

3-Way Proportional Pressure Control Valves

Nominal sizes 2, 4, 8, 12, 20, 30, 40

With integrated electronic pressure control

Poppet valve

Flanged design, sizes 30 and 40 with internal thread

Pressure setting p_v : 0 to 2, 10 or 16 bar

0 to 40 bar (sizes 30 and 40)

Catalog Register

P16

Publication 7502952.06.11.97



Description

General

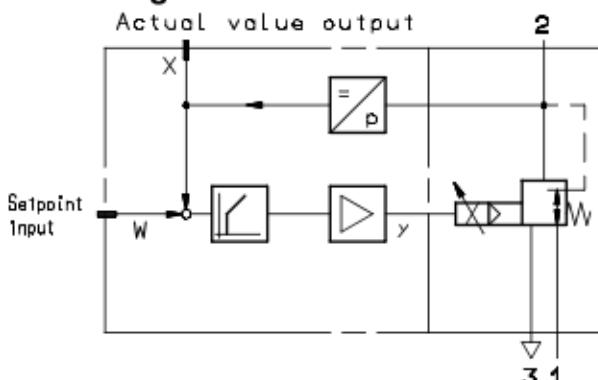
The proportional pressure control valve allows infinite adjustment of a pneumatic pressure. The integrated electronic circuitry with pressure sensor regulates the output pressure.

Function

Setting the pneumatic output pressure is achieved by supply of a specified level signal (command variable w). The electronic circuitry processes this signal and controls the force of the proportional solenoid at the valve by means of an electric current (final control variable y). This force effects the adjustment of the pneumatic output pressure. The output pressure is measured by an integrated pressure sensor (actual value x) and regulated by the internal electronic circuitry. The result is a proportional relationship between the specified level signal and the pneumatic output pressure.

On reduction of the specified level or system-dependent increase of the output pressure, the unit releases pressure from port 2 to 3 in order to bring the pressure down to the set level.

Block diagram



Features

- Valve and electronic control circuitry in a single unit
- Minimal hysteresis
- Good linearity
- Good response sensitivity
- Short actuating time
- Adjustable controller amplification
- Installation position to suit
- High flow capacity even at cross-sectional area of vent duct

Applications

- Remote pressure adjustment
- Program controlled pressure adjustment
- Open and closed loop control of rotational speed, position, flow volume and force by means of pressure
- Control of pneumatically actuated positioning and proportioning valves
- Mass retarding

Versions with integrated electronic pressure control

- For various setpoint inputs:
Analog 0 ... 10 V, 0 ... 20 mA, 4 ... 20 mA
Digital 8 bits with memory function (latch)
- With field-bus interface for Interbus-S 2-wire remote bus
- With threshold switch (comparator) for detection of actual value = setpoint
- With electrical isolation between setpoint input and power supply
- With pressure range adjustment

Further version

- Units without integrated closed-loop controller for use in open-loop control systems or in closed-loop control systems in combination with a closed-loop controller and an external actual-value generator.

Equipment list (standard units)

Cat. No. ¹⁾	Pressure setting p _v [bar]	For description, see Page ...							
		Page 5 Setpoint input w	Page 5 Actual-value output x	Page 7 Pressure range adjustment	Page 8 Threshold value switch	Page 10 Electrically-isolated setpoint	Page 11 Serial interface	Plug connector	Connection diagram No. Page
4091 x 00	0 ... 2	0 ... 10 V	0 ... 10 V	—	—	—	—	6-pin + PE	1 6
4091 x 01		0 ... 20 mA	0 ... 10 V	—	—	—	—	6-pin + PE	1 6
4091 x 02		4 ... 20 mA	0 ... 10 V	—	—	—	—	6-pin + PE	1 6
4091 x 03		Parallel 8 bits	0 ... 10 V	●	—	—	—	15-pin	2 6
4091 x 09		Serial 8 bits	²⁾	●	²⁾	²⁾	●	6-pin + PE	5 —
4091 x 10	0 ... 10	0 ... 10 V	0 ... 10 V	—	—	—	—	6-pin + PE	1 6
4091 x 11		0 ... 20 mA	0 ... 10 V	—	—	—	—	6-pin + PE	1 6
4091 x 12		4 ... 20 mA	0 ... 10 V	—	—	—	—	6-pin + PE	1 6
4091 x 13		Digital 8 bits	0 ... 10 V	●	—	—	—	15-pin	2 6
4091 x 16		0 ... 10 V	0 ... 10 V	●	—	—	—	6-pin + PE	3 9
4091 x 18		Parallel 8 bits	0 ... 10 V	●	—	—	—	15-pin	4 9
4091 x 19		Serial 8 bits	²⁾	●	²⁾	²⁾	●	6-pin + PE	5 —
4091 x 26	0 ... 16	0 ... 10 V	0 ... 10 V	—	—	—	—	6-pin + PE	1 6
4091 x 27		0 ... 20 mA	0 ... 10 V	—	—	—	—	6-pin + PE	1 6
4091 x 28		4 ... 20 mA	0 ... 10 V	—	—	—	—	6-pin + PE	1 6
4091 x 29		Parallel 8 bits	0 ... 10 V	●	—	—	—	15-pin	2 6
4091 x 39		Serial 8 bits	²⁾	●	²⁾	²⁾	●	6-pin + PE	5 —

¹⁾ The "x" should be replaced by:

- 0 for nominal size 2
- 1 for nominal size 4
- 3 for nominal size 8
- 4 for nominal size 12 / 20
- 5 for nominal size 30
- 6 for nominal size 40

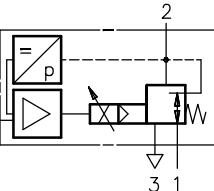
²⁾ For description, see Page 11
(serial interface Interbus-S)

Subplates and plug connectors should be ordered separately. For order numbers, see Accessories on Page 19

Dimensional drawings: Sizes 2, 4, 8, 12/20 (see Page 13)
Sizes 30 and 40 (see Page 14)

Characteristic data

General data

Description	3-way proportional pressure control valve with integrated electronic pressure control
Circuit symbol	
Design	Poppet valve
Connection	Flange, subplate Sizes 30 and 40 with internal thread
Mounting position	Any, preferably vertical
Flow direction	Defined
Actuator	Proportional solenoid
Ambient temperature [°C]	-10 ... +60
Nominal size [DN]	2, 4, 8, 12, 20, 30, 40
Material: Body: Seals	Al-alloy NBR
Degree of protection	IP 54

Pneumatic data

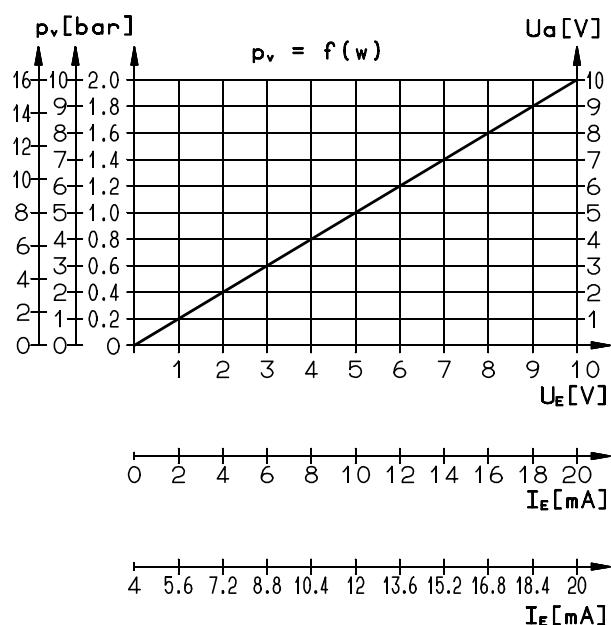
Fluid	Filtered compressed air, lubricated or unlubricated
Filter [µm]	50
Fluid temperature [°C]	-10 ... +40
Operating pressure range p_e [bar] for units with p_v	
0 ... 2 bar	max. 7
0 ... 10 bar	max. 12
0 ... 16 bar	max. 16.5
Pressure setting range p_v ²⁾ [bar]	0 ... 2 0 ... 10 0 ... 16 (except sizes 30 and 40)
Hysteresis [% p_v max.]	< 0.5
Repeatability [% p_v max.]	< 0.5
Linearity ¹⁾ [% p_v max.]	< 1
Response sensitivity [% p_v max.]	≤ 0.2

