

Introduction to Pneumatic Technology in Mechatronics



Pneumatics in our life

Applications of Pneumatics



Dismantle an automobile tire



Automobile painting



A heavy duty pneumatic jackhammer



Filling machine



A dental drill



Fill the tire with compressed air to adjust the tire pressure.

Application of Pneumatic



Operator for single door panel



Operator for double door panel



single panel



double panel

Overview

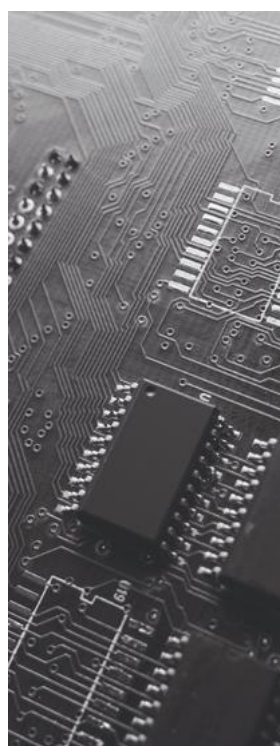
Pneumatics play a major role in the automated work environment and are still gaining in importance. Many production processes would be inconceivable without them. Pneumatics are an inherent part of almost every production system in the following industry sectors:



automotive



food industry and
packaging



electronics



handling



processing
industry



biotechnology/
pharmaceuticals

Overview



In these industries, pneumatics are used to perform the following functions:

- Replacing human force such as arms and fingers
- Creating a very fast movement compared to human limbs
- Creating a hygienic production scene
- Detecting states by means of input elements (sensors)
- Processing information using processing elements (processors)
- Switching operating elements by means of control elements
- Doing work using operating elements (drives)



Overview (characteristics of Pneumatics)

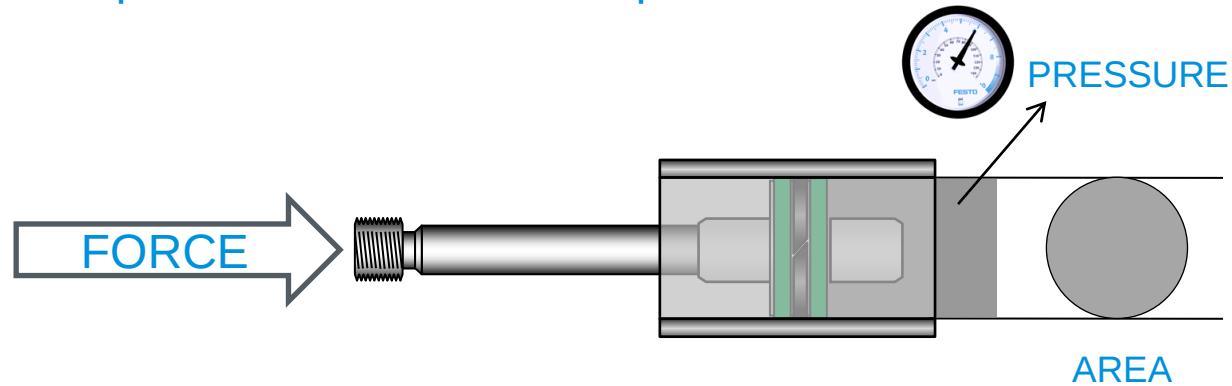
Parameter	Comment
Quantity	Air is available virtually everywhere in unlimited quantities.
Transport	Air can be very easily transported over long distances in ducts.
Storage ability	Compressed air can be stored in a reservoir and supplied from there. The reservoir can also be transported.
Temperature	Compressed air is virtually insensitive to temperature fluctuations. This guarantees reliable operation even under extreme conditions.
Safety	Compressed air does not represent a hazard in terms of fire or explosion.
Cleanliness	Leaks of unlubricated compressed air do not cause environmental pollution.
Design	The operating elements have a simple setup and are therefore inexpensive.
Speed	Compressed air is a fast working medium. It facilitates high piston speeds and fast switching times.
Overload protection	Pneumatic tools and operating elements can be loaded until they give out and are therefore overload-proof.

Definitions related to pneumatics

Force: Anything that causes an object with a mass to accelerate or decelerate. In pneumatics, this is the mass that the piston has to move or the perpendicular force that is applied to the tip of the piston rod.

Pressure: Is the force per unit area applied to an object, in pneumatics that is the pressure of the compressed air.

Area: The area of an object where the force is applied, in pneumatics that is the area of the piston or the area of the piston without the area of the rod.



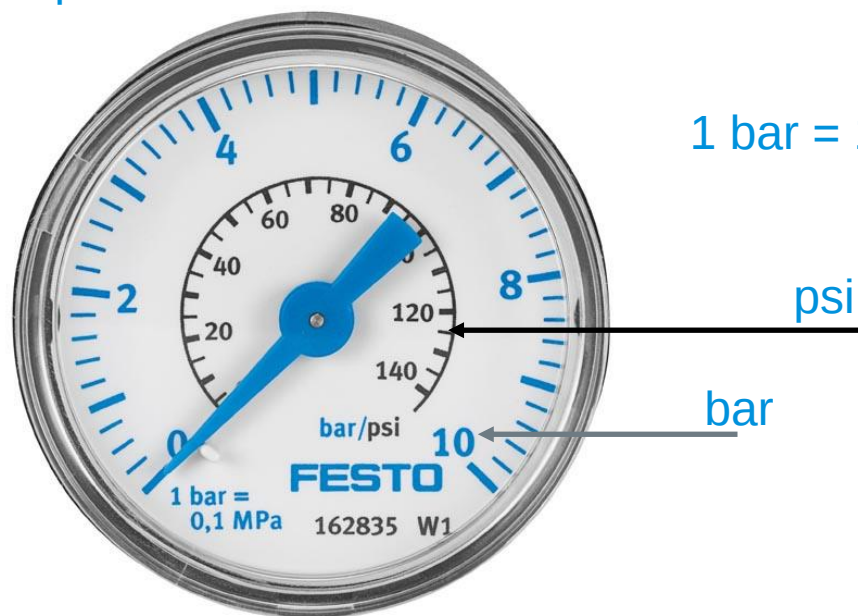
Pressure units

The most common pressure units that can be read on manometers are:

bar

psi

Mpa

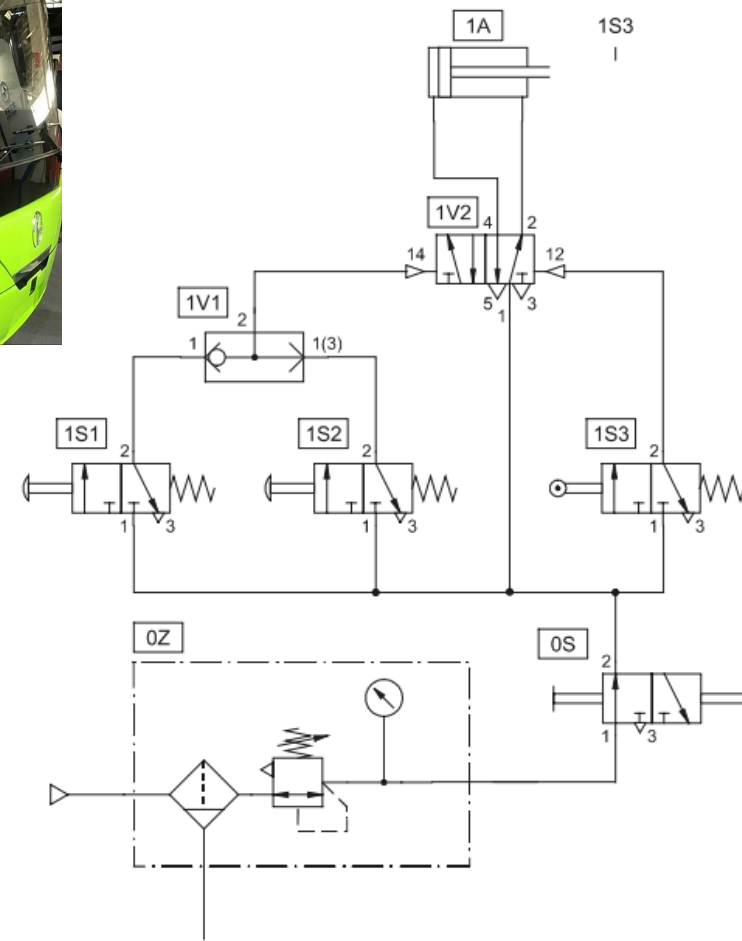
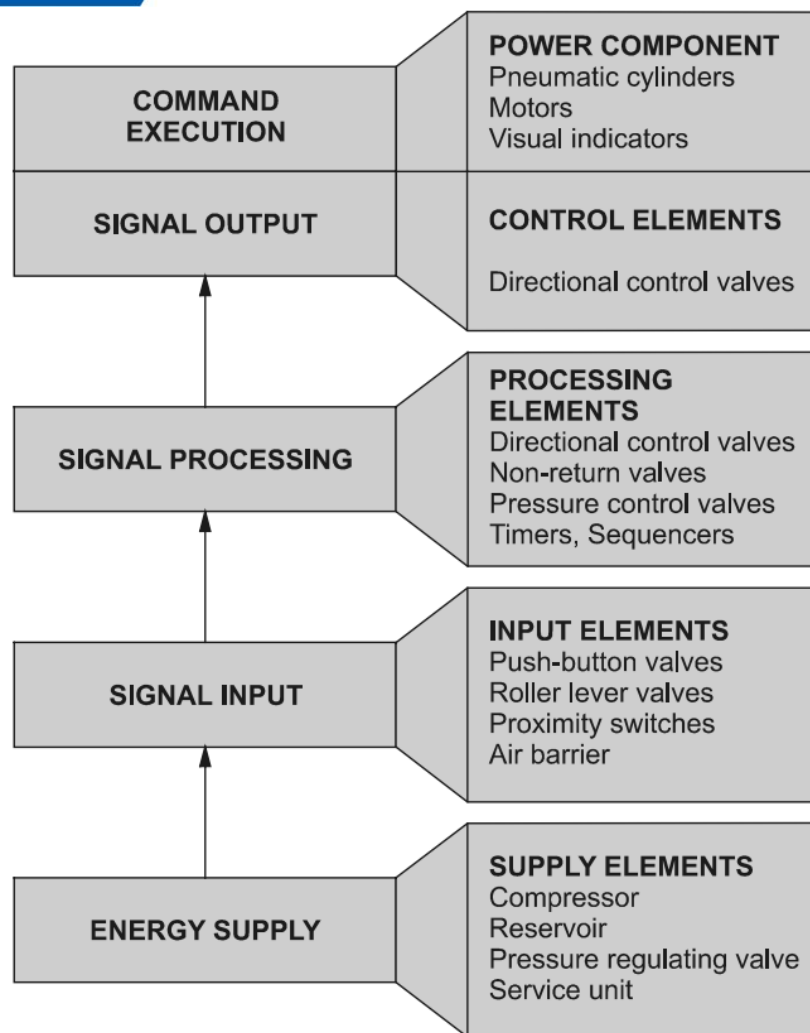


