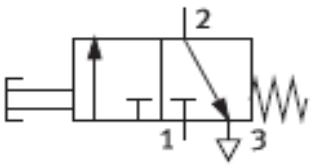
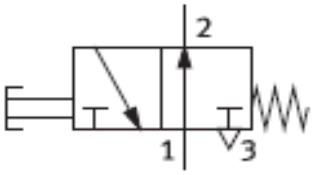
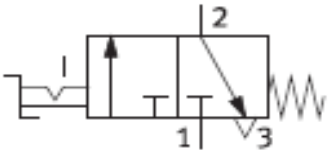
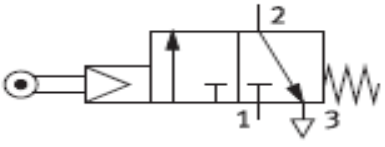
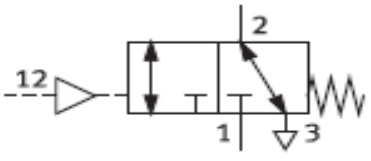
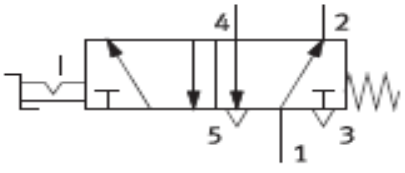
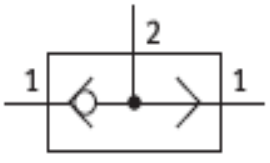
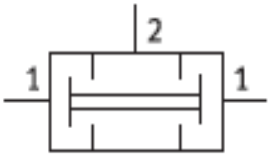
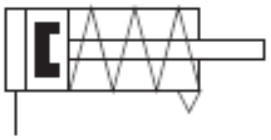
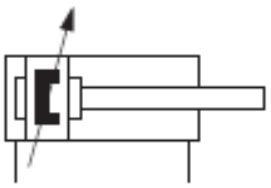
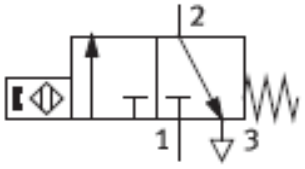
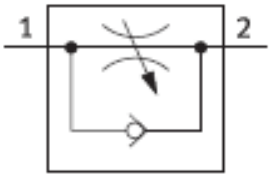
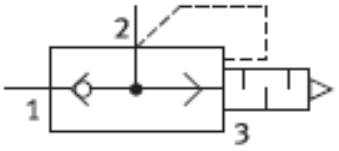
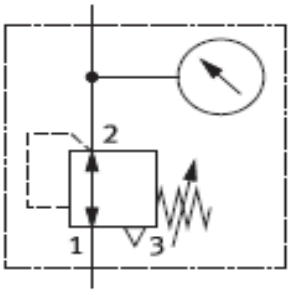
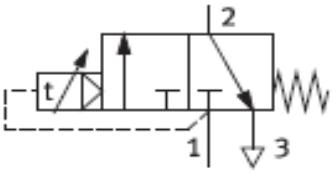
3.0 COMPONENTS

3.1 Components Set Symbols

Component	Symbol
3/2-way valve with pushbutton actuator, normally closed -SJ1	
3/2-way valve with pushbutton actuator, normally open -SJ1	
3/2-way valve with selector switch	
3/2-way roller-actuated valve, normally closed -BG1	
3/2-way valve, pneumatically actuated, one side -QM1	
5/2-way valve with selector switch -SJ1	
OR valve -KH1	
AND valve -KH1	

