* Automation Lab Final.

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1. Introduction to pneumatics:

- What are pneu. → • using Air pressure to apply mechanical force. → compressed air.
  • using binary actuators → Extended⁺ / retracted.⁻
  ↳ 2 cases.

- Good for: - Mechanisms with (2) discrete state; (on/off) applications:
  1. Gear shifters. 3. Lifters
  2. Gripper articulation 4. Brakers
  - when force & Displacement is needed.

- Strengths (adv.): 1. Durability & Reliability.
  2. Simple design; Easy to control.
  3. High effectiveness; 1. high force from small & Light device.
  2. Force is limited by air pressure & cylinder diameter. → Force Limited by ?
  $F = P * A$ → increasing in (D) will increase the force
  4. adaptability to harsh environment.
  5. Safety.

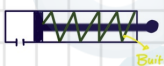
يستخدم هواء / مادة متي مشتعلة، ويشتغل بما تكون البيئة خيرة حرارة

- Drawbacks (disadv.): 1. Low accuracy.
  2. not for non-binary actuation → only for (on/off) applications.
  3. Low loading.
  4. Noise
  5. Processing required befor use.
  6. Uneven moving speed. → because air is easily compressed. : when the load is changing → the volume & the pressure of the air will change

- Pneu. Actuators: - Output device (conversion of Supply energy into work.) → main role
  - Output Signal is controlled by the control system → actuator responds.

  * Types of actuators: based on the type of motion.
  1. Linear : Single & Double acting cylinders
  2. Rotary : Air motor, Rotary cylinders, Rotary actuators.
  → Types & Examples.

- Single acting cylinders: • Compressed air is applied on one side of piston face, the othe side open for atmosphere
  • work only in one direction.
  • The return movement : by (1.) built in spring or 2. External forces.
  ↳ Spring Force designed to return the piston to its start position with high speed under no load conditions.



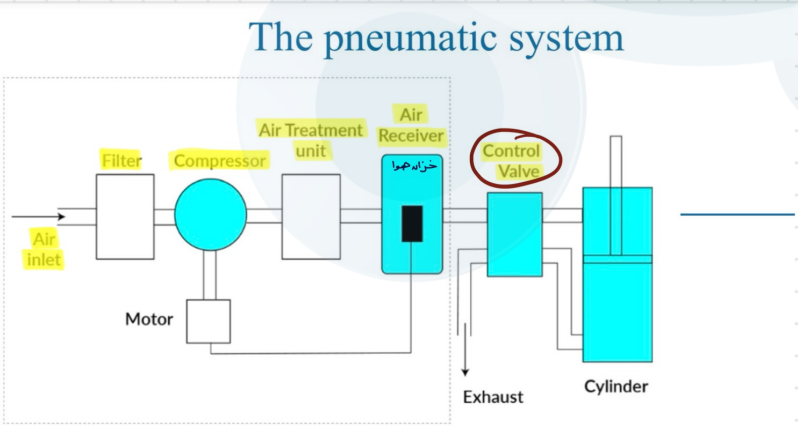
  • With built-in spring, the stroke is limited by the natural length of spring. → only available up to approximately 80 mm. → (stroke) كلما كان الـ أطول كلما كان عجاجه زنبرك أطول وهاد بيه حجم اسطوانات أكبر وهيك بيفقد خواصه مع الوقت

  * The construction & Simplicity → Makes it suitable for (compact, short stroke length)
  ↳ Applications: 1. Transferring 3. Clamping تثبيت / كبس
  2. Branching تفريع / توزيع 4. Ejecting طرد / اندفاع

- Double acting cylinder: • similar construction for Single-acting, no return spring → (2) ports : 1. Supply port 2. Exhaust ports.
  • Adv.: carry out work in both directions of motion → installation possibilities are universal → Universal Applications.



  • Force transferred for (forward stroke) Greater than the (Return stroke). → $F = P.A$
  $A_{eff} = A_{piston}$.
  ↳ The effective piston surface is reduced $[A_{eff} = A_{piston} - A_{rod}]$



• Directional Control valves (DCV): 1. Influence the path taken by an air stream.
2. Represented by 2 numbers, First: # of ports, Second: # of positions.