¹⁾ Values referred to 20°C

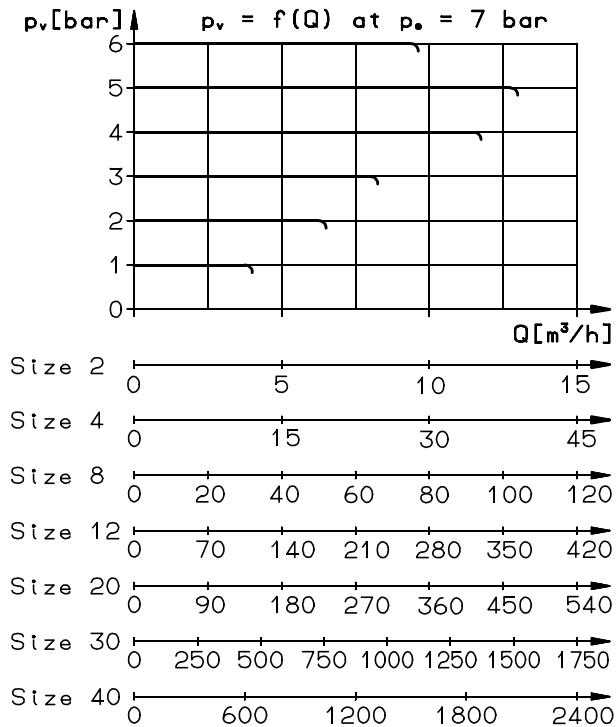
²⁾ Minimum value 1% of final value

Characteristic curves

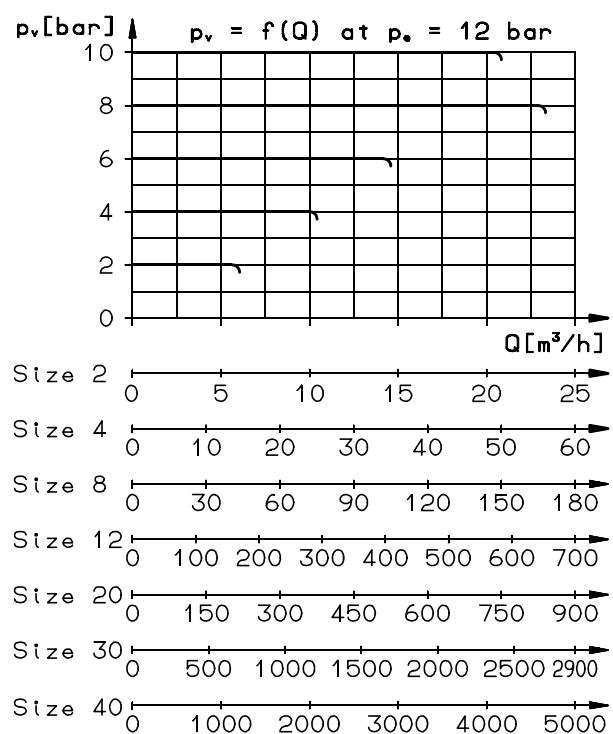
Static characteristic curve



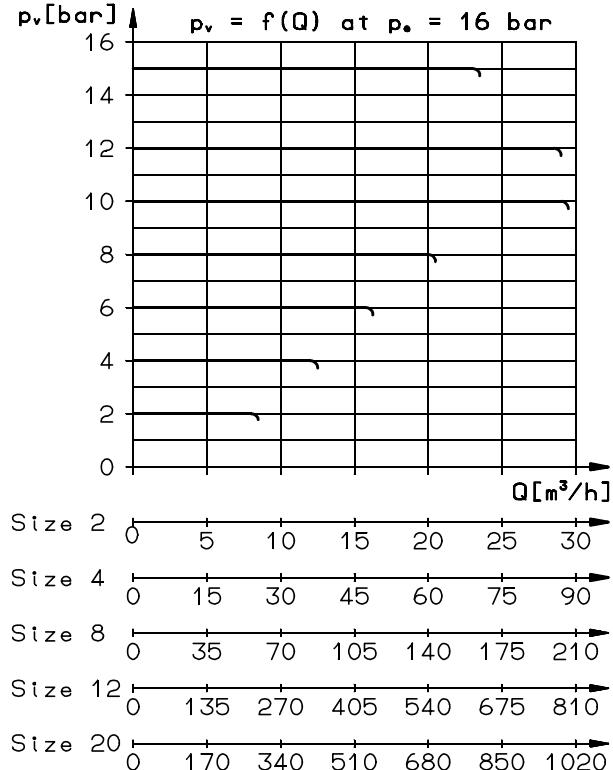
Flow characteristic with 12 bar operating pressure



Flow characteristic with 12 bar operating pressure



Flow characteristic with 16 bar operating pressure



Characteristic data

Electrical data

Power supply

Supply voltage	U_B [V]	18 ... 32 VDC incl. residual ripple
Residual ripple max.	[%]	10
Maximum current consumption for units with	I_B [A]	
p_v 0 ... 2 bar		1.2
0 ... 10 bar		1.2
0 ... 16 bar		1.5

Inputs

Analog setpoints

Voltage signal	U_E [V]	0 ... 10
Input resistance	R_I [$k\Omega$]	> 300
Current signal	I_E [mA]	(0) 4 ... 20
Load impedance	[Ω]	≤ 135

Digital setpoints

Data inputs (parallel)	[bits]	8 bits + memory function
Level for logic	"L" ² [V]	0 ... 2
Level for logic	"H" [V]	12 ... 32
Input current	[mA]	1

²⁾ Input open-circuit = Logic "L"

Outputs

Actual value

Voltage signal for pneumatic outlet pressure	U_A [V]	0 ... 10 = 0 ... p_v max.
Output current max.	I_A [mA]	2
Voltage output for supply of an external setpoint adjuster (only with version with voltage setpoint)	U [V]	15 ± 0.5

Output current max.

Output current max.

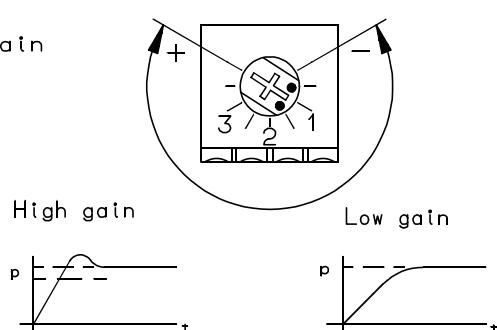
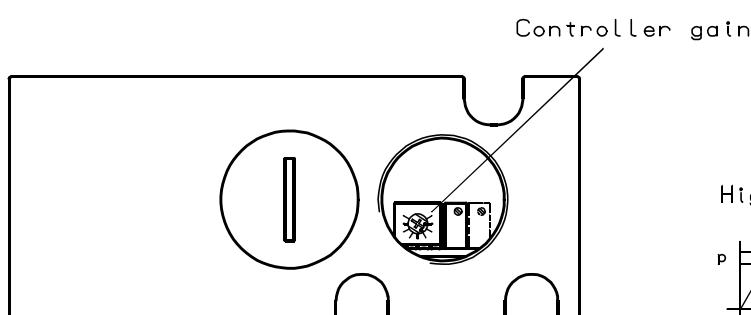
Setting the controller gain

The gain of the integrated controller is set in the factory to a value which allows universal use of the valve. If necessary, the controller gain can be varied to suit a specific pneumatic application of the valve. The controller gain can be changed by turning the potentiometer (under the screw plug in the electronics cover).

Factory setting:

For continuous air consumption at valve outlet 2 or for volumes as shown in right table:

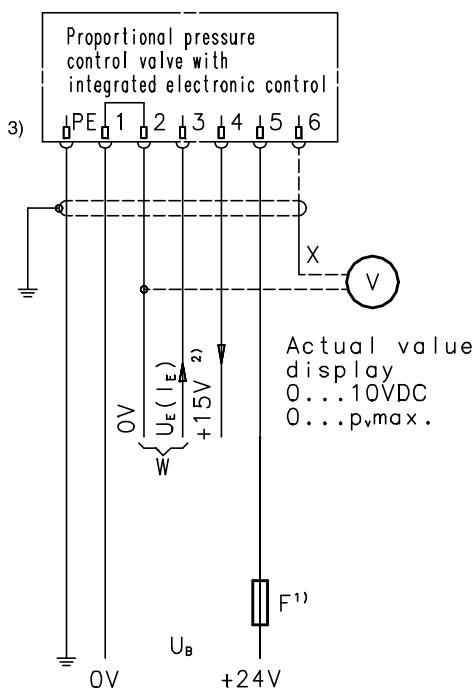
Size	For approx. volume [cm^3]
2	0 – 100
4	50 – 500
8	100 – 1500
12/20	1000 – 8000
30	>2000
40	>5000



If the controller gain is too high, the pressure control will become unstable.

