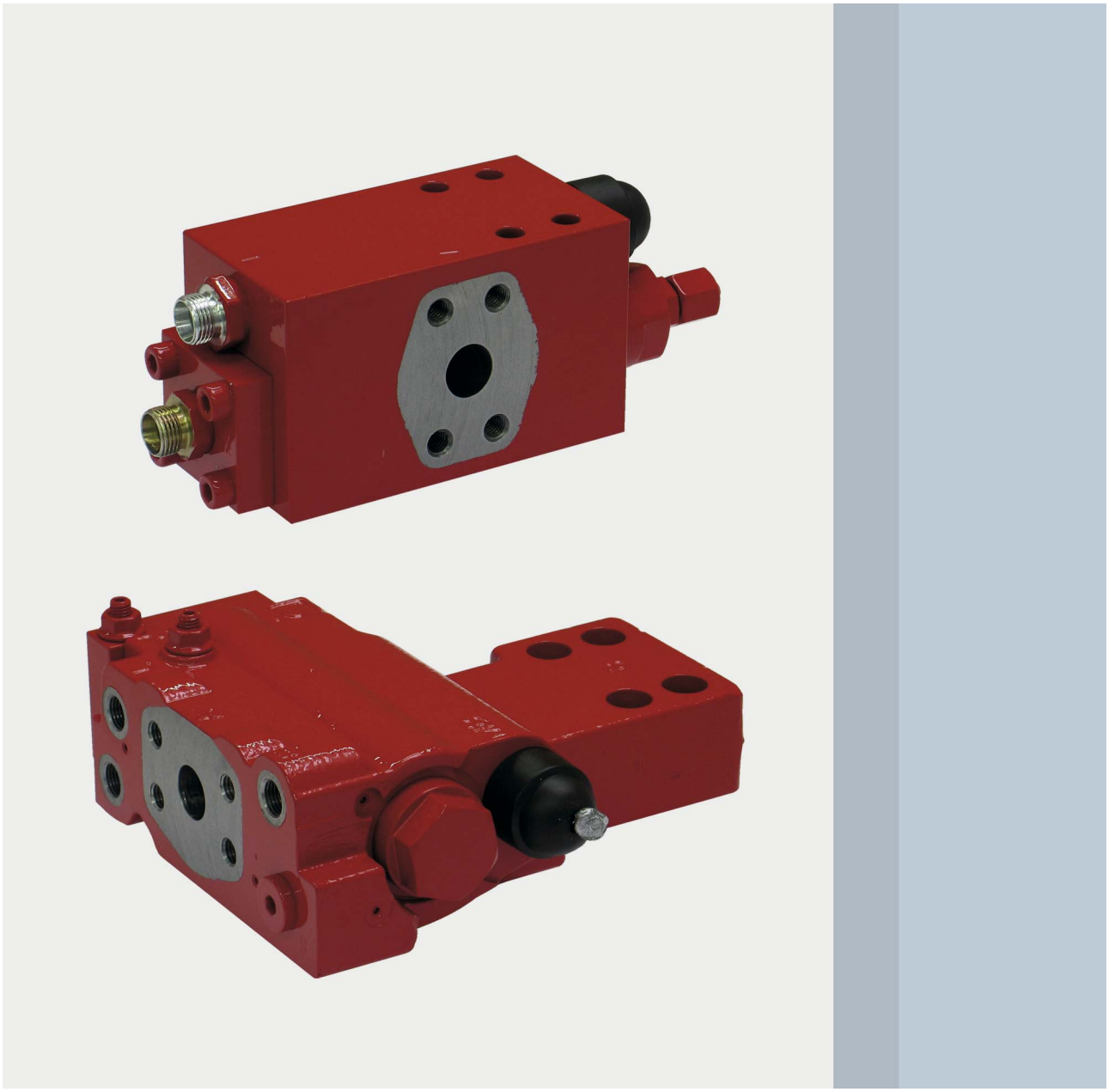
Leak-free Pipe-Rupture Valve for Excavators

Series ESV



motion and progress

Reference: 300-P-9050075-E-01/11.06

BUCHER HYDRAULICS

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1 General description

In accordance with standard EN 474-5 ”Safety of earth-moving machinery - Requirements for hydraulic excavators”, the excavator pipe-rupture valve, type ESV (**E**xcavator **S**afety **V**alve), prevents uncontrolled lowering of the actuator in the event of a pipe- or hose-rupture. In addition, it holds the actuator in its position without any leakage when the main valve is centred. The valve also includes a secondary pressure-relief function, which protects the actuator against overload.

2 Advantages

The inlet and actuator ports on the ESV excavator pipe-rupture valve are standard SAE flanged ports, and the valve can therefore be retrofitted to existing equipment without any difficulty.

Thanks to its pilot-operated opening principle and outstanding opening ratio, variations in load pressure - even right up to the maximum - have no effect on the fine-control characteristics and the hydraulic performance.

The ESV is set at the machine in a way that ensures that the excavator pipe-rupture valve has no effect on the hydraulic values that have already been set in the machine (pre-opening principle). This means that excavators with and without a lifting function can be equipped with the same basic hydraulic system; the machines' work cycles remain unchanged.

The secondary pressure-relief valve that is employed is a pressure-compensated design. Even when the main spool valve is a closed-centre model and a secondary valve is connected in series, no pressure summing occurs. The secondary pressure-relief valve in the excavator pipe-rupture valve opens at exactly the opening pressure that has been set. There is no need for a large-bore, external tank return line.

3 Application

The leak-free excavator pipe-rupture valve is used wherever so required by the standards EN 474, ISO 8643 and DIN 24093 for excavators with a lifting device (e.g. a load hook on the bucket). The actuators concerned are the lift cylinder, the stick cylinder and the adjusting cylinder.

It is also possible to envisage other machine applications in which a pipe-rupture on the actuators could produce dangerous situations e.g. machines for materials handling and demolition.

Attention: the excavator pipe-rupture valve may only be used for the purpose for which it has been designed!