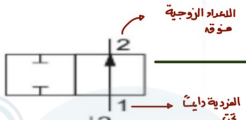
• (3/2) → Single acting cylinder
• (5/2) → Double acting cylinder.

Directional Control Valves

1. Air Supply
3. Exhaust.

Number of ports
Number of positions

2/2 — Way directional control valve, normally open



→ Simple applications.

3/2 — Way directional control valve, normally closed



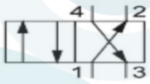
→ NC: compressed air can't flow through the valve. (1) when actuating become NO (1–2) x blocking (3).
• Un-actuating, Spring-loaded block the flow from (1)., so (2) connected to (3)

3/2 — Way directional control valve, normally open

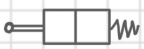


→ NO: actuated: From NO→NC: (2–3) blocking (1).
Un-actuated: Spring-loaded blocks (3), (1) connected to (2).

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



• (3/2) Roller Lever Valve: • Most important type of valve actuation → used for Automatic Operation of the pneumatic cylinders.
• Known as pneumatic Limit switch. (main role.)

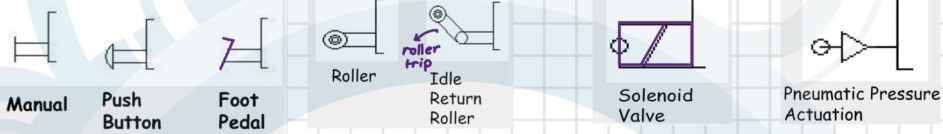


→ Actuated by: pressing the roller lever, x returned to normal position after releasing the roller lever. (the spring return.).

• (3/2) way Selector valve:



• Types of Actuators:



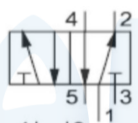
spring. lever
plunger
pilot air

1. Manual. 2. Mechanical 3. Electrical 4. Pneumatic.

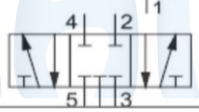
• (5/2) DCV: could be actuated manually or by using pressure actuation (Single / Double pilot). or Electrical actuation (Solenoid). 3 method of activation.

1: Air supply
2/4: working ports.
3/5: Exhaust

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



5/3 — Way directional control valve
Mid position closed

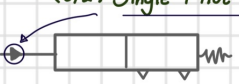


→ NO: Actuated: shifted (→); from (1) to (4), x from (2) to (3). (Extend.) (1)–(2) Retract.
: Un-Actuated ---

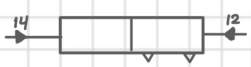
• (5/2) Selector Valve: - Used for manual operation (selector: مفتاح للدارة اسمها)
- Valve controlled by selector switch.
- Used for Simple applications. (manual controlling app.)



• (5/2) Single Pilot valve: (هاي اشارة هوائية بتأثر) - Used for Automatic operations (no manual operating.)
- The valve is controlled by pneu. signal x Spring return.



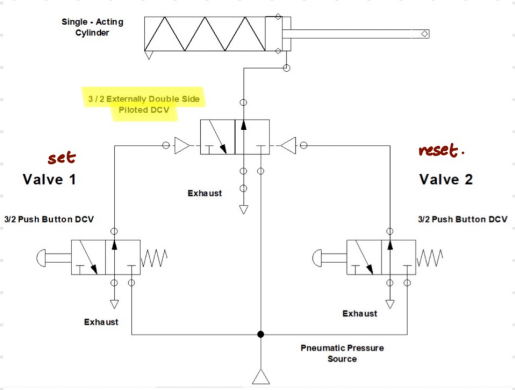
• (5/2) Double Pilot valve: - Used for Automatic operations
- The valve is controlled by (2 pneu. signal



* Keeps the last position after removing the applied signal. → called Memory valve

