



ثانوية التكنولوجيا التطبيقية
Applied Technology High School

Electro-Pneumatic

Module 2: Direct and Indirect Control in
Electro-pneumatics

PREPARED BY

Academic Services

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Module 2: Direct and Indirect Control in Electro-pneumatics

Module Objectives

After the completion of this module, the student will be able to:

- 1- Configure and connect the electrically actuated directional control valves (solenoid valves).
- 2- Configure the direct control in electro-pneumatics.
- 3- Configure the indirect control in electro-pneumatics.
- 4- Identify the advantages and disadvantages of direct and indirect control techniques.
- 5- Simulate and construct simple electric circuits

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Electrically-actuated directional control valves - Solenoid valves:

Introduction:

Two forms of energies are used to operate any electro-pneumatic control system.

- Electrical energy.
- Compressed air energy

Electrically actuated directional control valves (DCVs) are switched with the aid of an electric coil that is called a solenoid. The electric coil attracts or repels the valve spool as shown in Fig. 2.1.a.

- When the pushbutton switch is pressed (activated), an electric current flows through the solenoid coil, the solenoid is energized causing the valve spool to move, which in turn will switch the valve to the second position where the air flows to move the cylinder piston forward as illustrated in Fig 2.1.b.
- Releasing the pushbutton terminates the current flow, which in turn de-energizes the solenoid and the DCV moves back to its normal position.

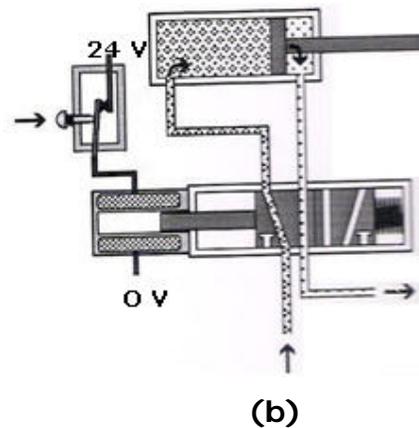
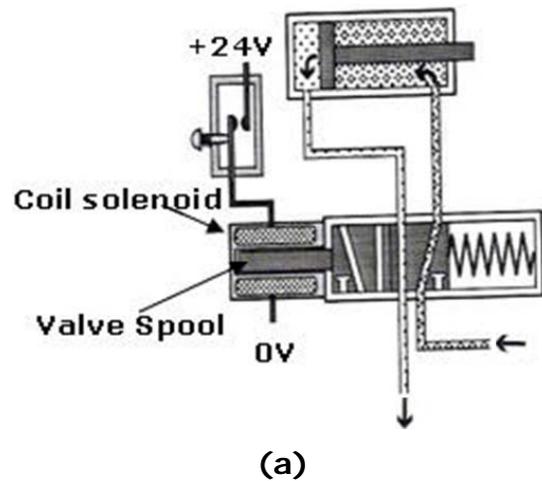


Fig.2.1:

(a): Solenoid coil is not activated

(b): Solenoid coil is activated

Types of solenoid valves

1. Single solenoid valve with a spring return (reset).

The valve remains in the actuated position as long as the current flows through the solenoid.

Example:

5/2 DCV with single solenoid and spring return, Fig.2.2.

2. Double solenoid valves.

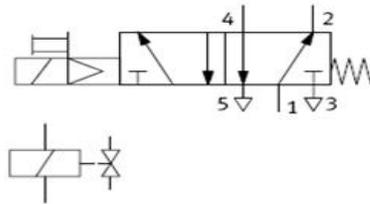
The valve will keep and maintain the last switched position even when no current flows through the solenoid. It is sometimes called memory valve.

Example:

5/2 DCV, with double solenoid, Fig. 2.3.



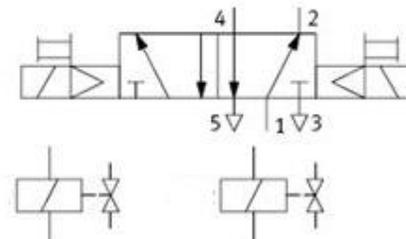
(a)



(b)



(c)



(d)

Fig.2.2:

(a): 5/2 way, single solenoid valve

(b): ISO symbol of 5/2 way single solenoid valve.