4 Technical data

General characteristics	Description, value, unit
Design	proportionally-controlled seat valve, with initial hydraulic decompression patented follower principle
Mounting method	flange mounting, SAE 6000 psi
Mounting attitude	unrestricted
Flow direction	A → B free flow through check valve B → A controlled flow
Weight	standard design = 6.9 kg flat design = 8.6 kg
Opening ratio	1:113 (seat area of pilot spool, to pilot-piston area)

Hydraulic characteristics	Description, value, unit
Nominal sizes	16, 20 25 other sizes - consult Bucher Hydraulics
Nominal flow rate	size 16 = 250 l/min size 20 = 350 l/min size 25 = 500 l/min
Pilot pressure range	opening pressure min. 4 bar … max. 9 bar (can be chosen) full opening opening pressure + 14 bar + drain-oil back pressure
Operating pressure	max. 420 bar
Secondary PRV - adjustment range	min. 80 bar … 420 bar (max. up to 460 bar also possible); settings are sealed
Operating fluid	mineral oil to DIN 51524 and DIN 51525 (HL/ HLP) other fluids - consult Bucher Hydraulics
Temperature range, seal materials	Nitrile = -20 °C … +90 °C Viton = -20 °C … +200 °C Low (N7T40) = -50 °C … +80 °C
Viscosity range	min. 2.8 mm^2/s (cSt) ... max. 1500 mm^2/s (cSt) recommended 10 mm^2/s (cSt) … 380 mm^2/s (cSt)
Filtration	NAS 1638 class 9, ß10 ≥ 75 ISO 4406 class 18/15 (valves do not have any internal filters)

Ports	Description, value, unit
SAE	to SAE J518 DEC87
Threads	to DIN 3852, Parts 1 and 2
Fittings	to ISO 8434-1

5 Installation/startup

5.1 Installation information

Attention: only trained and competent personnel may carry out any work on the excavator pipe-rupture valve!

The valve must not be opened without the manufacturer's express permission!

Mounting bolts can be supplied as an optional extra and are grade 12.9 to DIN 912, with "Geomet" surface treatment.

Before initial start-up, bleed all air from the hydraulic system. Do not use any pipe fittings that have tapered threads.

Attention: before removing or disassembling the valve, vent all hydraulic pressure from the system - double check!

5.2 Adjustment information

Pressure-relief valves

Pressure-relief valves are factory-set to the pressure stipulated by the customer and then sealed. The pressure is set with flow Q = 0.75 l/min

- Clockwise → increases the pressure
- Counterclockwise → decreases the pressure

Attention: the adjusting screw can be completely unscrewed - it has no end-stop!

Important: if the adjustment seal is broken, the warranty is null and void!

Change in pressure per turn

Basic setting	Sizes 16/20	Size 25
>220 bar	80 bar	100 bar
⩽220 bar	40 bar	50 bar

6 Description of function

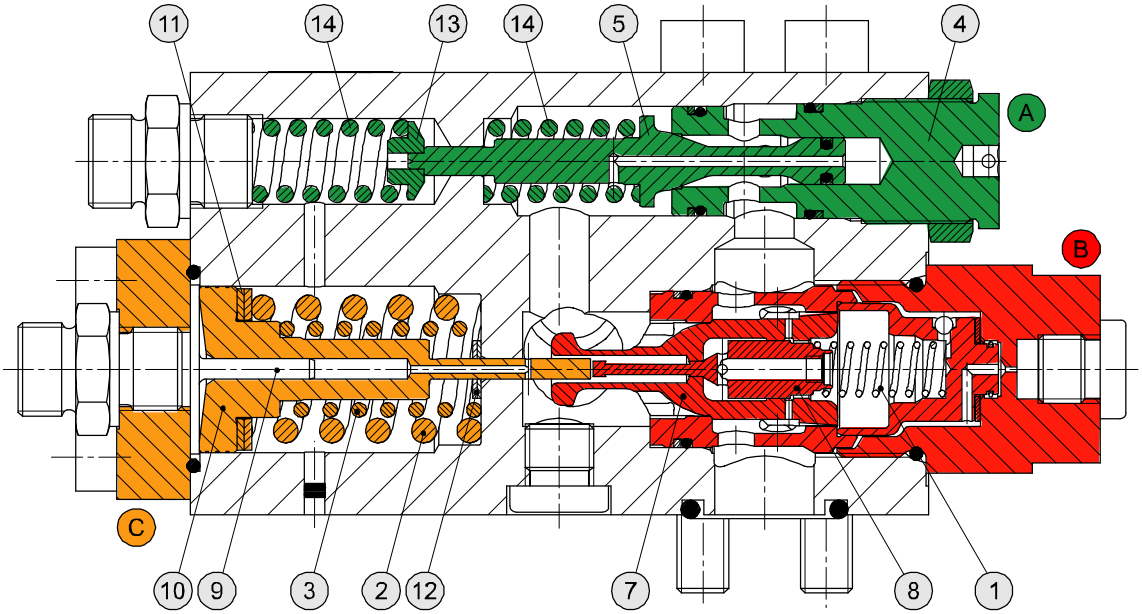


Fig. 1 Sectional view

1	CV spring	**10**	Pilot piston with compensating drilling
2	Control spring	**11**	Precision washer
3	Control spring	**12**	Stroke-limiting washer
4	Adjusting screw for secondary PRV	**13**	Spring plate
5	Poppet	**14**	Spring for secondary valve
7	Control spool	**A**	The secondary valve unit
8	Pilot spool	**B**	The load-control assembly
9	Compensating pin	**C**	The pilot control unit

Neutral position (load press. at B; A + X unpressurised)

In the neutral position, the excavator pipe-rupture valve has zero leakage. The valve is held closed by the spring (1), which acts on the pilot spool (8) and thus on the control spool (7), and also by the load pressure, which acts on the rear side of the pilot spool and the control spool.