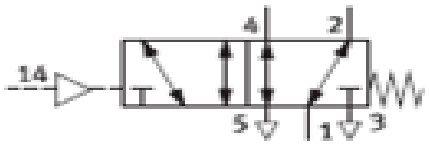
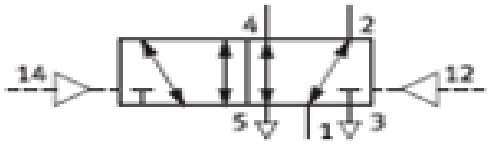
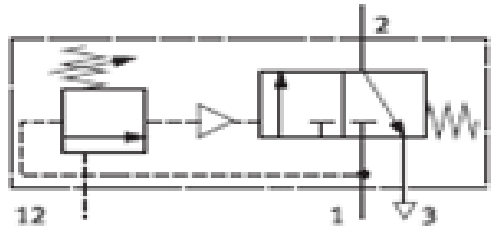
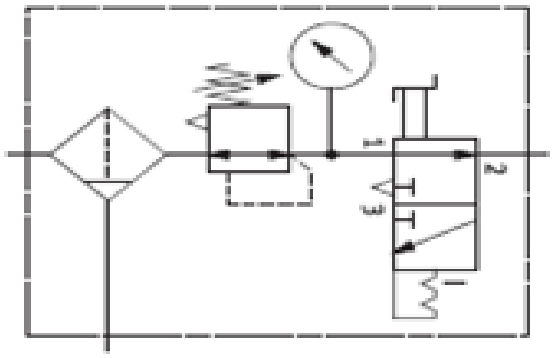
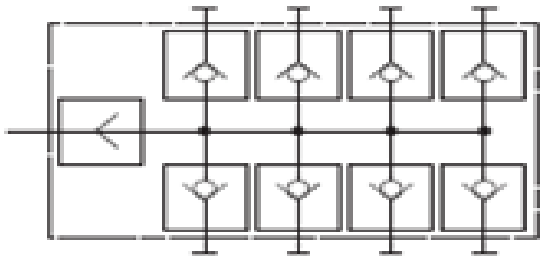
3.0 COMPONENTS

3.1 Components Set Symbols

Component	Symbol
Single-acting cylinder -MM1	
Double-acting cylinder -MM1	
Pneumatic proximity sensor -BG1	
One-way flow control valve -RZ1	
Quick-exhaust valve -KH1	
Pressure gauge -PG1	
Pressure regulator with gauge -PG1	
Pneumatic timer, normally closed	

3.0 COMPONENTS SET SYMBOLS

3.1 Components Set Symbols

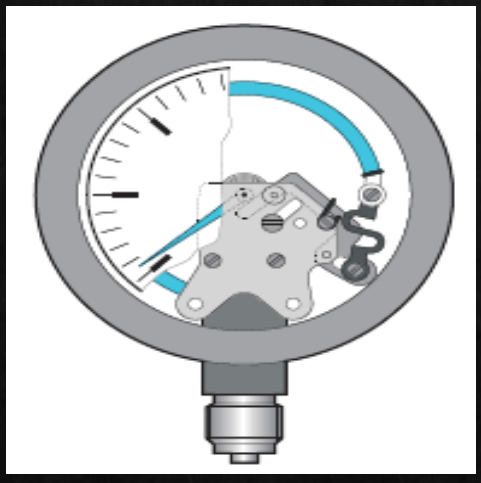
5/2-way valve, pneumatically actuated, one side -QM1	
5/2-way bistable valve, pneumatically actuated, both sides -QM1	
Pressure sequence valve -QN1	
On-off valve with filter regulating valve -AZ1	
Distributor block -XM1	

3.0 COMPONENTS SET SYMBOLS

3.2 Components Information

3.2.1 Bourdon pressure gauge

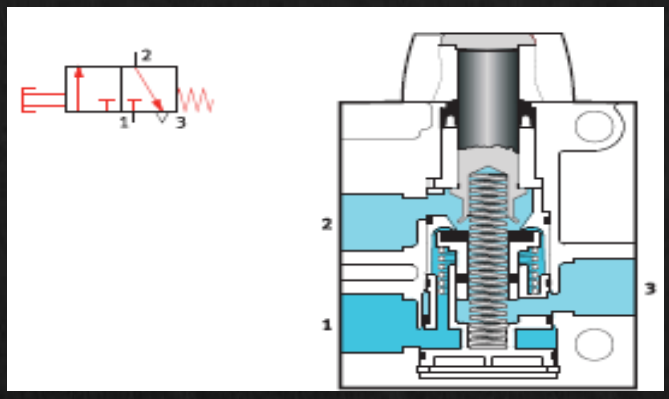
- A Bourdon pressure gauge consists essentially of a C-shaped, bent metal tube, which is sealed at one end and rigidly connected to the connecting flange at the other. The pressure that needs to be measured is generated in the tube, and ambient pressure prevails outside of the tube as a reference value.
- If the measured pressure is lower than the atmospheric pressure, the metal tube's curvature increases. If the measured pressure is greater than the atmospheric pressure, the metal tube straightens out.
- A measuring mechanism is attached to the sealed end of the tube so that its displacement can be indicated on a scale. The scale is linear, and can show both overpressure and partial vacuum (negative values).