Connection diagram 1

Valves with analog setpoint input



¹⁾ Recommended line fuse: M 1.0 A

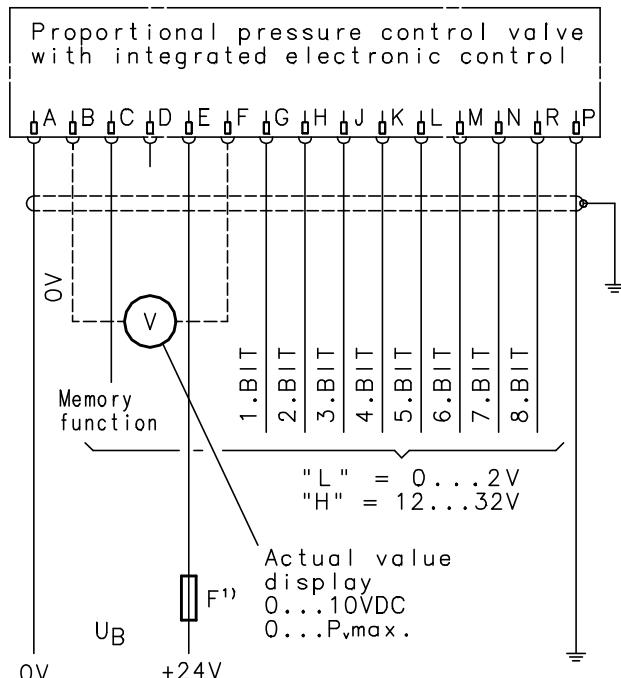
²⁾ Supply for external setpoint adjuster

(only with version with voltage setpoint)

³⁾ Internal connection 1 to 2 (only with version without electrical isolation)

Connection diagram 2

Valves with digital setpoint input



¹⁾ Recommended line fuse: M 1.0 A

Conversion table for digital input signal

Signal at pin	Value z (decimal)	Valve version for pressure range p_v [bar]		
		0 ... 2	0 ... 10	0 ... 16
L L L L L L L L	0	0.000	0.000	0.000
L L L L L L L H	1	0.008	0.039	0.063
L L L L L L H L	2	0.016	0.078	0.125
L L L L L H L L	4	0.031	0.156	0.251
L L L L H L L L	8	0.063	0.314	0.502
L L L H L L L L	16	0.126	0.627	1.004
L L H L L L L L	32	0.251	1.255	2.008
L H L L L L L L	64	0.502	2.510	4.016
H L L L L L L L	128	1.004	5.020	8.031
H H H H H H H H	255	2.000	10.000	16.000

$$p_v [\text{bar}] = \frac{2}{255} \times z \quad \frac{10}{255} \times z \quad \frac{16}{255} \times z$$

z = Sum of values triggered with "H"

Notes on memory function¹⁾

Logic table

R	N	M	L	K	J	H	G	C	Output signal
X	X	X	X	X	X	X	X	L	As triggered at pins G to R
X	X	X	X	X	X	X	X	H	The previously-set value is stored; the triggering signals at pins G to R are ignored

¹⁾ If the memory function is not required, pin C can be ignored. When the supply voltage for the valve is interrupted, the stored information is lost.

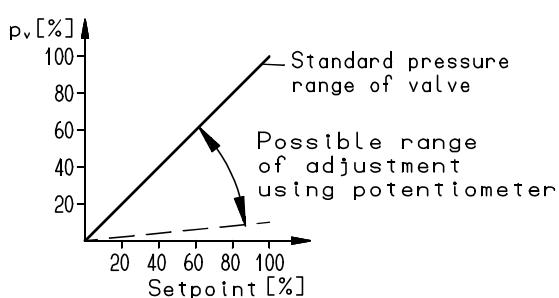
Pressure range adjustment (split range)

Description

In the case of the standard version, there is a fixed relationship between the setpoint and the outlet pressure. The "pressure range adjustment" option makes it possible to vary this relationship steplessly.

Characteristic curve

Outlet pressure p_v

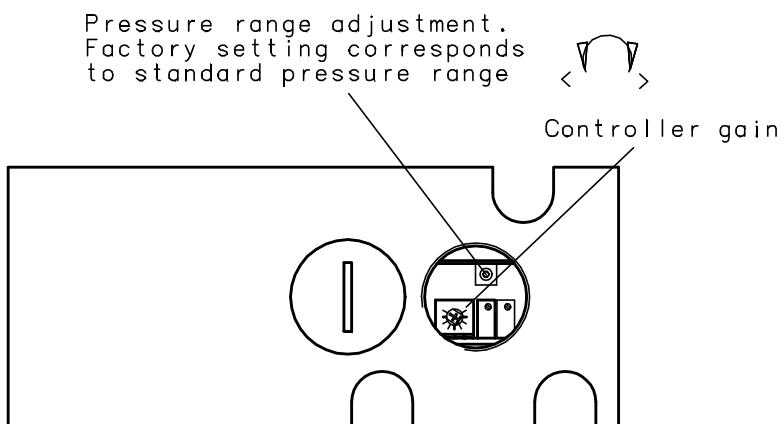
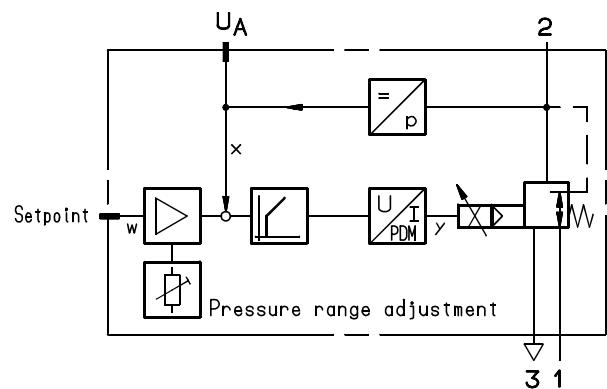


Note: This adjustment does not affect the relationship between the outlet pressure and the electrical actual value output.

Characteristic data

Adjustment range:
100% to 10% of the pressure adjustment range p_v

Block diagram



Threshold switch for detection of actual value = setpoint

Description

The "threshold switch" option allows the pressure regulator function to be monitored. For this purpose, the actual value is compared with the setpoint.

When these are equal, i. e. when the preset pressure has been reached, a message appears in the form of a 24 VDC signal at the "x = w" output.

Between the detection of "x = w" and the output of the "pressure reached" signal, an adjustable switch-on delay is operative. This suppresses any pressure peaks which may occur.

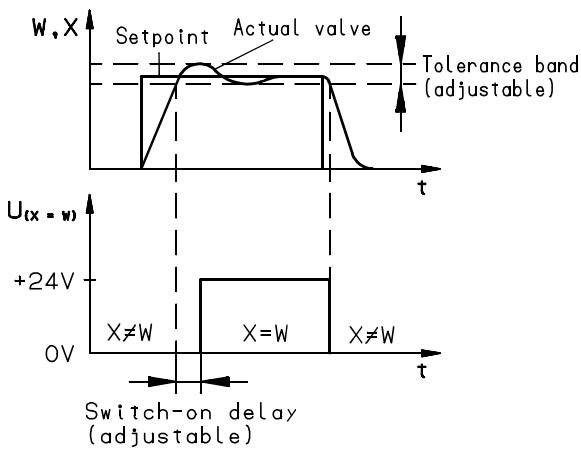
Characteristic data

Output U ($x = w$)

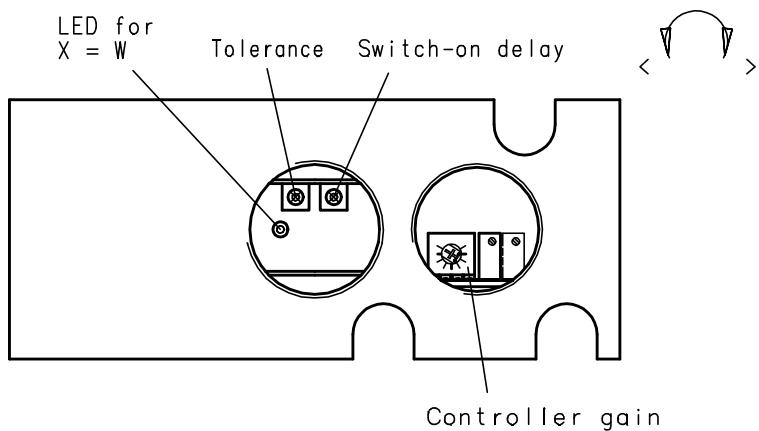
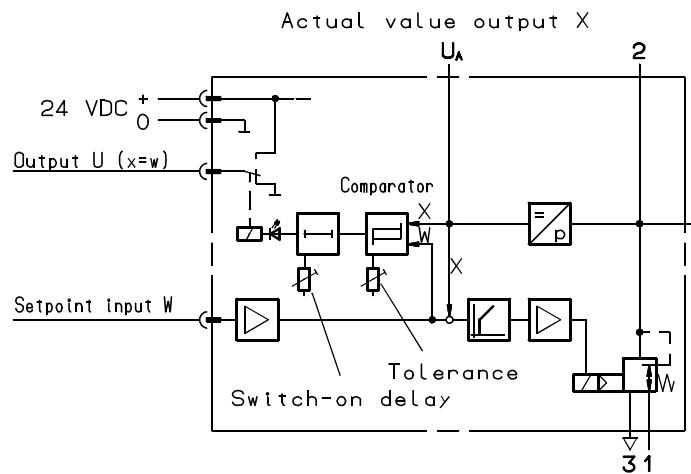
Voltage signal when $x \neq w$	[V]	0
$x = w$	[V]	$U_B - 0.5^{1)}$
Output current max.	[mA]	100
Adjustment ranges		
Tolerance	[%]	-0.8 ... +0.6 v. E.
Switch-on delay	[ms]	100 ... 1000