(c): 5/2 way, double solenoid valve

(d): ISO symbol of 5/2 way, double solenoid valve.

Direct control in electro-pneumatics

Direct control is the control of an electro-pneumatic valve without using intermediate components such as a relay, a contactor or an industrial computer (PLC). The valve is connected directly to electric switch as shown in Fig. 2.3 below

Advantages of direct control

- Simple and easy.
- Less wiring
- Cheap.

Disadvantages of direct control

- Remote control is not possible.
- Switching more than one valve at a time is not possible.
- Latching is not possible.
- Design improvement is not flexible.

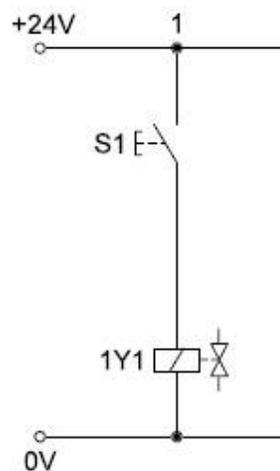


Fig.2.3 the solenoid valve is connected directly to the switch.

Practical Task 1

Title:

Direct control of a double acting cylinder by using 5/2 directional control valve, single solenoid

Objectives:

- The student should be able to use 5/2 DCV, single solenoid, with spring return.
- The student should be able to use different electro-pneumatic equipments.

Background:

A direct control circuit is used to control a 5/2 DCV single solenoid by using a push button switch. Activating the pushbutton will energize the coil (solenoid) which in turn will actuate (operate) the valve.

Required components:

- 1- Double acting cylinder
- 2- 5/2 way valve, single solenoid
- 3- Power supply
- 4- Switches

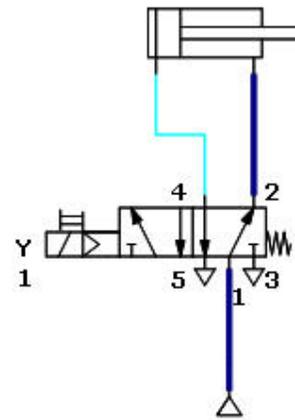
Procedures:

- 1- Connect the pneumatic circuit according to the pneumatic circuit as shown in Fig.2.4.a
- 2- Connect the electric circuit according to the electric circuit as shown in Fig.2.4.b
- 3- Check that all parts are connected firmly with each other.
- 4- Switch on the power from the power supply and open the service unit.
- 5- Press switch S1. Explain what happens to the cylinder.

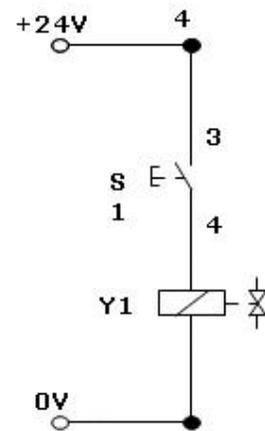
- 6- Deactivate switch S1 and explain what happen to the cylinder.

- 7- Replace switch S1 with a detent switch, repeat the steps above and explain what happen to cylinder.

- 8- Turn the power off and close the service unit.
- 9- Dismantle and tidy up.



(a)



(b)

Fig.2.4:

(a): Pneumatic circuit

(b): Electric circuit

Practical Task 2

Title: Diverting machine

Problem description:

The parts used in the diverting machine are to be moved from one conveyor track to another conveyor track. By pressing a pushbutton switch the frame of the diverting machine is pushed forward. The part is moved over and transported onwards in the opposite direction. By pressing another pushbutton switch the frame is returned to its start position as shown below in Fig 2.5

