valve	Standard	**AV 2 E**	Locating (hole for section 4)		500	40	0.6	AV 2(3) and AV 2(3) E
		AV 3 E			400	100	1.0	
	with check valve	**AV 3 RE**			400	100	1.2	
Corner valve for direct pipe connection	Standard	**AV 2**	G 1/2	Ports conforming ISO 228/1 (BSPP)	500	40	0.6	AV 2(3)R and AV 3 RE
		AV 3	G 3/4		400	100	1.7	
	with check valve	**AV 2 R**	G 1/2		500	40	0.6	
		AV 3 R	G 3/4		400	100	1.7	

[1]) This figures apply to a flow in throttled direction and a back pressure of approx. 10 bar

3. Additional parameter

Nomenclature, design	Throttle and shut-off valves; with or without by-pass check valve
Surface protection	All steel parts are zinc galvanized
Flow direction	A → B
Installed position	Any
Hydraulic fluid	Fluids 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 mm²/s Optimal operation range: approx. 10...500 mm²/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.
Temperature	Ambient: approx. -40...+80°C, fluid: -25...+80°C, pay attention to the viscosity range! Start temperature down to -40°C are allowable (Pay attention to the viscosity range during start!), as long as the operation temperature during subsequent running is at least 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.

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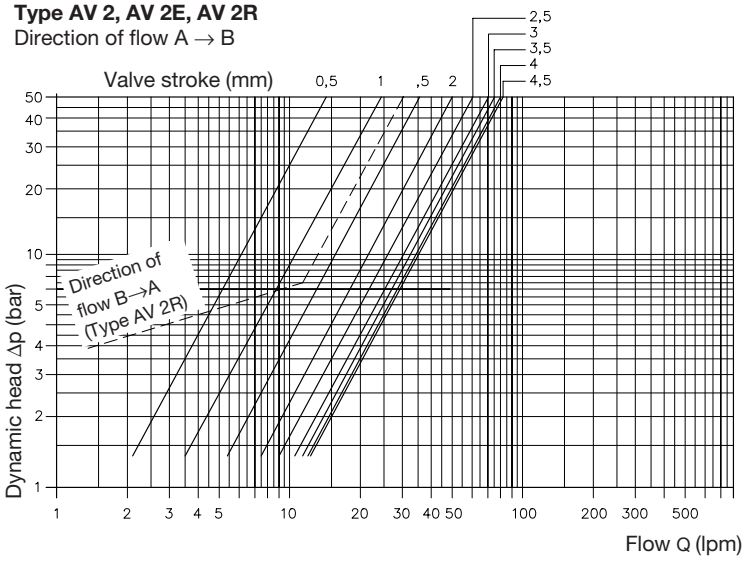
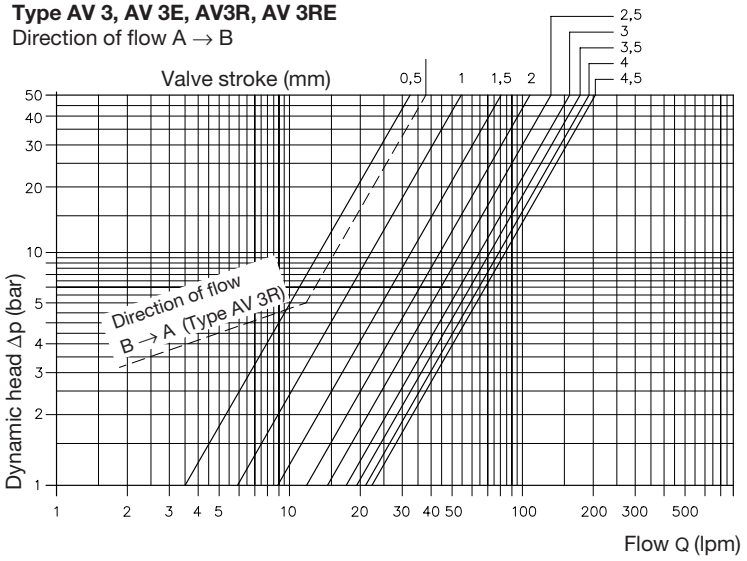
Δp-Q-Characteristics
Throttle resistances (mean values)

The coordinate charts show the relationship between the rate of flow Q (lpm) and the expected pressure drop Δp (bar) at 53 mm²/s oil viscosity and different valves strokes. In case of other viscosity's the bands of straight lines move slightly to the left (thicker oil) or to right (tinnier oil).
The coordinate charts therefore only give approximate values which can be a help in determining the size of valves.

Type AV 2, AV 2E, AV 2R
Direction of flow A → B

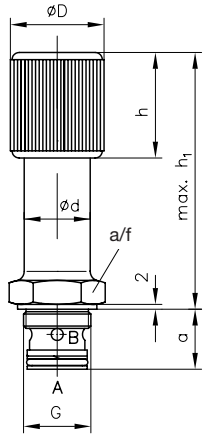


Type AV 3, AV 3E, AV3R, AV 3RE
Direction of flow A → B

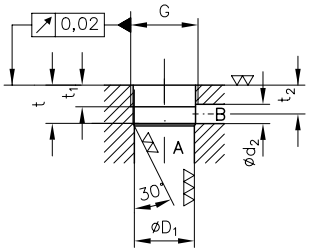


4. Unit dimensions

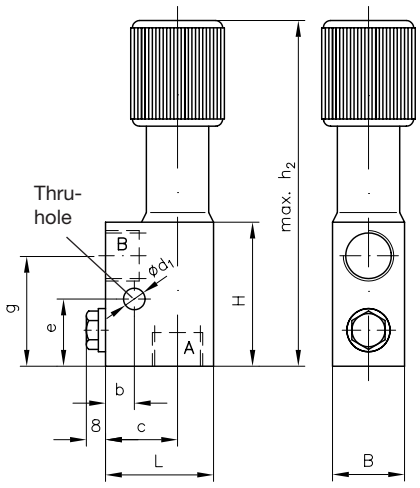
Cartridge valve
Type AV.. (R)E



Mounting bore



Corner valve for direct pipe connection
Type AV 2(R), AV 3(R)



Type	L	H	B	ØD	ØD1	a	b	c
AV 2E	45	60	30	40	25H8	25	12	30
AV 3(R)E	60	70	40	50	36H8	38	15	40
AV 2(R)	45	60	30	40	--	25	12	30
AV 3(R)	60	70	40	50	--	38	15	40

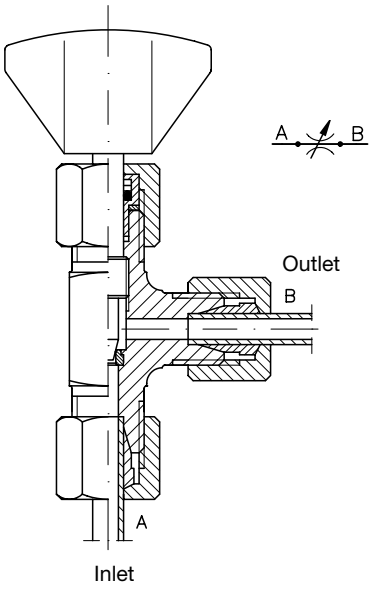
Type	Ød	Ød1	Ød2	e	g	h	h1	h2
AV 2E	26	9	8	28	46	45	115	145
AV 3(R)E	35	11	12	30	52	60	143	198
AV 2(R)	26	9	--	28	46	45	115	145
AV 3(R)	35	11	--	30	52	60	153	198

Type	t	t1	t2	G	a/f
AV 2E	16	9	12	M28x1.5	36
AV 3(R)E	26	14	18	M40x1.5	46

All dimensions in mm, subject to change without notice!

Shut-off valves, series AVT and AVM

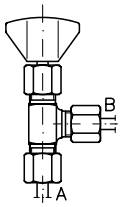
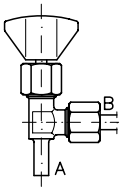
Operating pressure p_{max} = 630 bar
Flow Q_{max} = 100 lpm



1. General

Conical seated shut-off valves for pipes to pressure chambers in general, to pressure gauges, pressure switch units, control lines, drain l ines, connecting lines etc. The allow the drainage (decompression) of pressurized volumes and also switching (pressure build-up) e.g. in the test rig etc. The functional parts are incorporated in the T-housing of standard pipe connections and allow direct pipe connection by way of an cutting ring and union nut. Valve seats and valve cones are hardened and ground, is electrogalvanized. This results in precise blocking of the opening when the valve is closes without the risk of de maging the cone (pressing in when closed too forcibly) and good protection against corrosion of the outside surfaces.

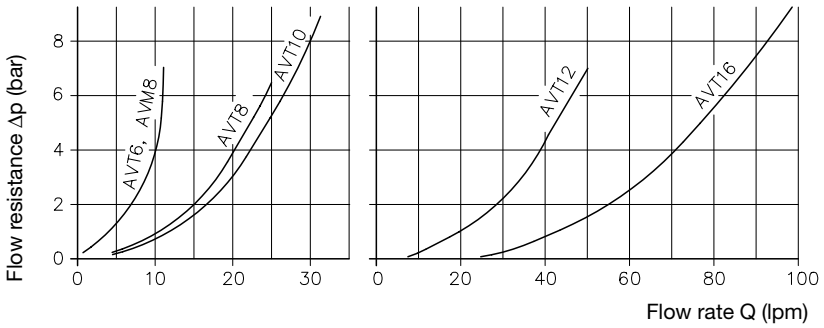
2. Types available, main data

Type		Coding	Connecting pipe $\varnothing_A$ (mm)	Operating pressure p_{max} (bar) Outlet B	Inlet A [2]	Mass (weight) approx.g
	with pipe connection on both sides	**AVT 6**	6	630	630	140
		AVT 8	8	630	630	175
		AVT 10	10	630	630	230
		AVT 12	12	630	630	315
		AVT 16	16	300	400	440
	with pipe socket on one side [1]	**AVM 8**	8	500	630	110
		AVM 8 L	8	315	315	100

[1] Preferably as press.gauge shutoff valve. The pipe socket allows the combination with straight screw parts or angle pieces to adjustable connecting elements. Also see D 7077, Sk 6900 H or Sk 7200 M.

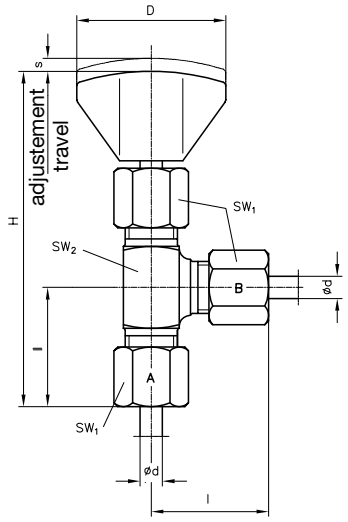
[2] See sect. 3 “Operating press.”

3. Characteristic data

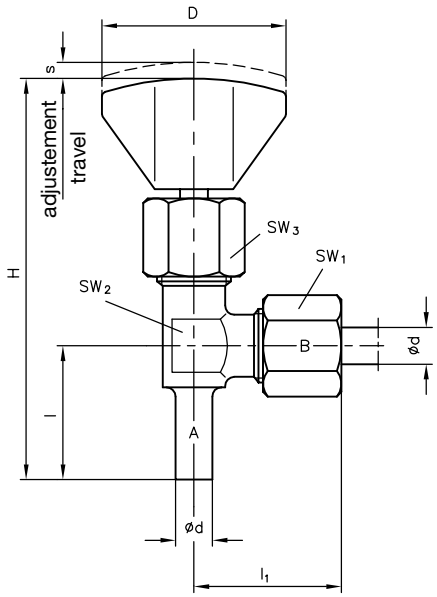
Designation and type	Shut-of valve with threaded handle operation
Use	For opening or closing (blocking) lines
Installation pos. and mounting	Any, freely suspended in pipeline
Material and surface protection	Steel. Seat and ball hardened and ground, housing surface galvanized and yellow chromated
Flow direction	Preferably A → B, so that A is the inflow side or the pressure side to be blocked and so that the blocked element (pressure gauge, pressure switch unit) or the continuing pressure line or return line is at B.
Blocking	Effective in both directions
Operating pressure	p_{max} (Sect. 2); correspond to rated pressure with 4-fold safety against bursting Pressure at B: Permissible system pressure when valve is open Pressure at A: Permissible overload capacity at inlet A when the valve is closed
Hydraulic fluid	Fluids 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 mm²/s Optimal operation range: approx. 10...500 mm²/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. Temperature Ambient: approx. -40...+80°C Fluid: -25...+80°C, pay attention to the viscosity range! Start temperature down to -40°C are allowable (Pay attention to the viscosity range during start!), as long as the operation temperature during subsequent running is at least 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.
Δp-Q-Characteristics Valid for fully-opened valve Oil viscosity during messurement appr. 60 mm²/s	

4. Dimensions of units

Type AVT ...



Type AVM 8



Type	H	D	Ød	l	s	SW1	SW2
AVT 6	91	40	6	31	3	17	14
AVT 8	94	40	8	32	3.5	19	17
AVT 10	94	40	10	34	4.5	22	19
AVT 12	114	50	12	38	5	24	22
AVT 16	123	60	16	43	8	30	24

Type	H	D	Ød	l	l1	s	SW1	SW2	SW3
AVM 8	91	40	8	29	32	3.5	19	14	19
AVM 8 L	92	40	8	30.5	30	3.5	17	17	19

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

Restrictor check valves type BC

for screwing into threaded boreholesn

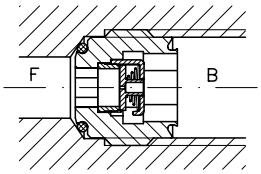
Pressure p_{max} = 700 bar
Flow Q_{max} = 60 lpm

For check valve type RC without orifice, see D 6969 R

1. General information

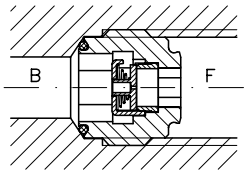
These valves enable unrestricted flow in the direction F → B and throttle the flow in the opposite direction in the same way as a hole or slot diaphragm. The valve housings are designed in such a way that they can be screwed into standard threaded boreholes with offset tap drill holes, drilled with conventional 118° drill point angles, and in both directions of operation.
Some kind of throttle sections has to be provided, when these valves are used in consumer circuits where an accumulator effect togehter with rapidly switching directional valves are apparent, which would otherwise cause pressure flow surges (decompression) in direction F → B. These throttle sections (e.g. small flow boreholes) are to be fitted and designed in such a way that, when the pressure drop occurs at the start of decompression, no flow rate takes place which is greater than permissible.

Valve throttles in screw-in direction



Unrestricted flow →
Throttled flow ←

Valve throttles in counter-direct. to screw thread



Unrestricted flow ←
Throttled flow →

2. Available versions, main data

Order examples: **BC 2 - 0,8** Cartridge
BC 1 - 0,6 G Housing design

Table 3: Design

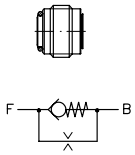
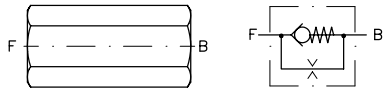
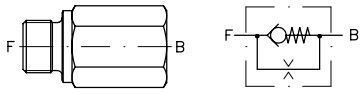
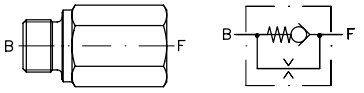
Cartridge	Version with housing for pipe connection	
Without coding 	**G** 	Pipe connection on both sides
	E 	Coding E and F are only differing in the screw-in direction of the restrictor check valve.
	F 	

Table 2: Throttles

Available for	Slot type orifice depths in 1/1000 (mm)					Hole orifice, hole diameter ∅ (mm)									
						0.2	0.4	0.5	0.6	0.8	1.0	1.2	1.5	1.8	2.0
	20	**30**	**40**	**60**	**80**	**0,2**	**0,4**	**0,5**	**0,6**	**0,8**	**1,0**	**1,2**	**1,5**	**1,8**	**2,0**
BC 1... [1]	●	●	●	●	●	●	●	●	●	●	●	●			
BC 2...							●		●	●	●	●	●		
BC 3...							●		●	●	●	●	●	●	●

Table 1: Basic type, size

Standard, with thread ISO 228/1 (BSPP)		with metric fine thread DIN 13 T6		Pressure p_{max} (bar)	Flow Q_{max} (lpm)
BC 1	G 1/4 A	**BC 14**	M 14x1.5	700	20
BC 2	G 3/8 A	**BC 26** **BC 28**	M 16x1.5 M 18x1.5	700	35
BC 3	G 1/2 A	**BC 30** **BC 32**	M 20x1.5 M 22x1.5	500	60

[1] Version with increased opening pressure, see also sect. 3 "Opening pressure"

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3. Further data

Nomination	Restrictor check valve with spring-loaded valve plate designed as hole or slot diaphragm
Installation position	Any
Opening pressure F → B	Serie = 0.05 ... 0.07 bar Size 1 also available with opening pressure approx. 1.5 bar; Order coding: BC 1 - **60/1**
Flow direction	F → B Unrestricted flow B → F Throttled flow
Surface	All versions with housing (G, E, and F) are zinc galvanized
Flow	20 ... 60 lpm, see table 1

Mass (weight) approx. g

		BC 1 (14)-...	BC 2 (26, 28)-..	BC 3 (30, 32)-...
Cartridge	6	15	25	
Housing design	G	75	105	170
	E and F	60	85	145

Pressure fluid

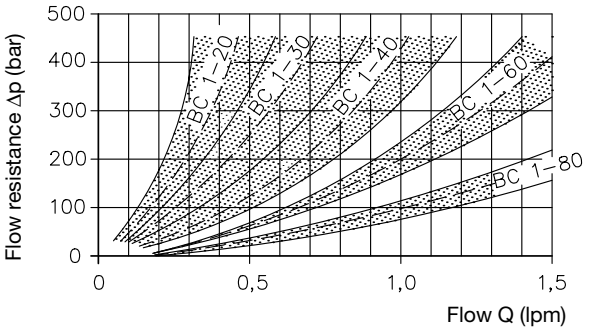
Hydraulic oil conforming DIN 51524 part 1 to 3: ISO VG 10 to 68 conforming DIN 51519.
Viscosity limits: min. approx. 4, max. approx. 1500 mm²/s;
opt. operation approx. 10... 500 mm²/s.
Also suitable are biologically degradable pressure fluids types HEPG (Polyalkylenglycol) and HEES (Synth. Ester) at service temperatures up to approx. +70°C.

Temperature

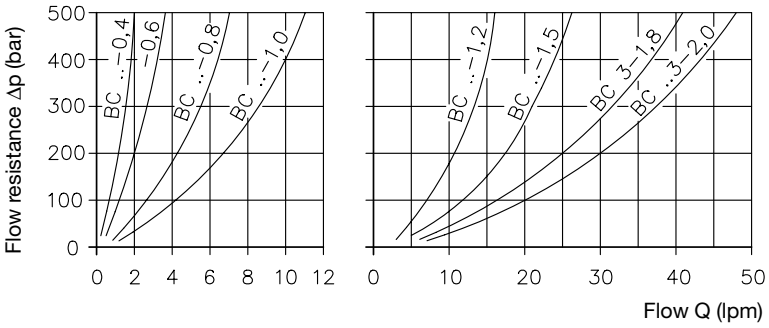
Ambient: approx. -40 ... +80°C
Fluid: -25 ... +80°C, Note the viscosity range !
Permissible temperature during start: -40°C (observe start-viscosity!), as long as the service temperature is at least 20K higher for the following operation.
Biologically degradable pressure fluids: Observe manufacturer's specifications. By consideration of the compatibility with seal material not over +70°C.

Δp-Q-curves

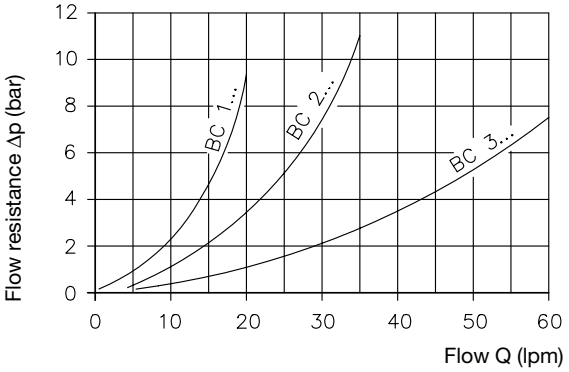
Throttled flow B → F



– – – = Mean value in each particular scatter range (manufacturing tolerances)



Unrestricted flow F → B

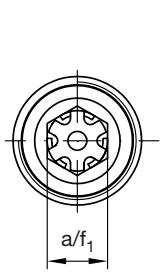


Viscosity during measurements approx. 60 mm²/s

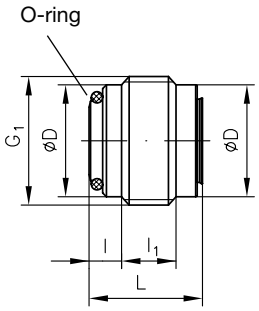
At viscosity above appr. 500 mm²/s, the Δp values deviate more and more as they increase.

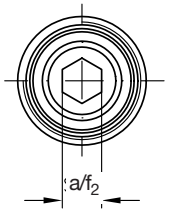
4. Unit dimensions

Cartridge



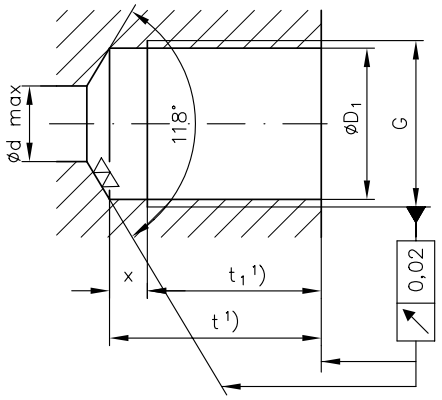
Larger Allan key for installation (side B)





Smaller Allan key for installation (side F)

Location hole



Caution: Do not apply box spanner with force, as this may cause damage to the internal valve components (BSPP)

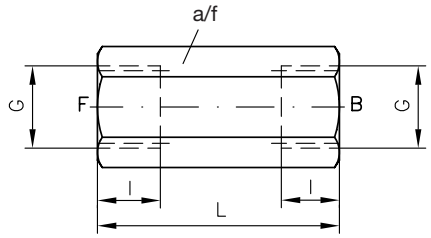
Type	G	G1	L	l	l1	D	D1	d	t	t1	x	a/f1	a/f2	O-ring NBR 90 Sh	max. starting torque M_A (Nm)
BC 1	*G 1/4	*G 1/4 A	13	3.5	6	11.6	11.8	8	25.5	22.5	3	8	4	9x1	9
BC 14	M 14x1.5					12.2	12.5								
BC 2	*G 3/8	*G 3/8 A	15	4.3	7.2	14.8	15.25	9	27	24	3	9	5	10x1.5	15
BC 26	M 16x1.5					14.2	14.5								
BC 28	M 18x1.5					16	16.5								
BC 3	*G 1/2	*G 1/2 A	18	5	8	18.5	19	12	32.5	28.5	3.5	12	8	14x1.5	40
BC 30	M 20x1.5			5.5	7	18.2	18.5								
BC 32	M 22x1.5			5	8	20	20.5								

1) Dimensions t and t1 are minimum values.
The screw thread runout x may be smaller but cannot be lager than the value given in the table (fitting requirement)!

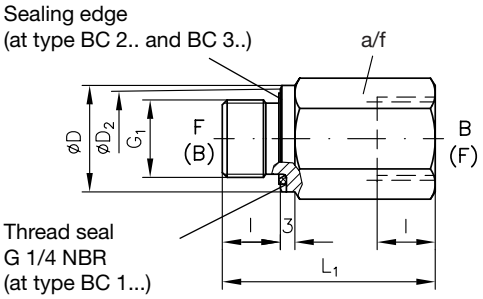
*G.. = (BSPP)

Housing design

Type BC ... G



Type BC ... E and F



Type	G	G1	∅D	D2	L	L1	l	a/f	max. torque (Nm)
BC 1	*G 1/4	*G 1/4 A	19	---	46	43	12	19	40
BC 14	M 14x1.5			16		42			
BC 2	*G 3/8	*G 3/8 A	22	20.5	50	44	12	22	80
BC 26	M 16x1.5		22	20				22	
BC 28	M 18x1.5		24	22				24	
BC 3	*G 1/2	*G 1/2 A	26	24	56	52	14	27	150
BC 30	M 20x1.5		25	24				27	
BC 32	M 22x1.5		27	26				30	

All dimension in mm and subject to change without notice!

Restrictor check valves type BE

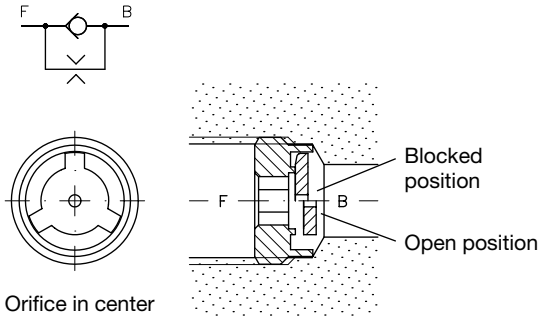
for screw in into simple tapped holes

Operating pressure p_{max} = 500 bar
Flow Q_{max} = 120 lpm

For check valves type RE D 7555 R
Restrictor check valves type BC (spring loaded) D 6969 B

1. General information

Restrictor check valves type BE stand out due to their very simple and space-saving design. They consist only of the valve seat and a small disc (no spring. i.e. there is no trouble caused by cracked of springs). The small disc and valve seat are hardened and ground.
These valves are to be screwed into simply shaped, tapped holes. The sealing of the inlet to outlet is of metallic type and takes place at the contact area between the facial cutting edge and the stepped shoulder of the core diameter at the location thread. Any standard steel drill (point angle 118°) automatically forms this stepped shoulder when the core diameter is drilled.
Restrictor check valves type BE enable a free flow in direction F→B and restrict the flow in opposite direction B→F similar to the basics of an orifice.



2. Available versions, main data

Order examples:
BE 2 - 0,8 Cartridge valve
BE 1 - 0,6 G Version with housing

Table 3: Design

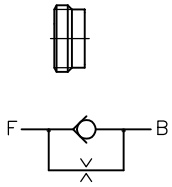
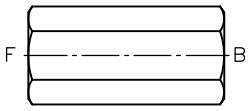
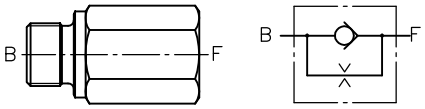
Cartridge valve	Body version for pipe connection
no coding 	**G**  Tapped ports for pipe connection on both sides
	F 

Table 2: Orifice

Avail-able with	Slot-type throttle depth in 1/1000 mm)		Orifice -∅ (mm)												
			0.4	0.6	0.8	1.0	1.2	1.5	1.8	2.0	2.3	2.5	3.0	3.5	4.0
	20	**40**	**0,4**	**0,6**	**0,8**	**1,0**	**1,2**	**1,5**	**1,8**	**2,0**	**2,3**	**2,5**	**3,0**	**3,5**	**4,0**
BE 0	●	●	●	●	●	●									
BE 1...			●	●	●	●	●	●	●	●		●	●		
BE 2...			●	●	●	●	●	●	●	●	●	●	●	●	●
BE 3... [1]			●	●	●	●	●	●	●	●		●	●		
BE 4..			●	●	●	●	●	●	●	●		●	●	●	

Table 1: Basic type, design

Standard, with pipe thread ISO 228/1 (BSPP)		with metric fine thread DIN 13 T6		Pressure p_{max} (bar)	Flow Q_{max} (lpm)
BE 0	G 1/8 A			500	12
BE 1	G 1/4 A			500	25
BE 2	G 3/8 A			500	40
BE 3	G 1/2 A	**BE 30** **BE 32**	M 20x1.5 M 22x1.5	450	80
BE 4	G 3/4 A			400	120

[1]) also available BE 32 -0.5

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September 2008-00

3. Further characteristic data

Nomenclature	Restrictor check valve without spring, valve shim either with hole or slot
Installation position	Any
Opening pressure F → B	A small pressure surge is required to ensure closing of the valve, if the valve is mounted in a position, where the disc doesn't automatically lie on the seat, due to its weight.
Flow direction	F → B free flow direction B → F throttled flow direction
Surface	Versions with housing type G and F are zinc galvanized
Perm. flow	20 ... 60 l/min, see acc. to table 1

Mass (weight) approx. (g)

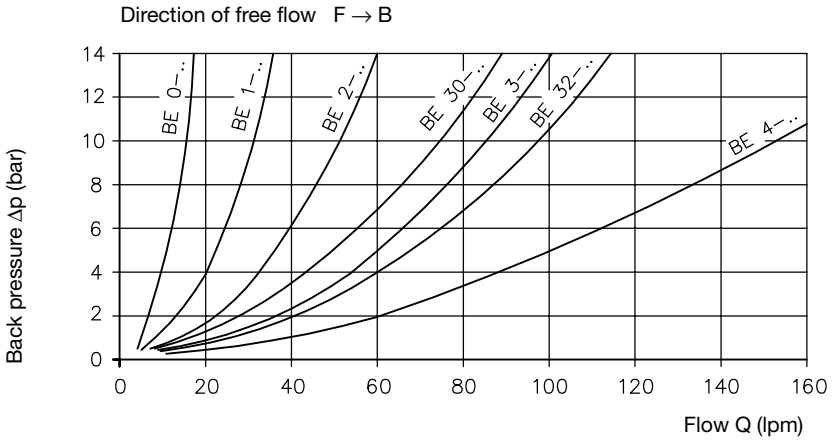
		BE 0	BE 1	BE 2	BE 3 (30, 32)	BE 4
Cartridge valve		2	4	6	10	18
Version with housing	G	30	75	105	160	340
	E	30	60	85	140	300

Pressure fluid	Hydraulic oil conforming DIN 51524 part 1 to 3; ISO VG 10 to 68 conforming DIN 51519. Viscosity limits: min. approx. 4, max. approx. 1500 mm²/s opt. operation approx. 10... 500 mm²/s Also suitable are biologically degradable pressure fluids type HEPG (Polyalkylenglykol) and HEES (synth. Ester) at operation temperatures up to approx. +70°C.
Temperature	Ambient: approx. -40 ... +80 °C Fluid: -25 ... +80 °C, pay attention to the viscosity range! Permissible temperature during start: -40°C (observe start-viscosity!), as long as the service temperature is at least 20 K higher for the following operation. Biological degradable pressure fluids: Observe manufacturer's specifications.

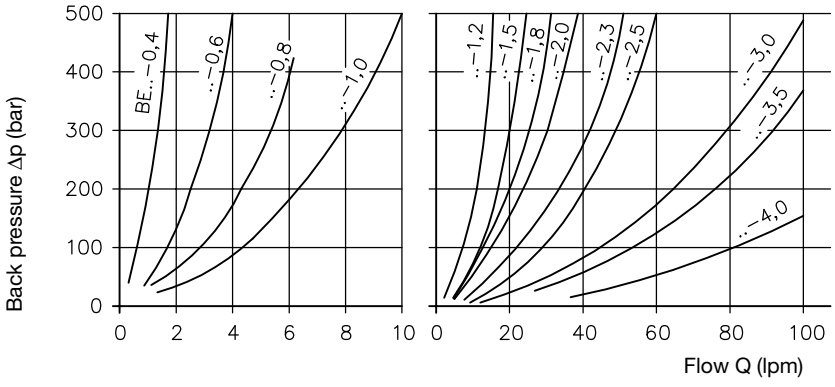
Δp-Q-curves

Direction of restricted flow B → F

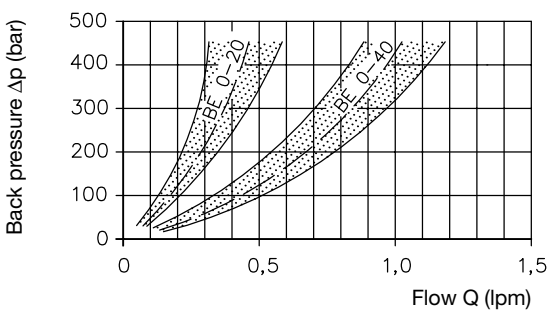
Direction of free flow F → B



Oil viscosity during tests approx. 50 mm²/s



Direction of restricted flow B → F

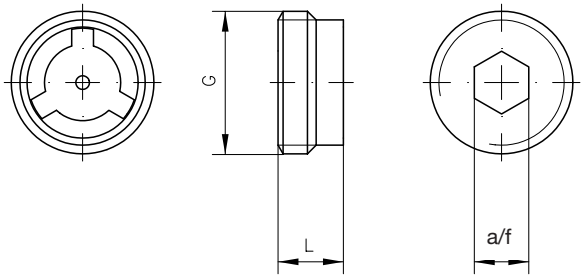


The indicated tolerances are only a guideline.

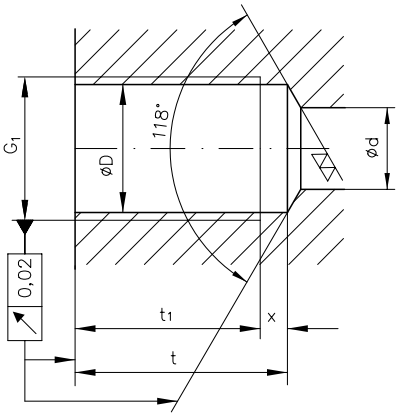
4. Unit dimensions

All dimensions in mm and subject to change without notice!

Cartridge valve



Mounting hole



Type	Thread G 3)	Thread G1	L	t	t1 1)	x 2)	D	d	a/f	Torque ± 20% (Nm)
BE 0	G 1/8 A	G 1/8	5	15	13	2	8.7	5.5	4	10
BE 1	G 1/4 A	G 1/4	6	19.5	17	2.5	11.8	7.5	5	15
BE 2	G 3/8 A	G 3/8	7	21	18	3	15.3	11	8	20
BE 3	G 1/2 A	G 1/2	7.5	23	20	3	19	14	10	35
BE 30	M 20x1.5	M 20x1.5	7.5	23	20	3	18.5	14	10	35
BE 32	M 22x1.5	M 22x1.5	7.5	23	20	3	20.5	15	10	35
BE 4	G 3/4 A	G 3/4	9	26.5	23	3.5	24.5	18	12	40

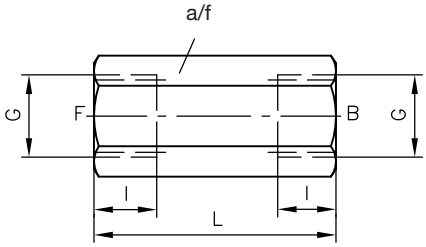
1) thread completely cut

2) The figures for thread run out x have to be observed accurately. It may be shorter but it mustn't be more. because this is fundamental for proper function and tightness of the sealing edge.

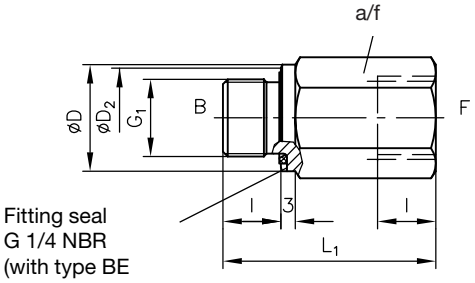
3) G = BSPP

Version with housing

Type BE ... G



Type BE ... F



Fitting seal G 1/4 NBR (with type BE 1...), all others with cutting edge

Type	G	G1	∅D	D2	L	L1	l	a/f	Torque (Nm)
BE 0	G 1/8	G 1/8 A	14	12.5	30	28	8	14	20
BE 1	G 1/4	G 1/4 A	19			43		19	40
BE 2	G 3/8	G 3/8 A	22	20.5	50	44	12	22	80
BE 3	G 1/2	G 1/2 A	26	24	56	52	14	27	150
BE 30	M 20x1.5		25	24	56	52	14	27	150
BE 32	M 22x1.5		27	26	56	52	14	30	150
BE 4	G 3/4	G 3/4 A	32	30	65	60	16		200

Drain valve type BR

Operation pressure $p_{P\,max}$ = 400 bar
$p_{R\,max}$ = 200 bar

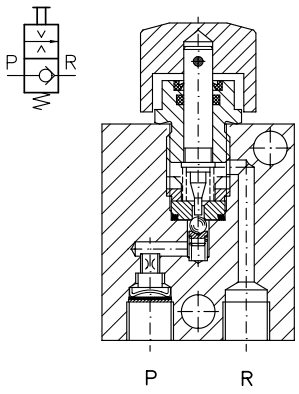
1. General information

The drain valve type BR is a valve combination consisting of a 2/2-way directional seated valve and a preconnected orifice limiting the flow.
All internal function parts of the valve are hardened and ground, with zero leakage when not actuated.
The valve is actuated via a push button while the operation pressure should be below 400 bar to keep the actuation force on an acceptable level. Main application are hoists and stackers where it is used as an emergency drain.

2. Available versions, main data

Order example: **BR 1 - 1,2**

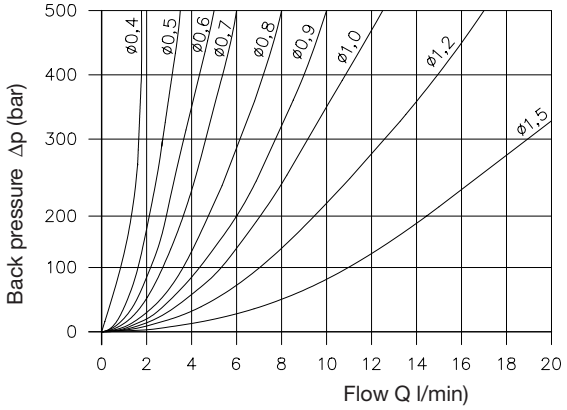
Basic type Size	Tapped ports P and R		Orifice-∅ (mm)
BR 0	G 1/8	DIN ISO 228/1 (BSPP)	Carburetor jet M 4 x ∅... **0,4 0,5 0,6 0,7 0,8 0,9 1,2 1,5**
BR 1	G 1/4		



Further parameters

Nomenclature	Drain valve
Pipe connection	Whitworth pipe thread DIN ISO 228/1 (see "Unit dimensions" in sect. 3)
Installed position	Any
Surface coating	Valve body: Zinc galvanized Push button: Red anodized
Flow direction	P → R
Mass (weight)	See "Unit dimensions" in sect. 3
Actuation force	Pressure dependent 100 bar = approx. 50 N, 200 bar = approx. 100 N, 300 bar = approx. 150 N, 400 bar = approx. 200 N (P_R= 0)
Hydraulic fluid:	Fluids 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 mm²/s Optimal operation range: approx. 10...500 mm²/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.
Temperature:	Ambient: approx. -40...+80°C Fluid: -25...+80°C, pay attention to the viscosity range! Start temperature down to -40°C are allowable (Pay attention to the viscosity range during start!), as long as the operation temperature during subsequent running is at least 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.

Δp-Q curve

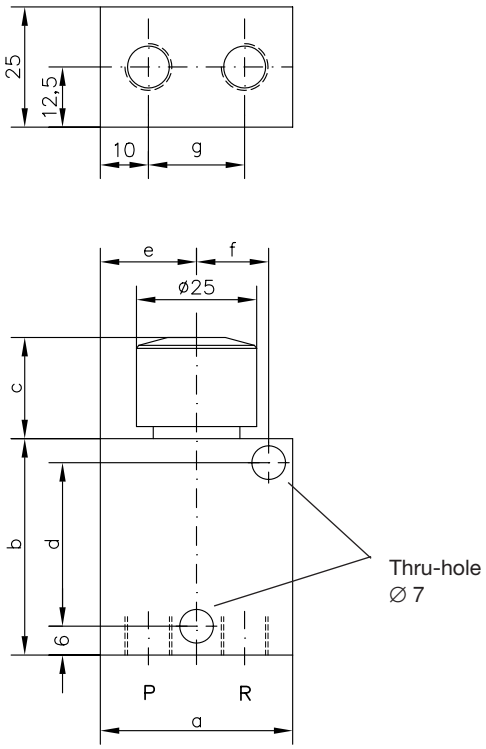


Fluid viscosity during measurement approx. 60 mm²/s

2.4

3. Unit dimensions

All dimensions in mm, subject to change without notice !



Type	a	b	c	d	e	f	g	Mass (weight) approx. (kg)	Ports (DIN ISO 228/1) P and R (BSPP)
BR 0	40	45	21	34	20	15	20	0.35	G 1/8
BR 1	45	50	21	39	22	18	24	0.45	G 1/4

Throttle and shut-off valves type CAV

for screw in into simple tapped holes

Pressure p_{max} = 500 bar
Flow Q_{max} = 50 lpm

Further cartridge valves:

- Pressure relief valves type CMV and CSV — D 7710 MV
- Pressure controlled shut-off valves type CNE — D 7710 NE
- Check valves type CRK, CRB, CRH — D 7712
- Throttle valves type CQ, CQR, and CQV — D 7713
- Flow control valves type CSJ — D 7736
- Pressure reducing valves type CDK — D 7745
- Pressure-dependent shut-off valves type CDSV — D 7876

Manually adjustable version
CAV..
CAV..R
CAV..V

Tool adjustable version (with lock nut)
CAV..K
CAV..RK
CAV..RD

Turn knob (self-locking)
CAV..D
CAV..RD
CAV..VD

1. General information

Throttle valves belong, according to DIN 1219-1, to the flow valves. With these valves it is possible to adjust a variable pressure difference, thereby determing the flow between inlet and outlet. This characteristic is used e.g. to simply adjust the velocity of cylinders in accumulator circuits and to limit the flow in control circuits etc.
Valves type CAV are of slot type design i.e. a slot forms the throttling cross section area. The slot has a constant width over the complete adjustment travel, therefore the cross section variation is linear. Because of this feature, the throttle has a superior adjustment characteristic when compared with ordinary tapered (annular gap) throttles. Due to the well designed ratio between depth and width, the slot is less sensitive to micro debris than tapered throttles. The throttling cross section is positioned at one point on the perimeter for slot type throttles whereas an annular gap is spread over the complete perimeter acting like a gap filter at fine adjustments.
CAV type throttle and shut-off valves are available in various sizes and versions. In principle all these valves are to be screwed into the simply shaped tapped holes of a manifold body. The sealing of the inlet to outlet takes place at the contact area between the facial sealing edge of the screwed-in end of the valve body and the stepped shoulder of the core diameter at the location thread. Any standard steel drill (point angle 118°) automatically forms this stepped shoulder when the core diameter is drilled. Therefore reaming of the hole and bevels to help the seals slip in is not necessary.
The sealing of the attached valve and its fixing at the manifold body are made by a sealing nut with a special thread seal and an O-ring.