Feature / Aspect	5/2-Way Single Pilot Valve	5/2-Way Double Pilot Valve
Control Signals	One pneumatic signal (*Single Pilot*). PDF	Two independent pneumatic signals (*Double Pilot*). PDF
Reset / Return Mechanism	Internal mechanical spring (*Spring Return*). PDF	Opposing pneumatic signal (no return spring). PDF
Behavior on Signal Loss	Returns **immediately** to its default position via spring force. PDF	**Maintains its current position** until a new signal arrives. PDF
Memory Function	No memory capacity (operates only while signal is active). PDF	Functions as a *Memory Valve* (latches last state). PDF
Typical Applications	Temporary automatic actuation, safety interlocks, basic reciprocating operations. PDF	Sequential control circuits, bistable operations, position-latching applications. PDF

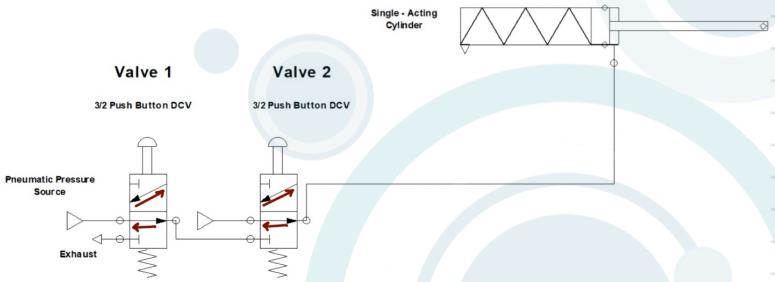
* Logic function :



Memory function :

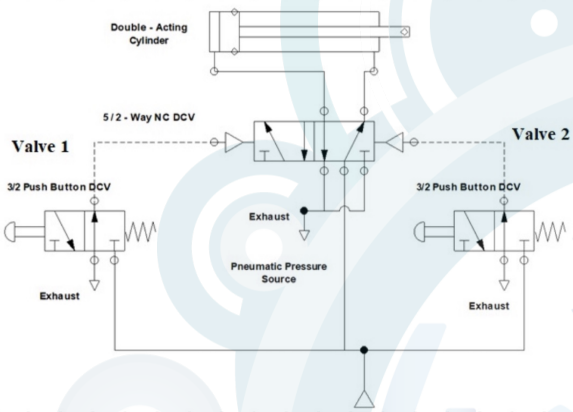
when both values are off → the pnum. keeps its last State.

V1	V2	cylinder
off	on	return.
on	off	Extend.



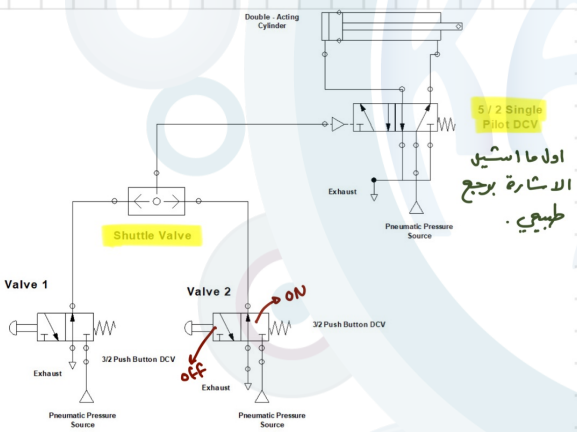
(AND) Logic function → Series.

off	off	return.
off	on	return.
on	off	return.
on	on	Extend.



Memory Logic function.

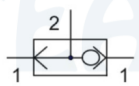
off	off	no change.
off	on	return. ✓
on	off	Extend.
on	on	

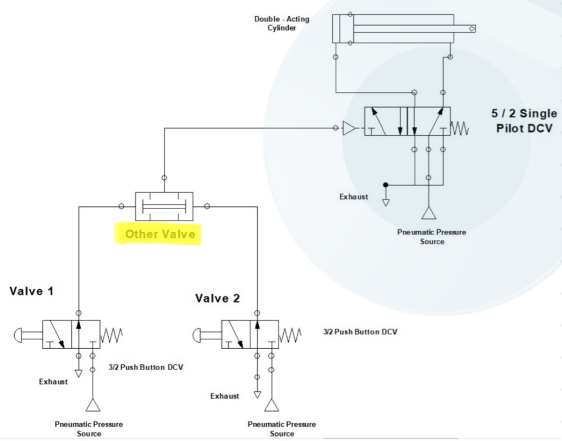


اول ما اشيل الاشارة برجع طبيعي .

