> **Nominal size: 8 mm**

> **High flow rate - low pressure loss**

> **Calibrated, linear flow characteristic with zero crossover**

> **Choice of setpoint input: 4 to 20 mA, ±5 V, 0 to 10 V, fixed value, function generator**

> **Fast dynamic response**

Technical features

Medium:
Air acc. to ISO8573-1
Grouping: 2-3-1, filtered
(recommended < 3 μm),
dried, oil-free
The dynamic performance and
service life of the valve may be
significantly reduced if using
unfiltered air containing water and
oil!
Operating pressure on all ports:
-1 ... 16 bar (-14 ... 232 psi)
Pneumatical flow coeff.:
C = 290 Nl/(min bar)
Critical pressure ratio:
b = 0,1 ... 0,4

Calibrated flow rate (Qmax.):
1200 Nl/min at P1 = 6 bar (87 psi),
P2, P4 = 5 bar (72 psi)
Leakage:
Typical value: 8 Nl/min
at (P1 = 10 bar (145 psi),
P2/P4 = 0 bar)
Port size:
G1/4, 1/4 NPT or flange mounted
according ISO 1
Spool deadtime:
3 ms max
Risetime 10 ... 90%:
5 ms
Threshold frequency -3dB:
105 Hz

Service life:
> 250 million full stroke operations
with recommended air quality
Ambient/Media temperature:
Ambient: 0 ... +60°C (+32 ... +140°F)
Media: +5 ... +60°C (+41 ... +140°F)
Storage temperature:
-20 ... +80°C (-4 ... +176°F)
Condensation not permitted!
Air supply must be dry enough to
avoid ice formation at temperatures
below +5°C (+41°F).

Materials:
Electronic enclosure: PAA
Valve housing and internal parts:
anodised aluminium
Other static seals: NBR
Actuator magnet: Fe, surface
refined

Technical data, standard model

Symbol	Orifice (mm)	Flow (l/min)	Set point	Actual value	Weight (kg)	Model
	8	1200	4 ... 20 mA	0 ... 10 V, 4 ... 20 mA	1,25	VP6010LJ461MB200
	8	1200	-5 ... +5 V	0 ... 10 V, 4 ... 20 mA	1,25	VP6010LJ661MB200
	8	1200	0 ... 10 V	0 ... 10 V, 4 ... 20 mA	1,25	VP6010LJ761MB200

Option selector

VP6010L★★★1★B200

Pneumatic port	Substitute
G1/4	J
1/4 NPT	K
ISO 1	T

Set point	Substitute
4 ... 20 mA	4
-5 V ... +5 V differential	6
0 ... 10 V differential	7

Electrical connection	Substitute
M12/8 polig	M

Output	Substitute
0 ... 10 V/4 ... 20 mA	6

en 6.6.060.01

Construction data:

Vibration resistance:
DIN EN 60068-2-6, 10 g at
12-500 Hz switched off.
When working more than > 1 g
function interference.

Shock resistance:
DIN EN 60068-2-67,
30g /18 schocks.

Weight:
1,25 kg

Electrical parameters

Supply voltage (Ub):
21 ... 32 V d.c.

Residual ripple:
10%

Switch-on point:
21 V

Switch-off point:
18 V

Voltage across diff. inputs:
-10 ... +40 V

Other voltages:
0 ... Ub V

Current input:
4 ... 20 mA

Working resistance:
500 Ω

Differential voltage input:
± 5 V
0 ... 10 V

Internal impedance:
117 kΩ

Current output:
4 ... 20 mA

Voltage output:
0 ... 10 V

Current consumption at 24 V setpoint, static:
0,1 A

Setpoint ±100%, 50 Hz sinus:
0,3 A

abs. max. for 10s:
2,0 A

Accessories

	Connection cable	
Description	**Model**	**Model**
M12x1, 8-pol., 5 m, standard	0250811	0250813

Material: PUR

Serial interface accessories

Description	Adaptor cable
	Model
Adaptor cable with software CD VP tool	5988319

Description
Design:

The flow-optimised, metal-sealed 5/3 way spool attains the setpoint position at maximum possible speed under µP control circuit using a moving coil and position sensor.

In the production process, the setpoint value is mapped onto setpoint travel for each VP60, to deliver a linear relationship between setpoint value and flow rate under constant pressure conditions. This cancels out any device-specific manufacturing tolerances.