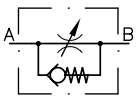
Symbols

Type CAV..(K)

with throttle / shut-off characteristic in both directions of flow

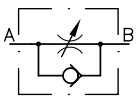
Type CAV..R(K)

with throttle / shut-off characteristic in direction of the thread and free return flow against it



Type CAV..V(K)

with free return flow in direction of the thread and throttle / shut-off characteristic against it



2. Available versions , main data

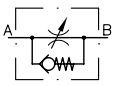
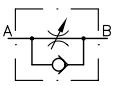
Order examples: **CAV 2R**

CAV 1V K - 1/4

Version with connection block (only with type CAV 1)
Ports A and B ISO 228/1 (BSPP)
- 1/4 = G 1/4
- 3/8 = G 3/8

Adjustment (during operation)

Coding	Description
without	Standard, (wing screw + wing nut)
K	Tool adjustable version see sect. 5.2
D	Turn knob

Description and symbol	Basic type and size	Pressure p_{max} (bar)	Flow Q_{max} approx. (lpm) [1]	Tapped journal metric fine thread conforming ISO DIN 13 T6	Max. torque Valve body (Nm) [2]	Max. torque Sealing nut (Nm) [2]
Throttling and blocking direction A → B and B → A 	**CAV 1**	500	30	M 16x1.5	40	35
	CAV 2		50	M 20x1.5	50	40
Throttling and blocking direction B → A, free flow A → B 	**CAV 1R**	500	15	M 16x1.5	40	35
	CAV 2R		25	M 20x1.5	50	40
Throttling and blocking direction A → B, free flow B → A 	**CAV 1V**	500	15	M 16x1.5	40	35
	CAV 2V		25	M 20x1.5	50	40

[1]) Valve fully opened

[2]) This applies to manifolds made of steel, nodular cast iron or other common materials, e.g. light alloy

3. Further data

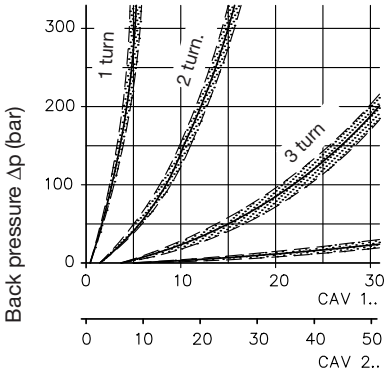
Nomination	Throttle and shut-off valve cartridge
Design	Slot type throttle, depending on version with/without by-pass check valve
Material	Steel body gas nitrided, sealing nut zinc galvanized, internal functional parts hardened and ground. For screw in into manifolds made of steel, cast iron and other materials (e.g. light alloy)
Installation position	Any
Port coding	A and B in flow diagrams and assembly drawings, only. See schematic drawings sect. 1 and dimensional drawings sect. 3. The port codings are not stamped onto the valve body
Static overload capacity	approx. 2 x p_{max} at tightened state and with sealing nut locked
Direction of flow	Arbitrary; blocked, throttled or free; see also cross-sectional drawings sect. 1 and table in sect. 2
Blocked position	CAV.. a completely closed throttle is leakagefree tight B→A (CAV ..R..) and A→B (CAV ..V..); a completely closed throttle is not leakagefree tight
Permissible pressure	p_{max} = 500 bar
Opening pressure	CAV 1(2)R approx. 0.2 ... 0.4 bar A → B CAV 1(2)V 0 bar B → A (valve disc not spring loaded)
Mass (weight)	Type CAV 1.. = 50 g; type CAV 2.. = 70 g connection block - 1/4, - 3/8 = + 260 g
Pressure fluid	Hydraulic oil conforming DIN 51514 part 1 to 3: ISO VG 10 to 68 conforming DIN 51519. Viscosity limits: min. approx. 4, max. approx. 1500 mm²/s; opt. operation approx. 10... 500 mm²/s. Also suitable are biologically degradable pressure fluids types HEPG (Polyalkylenglycol) and HEES (Synth. Ester) at service temperatures up to approx. +70°C
Temperature	Ambient: approx. -40 ... +80 °C Fluid: -25 ... +80 °C, observe the viscosity range ! Permissible temperature during start: -40°C (observe start-viscosity!), as long as the service temperature is at least 20K higher for the following operation.Biologically degradable pressure fluids: Note manufacturer's specifications. By consideration of the compatibility with seal al not over +70°C

Δp-Q curves

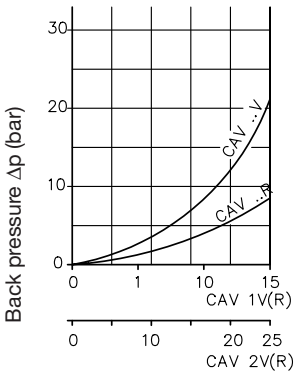
Viscosity during measurements approx. 60 mm²/s

Throttling curves

Guideline per turn, counted from blocked position

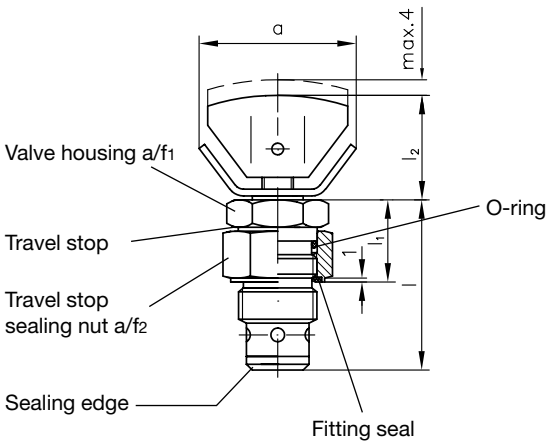


Direction of free flow

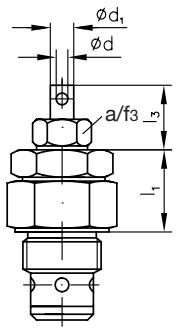


4. Unit dimensions

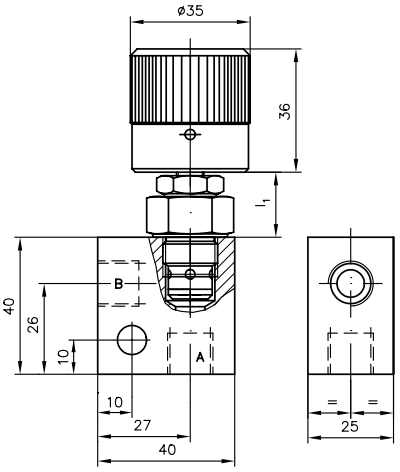
Type CAV 1 (R, V)
CAV 2 (R, V)



Type CAV 1 (R, V)K
CAV 2 (R, V)K



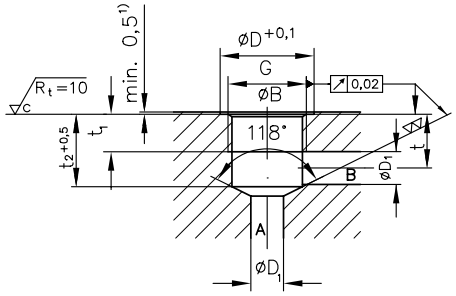
Type CAV 1 (R, V)D (- 1/4, - 3/8)
CAV 2 (R, V)D



Ports A and B ISO 228/1 (BSPP)
- 1/4 = G 1/4
- 3/8 = G 3/8

Surface zinc galvanized

Mounting hole



1) If pressure exceeds 100 bar at B, sinking is required!

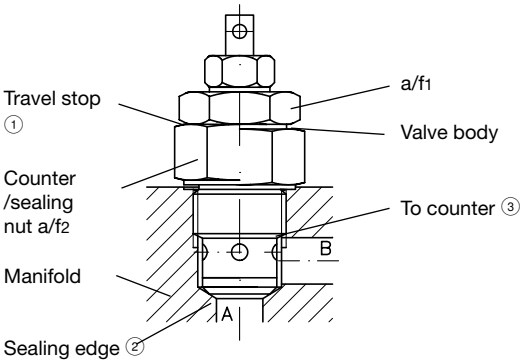
Type	Thread seal	O-ring AU 90 Sh
CAV 1..	Kantseal DKAR00016-N90	14x1.78
CAV 2..	Kantseal DKAR00018-N90	17.17x1.78

Type	D	D1	a	d	d1	l	l1	l2	l3	t	t1	t2	G	a/f1	a/f2	a/f3	Sinking B_{max}
CAV 1..	22	8	35	2	4.5	37	18	24	17	13	11	18	M 16x1.5	17	22	10	∅16 +0.2
CAV 2..	24	10	45	3	6	43	22	29	21	14	13	20	M 20x1.5	22	24	11	∅20 +0.2

All dimension in mm and subject to change without notice!

5. Assembly instructions

5.1 Screw in and locking



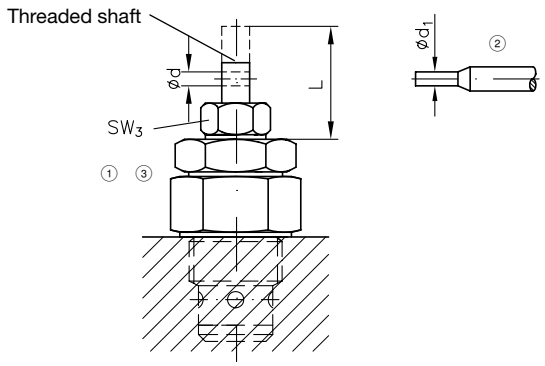
① Before screwing the valve body into the manifold, loosen the counter/sealing nut until the travel stop.

② Screw in the valve body (a/f1) and tighten with the correct torque. The metallic sealing of the inlet to the outlet takes place at the contact area of the facial sealing edge and the stepped shoulder of the core diameter at the location thread

③ Tighten the counter/sealing nut with the correct torque.

Type and size	Valve body		Counter/sealing nut	
	Spanner size a/f1	Torque (Nm) 2)	Spanner size a/f2	Torque (Nm) 2)
CAV 1..	17	40	22	35
CAV 2..	22	50	24	40

5.2 Adjustment of type CAV..K



① Loosen lock nut

② Insert a pin shaped tool in the hole (∅ d) of the threaded shaft

Clockwise = reduction of the throttling cross section area (Δp rises)

Anti clockwise = reduction of the throttling cross section area (Δp falls)

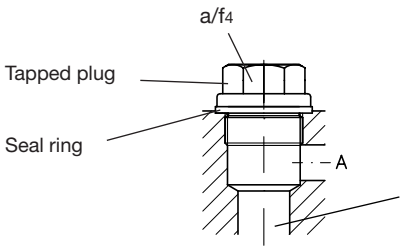
③ Re-tighten lock nut after adjustment

Type and size	L	Lock nut		Threaded shaft		
		Spanner size a/f3	Torque (Nm) 2)	Thread	∅d	∅d1 max.
CAV 1..	17	10	15	M 6	2	1.8
CAV 2..	21	13	30	M 8	3	2.8

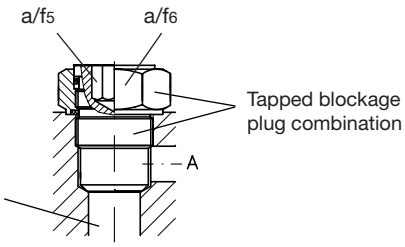
5.3 Tapped plugs

Mounting holes in the manifold may be blocked if required by tapped plugs e. g. if uniform manufactured manifolds should be equipped with or without cartrige valves depending on application.

Passage open



Passage blocked



Type and size	Passage open: Tapped plug DIN 910	a/f4	Torque (Nm) 2)	Seal ring DIN 7603-Cu	Passage blocked: Tapped blockage/plug combination 1) Drawing-No.	Tapped part a/f5	Tapped part Torque (Nm) 2)	Counter sealing nut a/f6	Counter sealing nut Torque (Nm) 2)
CAV 1..	M 16x1.5	17	40	A 16x22x1.5	Z 7712 003	8	40	22	35
CAV 2..	M 20x1.5	19	50	A 20x24x1.5	Z 7712 013	10	50	24	40

1) For fitting seal and O-ring see sect. 4.

2) This applies to manifolds made of steel, nodular cast iron or other common materials, e.g. light alloy

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

Cartridge-style for screwing into simple, tapped holes

Pressure p_{max} = 700 bar
Flow Q_{max} = 50 lpm

Further cartridge valves:

- Pressure valves type CMV and CSV — D 7710 MV
- Pressure controlled 2-way directional valve type CNE — D 7710 NE
- Check valves type CRK, CRB, and CRV — D 7712
- Flow control valves type CSJ — D 7736
- Pressure reducing valves type CDK — D 7745
- Pressure-dependent shut-off valve type CDSV — D 7876

1. General

Throttles serve to limit the flow within control circuits. The throttle valves detailed here are slot-type throttles, with or without check valve enabling free flow in one and restricted flow in the other direction.

The twin sealing of the setting spindle ensures adjustment without any leakage.
When combined with the individual connection block P-DW it becomes a flow control valve enabling load independent flow control at operating pressure up to 700 bar (max. pressure difference A-B 500 bar).

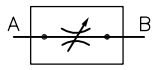
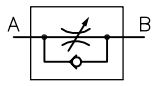
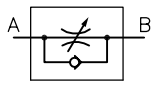
2. Available versions, main data

Order examples:

CQ 2
CQR 2
CQV 2 D - 1/4

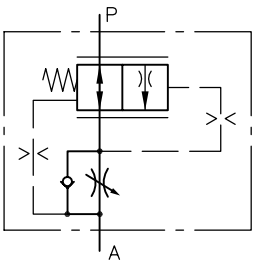
Version with connection block for pipe mounting
Ports A and B ISO 228/1 (BSPP)
- 1/4 = G 1/4
- 3/8 = G 3/8
- P-DW = Manifold mounting (only in combination with type CQ and CQV)

Adjustable during operation
no coding = tool adjustable
D = turn-knob (with lock nut)
D3 = turn-knob ∅35 mm (without lock nut)

Symbol	Basic type and size Standard version	Version with fine metering range	Nomenclature
	**CQ 2**	**CQ 22**	Throttle Rather equal throttle characteristic for A→B and B→A
	**CQR 2**	**CQR 22**	Throttle check valve Throttling direction B→A
	**CQV 2**	**CQV 22**	Throttle check valve Throttling direction A→B

Symbol

Version
CQ..-P-DW



Flow control valve function P → A
Flow direction A → P corresponding to the installed valve type CQ.2

Only in combination with
type CQ 2, CQ 22, CQV 2 and CQV 22

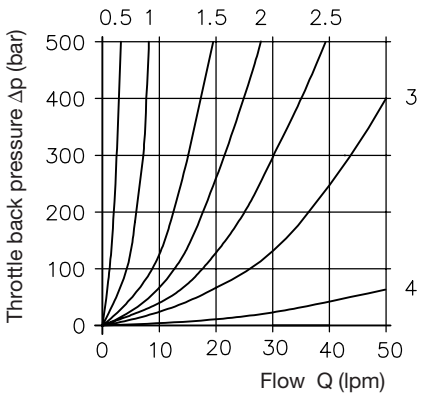
2.4

3. Additional parameters

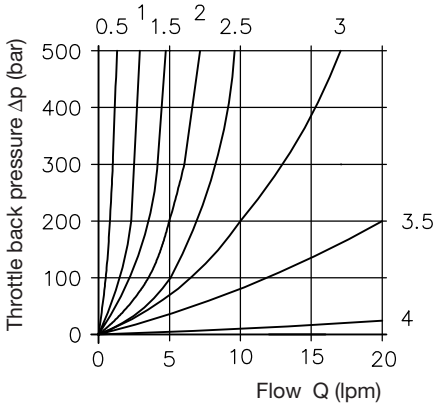
Δp - Q curves

Throttled flow direction
Guideline figure per turn of the setting spindle, counted from blocked position

Type CQ.2

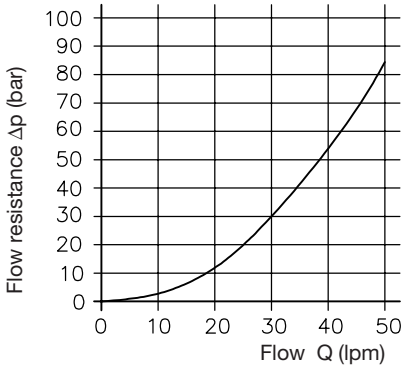


Type CQ.22

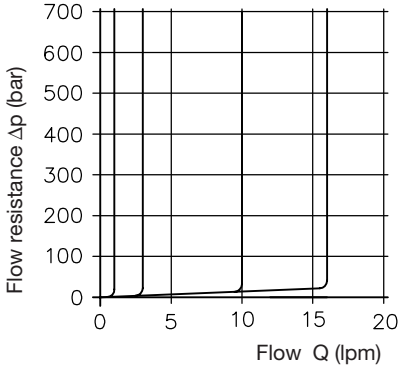


Oil viscosity during measurements approx. 50 mm²/s

Free flow
A→B (type CQR)
B→A (type CQV)



CQ.2.-P-DW
(flow control valve function)



Turns	Flow (lpm) guideline	
	CQ.2	CQ.22
0.5	0.7	0.15
1.0	2.4	0.25
1.5	3.8	
2.0	5.2	0.5
2.5	7.0	
3.0	9.8	1.16
3.5	15.4	
4.0	29.5	12.5

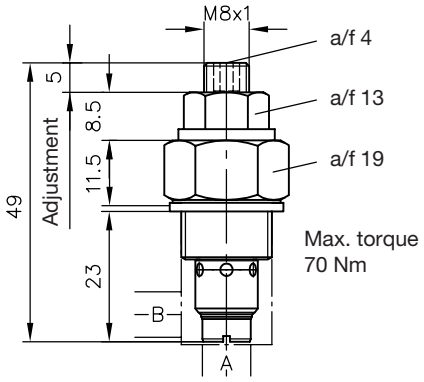
Nomenclature	Throttle and restrictor check valve
Design	Slot-type throttle
Installed position	Any
Surface	Housing nitrous hardened, sealing nut zinc galvanized
Flow	In throttled flow direction: dep. on setting, see Δp - Q curve The flow figures are viscosity dependent.
Pressure max.	700 bar
Pressure 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 mm²/s (viscosity during start) Optimal operation range: approx. 10...500 mm²/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.
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 (Kelvin) higher. Biological degradable pressure fluids: Pay attention to manufacturer‘s information. With regard to the compatibility with sealing materials do not exceed +70°C.
Mass (weight)	Single valve: CQ.2 = approx. 90 g Connection block: - 1/4, - 3/8 = approx. 320 g -P-DW = approx. 450 g

4. Dimensions

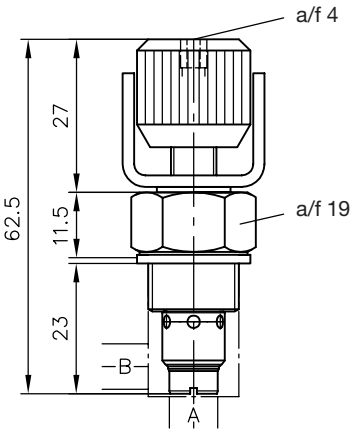
All dimensions in mm, subject to change without notice!

4.1 Single valve

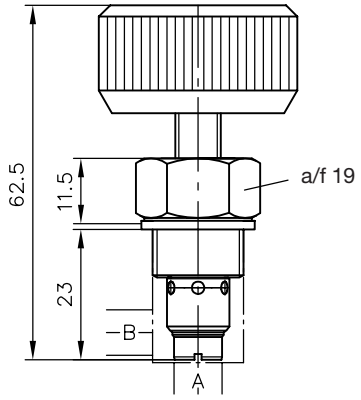
Tool adjustable version



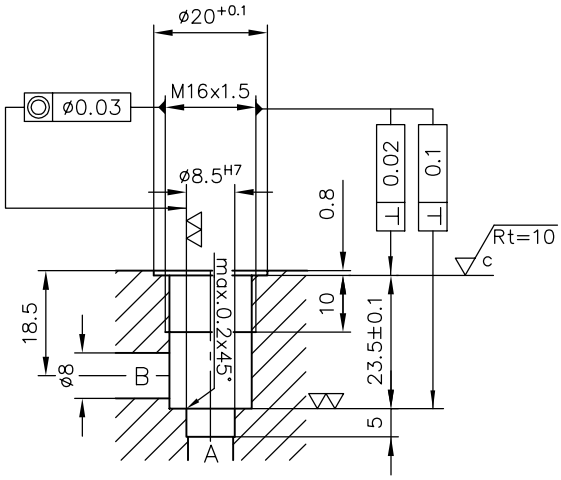
Coding **D**
Turn-knob (with lock nut)

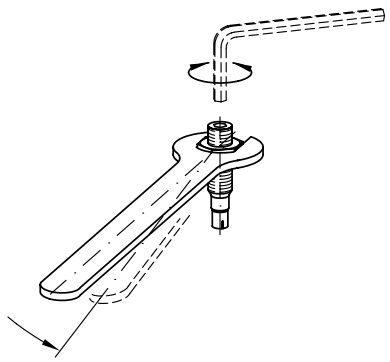


Coding **D3**
Turn-knob (without lock nut)



Mounting hole





Screw-in and locking

Loosen the counter/sealing nut until the travel stop before screwing the valve body into the manifold

1. Screw-in the valve body
2. Tighten the counter/sealing nut with correct torque
   (For torque, see dimensional drawing)

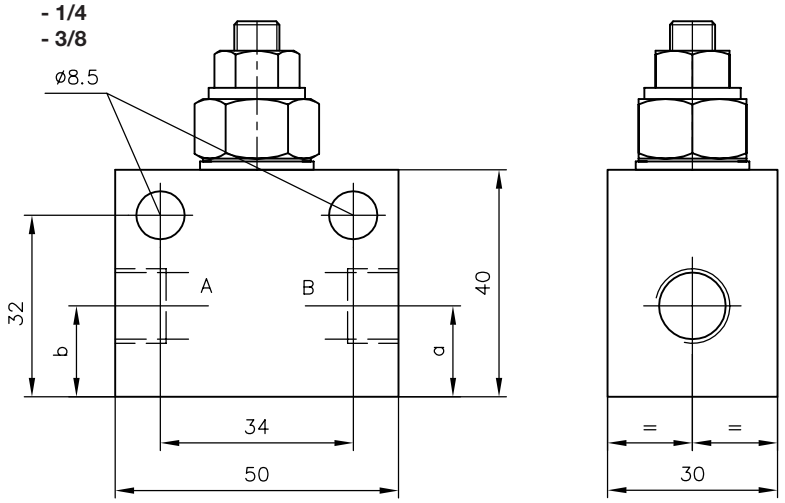
Adjustment

The lock nut is to be loosened a little bit prior to rotating the setting spindle with an Allen key

The twin sealing of the setting spindle ensures adjustment without any leakage.

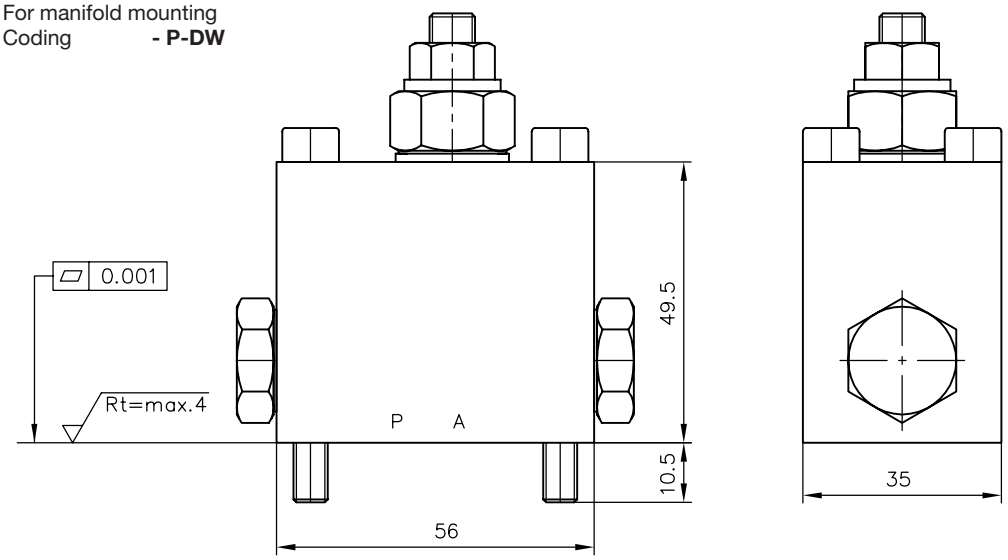
4.2 Version with connection block for pipe mounting

For pipe mounting
Coding **- 1/4**
- 3/8

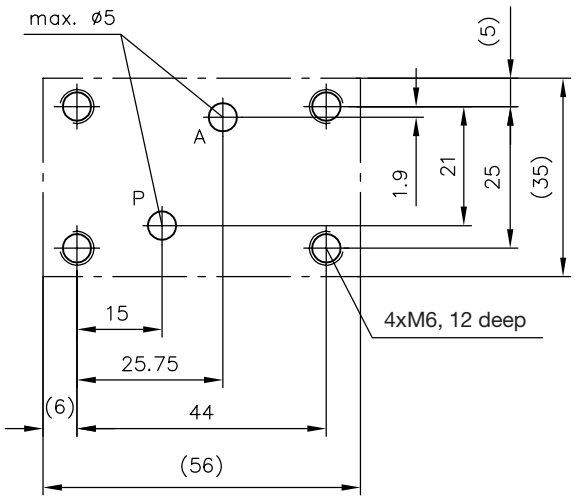


Coding	Ports A and B ISO 228/1 (BSPP)	a	b	Dwg.-No. for indiv. order
-1/4	G 1/4	18	15	7713 216
-3/8	G 3/8	16	16	7713 215

For manifold mounting
Coding **- P-DW**



Hole pattern



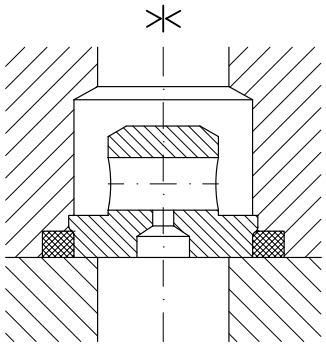
Orifice type EB

Operating pressure p_{max} = 500 bar
Flow Q_{max} = 120 lpm

1. General

Orifices are the most simple version of a flow valve, which are designed to influence mainly the flow (acc. to DIN ISO 1219-1). The employed effect is based on the physical flow law $\Delta p = (a\ Q)^m$. With usually m = 2 for sharp edged, viscosity effect minimizing, orifices. The calculation constant a copes for shape related back pressure constants as well as conversion factors for the differing dimensions; Δp (bar) and Q (lpm). This figure is evaluated best via tests (Δp-Q-curves).
These orifices are mainly employed to restrict the flow during shifting operations (e.g. increased shifting time, protection of pilot valve from excessive flow, in accumulator circuits, prevention of undesired side effects of shifting operations at directional valves with negative overlap etc.), see also D 7300. They are usually installed in hydraulic valves intended for manifold mounting. The throttle dimensions exactly fit in the port P of directional seated valves acc. to D 7300.

Symbol, mounting position



Ongoing bore

2. Available versions, main data

Order example: **EB 2 -1,7**

Orifice insert	Pressure p_{max} (bar)	Flow Q_{max} (lpm)	Orifice ∅ (mm)											
			- 0,4	**- 0,6**	**- 0,8**	**- 1,0**	**- 1,2**	**- 1,7**	**- 2,1**	**- 2,5**	**- 3,0**	**- 3,5**	**- 4,0**	**- 4,2**
EB 0	500	6		●	●	●	●							
EB 1	700	10	●	●	●	●								
EB 2	700	40					●	●	●					
EB 3	500	100								●		●		●
EB 4	500	120									●		●	

Nomenclature: Orifice insert

Installed position: Any

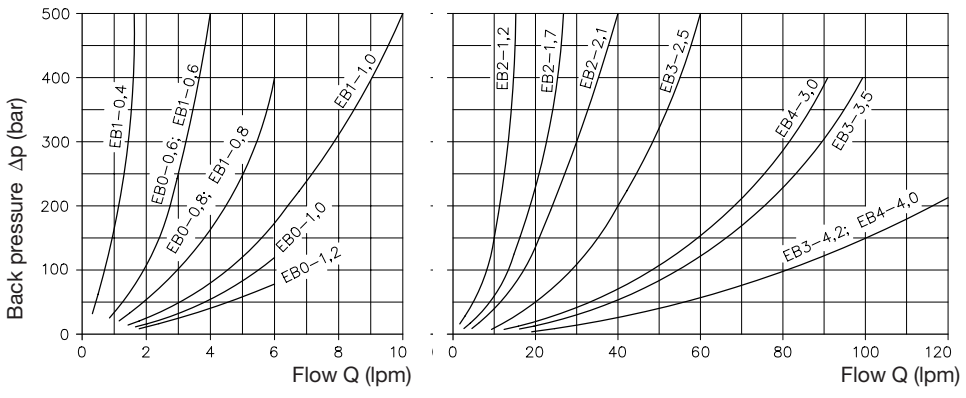
Mass (weight):

Type	EB 0	EB 1	EB 2	EB 3	EB 4
	2 g	4 g	6 g	10 g	18 g

Pressure fluid: Hydraulic oil acc. to DIN 51524 table 1 to 3; ISO VG 10 to 68 conf. DIN 51 519
Viscosity range: min. approx. 4; max. approx. 1500 mm²/sec; Optimum: 10 to 500 mm²/sec
Also suitable are biologically degradable pressure fluids type HEES (synth. Ester) at operation temperatures up to approx. +70°C.

Temperatures: Ambient: approx. -40...+80°C; Fluid: -25...+80°C, pay attention to the viscosity range!
Start temperature down to -40°C are allowable (Pay attention to the viscosity range during start!), as long as the operation temperature during subsequent running is at least 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.

Δp-Q-curve



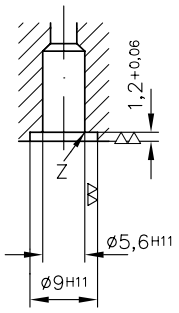
Oil viscosity during the test approx. 60 mm²/sec

2.4

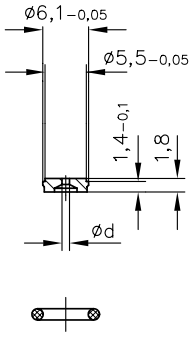
3. Unit dimensions, mounting holes

All dimensions in mm, subject to change without notice!

Type EB 0-...

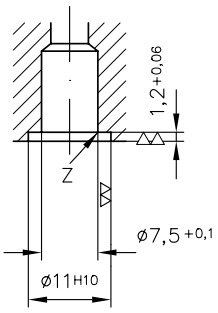


Ongoing bore
∅3.5

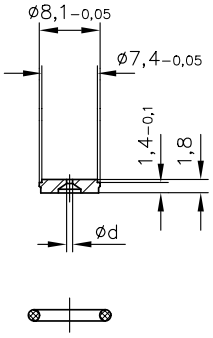


O-ring 6x1.5
NBR 90 Sh

Type EB 1-...

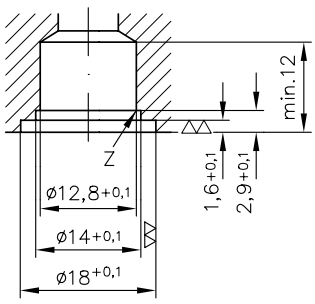


Ongoing bore
∅4.5

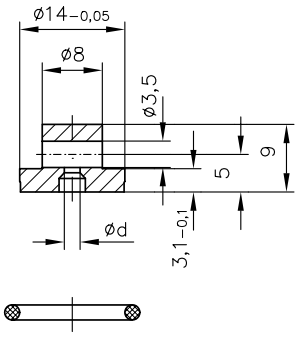


O-ring 8x1.5
NBR 90 Sh

Type EB 2-...

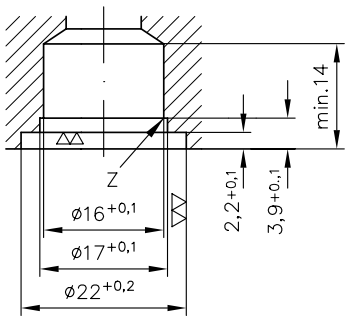


Ongoing bore
∅10

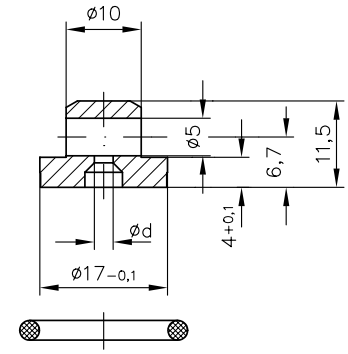


O-ring 14x2
NBR 90 Sh

Type EB 3-...

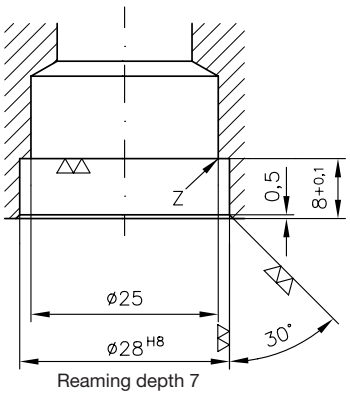


Ongoing bore
∅14



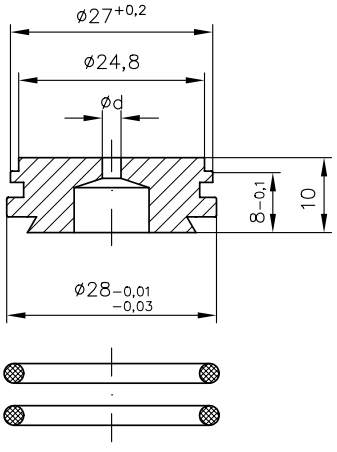
O-ring 17.12x2.62
NBR 90 Sh

Type EB 4-...



Reaming depth 7

Ongoing bore ∅20



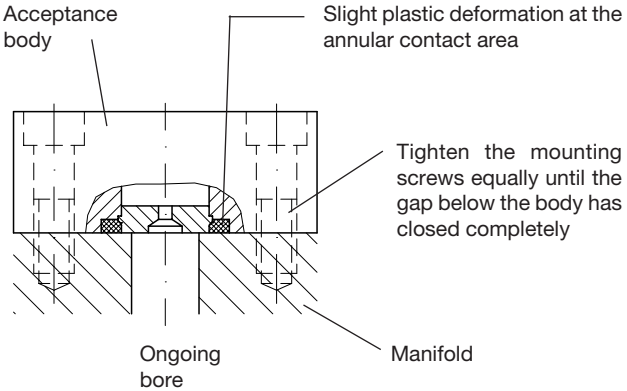
O-rings 23.47x2.62
NBR 90 Sh

Z = Sharp edged but deburred, all other bores with chamfer 0.2 mm
∅d = Orifice (sect. 2)

Attention: O-rings are not scope of delivery and have to be ordered additionally !

Notes regarding installation:

The exact fixation of the orifice insert in the housing takes place by plastic deformation of the surrounding material at the marked annular section during tightening of the mounting screws. This procedure makes housing bodies made of material with yield ability necessary i.e. all usual materials for hydraulic valves is fine excluding hardened or other material with extreme strength.



Throttles type ED
Restrictor check valves type RD and RDF/..

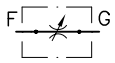
Operating pressure p_{max} = 500 bar
Flow Q_{max} = 130 lpm

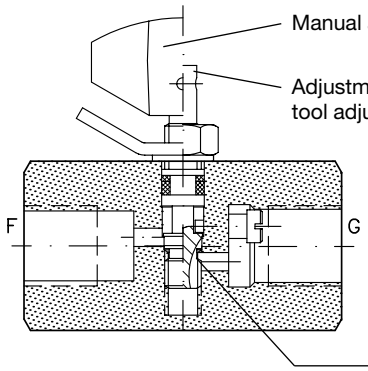
1. General

Throttle valves belong to the flow valve group (ISO 1219-1). They are used in hydraulic systems as resistance valves. This effect is based on the intentional utilization of the variable Δp-Q-characteristic.
The flow resistance can be regulated very precisely with both the manually and the tool adjustable version. Size 11 and 21 of type ED (RD) are basically designed as slot-type throttles, where the cross section is extended by an annular gap only for the last quarter of the stroke i.e. in the range of the greatest opening. Size 31 to 51 of type ED (RD) are pure annular gap throttles. The non-adjustable version RDF... is a orifice type throttle. The check valve is designed as a tilt plate with a low mass, a spring is omitted (no malfunction due to a broken). The valve opens and closes with the slightest fluid flow. The adjustment spindle is nitrided (making it wear resistant) and is permanently lubed by the hydraulic fluid (maintenance free).

Type ED.. and ED..K

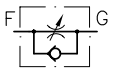
Throttle

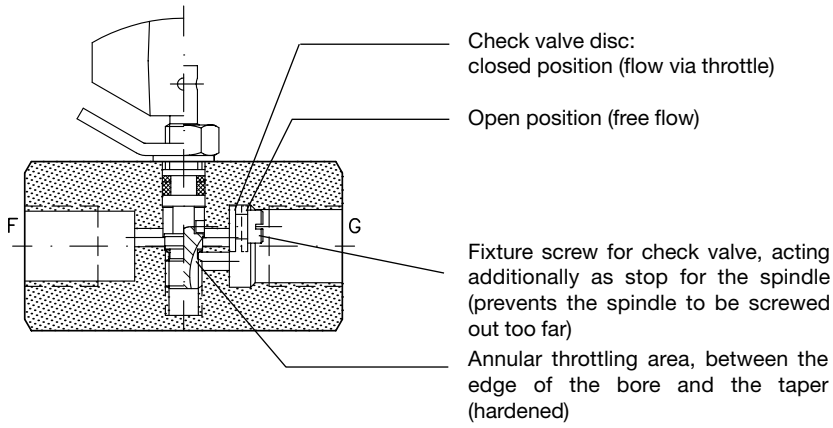




Type RD.. and RD..K

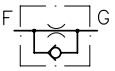
Restrictor check valve

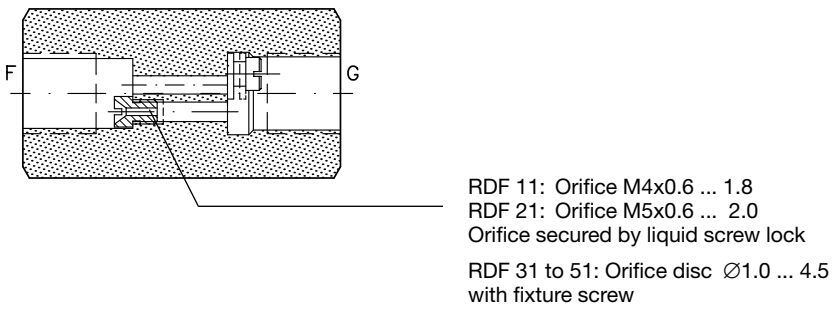




Type RDF...

Restrictor check valve with fine throttle





2. Available versions, main data

Order examples:

RD 11 Throttle (manually adjustable)

ED 31 **K** Throttle (tool adjustable)

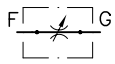
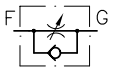
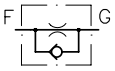
RDF 21/1,0 Restrictor check valve

Adjustability (only type ED.. and RD.. !)
no coding = manually adjustable (wing screw / lock nut)
K = tool adjustable (adjustment spindle / lock nut)

Table 2: Fixed throttle RDF ../..

∅ (mm)	0.4	0.5	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
Coding	**0,4**	**0,5**	**0,6**	**0,8**	**1,0**	**1,2**	**1,4**	**1,6**	**1,8**	**2,0**	**2,5**	**3,0**	**3,5**	**4,0**	**4,5**	**5,0**	**5,5**
RDF 11/..	●	●	●	●	●	●	●	●	●								
	Orifice M 4 x ...																
RDF 21/..		●	●	●	●	●	●	●	●	●							
	Orifice M 5 x ...																
RDF 31/..				●	●	●	●	●	●	●	●	●	●	●	●		
RDF 41/..				●	●	●	●	●	●	●	●	●	●	●	●	●	●
RDF 51/..				●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Orifice disc with fixture screw																

Table 1: Basic type, size

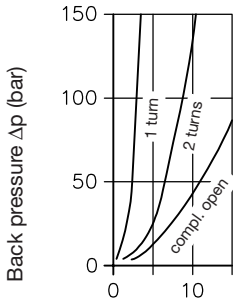
Version		Coding	Ports F and G conf. ISO 228/1 (BSPP)	Pressure p_{max} (bar)	Flow Q_{max} (lpm)	Mass (weight) approx. (g)
Throttle	F ↔ G throttling in both flow directions 	**ED 11**	G 1/4	500	12	180
		ED 21	G 3/8		30	220
		ED 31	G 1/2		60	350
		ED 41	G 3/4		80	660
		ED 51	G 1		130	840
Restrictor check valve	F → G free flow F ← G throttled flow 	**RD 11, RD 112**	G 1/4	500	12	180
		RD 21	G 3/8		30	220
		RD 31	G 1/2		60	350
		RD 41	G 3/4		80	660
		RD 51	G 1		130	840
	with fixed throttle F → G free flow F ← G throttled flow 	**RDF 11/..**	G 1/4	500	12	180
		RDF 21/..	G 3/8		30	220
		RDF 31/..	G 1/2		60	350
		RDF 41/..	G 3/4		80	660
		RDF 51/..	G 1		130	840

Note: The throttle characteristic of type RD 112 is more fine than with type RD 11, see curves in sect. 3

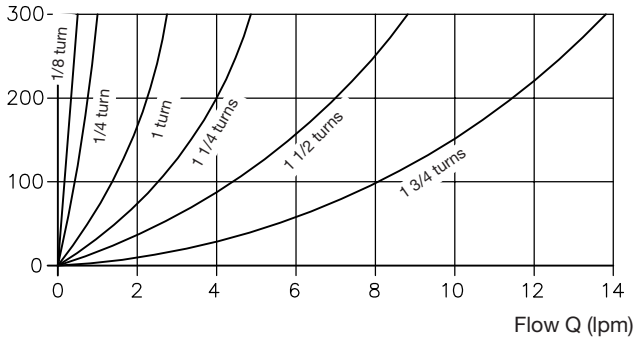
3. Additional parameters

Installed position	Any
Hydraulic fluid:	Hydraulic oil conforming DIN 51524 table 1 to 3 (ISO VG 10 to 68 conf. DIN 51 519) Viscosity range: min. approx. 4; max. approx. 1500 mm²/s Optimum: 10 to 500 mm²/s Also suitable are biologically degradable pressure fluids type HEPG (Polyalkylenglykol) and HEES (synth. Ester) at operation temperatures up to approx. +70°C.
Temperature	Ambient: approx. -40...+80°C Fluid: -25...+80°C, pay attention to the viscosity range! Start temperature down to -40°C are allowable (Pay attention to the viscosity range during start!), as long as the operation temperature during subsequent running is at least 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.
Δp-Q curves	Throttling direction G → F with type ED..(K) and RD..(K)

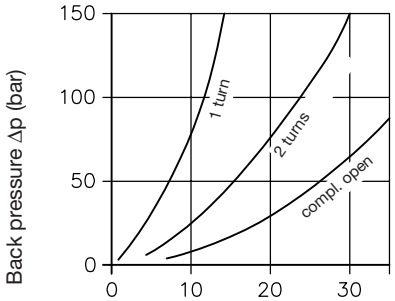
Type ED 11, RD 11



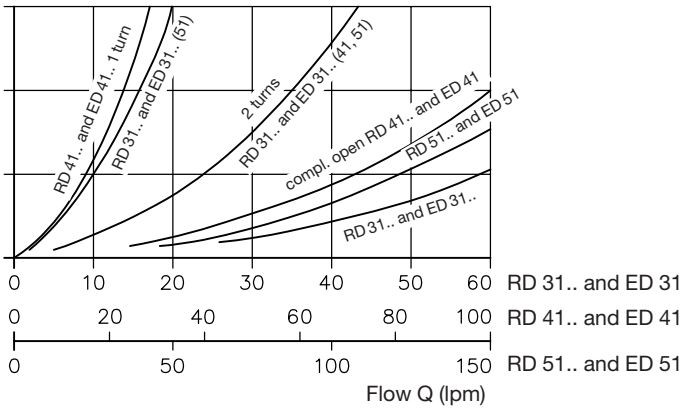
Type RD 112



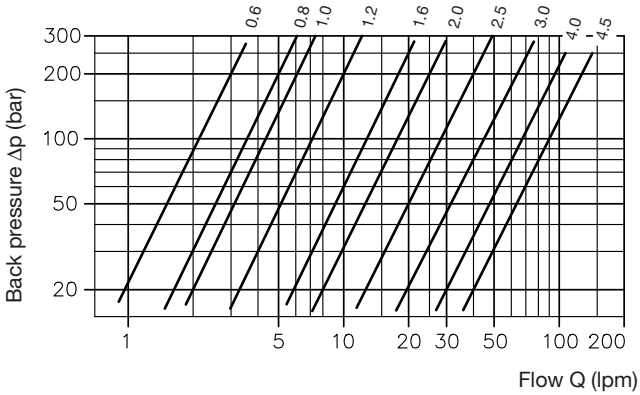
Type ED 21, RD 21



Type RD 31... (41, 51) and ED 31... (41, 51)



Throttling direction G → F with type RDF...