¹⁾ U_B = Valve supply voltage

Characteristic curves

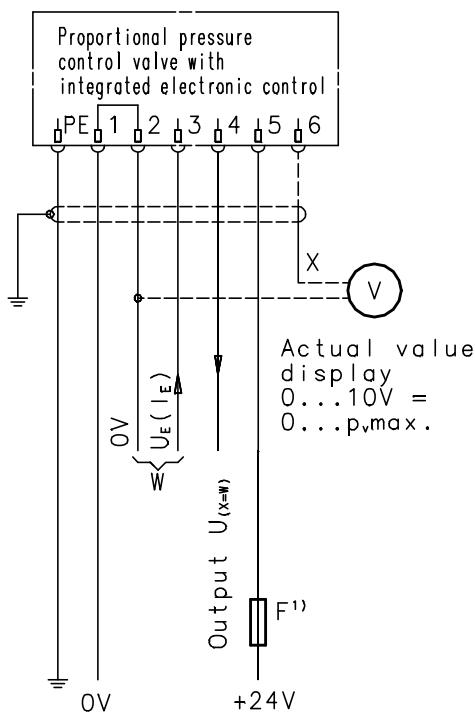


Block diagram



Connection diagram 3

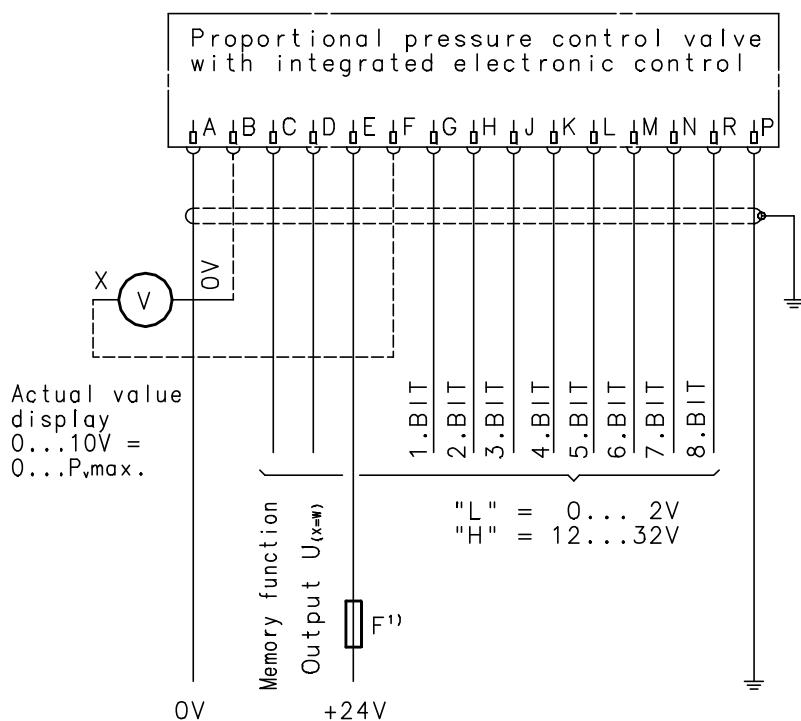
Valves with analog setpoint input and threshold switch



¹⁾ Recommended line fuse: M 1.0 A

Connection diagram 4

Valves with digital setpoint input and threshold switch



¹⁾ Recommended line fuse: M 1.0 A

For conversion table for digital input signal, see Page 6.

Electrically isolated setpoint input

Description

In this version, the electrical setpoint is electrically isolated from the power supply for the valve.

Possible setpoints are:

- 0 ... 10 V
- 0 ... 20 mA
- 4 ... 20 mA

The required setpoint input is selected by means of encoding switches.

Selection of setpoint input

Selection is carried out using switches S₁ to S₃ as shown in the table.

A voltage setpoint of 0 ... 10 V is set in the factory.

Characteristic data

Analog setpoint

Electrically isolated from power supply

Voltage setpoint

Voltage signal	U_E [V]	0 ... 10
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Input resistance	R_i [kΩ]	> 300
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Current setpoint

Current signal	I_E [mA]	0 (4) ... 20
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Load resistance	[Ω]	≤ 135
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Isolation voltage between setpoint circuit and power supply	$U_{\sim\text{eff}}$ [V]	200
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Transmission accuracy		
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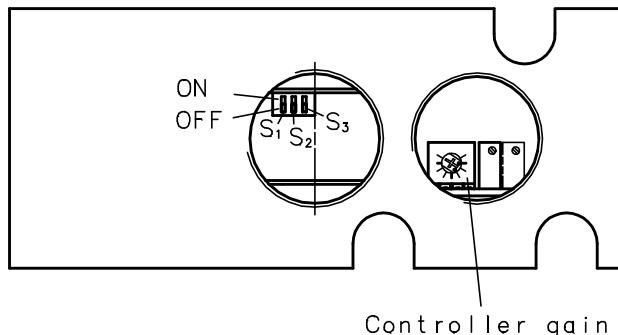
Zero point	[% from setting range]	≤ 0.25
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Span	[% from setting range]	≤ 0.25
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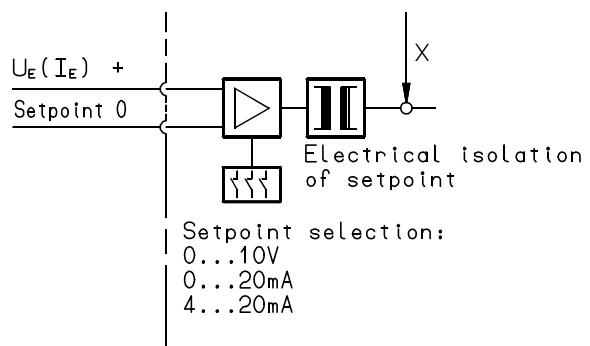
Table

	S ₁	S ₂	S ₃
Voltage input	0 ... 10 V	OFF	OFF
Current input	0 ... 20 mA	ON	ON
Current input	4 ... 20 mA	ON	ON

No other switch positions are permissible!



Block diagram



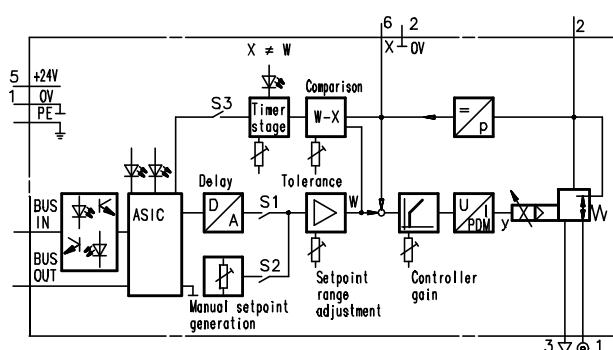
Bus interface for 2-wire remote bus, System Interbus-S

Description

This interface allows the setpoint to be fed to the valve serially via a 2-wire bus. The same interface can also be used at the same time to output an error signal in cases where the pneumatic pressure deviates from the setpoint (pressure monitoring function).

The relationship between the setpoint and the pneumatic outlet pressure (pressure range setting) can be adjusted internally (see Page 6). A switch in the electronics allows a switch-over for servicing purposes from a setpoint supplied via the bus to a setpoint provided by an internal potentiometer.