The check-valve function (flow A → B)

To raise the actuator, pump pressure is applied via port A to the valve-seat area of the control spool (7) and causes the control spool together with the pilot spool (8) to open, pushing against the light spring (1). When this check valve operates, the control spool moves in the opening direction but the pilot spool, due to its small effective area, does not open.

The control function (flow B → A)

1. Decompression

The pilot pressure at port X moves the pilot piston (10) in opposition to the springs (2) and (3) and opens the pilot spool (8). The load pressure behind the control spool now decays as it escapes past the pilot spool to port A. The progressive characteristic of the decompression phase ensures that the actuator motion begins smoothly and without jerks.

2. Main opening

With further increase in the pilot pressure at X, the pilot spool opens further and the reduced pressure behind the control spool falls still more. The load pressure acting on the differential area of the control spool now pushes the spool off its valve seat in the opening direction until the pressures of the oilflows into, and out of, the control spool have changed enough to produce a situation of force balance. The pilot pressure acting on the pilot piston therefore controls the open metering area of the control spool, and consequently the flow rate from B → A. As the control spool opens, the compensating pin (9) dictates that the opening action is completely independent of any back-pressure in port A.

The opening point of each pipe-rupture valve is precisely matched to the particular make/model of excavator and is set to the required value on the test stand with precision washers (11). Using stroke-limiting washers (12), the pilot piston stroke can also be restricted. This in turn influences the lowering speed.

During the lowering motion, and while the pilot pressure is kept constant, the constantly changing geometry can result in a steadily increasing load pressure. In this situation, from approx. 100 bar load pressure the valve begins to function like a compensated 2-way flow controller.

Function of the secondary pressure-relief valve

The secondary pressure-relief valve is connected directly to actuator port B. When the pressure setting is reached, the poppet (5) lifts and opens a connection to the return-line port A. This path is sized for the full nominal flow rate. The poppet is pressure balanced, so that forces resulting from back-pressure in the return line cancel each other out. This means that the opening point of the pressure-control valve is independent of the back-pressure in the port A i.e. with a closed-centre directional valve, no pressure summing occurs with the necessary downstream pressure-relief valve. The secondary pressure can be set at any desired level with the adjusting screw (4). For basic settings ⩽220 bar, the second compression spring (13) and the spring plate (14) are not fitted. This results in improved resolution at lower pressure settings.

As an option, the valves can be provided with a separate external tank port.

Leakage-oil drain

The spring chambers of the pilot piston and the secondary pressure-relief valve are drained to port L. This port should be drained to tank with the least possible back-pressure.

Any tank back-pressure at port L has a 1:1 effect on the opening values of both main functions.

Emergency-lowering feature

The standard ESV design does not have an emergency-lowering feature.

Emergency lowering B → L

In the flat ESV design, a mechanical emergency-lowering screw is incorporated. The actuator is vented to port L through a ø4 connecting drilling that is normally shut off.

When emergency lowering has been completed, the screw must be screwed in again to restore the valve's function!

Air-bleeding (optional)

The pilot piston includes a ø0.35 drilling for the permanent, automatic bleeding of any air in the pilot circuit to drain port L. There is a permanent flow of oil from X to L.

Air-bleeding X → L (optional)

An air-bleed screw is also available for the flat valve design. The pilot line is vented to port L through a connecting drilling that is normally shut off. When emergency lowering has been completed, the screw must be screwed in again to restore the valve's function!

Accumulator port (optional)

As an option, the flat valve design can be provided with an additional accumulator port. The port also has an M5 thread for an orifice to provide the port with a minimum level of protection.

7 Port designations

Port	Description
B	Actuator/load port
A, A1	Flow or return ports (the flat design has only one A port)
X	Pilot port
L	Drain port
E	Port for balance pipe in parallel-cylinder applications; protected by a ø1 fixed orifice
MB	Gauge port for the actuator/load pressure • MB is not available on standard models in parallel applications; it is used as the E port • Is separately drilled in the flat design
T (consult Bucher)	Port for a possible external secondary PRV tank return line
S (consult Bucher)	Special port for the actuator/load pressure (available as an option, and only for the flat design) • Port for overload warning device • Port for accumulator • Optionally, can be fitted with an orifice