Free flow F → G with type RD(F) 11 to RD(F) 51

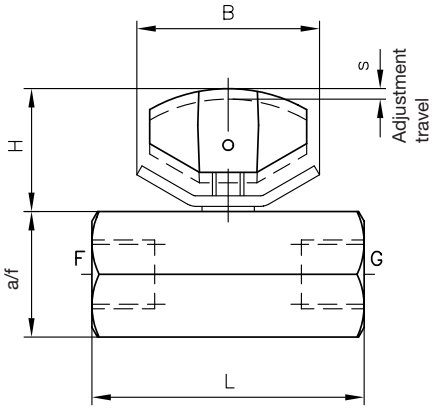
Δp ≈ 3 bar at approx. 0.5 Q_{max}
Δp ≈ 8 bar at approx. Q_{max}
For Q_{max} see main data in table 1, sect. 2

Oil viscosity during measuring approx. 54 mm²/s

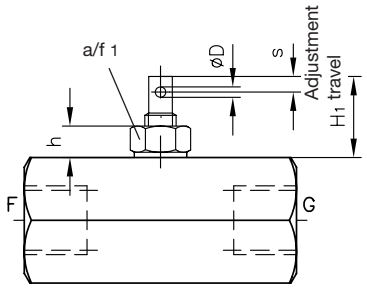
Attention: The throttles show a certain viscosity dependence, the Δp-Q curves can differ more or less strongly when used beyond the optimal range.

4. Unit dimensions

Type ED.. and RD..



Type ED..K
RD..K



Type RDF ../..

Type	Ports F and G ISO 228/1 (BSPP)	L	H	H_1	h	D	B	a/f	a/f_1	Adjustment travel s approx.	Turns approx.
ED 11(K), RD 11(K), RDF 11/..	G 1/4	52	23.5	15.5	6	2	32	24	10	2.25	2 1/4
ED 21(K), RD 21(K), RDF 21/..	G 3/8		24	16.5				27		2.5	2 1/2
ED 31(K), RD 31(K), RDF 31/..	G 1/2	62	32.5	21.5	7.5	3	45	32	13	3	3
ED 41(K), RD 41(K), RDF 41/..	G 3/4	72	41	25.5		3.5	55.5	41	17	4.5	
ED 51(K), RD 51(K), RDF 51/..	G 1	82	46.5	26.5		4	61	46	19	4.5	

All dimensions in mm, subject to change without notice!

Precision throttle type FG and FGS

for screw-in into control oil inlets or outlets of hydraulically actuated hydraulic units

Operating pressure p_{max} = 300 (400) bar

1. General

The precision throttle serves to delay the switching rate of pressure oil actuated valves:

- Response time setting of directional control valves
- Pulsations prevention
- Vibration dampening

The attenuation effect is achieved by means of thread with an adjustable screw length.

2. Available versions, main data

Coding examples:

FG 1 Throttle screw for screw-in into mounting hole (not available as type FGS)
FG 2 - S Version with thread type throttle and swivel housing
FGS H6 K Version with thread type throttle (locked against complete removal) and swivel housing

Sealing of the mounting hole
without = Standard, via sealing edge ring DKA 1/4
K = Seal KDS 14 A3C (only with FGS)

Table 1: Basic type and function

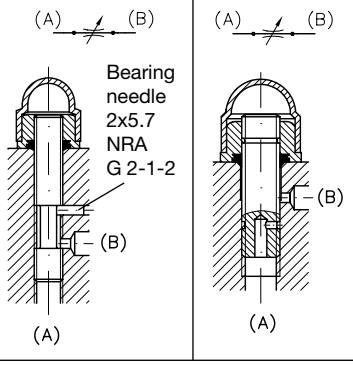
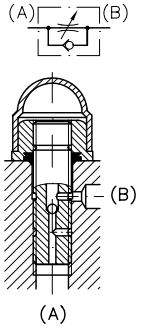
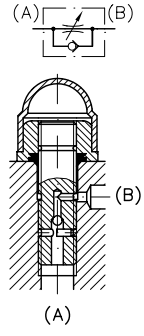
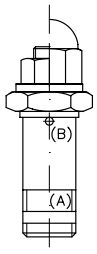
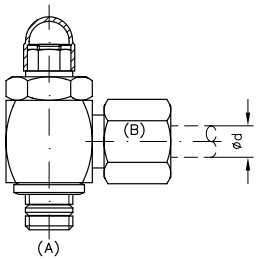
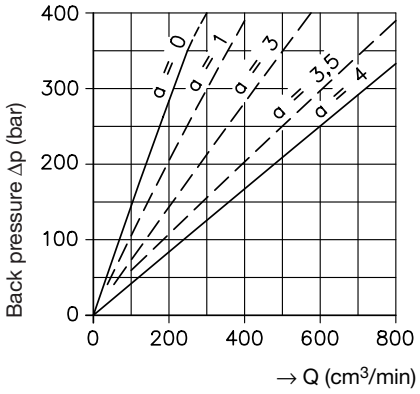
Version		With lock against complete removal	Standard (suited for screw-in into mounting hole)		
Codings, symbol and schematic cross-sectional view		**FGS** [1]	**FG**	**FG 1**	**FG 2**
					
[1] Only available as version with swivel housing (see table 2)					
Function	Throttling direction	A → B and B → A		B → A	A → B
	Free flow direction	None		A → B	B → A

Table 2: Version with housing

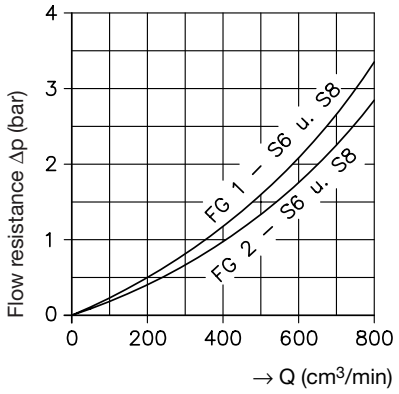
Banjo bolt FG / FG 1 / FG 2	Swivel housing		Ød	List of ERMETO components not scope of delivery: Housing	Tapered an cutting ring	Coupling nut
- S						
		FGS **H 6**	6	XWH 6-SR-A3C	DPR 6-LS	M 6-S-A3C
		FG **- S 6** FG 1 **- S 6** FG 2 **- S 6**		Xswve 6-SR		
		FGS **H 8**	8	XWH 8-SM/SR-A3C	DPR 8-LS	M 8-S-A3C
		FG **- S 8** FG 1 **- S 8** FG 2 **- S 8**		Xswve 8-SR		

3. Additional data

Design	Thread type throttle
Installed position	Any
Flow	In throttled direction: Depending on the setting, refer to the Δp-Q-a curves. The flow rate values are dependent on the viscosity.
Pressure max.	Type FG, FG 1 and FG 2 = 300 bar Type FGS = 400 bar
Pressure fluid	Hydraulic oil conforming DIN 51524 part 1 to 3; ISO VG 10 to 68 acc. to DIN 51519 Viskosity limits: min. approx. 4; max. approx. 1500 mm^2/sec opt. operation: approx. 10 ... 500 mm^2/sec Also suitable for biological degradable pressure fluids types HEPG (Polyalkylenglycol) and HEES (Synth. Ester) at service temperatures up to approx. +70°C
Temperature	Ambient: approx. -40 ... +80 C Fluid: -25 ... +80°C, note the viscosity range Permissible temperature during start: -40°C (observe start-viscosity!), as long as the service temperature is at least 20 K (Kelvin) higher for the following operation. Biological degradable pressure fluids: Observe manufacturer's specifications. Considering the compatibility with seal material not over +70°C.
Mass (weigth) approx.	Thread type throttle = approx. 15 g Version with banjo bolt = approx. 40 g Version with swivel housing = approx. 110 g
Δp-Q curves	Throttled flow direction (Δp-Q-a)



Flow direction
A → B (FG 1...)
B → A (FG 2...)



Oil viscosity during measurement 50 mm^2/s

Viscosity influence: The flow will be reduced in a ratio of approx. $50/p_x$, with setting unchanged (p_x = viscosity).

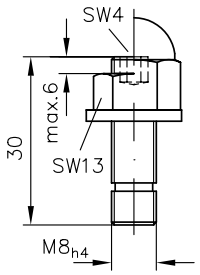
It is therefore recommended to use a setting for a above 1, when viscosities below 400 to 500 mm^2/s are anticipated in the later use (applications outside etc.). See also description regarding a_{max} in sect. 5.

4. Dimensions

All dimensions in mm, subject to change without notice!

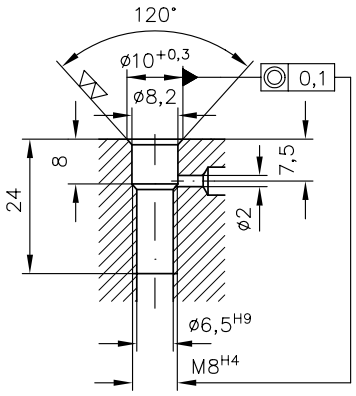
4.1 Throttle screw for screw-in into mounting hole

Type FG, FG 1 and FG 2



SW = a/f

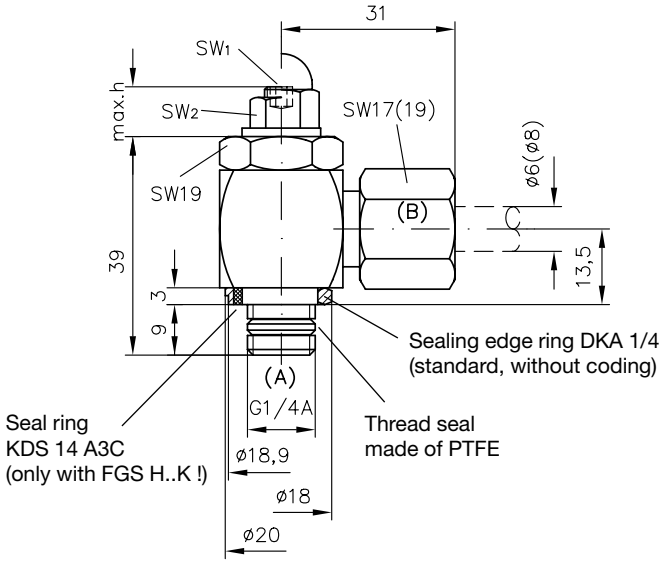
Location hole



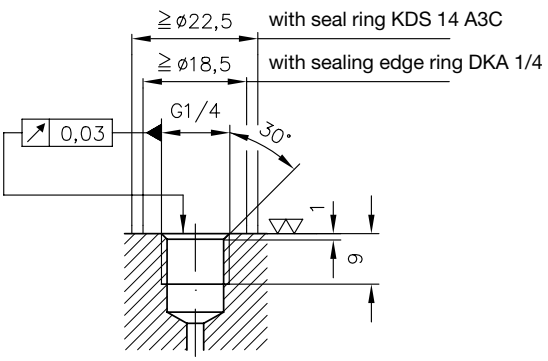
4.2 Housing design (swivel housing)

Type FGS H 6(8)
FG - S 6(8)
FG 1 - S 6(8)
FG 2 - S 6(8)

SW = a/f



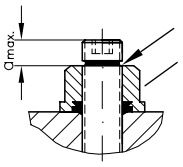
Location hole



5. Instructions for operation

Max. setting range 6 mm

Effective restriction
from 0 to 4 mm



Red marking

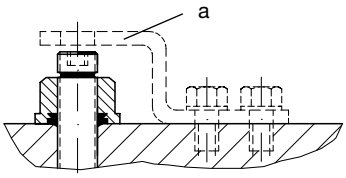
SEAL lock nut

max. torque 8 Nm

Setting range a
The greatest throttling action is achieved at a = 0 (the throttle screw and lock nut are flush with one another).
The throttling action is terminated when the red ring mark appears (= end of the permissible setting range). Do not unscrew the throttle screw any farther, since the number of supporting threads will decrease.

Type FGS: Locked via bearing needle 2x5.7 NRA G 2-1-2
Type FG, FG 1(2): The design of the screw does not allow the provision of a mechanical safeguard which would prevent the screw from being unscrewed farther or removed. Hence, special reference must be made in the operation manual or instructions for use to the red mark as the end of the permissible setting range.

If neccessary (e.g. for accident prevention), appropriate securing element (a) are to be attached to the manifold into which the FG-screw is inserted, so as to prevent the screw from turning outwards any further.
This also applies to housing designs ...-S, ...-S 6(8).



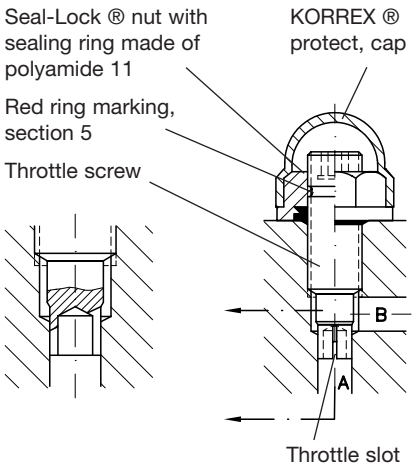
Lock nut
Prior to setting the throttle screw, loosen the SEAL lock nut completely to remove the tension from the elastomer sealing ring provided in the thread.

Slot type throttles type Q, QR and QV

Pressure p_{max} = 400 bar
Flow Q_{max} = 120 lpm

1. General

According to DIN 1219-1, throttle valves belong to the group of flow valves. Their functional task within the hydraulic circuit is to generate a vari-ably adjustable pressure corresponding to the throttle drop characteristic, with which, for example, it is possible to control the velocity of cylinders in accumulator circuits and to limit the oil flow in control circuits etc. The throttle valves described here are slotted throttles and areoptionally available with or without a built-in check valve, so that the throttle effect is present in either both or only one flow direction. The throttle cross section is adjustable with a hexagon socket screw key after undoing a self-sealing locknut. The end of the adjustment distance is shown by a red ring marking visible on the end of the knob. Refer to sect. 5 for important notes on this.
The groove width of the slot type throttles remains constant over a certain adjustment distance in each case, i.e. the throttle cross section changes in a linear manner in contrast to the needle valve or ball valve designs (annular gap throttles), something which allows fine adjustments to be made even when the flow values are low. The slotted throttle is largely insensitive to microcontamination by virtue of the favorable length/to width ratio.



2. Types availables, main data

Max. pressure loading capacity
Q..20.. to 50.. = 400 bar
Q..20 HL.. = 315 bar
Q..60 = 315 bar

	Throttle screw for location hole	Throttle valve for line installation: Corner valve		Banjo bolt [1]	Banjo fitting			Flow rate Q_{max}
			for pipe-Ø (mm)		with sealing edge ring	with plastic sealing ring	for pipe-Ø (mm)	approx. (lpm)
Single throttle throttling A→B and B→A largely the same	**Q 20**	**Q 20 T 6**	6	**Q 20 H** [2]	**Q 20 H 6** [2] / **H 8** [2]	**Q 20 H 6 K** [2] / **H 8 K** [2]	6 8	12
					Q 20 HL 8 [2] / **HL 10**	**Q 20 HL 8 K** [2] / **HL 10 K**	8 10	
	Q 30	**Q 30 T 8**	8	**Q 30 H**	**Q 30 H 10**	**Q 30 H 10 K**	10	25
	Q 40	**Q 40 T 10**	10	**Q 40 H**	**Q 40 H 12**	**Q 40 H 12 K**	12	50
	Q 50	**Q 50 T 12**	12	**Q 50 H**	**Q 50 H 16**	**Q 50 H 16 K**	16	90
	Q 60	---	---	**Q 60 H**	**Q 60 H 20**	**Q 60 H 20 K**	20	120
Restrictor check valve throttling B→A	**QR 20**	**QR 20 T 6**	6	**QR 20 H** [2]	**QR 20 H 6** [2] / **H 8** [2]	**QR 20 H 6 K** [2] / **H 8 K** [2]	6 8	12
					QR 20 HL 8 [2] / **HL 10**	**QR 20 HL 8 K** [2] / **HL 10 K**	8 10	
	QR 30	**QR 30 T 8**	8	**QR 30 H**	**QR 30 H 10**	**QR 30 H 10 K**	10	25
	QR 40	**QR 40 T 10**	10	**QR 40 H**	**QR 40 H 12**	**QR 40 H 12 K**	12	50
	QR 50	**QR 50 T 12**	12	**QR 50 H**	**QR 50 H 16**	**QR 50 H 16 K**	16	90
	QR 60	---	---	**QR 60 H**	**QR 60 H 20**	**QR 60 H 20 K**	20	120
Restrictor check valve throttling A→B	**QV 20**	**QV 20 T 6**	6	**QV 20 H** [2]	**QV 20 H 6** [2] / **H 8** [2]	**QV 20 H 6 K** [2] / **H 8 K** [2]	6 8	8
					QV 20 HL 8 [2] / **HL 10**	**QV 20 HL 8 K** [2] / **HL 10 K**	8 10	
	QV 30	**QV 30 T 8**	8	**QV 30 H**	**QV 30 H 10**	**QV 30 H 10 K**	10	12
	QV 40	**QV 40 T 10**	10	**QV 40 H**	**QV 40 H 12**	**QV 40 H 12 K**	12	20
	QV 50	**QV 50 T 12**	12	**QV 50 H**	**QV 50 H 16**	**QV 50 H 16 K**	16	30
	QV 60	---	---	**QV 60 H**	**QV 60 H 20**	**QV 60 H 20 K**	20	50

[1] Customer-furnished EO parts, see section 4.2
[2] Optional version with thread seal ring (see dimensional drawing in sect. 4.2). Simply add a D to the basic type coding e.g. Q 20 HD 8

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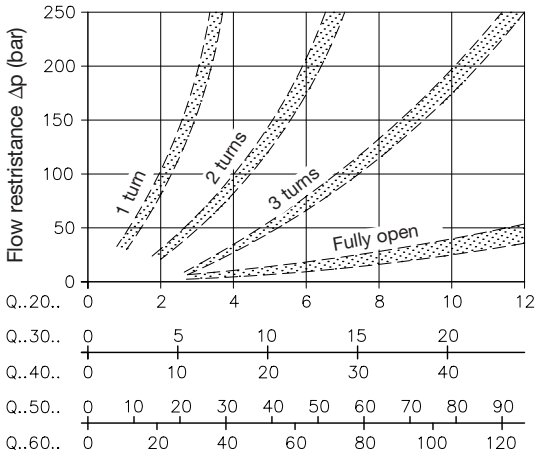
3. Characteristic data

Design	Slot type throttle
Line connection	Directly screwed into location hole of manifolds unit bodies or pipe mounting (housing design, see note in section 4.2)
Installation position	Any
Surface treatment	Housing versions electro-galvanized and yellow chromated (cC)
Pressure fluid	Hydraulic oil conforming DIN 51524 part 1 to 3: ISO VG 10 to 68 conforming DIN 51519. Viscosity limits: min. approx. 4, max. approx. 1500 mm²/sec; opt. operation approx. 10... 500 mm²/sec. Also suitable are biologically degradable pressure fluids type HEPG (Polyalkylenglycol) and HEES (Synth. Ester) at service temperatures up to approx. +70°C.
Temperature	Ambient: approx. -40 ... +80°C Fluid: -25 ... +80°C, Note the viscosity range ! Permissible temperature during start: -40°C (Note start-viscosity!), as long as the service temperature is at least 20K higher for the following operation. Biological degradable pressure fluids: Note manufacturer's specifications. By consideration of the compatibility with seal material not over +70°C.

Throttle characteristic Δp-Q

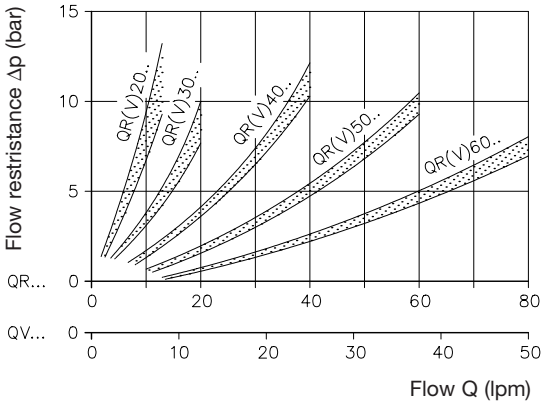
The characteristics must be regarded only as recommended values for the Δp-Q ratio within the relevant adjustment range. Different basic resistances of the various housing designs have only a slight effect in the fine adjustment range up to approx. 2...3 turns and would only be noticeable with the throttle fully open (red ring marking, sect. 5.1) if at all.
The turns for opening are counted from the closed state.



The throttle setting of the valve is always made with a pressure gauge at the installation site, since the flow resistance ranges from the theoretical value ∞ (throttle closed) to a lower limit value, which is determined by the intrinsic resistance of the angle deflection A → B. See the important note in sect. 5. The throttle screws are not suitable for an oil leak-free blocking position (do not forcibly turn into the closed position) .

Δp-Q curves
(back pressure via the check valve) in direction
A → B with type QR..
B → A with type QV..

It depends on the throttle opening and is between a limit curve for a closed throttle through to a fully opened throttle, corresponding to the above characteristics. The characteristics opposite show the tendency for a throttle which is opened by 3 turns.



Oil viscosity during the measurement appr. 60 mm²/s

Mass (weigth) approx.

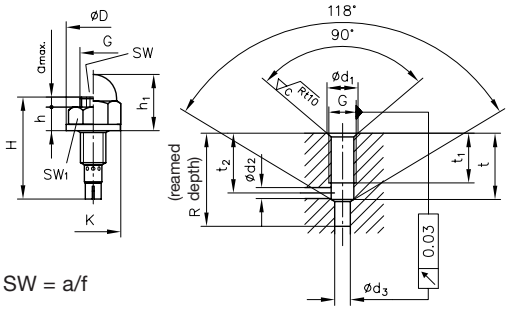
Throttle screw	Corner valve	Banjo bolt	Banjo fitting
Q(R,V) 20 = 15 g	Q(R.V) 20 T 6 = 115 g	Q(R.V) 20 H = 40 g	Q(R.V) 20 H 6(K) = 150 g
Q(R,V) 30 = 25 g	Q(R.V) 30 T 8 = 135 g	Q(R.V) 30 H = 70 g	Q(R.V) 20 H 8(K) = 150 g
Q(R,V) 40 = 40 g	Q(R.V) 40 T10 = 180 g	Q(R.V) 40 H = 90 g	Q(R.V) 20 HL 8(K) = 150 g
Q(R,V) 50 = 55 g	Q(R.V) 50 T12 = 255 g	Q(R.V) 50 H = 130 g	Q(R.V) 20 HL 10(K) = 150 g
Q(R,V) 60 = 100 g		Q(R.V) 60 H = 230 g	Q(R.V) 30 H 10 = 250 g
			Q(R.V) 40 H 12 = 290 g
			Q(R.V) 50 H 16 = 470 g
			Q(R.V) 60 H 20 = 830 g

4. Dimensions

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

4.1 Throttle screws

Location hole



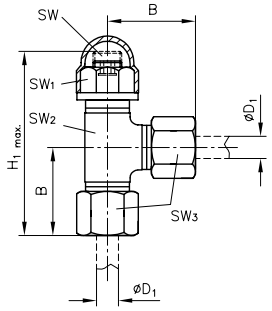
SW = a/f

Type	G	D	H	a_{max}	d_1 +0.3	d_2	d_3 H11
Q(R,V) 20	M8x1	17	32	5	10.2	5.5	5
Q(R,V) 30	M10x1	21	36	5	12.4	6.5	6.5
Q(R,V) 40	M12x1.5	23	41	6	15.2	7.5	8
Q(R,V) 50	M14x1.5	27	46	6	16.8	9	9
Q(R,V) 60	M16x1.5	30	58	6	19.0	11	11

Type	h	h_1	$t^{+0.5}$	t_1	t_2	K	R	a/f	a/f1	Max. torque
Q(R,V) 20	8.5	18	18	14	15	17	25	4	13	8 Nm
Q(R,V) 30	9	24	20.5	16	17	22	30	5	17	14 Nm
Q(R,V) 40	10	26	23.5	16	19.5	24	32	6	19	22 Nm
Q(R.V) 50	11	28	27	19	22	28	37	8	22	50 Nm
Q(R,V) 60	18	32	32	22	26	31	41	10	24	70 Nm

4.2 Throttle valve for inline installation

Corner valve

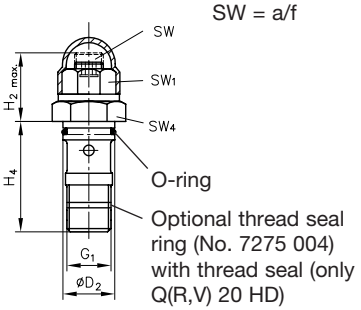


Type	B	H_1	D_1	a/f
Q(R,V) 20 T 6	31	56.5	6	4
Q(R,V) 30 T 8	32	58.5	8	5
Q(R,V) 40 T10	34	63.5	10	6
Q(R,V) 50 T12	38	72.5	12	8

Type	a/f1	a/f2	a/f3
Q(R,V) 20 T 6	13	14	17
Q(R,V) 30 T 8	17	17	19
Q(R,V) 40 T10	19	19	22
Q(R,V) 50 T12	22	22	24

Banjo bolt

Location hole



Type	G_1 3)	G_2 3)	D_2	D_3H9	D_4	H_2	H_4	d_4
Q(R,V) 20 H	G 1/4 A	G 1/4	15.45	15.5	20	20	33	5
Q(R,V) 30 H	G 3/8 A	G 3/8	18.95	19	25	21	38	8
Q(R,V) 40 H	G 3/8 A	G 3/8	18.95	19	25	23.5	38	12
Q(R,V) 50 H	G 1/2 A	G 1/2	22.95	23	30	27	49.5	12
Q(R,V) 60 H	G 3/4 A	G 3/4	28.95	29	35	34	59.5	15

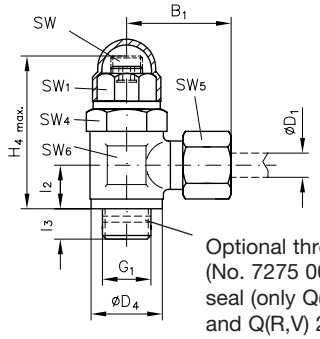
Type	L	L_1	t_3	t_4	a/f	a/f1	a/f4	Max. torque	O-ring NBR 90 Sh
Q(R,V) 20 H	23	10	10	7	4	13	19	50 Nm	12.5x1.5
Q(R,V) 30 H	27	12	13	9	5	17	24	75 Nm	16x1.5
Q(R,V) 40 H	27	12	13	9	6	19	24	75 Nm	16x1.5
Q(R,V) 50 H	35	15	14	9	8	22	30	130 Nm	20x1.5
Q(R,V) 60 H	43	18	20	10	10	24	36	250 Nm	25x1.5

Index of costomer-furnished EO-parts:

Banjo bolt	Pipe-Ø d_a	Swiveling housing	EO-parts are customer furnished 1) Cutting ring 2)	Plastic ring 2)	Progressive ring	Union nut
Q(R,V) 20 H	6	XWH 6-SR-A3C	DKA 1/4	KD 1/4	DPR 6-L/S	M 6-S-A3C
Q(R,V) 20 H	8	XWH 8-SM/SR-A3C	DKA 1/4	KD 1/4	DPR 8-L/S	M 8-S-A3C
Q(R,V) 20 HL	8	XWH 8-LR-A3C	DKA 1/4	KD 1/4	DPR 8-L/S	M 8-S-A3C
Q(R,V) 20 HL	10	XWH 10-LR-A3C	DKA 1/4	KD 1/4	DPR 10-L/S	M 10-S-A3C
Q(R,V) 30 H	10	XWH 10-SM/SR-A3K	DKA 3/8	KD 3/8	DPR 10-L/S	M 10-S-A3C
Q(R,V) 40 H	12	XWH 12-SR-A3C	DKA 3/8	KD 3/8	DPR 12-L/S	M 12-S-A3C
Q(R,V) 50 H	16	XWH 16-SR-A3C	DKA 1/2x4.5	KD 1/2	DPR 16-L/S	M 16-S-A3C
Q(R,V) 60 H	20	XWH 20-SM/SR-A3C	DKA 3/4	KD 3/4	DPR 20-L/S	M 20-S-A3C

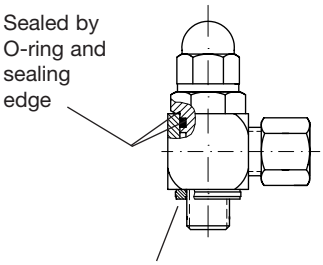
1) Parker Hannifin GmbH, division ERMETO Am Metallwerk 9, D-33659 Bielefeld
2) Observe the differing external-Ø of the seal rings, see also versions with swiveling housing at page 4!
3) G... (BSPP)

Threaded pipe connections



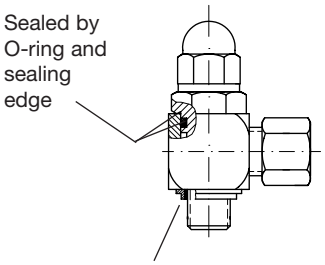
Optional thread seal ring (No. 7275 004) with thread seal (only Q(R,V) 20 HD 6(8) and Q(R,V) 20 HD 6(8)K

Type Q(R, V) ...H...



Sealed by cutting ring DKA

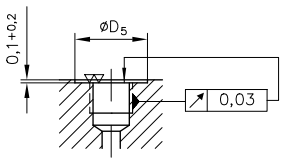
Type Q(R, V) ...H...K



Sealed by plastic ring KDS

SW = a/f

Sink for all types

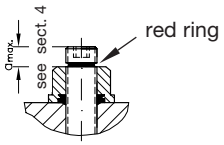


[1]) G... (BSPP)

Type	G1 [1])	B1	D1	D4	D5	H4	l2	l3	a/f	a/f1	a/f5	a/f6	a/f4	Max. torque
Q(R,V) 20 H 6 (K)	G 1/4 A	31	6	18.9	20	42.5	14	9	4	13	17	22	19	50 Nm
Q(R,V) 20 H 8 (K)	G 1/4 A	31	8	18.9	20	42.5	14	9	4	13	19	22	19	50 Nm
Q(R,V) 20 HL 8 (K)	G 1/4 A	29	8	18.9	20	42.5	14	9	4	13	17	22	19	50 Nm
Q(R,V) 20 HL 10 (K)	G 1/4 A	30	10	18.9	20	42.5	14	9	4	13	19	22	19	50 Nm
Q(R,V) 30 H 10 (K)	G 3/8 A	35	10	22	25	50	16.5	9	5	17	22	27	24	75 Nm
Q(R,V) 40 H 12 (K)	G 3/8 A	35	12	22	25	52	16.5	9	6	19	24	27	24	75 Nm
Q(R,V) 50 H 16 (K)	G 1/2 A	40	16	26.9	30	62.5	21.5	14	7	22	30	32	30	130 Nm
Q(R,V) 60 H 20 (K)	G 3/4 A	48	20	32.9	35	78	24	16	10	24	36	41	36	250 Nm

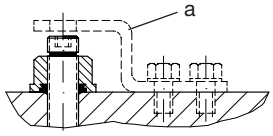
5. Notes for operation

5.1 Maximum adjustment distance

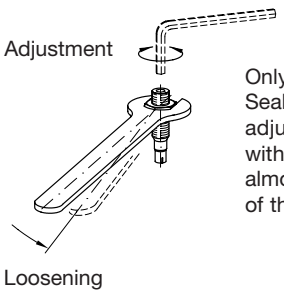


At the maximum adjustment length (guideline dimension a_{max}), the ring marking will become visible. Further unscrewing will not achieve any further change (reduction) in the Δp-value. From a design point of view, an internal stop to prevent further or complete unscrewing cannot be provided. The red ring marking accordingly also represents the end of the permissible adjustment length. If it is exceeded, the number of load-bearing threads will be reduced, and if unscrewed too far there is the risk that the throttle screw might be torn out at high pressure. This point should, if necessary, be included in the operating manual or the operating instructions for the system.

Caution:
Do not unscrew throttle screw beyond red marking ring!



If necessary (e.g. for accident prevention), appropriate securing elements (a) are to be attached to the unit bodies into which the Q-screw is inserted, so as to prevent the screw from turning out-wards any further. This also applies to housing designs as in section 4.2.



Only slight loosening of the Seal-Lock-nut is required for adjusting the throttle screw with an Allen key. This way almost no fluid will escape out of the bore.

2-way flow control valve type DSJ

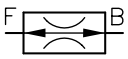
For both flow directions

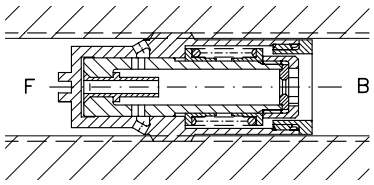
Flow Q_{min} = 1 lpm
Q_{max} = 21 lpm

Operation pressure p_{max} = 315 bar

1. General information

The 2-way flow control valves (double drop-rate braking valves) type DSJ serve for a pressure independent flow limitation for both flow directions. They are used preferably in stacker applications to control the speed in both directions for the additional functions „fork rotation“ and „fork transverse“. But they may be used in other kinds of industrial or mobile application as well.
The valve can be selected depending on requirement with various flow graduations. The flow in direction B differs usually by 20 to 30% over the flow in direction F over the complete pressure range. The valves are set at a pressure of 100 bar at HAWE, other adjustment pressures are possible depending on customer requirements.
The pump delivery flow is typically divided in the flow passing the flow valve type DSJ and a residual flow, which is either used for other consumers or led back to the tank via a pressure limiting valve.

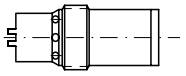
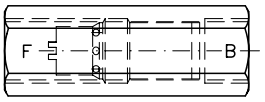
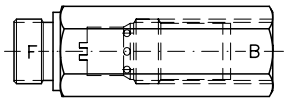
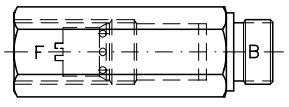




2. Available versions, main data

Order example: **DSJ 1 C - 5**

Basic type and size

Design	Coding	Illustration
Screw-in valve	**C**	
Version with housing for in-line installation	**G**	
	E	
	F	

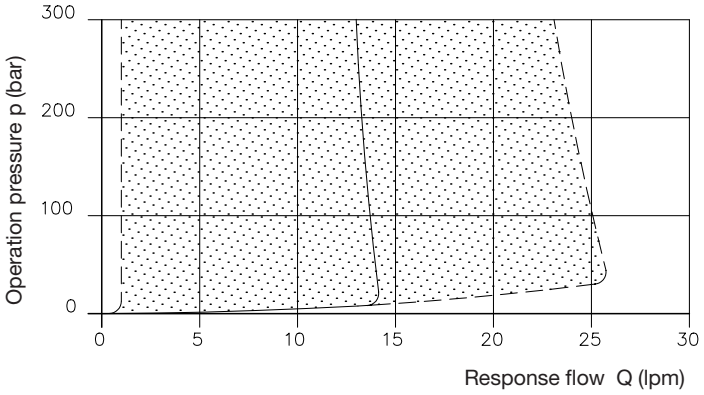
	Response flow Q (lpm) (applies to both flow directions)		
	Coding	Flow Q (lpm)	Tolerance
Main versions	**1,0**	1.0 - 1.3	+30%
	1,5	1.5 - 1.95	
	2,5	2.5 - 3.25	
	3,5	3.5 - 4.55	
	5,0	5.0 - 6.5	
	7,0	7.0 - 8.75	+25%
	8,5	8.5 - 10.2	+20%
	9,5	9.5 - 11.4	
	10,5	10.5 - 12.6	
	13,0	13.0 - 15.6	
	15,0	15.0 - 18.0	
	18,0	18.0 - 21.6	
Add. variants	**2,0**	2.5 - 3.25	+30%
	2,6	3.1 - 4.03	
	4,5	5.0 - 6.5	
	6,0	6.5 - 8.13	+25%
	6,6	7.1 - 8.88	
	8,3	8.8 - 10.56	+20%
	9,0	9.5 - 11.4	
	10,0	10.5 - 12.6	
	12,4	12.9 - 15.48	
	16,6	17.1 - 20.52	
	16 / 50 [1)]	15.2 - 16.8	±5%
	18 / 50 [1)]	18.0 - 21.6	+20%
	21 / 50 [1)]	21.0 - 25.2	
	5,0 / 180 [1)]	5.0 - 6.5	+30%

[1)] Set at pressure (non std.)

3. Further parameters

Pipe connection	Whitworth pipe thread ISO 228/1 (see „Unit dimensions“ in sect. 4)
Installed position	Any
Flow direction	Any
Operation pressure	p_{max} = 315 bar
Permissible flow	Q_{max} = 21 lpm; Q_{min} = 1 lpm
Mass (weight)	Without housing C | 30 g With housing E, F, G | 170 g
Hydraulic fluid	Fluids 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 mm²/s Optimal operation range: approx. 10...500 mm²/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.
Temperature	Ambient: approx. -40...+80°C Fluid: -25...+80°C, pay attention to the viscosity range! Start temperature down to -40°C are allowable (Pay attention to the viscosity range during start!), as long as the operation temperature during subsequent running is at least 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.

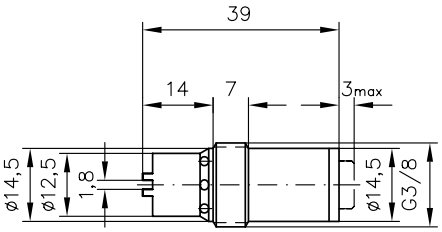
Δ-Q curves



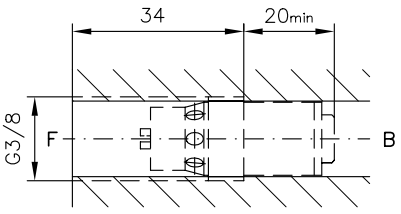
Fluid viscosity during measurement approx. 60 mm²/s

4. Unit dimensions

Screw-in cartridge type DSJ 1 C



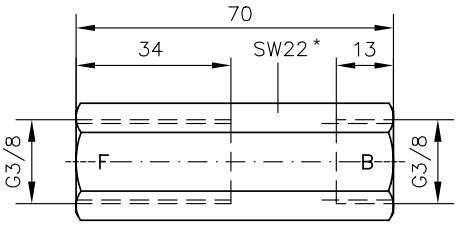
Mounting hole



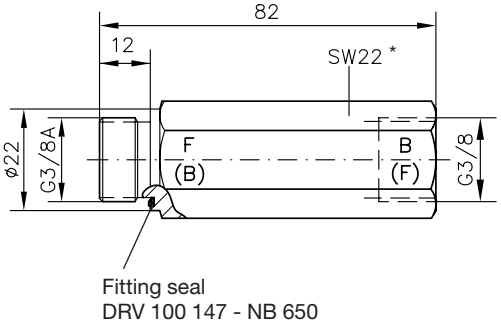
Max. torque 8 Nm for screw-in cartridge with customer furnished mounting hole / valve body.

Version with housing

Type DSJ 1 G



Type DSJ 1 E (F)



* SW 22 = a/f 22

All dimensions in mm, subject to change without notice !

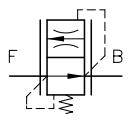
2-way flow control valve with sliding throttle type SB and SQ

Screw-in valves for tapped holes
Versions with housing

Operating pressure p_{max} = 315 bar
Flow Q_{max} = 400 lpm

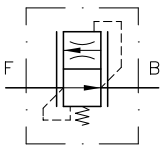
Design, not adjustable after installation

Screw in version
Type SB..C
SQ..C



Cartridge version

Type SB..G
SQ..G

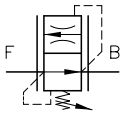


Type SB..E
SQ..E

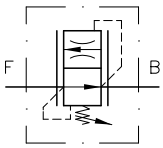
Type SB..F
SQ..F

Design, adjustable after installation

Screw in version
Type SB..H
SQ..H



Cartridge version with swivel housing
Type SB..H 6 (..20)
SQ..H 6 (..20)



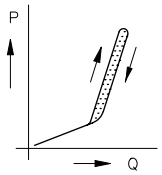
1. General information

These 2-way flow control valves (drop-rate braking valves) type SB and SQ restrict the flow down to the set figure rather independent of the respective load pressure. A large cross section area is opened up in reverse flow direction via the patented sliding throttle (see below). This way, an otherwise necessary by-pass check valve to minimize the back pressure, is superfluous.
With all other conventional designs, using fixed metering orifices, the smaller the regulated flow (i.e. the smaller the metering orifice required), the greater the flow resistance will become.
They consist basically of a cylinder liner (housing) with control piston and piston spring, plus a freely-movable metering orifice disk (patented sliding throttle). This is brought into the operational pos. (control position) by the flow medium, and forms an annular orifice in the control piston. The flow resistance of this orifice, in conjunction with the preloading (setting length) of the piston spring, determines the magnitude of the regulated flow. In the opposite direction, the orifice moves completely out of the control position, the metering orifice (annular orifice) is raised up, and flow is possible completely independent of any setting range and with minimum resistance (check valve effect).

Difference between type SB and SQ:

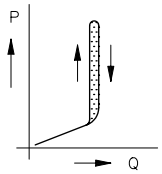
Type SB

Use at lifting devices with positive load, featuring an oscillation damping, where the Δp-Q curve is slightly angled in load direction



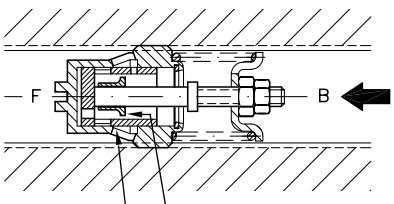
Type SQ

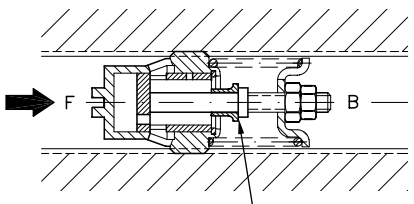
Use in hydraulic systems without a tendency to oscillations, e.g. to limit the speed of double acting cylinders



Function :

Working direction F ← B	Opposite directon F → B
Flow rate substantially constant as a result of the equilibrium automatically obtained between the internal pressure gradient and the pre-load of the piston valve spring	Free, unimpeded flow with minimal resistance through the sliding throttle which slides back out of the regulating position (thus cancelling the effect of the orifice)





2. Types available, main data

2.1 Version non adjustable when installed

Operating pressure p_{max} = 315 bar.