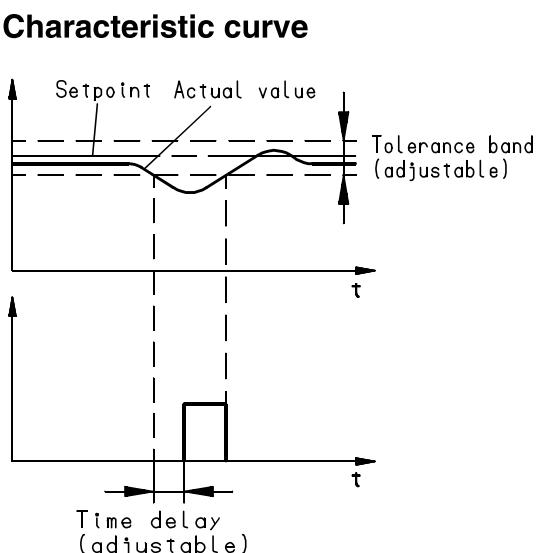
Block diagram



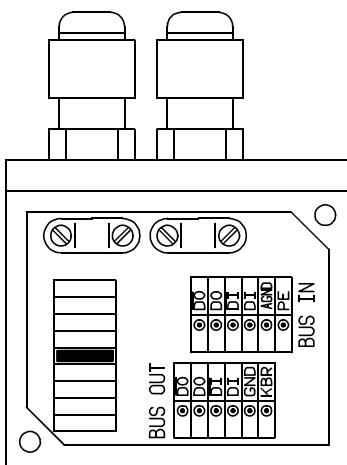
Pressure monitoring

If the outlet pressure (actual value) deviates from the desired pressure (setpoint) by more than an adjustable amount (tolerance band), an error message is generated. In order to prevent error messages caused by pressure peaks, the output of an error message is subject to an adjustable delay. The error signal is displayed by a LED. A switch can be used to select whether the error message is to be output via the bus as a module error. The factory setting is for no error-message output via the bus.

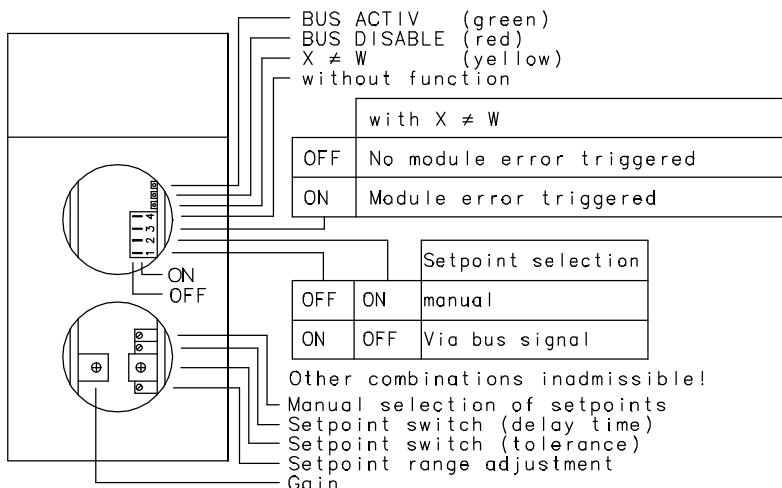
Adjustment ranges: Tolerance approx. 0 ... $\pm 2.5\%$ from full scale value
Delay time approx. 0.6 s ... 7 s



Terminal box with terminals



Control elements under conduit fittings

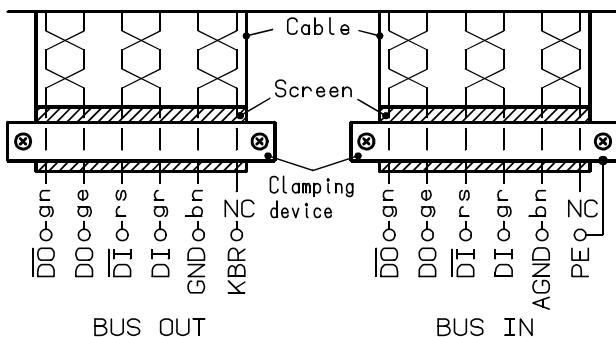


Connection diagram 5

Recommended data line LIYCY 3 x 2 x 0.2
(cable capacity $\leq 120 \text{ pF/m}$)

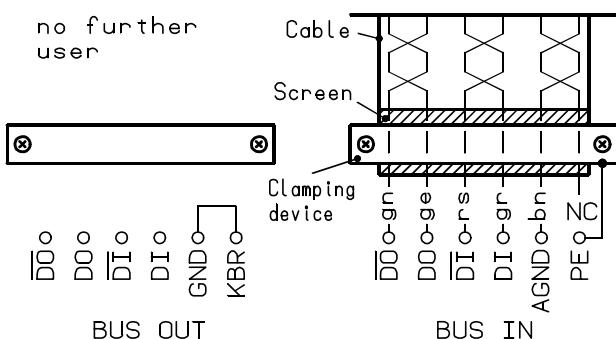
Interbus connection

Connection with further users



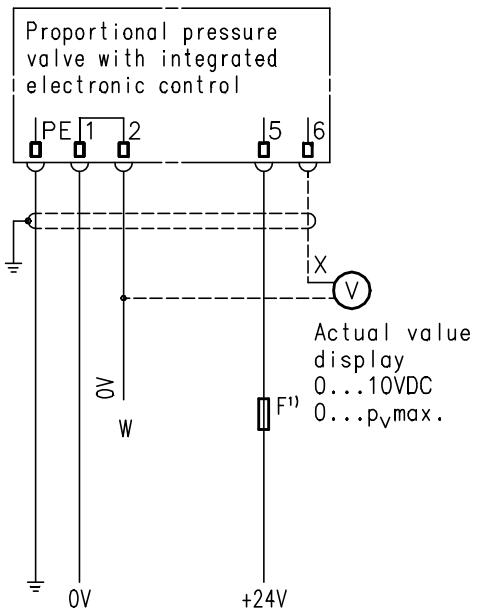
Attention:
Clamp screen under clamping device,
not to GND (AGND).
Remove jumper GND-KBR
(factory-installed).

Connection for last user



Attention:
Jumper GND-KBR (factory-installed).

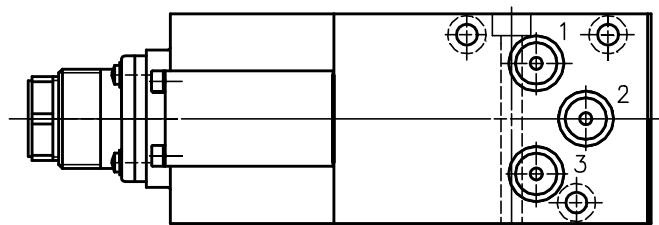
Power supply and actual value output



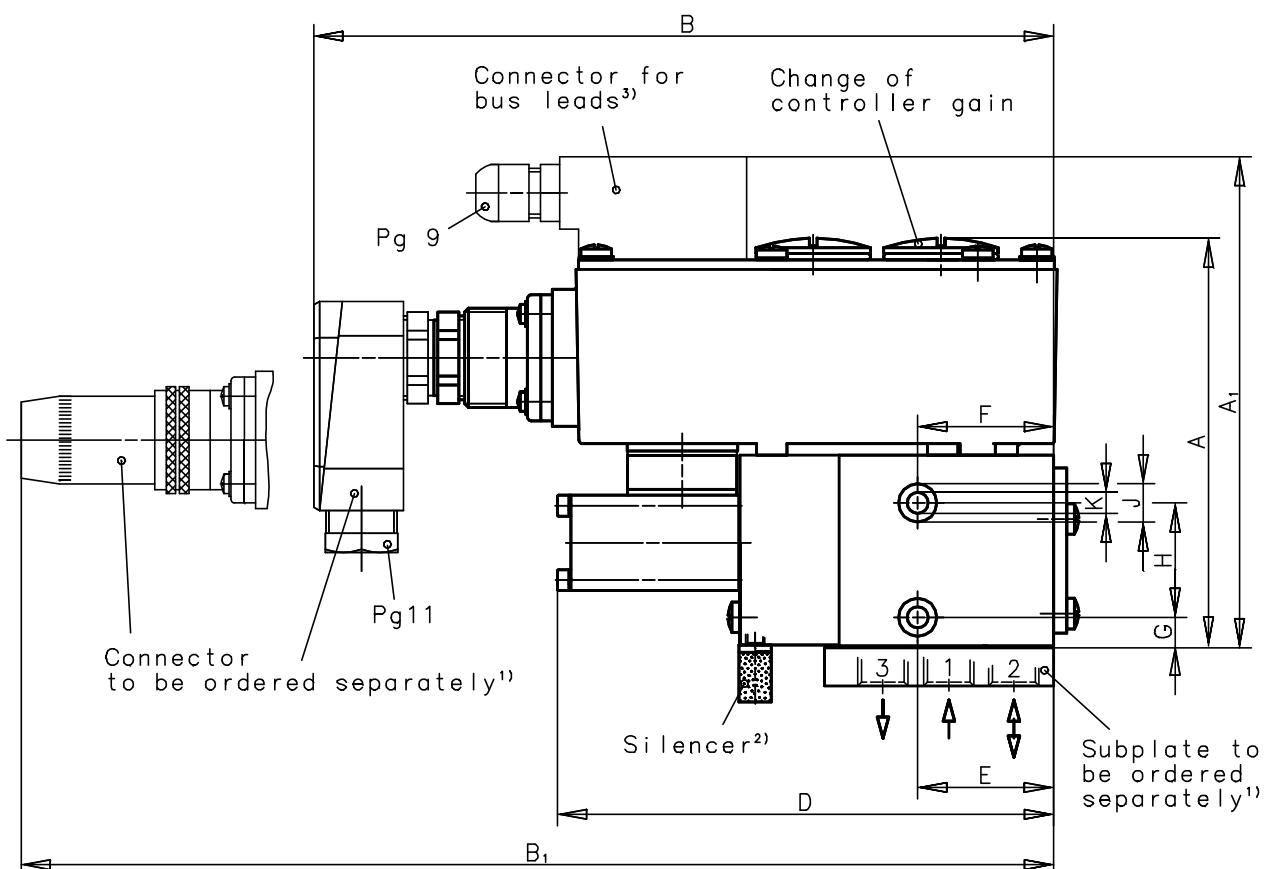
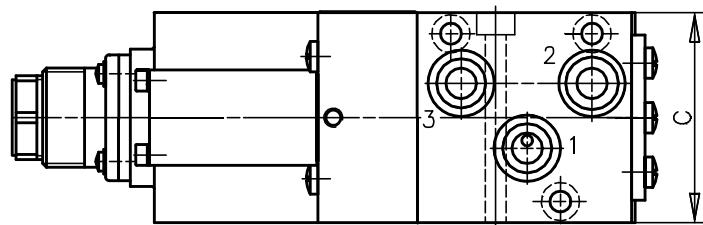
¹⁾ Recommended line fuse: M 1.0 A