8 Circuit example

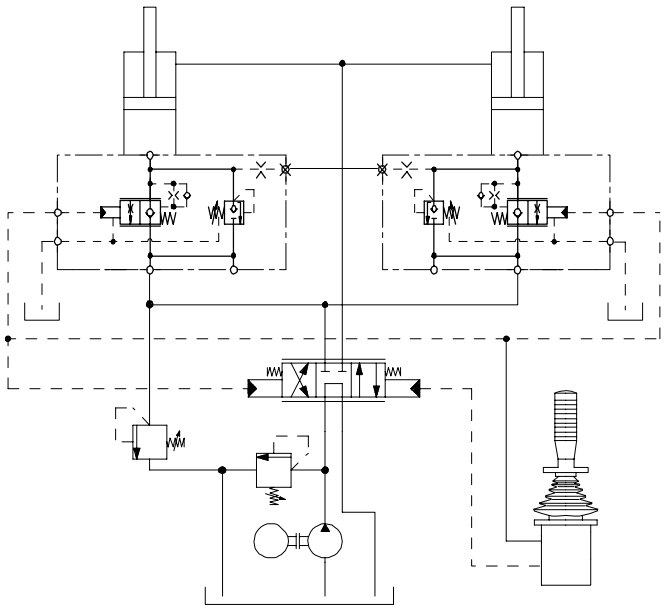


Fig. 2 Circuit example

9 Standard design, sizes 16/20

9.1 Dimensions

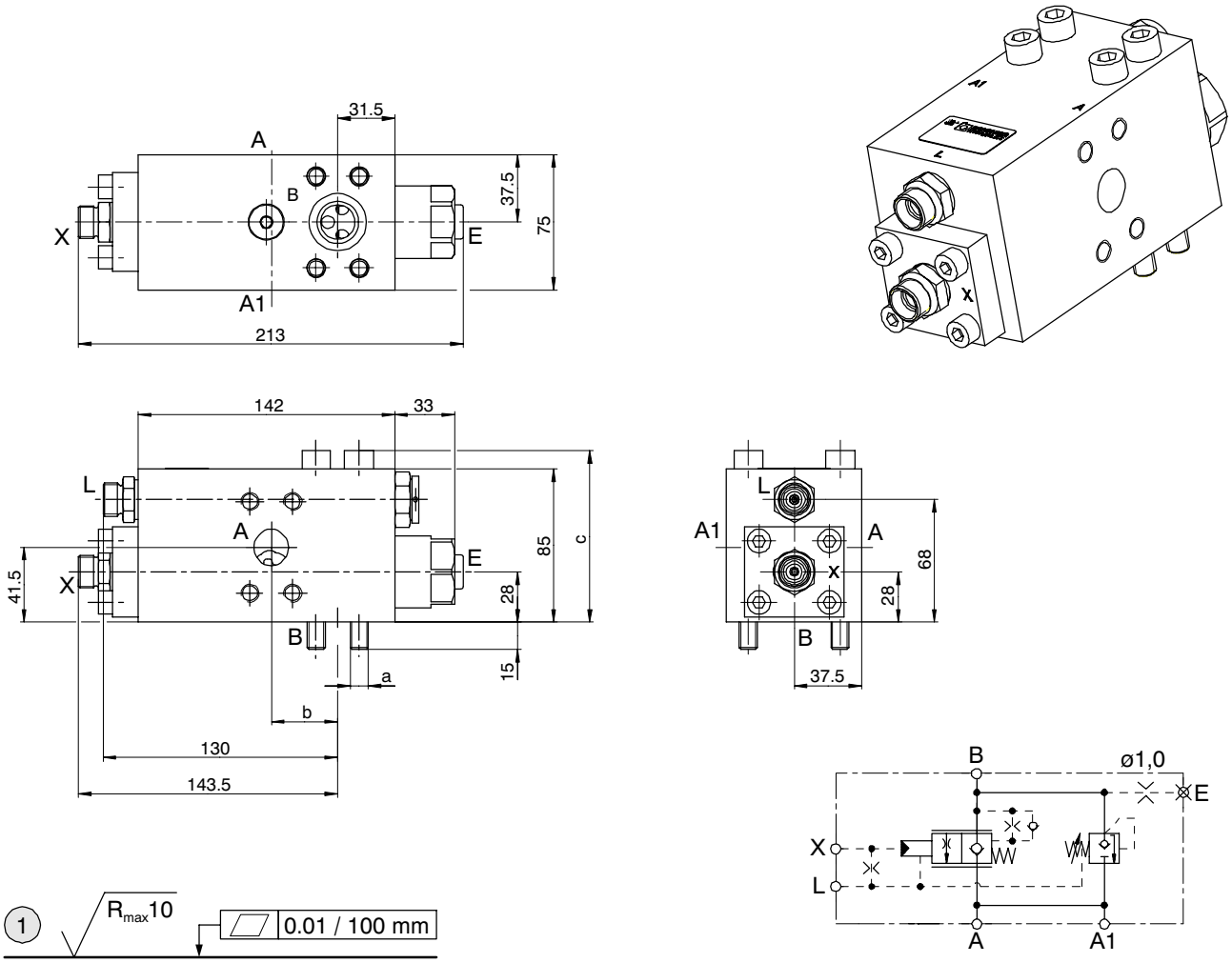


Fig. 3 Dimensions of ESV 16-B-S / ESV 20-B-S 300-4-10012916

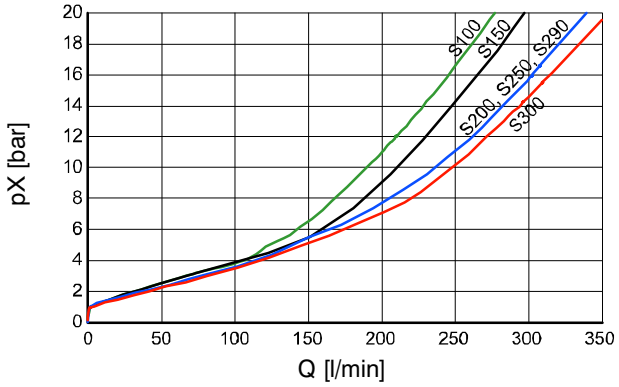
1	Required quality of the mating surface

Design	Ports					O-ring Port B
	A, A1	B	E (MB)	L	X	
ESV 16-B-S	SAE 3/4” 6000 psi	SAE 3/4” 6000 psi	G 1/4” (GE 8 PSR)	EO GE 12 PLM-ED (M18x1.5)	EO GE 12 PLM-ED (M16x1.5)	3.53 x 24.99
ESV 20-B-S	SAE 1” 6000 psi	SAE 1” 6000 psi	G 1/4” (GE 8 PSR)	EO GE 12 PLM-ED (M18x1.5)	EO GE 12 PLM-ED (M16x1.5)	5.53 x 32.92

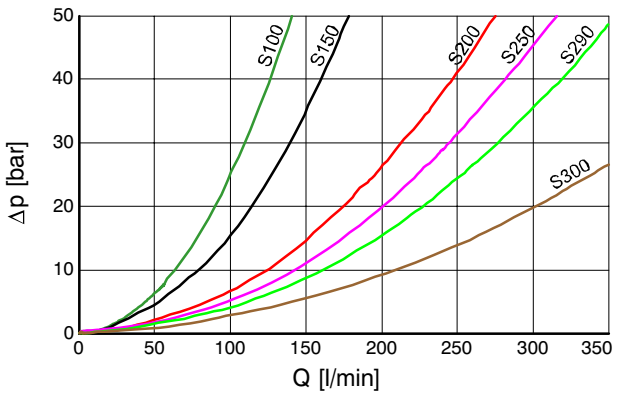
Design	Dimensions [mm]		
	a	b	c
ESV 16-B	M10	36.8	95
ESV 20-B	M12	43	97