Preferably for setting once only. Not accessible from outside when installed and accordingly completely protected against unauthorized adjustments.

Order example:

Standard design **SB 2 1 C - 20**

Version with metric thread **SB 2 5 22 C - 30**

Version with thread reduction ring **SB 3/2 3 G - 28**

Required response flow in lpm, within setting range, preset at HAWE (see also section 3.3)

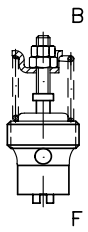
	Connection [1]	Basic type and size	Coding for setting range; below adjustable response flow from... to... (lpm) [5]						Additional coding for thread
			1	3	5	7	9	90	
Standard version for pipe connection, conforming DIN ISO 228/1 (BSPP)	G 1/4 (A)	**SB 0**	1 ... ... 1.6	1.6 ... ... 2.5	2.5 4	4 ... ... 6.3	6.3 10	10 15	
	G 3/8 (A)	**SB 1 SQ 1**	2.5 4	4 ... ... 6.3	6.3 10	10 16	16 25	25 ... ... 35 [2]	
	G 1/2 (A)	**SB 2 SQ 2**	16 21	21 28	28 37	37... ... 50	50 ... .. 67 [2]		
	G 3/4 (A)	**SB 3 SQ 3**	37 50	50 67	67 90	90... ... 120	120 ... ..150 [2]		
	G 1 (A)	**SB 4**	80 100	100 125	125 160	160... ... 200	200 250		
	G 1 1/4 (A)	**SB 5**	170 200	200 236	236 280	280... ... 335	335 400		
Version for metric fine thread, conforming DIN 13 T6	M 14x1.5	**SB 0**	1 ... ... 1.6	1,6 ... ... 2.5	2.5 4	4 ... ... 6.3	6.3 10	10 15	**14**
	M 16x1.5 M 18x1.5	**SB 1 SQ 1**	2.5 4	4 ... ... 6.3	6.3 10	10 16	16 25	25 ... ... 35 [2]	**16 18**
	M 20x1.5 M 22x1.5	**SB 2 SQ 2**	16 21	21 28	28 37	37... ... 50	50 ... .. 67 [2]		**20 22**
	M 27x2	**SB 3 SQ 3**	37 50	50 67	67 90	90... ... 120	120 ... ..150 [2]		**27**
	M 33x2	**SB 4**	80 100	100 125	125 160	160... ... 200	200 250		**33**
	M 42x2	**SB 5**	170 200	200 236	236 280	280... ... 335	335 400		**42**
[3]	7/8 14 UNF	**SB 2**	16 21	21 28	28 37	37... ... 50	50 67		**7/8 - 14 UNF**
Version for thread reduction ring only for threads, conforming DIN ISO 228/1 (BSPP)	G 3/8 (A)	**SB 1/0**	1 ... ... 1.6	1.6 ... ... 2.5			6920 151		
	G 1/2 (A)	**SB 2/1 SQ 2/1**	2.5 4	4 ... ... 6.3	6.3 10	10 16	6920 152		
	G 3/4 (A)	**SB 3/2 SQ 3/2**	16 21	21 28	28 37		6920 153		
	G 1 (A)	**SB 4/3 SQ 4/3**	37 50	50 67	67 90		7227 020		
	G 1 1/4 (A)	**SB 5/4**	80 100	100 125	125 160	160... ... 200	7227 070		

Order coding for thread reduction ring as single component

Design version

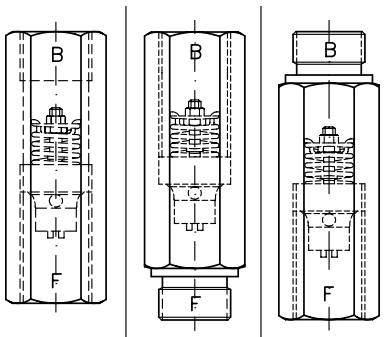
C

Screw in version

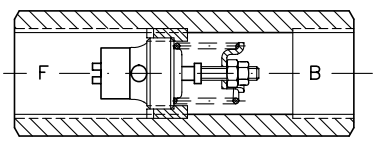


G | **E** | **F**

Version with housing for pipe connection [3] [4]



Screw-in cartridges size 0 to 4 with thread reduction ring, screwed into the next larger housing size 1 to 5.
Application example:
Adapting to the connection size of the hydraulic divices being used.
Example: SB 3/23 G-...



[1] G...A with tapped journal; G... for tapped ports
[2] Only available as type SB..
[3] UNF-thread conf. SAE J 514, is only available with design codings C, E, and F
[4] Version with metric thread available only as size 1 and 2 with design coding G, E and F
[5] corresponds to a set pressure of 50 bar, see sect. 3.2 „Nom. flow"

2.2 Version, adjustable when installed

Note: These versions are externally adjustable and may be additionally blocked (only type SB..K.., see appendix in sect. 5.2)!

Operating pressure p_{max} = 315 bar.
After releasing a locknut, the actuation flow can be adjusted within the given limits along a specific adjustment path S (see sect. 3.3).
The screw-in cartridges are located in a swiveling housing (corner valve), at versions with housing.

Order example:

Banjo bolt version [2]: **SB 3 9 H - 130**

Version with swivel housing (standard, suited for BSPP pipe fittings): **SB 1 7 H 12 - 14**

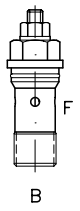
Version with swivel housing (special version featuring metric thread): **SB 2 5 22 H 16 - 30**

Required response flow in lpm within setting range, present at HAWE

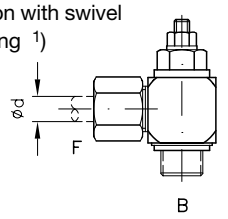
	Connection [1]	Basic type and size	Coding for setting range; below adjustable response flow from... to... (lpm) [5] 1	3	5	7	9	90	Additional coding for thread
Standard version with threads DIN ISO 228/1 (BSPP)	G 1/4 (A)	**SB 0 SQ 0**	1 ... ...1.6 [4]	1.6 ... ... 2.5 [4]	2.5 ... ...4 [4]	4 ... ... 6.3	6.3 10	10 ... ... 15 [4]	
	G 3/8 (A)	**SB 1 SQ 1**	2.5 ... ... 4 [4]	4 ... ... 6.3 [4]	6.3 10	10 16	16 ... ... 25 [4]	25 ... ... 35 [4]	
	G 1/2 (A)	**SB 2 SQ 2**	16 21	21 28	28 37	37... ... 50	50 ... ... 67 [4]		
	G 3/4 (A)	**SB 3 SQ 3**	37 50	50 67	67 90	90... ... 120	120 ... ... 150 [4]		
Version with metric fine thread DIN 13 T6	M 14x1.5	**SB 0**	1 ... ... 1.6	1.6 ... ... 2.5	2.5 4	4 ... ... 6.3	6.3 10	10 15	**14**
	M 18x1.5	**SB 1**	2.5 4	4 ... ... 6.3	6.3 10	10 16	16 25	25 35	**18**
	M 22x1.5	**SB 2**	16 21	21 28	28 37	37... ... 50	50 67		**22**
	M 27x2	**SB 3**	37 50	50 67	67 90	90... ... 120	120 150		**27**

Design version

H — Banjo bolt version [2]



Version with swivel housing [1]



Suited for	Coding	∅d
SB 0 SQ 0	**H 6** [3]	6
	H 8	8
	HL 10	10
SB 1 SQ 1	**H 12**	12
SB 2 SQ 2	**H 16**	16
SB 3 SQ 3	**H 20**	20

[1] DIN ISO 228/1 (BSPP), G...A with tapped journal; G... for tapped ports

[2] Banjo bolt version to be installed in customer furnished valve body, see mounting hole dimensions in sect. 4.2. It is also possible to convert this version to one with swivel housing H 6 ... H 20. The necessary parts are listed below.

[3] Not available for versions featuring metric fine thread

[4] Only available as type SB..

[5] corresponds to a set pressure of 50 bar, see sect. 3.2 „Nom. flow"

Individual fitting parts for conversion SB...H into SB...H 6 to H 20

	Individual part designation			
Type	Housing, W-type	Seal ring	Union nut	Cutting edge
SB(Q) 0 .. H 6	XWH 6 - SR - CFX	KDS 14 A3CX	m 6 - S - CFX	PSR 06 - L/X
SB(Q) 0 .. H 8	XWH 8 - SM/SR - CFX	KDS 14 A3CX	m 8 - S - CFX	PSR 08 - L/X
SB(Q) 0 .. HL 10	XWH 10 - LR - CFX	KDS 14 A3CX	m 10 - L - CFX	PSR 10 - L/X
SB(Q) 1 .. H 12	XWH 12 - SR - CFX	KDS 16 A3CX	m 12 - S - CFX	PSR 12 - L/X
SB(Q) 2 .. H 16	XWH 16 - SR - CFX	KDS 22 A3CX	m 16 - S - CFX	PSR 16 - L/X
SB(Q) 3 .. H 20	XWH 20 - SM/SR - CFX	KDS 27 A3CX	m 20 - S - CFX	PSR 20 - L/X

3. Characteristic data

3.1 General

Nomenclature and design: Flow valve (drop-rate flow control valve) in piston spool design

Flow direction: B → F controlled (limited) flow
F → B free flow

Pipe connection: Depending on type (see sect. 2.1 and 2.2)
Threads conforming DIN ISO 228/1 (BSPP), metric fine thread DIN 13 T6, UNF thread conforming SAE J 514

Installation position: Any

Mounting: SB...C; SQ..C (cartridge) is clamped at the end of the thread when tightened with the correct torque (see sect. 4.1)
SB...G; SQ..G (screw-in cartridge with housing) mounted any place in the pipe system
SB...E, F and H..; SQ...E, F and H (screw-in cartridge with housing) mounted in the device housing

Mass (weight) approx. g

Basic type	SB 0.. SQ 0..	SB 1.. SQ 1..	SB 2.. SQ 2..	SB 3.. SQ 3..	SB 4..	SB 5..
Cartridge C	13	23	40	80	150	300
With housing E, F, G	130	150	250	550	800	1650
Banjo bolt version SB...H, SQ...H	50	110	180	270	---	---
With swivel housing SB..H 6 to H 20 SQ..H 6 to H 20	140	250	470	770	---	---

3.2 Hydraulic

Operating pressure: approx. 15 ... 315 bar

Setting range: see section 2

Pressure fluid: Hydraulic oil conforming DIN 51524 part 1 to 3: ISO VG 10 to 68 conforming DIN 51519.
Viscosity limits: min. approx. 4, max. approx. 1500 mm²/s,
Opt. operation approx. 10 ... 500 mm²/s.
Also suitable for biological degradable pressure fluids types HEPG (Polyalkylenglycol) and HEES (Synth. Ester) at service temperatures up to approx. +70°C.

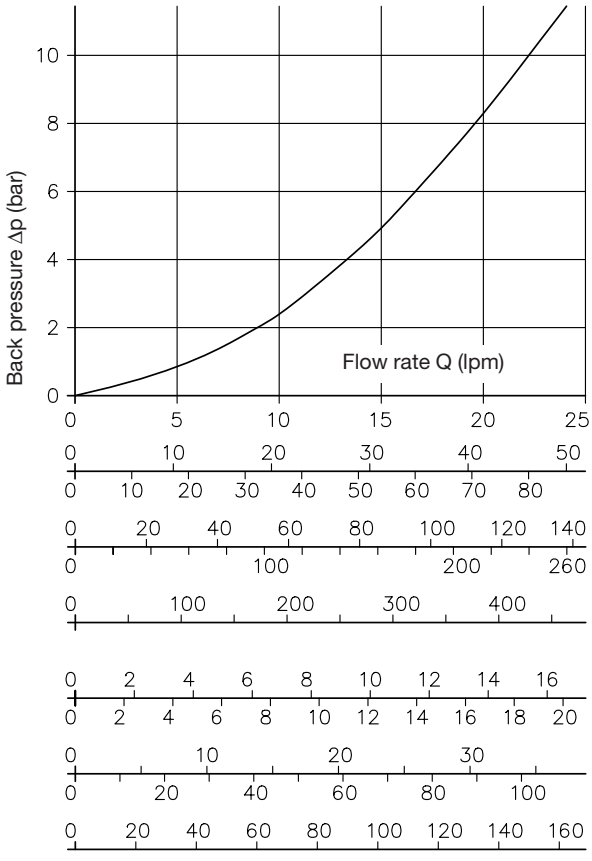
Temperature: Ambient: approx. -40 ... +80°C
Fluid: -25 ... +80°C, Note the viscosity range !
Permissible temperature during start: -40°C (Note start-viscosity!), as long as the service temperature is at least 20K higher for the following operation. Biological degradable pressure fluids:
Note manufacturer's specifications. By consideration of the compatibility with seal material not over +70°C.

Nominal flow: Factory set for a load pressure Δp = 50 bar, see also sect. 3.3
The adjustment tolerance depends on size and adjustment range;
Guideline approx. ± 25 % (SB 0.., SQ...) to ± 7 % (bigger versions)

Δp-Q-characteristic curves

(in free flow direction F → B)

Oil viscosity during measurement approx. 60 mm²/s



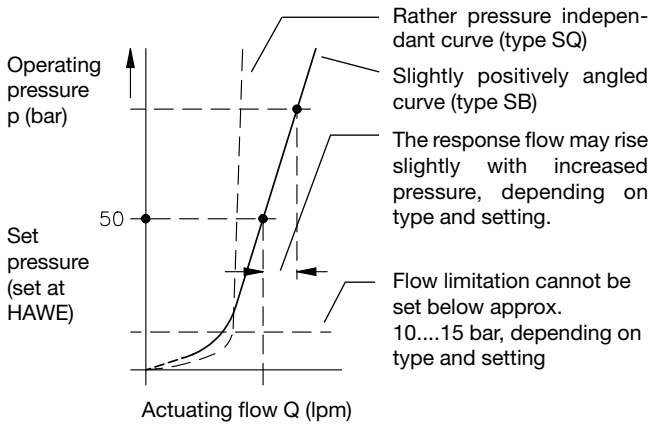
SB 0, SB 1/0...
SB 1, SB 2/1...; SQ 1, SQ 2/1
SB 2, SB 3/2...; SQ 2, SQ 3/2
SB 3, SB 4/3...; SQ 3, SQ 4/3
SB 4, SB 4/4...
SB 5

SB 0..H 6; SQ 0..H 6
SB 0..H 8; SQ 0..H 8
SB 1..H 12; SQ 2..H 12
SB 2..H 16; SQ 2..H 16
SB 3.. H 20; SQ 3..H 20

3.3 Adjustment characteristic

Response flow type SB (operat. direction B → F)

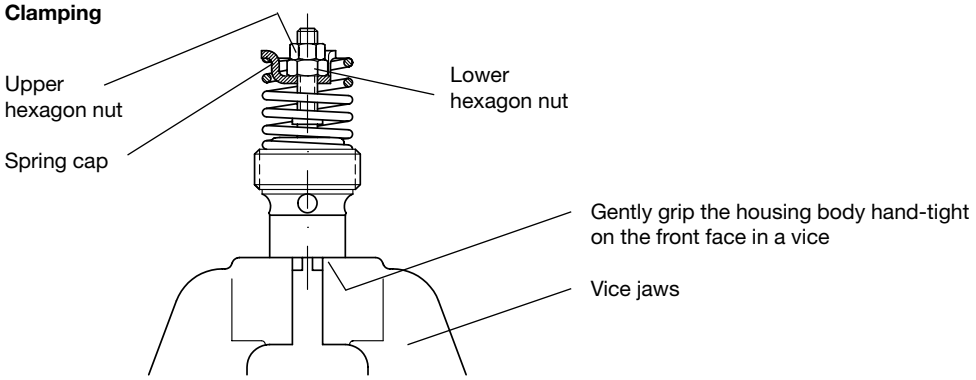
The response flow is set at HAWE at an operating pressure of 50 bar. When the characteristic is comoletely pressure-dependent (vertical), oscilations can occur on lifting equipment as a result of the elasticity of the oil volume in the lifting cylinder and hoses. In the case of the drop-rate brakes SB, the characteristic is therefore set with a slight incline, which allows such possible oscilations to be effectively suppressed.
If you wish the desired actuating flow (set value) to be reached under a different pressure load, this pressure must be specified additionally to the order coding. The works setting is then made at this pressure, which then also appears in the type description on the valve housing in addition to the actuating flow value, e.g. SB 25 G -30/150 (30 lpm at 150 bar)



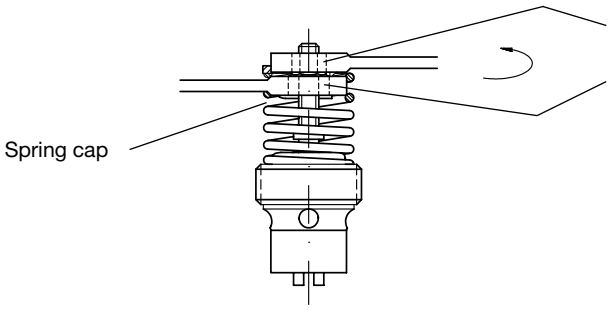
Changing the setting length S

The setting length S is only a guideline figure for the response flow at $\Delta p_{B \rightarrow F}$ = 50 bar, see also curves an page 6.
For altering the setting within the range (table in sect. 2) follow the instructions below.

- **Clamping**



- **Adjustment**

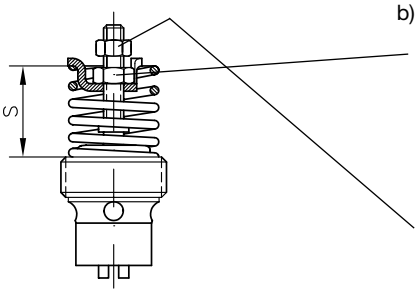


a) Unlock:

Loosen the upper nut with a spanner or a socket

Hold the lower nut in position with the spanner (press down the spring cap as far as necessary)

Type	Upper nut HAWE-part	Lower nut ISO 4032-M..-8-A2K
SB 0...C	M 3 (a/f 4.5)	M 3 (a/f 5.5)
SB 1...C, SQ 1	M 4 (a/f 6)	M 4 (a/f 7)
SB 2...C. SQ 2	M 4 (a/f 6)	M 4 (a/f 7)
SB 3...C, SQ 3	M 4 (a/f 6)	M 4 (a/f 7)
SB 4...C	M 5 (a/f 7)	M 5 (a/f 8)
SB 5...C	M 6 (a/f 9)	M 6 (a/f 10)



b) Adjustment and locking:

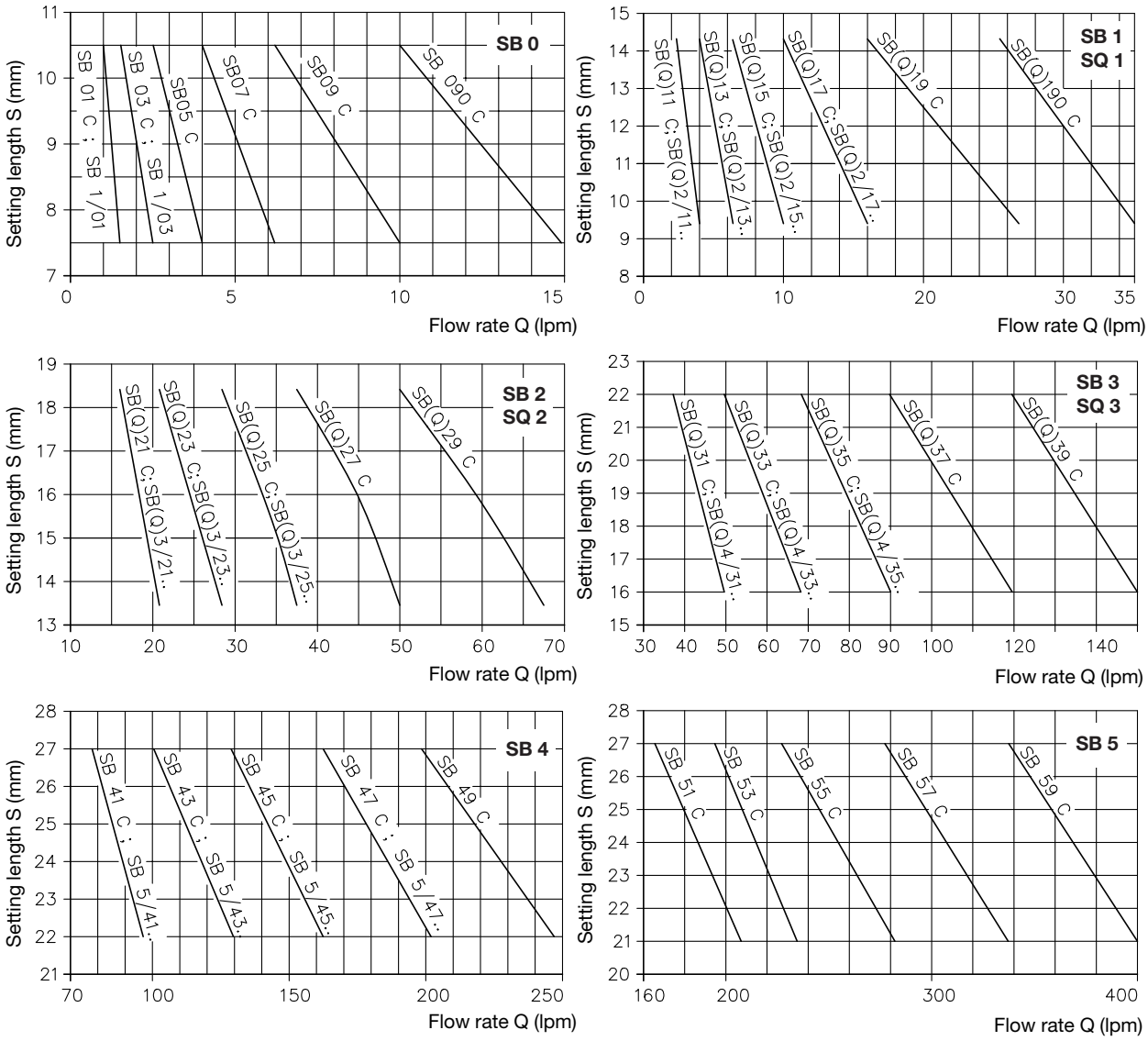
Screw the lower nut in or out according to the required length S (recommended value, see table, page 6) (socket best). The spring force prevents the control piston turning as well. Measure the length S (recommended value in tables, page 6) at three positions at the spring cap and determine the average value.

Next hold the lower nut in position and tighten the upper nut as in a).

For adjustment control, see continuation on page 6!

- **Checking the adjustment**

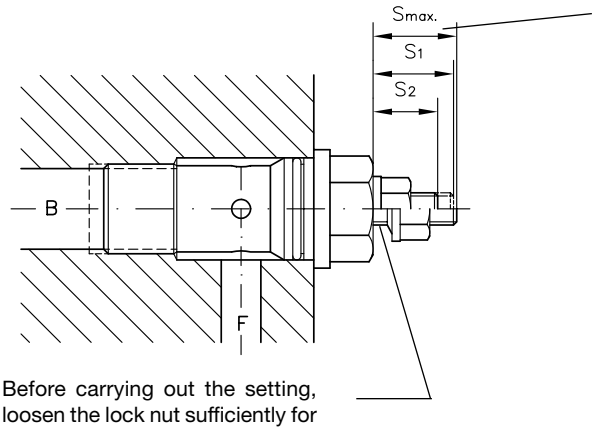
  Reinstall the flow control valve in the circuit and check the newly adjusted flow. When the new setting is correct a mark should be put on the rod thread 3 d with a center punch just above the lock nut to prevent loosening. Observe the correct torque for the valve in sect. 4.1 !



Banjo bolt version SB...H and SQ...H

Adjustment of the response flow is carried out at the threaded spindle within the particular range, using an allan key 3 mm, after loosing the Seal-Lock locknut.

Caution: Do not screw out the threaded spindle out of the housing beyond the dimension S_{max}, because there is no internal stop provided. This note shout be included in the setting instructions in the operating manual.



Before carrying out the setting, loosen the lock nut sufficiently for the integrally-vulcanized sealing ring to be free.

do not exceed this value !

Setting lengths

Type	Smax	S1	S2
SB 0...H; SQ...	12	10 ... 11	7 ... 9.5
SB 1...H; SQ...	13	11 ... 12	7.5 ... 9.5
SB 2...H; SQ...	13	9.5 ... 11	7 ... 8.5
SB 3...H; SQ...	14	11.5 ... 13	7 ... 9.5

Approximate guideline values

S1 approx. corresponds to the lower and

S2 approx. to the upper limit value of the response flow of each particular setting range. See table under section 2.2

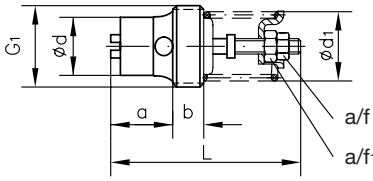
4. Dimensions

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

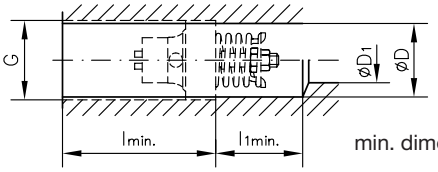
4.1 Version non adjustable when installed (acc. to section 2.1)

Cartridge version

Cartridge version



Location hole (see also example sect. 5.1)



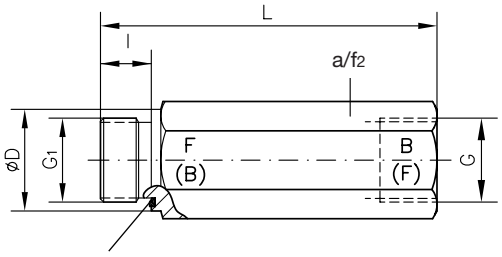
min. dimensions

Type	G1	L	a	b	d	d1	a/f	a/f1	G	D	D1	lmin	l1min	Torque (Nm)
SB 0	G 1/4 A M 14x1.5	39	12.5	7	10	10.5	4.5	5.5	G 1/4 M 14x1.5	11.75	5	33	22	6
SB 1 SQ 1	G 3/8 A M 16x1.5 M 18x1.5	43	13.5	7	11.5	13.5	6	7	G 3/8 M 16x1.5 M 18x1.5	15.25	8	34	26	8
SB 2 SQ 2	G 1/2 A M 20x1.5 M 22x1.5 7/8-14 UNF-2B	49	16	8	15	18	6	7	G 1/2 M 20x1.5 M 22x1.5 7/8-14 UNF-2A	19	12	40	30	12
SB 3 SQ 3	G 3/4 A M 27x2	61	21	10	20	23	6	7	G 3/4 M 27x2	24.5	16	51	29	15
SB 4	G 1 A M 33x2	78	25	15	26	28.5	7	8	G 1 M 33x2	30.5	20	65	40	20
SB 5	G 1 1/4 A M 42x2	94	31	21	33	34.5	9	10	G 1 1/4 M 42x2	39.5	25	78	42	25

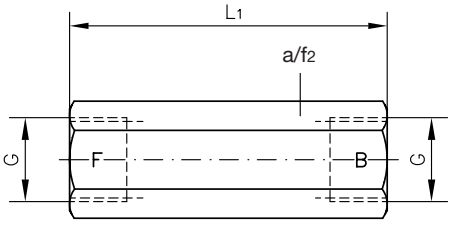
Max. torque for cartridge version retaining borehole, provided by client, and in valve housing

Housing design

Design **E** and **F**



Design **G**



Seal : G 1/4 NBR (SB 0..E and F)

[1] DRV 100 147 - NB 650 (SB 1..E and F; SQ 1..E and F)
DRV 100 185 - NB 650 (SB 2..E and F; SQ 2..E and F)
DRV 100 239 - NB 650 (SB 3..E and F; SQ 3..E and F)
DRV 100 297 - NB 650 (SB 4..E and F)
DRV 100 388 - NB 650 (SB 5..E and F)

[1] With type SB 2..E(F) -7/8 14 UNF cutting edge

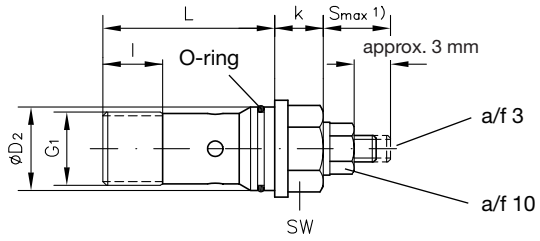
[2] G...(A) ≙ BSPP

Type	G	G1	D	L	L1	l	a/f2
SB 0..E (F, G)	G 1/4	G 1/4 A	19	78	66	11.5	19
SB 1.. E (F, G) SQ 1.. E (F, G)	G 3/8 M 16x1.5	G 3/8 A M 16x1.5	22	82	70	12	22 22
	M 18x1.5	M 18x1.5					24
SB 2.. E (F, G) SQ 2.. E (F, G)	G 1/2 M 20x1.5	G 1/2 A M 20x1.5	27	96	80	14	27 27
	M 22x1.5	M 22x1.5					30
	7/8-14 UNF-2B	7/8-14 UNF-2A	--	102	--	19.3	30
SB 3.. E (F, G) SQ 3.. E (F, G)	G 3/4	G 3/4 A	32	106	100	16	32
SB 4.. E (F, G)	G 1	G 1 A	40	145	125	18	41
SB 5.. E (F, G)	G 1 1/4	G 1 1/4 A	50	160	145	20	50

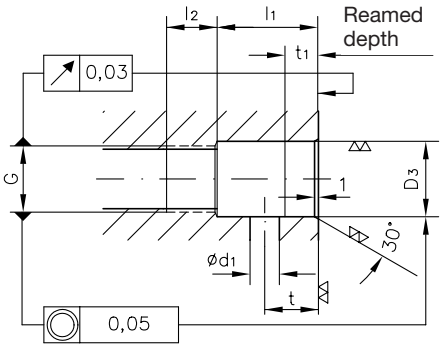
4.2 Version, adjustable when installed (acc. to section 2.2)

Banjo bolt version

Banjo bolt version



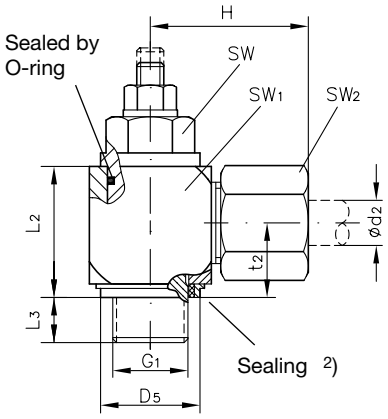
Location hole



Caution: Do not screw the threaded rod out of the housing beyond the specified dimension S_{max}, as there is no internal stop !

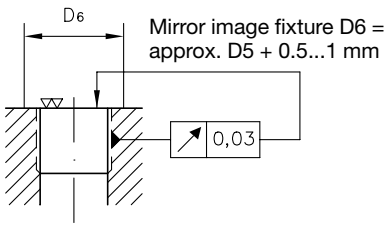
Type	G1 3)	D2	L	k	l	a/f	Torque max. (Nm)	O-ring NBR 90 Shore	G 3)	D3	d1	l1	l2	t	t1
SB(Q) 0..H	G 1/4 A	15.45	35	8	12	13	50	12.5x1.5	G 1/4	15.5 +0.1	5	23	13	12	5
SB(Q) 0..14 H	M 14x1.5								M 14x1.5						
SB(Q) 1..H	G 3/8 A	18.95	39	11	12	17	75	16x1.5	G 3/8	19 +0.1	8	27	13	13	8
SB(Q) 1..18 H	M 18x1.5	20.95	43	13		19	130	18x1.5	M 18x1.5	21 +0.1		31			
SB(Q) 2..H	G 1/2 A	22.95	49.5	12.5	15	19	130	20x1.5	G 1/2	23+0.1	12	35	15	16	12
SB(Q) 2..22 H	M 22x1.5								M 22x1.5						
SB(Q) 3..H	G 3/4 A	28.95	59.5	14.5	20.5	24	250	25x2	G 3/4	29 +0.1	16	43	18	20	10
SB(Q) 3..27 H	M 27x2								M 27x2						

Housing design (Cartrige version with swivel housing)



Type	G1 3)	L2	L3	H	D5	t2	d2
SB(Q) 0..H 6	G 1/4 A	24	11	31	18.9	14	6
SB(Q) 0..H 8	G 1/4 A	24	11	31	18.9	14	8
SB(Q) 0..14 H 8	M 14x1.5	24			18.9		
SB(Q) 0..HL 10	G 1/4 A	24			18.9	14	10
SB(Q) 1..H 12	G 3/8 A	27	12	35	21.9	16.5	12
SB(Q) 1..18 H 12	M 18x1.5	32	11		23.9	18.5	
SB(Q) 2..H 16	G 1/2 A	34.5	15	40	26.9	21.5	16
SB(Q) 2..22 H 16	M 22x1.5	31	14		26.9		
SB(Q) 3..H 20	G 3/4 A	43.5	16	48	32.9	24	20
SB(Q) 3..27 H 20	M 27x2	40			32.9		

Location hole



For missing dimensions, see above !

Type	a/f1	a/f2	a/f	Torque max. (Nm)
SB(Q) 0..H 6	22	17	13	50
SB(Q) 0..H 8 SB(Q) 0..14 H 8 SB(Q) 0..HL 10	22	19	13	50
SB(Q) 1..H 12	27	24	17	75
SB(Q) 1..18 H 12	30			
SB(Q) 2..H 16 SB(Q) 2..22 H 16	32	30	19	130
SB(Q) 3..H 20	41	36	24	250
SB(Q) 3..27 H 20		30		

1) S_{max} = 12 ... 14 depending on type see sect 3.3

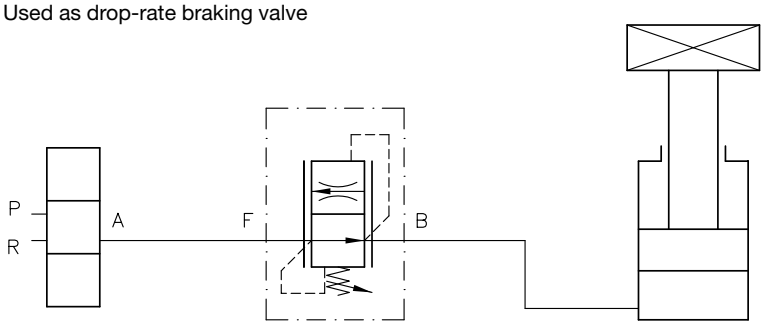
2) Sealing by plastic seal ring type KDS, must be replaced when valve is remounted.

3) G...(A) ≙ BSPP

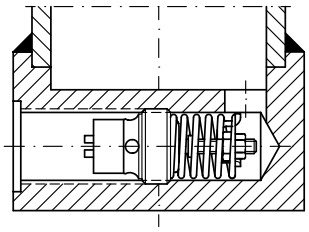
5. Appendix

5.1 Example circuits

Used as drop-rate braking valve



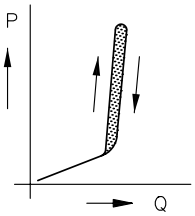
Installation example:
Drop-rate braking valve in cylinder base



5.2 Version with housing, that can be adjusted and locked externally

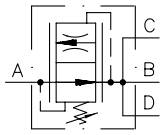
Version

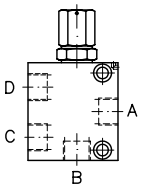
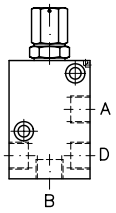
- The control piston of the drop-rate braking valve can be blocked via the set-screw for functional tests of line rupture safety valves in the circuit (e.g. stackers). This cuts-off the control function of the drop-rate braking valve and enables unhindered flow B, C, D → A.
- The curve of the standard version is positively angled to prevent oscillations of the cylinder during downward movement. This means the resulting flow will be higher in the area of p_{max} than adjusted (setting is for 50 bar at HAWE if not specified otherwise)
- This curve can be more or less erected with different piston/orifice combinations (e.g. type SB 275 K). Attention: It has to be checked whether undesired oscillations do occur at the respective application.



Order examples:

SB 2 7 K
SB 27 5 K



	Connections A, B, C, D DIN ISO 228/1 (BSPP)	Basic type and size	Coding for setting range; below adjustable response flow from... to... (lpm)					Housing versions	
			1	3	5	7	9		
			16 ... 21	21 ... 28	28 ... 37	37 ... 50	50 ... 67	**K**	**K1**
Standard	G 1/2	**SB 2**	●	●	●	●	●	●	●
	G 3/4	**SB 3**	●	●	●	●	●	●	
Special version	G 1/2	**SB 23**	●					●	●
		SB 25		●				●	●
		SB 27			●			●	●
		SB 29				●		●	●
	G 3/4	**SB 33**	●					●	
		SB 35		●				●	
		SB 37			●			●	
		SB 39				●		●	

Operating pressure	p_{max} = 315 bar
Flow direction	A→B, C, D free flow B, C, D→A controlled (limited) flow
Mounting	via thru-holes for lateral attachment

Mass (weight)

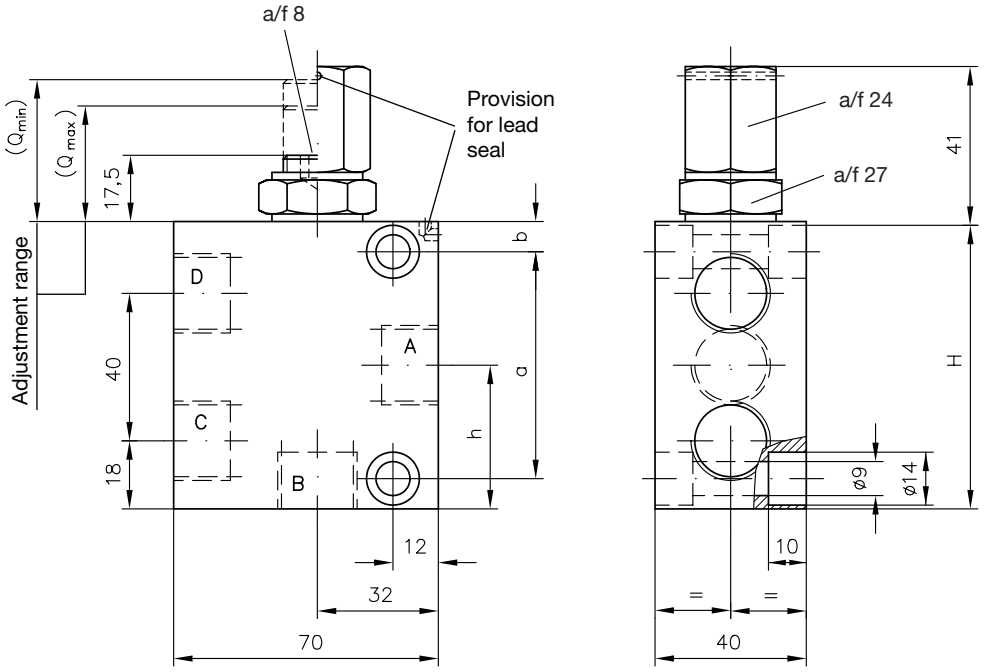
Type	SB 2..K	SB 2..K1	SB 3..K
approx. kg	1.4	1.2	1.5

Characteristic data	see section 3.1 and 3.2

Dimensions

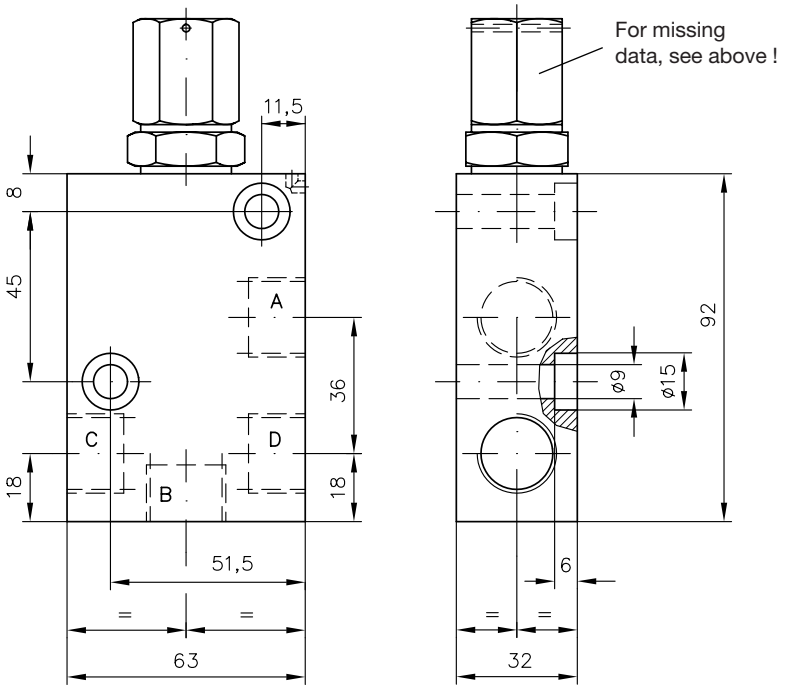
All dimensions are in mm, subject to change without notice!

Type SB 2..K
SB 3..K



Type	Ports A, B, C, D DIN ISO 228/1 (BSPP)	H	a	b	h
SB 2..K SB 275 K	G 1/2	76	60	8	38
SB 3..K	G 3/4	83	55	12	41

Type SB 2.. K 1



2- and 3-way flow control valves type SF, SD, SK, SKR, SU

Pressure p_{max} = 315 bar
Flow Q_{max} = 130 lpm

3-way flow control valve for threaded connection

Set-screw

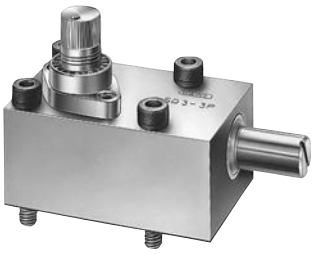
Roller adjustment

Rotary knob adjustment

2-way flow control valve for threaded connection

Adjustment as shown opposite left

2- and 3-way flow control valve, for manifold mounting



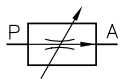
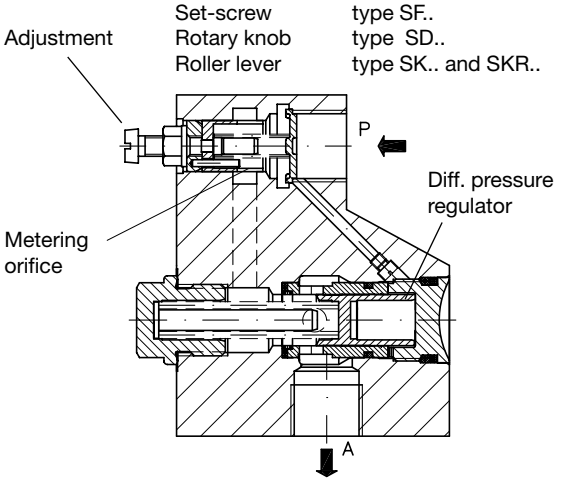
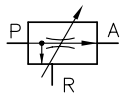
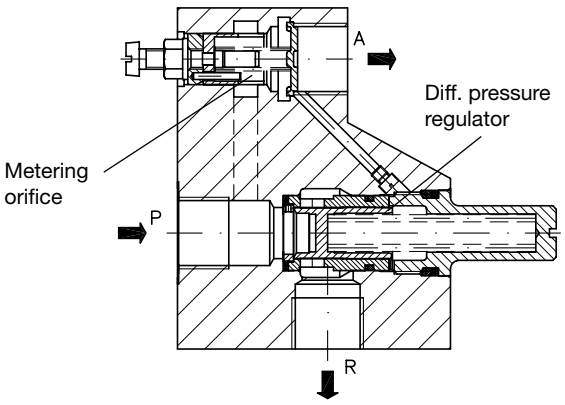
Adjustment as shown in outside left picture

1. General

The type S flow control valves are flow valves (DIN ISO 1219-1) and serve for inifinite adjustment of the flow into oil-hydraulic, hydrostatic system. Once set, the flow rate is constantly maintained at a tolerance of approx. ±3%, regardless of the pressure within the system and the viscosity of the hydraulic fluid.
It is possible to select electrically between two different flow rates with type SU (see sect. 3.3).