Dimensional drawing [mm]

View Size 2



View Sizes 4, 8, 12, 20



¹⁾ See Accessories, Page 19

²⁾ Size 2 without silencer

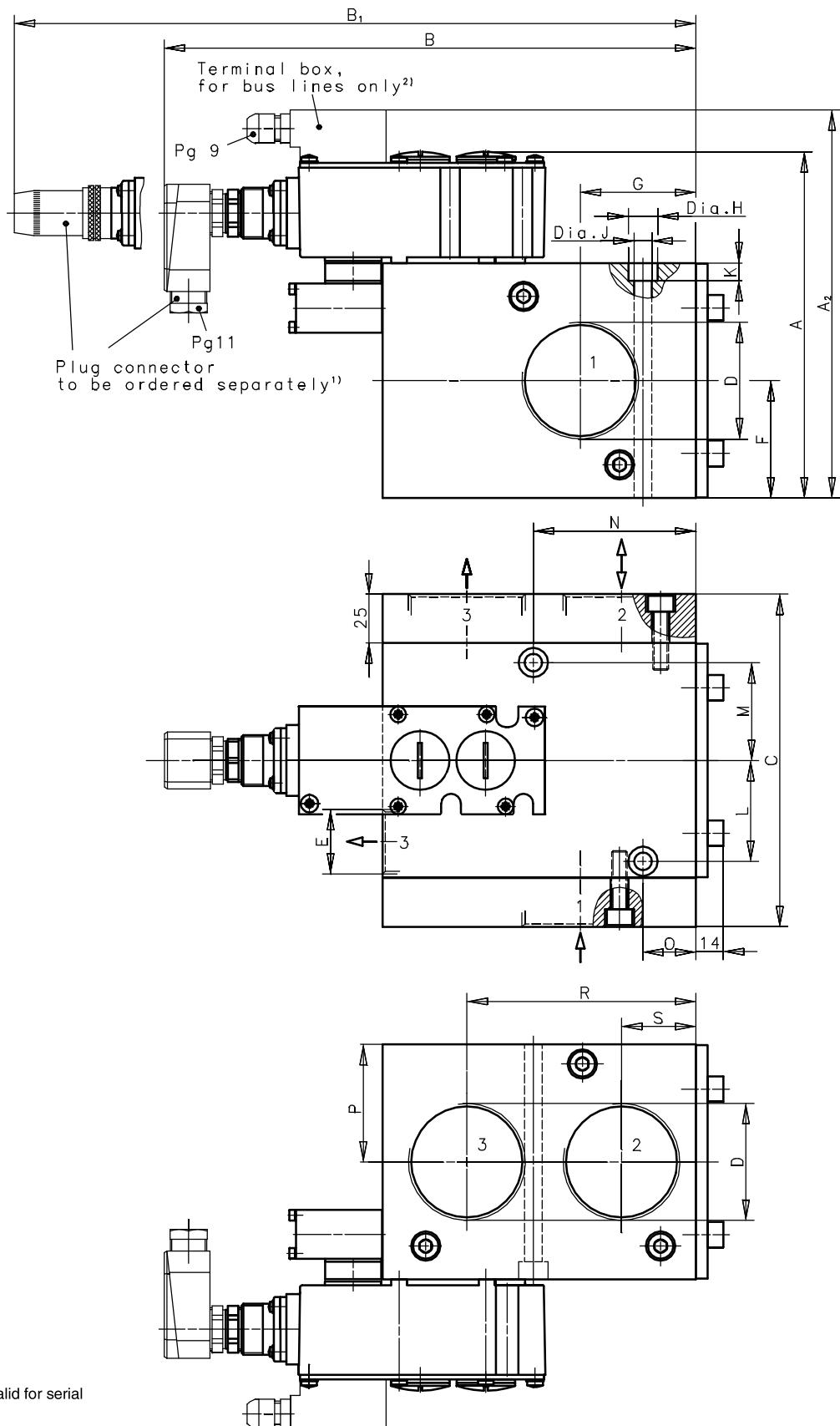
³⁾ Connector for bus leads only valid for serial interface from Interbus-S as described on Page 11

Dimensional table [mm]

Size	A	A ₁	B	B ₁	C	D	E	F	G	H	J	K
2	93	123	194	195	55	130	35.7	35.7	6.5	22	10	5.5
4	93	123	197	198	55	133	36.8	36.8	6.5	22	10	5.5
8	107	137	201	202	55	137	35.6	35.6	7.5	30	10	5.5
12	127	157	231	232	70	167	61.5	60.0	8.5	49.8	11	6.5
20	127	157	231	232	70	167	61.5	60.0	8.5	49.8	11	6.5

Dimensional drawing [mm]

Sizes 30, 40



¹⁾ See Accessories, Page 19

²⁾ Connector for bus leads only valid for serial interface from Interbus-S as described on Page 11

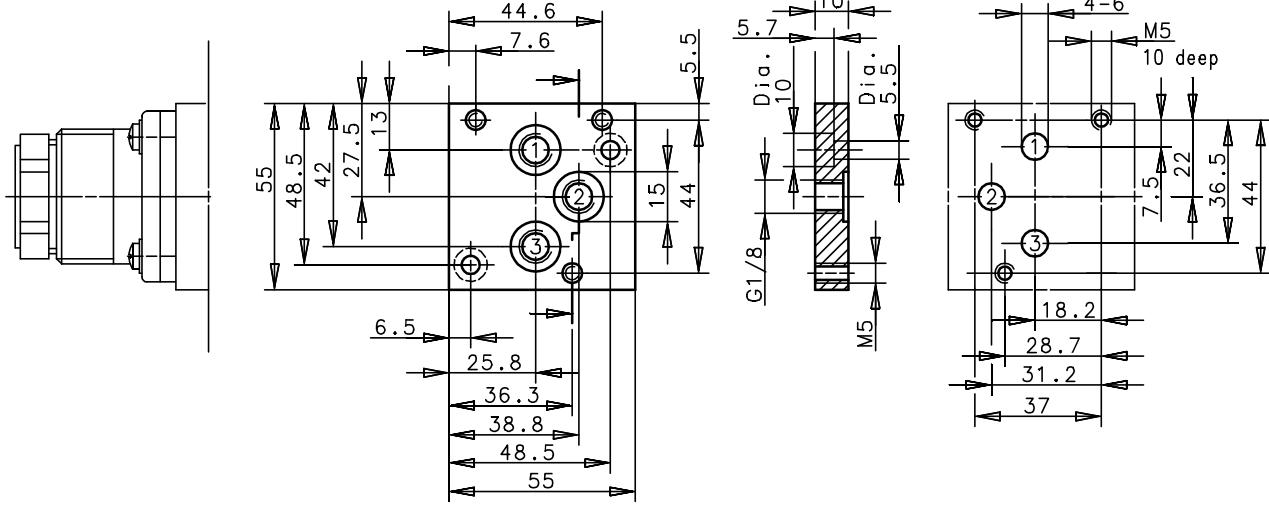
Dimensional table [mm]

Size	A	A ₂	B	B ₁	C	D	E	F	G	Dia. H	Dia. J	K	L	M	N	O	P	R	S
30	147	177	236.5	237.5	140	G 1 1/2	G 3/4	45	43	11	6.6	6.8	37	37	65	27.5	45	92	32
40	178	208	272	273	170	G 2	G 1	60	59	15	9	9	51.5	50	83	27	60	117	38