9.2 Performance graphs

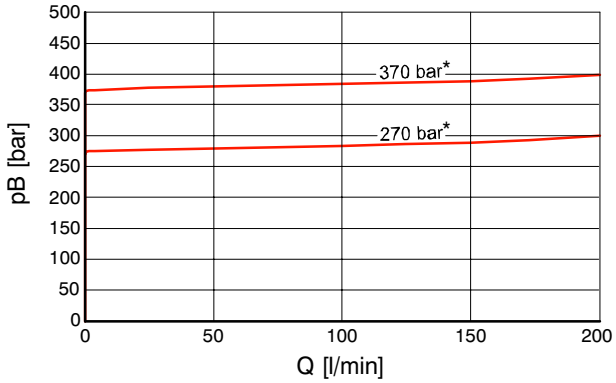
Δp A to B = ƒ (Q)



Δp B to A = ƒ (Q)

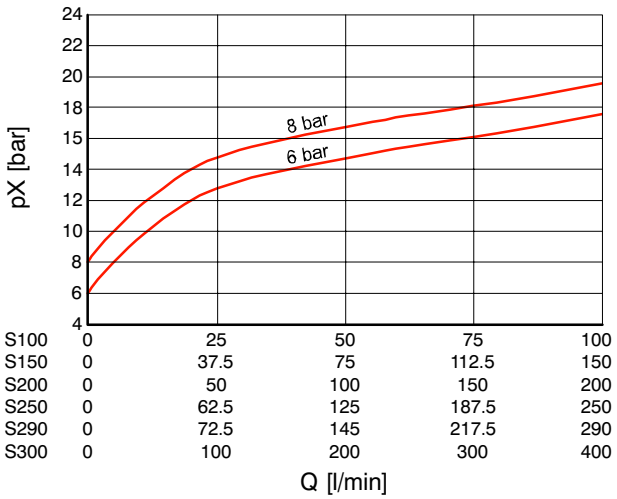


Pressure-relief valve, secondary PRV, Q = ƒ (Load)
(Example curve)



* pressure setting

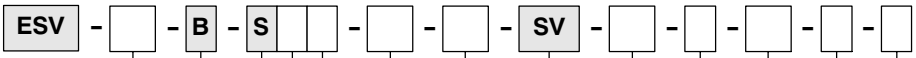
Opening pilot press. X from B to A, Q = ƒ (pX) at 33 bar load



S100	0	25	50	75	100
S150	0	37.5	75	112.5	150
S200	0	50	100	150	200
S250	0	62.5	125	187.5	250
S290	0	72.5	145	217.5	290
S300	0	100	200	300	400

Q [l/min]

9.3 Model code



Nominal size

size 16	= 16
size 20	= 20

Version

B	= B

Design

standard design	= S

Seal material

	Temperature range	
Nitrile (standard)	-20°C to +90 °C	= N
Nitrile (low temperature)	-50°C to +80 °C	= T
Viton	-20°C to +200 °C	= V

Mounting bolts

without mounting bolts	= O
with surface-treated mounting bolts	= D

Control spool

Q at approx.. 33 bar Δp B →A	Size 16	Size 20
100 l/min.	= S100	= S100
150 l/min.	= S150	= S150
200 l/min.	= S200	= S200
250 l/min.	= S250	= S250
290 l/min.		= S290
300 l/min.		= S300

Start of opening

Opening pressure ... bar	= ... [bar]

Secondary pressure relief

Pressure relief from B	=

Pressure setting

Pressure setting ... bar at approx. 0.75 l/min.	= ... [bar]

Ports X, L, E

(standard) with fittings in X and L (E=VSTI)	= V
with fittings in X, L and E	= R

Inlet port

port A	= A
portA1	= A1
port2A	= 2A

Optional stroke-limiting

e.g. 1.2 mm of stroke-limiting (shims)	= H12

Option (consult Bucher Hydraulics)