3.2.1

3.2.2 3/2-way valve

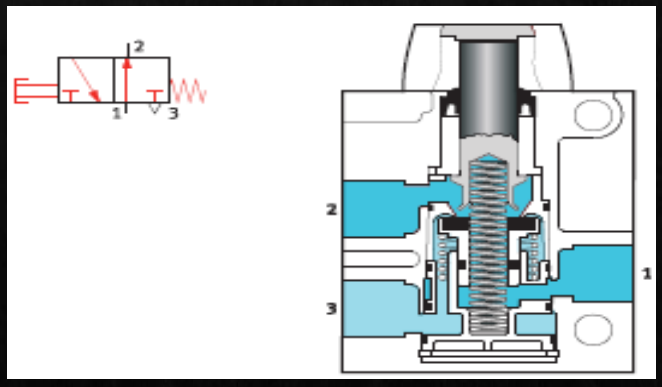
- A 3/2-way valve has 3 ports and 2 switching positions. It is shown here in its normal position.
- **"Normally closed"** means that the compressed air cannot flow through the valve. When the pushbutton actuator is pressed, the 3/2-way valve opens up the air flow. The piston chamber of a connected cylinder is pressurized and the piston rod advances.



3.2.2

3.2.3 3/2-way valve

- A 3/2-way valve, **normally open**, has 3 ports and 2 switching positions. It is shown here in its normal position.
- This variant of the valve is normally open. This means that the compressed air flows through the valve to the cylinder, holding the cylinder's piston rod in the advanced end position. When the pushbutton actuator is pressed, the 3/2-way valve closes, shutting off the compressed air. The cylinder's piston chamber can exhaust via the 3/2-way valve, and the piston rod retracts.



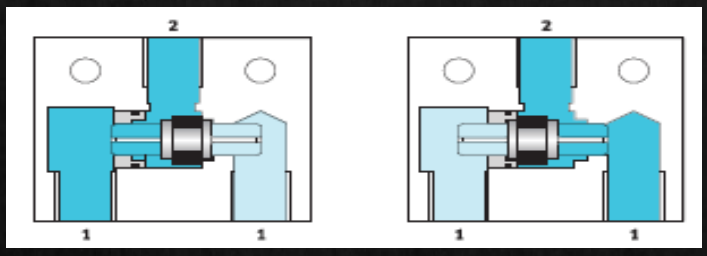
3.2.3

3.0 COMPONENTS SET SYMBOLS

3.2 Components Information

3.2.4 OR valve

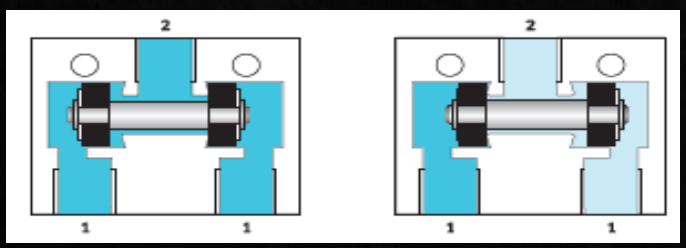
- The OR valve has two inputs (1) and one output (2).
- When the left-hand input (1) is pressurized with compressed air, it seals off the piston for the righthand input (1). The compressed air flows from the left-hand input (1) to the output (2). When the compressed air from the right-hand input (1) reaches the output (2), the left-hand input (1) is shut off.
- When the compressed air flows back, the pressure conditions hold the piston in position.
- This valve is also called an OR gate.
- If a cylinder or a control element needs to be actuated from two or more locations, one or more OR valves must always be used.
- If there are signals at both inputs, the signal that arrives first or has the higher pressure will reach the output.