2. Overview

Typical configuration - System functions

Design	Schematic diagram	
2-way flow control valve (flow control in serial arrangement, secondary pressure) 		**Design and configuration:** Secondary flow control, meaning that the differential pressure regulator (pressure balance) is fitted downstream of the metering orifice to provide a good dynamic damping. A 2-way flow control valve will operate only in conjunction with a pressure relief valve on feed side P, and may therefore be used for both feed and drain control. Observe notes in sect. 3.1 and 6.1! Versions with by-pass check valve for unhindered return flow or check valve rectifier circuit (enabling flow control for both flow directions) are also available.
3-way flow control valve (flow control valve in parallel) 		**Design and configuration:** The differential pressure regulator (pressure balance) and metering orifice are arranged in parallel. Contrary to the 2-way flow control valve, the flow is separated in the consumer flow (→A) and residual flow (→R), i.e. the 3-way valve can be used for controlling the feed flow only. The valve acts against the momentary consumer counter-pressure. Additional control functions for pressure limitation or idle circulation may be integrated via directly mounted piloting valves or remote control via control port Z.

3. Types available, main data

3.1 2-way flow control valve

Order examples:

SD 2 - 3/15 R
SF 2 - 4/90 P

Table 1: Basic type and actuation

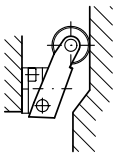
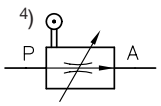
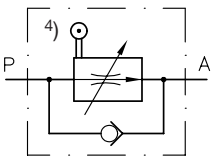
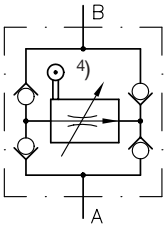
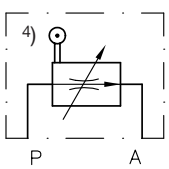
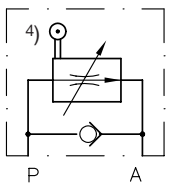
Set-screw	Rotary knob adjustment	Roller adjustment	
		Non-shielded version	Shielded version
SF 2	**SD 2**	**SK 2**	**SKR 2** [1]
with lock nut for fixed setting 	with fine setting by 3.8 rotations Marking rings for counting the number of rotations 	with mechanical operation via cam 	

Table 2: Size and flow

Size	Nominal flow deenergized open [2]										Ports P and A	
	/3	/6	/15	/30	/36	/50	/60	/70	/90	/130	Pipe contec-tion ISO 228/1 (BSPP)	Manifold mounting
	Nominal flow deenergized blocked [2]											
	-	/6F	/15F	/30F	/36F	/50F						
	Adjustment range $Q_{A\,min}$ ... $Q_{A\,max}$ (lpm)											
		0.3 to 6	0.3 to 15	0.3 to 30	0.3 to 36	0.3 to 50 [3]	0.3 to 60 [3]	0.3 to 70	0.3 to 90	1 to 130		
3	●	●	●	●	●	●	●				G 1/2	See dimen-sional drawing in sect. 5.2
4								●	●		G 3/4	
5										●	G 1	

Table 3: Connection pattern, symbols and auxiliary valves

Type of connection	Basic version	With auxiliary valve	
		Bypass check valve for free reflow A→P	Check valve rectifier circuit (only for pipe connection), flow control in both directions, see also footnote [3] above
Pipe connection	(no coding) 	**R** 	**B** Only size 3! 
Manifold mounting	**P** 	**PR** 	

[1] Suited for out door use, but not available for manifold mounting valves.

[2] To ensure optimum control, the flow at port P must always ex-ceed the consumer flow in operation in order to built up an internal control pressure drop for activating the pressure balance.

[3] When used with auxiliary valve B, the flow range is 0.3 to 40 lpm

[4] Actuation symbol is omitted with type SF 2

3.2 3-way flow control valve

Order examples:

SF 3 - 3/15 P
SD 3 - 4/70 S - 100
SD 3 - 3/15 S - WN1F - G12 - 120

Pressure specifiction in bar, max. 315
(only in connection with auxiliary valve, coding **S**)

Table 4: Basic type and actuation

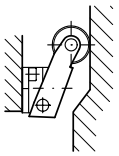
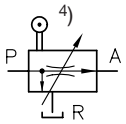
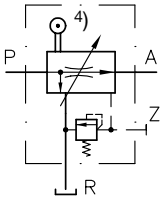
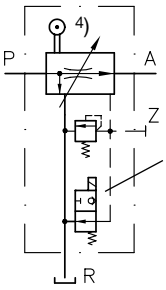
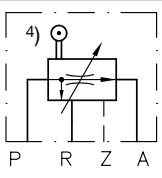
Set screw	Rotary knob adjustment	Roller adjustment	
		Non-shielded version	Shielded version
SF 3	**SD 3**	**SK 3**	**SKR 3** [1]
with lock nut for fixed setting 	with fine setting by 3.8 rotations Marking rings for counting the number of rotations 	with mechanical operation via cam 	

Table 5: Size and flow

Size	Nominal flow deenergized open [2]										Ports P and A			
	/3	**/6**	**/15**	**/30**	**/36**	**/50**	**/60**	**/70**	**/90**	**/130**	Pipe connection ISO 228/1 (BSPP)		Manifold mounting	
	Nominal flow deenergized blocked [2]													
	-	**/6F**	**/15F**	**/30F**	**/36F**	**/50F**								
	Adjustment range $Q_{A\,min}$ ... $Q_{A\,max}$ (lpm)													
		0.3 to 6	0.3 to 15	0.3 to 30	0.3 to 36	0.3 to 50	0.3 to 60	0.3 to 70	0.3 to 90	1 to 130	P, R, A	Z [3]	P, R, A	Z [3]
3	●	●	●	●	●	●	●				G 1/2	G 1/4	See dimensional drawing in sect. 5.3	
4								●	●		G 3/4	G 1/4		
5										●	G 1	G 1/4		

Table 6: Connection pattern, flow pattern symbols and auxiliary valves

Type of connection	Basic version	With auxiliary valve: Pressure limiting valve	With auxiliary valve: Pressure limiting valve with directly mounted 2-way direct. seated valve acc. to D 7470 A/1	Nominal voltage U_N	
Pipe connection	(no coding)	**S**	**S-WN 1 F-..** **S-WN 1 D-..**	**G 12**	12V DC
			 Circulation setting (circulation pressure 6...10 bar) S-WN 1 F S-WN 1 D 	**G 24**	24V DC
				WG 110	110V AC 50 / 60 Hz
				WG 230	230V AC
				See sect. 4.2 for main electrical data! For further data, see D 7470 A/1.	
Manifold mounting	**P** 				

[1] Suited for out-door use, but not available for manifold mounting valves.

[2] To ensure optimum control, the flow at port P must always exceed the consumer flow in operation in order to built up an internal control pressure drop for activating the pressure balance.

[3] Z = Control port with type S.3-3(4.5)/...S... and ...-3(4.5)/...P(PS)
It is used when an arbitrary idle pump circulation P→R is intended via an externally connected 2/2-way directional valve e.g. type WN1D(F)-1/4-.. acc. to D 7470 A/1 (see symbols above)

[4] Actuation symbol is omitted with type SF 2

3.3 2- and 3-way flow control valve type SU

Flow control valve where two constant flow rates can be selected electrically.

These flow control valves feature an additional solenoid as actuation, contrary to the versions specified in sect. 3.1 and 3.2. This way, plus a corresponding metering orifice, two different (constant) flow rates can be remotely activated by energizing or deenergizing the solenoid. This can be employed for e.g. creeping or rapid traverse. It also may make prop. flow control valves (e.g. type SE or SEH acc. to D 7557/1) and respective prop. amplifiers superfluous.
With some types (e.g. SU 2-3-0/40-G24) it is even possible to block the connection to the consumer ($Q_A = 0$) when required.

Order examples:

SU 2-3 - 4/ 16 - G 24
SU 3-3 - 25/10 S - WG 230 - 100

Pressure specification in bar, max. 315
(only in connection with auxiliary valve, coding **S**)

Table 7: Basic type with actuation (only size 3!)

Coding	Design	Only tapped ports for direct pipe connection ISO 228/1 (BSPP)	
		P, R, A	Z [1]
SU 2-3	2-way flow control valve	G 1/2	---
SU 3-3	3-way flow control valve	G 1/2	G 1/4

Table 8: Flow (= Effective consumer flow Q_A in lpm)
Combinations are possible, dep. on requirement

0 [2]	**0,4**	**0,6**	**1**	**2,5**	**4**	**6**	**10**	**16**	**25**	**40**	**50**

4 / 16
First coding = Usable consumer flow Q_A with deenergized solenoid
Second coding = Usable consumer flow Q_A with energized solenoid

Table 9: Flow pattern symbols and auxiliary valves

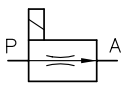
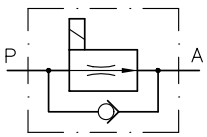
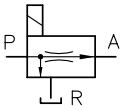
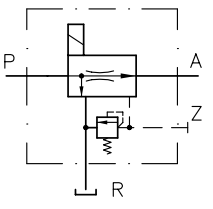
Basic version	Pipe connection	With auxiliary valve: Bypass check valve	With auxiliary valve: Pressure limiting valve
	(no coding)	**R**	**S**
2-way flow control valve			
3-way flow control valve			

Table 10: Operating voltage for the actuation solenoid

Coding	Nominal voltage U_N	
G 12	12V DC	For more detailed electrical data, see sect. 4.2
G 24	24V DC	
WG 110	110V AC 50 and 60 Hz	
WG 230	230V AC	

[1] Z = control connection. To be used only if operation is to be switched at random to P→R pump circulation via an externally connected 2/2-way valve, e.g. WN 1D(F) - 1/4-.. according to D 7470 A/1; see symbol

[2] Usable consumer flow $Q_A = 0$ lpm (spool valve characteristic)

4. Further data

4.1 General and hydraulic data

Installation position: Any

Ports:
P = Inlet
A and B = Consumer side
R = Return
Z = External control port, see 3) in sect. 3.2

Surface: Valve body gas nitrided, other parts zinc galvanized
Solenoid (with type ...S-WN1.. and SU..) zinc galvanized and olive passivated

Direction of flow: Only in direction of arrow from P→A(R);
opposite direction A→P only possible with by-pass check valve.
With flow control valve in rectifier circuit A→B or B→A.

Inflow: The pump delivery on the inlet side must exceed $Q_{A\,max}$ by 10% when the full range will be exploited.

Mass (weigth) approx. kg

Size	Basic valve	With directly mounted 2-way directional seated valve acc. to D 7470 A/1
3	1.4 (2.0) 1)	2.0
4	2.1	2.7
5	3.1	3.7

1) Figures in brackets apply to SU 2(3)-3

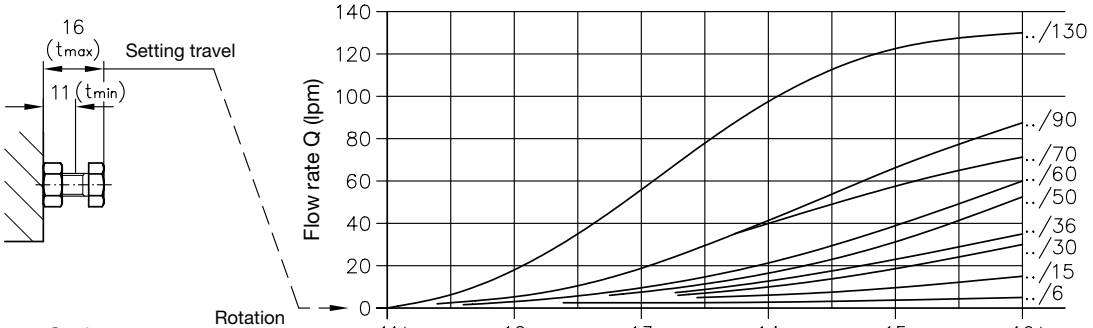
Operating pressure: p_{max} = 315 bar; p_{min} = 10...20 bar, depending on flow rate pressure required for opening pressure balance approx. 6 bar. Counter-pressure at drain port R at 3-way flow control valves must always be lower than the feed pressure applied at port A (min. diff. 8 bar)

Pressure fluid: Hydraulic oil conforming DIN 51524 part 1 to 3: ISO VG 10 to 68 conforming DIN 51519.
Viscosity limits: min. approx. 4, max. approx. 1500 mm²/sec;
opt. operation: approx. 10... 500 mm²/sec
Also suitable are biologically degradable pressure fluids types HEPG (Polyalkylenglycol) and HEES (Synth. Ester) at service temperatures up to approx. +70°C.

Temperature: Ambient: approx. -40 ... +80°C
Fluid: -25 ... +80°C. Note the viscosity range!
Permissible temperature during start: -40°C (observe start-viscosity!), as long as the service temperature is at least 20K (Kelvin) higher for the following operation.
Biologically degradable pressure fluids: Observe manufacturer's specifications. By consideration of the compatibility with seal material not over +70°C.
Attention: Observe the restrictions in sect. 4.2 regarding the perm. duty cycles of the solenoids!

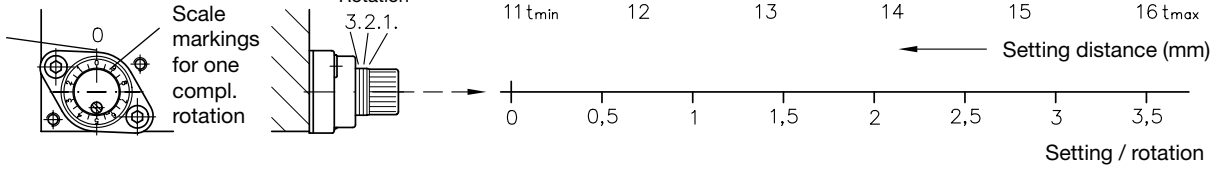
Setting curves (basic values)

Type SF..

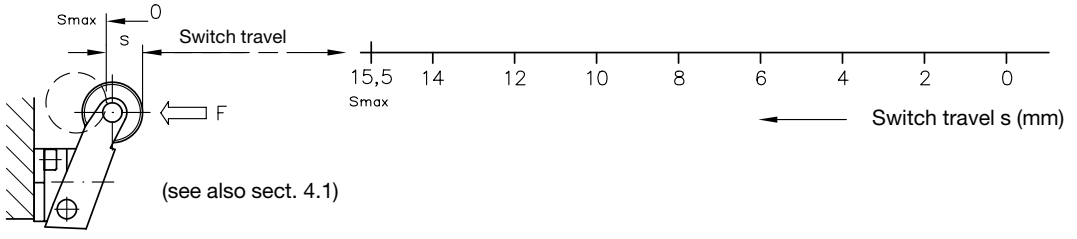


Type SD..

Notch for marking position 0



Type SK..
SKR..



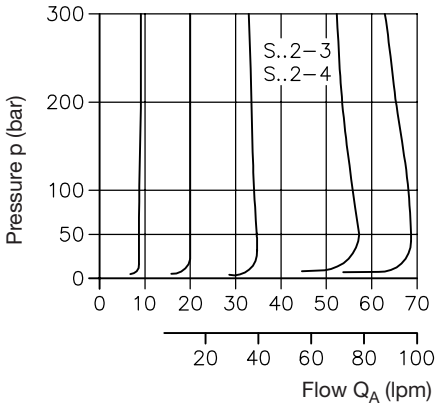
Operating force F (basic values) at
0 bar ... approx. 30 N
100 bar ... approx. 44 N
200 bar ... approx. 56 N
300 bar ... approx. 70 N

(see also sect. 4.1)

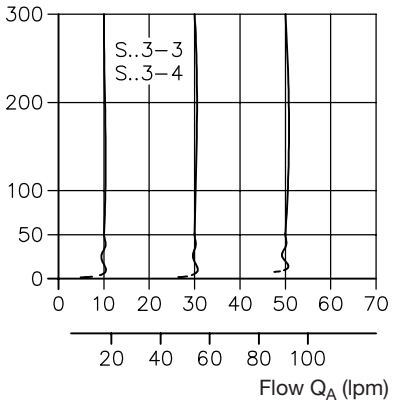
Type SU.. two fixed figures corresponding to the type coding

△p-Q - curves

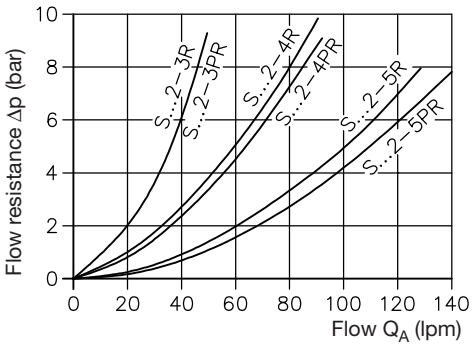
2-way flow control

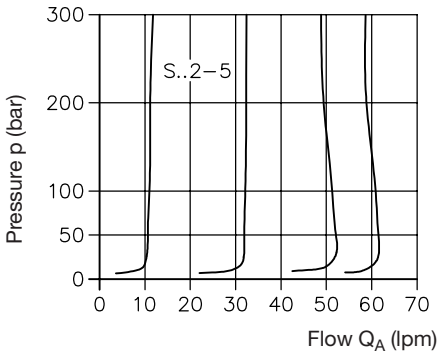


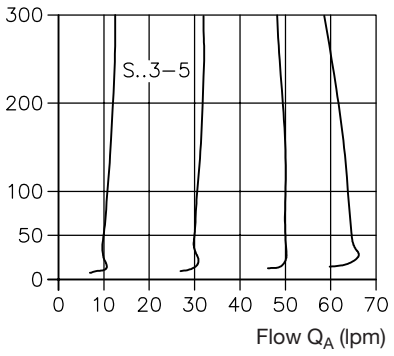
3-way flow control



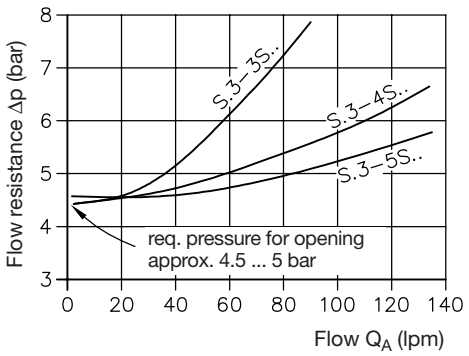
2-way flow control with bypass relief valve, flow direction A → P







Circulation back pressure with relieved flow controller



Oil viscosity during measurement approx. 35 mm²/sec

4.2 Electrical data

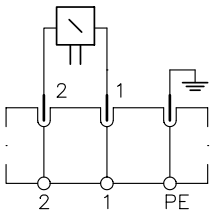
of the solenoid valve with type S..3-3 (4, 5) as specified in sect. 3.2 or 3.3

Solenoid	Built and tested acc. to DIN VDE 0580, wet armature sealed to outside Basic rating at P_N nom. output ≈ 24.4 W ± 6% depending on nom. voltage U_N and manufacter				
Coding	G 12	G 24	WG 110	WG 230	
Nom. voltage U_N	12V DC	24V DC	110V AC	230V AC 50/60 Hz	Other voltages on enquiry
Nom. current I_{20}	2A	1A	0.22A	0.14A	

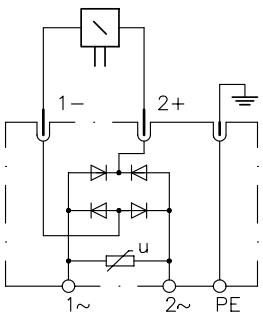
Plug (connection and circuitry)

All plugs with cable glands

DC-voltage coding G..



AC-voltage coding WG..



Relative duty cycle: 100% ED, Stamped on the solenoid body

Service:

At ambient temperature (°C)	< 40	60	< 80
Duty cycle (%)	100	approx. 60	approx. 40

Protection class	IP 65 conf. DIN EN 60529 / IEC 60529 (in properly assembled state)
Insulation material class	F
Surface temperature	approx. 85°C at ambient temperature 20°
Mounting	The solenoid can be easily exchanged in case of an electrical defect. Simply pull-off the solenoid after removing the 4 mounting screws and put on a new one.

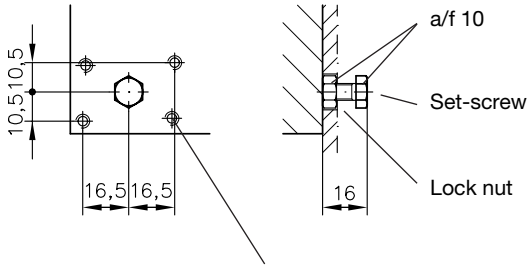
5. Dimensions

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

In the interest of simplicity, different drawings are provided for the adjustment versions and the valves. Just combinc the individual drawings in order to obtain an drawing for the entire valve system. (See also photo on page 1).

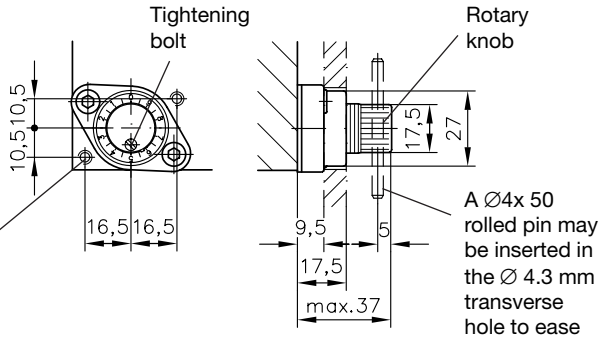
5.1 Adjustment versions

Type SF..

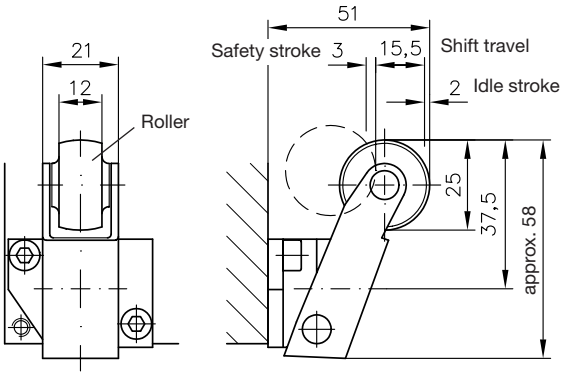


M5, 4 deep fastening thread for installing at an instrument console. Version for instrument console installation not possible with type S..2 - 3 B and with all types for manifold mounting.

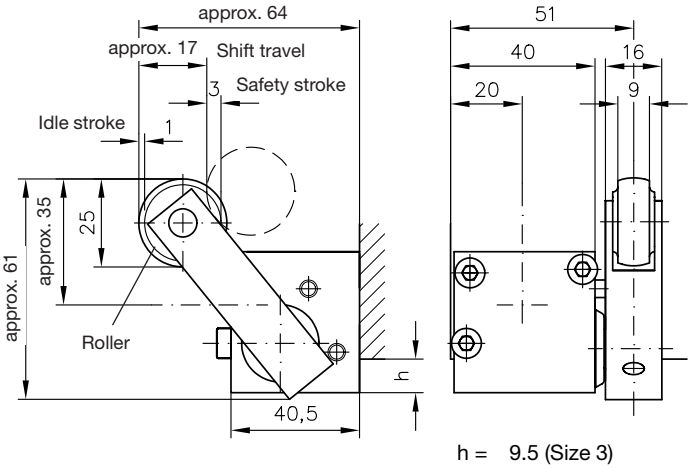
Type SD..



Type SK..

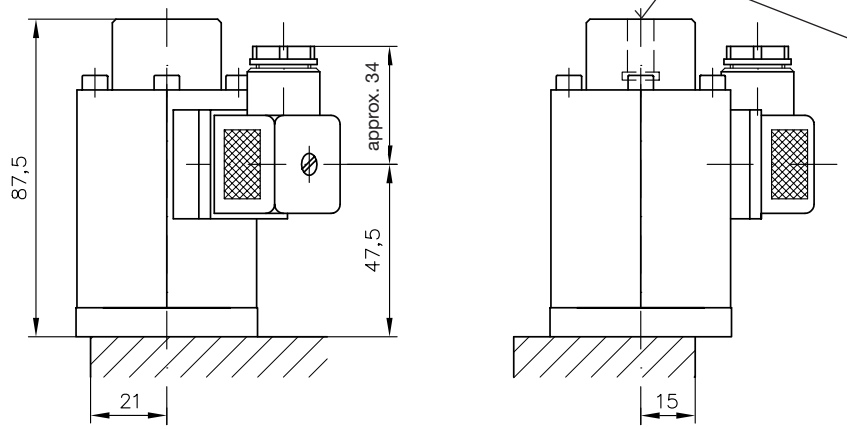


Type SKR..



h = 9.5 (Size 3)
13.5 (Size 4)
2.5 (Size 5)

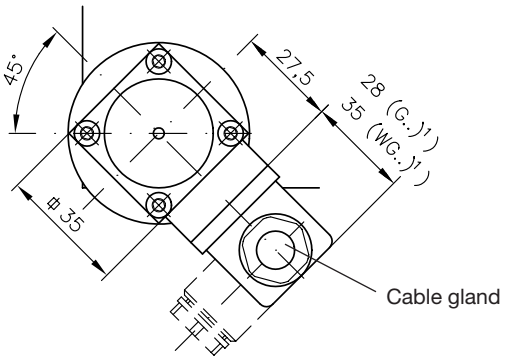
Type SU..



Manual emergency actuation:

Push down the pin with an actuation aid (not sharp edged) when required. Actuation force ≤ 10 N.

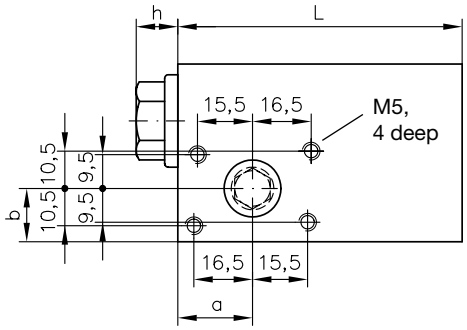
Solenoid and plug may be fitted rotated by 3x90°

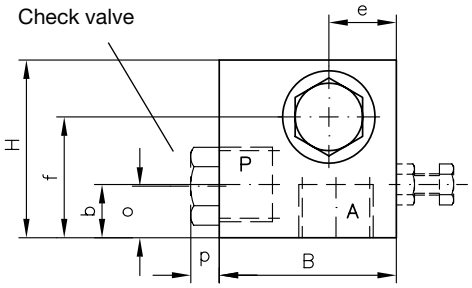


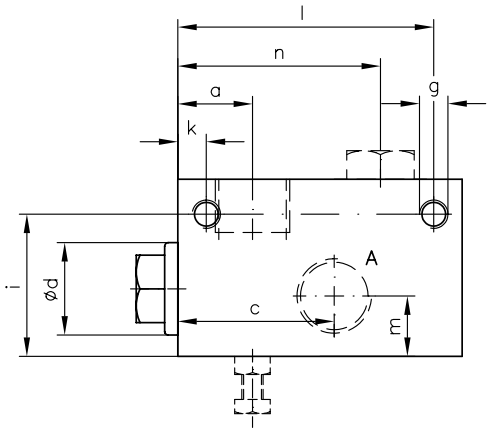
1) This dimension is depending on the manufacturer and can be max. 40 mm acc. to DIN EN 175 301-803.

5.2 2-way flow control valve

Version with tapped ports
Type S.. 2-3(4, 5) and S.. 2-3(4, 5)...R acc. to sect. 3.1
Type SU 2-3...(R) acc. to sect. 3.3



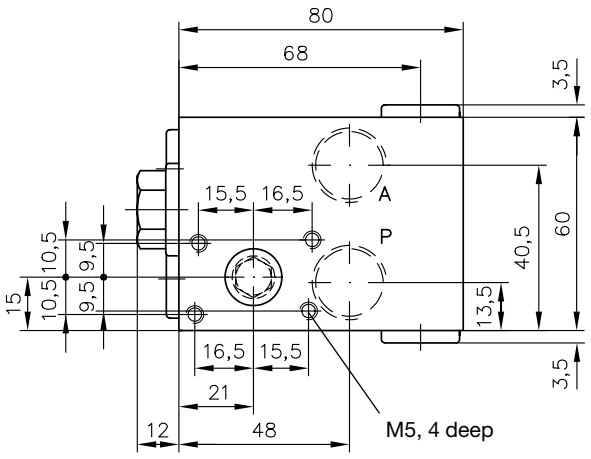


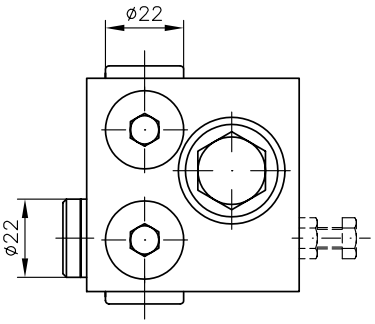


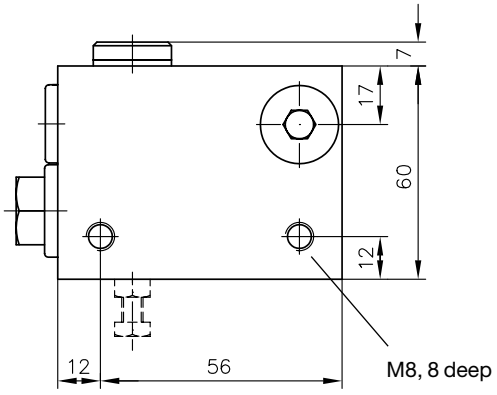
Size	Ports P and A ISO 228/1 (BSPP)	L	B	H	a	b	c	d	e	f
3	G 1/2	80	50	50	21	15	44	26	19	34
4	G 3/4	85	60	60	25	19	53	32	21	41
5	G 1	100	70	70	27	24	60	39	23	47

Size	g	h	i	k	l	m	n	o	p
3	M8, 8 deep	12	40	8	72	17	57	14.5	5.5
4	M8, 10 deep	14	48	10	75	21	68	18	5.5
5	M10, 12 deep	16	52	20	80	23	80	21	11

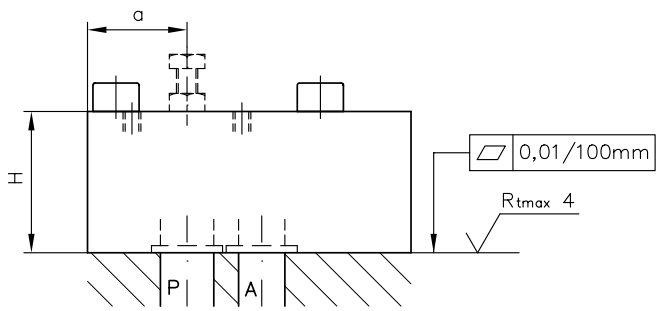
Version with tapped ports and rectifier circuit
Type S.. 2-3...B acc. to sect. 3.1 (not with type SU 2-3)

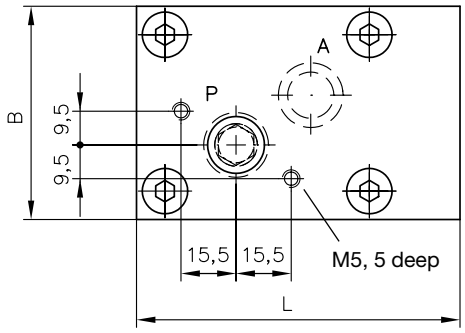






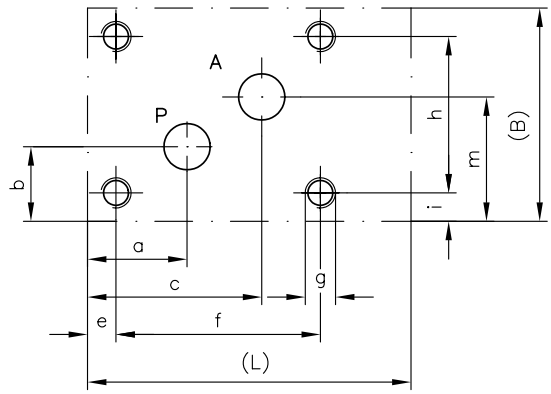
Manifold mounting version
Type S.. 2-3(4, 5)..P and S.. 2-3(4, 5)..PR (not with type SU 2-3)





Size	L	B	H	a	b	c	e	f	g
3	93	60	40	28	21	49	8	57.5	M8, 10 deep
4	100	70	50	35	26	57	16	57	M10, 10 deep
5	106	80	50	33	28	65	9	88	M10, 10 deep

Hole pattern of the manifold (top view)

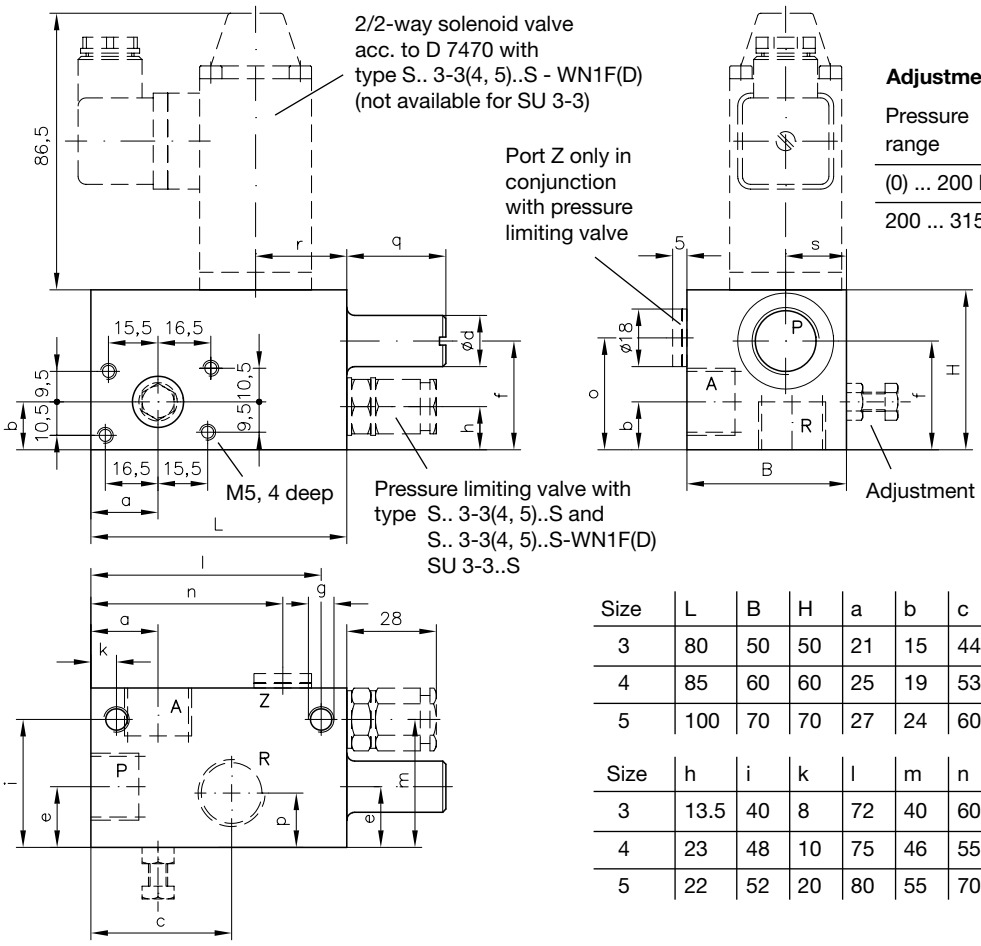


Size				Port ∅		Seals (O-ring NBR 90 Sh)	
	h	i	m	P	A	P	A
3	44	8	35	14	12	15x2.5	
4	52	9	42	17	17	18.75x2.62	
5	64	8	48	17	17	26x3	18.75x2.62

5.3 3-way flow control valve

Version with tapped ports

Type S.. 3-3(4, 5); S.. 3-3(4, 5)...S; S.. 3-3(4, 5)...S - WN 1 F(D) acc. to sect. 3.2 and type SU 3-3...(S) acc. to sect. 3.3



Adjustment of the pressure limiting valve

Pressure range	Travel f_{max} (mm)	Δp (bar) per turn
(0) ... 200 bar	4	90
200 ... 315 bar	4	150

Ports ISO 228/1 (BSPP):

Size	P, R, A	Z
3	G 1/2	G 1/4
4	G 3/4	
5	G 1	

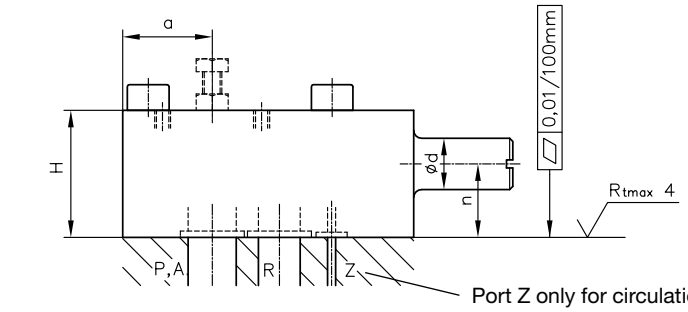
Size	L	B	H	a	b	c	d	e	f	g
3	80	50	50	21	15	44	16.5	19	34	M8, 8 deep
4	85	60	60	25	19	53	16.5	21	41	M8, 10 deep
5	100	70	70	27	24	60	24	23	47	M10, 12 deep

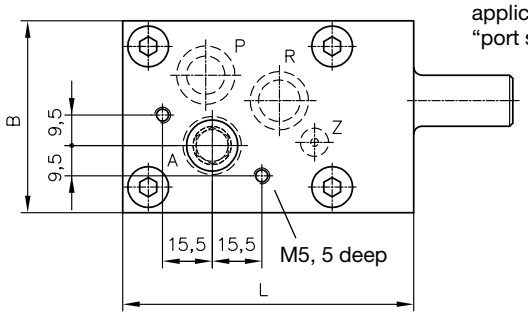
Size	h	i	k	l	m	n	o	p	q	r	s
3	13.5	40	8	72	40	60	35	17	31	28.5	19
4	23	48	10	75	46	55	41	21	31	28.5	21
5	22	52	20	80	55	70	47	23	30	29.5	23

Manifold mounting version

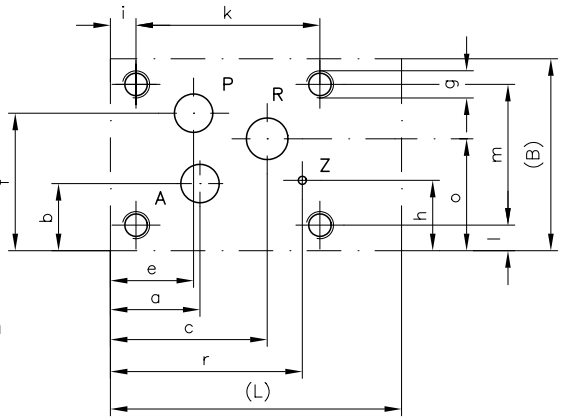
Type S.. 3-3(4, 5)...P and S.. 3-3(4, 5)...PS acc. to sect. 3.2

(not with type SU 3-3)





Hole pattern of the manifold (top view)



Size	L	B	H	a	b	c	d	e	f	g
3	93	60	40	28	21	49	16.5	26	43	M8, 10 deep
4	100	70	50	35	26	57	16.5	33.5	53	M10, 10 deep
5	106	80	50	33	28	65	24	33	62	M10, 10 deep

Size	h	i	k	l	m	n	o	p	r
3	22	8	57.5	8	44	23	35	31	60
4	21	16	57	9	52	29	42	31	55
5	40	9	88	8	64	27	48	30	87

Adjustment of the pressure limiting valve

Pressure range	Travel f_{max} (mm)	Δp (bar) per turn
(0) ... 200 bar	6.3	40
200 ... 315 bar	4.5	95

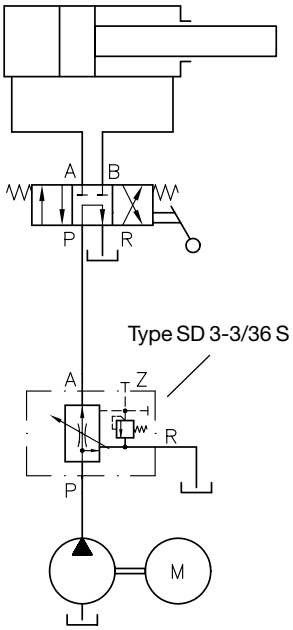
Size	Port Ø			Seals (O-ring NBR 90 Sh)		
	P, R	A	Z	P and R	A	Z
3	12	14	4	15x2.5		6x2
4	17		4	18.75x2.62		6x2
5	17		4	18.75x2.62	26x3	6x2

6. Appendix

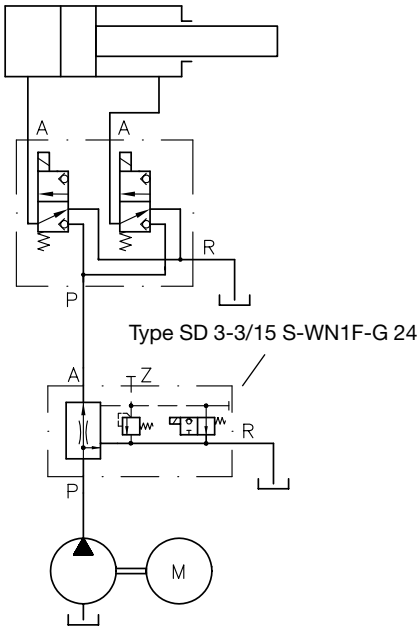
6.1 Typical circuitry

Feed control with 3-way flow control valve

Feed control with simultaneous pressure control

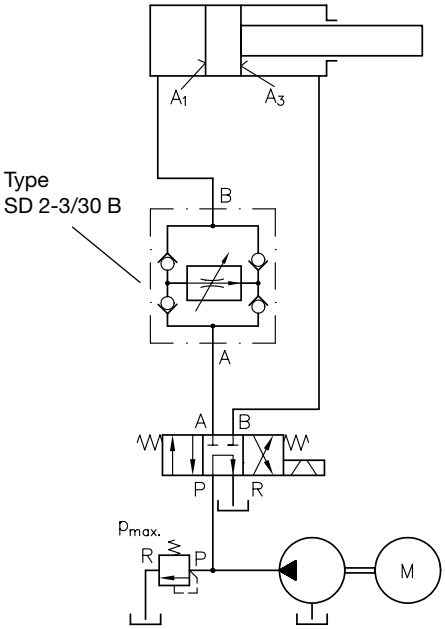


Feed control with simultaneous pressure control and idle circulation mode

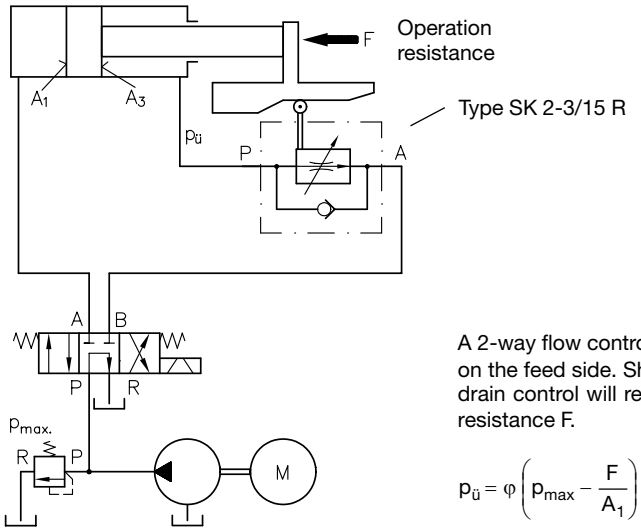


Speed control in both directions by rectifier circuit

Forward and reverse velocity are equal.
Attention: The pressure may be geared up when the flow control valve is connected to the rod side.