external tank port, G$^3/_4$ *	= T

* only possible with type A inlet port

10 Standard design, size 25

10.1 Dimensions

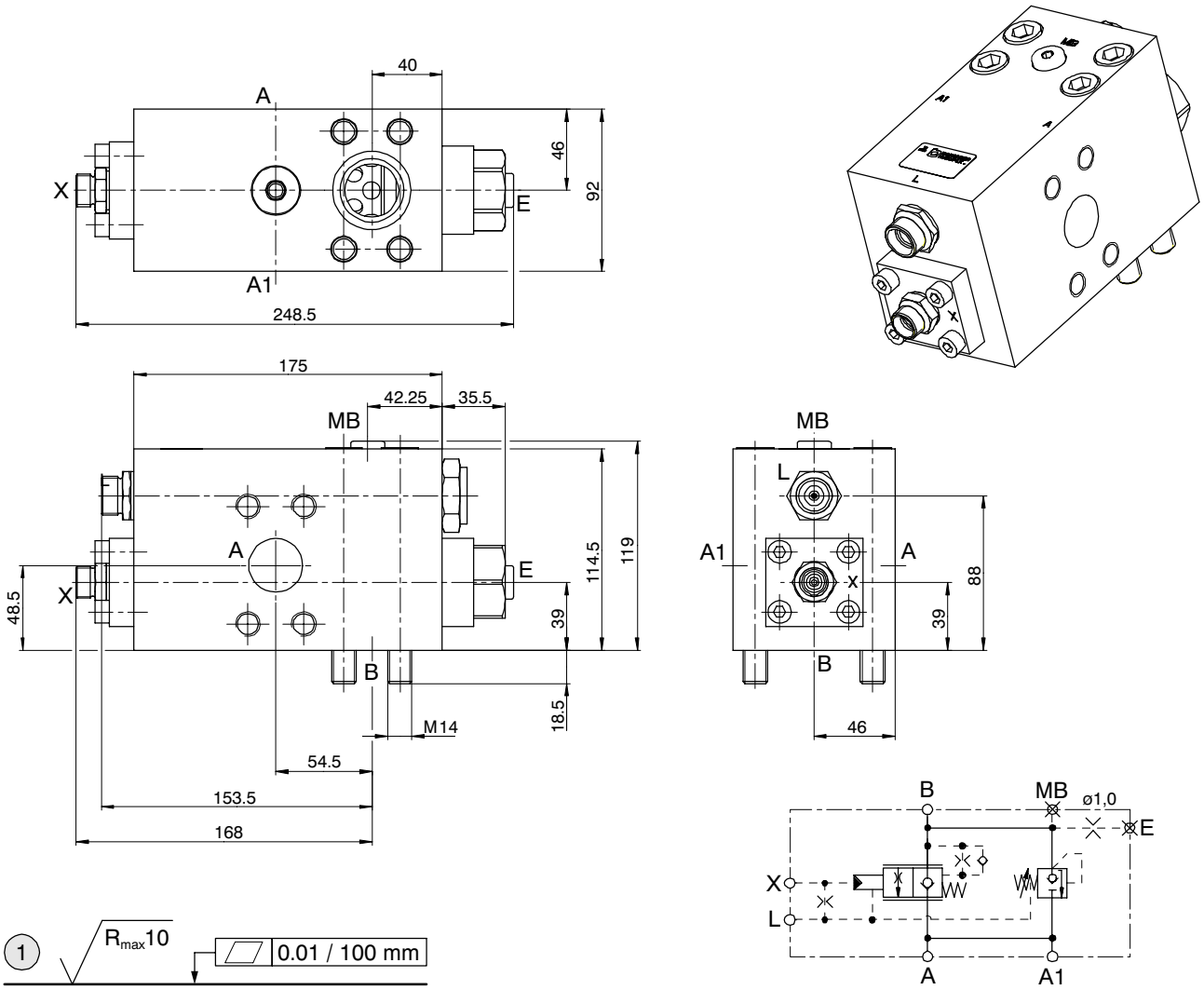


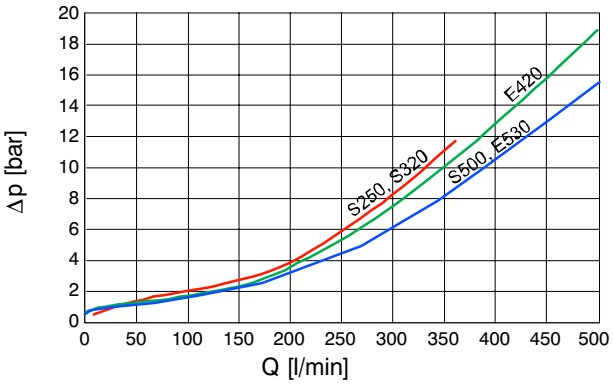
Fig. 4 300-4-10012913

1	Required quality of the mating surface

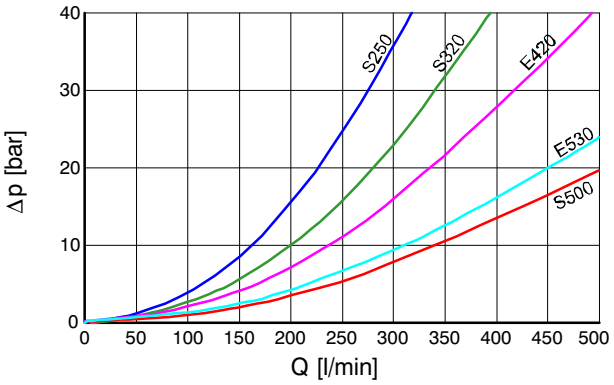
Design	Ports					O-ring Port B
	A, A1	B	E/MB	L	X	
ESV 25-B	SAE 1 1/4” 6000 psi	SAE 1 1/4” 6000 psi	G 1/4” (GE 8 PSR)	GE 15 PLM-ED (M22x1.5)	GE 12 PLM-ED (M16x1.5)	3.53 x 37.69

10.2 Performance graphs

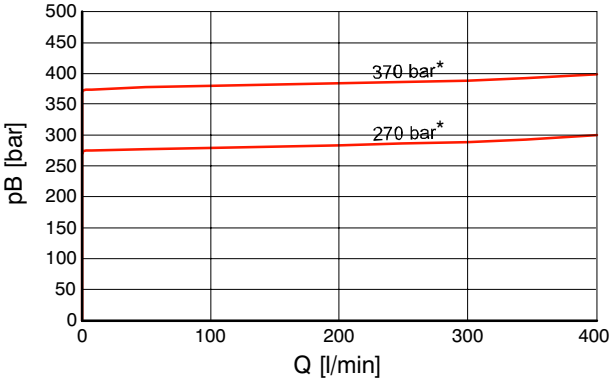
Δp A to B = ƒ (Q)



Δp B to A = ƒ (Q)



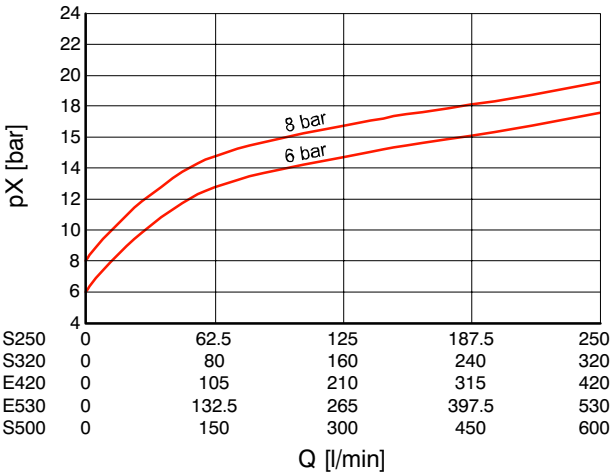
Pressure-relief valve, secondary PRV, Q = ƒ (Load)
(Example curve)