3.2.4

3.2.5 AND valve

- The AND valve has two inputs (1) and one output (2).
- The air can only flow through it when both input signals are present. If there is only an input signal at one of the two inputs, the flow will be shut off due to the differential forces at the piston spool.
- If there is a time delay between the two input signals, but they both have the same inlet pressure, the last signal that arrives reaches the output.
- If there is a difference in pressure between the two signals, the signal with the higher pressure closes the valve while the signal with the lower pressure reaches the output (2).
- The AND valve is used mainly for locking control systems, monitoring functions and AND logic operations.
- This valve is also called an AND gate.



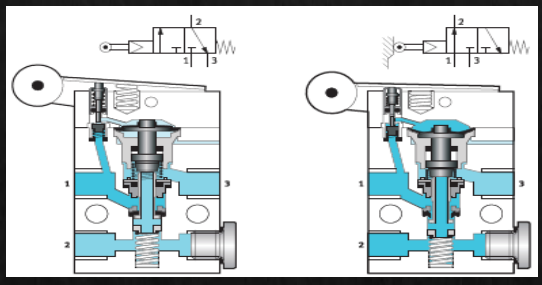
3.2.5

3.2.6 3/2-way roller-actuated valve

- A 3/2-way roller-actuated valve has 3 working ports and 2 switching positions.
- The roller plunger can be actuated in a number of ways, e.g. by the trip cam of a cylinder. Thanks to the pilot control, a reduced actuating force is generated.

Description

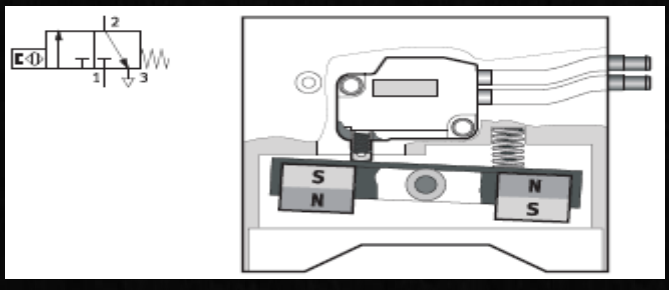
- A duct with a small diameter connects supply port 1 with the pilot valve. When the pilot valve opens, the compressed air flows to the diaphragm and moves the valve disc of the main valve downward.
- When the pilot valve is closed, exhausting takes place along the guide bushing of the plunger. On directional control valves with a spring return, the valve disc of the main valve is returned to its normal position by the spring return.



3.2.6

3.2.7 Pneumatic proximity sensor

- A 3/2-way stem-actuated valve is actuated by a switching jack with a spring return and a built-in permanent magnet.
- The ring magnet, which is mounted on the piston of a cylinder, reverses the direction of the switching jack. The 3/2-way stem-actuated valve switches and a control signal is generated at port 2 of the valve.
- Pneumatic proximity sensors sense the positions of the cylinder pistons. They are only used in pure pneumatic control systems. Pneumatic proximity sensors are mounted directly on the cylinder barrel.



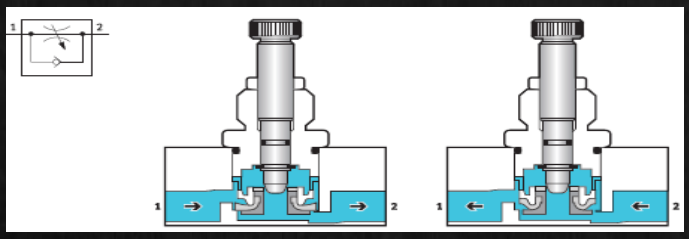
3.2.7

3.0 COMPONENTS SET SYMBOLS

3.2 Components Information

3.2.8 One-way flow control valve

- In a one-way flow control valve, the air flow is controlled in one direction only. The check valve shuts off the air flow in one direction so that the air can only flow via the set cross section. Air flows freely in the reverse direction through the open check valve.
- These valves are used primarily to regulate the speed of pneumatic cylinders. One-way flow control valves can be used to control the speed of the piston rod by regulating the flow rate.