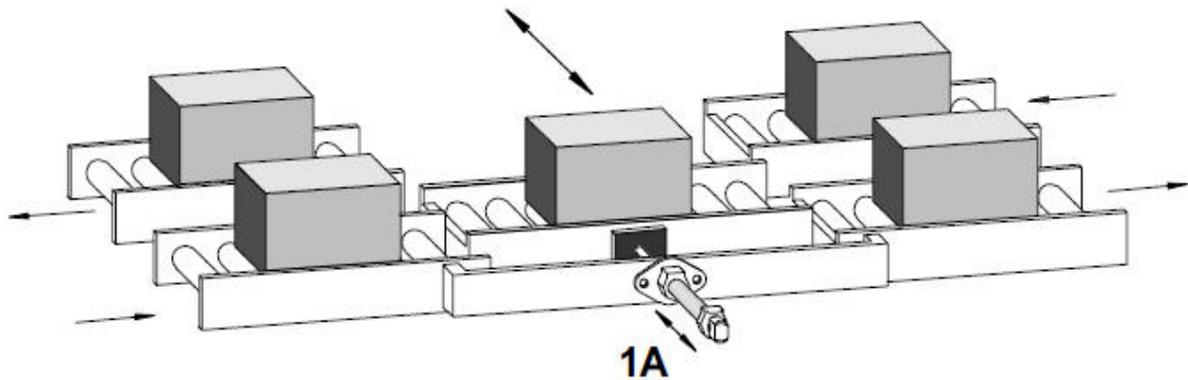


Fig 2.5 Positional sketch of the diverting machine

Procedures:

1. Draw the electro-pneumatic circuit using the FluidSim software
2. Test the circuit functions against any errors or mistakes.
3. Construct the circuit on the workstation
4. Write down your notes and observations.

Pneumatic circuit	Electric circuit

Observations

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Class work (1)

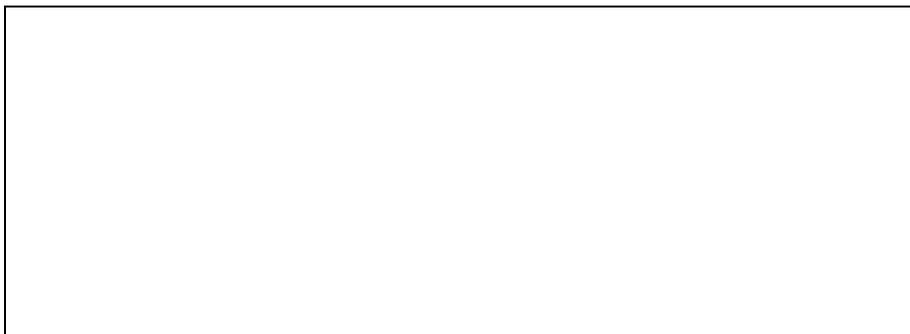
1. What is the difference between 5/2 directional control valve, single solenoid and 5/2 Directional control valve, double solenoid.

2. Draw the I.S.O symbol of:

- 5/2 DCV, single solenoid



- 5/2 DCV, double solenoid.



3. Draw a pneumatic and an electric circuit to control a double solenoid valve directly, by using a normally closed detent switch.

Pneumatic circuit	Electric circuit

Home Work (1)

The circuit shown below in Fig 2.6 illustrates an electro-pneumatic system. Answer the following questions:

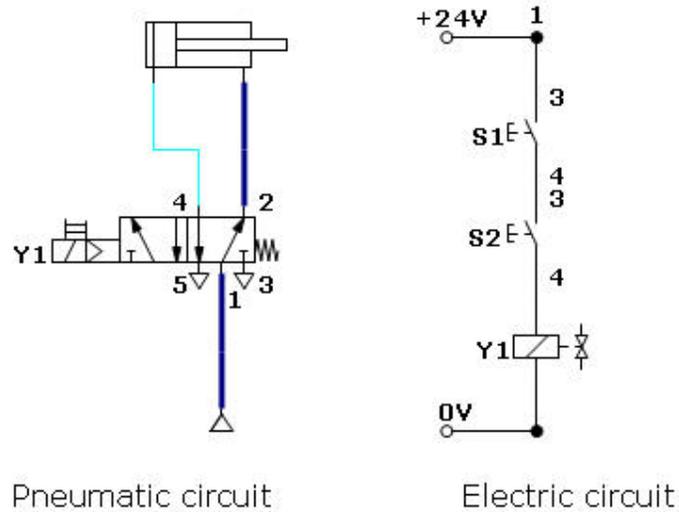


Fig 2.6

1. What is the type of switch S1 and S2?

2. Is the electric circuit above direct or indirect? Justify your answer

3. What is the name of the part which labeled as Y1?

4. Explain what happen when switch S1 is pressed. Does the cylinder extend?

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5. Explain what happens when switch S2 is pressed. Does the cylinder extend?