Control of flow out via a 2-way flow control valve



A 2-way flow control valve operates only in conjunction with a pressure relief valve on the feed side. Should the area ratio φ = A1/A3 (see wiring diagram) be unequal, drain control will result in a pressure transmission factor depending on operating resistance F.

$$p_{ü} = \varphi \left(p_{max} - \frac{F}{A_1} \right)$$

It follows that the pressure transmission factor may be excessive when running without load.

7. Type over view

Order examples:

SD 2 - 3 / 15 P
SKR 3 - 4 / 70 S-WN1F - G 12 - 120
SU 2 - 3 - 25/10 - G 24

Pressure specification for the pressure limiting valve (bar)

Nom. voltage of the solenoid
G 12, G 24, WG 110 and **WG 230**

Connection pattern and ancillary valve

Without	Version for pipe connection
P	Manifold mounting valve, not with type SU
R, PR	Valve with bypass check valve (2-way flow control valve)
B	Rectifier circuit via check valves (2-way flow control valve)
S	Pressure limiting valve (3-way flow control valve)
S-WN1F, S-WN1D	Pressure limiting and idle circulation valve (3-way flow control valve, not with type SU)

Flow

/3, /6, /15, /30, /36, /50, /60	size 3 (deenergized open)
/6F, /15F, /30F, /36F, /50F	size 3 (deenergized blocked)
/70, /90	size 4
/130	size 5
-0/50.., -4/25.., -50/0	size 3, only type SU

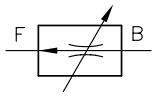
Size
3, 4, 5 (Type SU only in size 3)

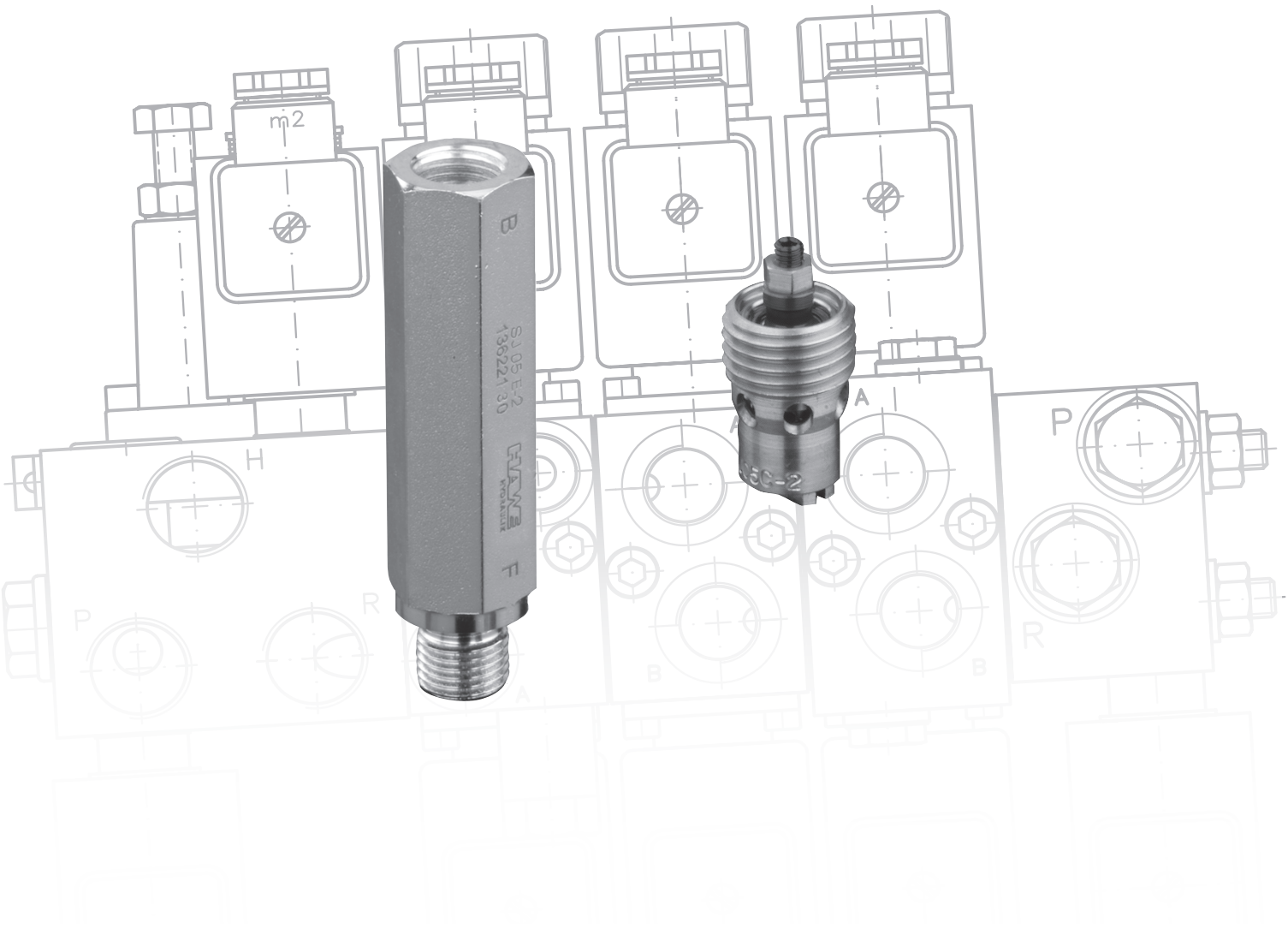
Version
2 2- way flow control
3 3- way flow control

Basic type and adjustment mode
SF - Tool adjustable, with lock nut
SD - Via rotary knob adjustment
SK - Via roller (unshielded version)
SKR - Via roller (shielded version, not available for manifold mounting)
SU - Solenoid actuation, activating one of two fixed settings (only available for size 3 and pipe connection)

2-way flow control valve type SJ

Compact screw-in valve

Pressure p_{max}:	315 bar	Switching symbol:	
Volume V_{max}:	15 l/min		
Adjustability:	With tool		



Product documentation

D 7395

11-2013-1.0

HAWE Hydraulik SE - Streitfeldstr. 25 • 81673 München

Contents

1 Overview of 2-way flow control valve type SJ

The 2-way flow control valve type SJ serves as a pressure independent flow limitation, maintaining a rather constant flow to hydraulic consumers or circuits. Any excess flow apparent on the inflow side must be routed back to the tank via a pressure limiting valve (pure pump circuits).
These flow control valves are preferentially used to limit control flows in pilot circuits.

Features and benefits:

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

Intended applications:

- General hydraulic systems
- Industrial trucks
- Lifting equipment

Figure 1: Screw-in valve type SJ, adjustment range C

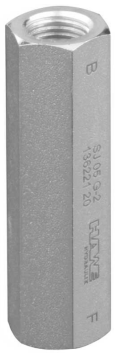


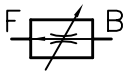
Figure 2: SJ Valve with housing, adjustment range G

Figure 3: SJ Valve with housing, adjustment range E and F

2 Available versions, main data

2.1 Basic version

Symbol:



Order example:

SJ 0	3	C	- 2
SJ 0	5	G	- 3

Response current Desired factory-set response flow [lpm] at 50 bar

Design Table 2 Design

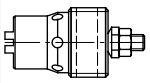
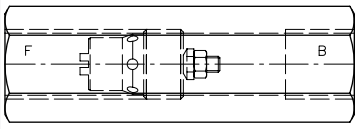
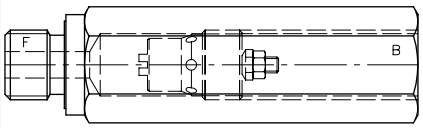
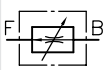
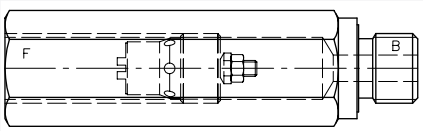
Flow setting Table 1 Type and response current

Type and size Table 1 Type and response current

Table 1 Type and response current

Type and size	Response current Q from ... to (lpm)							
	--	0	1	3	5	7	9	90
SJ 0	0.5 ... 0.9	0.25 ... 0.5	1.0 ... 1.6	1.6 ... 2.5	2.5 ... 4	4 ... 6.4	6.4 ... 10	10 ... 15

Table 2 Design

Coding	Design	Symbol
C		Screw-in valve 
G		
E		Valve with housing 
F		

3 Parameters

3.1 General

Description	2-way flow control valve
Design	Screw-in valve and valve with housing
Design	Screw-in valve, valve for pipe connection
Material	Steel; valve housing galvanized zinc plated; hardened and ground functional inner parts
Installed position	Any
Port	■ B = port (pump or primary side) ■ F = consumer (secondary side)
Flow direction	Working direction B→F: flow maintained constant Return flow F→B: possible, depending on the adjustment range (see Δp-Q-characteristics)
Hydraulic fluid	Hydraulic oil conforming DIN 51 524 part 1 to 3; ISO VG 10 to 68 conforming DIN 51 519 Viscosity limits: min. approx. 4, max. approx. 1500 mm^2/s opt. operation approx. 10... 500 mm^2/s. Also suitable are biologically degradable pressure fluids types HEPG (Poly-alkylenglycol) and HEES (Synth. Ester) at service temperatures up to approx. +70°C.
Purity class	**ISO 4406** / **NAS 1638** / **SAE T 490** 21/18/15...19/17/13 / 12 ... 8 / ≥ 6
Temperature	Ambient: approx. -40 ... +80°C, Fluid: -25 ... +80°C, Note the viscosity range! Permissible temperature during start: -40°C (observe start-viscosity!), as long as the service temperature is at least 20K higher for the following operation. Biologically degradable pressure fluids: Observe manufacturer's specifications. By consideration of the compatibility with seal material not over +70°C.

Pressure and flow

Operating pressure	p_{max} = 315 bar
Static overload capacity	Approx. 2 x p_{max}
Flow	See Chapter 2.1, "Basic version" Table 1

Curves

Viscosity during measurements approx. 60 mm²/s

Caution
Danger of personal injury when components are overloaded due to wrong flow setting!

- Always monitor the pressure gauge when setting or changing the flow.

Working direction B → F

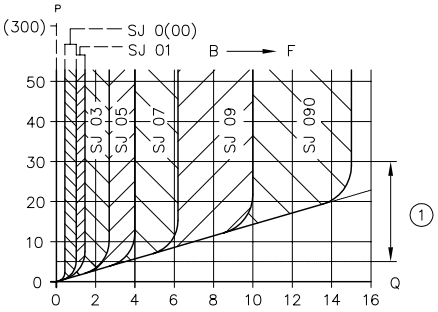


Figure 4: Q Response current (lpm); p Operating pressure (bar)

1 Response starts at approx. 5 ... 30 bar

Flow direction F → B

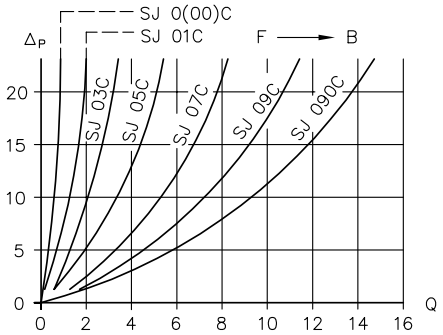


Figure 5: Q Flow (lpm); Δp Back pressure (bar)

Mass

Screw-in valve

Type SJ 0..C	= 35 g

Valve with housing

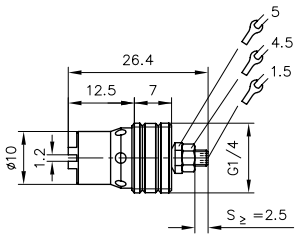
Type SJ 0 G (E and F)	= 130 g

4 Dimensions

All dimensions in mm, subject to change.

4.1 Basic version (screw-in cartridge)

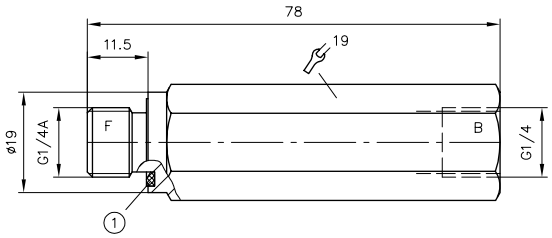
Type SJ 0.. C



Note
Screw in type SJ 0.. C until the end of the thread is reached and tighten it. Tightening torque: M_{max} = 4 Nm

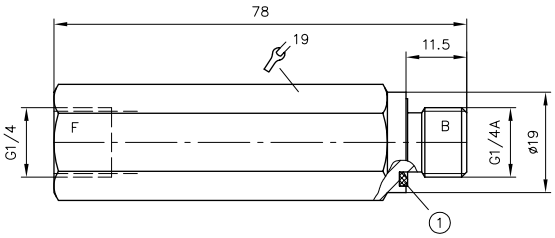
4.2 Valve with housing

Type SJ 0.. E



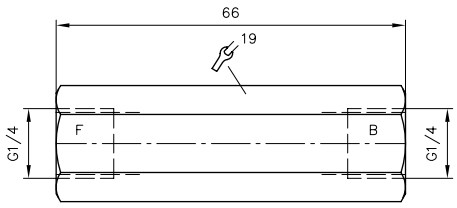
1 Seal G 1/4 NBR

Type SJ 0.. F

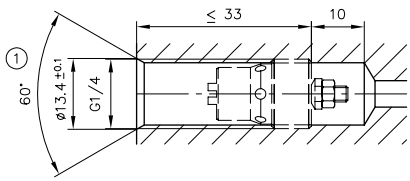


1 Seal G 1/4 NBR

Type SJ 0.. G



4.3 Mounting hole



1 60° bevels to help the thread seal slip in, only on type SJ 0(00) C

Note
Screw in type SJ 0.. C until the end of the thread is reached and tighten it. Tightening torque: M_{max} = 4 Nm

5 Installation, operation and maintenance information

5.1 Designated use

This fluid-power product has been designed, manufactured and tested using standards and regulations generally applicable in the European Union and left the plant in a safe and fault-free condition.

To maintain this condition and ensure safe operation, operators must observe the information and warnings in this documentation.

This fluid-power product must be installed and integrated in a hydraulic system by a qualified specialist who is familiar with and adheres to general engineering principles and relevant applicable regulations and standards.

In addition, application-specific features of the system or installation location must be taken into account if relevant.

This product may only be used as a flow control valve within oil-hydraulic systems.

The product must be operated within the specified technical parameters. This documentation contains the technical parameters for various product versions.

Note
Non-compliance will void any warranty claims made against HAWE Hydraulik.

5.2 Installation information

The hydraulic system must be integrated in the equipment with standard connection components that comply with market requirements (screw fittings, hoses, pipes, etc.). The hydraulic system must be shut down as a precautionary measure prior to dismounting; this applies in particular to systems with hydrostatic accumulators.

5.3 Operating instructions

Product, pressure and/or flow settings

All statements in this documentation must be observed for all product, pressure and/or flow settings on or in the hydraulic system.

Any flow setting alternations have to be monitored via a pressure gauge!

Filtering and purity of the hydraulic fluid

Fine contamination (e.g. grit and dust) or contamination in the macro range (e.g. filings, rubber particles from hoses and seals) can significantly impair the function of a hydraulic system. It should also be noted that new hydraulic fluid straight from the container does not necessarily meet the highest purity standards.

Attention must therefore be paid to the purity of the hydraulic fluid to ensure smooth operation (see also “Purity class” in Chapter 3, "Parameters").

5.4 Maintenance information

This product is largely maintenance-free.

Conduct a visual inspection to check the hydraulic connections for damage at regular intervals, but at least once per year. If external leaks are found, shut down and repair the system.

Check the device surfaces for dust deposits at regular intervals (but at least once per year) and clean the device if required.

6 Additional information

6.1 Accessories, spare parts and separate components

Housing coding G

Type	Order number
SJ 0	7395 017
SJ 01 ... SJ 090	6920 110

Housing coding E and F
(complete with screw connection seal)

Type	Order number
SJ 0..	69202 10 b

Weitere Ausführungen

- Two-way flow valves, type SB: D 6920
- 2-way flow control valve type CSJ 0: D 7736
- 2-way flow control valve type DSJ: D 7825

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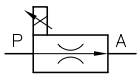
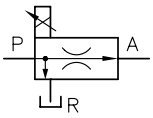
Proportional, solenoid actuated flow control valves type SE and SEH

Operating pressure p_{max} = 315 bar
Flow Q_{max} = 120 lpm

2-way
flow control valve



3-way
flow control valve



1. General information

The proportional flow control valves type SE 2 and SEH 2 (2-way version) as well as SE 3 and SEH 3 (3-way version) are used for pressure independent, stepless remote control of the operating speed of the connected hydraulic consumers.
They enable the effective consumer flow to be proportional to the electrical signal (control current), according to any desired profile within the adjustment range, ranging from simple, time-adjustable acceleration and deceleration, by manual remote adjustment of the operating speed to e.g., pre-selectable speeds of automatic work cycles.
The control of these valves is via proportional amplifiers maintaining a constant current level e.g. type EV1M2 acc. to D 7831/1 or type EV1G1 acc. to D 7837.
For the most simple applications (e.g. ON/OFF pump operation) control may be via a potentiometer connected in series to the proportional solenoid.
The essential components of these pressure compensated flow control valves are the proportional solenoid, the metering orifice, and the flow controller. The metering orifice, whose flow cross section is adjusted by the actuated proportional solenoid, generates a specific, low pressure drop which is required for the function of the flow controller.

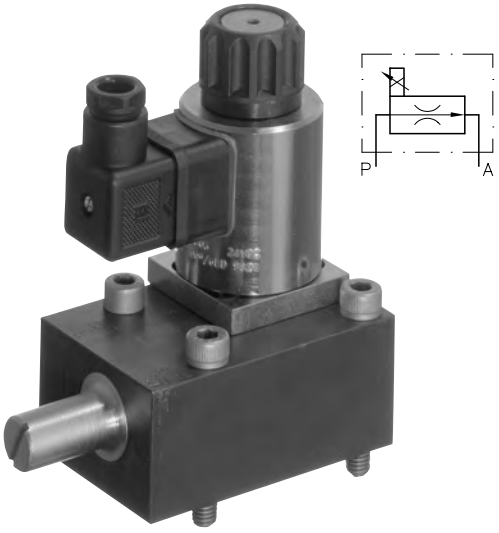
The following basic types are distinguished:

- Type SE with a directly actuated metering orifice
  most advantageous for application mainly operated at Q_{min} near 0, its high, oscillated mass limits the response time.
- Type SEH with a piloted metering orifice
  advantageous for application where quick response is a must; a min. inlet flow is required as there is always a design related leakage loss (see table 1 and 4).
- Both types are available as 2- or 3-way flow control valves
- The individual valves are available either as manifold mounting design or for direct pipe connection
- Additional function (3-way valve): Pressure limiting valve to the limitation of the pressure on the consumer side, arbitrary idle circulation, etc.
- Additional function (2-way valve): Bypass check valve, rectifier circuit via check valves enabling arbitrary flow direction.
- Type PB proportional throttle
  used for not completely load compensated speed controls (e.g. accelerating and decelerating tasks) and limited flow.

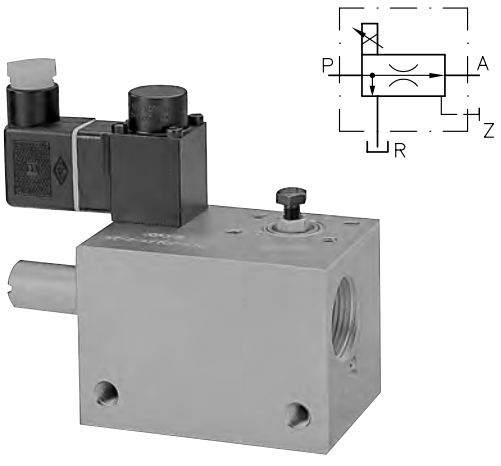
Two metering orifice versions are available:

- Metering orifice completely open when deenergized (idle position), i.e. full consumer flow at port A which is gradually reduced down to the min. rating in accordance to the rising voltage applied at the proportional solenoid.
- Metering orifice closed when deenergized (idle position), i.e. min. consumer flow at port A which is gradually increased up to the max. rating in accordance to the rising voltage applied at the proportional solenoid.

Version with directly actuated metering orifice
e.g. type SE 2 - 3/50 P - G24



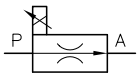
Version with piloted metering orifice
e.g. type SEHF 3 - 4/70 F - G24



2. Available versions, main data

2.1 2-way flow control valve

Order examples: **SE 2 - 3/15 B - G24**
SEH 2 - 2/30 F P - G24



Design, connection mode and size, as well as optional functions, see table 2

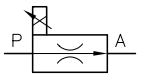
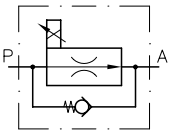
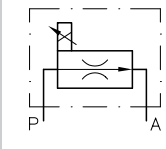
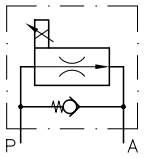
Table 3: Solenoid voltage (proportional solenoid)

Coding		Type SE			Type SEH(F)	
		G 12	**G 24**	**G 80**	**G 12**	**G 24**
Nom. voltage	U_N (V DC)	12	24	80	12	24
Power, cold	P_{20} (W) [2]	37	37	37	24	24
Min. power	P_G (W) [3]	24.7	24.7	24.7	9.5	9.5
For additional electrical data, see sect. 3.2						

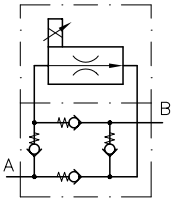
Table 1: Basic type, size and flow rating

Basic type and size	Version	Pressure p_{max} (bar) with version for		Flow (nom. flow rating of the metering orifice) Closed when deenergized (standard)												
				3F	**6F**	**10F**	**15F**	**22F**	**30F**	**36F**	**50F**	**70F**	**90F**	**3/7F**	**3/26F**	**4/18F**
				Open when deenergized [1]												
				3	**6**	**10**	**15**	**22**	**30**	**36**	**50**	**70**	**90**	**---**	**---**	**---**
				Flow control range $Q_{A\,min}$ ... $Q_{A\,max}$ (lpm)												
		Pipe connection	Manifold mounting	0.1 to 3	0.1 to 6	0.1 to 10	0.2 to 15	0.2 to 22	0.2 to 30	0.3 to 36	0.3 to 50	0.6 to 70	0.6 to 90	0.1 to 7 [4]	0.1 to 26 [4]	0.1 to 18 [4]
SE 2 - 3/	with directly actuated metering orifice	315	200	● [6]	●		●		●	●	●					
SE 2 - 4/												● [6]	● [6]			
SEH 2 - 2/	with piloted metering orifice	315	315	●	●	●	●	●	●	●				●	●	●
SEH 2 - 3/ SEHF 2- 3/ [5]		---	315		● [7]		● [7]		● [7]	● [7]	● [7]					

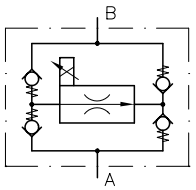
Table 2: Design, connection mode and size

Connection mode	Basic type	Connection size (BSPP)	Coding: Basic version	With options: By-pass check valve for free reverse flow A→P	With options: Rectifier circuit via check valves, controlled flow in both directions
Pipe connection	SEH 2-2	G 3/8	Without coding (standard) 	---	**P - 3/8 B**
	SE 2-3	G 1/2		**R** 	**B**
	SE 2-4	G 3/4			---
Manifold mounting	SEH 2-2 SEH 2-3 SEHF 2-3	See dimensional drawings in sect. 4.2	**P** 	---	---
	SE 2-3 SE 2-4			**PR** 	---

SEH 2-2/..
..P - 3/8 B



SE 2-3/.. B-..



Additional order examples:

SEH 2-2/15 FP-3/8 B-G12
SEH 2-2/30-G24
SE 2-3/50 B-G80

[1] 2-way flow control valves type SEH 2-.. (free flow when deenergized):
A min. flow (pump delivery) of 2/3 of the nom. flow rating must be apparent at port P (inlet side) to achieve the necessary internal pressure drop which is required to drive the piston (metering orifice) in its control position.
This version must not be used if the $Q_{pu\,min}$ figures (see table below) are not available.

Metering orifice	3	6	10	15	22	30	36	50
$Q_{pu\,min}$ (lpm)	2	4	6	10	15	20	24	33

[2] Power when cold (ambient temperature 20°C)

[3] Power when hot

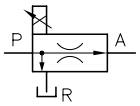
[4] Version with fine control range (see curves in sect. 3.1)

[5] Type SEHF with min. flow limitation, adjustment via set screw

[6] Deenergized open version available only

[7] Deenergized blocked version available only

2.2 3-way flow control valve



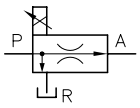
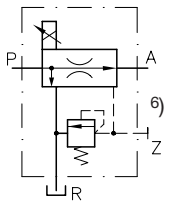
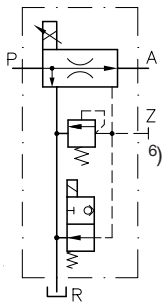
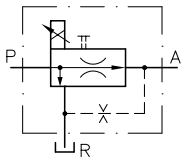
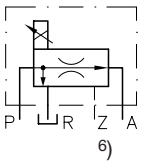
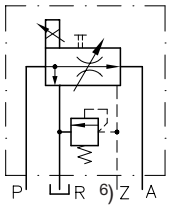
SE 3 - 3/50 S - WN 1 F - G24/WG230 - 120
SE 3 - 4/70 P - B0,6 - G24
SEH 3 - 2/6F P - G12

- 120: Pressure specification [4] (p_{max} = 315 bar)
- G24/WG230: Differing voltage of idle circulation valve (On/Off solenoid) For available voltages see pamphlet D 7470 A/1
- G24 / G12: Solenoid voltage (prop. solenoid), see table 3 in sect. 2.1
- SE 3 - 3/50 S - WN 1 F / SE 3 - 4/70 P - B0,6 / SEH 3 - 2/6F P: Design, connection mode and size, as well as optional equipment (see table 5)

Table 4: Basic type, size and flow

Basic type and size	Version	Pressure p_{max} (bar) with version for		Flow (nom. flow of the metering orifice) Deenergized closed (standard)													
				3F	**6F**	**10F**	**15F**	**22F**	**30F**	**36F**	**50F**	**70F**	**90F**	**120F**	**3/7F**	**3/26F**	**4/18F**
				Deenergized open (only type SE 3-.. and SEH 3-2!)													
				3	**6**	**10**	**15**	**22**	**30**	**36**	**50**	**70**	**90**	**---**	**---**	**---**	**---**
				With locked closed position of the metering orifice while deenergized (only SEH 3-2) [1]													
				3F0	**6F0**	**10F0**	**15F0**	**22F0**	**30F0**	**36F0**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
				Flow control range $Q_{A\,min}$ ... $Q_{A\,max}$ (lpm)													
		Pipe connection	Manifold mounting	0.1 to 3	0.1 to 6	0.1 to 10	0.2 to 15	0.2 to 22	0.2 to 30	0.3 to 36	0.3 to 50	0.6 to 70	0.6 to 90	1 to 120	0.1 to 7 [7]	0.1 to 26 [7]	0.1 to 18 [7]
SE 3 - 3/	with directly actuated metering orifice	315	200	●[10]	●		●		●	●	●						
SE 3 - 4/												● [10]	● [10]				
SEH 3 - 2/	with piloted metering orifice [8]	315	315	●	●	●	●	●	●	● [11]					●	●	●
SEH 3 - 3/ SEHF 3 - 3/ SEHD 3 - 3/		315	315		● [12]		● [12]		● [12]	● [12]	● [12]						
SEH 3 - 4/ SEHF 3 - 4/ SEHD 3 - 4/		15	315									● [12]	● [12]				
SEH 3 - 5/ SEHF 3 - 5/ SEHD 3 - 5/		315	---											● [12]			

Table 5: Design, connection mode and size, as well as optional equipment

Connection mode	Basic type	Connection size (BSPP)	Coding Basic version	Pressure limiting valve		By-pass orifice ∅0.6
Direct pipe connection	SEH 3-2	G 3/8	Without coding (standard) 	**S, ST** [9]	..S  S-WN 1 F(D) 	---
	SE 3-3 SEH 3-3 SEHF(D) 3-3 [8]	G 1/2		**S-WN1F S-WN1D** (with idle circulation valve) [5]		---
	SE 3-4	G 3/4				---
	SEH 3-4 SEHF(D) 3-4 [8]	G 3/4				**B0,6** 
	SEH 3-5 SEHF(D) 3-5 [8]	G 1				Also available in combination with a pressure limiting valve or idle circulation valve e.g. SEH3-4/70FS ..**B0,6**-G 24-220 (see also note in sect. 5.2)
Manifold mounting	SEH 3-2 SE 3-3	See dimensional drawings in sect. 4.2	**P** 	---		---
	SEH 3-3 SEHF(D) 3-3 [8]			**PS**	 WN 1D 	---
	SE 3-4			---		---
	SEH 3-4 SEHF(D) 3-4 [8]			**PS**		---

[1] For description, see sect. 5.1
[2] Power when cold (ambient temperature 20°C)
[3] Power when hot
[4] Only in connection with additional element coding S and ST (table 5)
[5] Idle circulation valve acc. to D 7470 A/1 (p_{min} 6 ... 10 bar)
[6] Control port Z (For dimensions, see sect. 4 ++)
[7] Version with fine control range (For curves, see sect. 3.1)
[8] Type SEHF with min. flow limitation, adjustment via set screw (hexagon head).
Type SEHD with min. flow limitation, adjustment via set screw (turn knob).
[9] Type ST..; for symbols and brief description, see sect. 5.3
Only available for type SEH... size 4 and 5
[10] Deenergized open version available only
[11] only available as version /36F and /36F0
[12] Deenergized blocked version available only

3. Additional parameters

3.1 General and hydraulic data

Installed position: Any

Flow direction: Only in indicated arrow direction P→A(R), reverse flow A→P only via by-pass check valve.
Flow control valve versions with rectifier circuit via check valves: A→B or B→A

Surface protection: Valve body nitrous hardened, solenoid body zinc galvanized, olive passivation

Ports and operating pressure:
P = Inlet port (pump) $p_{P\,max}$ = 315 bar
R = Return port $p_{R\,max}$ = 310 bar
20 bar (only type SE(H) 3../..S..)
A = Outlet port (consumer) $p_{A\,max}$ = 315 bar
Z = Control port; $p_{Z\,max}$ = 315 bar (only with type SEH..3-..S and ST)
T = Return port $p_{T\,max}$ = 20 bar (only with type SEH..3-..ST)

p_{min} = 8 bar, opening pressure of the metering orifice approx. 8 bar.
3-way flow control valves: The back pressure at return port R must be always lower than the one apparent at port A (consumer); min pressure difference 8 bar)

Consumer flow: Q_{max} = 120 lpm (3-way flow control valve)
90 lpm (2-way flow control valve)

The flow codings and the guide line figures differ due to coil dependant tolerances of the utilized proportional solenoids.

Static overload capacity: approx. 2 x p_{max}

Mass (weight) approx. kg

Size	SE 2-..(R), SE 3-..(S)	SE 2-..B	SE 2-..P(PR)	SE 3-..S-WN 1 F(D)
3	2.2	2.4	2.4	2.4
4	2.8	---	3.1	3.1

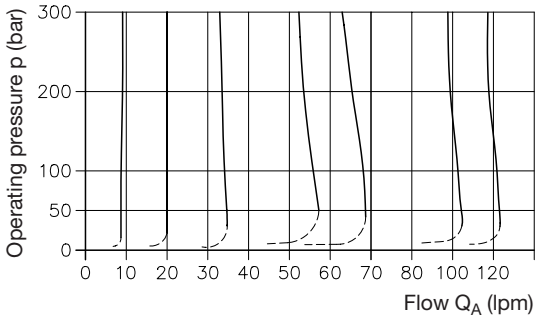
Size	SEH 2	SEH 2-2/..-P SEHF 2-2/..P	SEH 2-2/..-P- -3/8 B	SEH 3-..S(T) SEHF(D) 3-..S(T)	SEH 3-..S-WN 1.. SEHF(D) 3-..S-WN 1..	SEH 3-..P SEHF(D) 3-..P
2	1.0	1.1	1.8	1.0	---	1.1
3	---	---	---	1.6	2.0	1.9
4	---	---	---	2.2	2.6	2.5
5	---	---	---	3.3	3.7	---

Hydraulic fluid: Hydraulic oil acc. to DIN 51524 table 1 and 3; ISO VG 10 to 68 acc. to DIN 51519
Viscosity range: min. approx. 4; max. approx. 1500 mm²/s
Optimal operation range: approx. 10...500 mm²/s Also suitable are biologically degradable pressure fluids type HEPG (Polyalkylenglykol) and HEES (synth. Ester) at operation temperatures up to approx. +70°C.

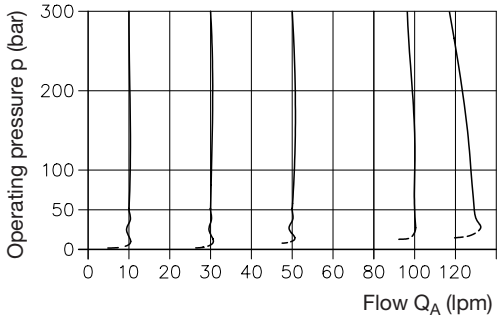
Temperature: Ambient: approx. -40...+80°C; Fluid: -25...+80°C, pay attention to the viscosity range!
Start temperature down to -40°C are allowable (Pay attention to the viscosity range during start!), as long as the operation temperature during subsequent running is at least 20K higher. Biological degradable pressure fluids: Pay attention to manufacturer's information. With regard to the compatibility with sealing materials do not exceed +70°C.
Attention: Observe the restrictions regarding the perm. operation cycles for the prop. solenoids, see sect. 3.2!

p-Q curves (guideline)

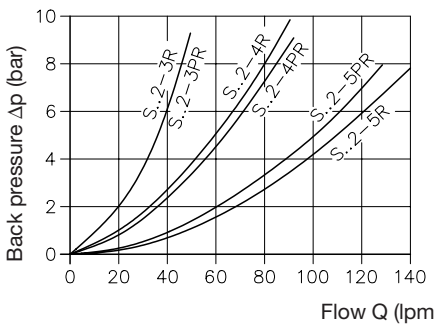
2-way flow control valve



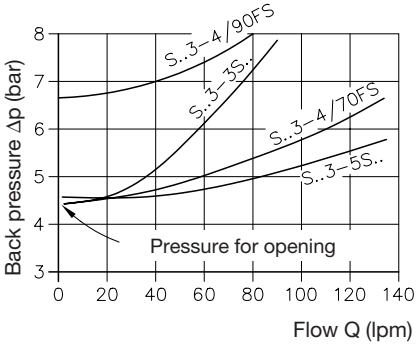
3-way flow control valve



2-way flow control valve with bypass check valve for flow direction A→P



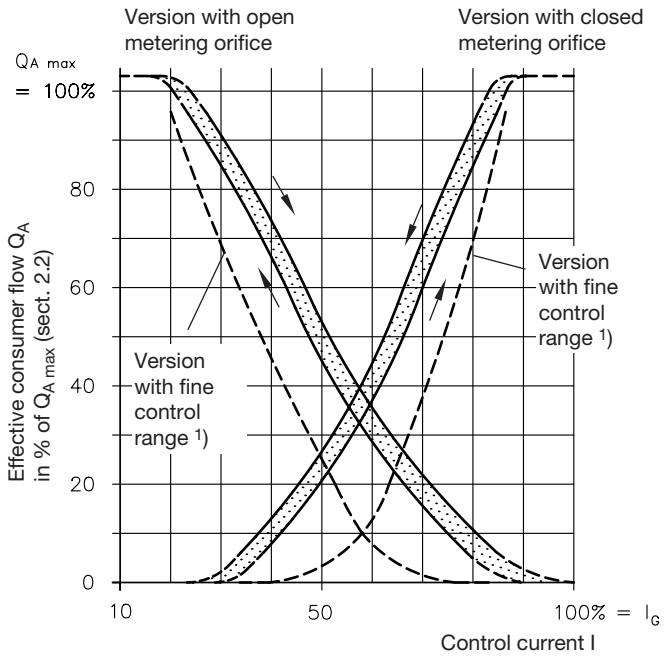
Circulation back pressure with relieved flow control valve



Oil viscosity during measuring approx. 35 mm²/s

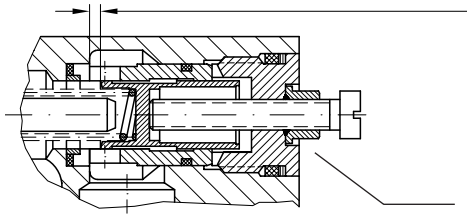
Q-I curves (guideline), oil viscosity during measuring approx. 50 mm²/s

2- and 3-way flow control valve



1) Qualitative representation.
The fine control range ends at approx. 0.5 $I_{contr.}$; the flow achieved at that point is part of the respective metering orifice coding (e.g. 4/18, fine control range up to approx. 4 lpm, Q_{max} approx. 18 lpm).

Note for 2-way flow control valve:

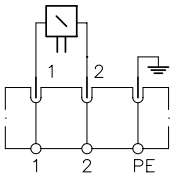


The initial idle stroke may be reduced via the set screw in cases where $Q_{pump} \leq Q_{A\ max}$. This will also reduce the response time. The initial idle stroke is set at HAWE according to Q_{max} represented by the nom. flow coding (sect. 2.1).

The Seal-Lock nut must be loosened for min. 1 turn, prior to adjustment of the set screw to prevent any damage of the vulcanized thread seal.

3.2 Electrical data (proportional solenoid)

Solenoid conforming VDE 0580
Proportional amplifier type EV1M2 acc. to D 7831/1 and type EV1G1 acc. to D 7837 for DC-versions G 12 and G 24 (a prop. amplifier is not available for G80V).

Type		SE 2.. and SE 3..			SEH(F, D) 2.. and SEH(F, D) 3..	
Nom. voltage U_N	(V DC)	12	24	80	12	24
Coil resistance R_{20} ±5%	(Ω)	4.1	17.6	200	6	24
Current, cold I_{20}	(A)	2.8	1.4	0.45	2	1
Current, hot I_G	(A)	1.9	0.95	0.29	1.26	0.63
Power, cold P_{20}	(W) 2)	37	37	37	24	24
Power, hot P_G	(W)	24.7	24.7	24.7	9.5	9.5
Relative duty cycle		100% ED (reference temperature ϑ_{11} = 50°C)				
Electrical connection		DIN EN 175 301-803			Industrial standard (like DIN EN 175 301-803)	
Protection class		IP 65 (IEC 60529) (with properly installed plug)				
Insulation material class		F				
Necessary dither frequency		60 ... 150 Hz				
Dither amplitude		20 ... 40% of I_{20}				
Cable gland						

2) Power when cold (ambient temperature 20°C). Power when cold will differ accordingly at differing start temperatures $P_k = P_{20} \cdot R_{20}/R_k$. This must be observed when a customer furnished electronic control without current limitation is used, as it might be over loaded otherwise.

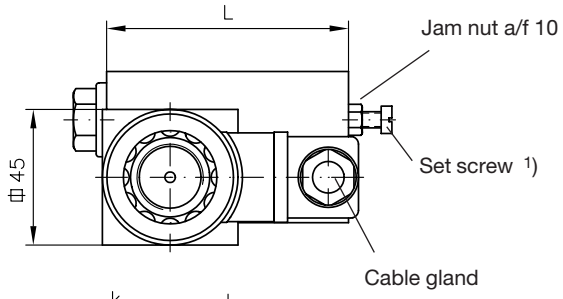
4. Unit dimensions

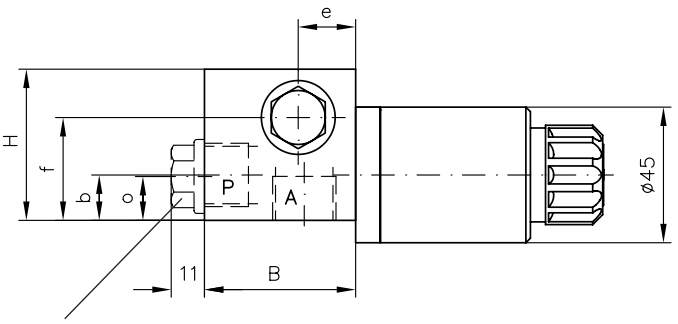
All dimensions in mm, subject to change without notice !

The proportional solenoid may be rotated and fixed at any angle but may be also installed upside down (cable gland will face in the other direction).