3.2.8

3.2.9 Two types of flow control used in a double-acting cylinder.

Supply air flow control

- With supply air flow control, the one-way flow control valves are installed in such a way that the air flow to the cylinder is controlled. The exhaust air can escape freely on the outlet side via the check valve. The smallest fluctuations in load at the piston rod, e.g. when the rod passes a proximity sensor, result in erratic feed speeds. A load in the cylinder's direction of movement accelerates the cylinder above the set value.

Exhaust air flow control

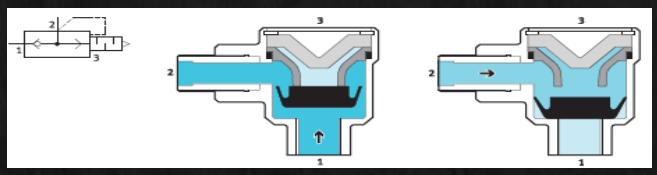
- With exhaust air flow control, the supply air flows freely to the cylinder and the flow control valve in the outflow pipe offers resistance to the outward flow. The piston is clamped between two air cushions that build up due to the pressure of the supply air and the resistance of the flow control valve for the exhaust air. This configuration of one-way flow control valves helps greatly to improve the feed behavior. Exhaust air flow control should be used with double-acting cylinders.

Type of flow control

- This control system provides exhaust air flow control. The supply air flows freely to the cylinder via the check valve. The exhaust air flows through the flow control valve.

3.2.10 Quick-exhaust valve

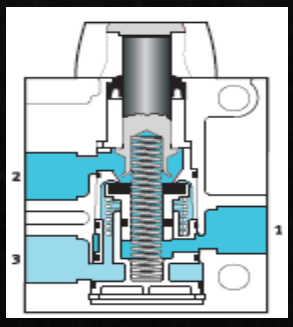
- Can be used to achieve higher piston speeds on the return stroke of single and double-acting cylinders. The quick-exhaust valve reduces the flow resistance of the exhaust air during the movement.
- Compressed air flows from the control valve and via the quick-exhaust valve to the cylinder. This closes exhaust port 3.
- When the pressure at port 1 falls, exhaust flow occurs from port 2 to port 3. In order to allow optimum quick exhausting, the valve must be mounted directly on the cylinder's air connection.



3.2.10

3.2.11 3/2-way valve

- A 3/2-way valve, **normally open**, has 3 ports and 2 switching positions. It is shown here in its normal position.
- This variant of the valve is normally open. This means that the compressed air flows through the valve to the cylinder, holding the cylinder's piston rod in the advanced end position. When the pushbutton actuator is pressed, the 3/2-way valve closes, shutting off the compressed air. The cylinder's piston chamber can exhaust via the 3/2-way valve, and the piston rod retracts.



3.2.11

3.0 COMPONENTS SET SYMBOLS

3.2 Components Information

3.2.12 Pressure sequence valve

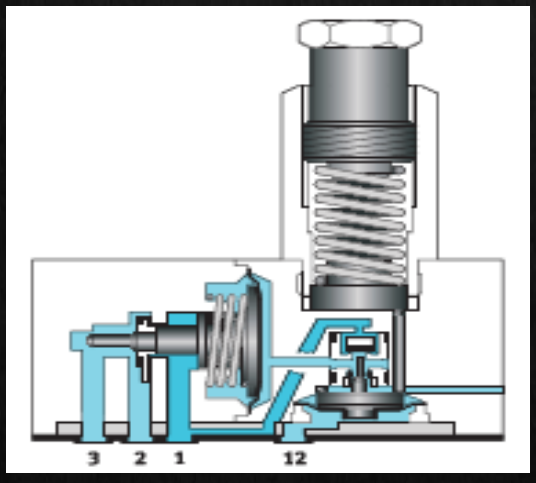
- When the pressure at pilot port 12 exceeds a predefined level, the actuated 3/2-way valve switches; there is compressed air at working port 2.
- The 3/2-way valve switches back when the pressure at pilot port 12 drops below the set level.