The valve cannot correct for the physical effect of changing pressure conditions on the flow rate.

However, these changes do not affect the proportionality and zero crossover of the characteristic curve, which has precision adjustment.

In the event of power loss or faults, a spring forces the spool into the preferred position.

The low-loss, digital electronics are integrated in the valve.

Function:

The VP60 is a bi-directional linearised control valve.

The flow rate is (between calibrated negative an positive maximum) continuosly variable adjustable by set value.

All ports are closed in the centre position.
Above-centre setpoint values open the paths 1 to 2 and 4 to 5.
Below-centre setpoint values open the paths 1 to 4 and 2 to 3.
The latter paths are fully opened by spring control in the event of power loss or faults.

The VP60 can be used, e.g. for continuous, reversible speed control of double-acting cylinders or reversible pneumatic motors.

5/3 operation:

Filtered compressed air (see technical data)
is supplied to port 1. The actuator (e.g. cylinder) is connected to ports 2 and 4. Ports 3 and 5 are used as the exhaust. Mufflers with low flow resistances should be connected here.

The power-off response of the actuator (e.g. cylinder moving in or out) depends on its connection to ports 2 and 4 of the VP60 as shown in its connection diagram.

If no movement is required for the power-off response the system developer concerned must provide additional non-return valves.

3/2 operation:

For loads that need only one supply connection
(e.g. spring-return cylinders).
The following sub-functions are possible:

3/2 power-off response exhaust:

Load connected to port 2. Port 4 closed.
Air is taken in for an above-centre setpoint value and expelled for a below-centre setpoint.
In case of an error the cylinder assumes the spring set preferred position.

3/2 power-off response air intake:

Load connected to port 4. Port 2 closed.
Air is expelled for an above-centre setpoint value, and taken in for a below-centre setpoint. (The cylinder assumes the opposite position to the spring-set preferred position for power off).

If no movement is required for the power-off response, the system developer concerned must provide a non-return valve.

The VP60 fault output can be used as the control signal for the output stage of the non-return valves.
The VP60 does not include such an output stage as standard.

2/2 operation:

For loads with continuous air flow requiring just one supply port and no exhaust. (e.g. jets or turbines).
The following sub-functions are possible:

2/2 NC (power-off closed):

Load connected to port 2. Ports 3, 4 and 5 closed

The VP tool software can be used to assign the whole setpoint range with optional action (opening/closing) to 2/2 valve operation.
Otherwise the VP60 remains closed below the centre.
An air intake action can be configured above the centre.
centre = closed, max. setpoint value = max. flow.

2/2 NO (power-off open):

Load connected to port 4. Ports 2, 3 and 5 closed.

The VP tool software can be used to assign the whole setpoint range with optional action (opening/closing) to 2/2 valve operation.
Otherwise the VP60 remains closed above the centre.
An air intake action can be configured below the centre.
min. setpoint value = max. flow, centre = closed.

Functional safety:

VP60 is not a design with fail-safe (type caused) features.
Safety orientated features on valve level cannot be confirmed,
neither conforming to EN-ISO13849 (PL) nor to IEC61508 (SIL).
For engine controls (complex mechatronic systems) with VP60 series we strongly recommend a risk analysis, e.g. conforming to EN ISO12100.

Information about the current standard situation are available at the institutes VDMA or BGIA

Installation recommendation:
It is strongly recommended to fit a 3 µm filter before the supply port 1.

To maintain the linearity of the VP60 even at high flow rates, the nominal size of pipes and any extra valves fitted should at least be larger than the VP60 (DN8), i.e. DN10, and be as short as possible.

For dynamic applications, it is advisable to build in buffer capacity, equal to the working volume of the actuator, in the compressed-air supply between the filter and port 1.

Pipes should be cleaned of any residues, e.g. by blowing out, before connecting to the VP60.

If installed on moving surfaces, the valve should be fitted as perpendicular as possible to the main direction of movement.
The VP60 can be fitted in any orientation. The preferred orientation is vertical, however, with the magnet uppermost (the thermal load from the electronics, and the mechanical forces on the spool, are lowest in this orientation).

Voltage supply:
The VP60 is rated for a 24 V d.c. voltage supplied between Ub and GND. Reversing the polarity of the supply will not damage the electronics because they have built-in protection. The valve will not work, however.