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6. Suggest a way to extend the above cylinder rod using the same electric circuit.

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Indirect control in electro pneumatics

Indirect control is the control of an electro-pneumatic valve using intermediate components such as relays, contactors or programmable logic controllers (PLC).

Advantages of indirect control systems

- Remote control is possible
- Switching more than one valve at a time is possible
- Latching is possible.
- Flexible design improvement and development.
- Incorporating logic operating conditions (OR, AND conditions)

Disadvantages of direct control

- Complicated
- More wiring
- More cost involved

Practical Task 3 Title: Bulk material

Problem description:

Bulk material is to be emptied from a hopper as shown below in Fig.2.8. By pressing a pushbutton switch, the hopper is opened and the bulk material is emptied out. By pressing another pushbutton switch the hopper is closed again.

Hint: The controlling circuit should contain relays for the indirect control

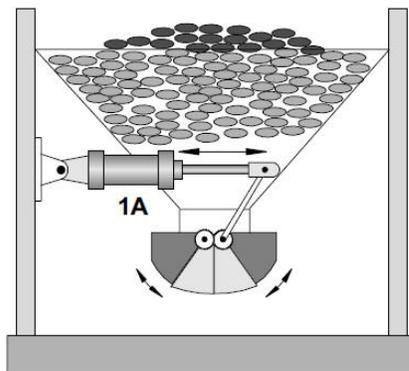


Fig. 2.8 Positional sketch of the hopper machine

Procedures:

1. Draw the electro-pneumatic circuit using the FluidSim software
2. Test the circuit functions against any errors or mistakes.
3. Construct the circuit on the workstation
4. Write down your notes and observations.

Pneumatic circuit	Electric circuit

Observations

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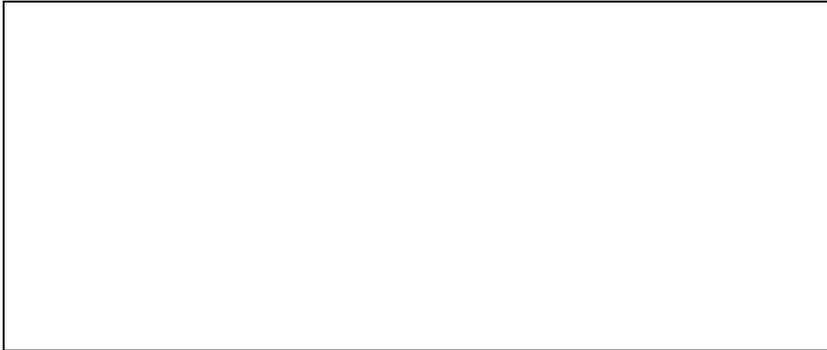
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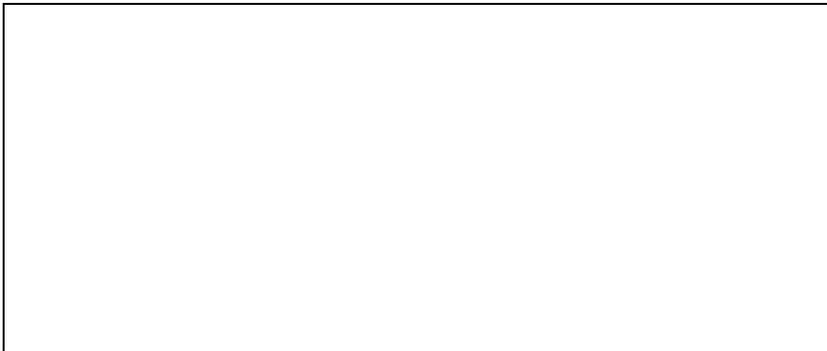
Class work (2)

1. Draw the I.S.O symbol of both

- A 5/2 DCV, single solenoid.