Application

- The pressure sequence valve is used when a pressure-dependent signal is required to switch a control system again.

Examples of applications:

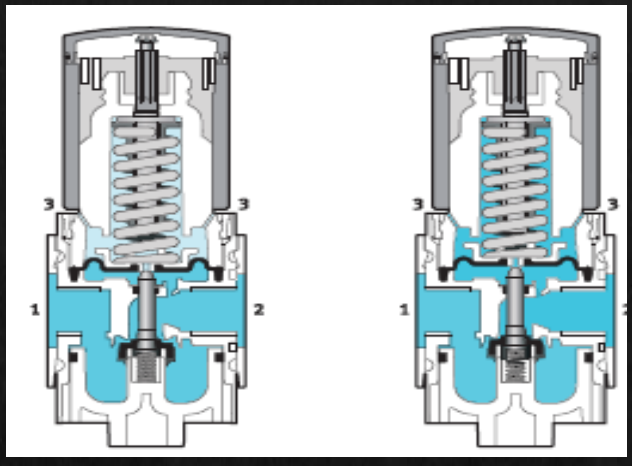
- Building up a clamping pressure for cylinders
- Dropping below the operating pressure



3.2.12

3.2.13 Pressure regulator

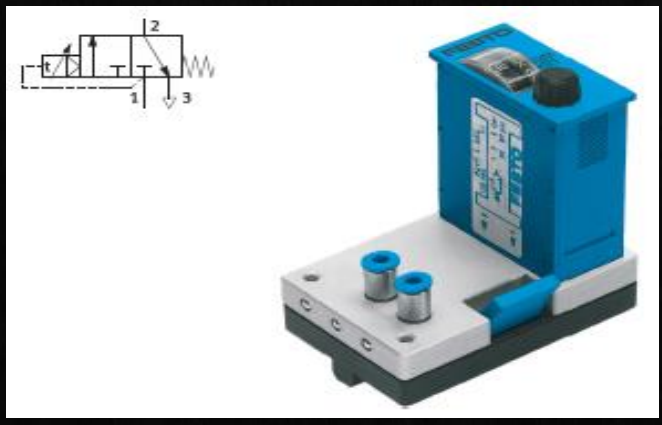
- The inlet pressure (primary pressure) at the pressure regulator must always be higher than the outlet pressure (secondary pressure). The pressure regulation itself is performed by a diaphragm. The outlet pressure acts on one side of the diaphragm, the force of a spring on the other. The spring force can be set using an adjusting screw.
- If the pressure on the secondary side increases, e.g. during a load change at the cylinder, the diaphragm is pressed against the spring and the outlet cross-sectional area at the valve seat is reduced or closed. The valve seat of the diaphragm opens and the compressed air can escape into the atmosphere through the relief ports in the housing.
- If the pressure on the secondary side decreases, the spring force opens the valve. Regulating the air pressure to the preset operating pressure therefore means constantly opening and closing the valve seat. This is done by the air volume flowing through the regulator.



3.2.13

3.2.14 Pneumatic timer

- The pneumatic timer switches the inlet pressure at port 1 to 2 after a set period of time. If the compressed air supply at port 1 is interrupted, working port 2 is depressurized again. The pneumatic timer is reset automatically after 200 ms. The time delay can be adjusted steplessly using an adjusting knob.