The actuator system (= spool position controller) soft starts at a voltage of 21 V and above, preventing severe current spikes.
Although the mean current consumption is limited to 0.6 A (at 24 V) over 10 seconds because of the thermal balance, and is reduced reversibly to 0,2 A if this limit is exceeded, spikes up to 2 A may occur.

The system developer should take this factor into account to avoid overloading the power supply.

Note:
Some power supplies have electronic current limiting, which reduces the output voltage when activated. This may cause the voltage to drop below the 18 V switch-off threshold of the VP60 actuator. The valve then draws drastically less current (40 mA),
so the power supply voltage rises again above the switch-on threshold; this can therefore set up an undesirable oscillation process.

Voltages continuously greater than 36 V destroy the internal overvoltage protection.

Since the VP60 starts working at 21 V, the specified supply voltage range is 21 to 32 V. If the voltage drops below the switch-on threshold, operation of the valve is still guaranteed until the voltage falls below the 18 V switch-off threshold.

This 3 V hysteresis prevents the aforementioned oscillations if the power supply is designed properly. Any ripples in the supply (rated value 10% Ubrated = max. 2,4 V) must be less than this hysteresis for the VP60 to be able to start operating properly.

Setpoint inputs:
The input and input range is factory-set according to the type code specified in the order; these settings are indicated on the type plate. The active input can be changed via the V24 interface, PC and VP tool software. Values outside the range limits are handled as values equal to the respective limits.

Note:
The resistance of the GND wire of the supply cable lies between the GND star point of the switch cabinet (terminal block with strapping) and the internal GND potential of the VP60; this produces a voltage drop that depends on the current drawn from the power supply.
This means that the GND potential of the VP60 is raised by this voltage above the star point. A voltage referenced to GND in the switch cabinet would appear in the VP60 as a potential reduced by this voltage drop. Since the setpoint encoder usually does not know the actual current drawn from the supply, this results in a random error in the setpoint input.

For this reason there is no GND-referenced voltage input for the setpoint in the VP60. The design of differential current and voltage inputs means that they do not experience such an error.

Current input (Iin):
The setpoint can be input here in the range 4 to 20 mA across a working resistance of 500 Ω to GND. The working resistance is only enabled when the valve is operating and the current input is selected.
If this input is enabled but a current source is not connected, the 4 mA setpoint value is used, i.e. -100% (path 1 to 4 and 2 to 3).

Differential voltage input (+Ud, -Ud):
The difference between the two voltages gives the setpoint value.
+Ud with reference to -Ud can be in the range of 0 to 10 V or -5 to +5 V. The range can be changed using VP tool. Both voltages should lie within the common mode rejection range of -10 to 40 V. Both inputs have an internal impedance of 117 kΩ to an internal source voltage of 3,6 V vs GND. This situation is produced by the design of the internal differential amplifier.
If this input is enabled but a setpoint encoder is not connected, 0 V is used as the setpoint value:
i.e. in the 0 to 10 V range -100% (path 1 to 4 and 2 to 3); in the -5 ... 5 V range 0% (approximately the centre, all ports closed).

If the GNDs of the setpoint encoder and power supply source are connected in the switch cabinet, the valve's response will also depend on which of the inputs +Ud und -Ud is not connected and what setpoint voltage is input. The following actual flow rates result:

The following actual flow rates result:

0 ... 10 V:
+Ud not connected: -27%.
-Ud not connected, +Ud = 0V: -100%, +Ud = 5 V: -53%, +Ud = 10 V: -6%.

-5 ... 5 V:
+Ud not connected: 73%
-Ud not connected, +Ud = -5 V: -100%,
+Ud = 0 V: -53%, +Ud = 5 V: 23%.

Internal fixed value:
If the VP60 will only ever need to regulate the flow to a fixed setpoint value, this value can be set using the VP tool software without additional external circuitry.

Note:
This approach can be used by applications to control the VP60 directly via the V24 interface. Please see separate datasheet.

Frequency generator:
This option can be used for varying the setpoint input over time for demonstrations and endurance testing.