$$1 \text{ bar} = 14,5 \text{ psi} = 0,1 \text{ Mpa}$$

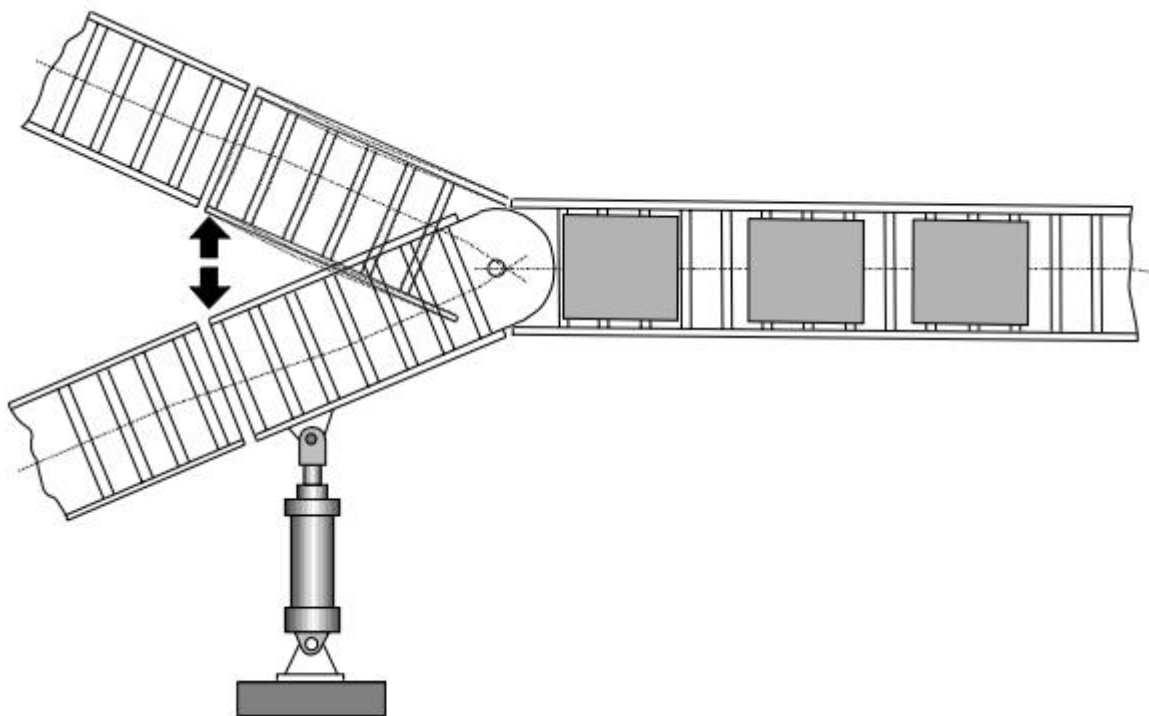
***PSI (Pounds per square inch)**



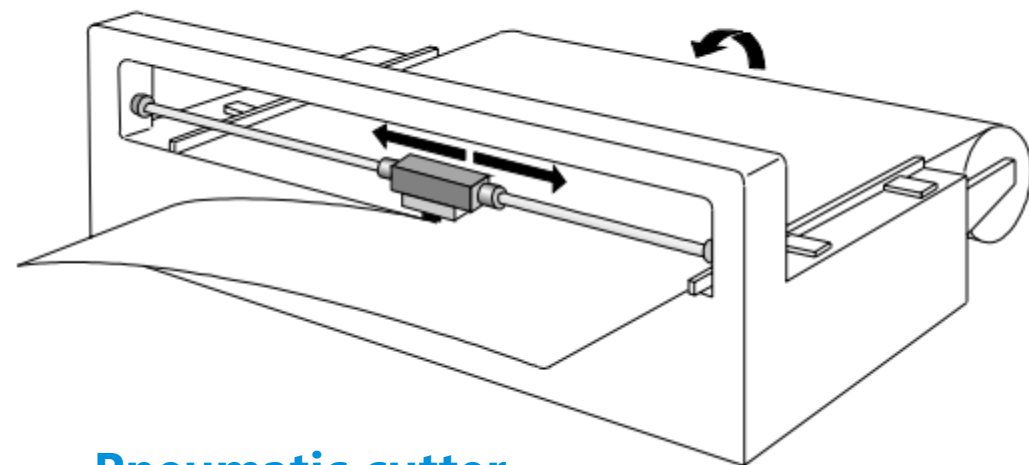
Pneumatic control system



Application Example



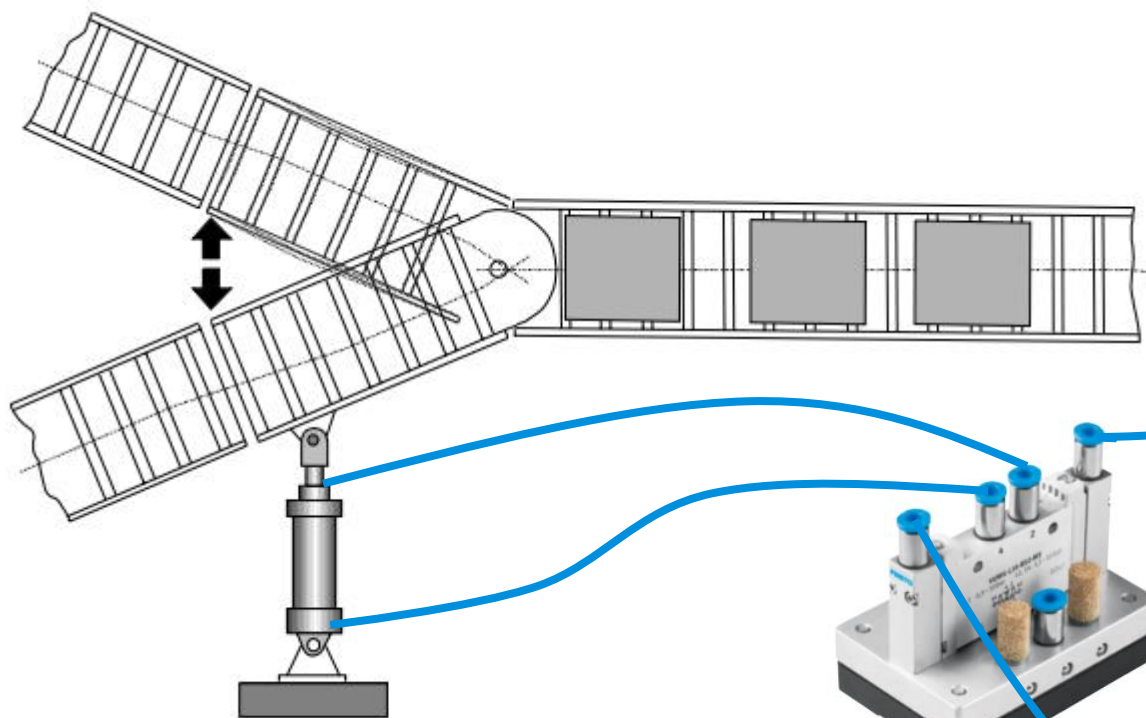
Points switch for two conveyor belts



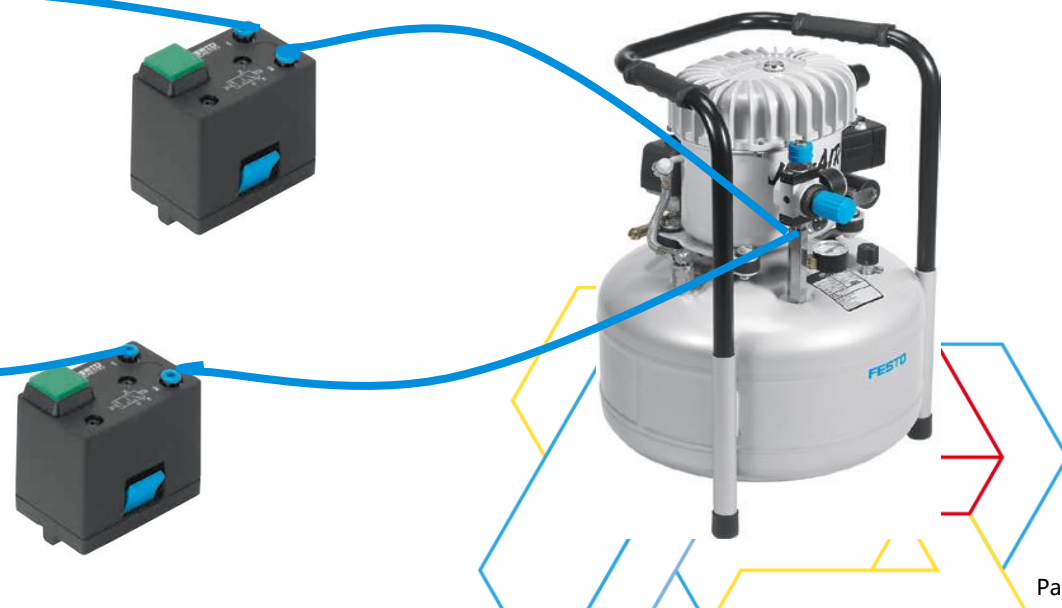
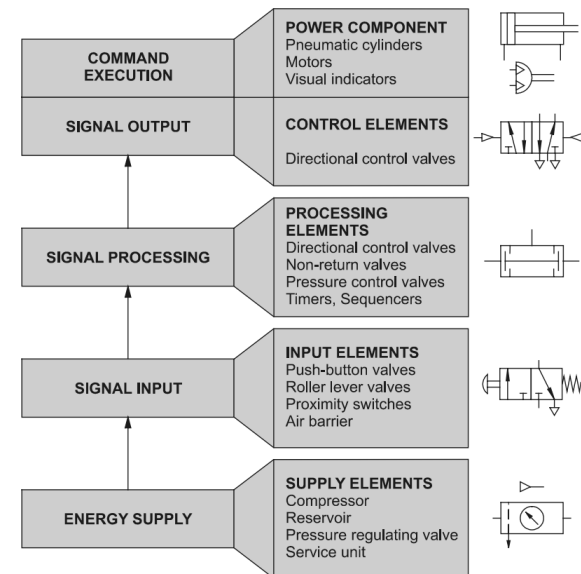
Pneumatic cutter



Application Example



Points switch for two conveyor belts



Compressor

The compressor is the starting point for any pneumatic application



Features

- Extremely quiet
- Excellent reliability
- Compact and easy to use
- Easy maintenance
- Long-life, 2-year warranty
- 50% duty cycle

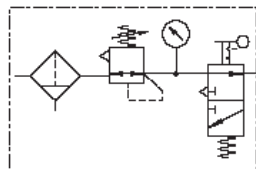
Description

- 5μm air filtration
- Pressure regulator included
- 5-year warranty on receiver

Model		6-25	
Voltage	V	1x230	1x120
Frequency	Hz	50	60
Motor	HP	0.46	0.54
	kW	0.34	0.4
Displacement	l/min	50	60
Air flow @ 8bar	l/min	32	37
	cfm	1.13	1.31
Max. pressure	bar	8	8
	psi	120	120
Max. current	A	2.9	6.2
Receiver volume	litres	25	25
	gallon	6.6	6.6
Weight	kg	26	26
	lbs	57	57
Noise level	dB(A)/1m	45	45
Duty cycle		50%	50%



Service Unit



Pressure regulating handle: When operating, the blue sleeve needs to be lifted upwards



Pressure gauge

stop valve

filter

Service unit with on/off valve

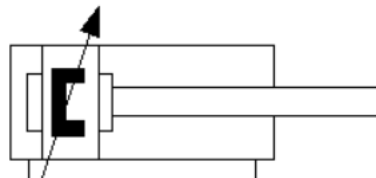
The Service unit consists of a filter, pressure gauge, shut-off valve, and quick plug, Installed on a rotatable bracket.

The filter has a water separation device that can remove condensed water, solid impurities with larger particles, and oil droplets from compressed air. The pressure reducing valve can control the working pressure in the system and compensate for pressure fluctuations.