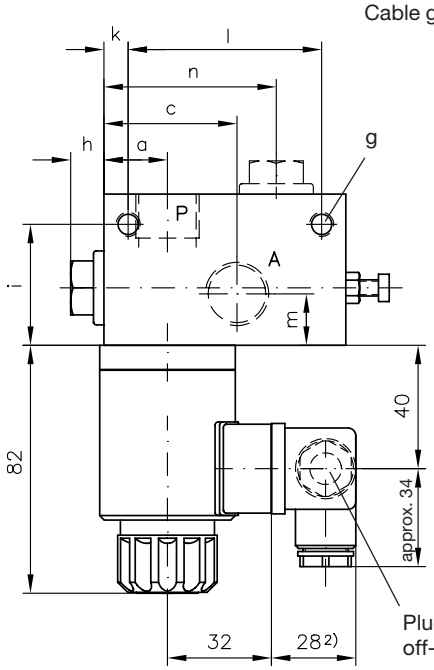
4.1 2- and 3-way flow control valve for direct pipe connection

Type SE 2-3/.., SE 2-3/..R, SE 2-4/.. and SE 2-4/..R





By-pass check valve coding **R**

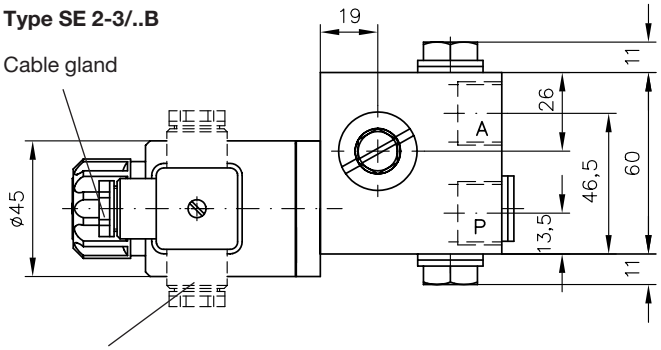


Plug may be installed off-set 3x90°

Type	L	B	H	a	b	c	e	f	g
SE 2-3 (R)	80	50	50	21	15	44	19	34	M8, 8 deep
SE 2-4 (R)	85	60	60	25	19	53	21	41	M8, 10 deep

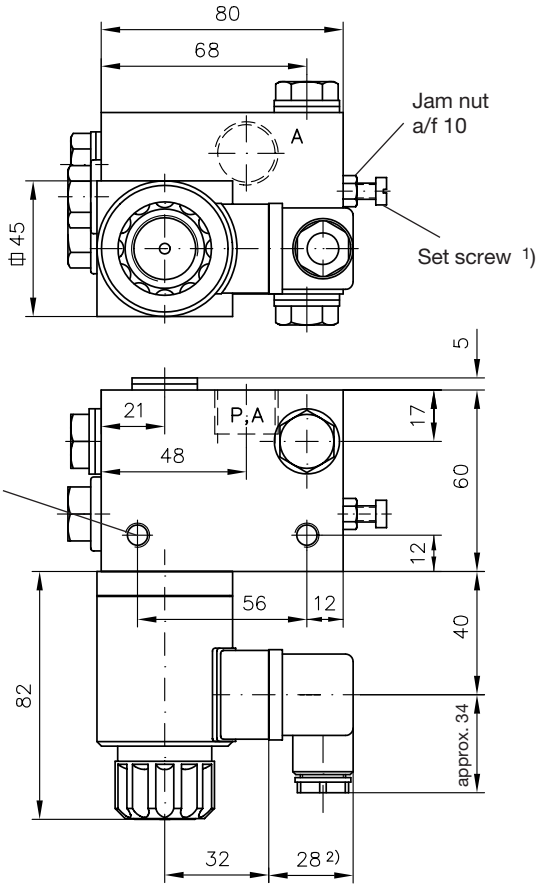
Type	h	i	k	l	m	n	o	Ports ISO 228/1 (BSPP) P and A
SE 2-3 (R)	12	40	8	64	17	57	14.5	G 1/2
SE 2-4 (R)	14	48	10	65	21	68	18	G 3/4

Type SE 2-3/..B



Plug may be installed off-set 3x90°

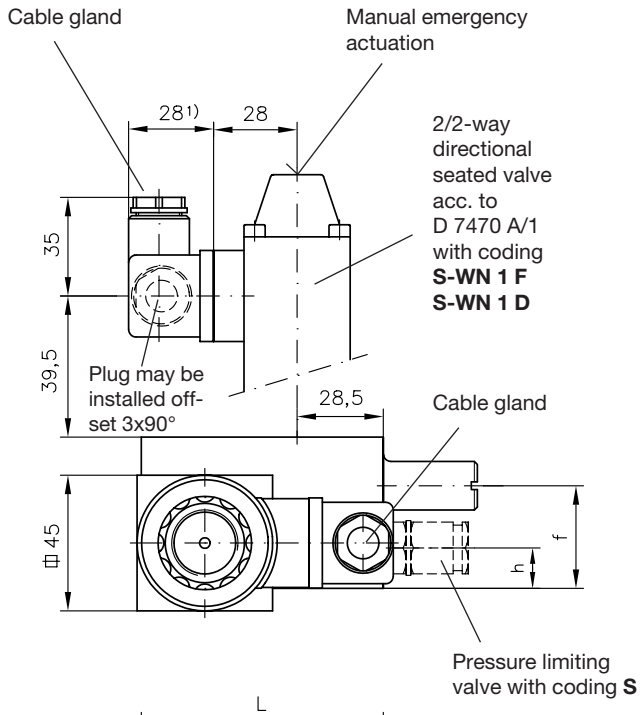
Ports ISO 228/1 (BSPP):
P and A = G 1/2

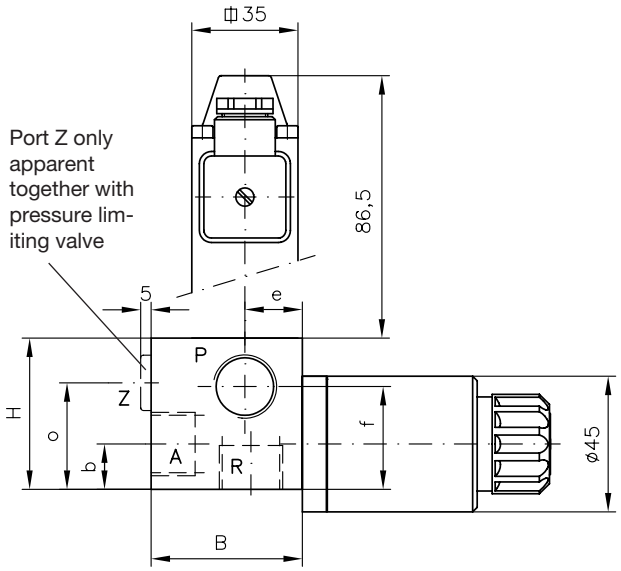


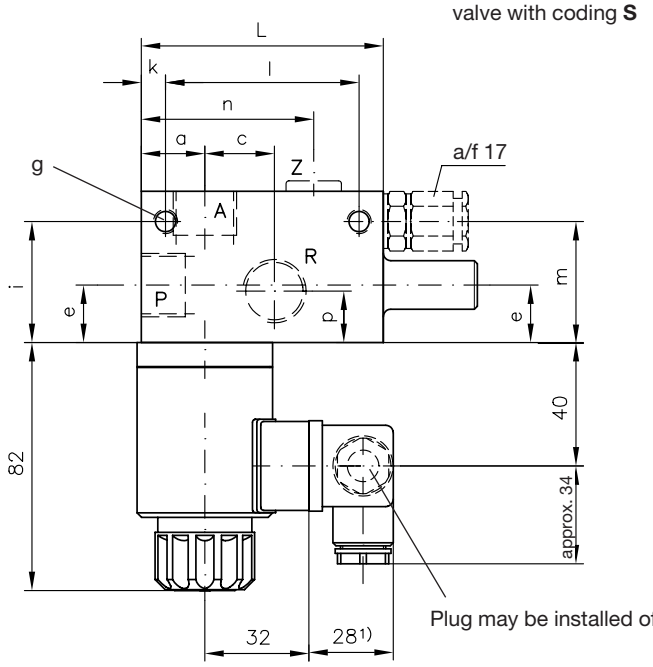
1) The Seal-Lock nut must be loosened for min. 1 turn, prior to adjustment of the set screw to prevent any damage of the vulcanized thread seal. See also note on page 5 !

2) **Attention:** This dimension is depending on the manufacturer and may be up to max. 40 mm (acc. to DIN EN 175 301-803)!

Type SE 3-3/.., SE 3-3/..S.., SE 3-4/.. and SE 3-4/..S..







Type	L	B	H	a	b	c	e	f	g
SE 3-3(S)	80	50	50	21	15	23	19	34	M8, 8 deep
SE 3-4(S)	85	60	60	25	19	28	21	41	M8,10 deep

Type	h	i	k	l	m	n	o	p
SE 3-3(S)	13.5	40	8	64	40	60	35	17
SE 3-4(S)	19	48	10	65	46	55	41	21

Ports ISO 228/1 (BSPP):

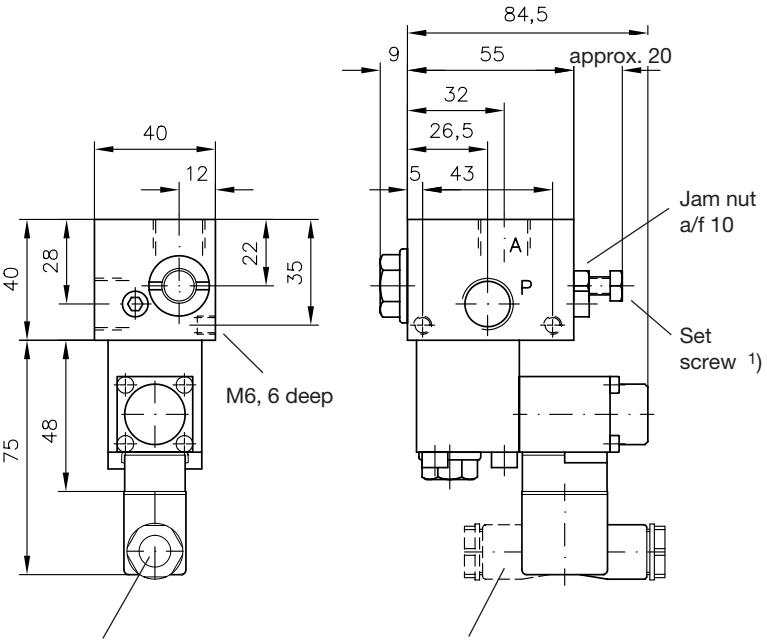
Type	P, R, A	Z
SE 3-3(S)	G 1/2	G 1/4
SE 3-4(S)	G 3/4	G 1/4

Pressure adjustment

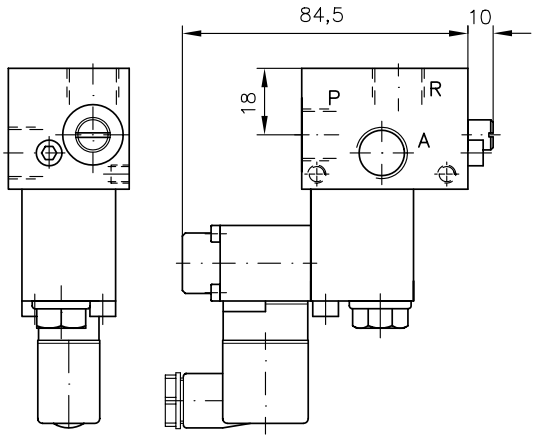
Coding (table 5) / acc. to pressure specification	Travel f_{max} (mm)	Δp (bar) per turn
S(ST) / (0) ... 200 bar	4	90
S(ST) / 200 ... 315 bar	4	150

[1] **Attention:** This dimension is depending on the manufacturer and may be up to max. 40 mm (acc. to DIN EN 175 301-803) !

Type SEH 2-2/..

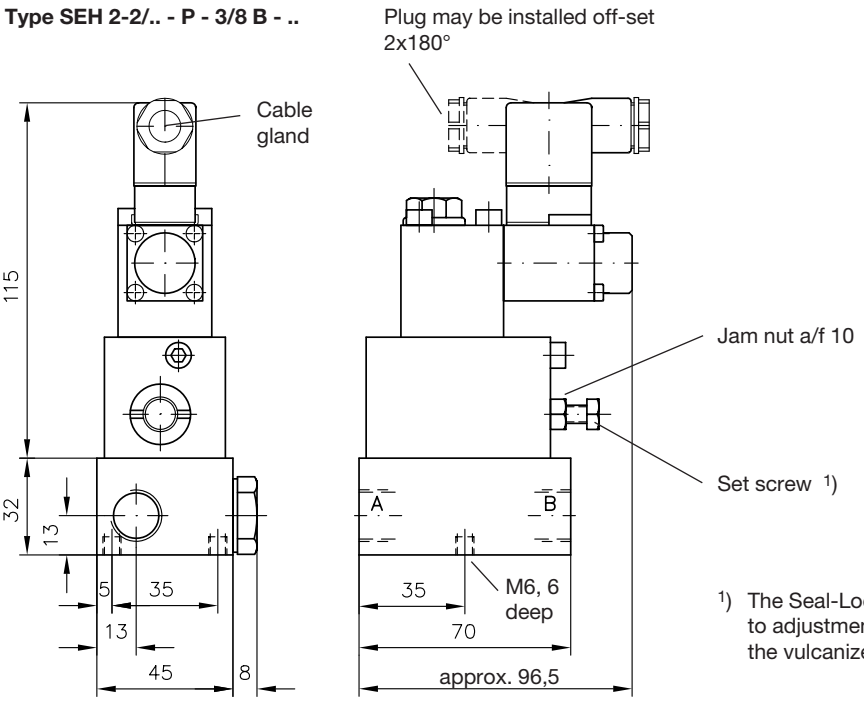


Type SEH 3-2/..



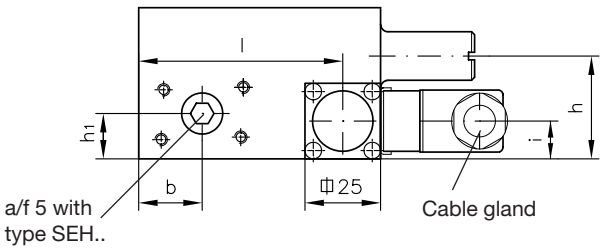
For missing data,
see below!

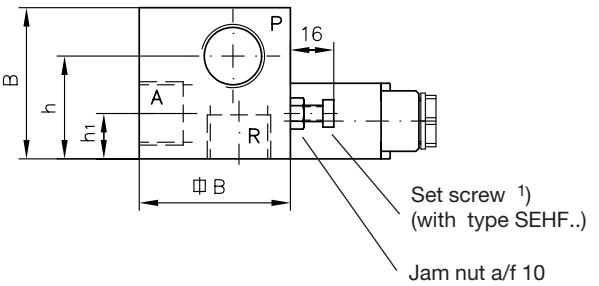
Type SEH 2-2/.. - P - 3/8 B - ..

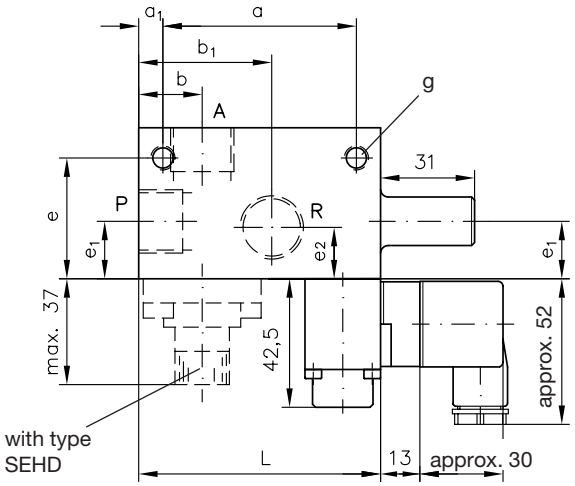


1) The Seal-Lock nut must be loosened for min. 1 turn, prior to adjustment of the set screw to prevent any damage of the vulcanized thread seal. See also note on page 5 !

Type SEH 3-3/.., SEH 3-4/.. and SEH 3-5/..
SEHF(D) 3-3/.., SEHF(D) 3-4/.. and SEHF(D) 3-5/..





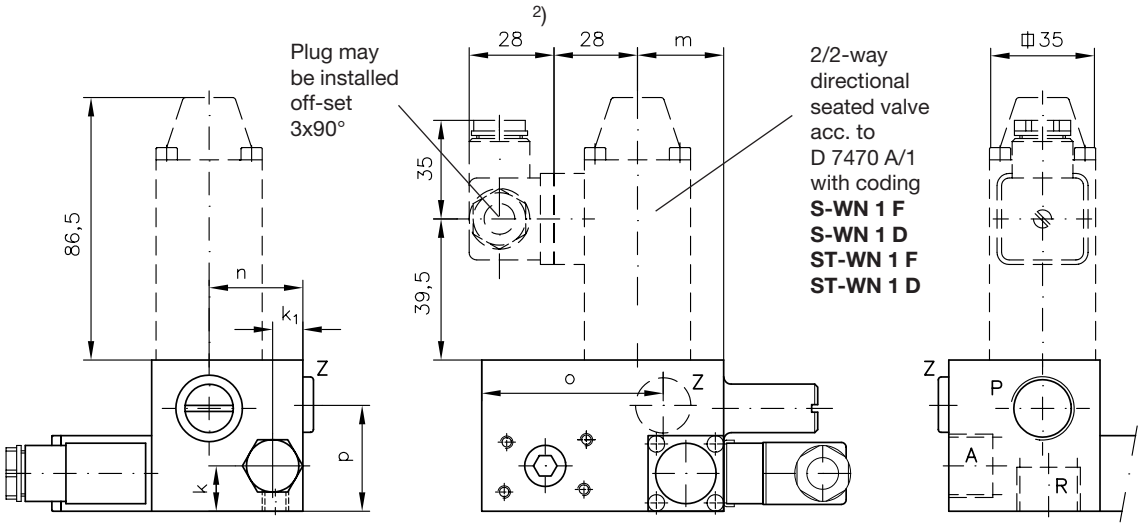


1) The Seal-Lock nut must be loosened for min. 1 turn, prior to adjustment of the set screw to prevent any damage of the vulcanized thread seal. See also note on page 5 !

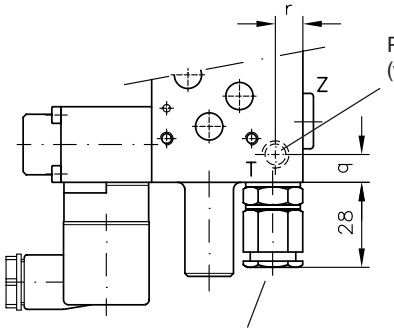
Ports A, P, R conf. ISO 228/1 (BSPP):
SEH..3-3/.. = G 1/2
SEH..3-4/.. = G 3/4
SEH..3-5/.. = G 1

Type	B	L	a	a1	b	b1	e	e1	e2	g	h	h1	i	l
SEH..3-3/..	50	80	64	8	21	44	40	19	17	M8, 8 deep	34	15	12.5	67.5
SEH..3-4/..	60	85	65	10	25	53	48	21	21	M8, 10 deep	41	19	12.5	72.5
SEH..3-5/..	70	100	60	20	27	60	52	23	23	M10, 12 deep	47	22	17.5	87.5

Valve with additional pressure limitation function



For missing data, see above!



Port T = G 1/4 (BSPP)
(with coding **ST**)

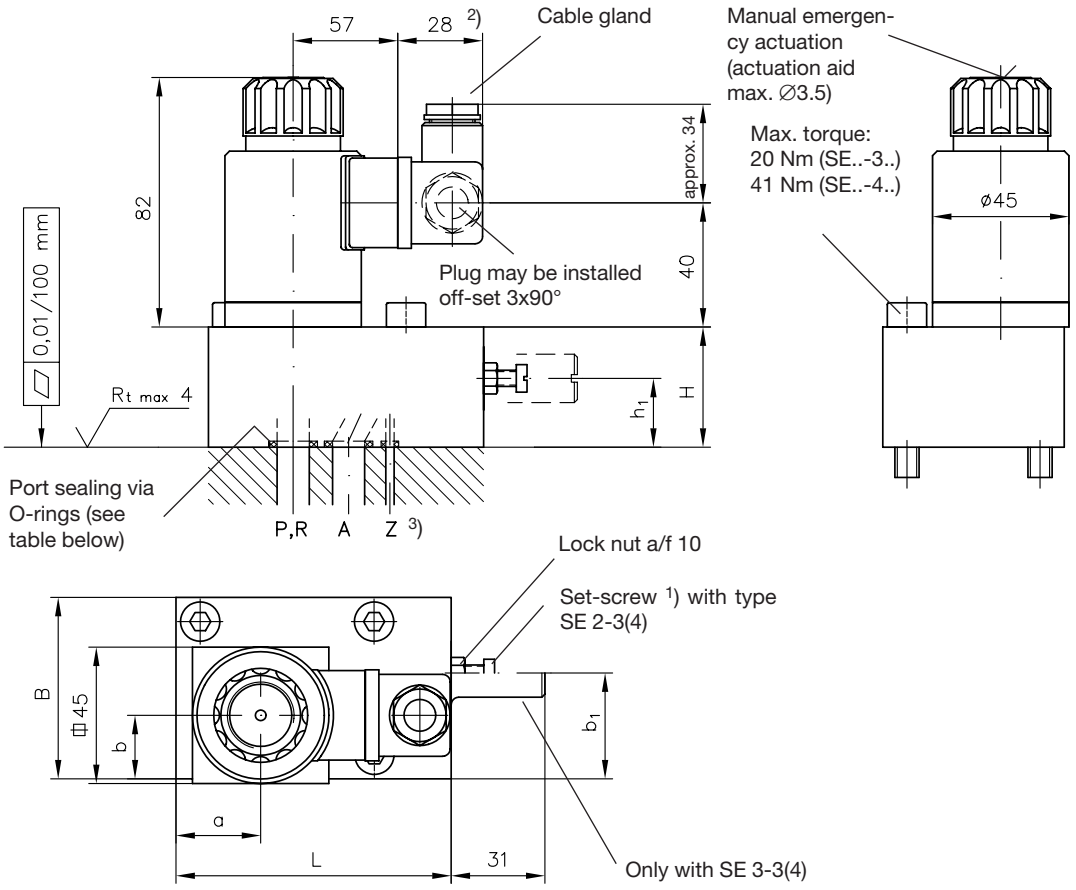
Pressure limiting valve with coding **S** and **ST**
(See note for the pressure adjustment in page 7)

Type	k	k1	m	n	o	p	q	r
SEH..3-3/..S.. (S..-WN 1..)	15	10	28.5	31	60	35	13	11
SEH..3-4/..S.. (S..-WN 1..)	19	14	28.5	39	55	41	11	15
SEH..3-5/..S.. (S..-WN 1..)	22	15	29.5	47	70	47	--	--

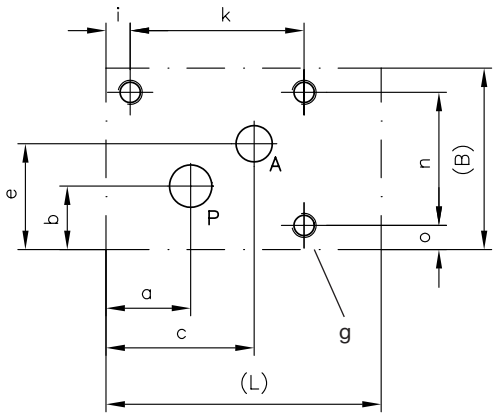
2) **Attention:** This dimension is depending on the manufacturer and may be up to max. 40 mm (acc. to DIN EN 175 301-803) !

4.2 2- and 3-way flow control valve for manifold mounting

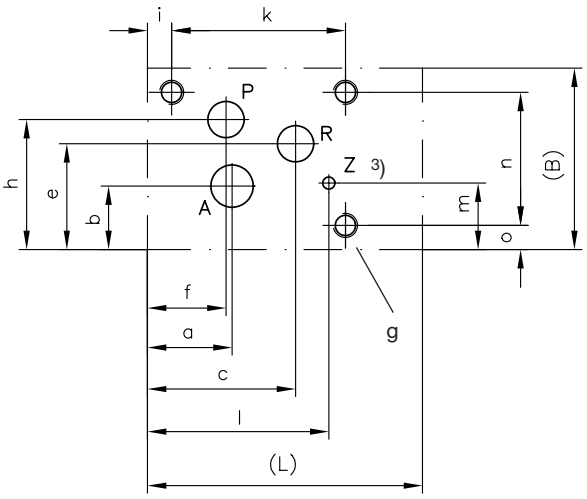
Type SE 2-3/..P(PR), SE 2-4/..P(PR), SE 3-3/..P and SE 3-4/..P



Hole pattern of the manifold for 2-way flow control valve Type SE 2-3/.. and SE 2-4/..



Hole pattern of the manifold for 3-way flow control valve Type SE 3-3/.. and SE 3-4/..



Type	L	B	H	a	b	b1	c	e	f
SE..-3 P(R)	91	60	40	28	21	35	49	35	26
SE..-4 P(R)	100	70	50	35	26	42	57	42	33.5

Type	g	h	h1	i	k	l	m	n	o
SE..-3 P(R)	M8, 12 deep	43	23	8	57.5	60	22	44	8
SE..-4 P(R)	M10, 12 deep	53	29	16	57	55	21	52	9

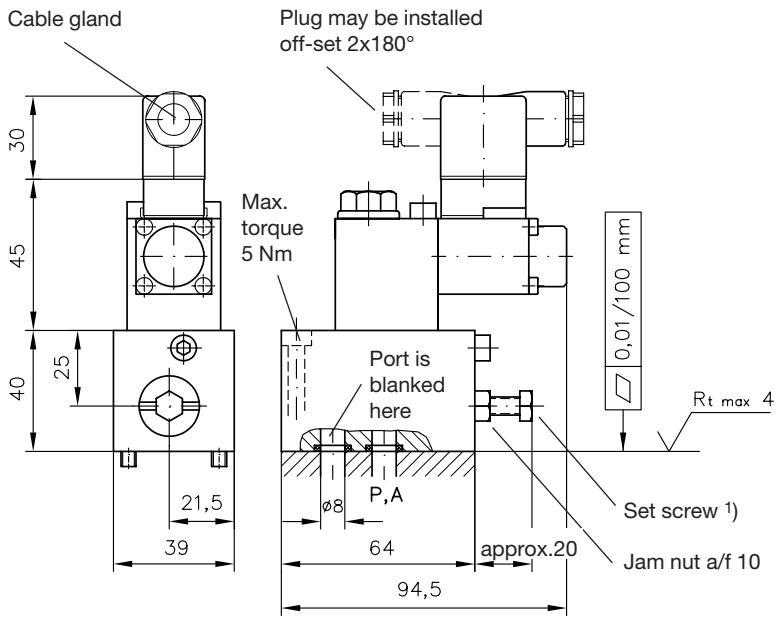
	Port ∅				Sealing (O-ring 90 Sh)	
Type	P	R	A	Z	P, R and A	Z
SE 2-3 P(R)	14	---	12	---	15x2.5	---
SE 2-4 P(R)	17	---	17	---	18.5x2.62	---
SE 3-3 P	12	12	14	4	15x2.5	6x2
SE 3-4 P	17	17	17	4	18.75x2.62	6x2

1) The Seal-Lock nut must be loosened for min. 1 turn, prior to adjustment of the set screw to prevent any damage of the vulcanized thread seal. See also note on page 5 !

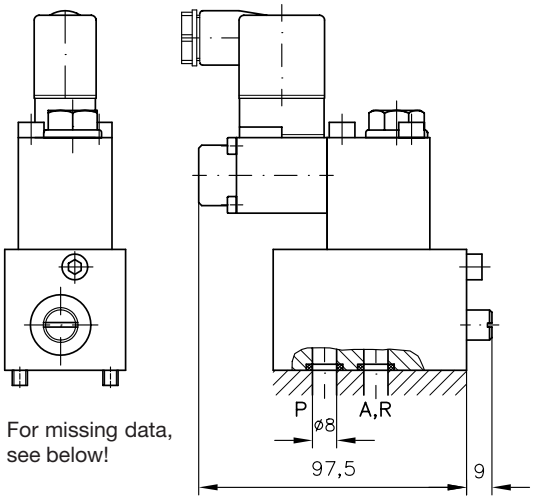
2) **Attention:** This dimension is depending on the manufacturer and may be up to max. 40 mm (acc. to DIN EN 175 301-803) !

3) Port Z only apparent with idle circulation circuit (see sect. 2.2 foot note 5) and 6))

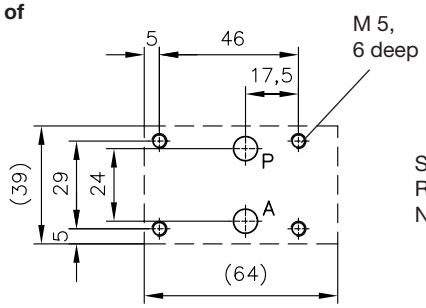
Type SEH 2-2/.. P



Type SEH 3-2/.. P

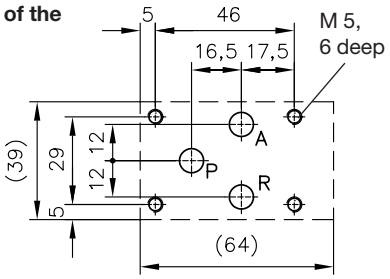


Hole pattern of the manifold
(top view)

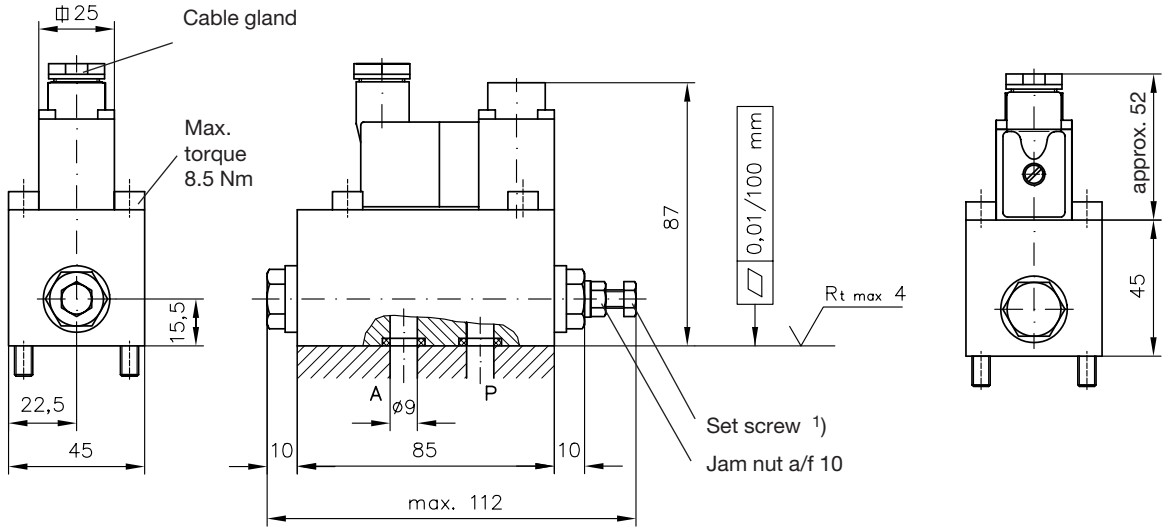


Sealing of ports A, P and R via O-rings 9.25x1.78 NBR 90 Sh

Hole pattern of the manifold
(top view)

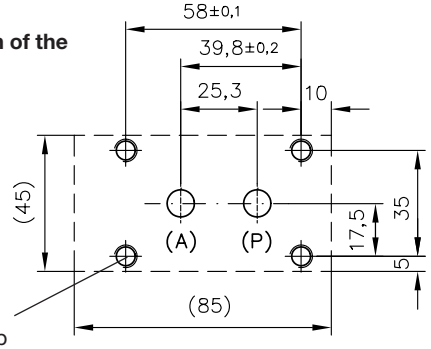


Type SEH 2-3/..-P and SEHF 2-3/..-P



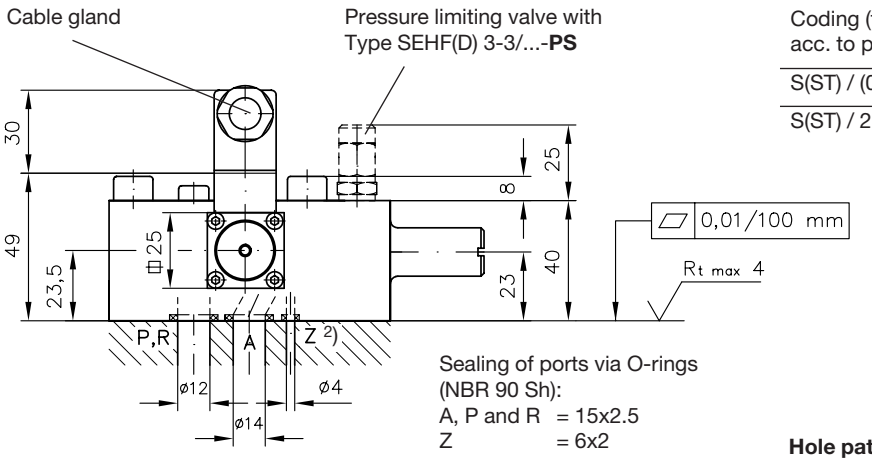
Sealing of ports A and P via O-rings 10.82x1.78 NBR 90 Sh

Hole pattern of the manifold
(top view)



1) The Seal-Lock nut must be loosened for min. 1 turn, prior to adjustment of the set screw to prevent any damage of the vulcanized thread seal. See also note on page 5 !

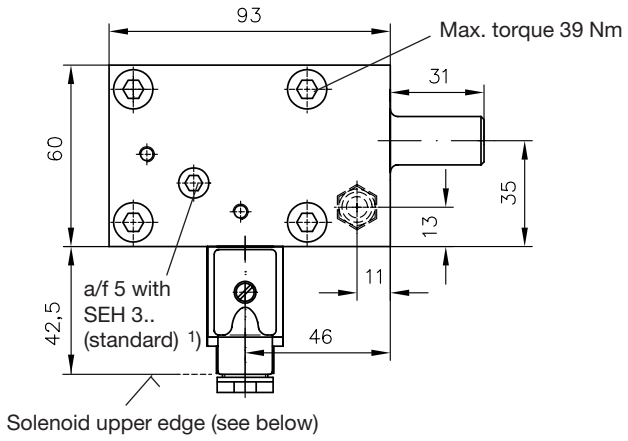
Type SEH(F, D) 3-3/.. - P and SEH(F, D) 3-3/.. - PS



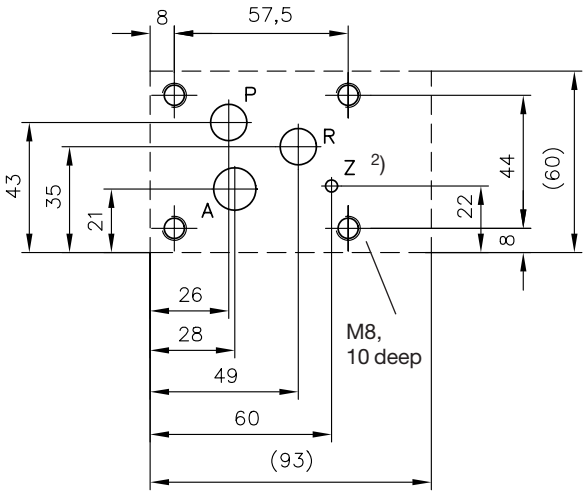
Sealing of ports via O-rings
(NBR 90 Sh):
A, P and R = 15x2.5
Z = 6x2

Pressure adjustment

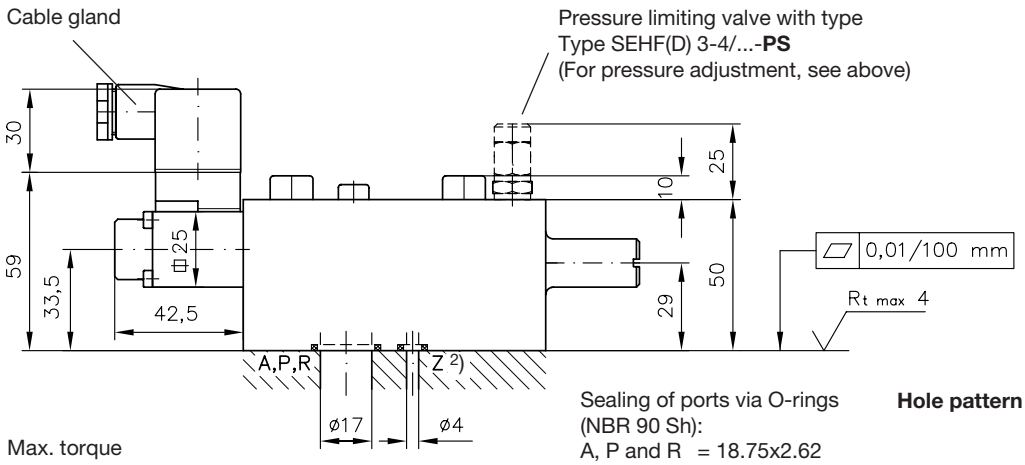
Coding (table 5) / acc. to pressure specification	Travel f_{max} (mm)	Δp (bar) per turn
S(ST) / (0) ... 200 bar	6.3	40
S(ST) / 200 ... 315 bar	4.5	95



Hole pattern of the manifold (top view)

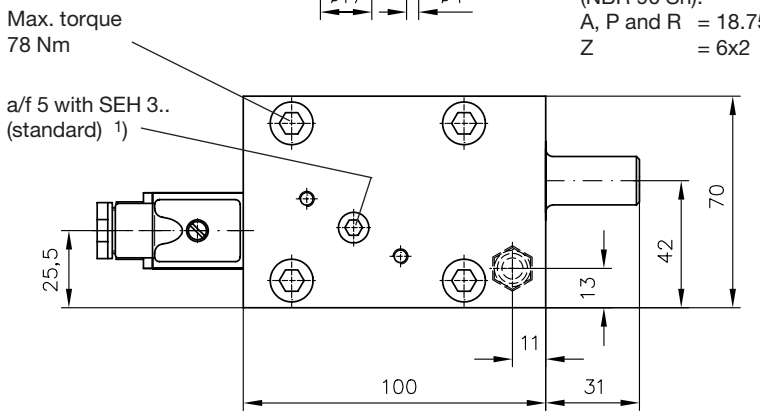


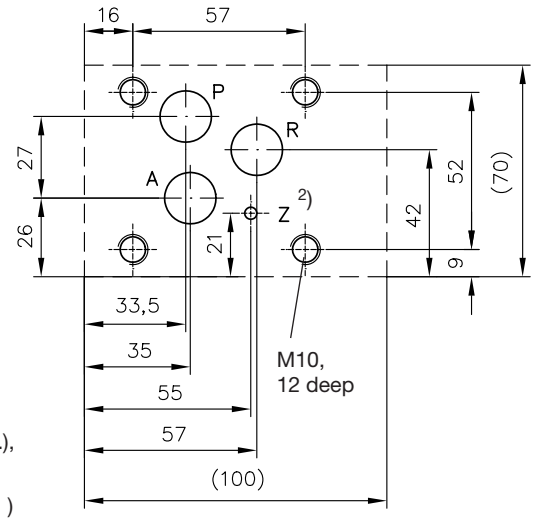
Type SEHF 3-4/.. - P



Sealing of ports via O-rings
(NBR 90 Sh):
A, P and R = 18.75x2.62
Z = 6x2

Hole pattern of the manifold (top view)





1) For illustration of the locked screw (type SEHF 3..) or the turn knob (type SEHD 3..), see page 9

2) Port Z only apparent with idle circulation circuit (see sect. 2.2 foot note 5) and 6))

5. Appendix

5.1 Notes to the metering orifice codings ...F0

(acc. to table 4, sect. 2.2)

- Available versions:

  3-way flow control valve type SEH 3-2 as well as the flow control valves integrated in the connection block of directional spool valve banks type SWR 1(2) SE.. and SWS 2 SE.. acc. to D 7450, D 7451, and D 7951.

- Use:

  Enables controlled supply of pressurized fluid in hydraulic circuits connected in parallel, where usually 2-way flow control valves are utilized.
  Example: Variable supply of pressurized fluid to an auxiliary circuit which is diverted from a main circuit and fed via a constant delivery pump. The forced blocked position of the flow control valve (when not actuated) i.e. all consumers of the auxiliary circuit are in blocked idle position enables actuation of all consumers fed by the constant flow (main) circuit without influence due to uncontrolled movement of the flow control valve with accompanied loss via port R.

- Advantage:

  The auxiliary circuit shows only the loss of a 3-way control. The excess flow will be only returned to the tank against the set pressure for the consumer side. The common procedure with a 2-way flow control valve shows higher losses as the excess flow is returned to the tank via the main pressure limiting valve (max. pressure setting).

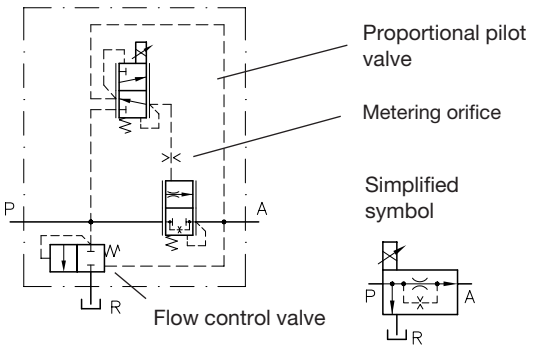
- Restriction:

  This system must not be used while one of the consumers of the main circuit is actuated. This version shows a slightly higher minimum consumer flow $Q_{A\ min}$ to be achieved when compared with the standard version as the metering orifice is always slightly opened.
  Attention: The metering orifice is slightly open in “0”-position !

- Description:

  This version (other than standard) features a stop for the F flow control valve (deenergized closed) in idle position via a washer (may be retrofitted). This residual passage enables a connection between P- and A-side and therewith to therear side of the flow control valve (spring cavity). This enables a permanent compensation of the losses from the spring cavity to R, maintaining a pressure balance between the front and rear side of the flow control valve while the directional seated or spool valves are not actuated i.e. in blocked idle position. The spring enforced flow control valve blocks the passage to R or returns promptly from its working position to blocked position thereby minimizing influence of the main circuit.

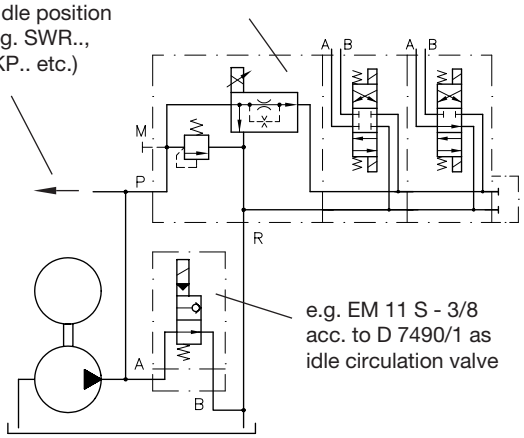
Detailed flow pattern symbol



Example circuit

To the main circuit via e.g. directional valve banks with blocked to P idle position (e.g. SWR.., SKP.. etc.)

Auxiliary circuit utilizing e.g. SWR 2 SE 10F0-GG-G 24-150.
The pressure limiting valve safeguards both circuits in this example.



5.2 Notes to type SEH 3 -4(5)/.. B0,6 version with by-pass orifice

(acc. to table 5, sect. 2.2)

- Available versions:

  3-way flow control valve type SEH 3-4/.. and SEH 3-5/.. (version for pipe connection) may be retrofitted (see illustration below).

- Use:

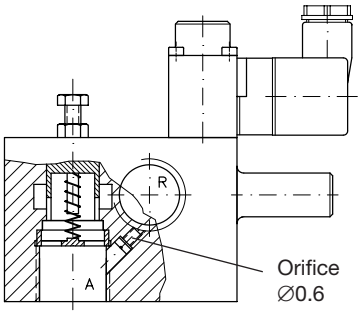
  Automatic switch-over even with blocked consumer at A. This makes an otherwise required 2/2-way solenoid valve superfluous, e.g. type SEH 3-4/.. S-WN1D-G24.