Actual value outputs:
The direct spool position is not output here, but the actual flow rate in 5/3 operation calculated back from the spool position under constant pressure conditions. This allows direct comparison of setpoint and actual values, except in the following situations.
The built-in scaling function allows a huge variation in the relationship between setpoint value and desired flow rate, and hence the user can deliberately change the direct 1:1 representation.
In 2/2 operation enabled using VP tool, the whole setpoint range is assigned to just one flow-rate quadrant. The actual value will then only vary in the selected quadrant (1 to 4 (0 ... 50%) or 1 to 2 (50 ... 100%)) as regards 5/3 operation, even with 1:1 scaling.

Voltage output 0 ... 10 V:
Voltage – actual flow-rate relationship:
0 V = -100%, 5 V= 0% (centre, ports closed), 10 V=100%
The output is referenced to GND and can supply a max. load current of 10mA. (The information given for the setpoint inputs regarding the ground line also applies here)

Current output 4 ... 20 mA:
Current – actual flow-rate relationship:
4 mA = -100%, 12 mA= 0% (centre, ports closed), 20 mA=100%
The source (high side) normally drives a 500 Ω working resistance to GND.

Other working resistances can also be used, provided the minimum 3 V voltage that the source needs to work is taken into account, i.e. the voltage at the current output cannot be greater than
U_{bmin} - 3 V at 20 mA. e.g. U_{bmin} =18 V. 18 V - 3 V = 15V.
R_{max} = 15 V / 20 mA = 750 Ω.

LED indicator:
The LED in the electronic enclosure cover shows green for running OK and red for the following faults: supply voltage too low, excess current in actuator or execution error in microprocessor (µP) program

Power-on test:
The µP in the VP60 starts to work at a supply voltage of about 8 V and above. The Power-on test lasts about 500 ms, in which it checks the code consistency, and that the RAM and CPU are working. The LED shows a green light during this time. If a fault is found, the LED turns red and operation is not started. If the test was OK, the VP60 immediately starts operating and the LED goes out for about 2 s, to indicate the smooth transition into operation (LED green).

Undervoltage:
Supply below 18 V. The actuator is switched off immediately (40 µs), because the moving coil system can no longer generate the forces needed for operation, and the power dissipation in the output stage electronics rises to unauthorised levels.

The undervoltage state ends once the voltage goes above 21 V.
In a soft-start phase lasting approximately 80ms, the actuator current increases to the operating current required at that instant, with regular valve operation then resumed.

In the 18 to 21 V range, the prevailing state is maintained (hysteresis). So, once the voltage has risen above 21 V, the VP60 still remains operating down to 18 V.

Excess current:
This fault condition exists when the thermal load derived from the 10-second mean absolute value of the actuator current has reached the limit of the actuator. In the event of a fault, the current is reduced but not cut off. The fault remains in force until the mean current value has dropped below the continuous-load limit of the drive system. The fault has then passed and the current is no longer limited.
The excess-current fault can have a number of causes, and indicates that the setpoint position of the spool has not been reached:
Natural wear after well over 250 million full stroke operations has made the spool stiff to move – its service life has expired.
The control edges have become jammed by dirt particle – possibly no filter fitted. As the VP60 does not switch off, but continues to work at lower performance, the particles may get blown out.
The setpoint value changes continuously at too high a frequency and too large a stroke at a high rate of change. Until the situation is rectified, the VP60 follows the setpoint value far more slowly.
Up to 50Hz, it is possible to achieve ±100% spool stroke, at 100 Hz still ±50%. Maximum operating frequencies are achieved by a sinusoidal waveform for the setpoint.

Program execution errors:
During operation, the VP60 tries to keep running by correcting or restarting the system.
The V24, PC and VP tool can be used to display any errors that occur.

Fault output:
The high-side output (24 V) can supply a 15 mA current to GND.
The power-on test is not shown here – the output is not enabled until the valve is operating. The logic signal assignment can be set using VP Tool. The factory setting is enabled (24 V) for operation OK, disabled (0 V, off) for undervoltage or excess-current faults.

Note:
If reversing the logic assignment (enabled, 24 V for fault), it should be remembered that no fault can be signaled if there is no power connected.