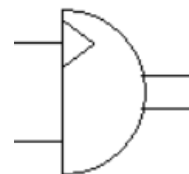
Flow rate	750 l/min
Max. input pressure	1600 kPa (16 bar)
Max. operation pressure	1200 kPa (12 bar)
Filter lever	40 μm
Condensation capacity	14 cm ³
installation angle	vertical ±5°

Cylinders

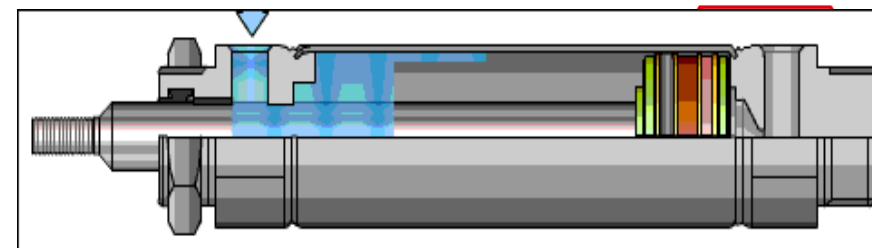
Linear cylinders



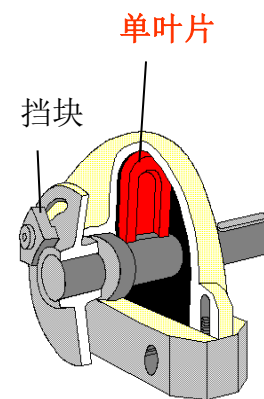
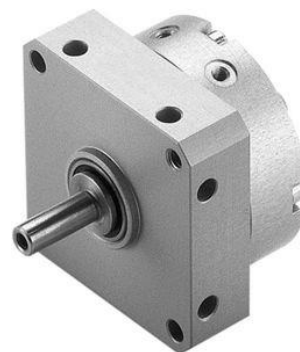
Rotary cylinders



Various cylinders (linear)



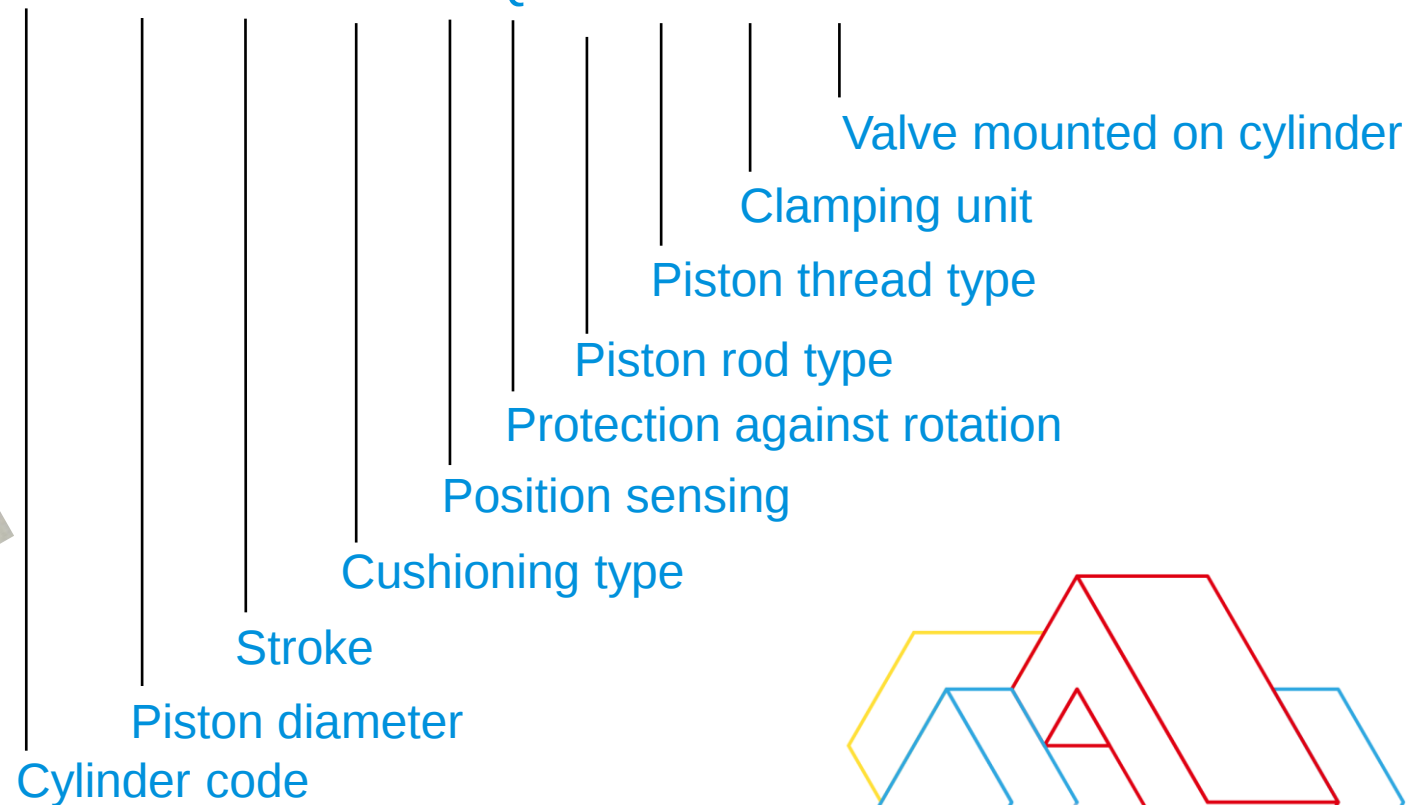
Various cylinders (rotary)



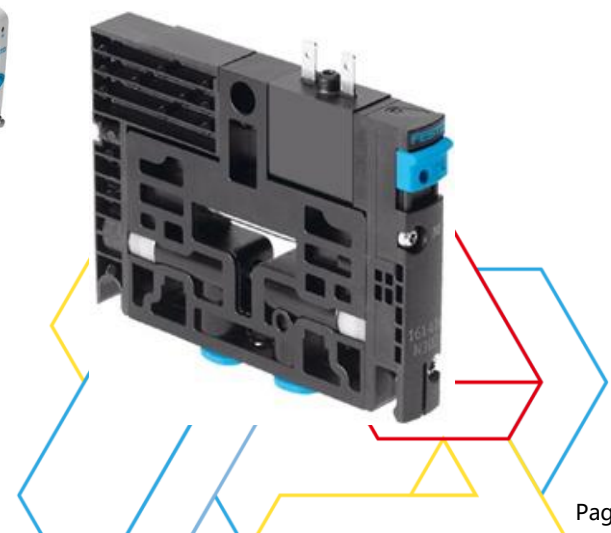
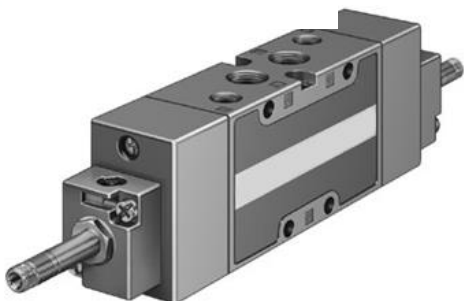
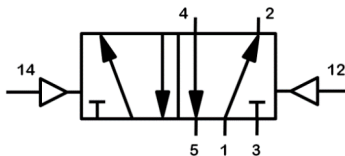
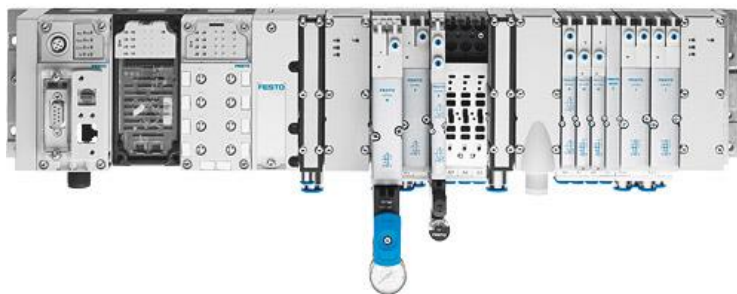
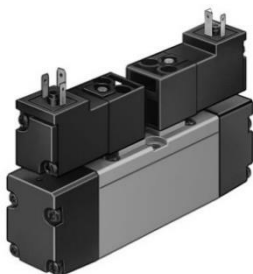
Cylinder definitions



DNC-40-150-PPV-A-Q-S2-K3-KP-V3



Valves



Directional control valves: symbol development

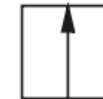
Valve switching positions are represented as squares



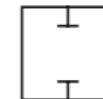
The number of squares shows how many switching positions the valve has



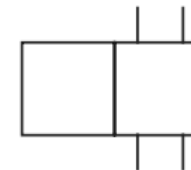
Lines indicate flow paths, arrows shows the direction of flow



Shut off positions are identified in the boxes by lines drawn at right angles



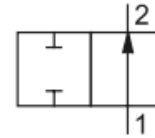
The connections (inlet and outlet ports) are shown by lines on the outside of the box



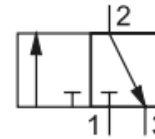
Directional control valves: ports and positions

Number of ports
Number of positions

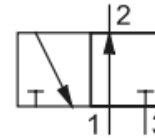
2/2 – Way directional control valve, normally open



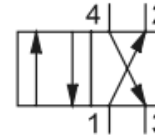
3/2 – Way directional control valve, normally closed



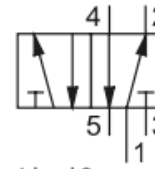
3/2 – Way directional control valve, normally open



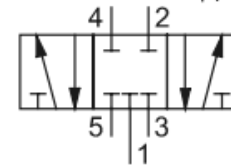
4/2 – Way directional control valve
Flow from 1 → 2 and from 4 → 3



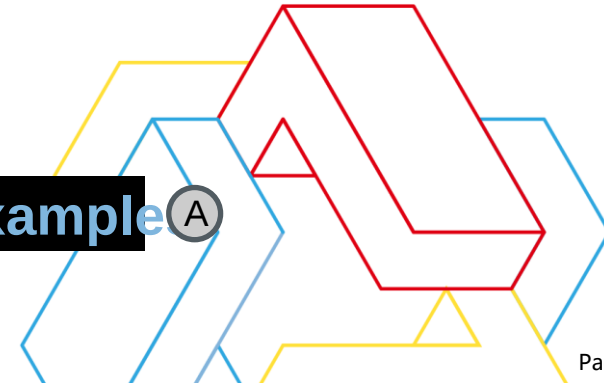
5/2 – Way directional control valve
Flow from 1 → 2 and von 4 → 5



5/3 – Way directional control valve
Mid position closed



Pneumatic applications (single acting cylinder)

Application example 

Single acting cylinder

How does it work?