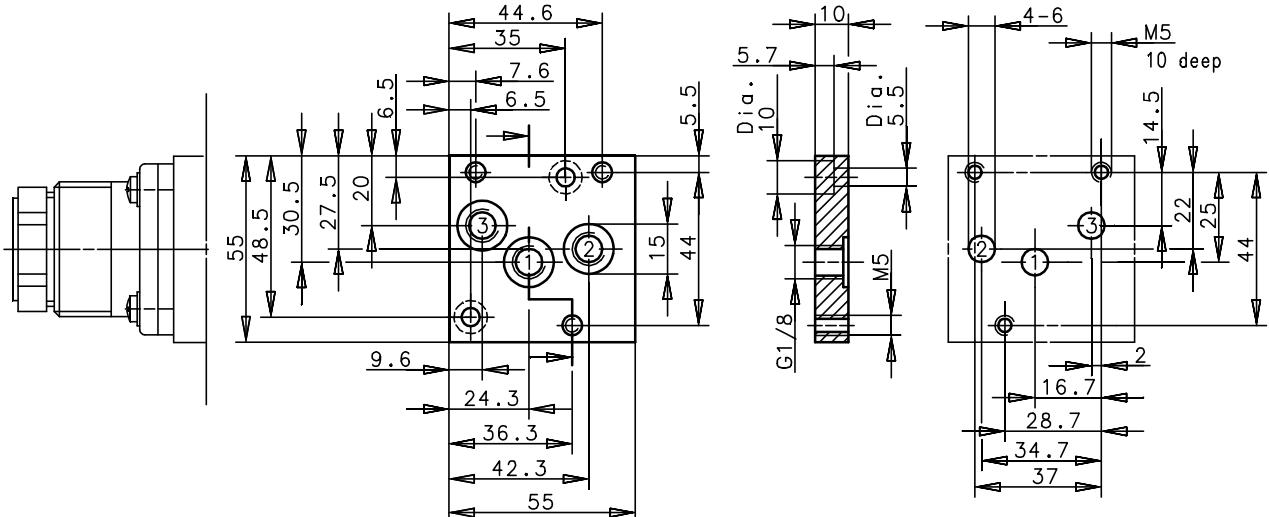
Dimensional drawing [mm]

Subplate G 1/8 for Size 2 to be ordered separately
Cat. No. **0542845**

Hole pattern



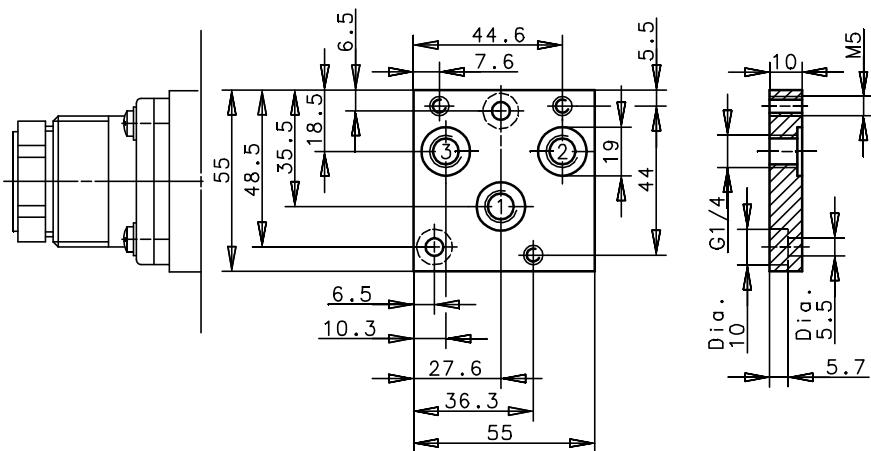
Subplate G 1/8 for Size 4 to be ordered separately
Cat. No. **0542848**



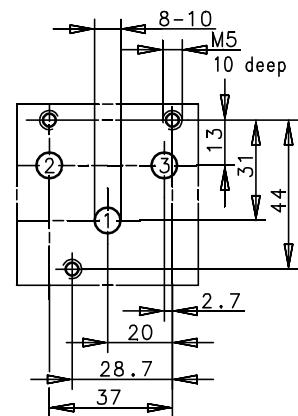
Surface finish in sealing area: R₁₆

Dimensional drawing [mm]

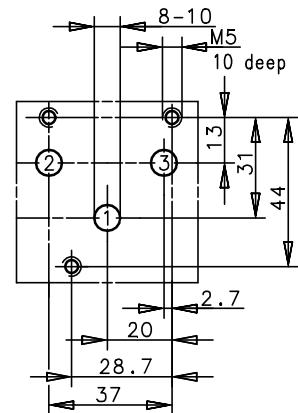
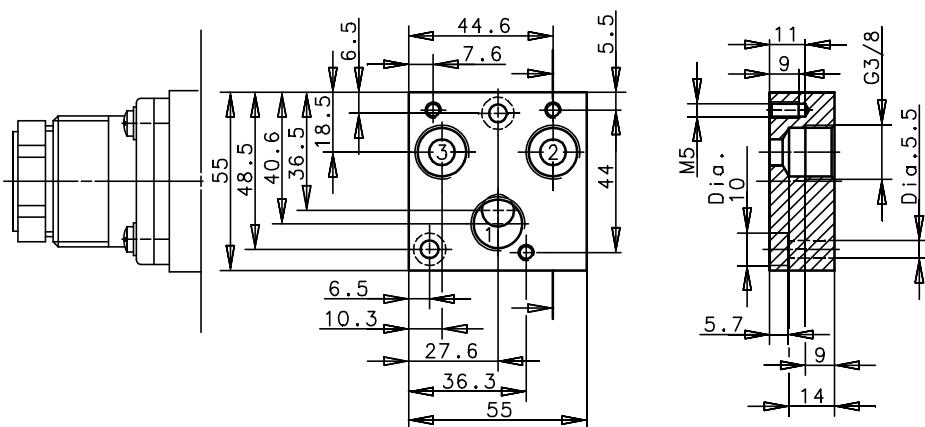
Subplate G 1/4 for Size 8 to be ordered separately
Cat. No. 0542636



Hole pattern



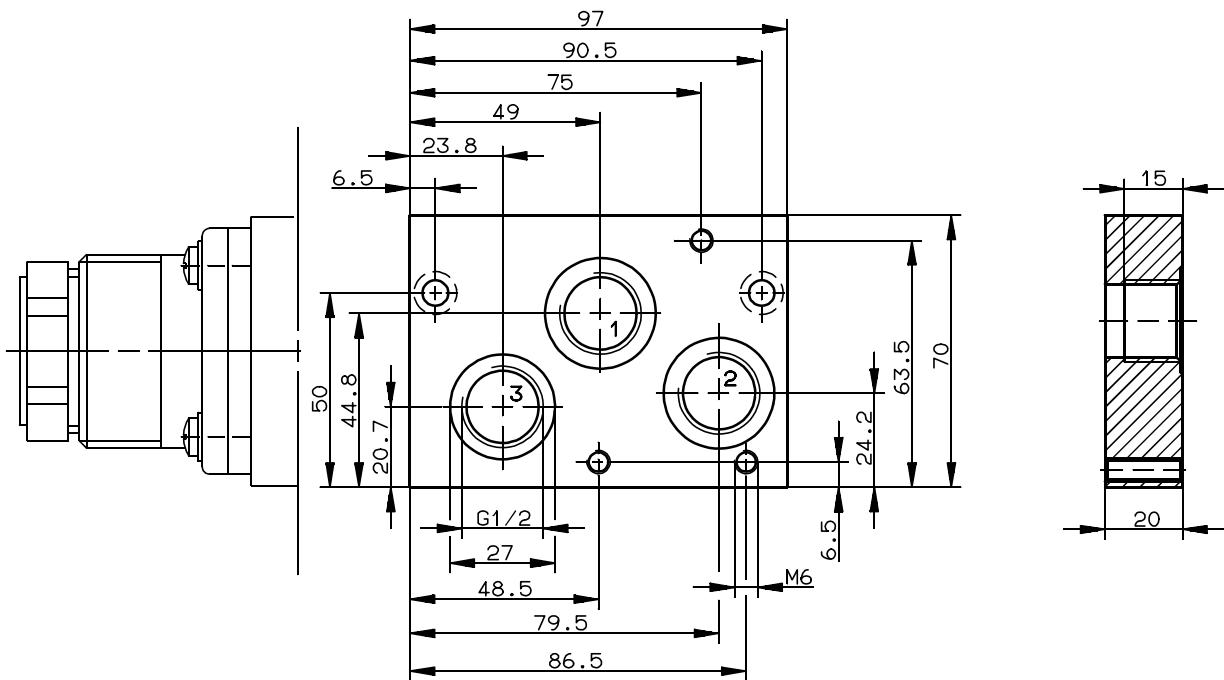
Subplate G 3/8 for Size 8 to be ordered separately
Cat. No. 0543705