Scaling:
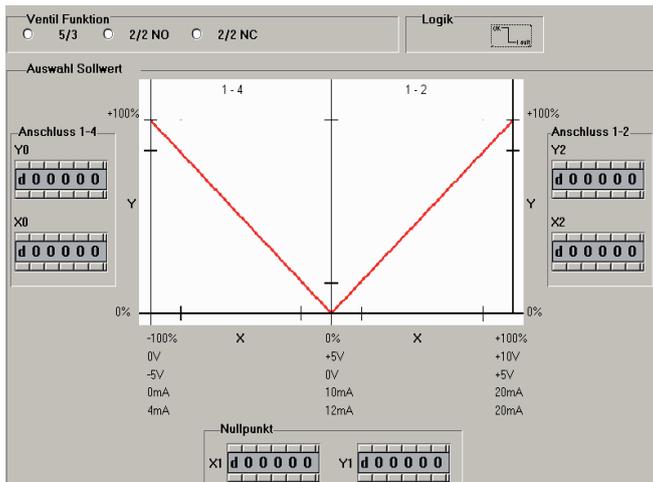
Note:
It is only useful to perform scaling in the valve if working with rigid (analogue) setpoint systems. In software-configurable installations (controller cards), it is clearer to set and manage all setpoint-related parameters (limits, gradients, offsets etc.) in the application software. Scaling is performed via the V24 interface, using a PC and VP tool.

The relationship between setpoint and flow-rate is defined by three X/Y coordinate pairs. The X values refer to the setpoint value, the Y values to the flow rate corresponding to X.
With regard to 5/3 operation, X0/Y0 specifies the setpoint value at and above which the max. flow rate in direction 1-4 is to be obtained; X2/Y2 specifies the same in the 1-2 direction.
X1 defines the position of the zero point. The flow rate (Y1) at the zero point cannot be set for 5/3 or 3/2 operation because it equals the low leakage level for this position, which is fixed by design constraints.

5/3 and 3/2 operation:
Y0 and Y2 can be used to adjust the gradient of the setpoint/flow rate characteristic between 100% and 10% of the maximum flow rate.
X0 and X2 can be used to place limits in the range 100 ... 50% (setpoint) on the flow-rate limits set in Y0/2.

2/2 NC operation:
Since the entire setpoint range (X) is applied to the path 1-2 in this case, X/Y-1/2 can be used to define the transfer function to suit.
Flow rate value Y1 applies below setpoint value X1. Flow rate value Y2 applies above X2. Between these points, the characteristic is linear-proportional.

2/2 NO operation:
The details for NC operation apply here to X/Y-0/1 for the path 1-4.

Electrical inputs and outputs:

In addition to the power supply, the VP60 has two analogue inputs and two analogue outputs, plus one digital output. These are combined in one 8-pin M12 connector:
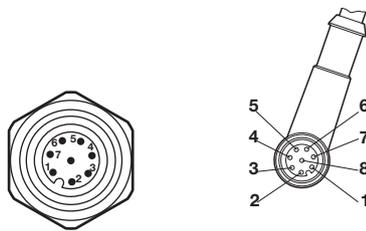
Pin	Colour	Name	Function
1	white	Iin	Setpoint input, current 4 ... 20 mA (500 Ω working resistor to GND)
2	brown	Fault	Fault output (current limited to 15 mA from Ub)
3	green	-Ud	Setpoint input, differential voltage, reference potential
4	yellow	+Ud	Setpoint input, differential voltage, 0 ... 10 V / ± 5 V signal
5	grey	Iout	Current output, actual value, 4 ... 20 mA from Ub
6	pink	Ub	Supply voltage +24 V d.c.
7	blue	GND	Supply ground GND
8	red	Uout	Voltage output, actual value 0 ... 10 V (referenced to GND)

Curves
Flow-rate as a function of setpoint value and P1, P2, P4 = 0 bar (free-flowing):

Flow direction
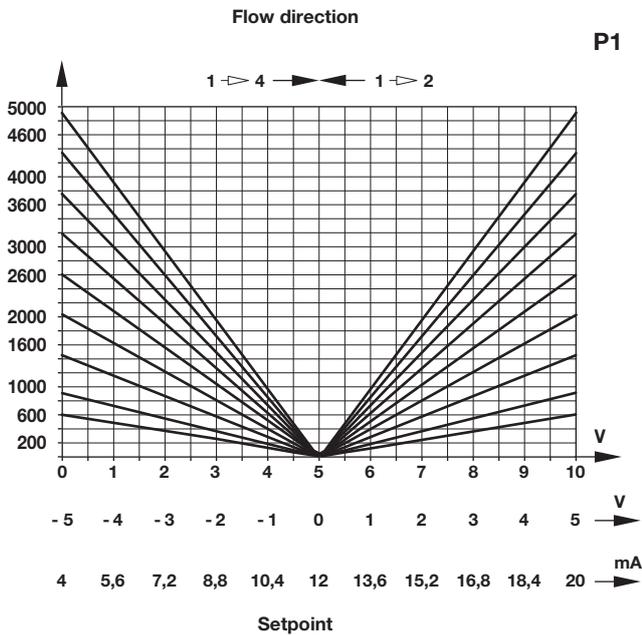
Flow-rate as a function of setpoint value at constant pressure P1=6 bar, P2, P4 = 5 bar:

Flow direction
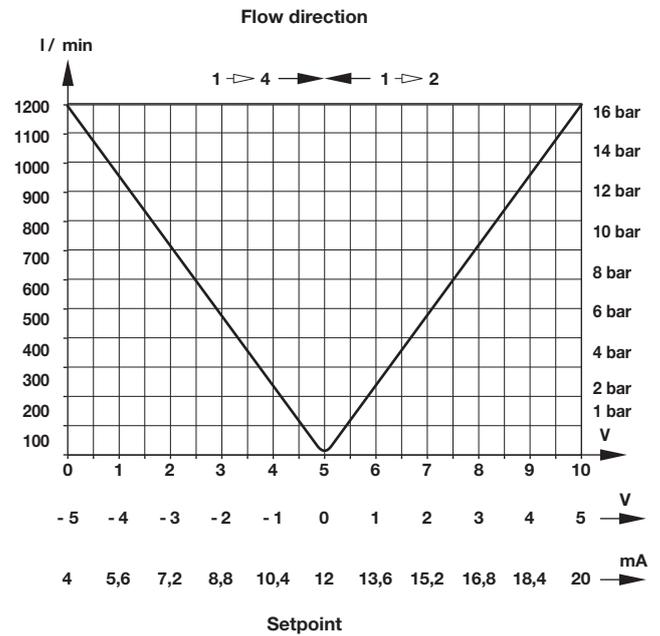
Frequency response and phase of spool position-controller for 10, 50 and 100% setpoints
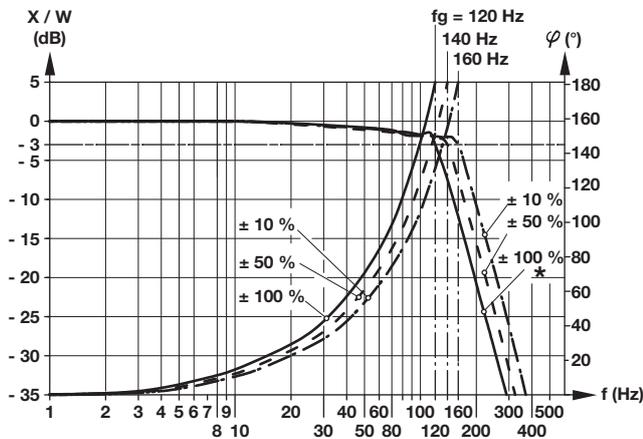
Valve in 5/3 operation. 0% corresponds to centre position

Flow-rate as a function of the pressure ratio P2/P1 for setpoint values 10, 20, ...100%

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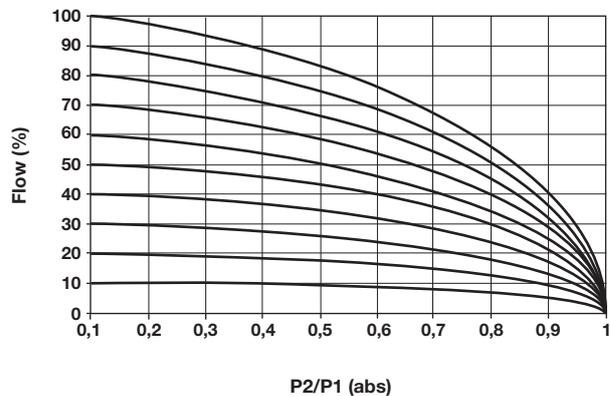
Basic dimensions
Standard model G1/4 and 1/4 NPT