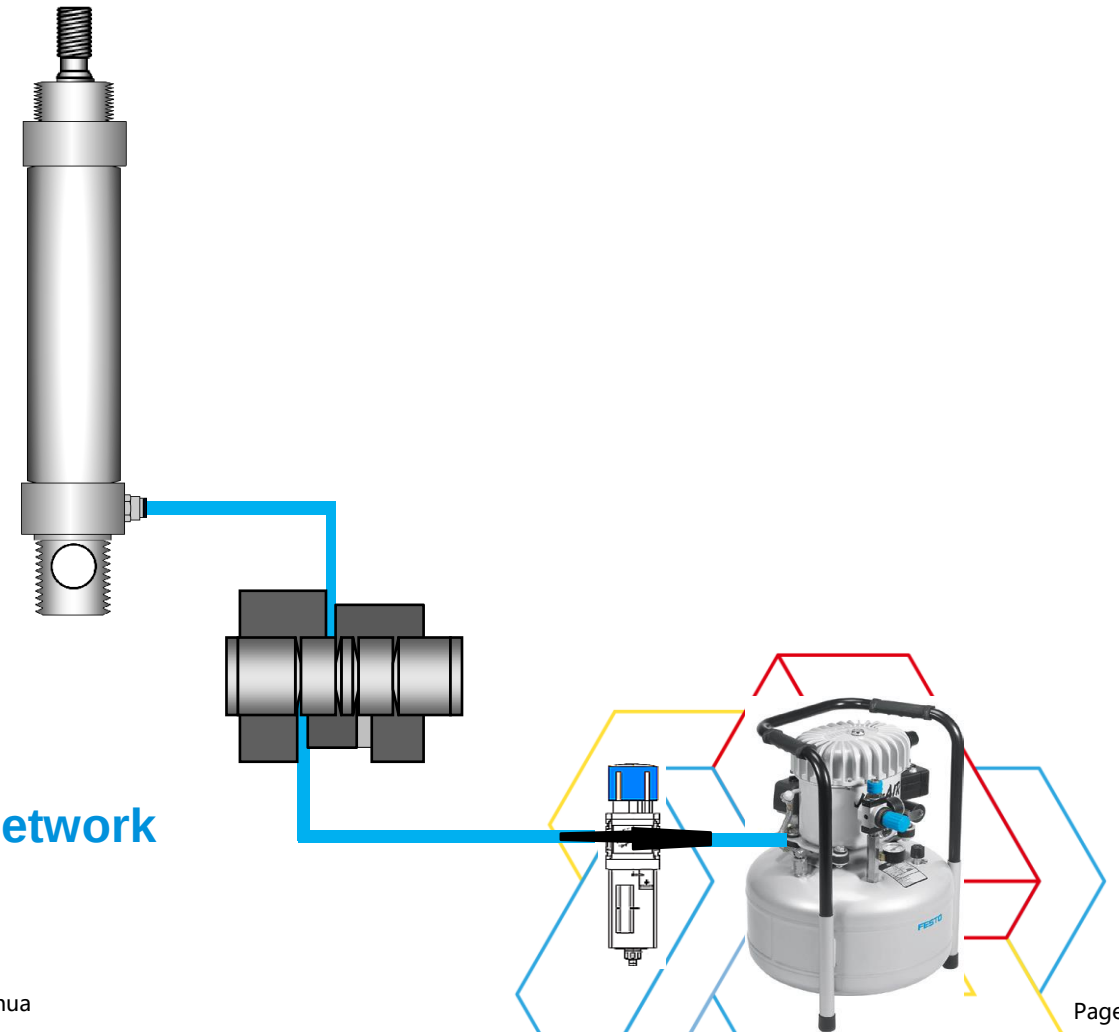
The piston moves, because:

Pressure air applies force on the piston of the **cylinder** and pushes it.

Pressure air is directed into the cylinder from the outlet of a **direction control valve**

Pressure air comes from **service unit** to the direction control valve inlet

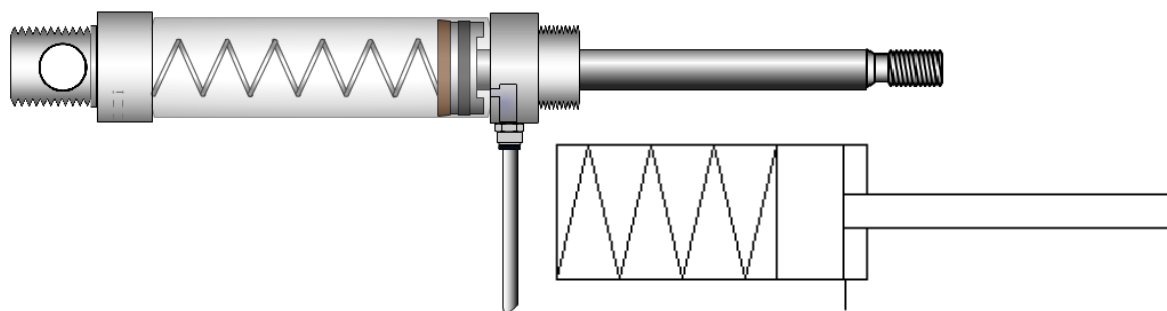
Pressure air comes to service unit from the **network** which starts with a compressor.



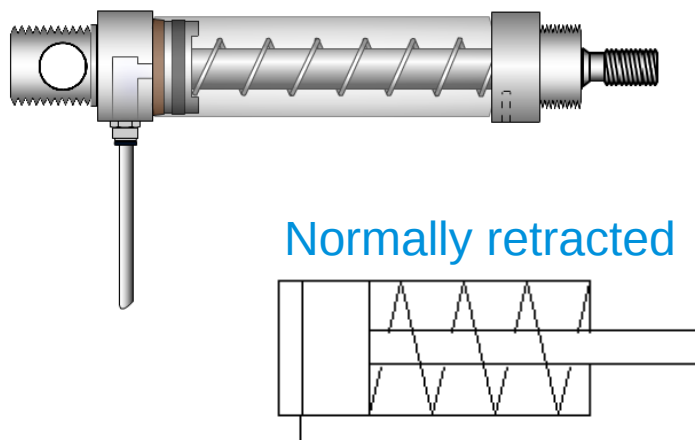
Single acting cylinder



Single acting cylinder

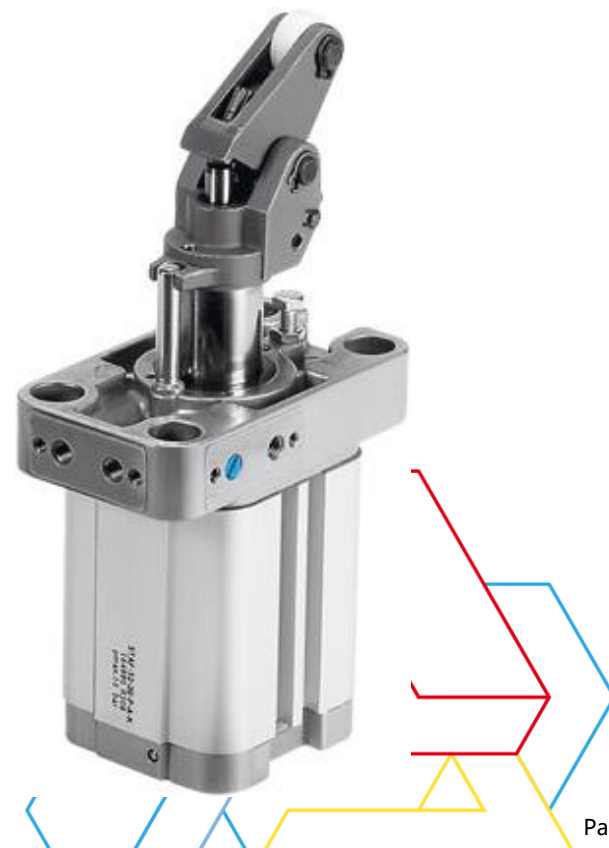


Normally extended



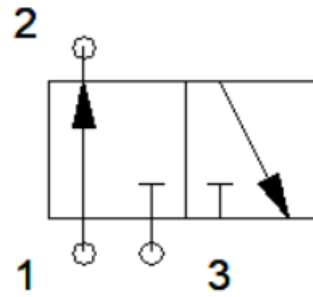
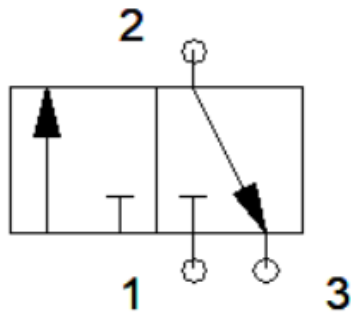
Normally retracted

Normally extended
single acting stopper

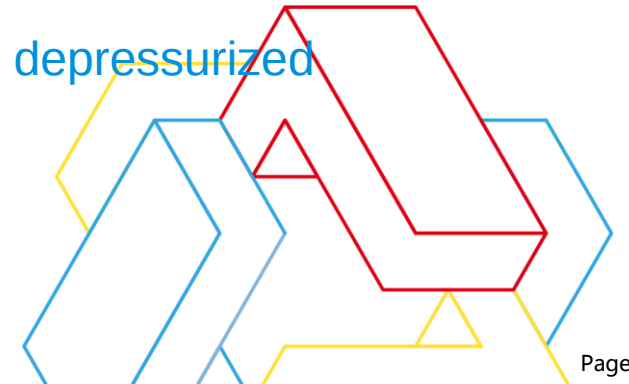


3/2 way valves

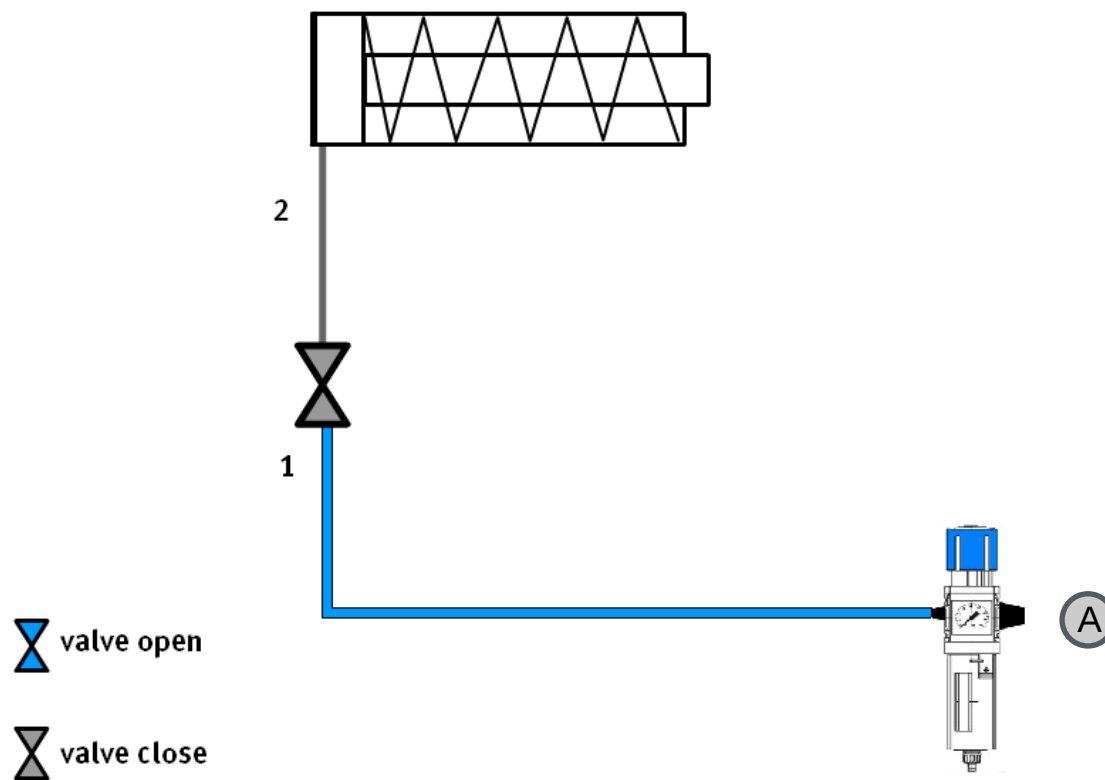
Normally closed : In the neutral position of the valve the pressure line (1) is closed (blocked) so that the working line doesn't have pressure till the valve is actuated.



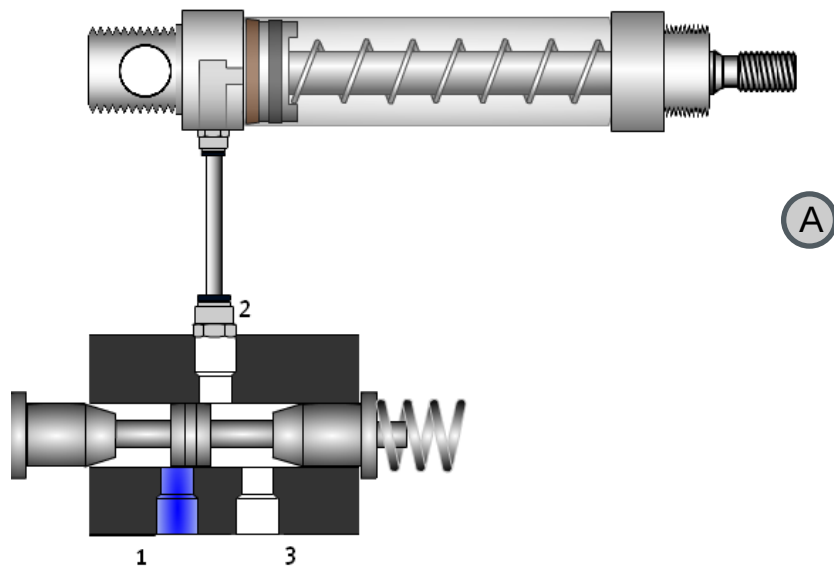
Normally open: In the neutral position of the valve the pressure line (1) is open (unblocked) so that the working line is pressurized and is only depressurized when the valve is actuated.