* pressure setting

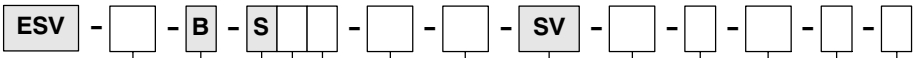
Example curve = setting

Opening pilot press. X from B to A, Q = ƒ (pX) at 33 bar load



S250	0	62.5	125	187.5	250
S320	0	80	160	240	320
E420	0	105	210	315	420
E530	0	132.5	265	397.5	530
S500	0	150	300	450	600

10.3 Model code



Nominal size

size 25	= 25

Version

B	= B

Design

standard design	= S

Seal material

	Temperature range	
Nitrile (standard)	-20°C to +90 °C	= N
Nitrile (low temperature)	-50°C to +80 °C	= T
Viton	-20°C to +200 °C	= V

Mounting bolts

without mounting bolts	= O
with surface-treated mounting bolts	= D

Control spool

Q at approx. 33 bar Δp B →A	Size 25
250 l/min.	= S250
320 l/min.	= S320
400 l/min.	= S400
420 l/min.	= (E420)
500 l/min.	= S500
530 l/min.	= (E530)

Start of opening

Opening pressure ... bar	= ... [bar]

Secondary pressure relief

Pressure relief from B	=

Pressure setting

Pressure setting ... bar at approx. 0.75 l/min.	= ... [bar]

Ports X, L, E

(standard) with fittings in X and L (E=VSTI)	= V
with fittings in X, L and E	= R

Optional stroke-limiting

e.g. 1.2 mm of stroke-limiting (shims)	= H12

Inlet port

port A	= A
portA1	= A1
port2A	= 2A

Option (consult Bucher Hydraulics)

external tank port, G 3/4	= T

11 Flat design, sizes 16/20

11.1 Dimensions

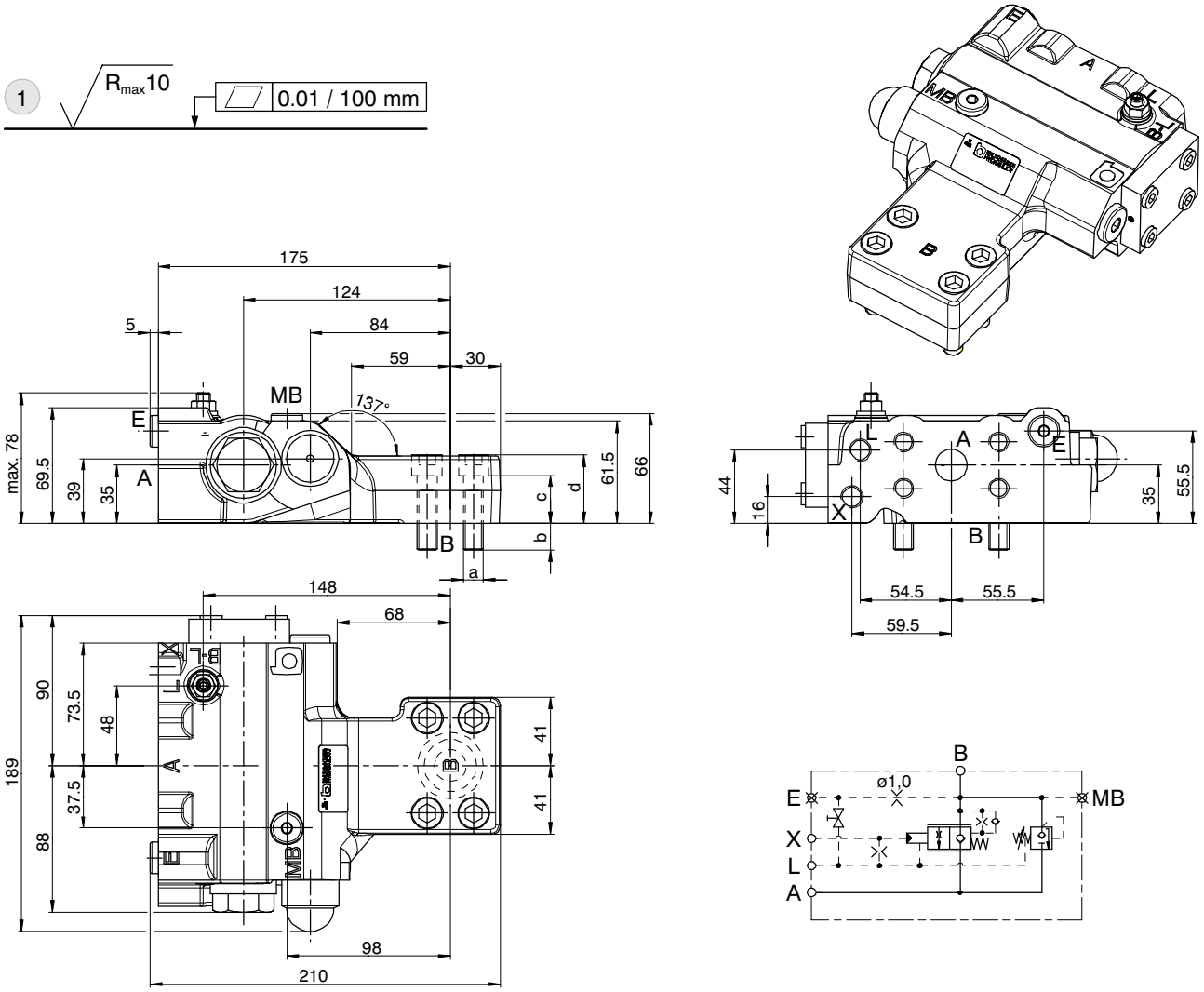


Fig. 5 Dimensions of ESV 16-B-F/ESV 20-B-F 300-4-10012911

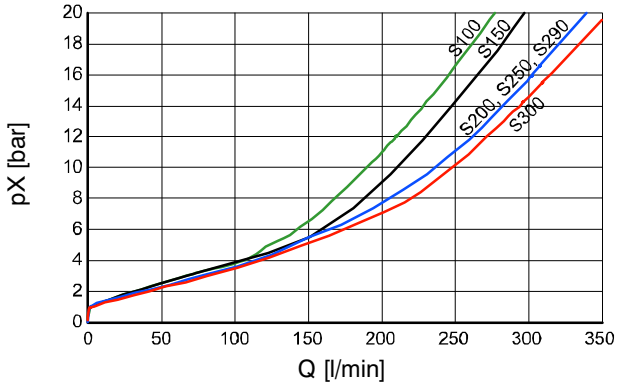
1	Required quality of the mating surface