Shuttle valve → OR function.

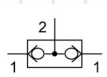
off	off	return.
off	on	forward.
on	off	forward.
on	on	forward.



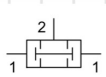


AND Logic function ;

off	off	return
off	on	return
on	off	return
on	on	forward → both operate.



ISO 1219-1 symbol

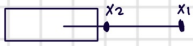


Popular old symbol

* PLC for pneumatic cylinder

• PLC for Pneumatic Cylinder

- Pneumatic controlled by PLC → control the solenoid that supplies the pressed air.
- two (position sensors needed. → read the position of cylinder rod → Extended or retracted.
- Rod's piston reaches the forword position switch (X), X1 will be high & Q_1 off, then the rod retracted inside the cylinder
  - output of the solenoid
  - X_1 will be off again.



Q_1 on → Extend
Q_1 off → Retract.

- When reach the backward position switch X_2, X_2 high → Q_1 high → pushing forward.
- Cycle movement repeated according to counter reading. (C_1).
  - count the number of times the cylinder's rod energised.
  - & when the # Reaches to (C_1) it will be disable the overall process.
- Counter better than the timer because it support the feedback & the compeletion of the movement.

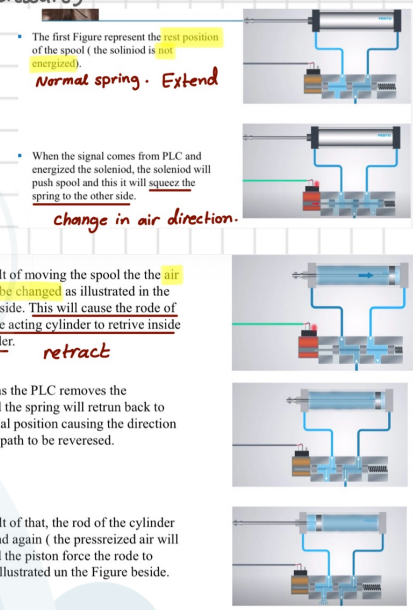
• Solenoid Valve : - composed of ports that supply the air pressure in/out of the acting cylinder.

يتحكم باتجاه ومقدار الهواء

- Spool : moving part that open & close ports → controlling the inlet & Outlet of air pressure)
  - controlled by electric solenoid, ON/OFF actuator controlled by Signal from PLC ports.

air → Spool → sole. → PLC.

- Return of its position by Mechanical spring.
- Spool change the air direction of the air the opposite of the Spring.



- The first Figure represent the rest position of the spool (the soliniod is not energized).

Normal spring. Extend

- When the signal comes from PLC and energized the soleniod, the soleniod will push spool and this it will squeez the spring to the other side.

change in air direction.

- As a result of moving the spool the the air path will be changed as illustrated in the Figure beside. This will cause the rode of the double acting cylinder to retrive inside the cylinder.

retract

- As soon as the PLC removes the command the spring will retrun back to it's original position causing the direction of the air path to be reveresed.
- As a result of that, the rod of the cylinder will extend again (the pressreized air will be behind the piston force the rode to exted as illustrated un the Figure beside.

- IF the PLC Suddenly stop → Spool to rest position.

عادة هيك :

CL RESPONSE	RISE TIME	OVERSHOOT	SETTLING TIME	S-S ERROR
Kp ↑	Decrease	Increase	Small Change	Decrease
Ki	Decrease	Increase	Increase	Eliminate
Kd	Small Change	Decrease	Decrease	Small Change

Numerator → Zeros. , Num = 0
Denominator → Poles. , Poles = 0.