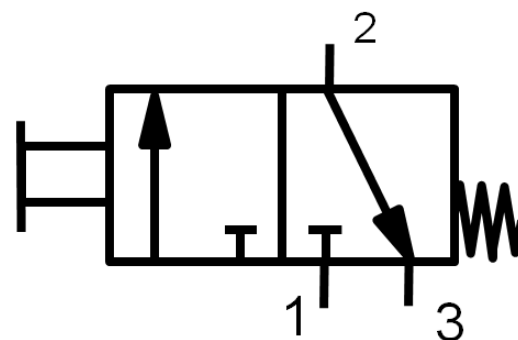
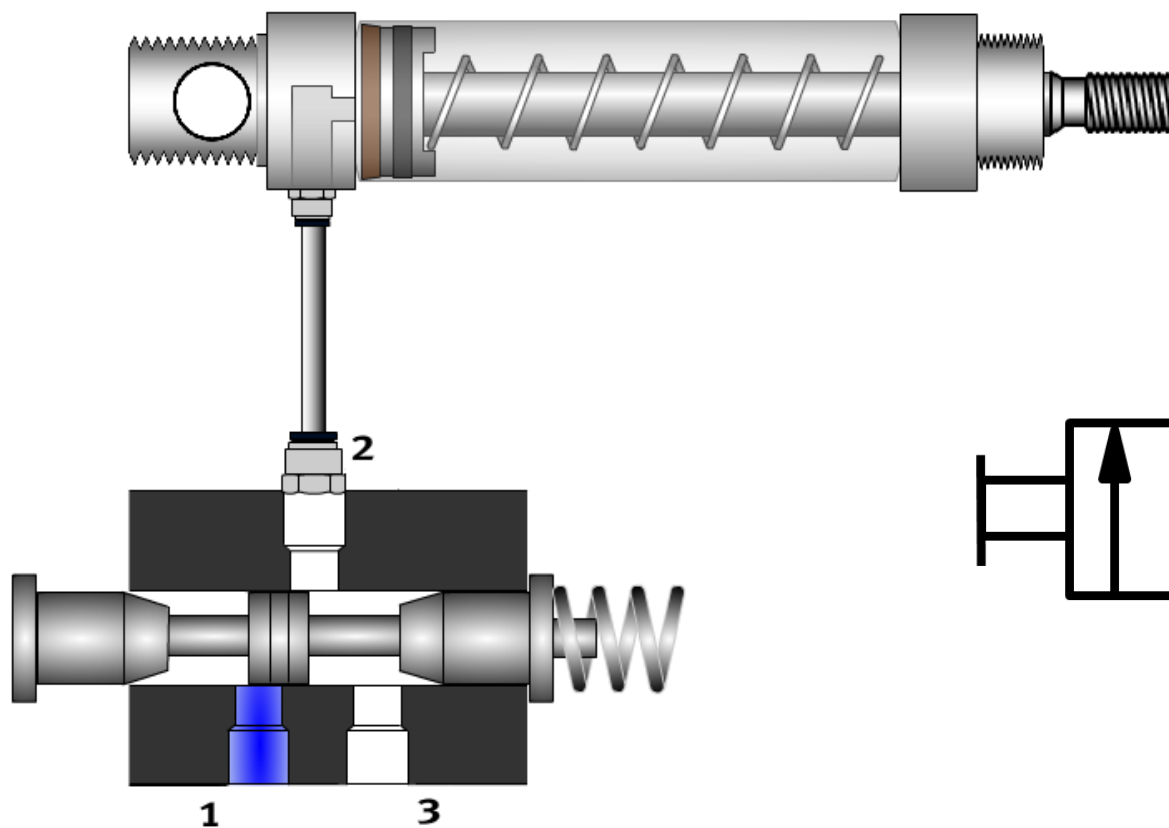
3/2 way valve and symbol



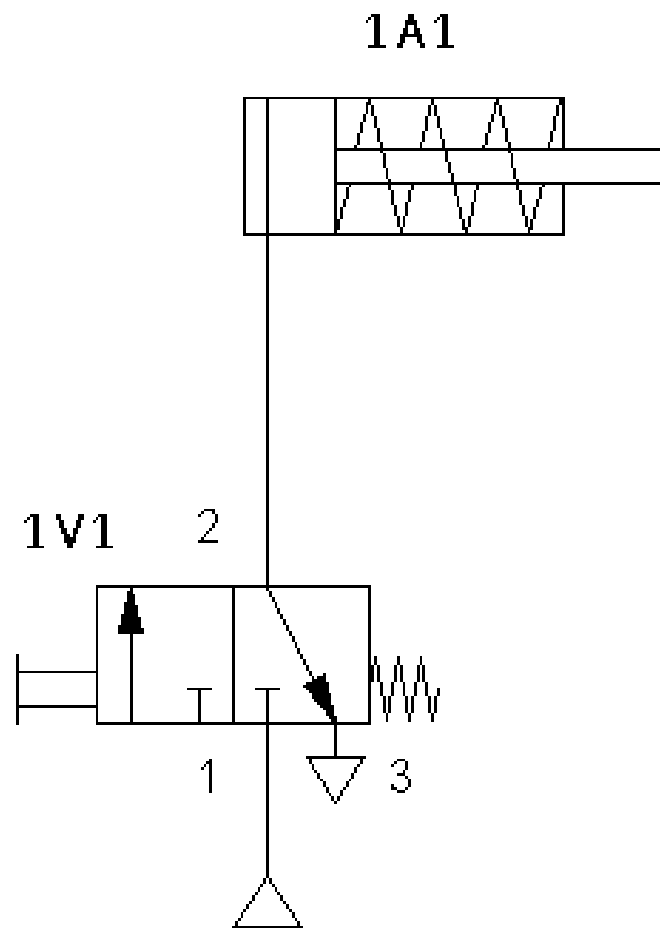
Actuating a single acting cylinder



3/2 Normally Closed valve



Exercise 1 : Single acting cylinder (NC way valve)



Component identifier and component number

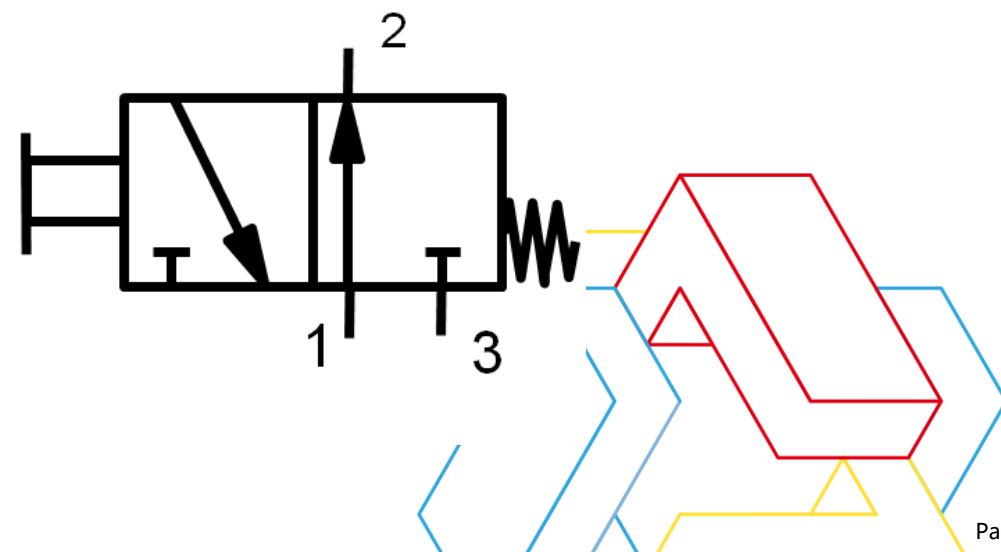
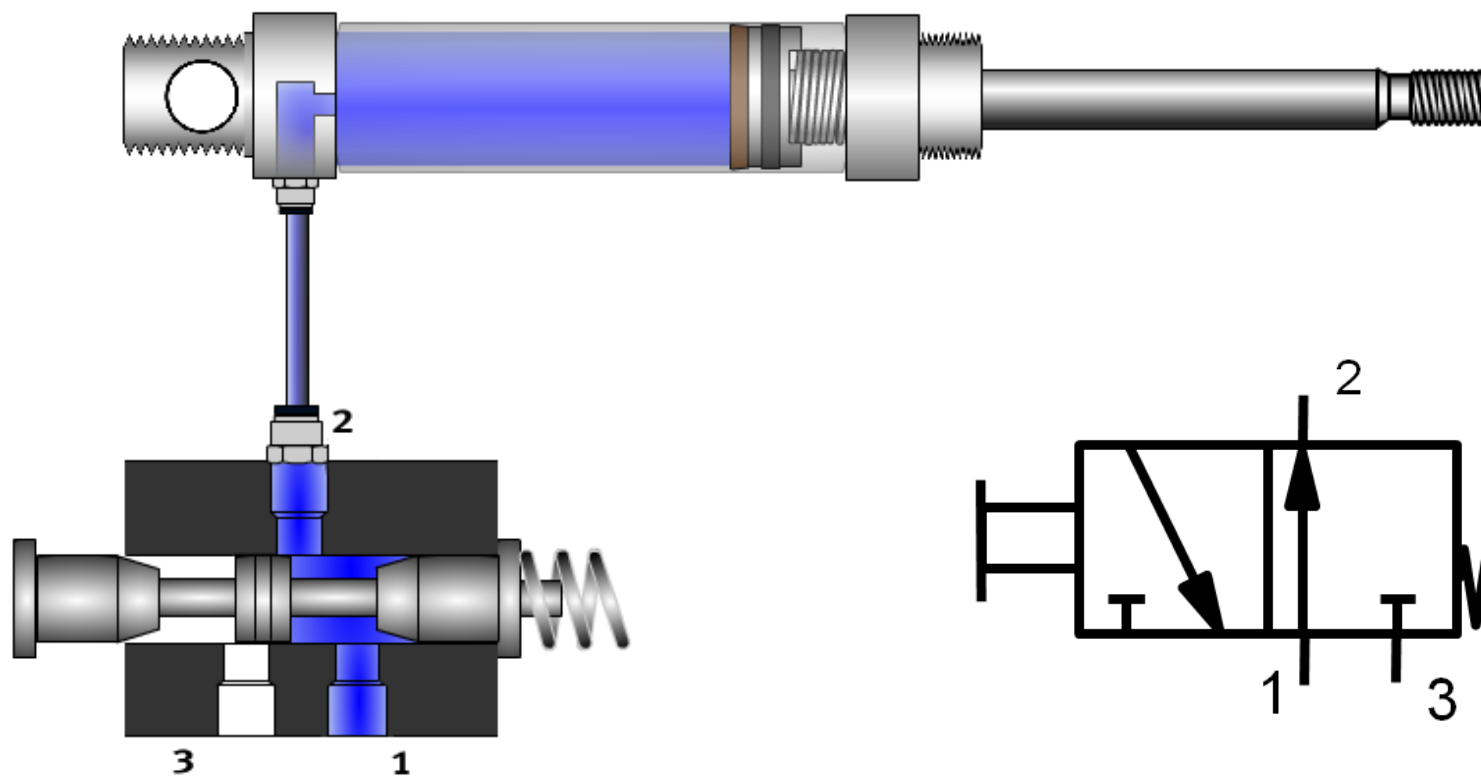
Identification key for components in a
pneumatic circuit diagram