Design	Ports					O-ring Port B
	A	B	E	L	X	
ESV 16-B	SAE 3/4” 6000 psi	SAE 3/4” 6000 psi	G 1/4”	G 1/4”	G 1/4”	3.53 x 24.99
ESV 20-B	SAE 1” 6000 psi	SAE 1” 6000 psi	G 1/4”	G 1/4”	G 1/4”	5.53 x 32.92

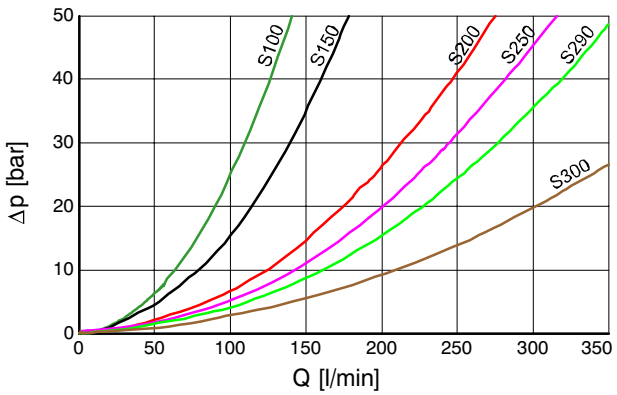
Design	Dimensions [mm]			
	a	b	c	d
ESV 16-B	M10	15.5	29.5	40.5
ESV 20-B	M12	16	29	41

11.2 Performance graphs

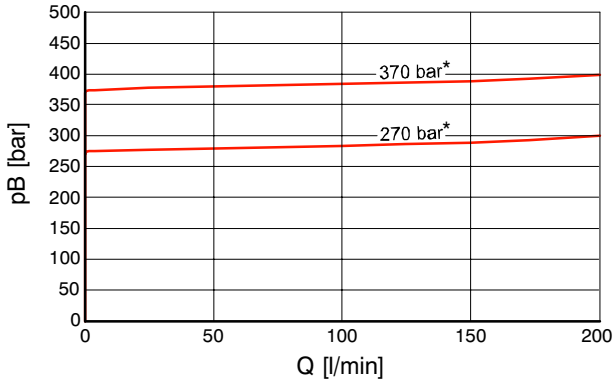
Δp A to B = ƒ (Q)



Δp B to A = ƒ (Q)

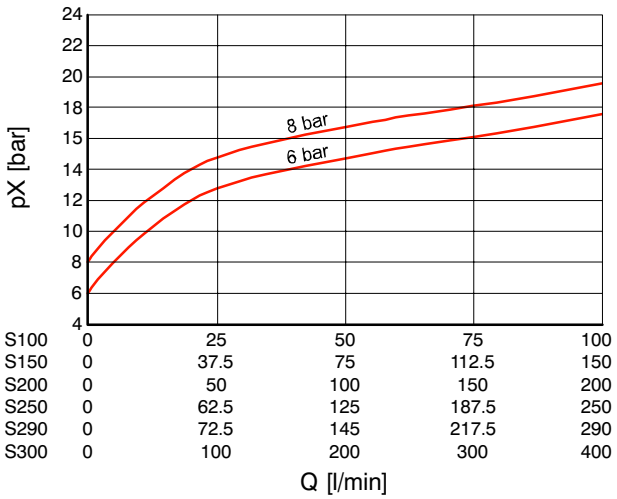


Pressure-relief valve, secondary PRV, Q = ƒ (Load)
(Example curve)



* pressure setting

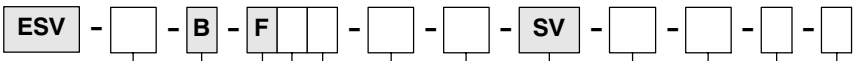
Opening pilot press. X from B to A, Q = ƒ (pX) at 33 bar load



S100	0	25	50	75	100
S150	0	37.5	75	112.5	150
S200	0	50	100	150	200
S250	0	62.5	125	187.5	250
S290	0	72.5	145	217.5	290
S300	0	100	200	300	400

Q [l/min]

11.3 Model code



Nominal size

size 16	= 16
size 20	= 20

Version

B	= B

Design

flat design	= F

Seal material

	Temperature range	
Nitrile (standard)	-20°C to +90 °C	= N
Nitrile (low temperature)	-50°C to +80 °C	= T
Viton	-20°C to +200 °C	= V

Mounting bolts

without mounting bolts	= O
with surface-treated mounting bolts	= D

Control spool

Q at approx. 33 bar Δp B → A	Size 16	Size 20
100 l/min.	= S100	= S100
150 l/min.	= S150	= S150
200 l/min.	= S200	= S200
240 l/min.	= S240	= S240
250 l/min.	= S250	= S250
290 l/min.		= S290
300 l/min.		= S300

Start of opening

Opening pressure ... bar	= ... [bar]

Secondary pressure relief

Pressure relief from B	=

Pressure setting

Pressure setting ... bar at approx. 0.75 l/min.	= ... [bar]

Optional stroke-limiting

e.g. 1.2 mm of stroke-limiting (shims)	= H12

Optional ports

accumulator port G1/4	= S
tank port G3/4	= T

Option

mechanical air-bleeding	= E

info.nh@bucherhydraulics.com **www.bucherhydraulics.com**