Dimensions in mm
Projection/First angle
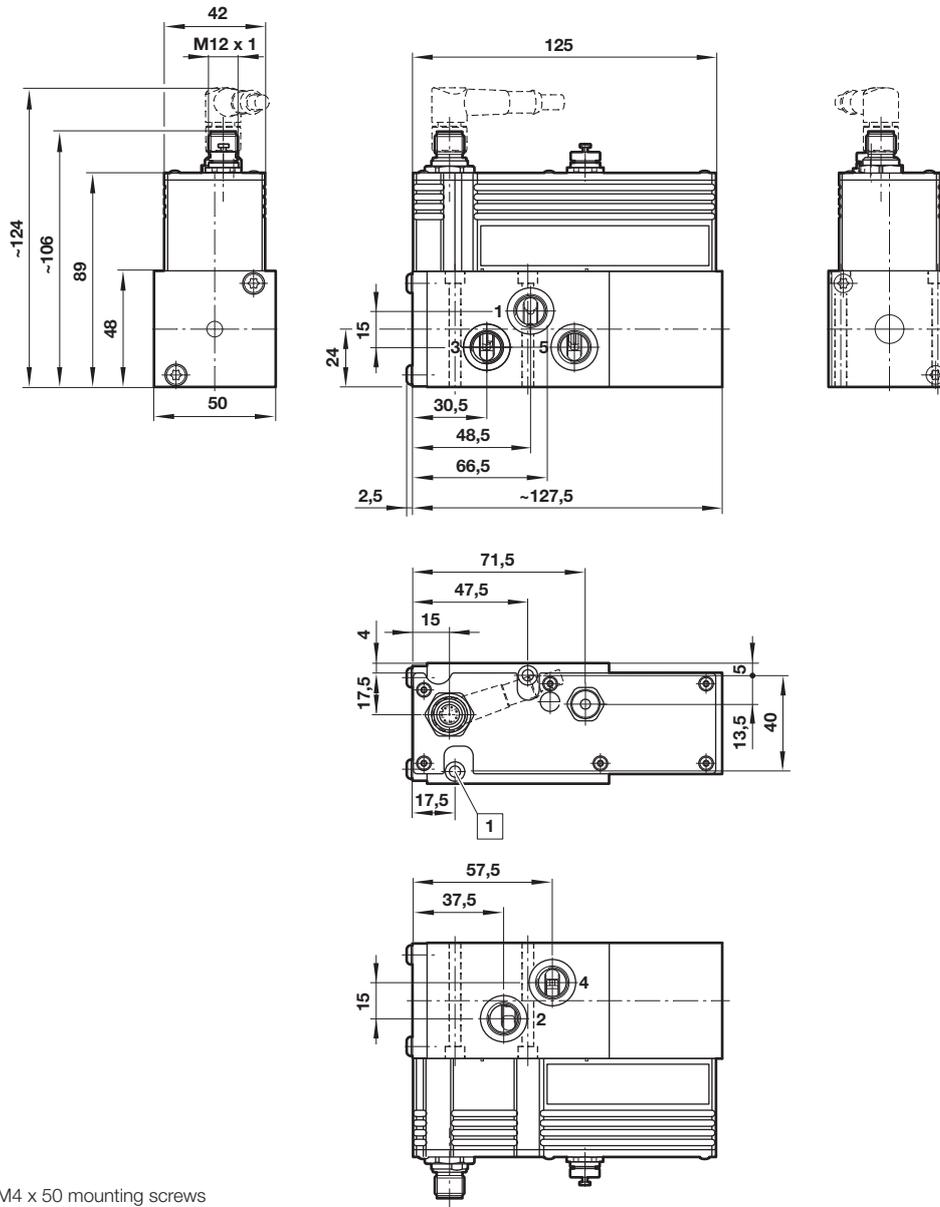
1 Valves are delivered with M4 x 50 mounting screws

Warning

These products are intended for use in industrial compressed air systems only. Do not use these products where pressures and temperatures can exceed those listed under **»Technical features/data«**.
Before using these products with fluids other than those specified, for non-industrial applications, life-support systems or other applications not within published specifications, consult IMI Precision Engineering, Norgren GmbH.
Through misuse, age, or malfunction, components used in fluid power systems can fail in various modes.

The system designer is warned to consider the failure modes of all component parts used in fluid power systems and to provide adequate safeguards to prevent personal injury or damage to equipment in the event of such failure.
System designers must provide a warning to end users in the system instructional manual if protection against a failure mode cannot be adequately provided.
System designers and end users are cautioned to review specific warnings found in instruction sheets packed and shipped with these products.