Components	Identifier
Compressors	P
Operating elements	A
Drive motors	M
Signal input	S
Sensors	B
Valves	V
Solenoid coils	M*
Other components	Z**
* National addition in German standard ** Or any other letter not in the list	

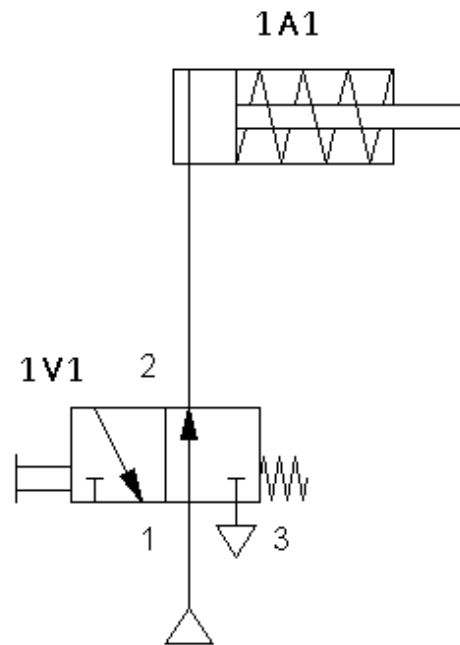
Each component in an electropneumatic control system is assigned a component identifier and a component number in the circuit diagram. Within a circuit, components with the same component identifier are numbered consecutively from bottom to top and from left to right. The valves in the "Insert/clamp" sequencer (circuit 1 in the circuit diagram Figure 12.3) must therefore be identified as follows:

- Directional control valve: 1V1 (circuit number 1, component identifier V, component number 1)
- One-way flow control valve: 1V2 (circuit number 1, component identifier V, component number 2)

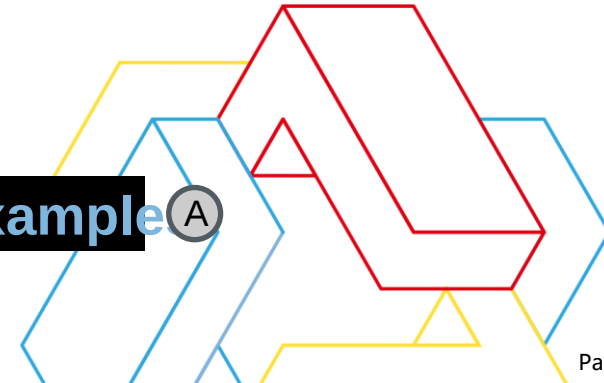
3/2 Normally Open valve



Exercise 2 : Single acting cylinder (NO way valve)



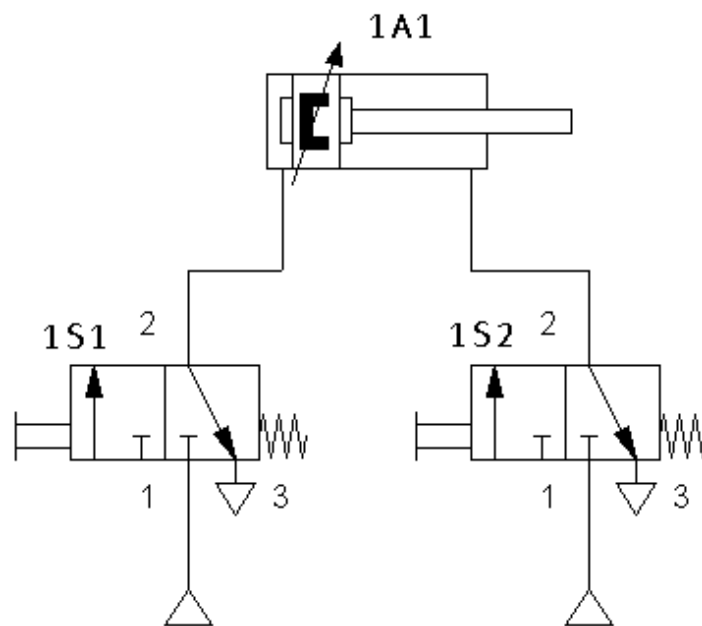
Pneumatic applications (Double acting cylinder)

Application example 

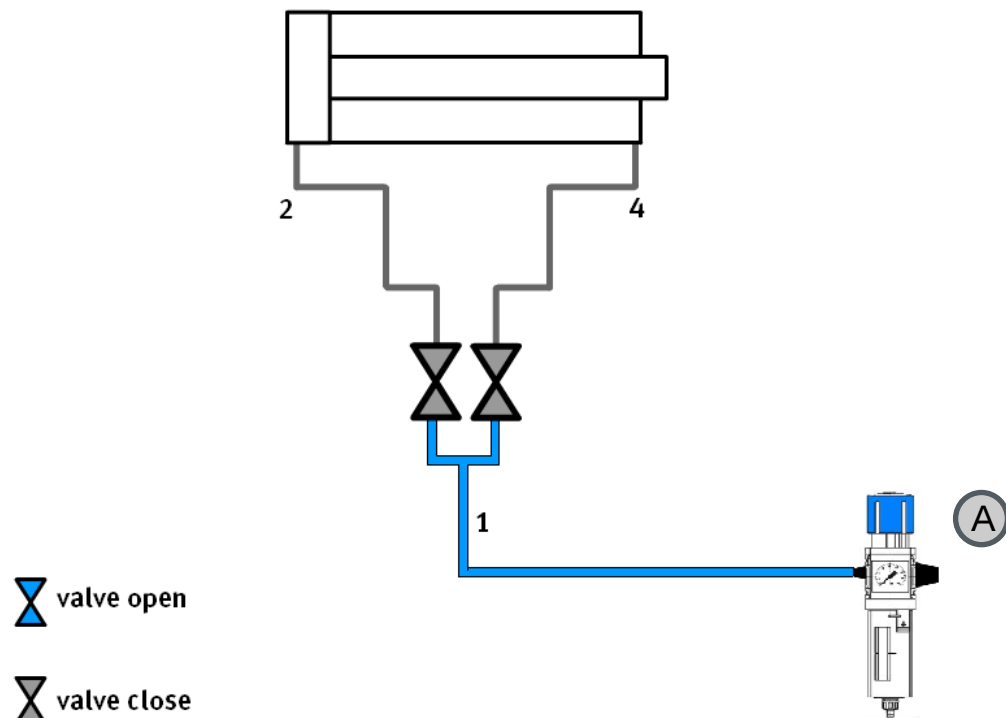
Double acting cylinder



Exercise 3 : Double acting cylinder (2 x 3/2 NC valve)



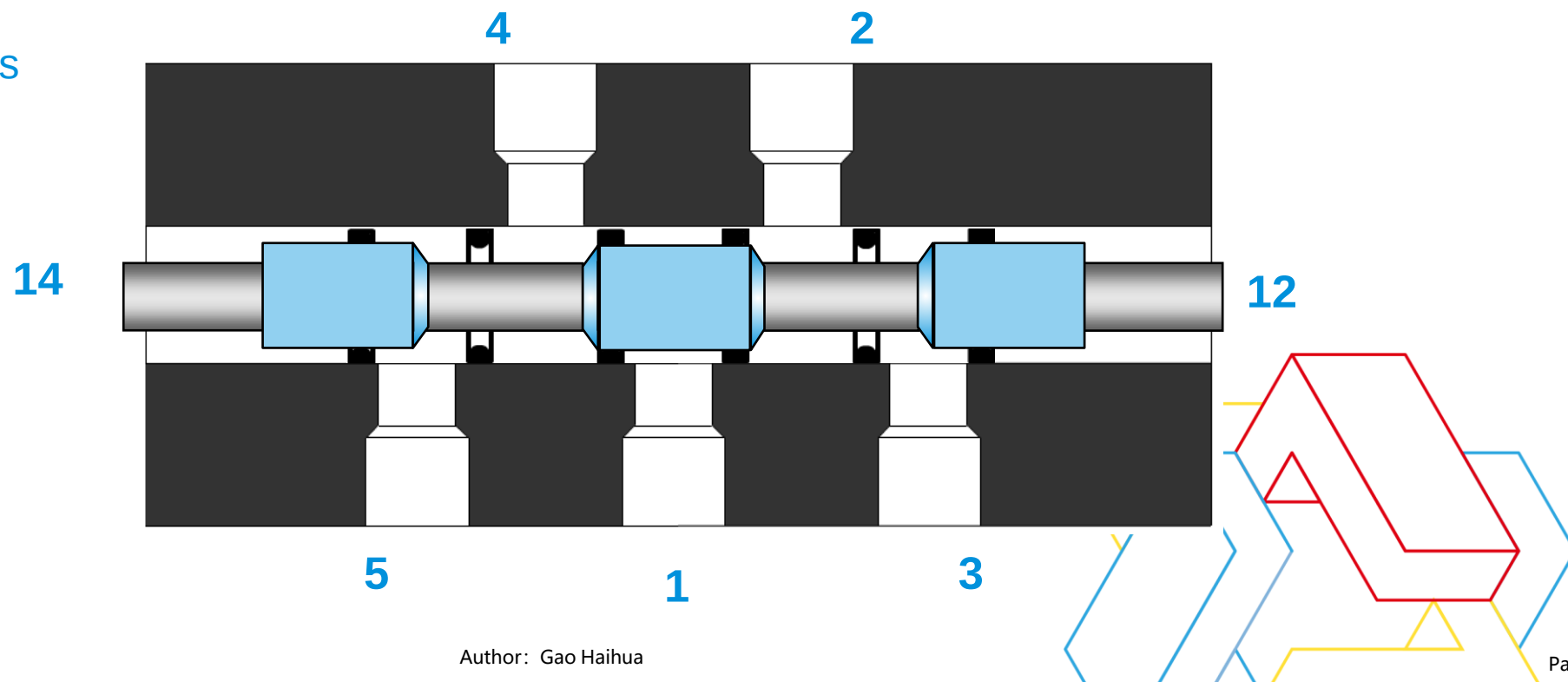
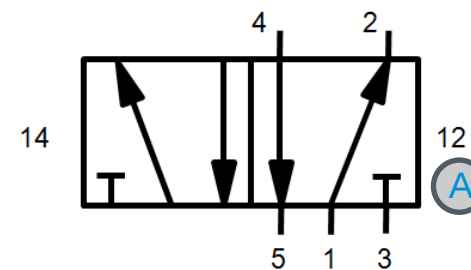
5/2 way valve and symbol



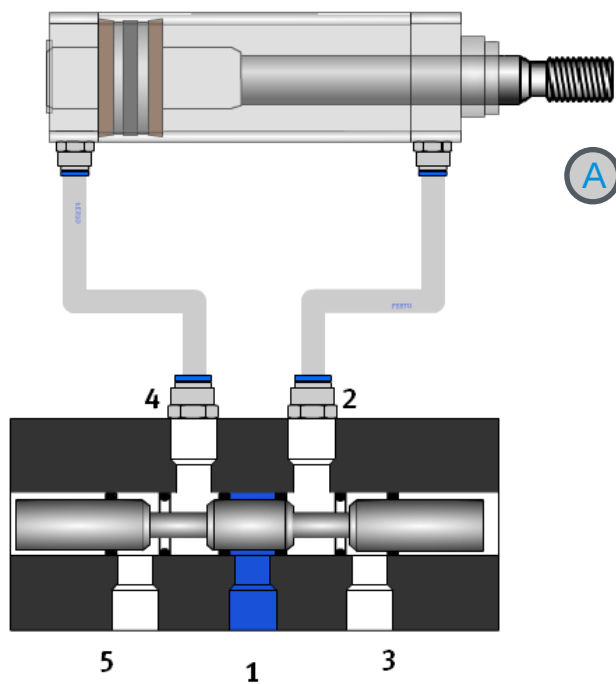
5/2 way valve

The main parts of a valve:

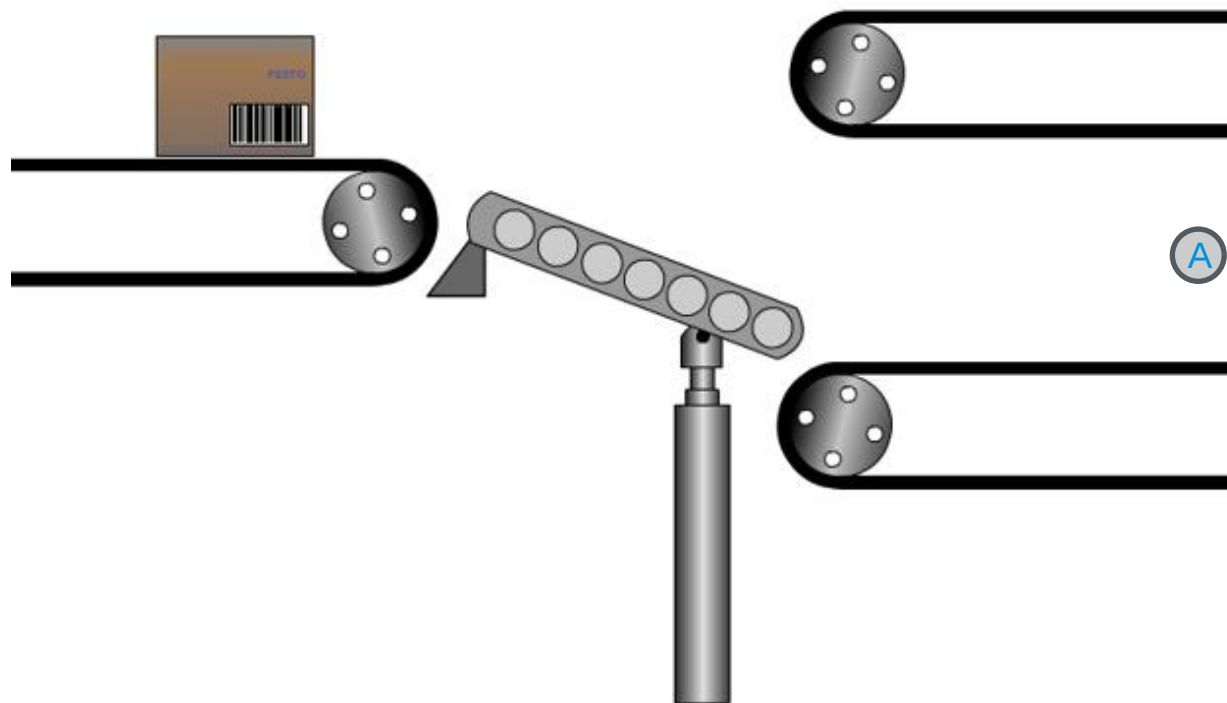
- 1 – Valve Body
- 2 – Seals
- 3 – Spool
- 4 – Controls



Actuating a double acting cylinder

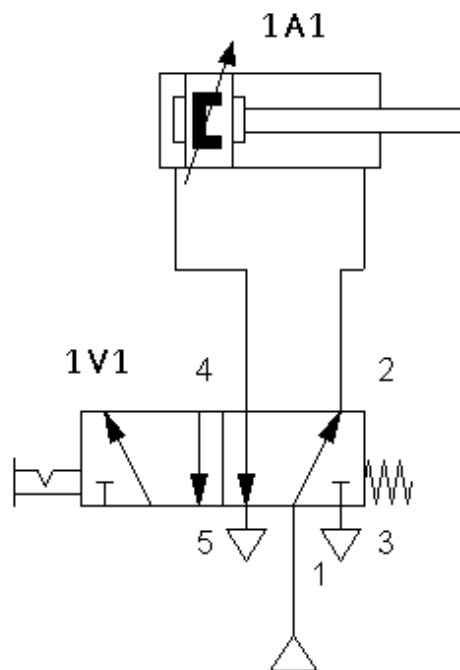


Exercise 4 : Double acting cylinder (5/2 selector switch)



Exercise 4 : Double acting cylinder (5/2 selector switch)

Task!



Direct control

Valve actuating methods

MANUAL

 General

 Push button

 Lever

 Foot lever

 Selector

MECHANIC

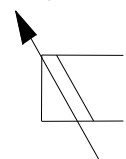
 Spring

 Pin button

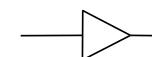
 Roller

ELECTRIC

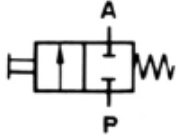
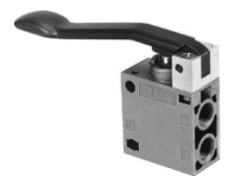
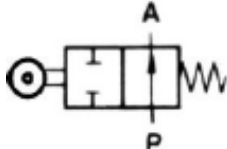
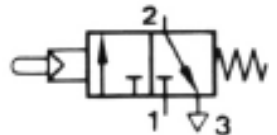
 Solenoid

 Proportional solenoid

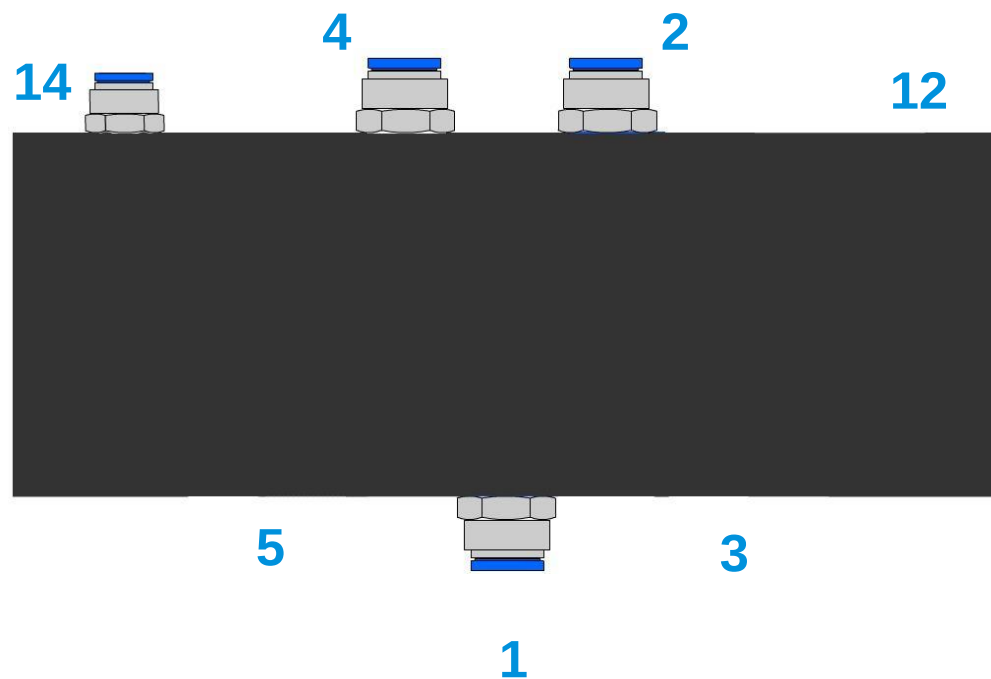
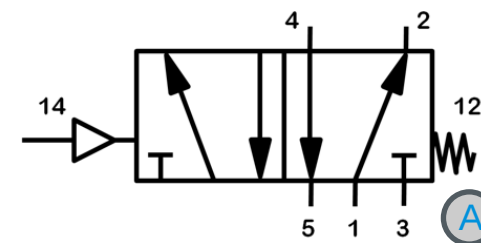
PNEUMATIC

 Pneumatic

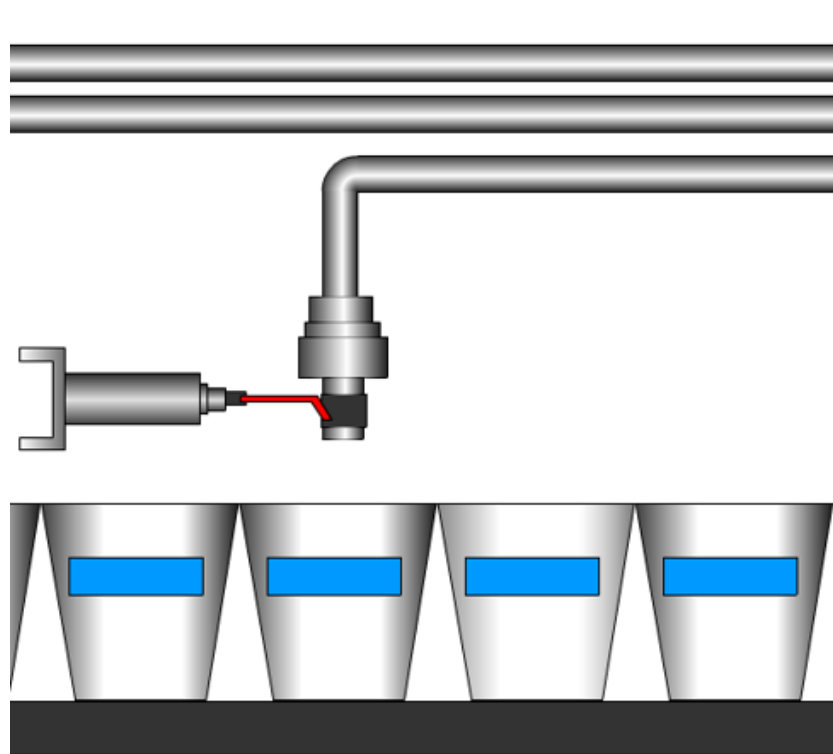
Various valves

Symbol	Model	Picture
	Valve 2 / 2 direct drive by key	
	Valve 2 / 2 way drive by direct roller	
	Valve 4 / 2 drive cam	
	Valve 4 / 2 by direct drive pedal	
	Valve 5 / 2 by solenoid	

Spring return way valves



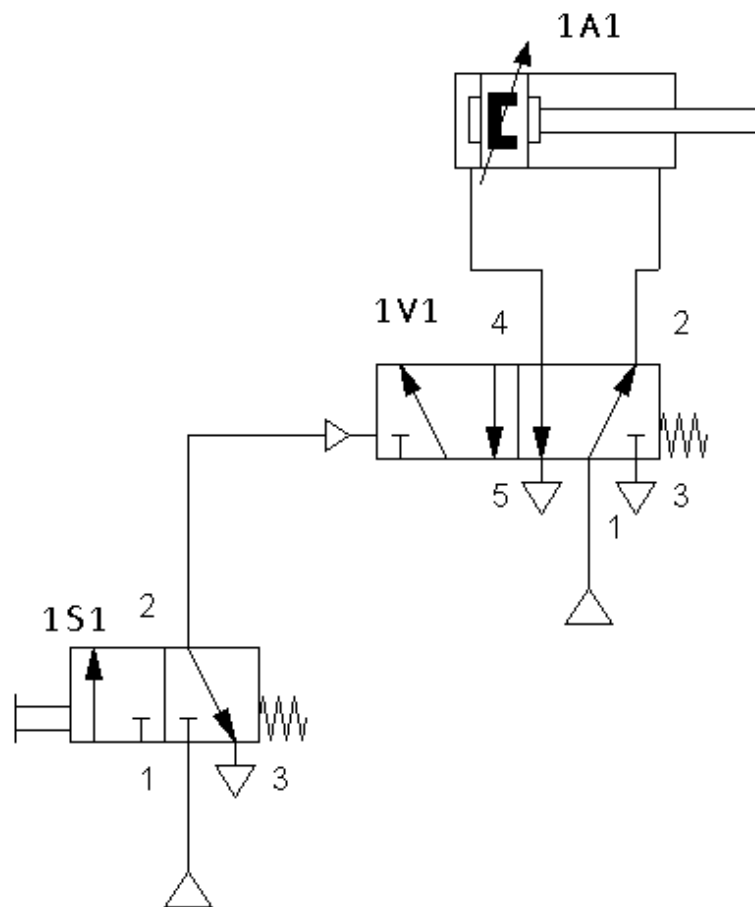
Exercise 5 : Double acting cylinder (5/2 spring return valve)