3.2.14

3.0 COMPONENTS SET SYMBOLS

3.2 Components Information

3.2.15 5/2-way valve

How a 5/2-way valve, unactuated, works

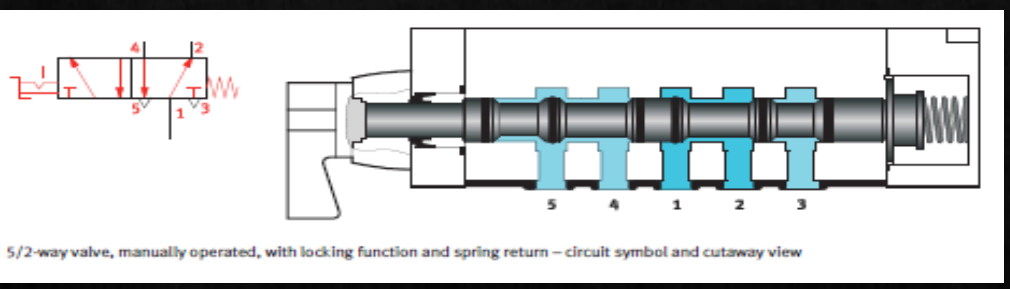
- When the 5/2-way valve is not actuated, the spring return holds the control piston valve in its initial position. The piston rod side of a connected double-acting cylinder is pressurized and the piston rod retracts.

How a 5/2-way valve, actuated, works

- When the 5/2-way valve is actuated, the control piston is pushed against the valve's spring return. In this state, the supply port is connected to the piston side of the cylinder via the valve, while the piston rod side is exhausted via the valve. The pressure that builds up on the piston side causes the piston rod to advance. As soon as the piston rod reaches its advanced end position, the maximum operating pressure builds up on the piston side of the cylinder.

Actuation with a switch

- If the valve is actuated with a switch, the valve position remains unchanged until the switch is switched back.



5/2-way valve, manually operated, with locking function and spring return – circuit symbol and cutaway view

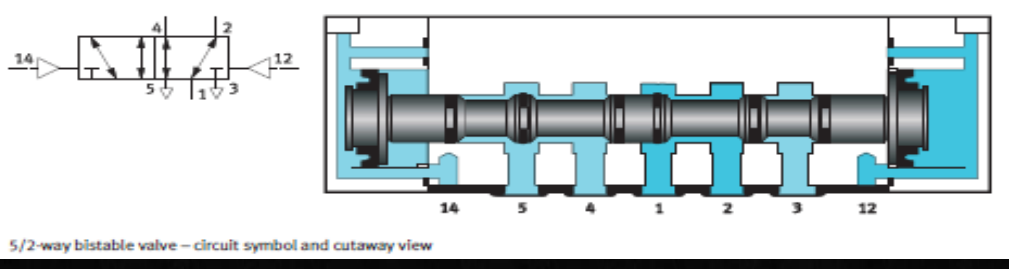
3.2.15

3.2.16 5/2-way bistable valve

- A 5/2-way bistable valve has 5 working ports and 2 switching positions. The valve is equipped with a latching function, and a short signal (pulse) at the pilot ports suffices for reversal.
- When a compressed air pulse is generated at one of the two pilot ports (12/14), the valve piston is moved to the opposite switching position. The compressed air from the working port holds the valve piston in this position until a compressed air pulse on the opposite side switches the valve back to the previous position. If there are signals at both pilot ports, the one that arrives first takes precedence.
- A pneumatic signal at pilot port 12 results in flow from port 1 to port 2. A pneumatic signal at pilot port 14 results in flow from port 1 to port 4.

Description

- When pilot port 14 is pressurized with compressed air, the valve piston is moved to the right. The compressed air flows from port 1 to port 4. Port 2 is exhausted via port 3. When pilot port 14 is depressurized again, the valve remains in the same position.



5/2-way bistable valve – circuit symbol and cutaway view

3.2.16

3.0 COMPONENTS SET SYMBOLS

3.2 Components Information

3.2.17 Single-acting cylinder

- In the normal position, the piston rod is kept retracted by the spring return. A permanent magnet is mounted on the piston for position sensing purposes.

Description

- The compressed air flows into the cylinder's piston chamber. Pressure is built up in the chamber and force is applied to the surface of the piston as a result. When this force exceeds the static friction, the piston advances. The full operating pressure is not reached until the piston is fully advanced.
- When the pressure drops, the built-in spring return pushes the piston back to its start position. The spring force is not great enough to move heavy loads on the piston rod. As such, single-acting cylinders only work in one direction.

3.2.18 Double-acting cylinder

- A permanent magnet is mounted on the piston for position sensing purposes. The cylinder has adjustable end-position cushioning on both sides.