- A 5/2 DCV, double solenoid.



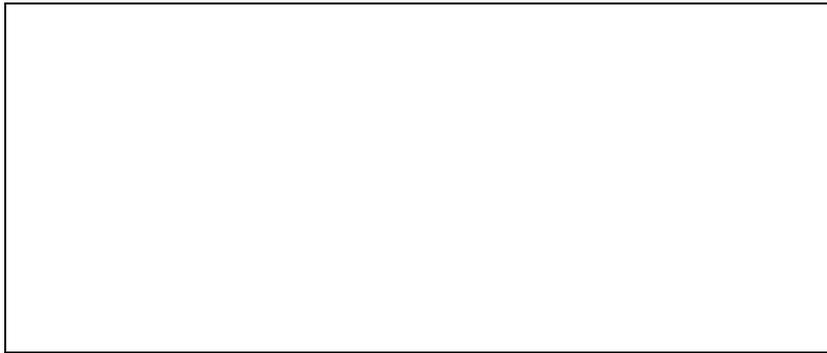
2. Explain the difference between direct and indirect control.

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3. What is the function of a relay?

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4. Draw the I.S.O symbols of a relay.

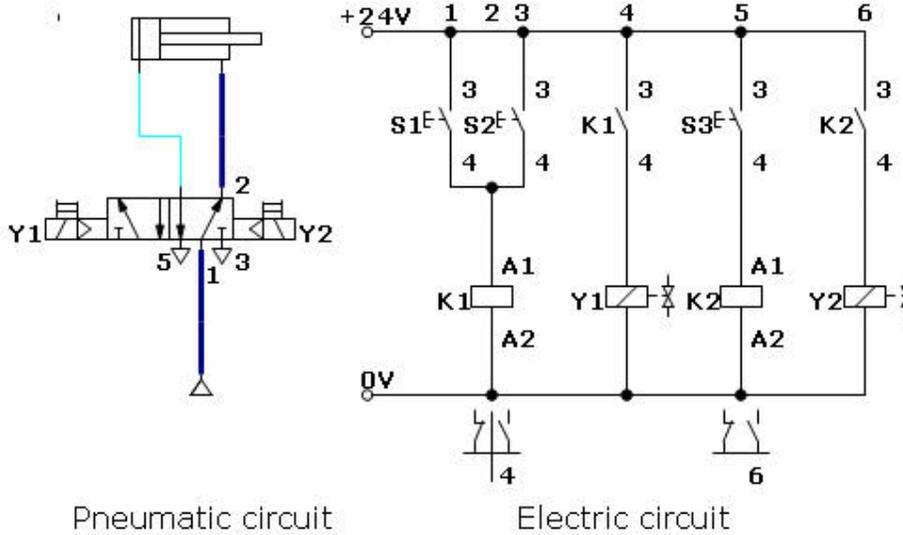


5. Draw a pneumatic and an electric circuit to control a double solenoid 5/2 DCV indirectly through N.C. relay contacts and pushbutton switches.

Pneumatic circuit	Electric circuit

Home Work (2)

The circuit below illustrates an electro-pneumatic system. Answer the following questions:



Pneumatic circuit

Electric circuit

1. What are the type of the switches S1, S2 and K1?

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2. Is the electric circuit above direct or indirect? Explain why.

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3. What is the name of the part which is labeled as Y1?

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4. Explain what happens when the switch S1 is pressed. Does the cylinder extend? Explain why.

.....

5. Explain what happens when the switch S2 is pressed. Does the cylinder extend? Explain why.

.....

6. Explain how to retract the above cylinder.

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7. Determine if the following statements are true or false

Number	Statements	T/F
1	The electric circuit is supplied by AC current	
2	The electric circuit has 8 branches	
3	A1 and A2 in the electric circuit refer to the relay voltage terminals	
4	K1 in branch 1 refers to a relay contact	
5	S1 and S2 in branch1 and branch 3 represent AND gate	

References

1. Electro-pneumatic text book TP 201 2005 – Festo
2. Electro-pneumatic work book TP201 2005 – Festo
3. Electro-pneumatic work book TP202 advanced level – Festo