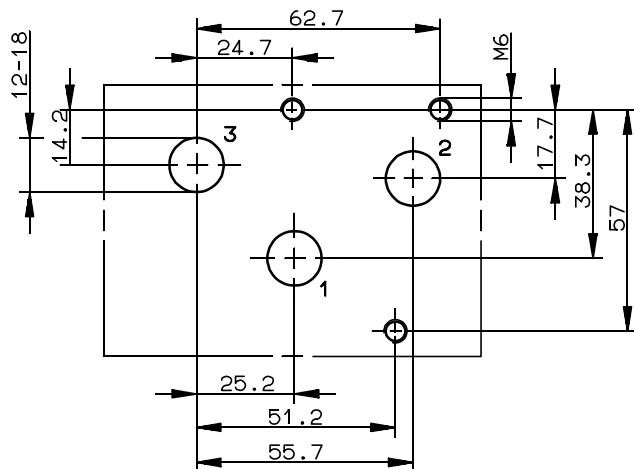
Surface finish in sealing area: R_z 16

Dimensional drawing [mm]

Subplate G 1/2 for Size 12 to be ordered separately
Cat. No. **0542814**



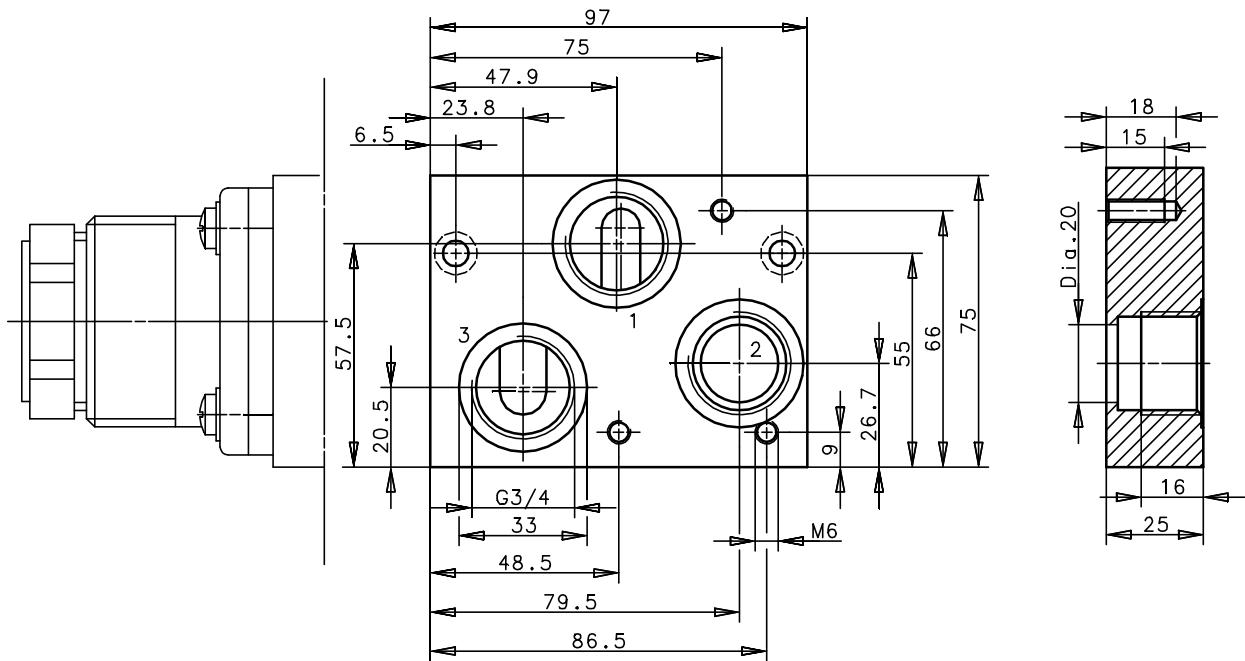
Hole pattern



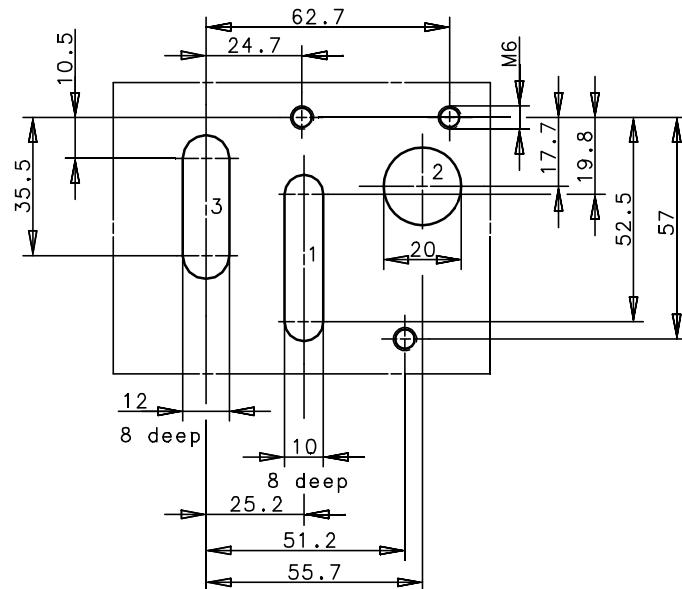
Surface finish in sealing area: R_z 16

Dimensional drawing [mm]

Subplate G 3/4 for Size 20 to be ordered separately
Cat. No. 0542840



Hole pattern



Surface finish in sealing area: R_z 16

Accessories

Designation	Specification	Publication No.	Cat. No.
Setpoint adjuster SE 01 1-turn potentiometer Angle of rotation 270°	0 ... 10 V	7501675	5998534
Setpoint adjuster SE 02 10-turn potentiometer Angle of rotation 360°	0 ... 10 V	7501782	5998536
Setpoint adjuster SE 03 <u>digital</u>	0 ... 10 V	7501783	5998647
Setpoint adjuster SE 13 <u>digital</u>	0 ... 20 mA	7502504	5998774
Setpoint adjuster SE 13 <u>digital</u>	4 ... 20 mA	7502504	5998775
Transformer TR 21	110/220 VAC/50–60 Hz 24 VDC 3.0 A	7501789	5998609
Transformer TR 22	380 VAC/50–60 Hz 24 VDC 6.0 A	7501789	5998611
Connector	6-pin + PE acc. to DIN 43651	—	0660689
Connector	15-pin MIL-C-26482	—	0680683
Subplates	Size 2 G 1/8	—	0542845
	Size 4 G 1/8		0542848
	Size 8 G 1/4		0542636
	Size 8 G 3/8		0543705
	Size 12 G 1/2		0542814
	Size 20 G 3/4		0542840
	Size 30 G 1 1/4		0546412
	Size 30 G 1 1/2		0546410
	Size 40 G 2		0798598
Silencer for venting port at subplate up to size 20, for sizes 30 and 40 in housing	G 1/8	7501079	0014510
	G 1/4		0014610
	G 3/8		0014710
	G 1/2		0014810
	G 3/4		0014910
	G 1 1/2		0016630
	G 2		0016730

Instructions for pneumatic installation and commissioning

1. Operating pressure p_e

The operating pressure must be higher than the max. required set pressure at the valve outlet.
Recommended: ≤ 1 bar. When switching off the operating pressure, the operating voltage should be disconnected as well.

2. Line cross section

Cross section of supply line to 1(P) should be larger than the nominal width of the valve.
Cross section of the working line to 2(A) should be of the same size but at all events larger than the nominal width of the valve.
Air at the exhaust port 3 (R) must be discharged without pressure.

3. Combination with other units

3.1 Units connected upstream (e.g. pressure sensors)

Flow rate must be larger than that of the proportional valve.

3.2 Units connected downstream (e.g. pilot valves)

Same flow rate, but at any rate larger than that of the proportional valve.

4. Mounting place

As close as possible to the consuming device.

5. VERY IMPORTANT !

Before mounting the valve on the connection plate, the pneumatic lines must be blown out and freed from mounting residues.

Instructions for electrical installation

1. Voltage supply

Voltage supply 18 ... 32 V (incl. residual ripple)
Excess voltage may destroy the electronic system !

2. Avoidance of interferences

2.1 Screening

In order to prevent interferences by electric fields, screened lines must be used. The screen must be connected to PE (see circuit diagram).

2.2 Laying of cables

Supply and signalling lines must not be laid in parallel with power mains or high-voltage lines.

3. Line cross section

According to VDE 0113

4. Zero potentials

For zero potentials (0 V), the supply voltage and the setpoint signal, two separate wires must be used in order to prevent distortion of the setpoints.