- Description:

  A prompt depressurization of A (consumer) and therewith the rear side (spring cavity) of the flow control valve is ensured while closed (deenergized prop. solenoid) via a by-pass orifice ∅0.6 mm installed between A and R enabling return of the flow control valve to its idle circulation position (back pressure 6 bar).

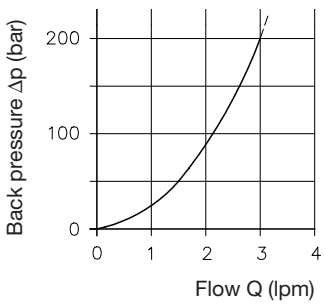
- Restriction:

  This control must not be used for systems with load induced pressure (loaded single acting cylinders) at A. It is possible to block this pressure via an external check valve (e.g. RC1-E at A).
  Attention: There is a permanent, pressure dependant loss of the effective consumer flow at A/R via the orifice during operation. This slightly harms the load independence of the device (see Δp-Q curves in sect. 3.1).



The orifice B 0.6 is accessibly via port A after removal of the tapped plug (with O-ring 4x1 NBR 90 Sh). Therefore it may be retrofitted any time (carburetor jet M4x∅0.6).

The flow at A (see Q-I curve on page 5) is pressure-dependently reduced by the loss via the orifice (see curve below).



5.3 Notes to type SEH 3 -4(5)/.. ST.. version with pressure limiting valve

(acc. to table 5, sect. 2.2)

- Available versions:

  3-way flow control valve type SEH 3-4/.. and SEH 3-5/..
  (version for pipe connection).

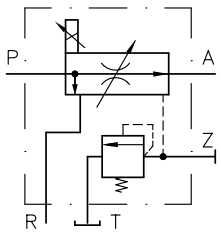
- Use:

  3-way flow control valve connected in series featuring individual pressure limitation for consumer port A or circuits with pressurized port R, where a pressure limitation for port A is required even though (standard version type SEH 3-../.. S.. $p_R \leqq 20$ bar).

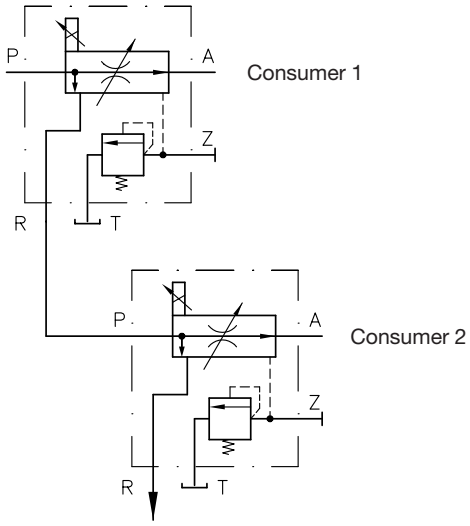
- Description:

  The return flow of the pressure limiting valve is to be routed back individually via port T. This prevents any influence of the apparent pressure at R on the pressure setting.

Type SEH 3-4(5)/.. ST-..



Example circuit



Additional consumer
or tank

5.4 Proportional throttle type PB

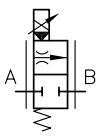
The metering orifice utilized at flow control valves type SEH size 2 may be used also individually as a proportional throttle valve.
Attention: The flow and with that the consumer velocity is herewith not load independent.
Main parameter is the control current applied to the proportional solenoid but also the current pressure conditions at ports A and B.

Order example: **PB 2 - 15 F**

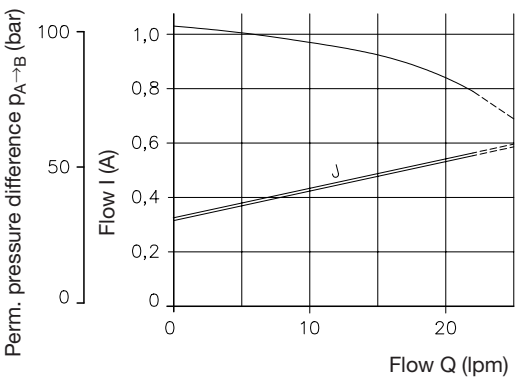
Basic type

Flow **3 F**
5 F
10 F
15 F

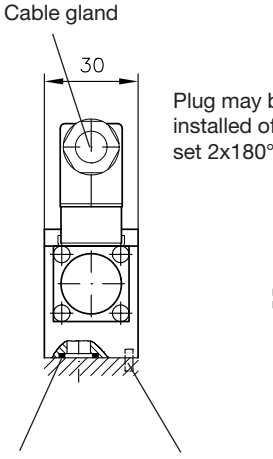
Flow pattern symbol



Perm. pressure difference A→B 315 bar
Flow direction A→B (mandatory)

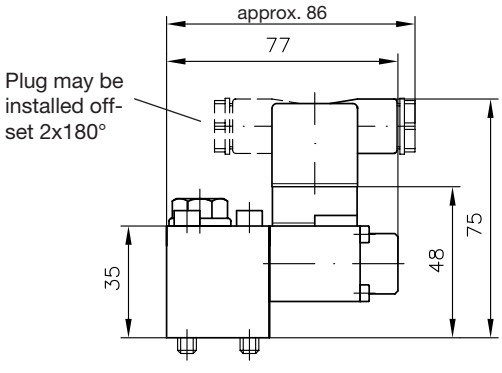


Cable gland

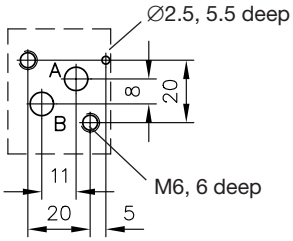


Sealing of ports A and B via O-rings 9.25x1.78 NBR 90 Sh

Centering pin at the manifold (Ø2.5x8)

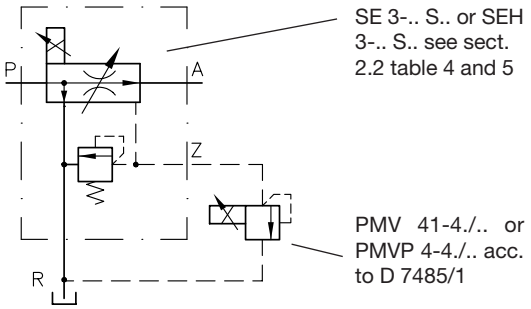


Hole pattern of the manifold (top view)



5.5 Combination with a proportional pressure limiting valve

The connection of a proportional pressure limiting valve type PMV 41-4./.. or PMVP 4-4./.. at control port Z of the 3-way flow control valve (featuring an integrated pressure limiting valve with fixed setting) enables proportional control of the flow and the operating pressure as well as an idle circulation pressure (P→R) of roughly 8 ... 10 bar when deenergized (applies to both flow controller versions, deenergized open or closed).
The already apparent piloting pressure limiting valve in the controller can be used as a main pressure limitation for the circuit but has to be set always higher than the intended pressure conditions for the proportional pressure limiting valve (PMV 41-4./.. or PMVP 4-4./..).



6. Type coding key

Order examples: **SE 2 - 3/15 B - G12**
SE 3 - 3 S - WN 1 F - G24 - 120
SEHF 3 - 4/70 P - B0,6 - G24

Pressure specification (bar)
for the pressure limiting valve

Nom. voltage of the solenoids (see sect. 2.1 and 2.2, table 3)

G12, G24, G80	Type SE..
G12, G24	Type SEH..

Design, connection mode and size
of the 2-way flow control valve (see sect. 2.1, table 2):

(without)	Standard (pipe connection)
P	Manifold mounting
R	By-pass check valve
P-3/8B	Rectifier circuit (only type SEH 2-2)
B	Rectifier circuit (only type SE 2-3)

3-way flow control valve (see sect. 2.2, table 5):

(without)	Standard (pipe connection)
P	Manifold mounting
PS	Manifold mounting with pressure limiting valve
S, ST	Pressure limiting valve
S-WN 1 F	Pressure limiting valve plus idle circulation valve WN 1 F acc. to D 7470 A/1
S-WN 1 D	Pressure limiting valve plus idle circulation valve WN 1 D acc. to D 7470 A/1
B0,6	By-pass orifice ∅0.6

Flow (nom. flow P→A) see sect. 2.1 and 2.2, table 1 and 4
Deenergized closed (standard):

3F, 6F, 10F, 15F, 22F, 30F	Size 2
6F, 10F, 15F, 22F, 30F, 36F, 50F, 3/7F, 3/26F, 4/18F [1]	Size 3
70F and 90F	Size 4
120F	Size 5

Deenergized open:

3, 6, 10, 15, 22, 30	Size 2
3, 6, 10, 15, 22, 30, 36, 50, 3/7, 3/26, 4/18 [1]	Size 3
70 and 90	Size 4
120	Size 5

With forced blocked position of the flow control valve when not actuated:

3F0, 10F0, 15F0, 22F0, 30F0	only SEH 3-2!

Size
2
3
4
5

Basic type
2-way flow control valve (see sect. 2.1, table 1):

SE 2	with directly actuated metering orifice
SEH 2	with piloted metering orifice
SEHF 2	with stop for minimum consumer flow

3-way flow control valve (see sect. 2.2, table 4)

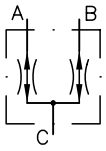
SE 3	with directly actuated metering orific
SEH 3	with piloted metering orifice
SEHF 3	with stop for minimum consumer flow (adjustment via set-screw)
SEHD 3	with stop for minimum consumer flow (adjustment via turn knob)

PB	Proportional throttle	see sect. 5.4

[1] only SEH(F) 2-3/.. and SEH(F) 3-3/..

Flow divider (flow distributor), type TQ

Pressure p_{max} = 350 bar
Flow $Q_{CN\ max}$ = 200 lpm
Share ratio = 1:1



1. General

- **Task**

  Flow dividers type TQ are self-regulating valves, which largely irrespective of the pressure differentials at the operating connections A and B, divide a flow Q_C entering at C into two equal output flows, Q_A and Q_B. Alternatively, in the opposite direction they can retain both partial flows Q_A and Q_B at equal rates, and combine them into one overall flow Q_C.

- **Mounting and function**

  Two hardened and ground control pistons, flexibly linked to one another, are arranged in a steel housing in such a way that they can be easily displaced and centered in the center position (neutral position) by springs. Orifice boreholes connected one behind another in the two control pistons form throttle points with constant and variable cross-sections between the single flow connection and the two part flow connections. When an appreciable flow rate is present, pressure drops occur at these throttle points, which bring the pistons into the control position as well as balancing out any pressure difference, which may have arisen between the two part flows as a result of load differences at the connected consumer units. Accordingly, the total pressure drops between the two part flow connections and the single common connection are always of the same value; depending on the physical connection between flow resistance and flow rate, this also results in two equally high part flow rates.

- **Application**

  The valves are used in situations where two hydraulic consumers, fed by one pump but without any forced mechanical connection, are controlled by a common directional valve and are intended to move in and out simultaneously, without influencing one another despite differing load levels. Where hydraulic consumers of equal size are involved, this produces a certain synchronized motion, although this is dependent on the division precision of the flow distributor and the internal leakage losses of the consumers (e.g. as with hydraulic motors) and the volumetric elasticity of the system (oil compressibility, hose expansion etc.). Division precision is not a constant value, but dependent on a variety of operational parameters (see sect. 3.2), and may change in the course of a work cycle, depending for example on the load proportions. Flow dividers can therefore only fulfil the task of flow equalizer valves if a division error of a few percent is permissible and without any disturbing influence. Therefore truly exact synchronized flow control cannot be achieved. Other devices are required for this (such as mechanical flow dividers working on the gear wheel or piston principle), or proportional or servovalves for high demands, which are guided by continuous scanning of the stroke and angle of rotation. The influence of the viscosity of the pressure medium on division precision is negligible, but it becomes noticeable by way of the consumer leakage losses mentioned above.
  Synchronization differentials in hydraulic cylinders are balanced out in each case at the final stroke position.

2. Types available, main data

2.1 Valves with equal dividing ratio

Order example: **TQ 32-A 3**

Table 1: Basic type, size

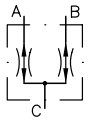
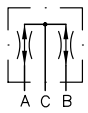
Connection mode	Coding		Port size ISO 228/1 (BSPP) or JIS B 2351 C	A, B
Pipe connection 	TQ	**21-A**	G 3/8	G 1/4
		21 JIS		
		22-A	G 3/8	G 3/8
		22 JIS		
		32-A	G 1/2	G 3/8
		32 JIS		
		33-A	G 1/2	G 1/2
		33 JIS		
		43-A	G 3/4	G 1/2
		54-A	G 1	G 3/4
Manifold mounting 	TQ	**3P-A**	see dimensional drawings in sect. 4.2	
		4P-A		
		5P-A		

Table 2: Flow

Available for basic type	Coding	Rated total flow Q_{CN} [2] approx. lpm	Final pos. balance [3] approx. lpm A→C	B→C
TQ 21.-A to TQ 33.-A and TQ 3P-A	**0,78**	3.8	0.2	0.1
	1,1	7.5	1.6	1
	1,6	15	1.6	1
	2,3	30	2.5	1.5
	3	45	4	1.7
	3,5	60	5	2
	4 [1]	70	6.5	3
TQ 43-A TQ 4P-A	**4**	80	6.5	3
	5	120	9	5
TQ 54-A TQ 5P-A	**5,5**	140	12	6
	6,8	200	15	7

[1] Not for TQ 21.; $Q_{CN} \approx$ 70 lpm. Only for applications, where a greater dividing error is no problem (approx. ± 8...10%)

[2] Guideline for the permissible flow in at port C. In this case, a flow resistance prevails in the flow directions C → A and C → B (and vice versa, when two flows are joint) of about 30 bar, see Δp-Q curves

[3] If (in the case of hydraulic cylinders) the advancing end comes to a standstill at the limit stop, the other end will follow according to the specified balance flow (approx. value); see note under section 5.

2.2 VUnequal dividing ratios

The smaller part flow is always at connection

Note:

Max. part flow at $Q_{A\,max} = 0.5\ Q_{CN}$!

For Q_{CN} of the respective metering orifice coding (flow spec.) refers to table 2 in sect. 2.

Valves with unequal flow ratio: The perm. inlet flow $Q_{C\,perm}$ is always lower than the Q_{CN}. It can be determined with share parameter z = 2, 3, 4 $Q_{C\,perm} = Q_{A\,max} + Q_{B\,max}$ applies in general or $Q_{C\,perm} = 0.5\ Q_{CN} \left(1 + \frac{1}{z}\right)$

Order example:

TQ 32 - A 3/2

- Basic type and port size as, acc. to table 1, sect. 2
- Flow rate characteristic according acc. to table 2, sect. 2 for port A (Q_A)
- Division figure for the relationship of the consumer flows $Q_B : Q_A = \frac{1}{z}$

z = 2 ... $Q_B = \frac{1}{2}\ Q_A$

3 ... $Q_B = \frac{1}{3}\ Q_A$

4 ... $Q_B = \frac{1}{4}\ Q_A$

Available versions:

	- A 1,1/2	**- A 3/3**
	- A 1,6/2	**- A 3,5/2**
	- A 2,3/1,4	**- A 3,5/3**
TQ 2..	**- A 2,3/2**	**- A 3,5/4**
TQ 3..	**- A 2,3/3**	**- A 4/1,4** [1]
	- A 2,3/4	**- A 4/2** [1]
	- A 3/1,5	**- A 4/3** [1]
	- A 3/2	**- A 4/4** [1]
	- A 4/1,5	
	- A 4/2	
	- A 4/3	
TQ 4..	**- A 5/2**	
	- A 5/3	
	- A 5/5	
	- A 5/1,5	
	- A 5,5/2	
TQ 5..	**- A 6,8/2**	
	- A 6,8/3	

[1]) Not for TQ 21.; Q_{CN}, 70 lpm. Only for applications, where a greater dividing error is no problem (approx. ± 8...10%)

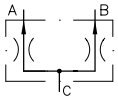
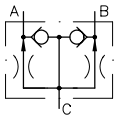
2.3 Valves only for division C → A, B

Share ratio 1:1

Order example: **TQ 32 R-B 2,3**

Flow
(see table 2, coding 0.78 to 4)

Table 3: Basic type, size

Connection mode	Coding	Port size ISO 228/1 (BSPP) C	Port size ISO 228/1 (BSPP) A, B	Symbols	Remarks
Pipe connection	TQ 21-B	G 3/8	G 1/4	 No return flow	Valves featuring only a mono metering spool are only suited for flow direction C → A, B. Return flow in reverse direction is not permissible with type TQ 21-B... to TQ 33-B... .
	TQ 22-B	G 3/8	G 3/8		
	TQ 32-B	G 1/2	G 3/8		
	TQ 33-B	G 1/2	G 1/2		
	TQ 43-B	G 3/4	G 1/2		
	TQ 54-B	G 1	G 3/4		
	TQ 32 R-B	G 1/2	G 3/8		Features an internal by-pass check valve. This enables free, but not metered return flow. Examples: Grab buckets or forks wich are intended to open quickly by grafitational force and are intended to strike against integrated stops in order to knock free any material which may still be clinging to them.

3. Additional data

Nomenclature	Spool valve
Installation position	Any
Operating pressure	p_{max} = 350 bar
Flow	Q_{CN} = 3.8 ... 200 lpm, see table 2
Surface protection	Valve housing zinc galvanized
Pressure fluid	Hydraulic oil conforming DIN 51524 part 1 to 3: ISO VG 10 to 68 conform. DIN 51519; Viscosity range: Viscosity during start min. approx. 4; max. approx. 1500 mm²/s; opt. service: approx. 10 ... 500 mm²/s Also suitable are biologically degradable pressure fluids type HEPG (Polyalkylenglykol) and type HEES (Synth. Ester) at service temperatures up to approx. +70°C.
Temperature	Ambient: approx. -40° ... +80°C; Öl: -25° ... +80°C; take note of viscosity ranges! Start temperature down to -40°C are allowable (Pay attention to the viscosity range during start!), as long as the operation temperature during subsequent running is at least 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.

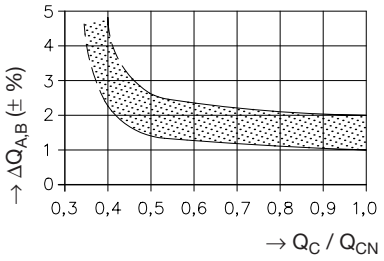
Mass (weight)

Type	TQ 21. TQ 22.	TQ 32. TQ 33.	TQ 43	TQ 54	TQ 3P-A	TQ 4P-A	TQ 5P-A
approx. kg	0.6	0.6	1.5	3	0.7	1.6	3.1

Dividing precision

depends on total flow Q_C. This should be between 50...100% of Q_{CN}. Below 50% of Q_{CN}, devision precision starts to drop. In this case a valve with the next smaller flow coding should be selected

The dividing precision is also dependent on the pressure differential between the consumer ports A and B. If the pressures are the same or only slightly diff. (≦ 20 bar), the dividing error is about ±1...2%. Where higher pressure differentials are involved, the dividing error increases and amounts to approx. ± 2...2.5% at a differential of about 100 bar for the flow characteristics A 0.78...2.3 may rise to ± 3...5% with larger characteristic values, and is approx. ± 5...7% at A 6.8.



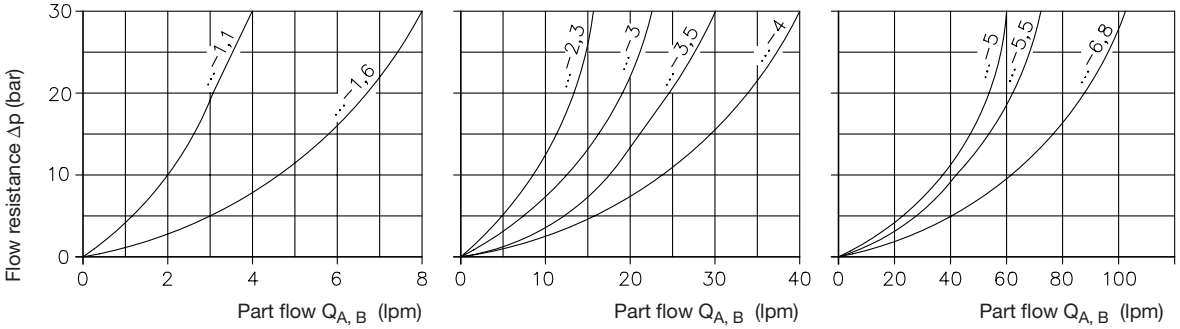
Dividing error

$$Q_{A,\,B} = f\left(\frac{Q_C}{Q_{CN}}\right) \text{ in \% of } Q_{A,\,B} = \frac{1}{2} Q_C$$

at equal load pressures or low pressure differentials between the connections A and B

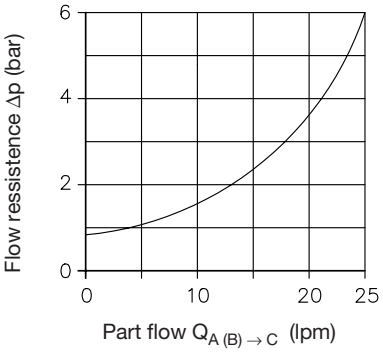
Type TQ..-A.. TQ..-B..

Δp-Q-Characteristic curves



Additional data for type TQ 32 R-B

Δp-Q-Characteristic curves for return flow

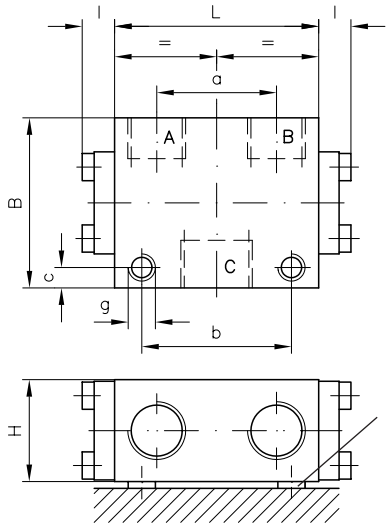


Oil viscosity during measurement 60 mm²/s

4. Dimensions

4.1 Pipe connection design

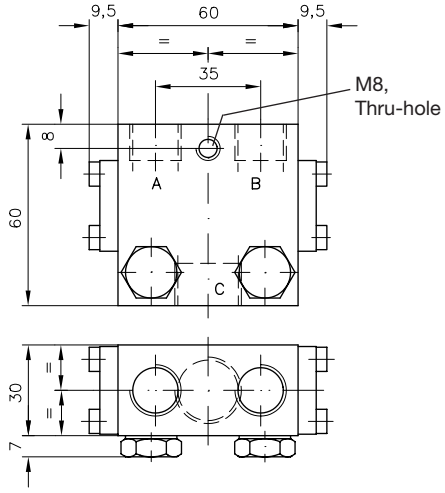
Type TQ 21 to TQ 54



Type	H	B	L	a	b	c	g	l
TQ 21 TQ 21 JIS TQ 22 TQ 22 JIS	30	50	60	35 31 35 31	44	6	M8, thru-hole	9.5
TQ 32 TQ 32 JIS TQ 33 TQ 33 JIS	30	60	66	36 35 36 35	44	8		9.5
TQ 43	40	60	80	50	60	6	M8, 10 deep front and back, core bore is a thru-hole	15
TQ 54	50	80	104	60	80	10		15

Caution:
Do not distort the housing by forcing it against the securing plane. Insert shims as spacers to even out irregularities

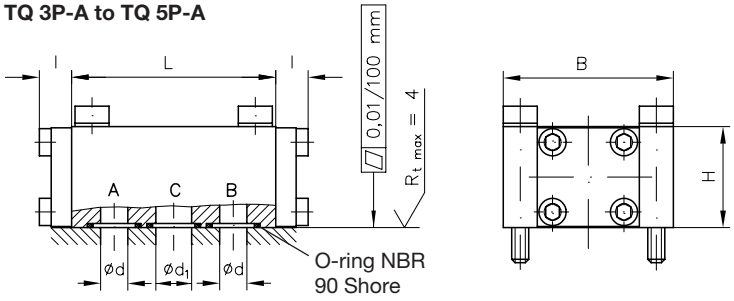
Type TQ 32R - B..



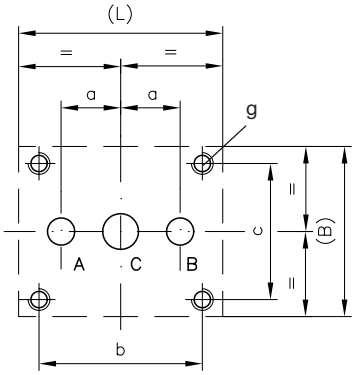
All dimensions are in mm, subject to change without notice!

4.2 Manifold mounting design

Type TQ 3P-A to TQ 5P-A



Hole pattern of the manifold (top view)



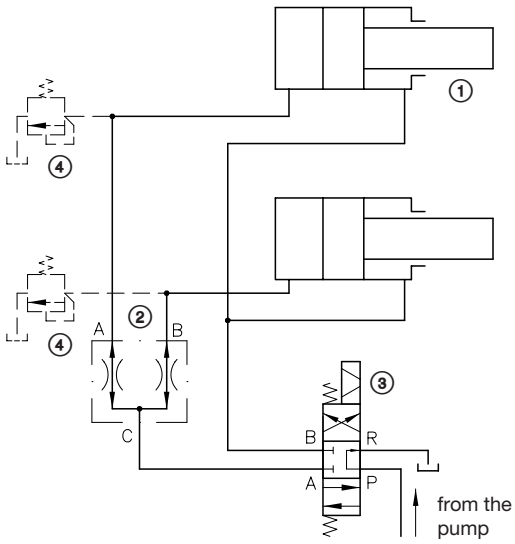
Type	H	B	L	a	b	c	d	d_1	l
TQ 3P-A	30	50	60	17.5	48	40	8	10.5	9.5
TQ 4P-A	40	60	80	26	64	47	13	16	15
TQ 5P-A	50	80	104	31	80	63	15	20	15

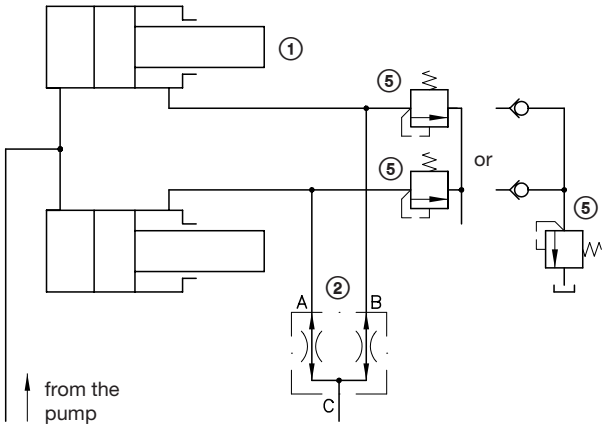
Type	g	O-ring
TQ 3P-A	M6, 10 deep	12.42x1.78
TQ 4P-A	M8, 10 deep	18.72x2.62
TQ 5P-A	M10, 10 deep	31.42x2.62

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

5. Typical circuit diagrams

5.1 Double-acting consumers





① Double-acting hydraulic cylinder, e.g. acc. to D 2055

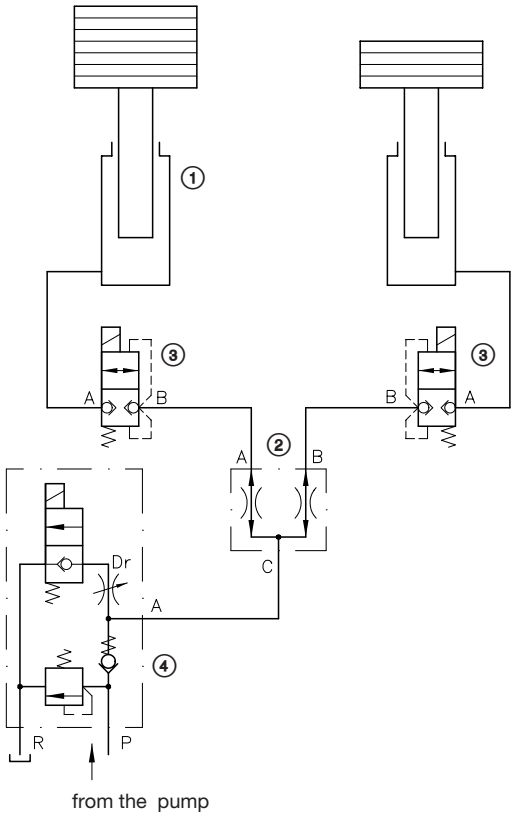
② Flow divider type TQ... acc. to sect. 3.1

③ Directional spool valve
In the arrangement shown in the figure on the left, when the cylinder travels out (dividing motion), a flow resistance occurs at the flow divider for $Q_A = Q_B = 0.5\ Q_C$ (= $0.5\ Q_{pump}$), according to the Δp-Q characteristic (sect. 3). When the cylinder travels in (joining the flows), the part flows Q_A and Q_B are larger due to the area ratios of the cylinder, and the pertinent flow resistance for the pump is likewise greater in the surface ratio. Particularly in borderline cases with Q_{pump} in the range $Q_{C\ max}$, it follows that connecting the flow divider to the piston side of the cylinder can be more satisfactory; take note of ⑤.

④ Pressure limiting valves (setting value as for pump safety valve) are then to be arranged if it is intended for the final position balance of the returning cylinder to take place without any speed limitation (see [3]) in sect. 2.1). The pressure limiting valve which then responds, belonging to the first to reach the final stop, simulates a continued demand for pressure fluid for the flow divider, despite the piston being at a standstill.

⑤ Pressure limiting valves in an arrangement with the pressure divider on the piston side are always advisable, in order to avoid pressure transfers at final position compensation resulting from the cylinder surface differential. Pressure setting as for pump safety valve.

5.2 Single-action, weight-loaded consumer element (stroke devices)



Caution:
When loads are being lowered (part flows being joined), only a small backflow resistance prevails at connection C due to the directional valve being opened to the tank. The control diaphragm on the higher-loaded consumer side (at A in the diagram) does indeed balance the pressure differential with the lower-loaded consumer, but the part flows $Q_A = Q_B$ would be set which, according to the Δp-Q characteristic in section 3, would be derived for Δp = load pressure of the lower-loaded cylinder. In order to avoid excessively high lowering speeds, the return counterflow must be limited by an appropriate flow valve to values equal to or less than $\leqq Q_{CN}$. In the example shown, this is achieved by the throttle provided in the stroke lowering valve, or by a drop-rate braking valve pamphlet D 6920, or by another device of equal value.

① Single-acting hyd. cylinder, weight-loaded

② Flow divider TQ see sect. 2.1

③ Leak-free seated valves, e.g. acc. to D 7765 or D 7300 designs of equal value, for blocking the cylinder lines at „Stop“ in any desired raised intermediate position. These prevent any uncontrolled volume exchange via ② from the higher to the lower loaded cylinder, and thus also prevents one cylinder moving in and the other moving out. If travel is always against the final stop without an interim stop, then the valves ③ are not required.

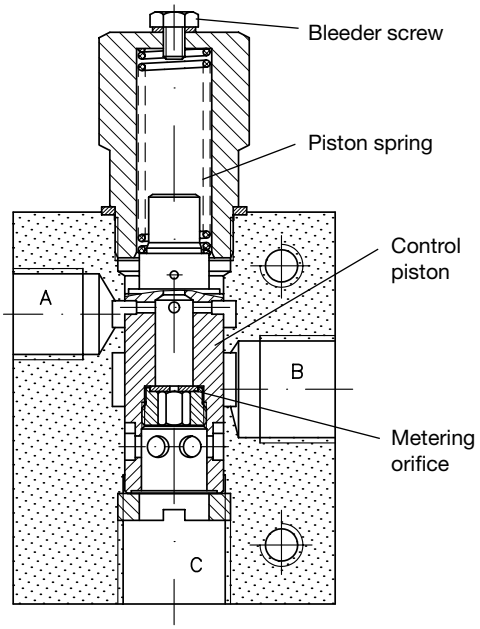
④ Lift/lower valve type HSV 21 acc. to D 7032.
The lowering speed can be adjusted by means of the throttle “Dr”.

Flow divider type TV 3

with privilege division

Pression p_{max} = 300 bar
Flow Q_{max} = 60 lpm
Max. privileged flow $Q_{A\ max}$ = 8.8 lpm

Section drawing of TV 3



1. General

The valve devides the flow (Q_C) entering at port C in two flows(Q_A and Q_B). The previliged flow (Q_A) leaving at port A is kept constant and a residual flow (Q_B) leaving at port B. This residual flow can be calculated as it is the difference Q_C - Q_A i.e. whenever Q_C changes Q_B will change as well whereas Q_A remains constant (as long as $Q_C > Q_A$).

The flow division is achieved by way of a spring-loaded piston which, in its current control setting with ring grooves in the housing, displays a throttle cross section which closes towards A and opens towards B simultaneously. The control setting is determined by a metering orifice, whose flow resistance will move the piston against the spring force. The orifice bore determines the flow Q_A.

The valve is only working properly when there is a flow at both ports A and B. When there is no flow at one of the outlet ports, the valve will stop the flow to the other one as well. But there will be always a minimum leakage flow (depending on the pressure difference) via the the piston /bore gap. Either a pressure limiting valve or a valve with idle circulation mode (in case of directional valve control) has to be installed in the respective consumer line to maintain proper function of the privilege flow devider when one side (A or B) would show no flow otherwise.

2. Types available, main data

Coding example:

TV 3 - 2,5

Table 1: Basic type, and size

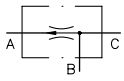
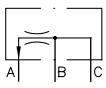
Design	Coding	Flow $Q_{C\ max}$ (lpm)	Press. p_{max} (bar)	Connections A | B, C	Mass (weight) approx. (kg)	Symbols
Pipe connection	**TV 3**	60	300	G 3/8 | G 1/2 ISO 228/1 (BSPP)	1.0	
Manifold mounting	**TV 3 P**	60	300	For dimensions, see sect. 4	1.0	

Table 2: Available metering orifices

Identific. (= ∅ mm)	**1,6**	**1,8**	**2,0**	**2,4**	**2,5**	**2,7**	**3,2**	**3,3**
Guide line Q_A (lpm)	2.7	3.2	4.1	5.4	5.8	6.9	8.8	10.2
	see also coding sect. 3							

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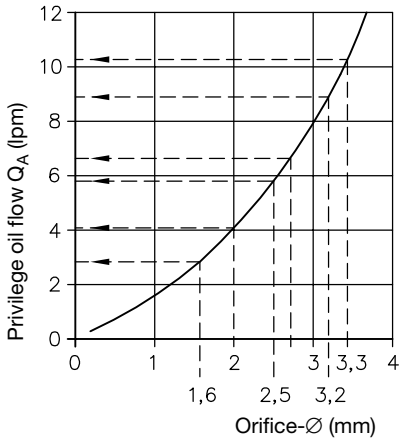
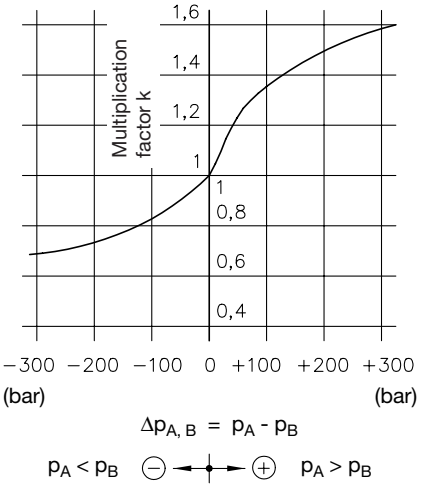
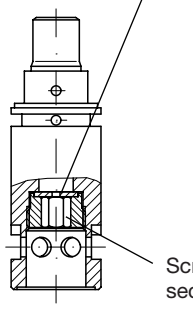
3. Additional data

Type	Piston valve	
Design	Full steel design, piston hardened and ground, running surfaces polished	
Hydraulic connection	Type TV 3:	ISO 228/1 (BSPP), suitable for threaded pipe fittings with shape B male fittings, DIN 3852-2
	Type TV 3 P:	Manifold mounting
Installation position	Any, Bleeding is necessary when installed in upright position (see below)	
Flow direction	from C to A and B	
Pressure medium	Hydraulic oil conforming DIN 51524 part 1 to 3: ISO VG 10 to 68 conform. DIN 51519 Viscosity range: Viscosity during start min. approx. 4; max. approx. 1500 mm^2/s opt. service: approx. 10 ... 500 mm^2/s Also suitable are biologically degradable pressure fluids type HEPG (Polyalkylenglykol) and type HEES (Synth. Ester) at service temperatures up to approx. +70 °C. Obey general insturctions in D 5488/1, sect. 2	
Temperature	Ambient: approx. -40 ... +80°C; Fluid: -25 ... +80°C; Take note of the viscosity ranges! Start temperature down to -40°C are allowable (Pay attention to the viscosity range during start!), as long as the operation temperature during subsequent running is at least 20K (Kelvin) higher. Biological degradable pressure fluids: Pay attention to manufacturer's information. With regard to the compatibility with sealing materials do not exceed +70°C.	

Q_A orifice characteristic for $p_A = p_B$

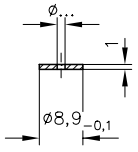






Orifices-∅	Order-Nr
1.6	7360 050 a
1.8	7360 050 e
2	7360 050 g
2.4	7360 050 h
2.5	7360 050 b
2.7	7360 050 d
3.2	7360 050 c
3.3	7360 050 f

Screw (part No. 7360 054) secured with LOCTITE 241

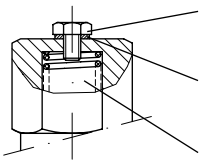


Material St 1203m
DIN 1541

The above Q_A characteristic (recommended value) applies to equal pressure at outlets A and B. If the pressures are different, the constant flow changes slightly depending on the current pressure difference $P_{A,B} = P_A - P_B$ corresponding to $Q_{A\ actual} = k \cdot Q_A$.

The privilege oil flow Q_A allocated to the orifice ∅ is only to be regarded as a recommended value.
The most frequently required Q_A ranges between approx. 2... 10 lpm can be recorded with the metering orifices available as standard. The only important thing is that the desired value has been determined when ordering and is quoted by the corresponding orifice identification number. Later replacement of orifices would only be possible by heating the removed control piston to approx. 180°C with the aid of a hot-air gun, because a threaded ring fixing the orifices is secured with Loctite and this bonding only becomes yielding over 150°C.

Bleeding



Bleeder
ISO 4017-M 4x6-8.8-A2K

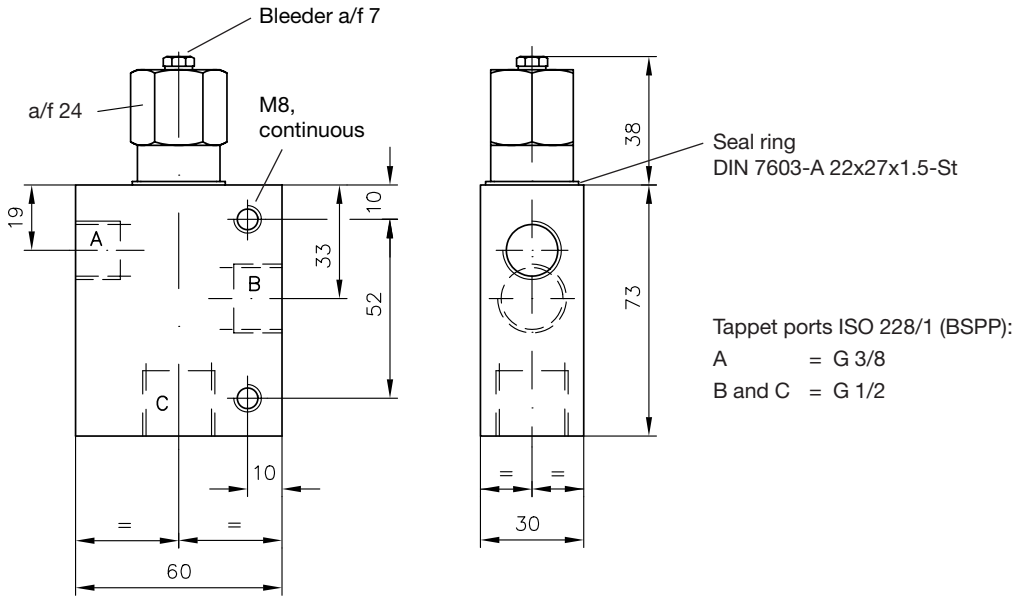
Seal ring A 4x8x1
DIN 7603-Cu

Spring cavity

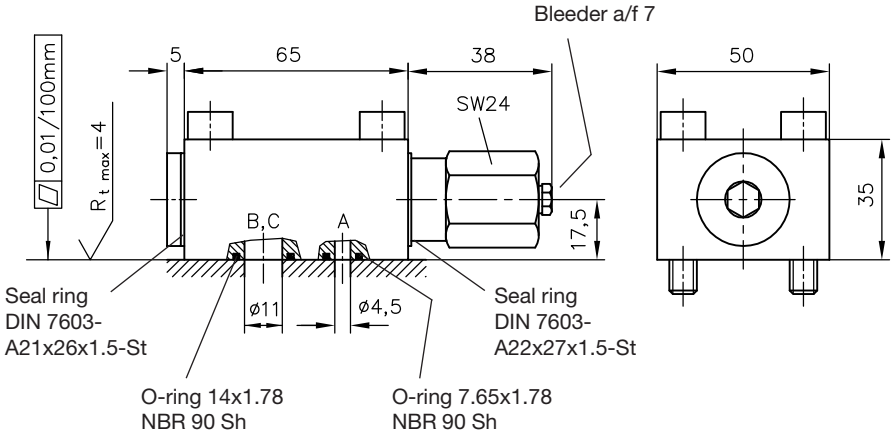
Usually any air which entered the spring cavity during initial operation or fluid service will be flushed out during subsequent operation. The spring cavity has to be bled via the bleeder screw, in case the device is installed in upright position (spring cavity in top position) or a whirring noise does occur. Procedure: Run the system in unloaded state (reduce the system pressure if possible). Loosen the bleeder (do not remove) until no more bubbles are detected. Retighten the bleeder and reset the pressure limiting valve (use a pressue gauge)!

4. Dimensions of units

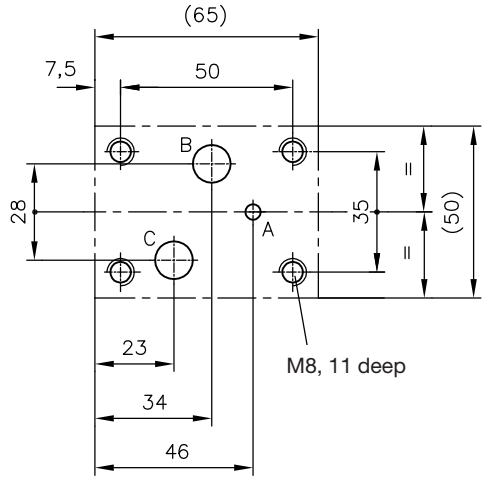
Type TV 3



Type TV 3 P



Hole pattern of the manifold (top view)



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