A



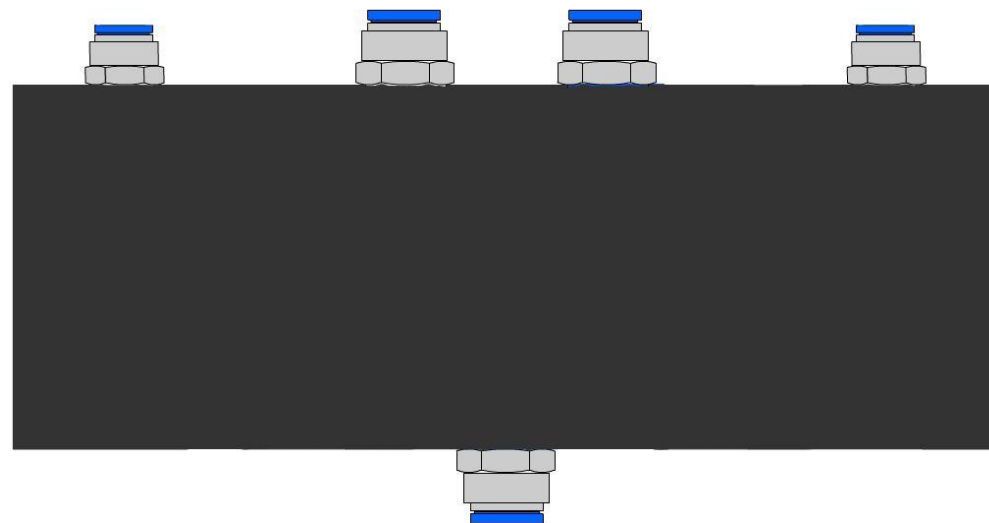
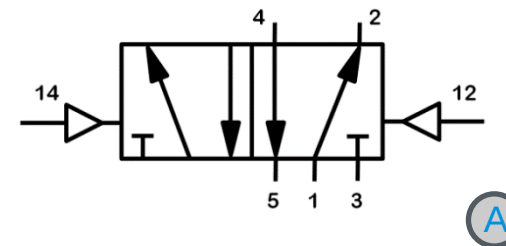
Exercise 5 : Double acting cylinder (5/2 spring return valve)



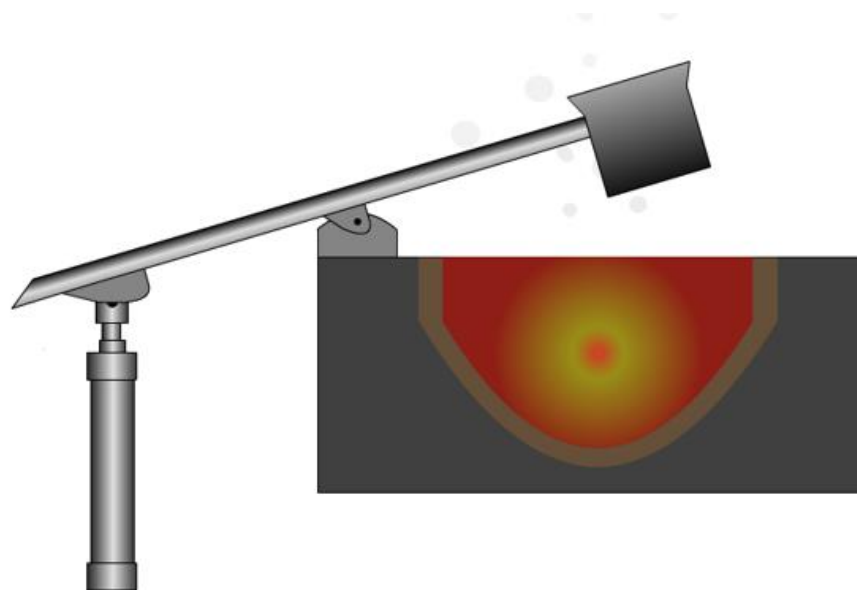
Indirect
control



Bistable valves (impulse valves)



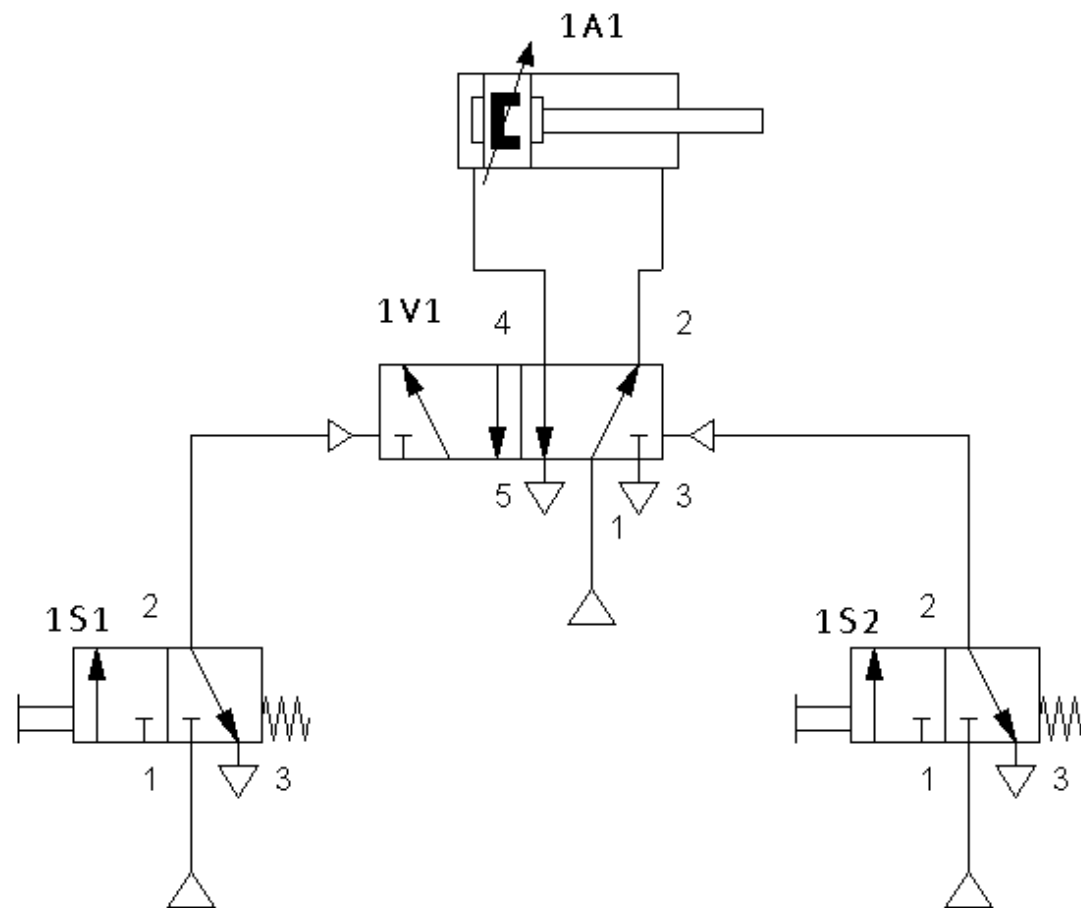
Exercise 6 : Double acting cylinder (5/2 bistable valve)



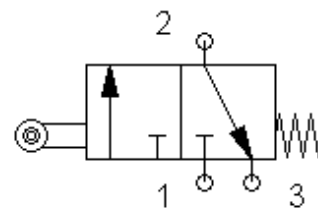
A



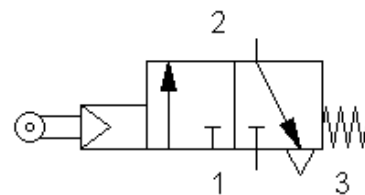
Exercise 6 : Double acting cylinder (5/2 bistable valve)



Position controlling with limit switches



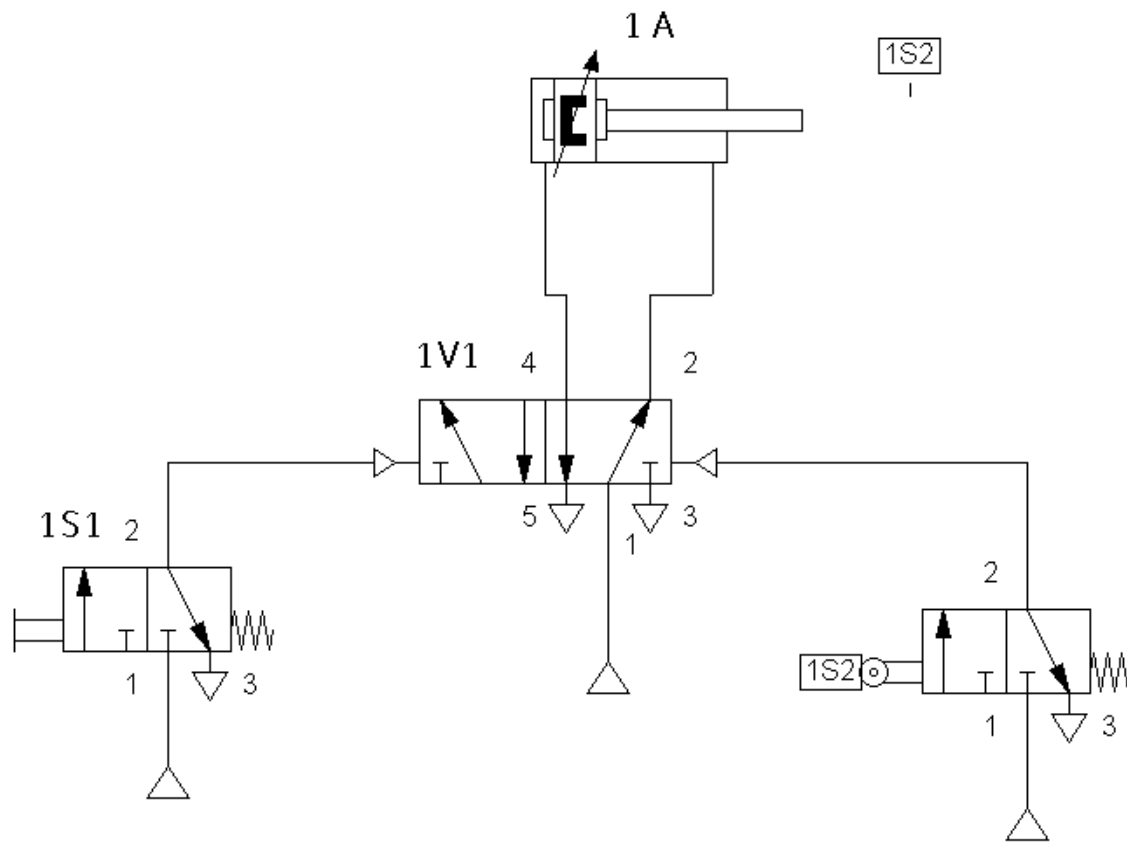
3/2 NC valve



3/2 NC pilot operated valve



Exercise 7 : Limit switch



Thank You !