Description

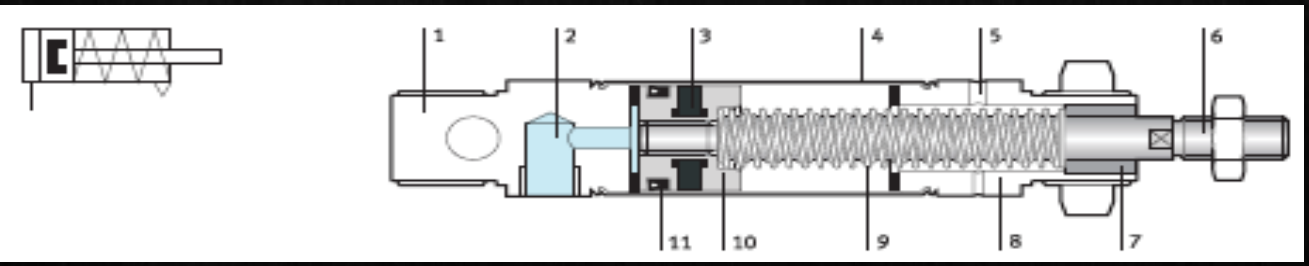
- The double-acting cylinder has a higher air consumption than the single-acting cylinder. Due to the different surface areas on the piston and piston rod sides, there are different effective forces at the same pressure.

Forward stroke

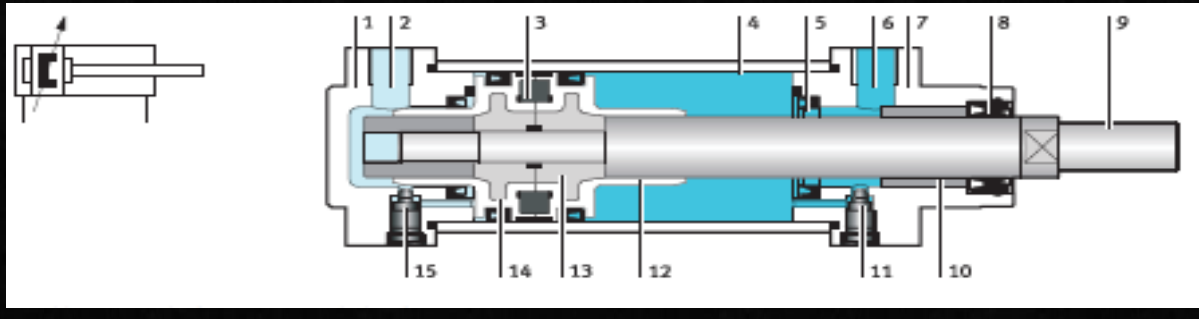
- The compressed air flows through the piston chamber supply port and into the cylinder. Pressure is built up in the chamber and force is applied to the surface of the piston as a result. When this force exceeds the static friction, the piston advances – and as a result, so does the piston rod. The air in the piston rod chamber escapes through the port on the piston rod side. The full operating pressure is not reached until the piston is fully advanced.

Return stroke

- On reversal, the air flows into the piston rod chamber supply port, where it builds up the pressure until the piston moves back. The air escapes from the piston chamber via the piston chamber port.



3.2.17



3.2.18

3.0 COMPONENTS SET SYMBOLS

3.2 Components Information

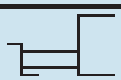
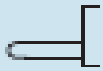
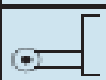
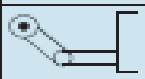
The type of actuation used for the directional control valves depends on the system requirements. The following types of actuation are possible:

- Manually operated
- Pneumatically actuated
- Mechanically actuated
- Combined types of actuation

A complete description of a directional control valve in the pneumatic circuit diagram includes:

- The basic type of actuation method used for the valve
- The pilot control (where applicable)
- The return control
- Additional types of actuation (where applicable)

Each actuation symbol is drawn on the side of the switching position that corresponds to its direction of action.

Function	Symbol
Manual operation	
Pressing	
Turning	
Lever operation	
Mechanical actuation	
With plunger	
With roller plunger	
With roller lever	
Pneumatic actuation	
Using compressed air	
Pneumatic spring return	
Mechanical components	
Spring return