Module 2: Direct and Indirect Control in Electro-pneumatics

Module Objectives

The students will be familiar with:
1- Electrically actuated directional control valves (solenoid valves).
2- Direct control in electro-pneumatics.
3- Indirect control in electro-pneumatics.
4- Advantages and disadvantages of direct and indirect control techniques.
5- Simple electric circuits.

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**Electrically actuated directional control valves (DCV) - Solenoid valves.**

An electro-pneumatic control system works with two forms of energy.

- Electrical energy in the signal control section.
- Compressed air in the power section.

Electrically actuated DCVs are switched with the aid of a coil that is called a solenoid. The coil attracts or repels the valve spool, see Fig. 2.1-a.

- When the pushbutton is pressed, current flows through the solenoid coil, the solenoid is energized causing the valve spool to move, which in turn will switches the valve to the second position where the air flows to fill the cylinder and cylinder piston will advance, see Fig 2.1 –b.

- Releasing the pushbutton will cut the current flow, this will de-energize the solenoid and the DCV moves back to its normal position.

**Fig. 2.1:** Actuation of a DCV with a solenoid.
Solenoid valves are divided into two groups:

1. **Single solenoid valve with a spring return.**
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.
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).

Advantages of direct control

- Simple and easy.
- 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.
Experiment # 1

Title

Direct control of a double acting cylinder by using 5/2 DCV, single solenoid.

Objectives

Students to be familiar with:

- 5/2 DCV, single solenoid, with spring return.
- Electro-pneumatic equipments.

Background

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

Required components

<table>
<thead>
<tr>
<th>SR.</th>
<th>Name</th>
<th>Qty.</th>
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<tbody>
<tr>
<td>1</td>
<td>Double-acting cylinder</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>5/2 way valve, single solenoid</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Power supply</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Switches</td>
<td>1</td>
</tr>
</tbody>
</table>
Procedure

1- Connect the pneumatic circuit according to the pneumatic circuit a).

2- Connect the electric circuit according to the electric circuit b).

3- Check that all parts are connected properly with each other.

4- Switch the power on from the power supply and open the service unit.

5- Press switch S1. Explain what happens to the cylinder.

6- Release switch S1. 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.

Conclusion

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Experiment # 2

Title

Direct control of a double acting cylinder by using 5/2 DCV, double solenoid.

Objectives

Students to be familiar with:
- 5/2 DCV, double solenoid.
- Electro-pneumatic components.
- Electric circuits.

Background

A direct control circuit is used to control a pneumatic circuit by using push button switches; that give a direct signal to the solenoid.

Required components

<table>
<thead>
<tr>
<th>SR.</th>
<th>Name</th>
<th>Qty.</th>
</tr>
</thead>
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<td>1</td>
<td>Double – acting cylinder</td>
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</tr>
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<td>2</td>
<td>5/2 way valve, double solenoid.</td>
<td>1</td>
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<tr>
<td>3</td>
<td>Power supply</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Switches</td>
<td>1</td>
</tr>
</tbody>
</table>
Procedure

1. Connect the pneumatic circuit according to the pneumatic circuit a).
2. Connect the electric circuit according to the electric circuit b).
3. Check that all parts are connected properly with each other.
4. Switch the power supply on and open the service unit.
5. Press switch S1. Explain what happens to the cylinder.
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6. Release switch S1 and explain what happens to the cylinder. Did the piston retract?
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7. Press switch S2 and explain what happen to the cylinder.
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9. Turn the power off and close the service unit.
10. Dismantle and tidy up.

Conclusion
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a) Pneumatic circuit

b) Electric circuit
Assignment 1: Class work

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

2. Draw the I.S.O symbol of both
   - a 5/2 DCV, single solenoid
   - a 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.
Assignment 2: Home Work

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

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

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

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?

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

6. Suggest a way to extend the above cylinder using the same electric circuit.
Indirect control in electro-pneumatics

Indirect control is the control of an electro-pneumatic valve using intermediate components such as a relay, a contactor or any industrial computer (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.

Disadvantages of direct control

- Complicated, more wiring.
- More cost involved.
Experiment # 3

Title
Indirect control of a double acting cylinder by using 5/2 DCV, single solenoid with spring return.

Objectives
The students will be familiar with:
1. 5/2 way valve single solenoid.
2. Relays and switches.
3. Indirect control circuit.

Background
We use a relay to indirectly control a solenoid valve.

Required components

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1</td>
<td>Double acting cylinder</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>5/2 DCV, single solenoid</td>
<td>1</td>
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<tr>
<td>3</td>
<td>Power supply</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Switches block</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Relays block</td>
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</tr>
</tbody>
</table>
**Procedure**

1. Connect the pneumatic circuit according to the pneumatic circuit a).

2. Connect the electric circuit according to the electric circuit b).

3. Check that all parts are connected properly with each other.

4. Switch the power supply on and open the service unit.

5. Press switch S1 and explain what happens to the cylinder. Did the piston extend?

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6. Release switch S1 and explain what happens to the cylinder. Did the piston retract?

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7. Turn off the power. Connect the relay as normally closed and reconnect the power. Explain what happen to the cylinder with and without pressing the switch S1.

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8. Turn the power off and close the service unit.

**Conclusion**

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![Diagram](image.png)
Experiment # 4

Title

Indirect control of a double acting cylinder by using 5/2 DCV, double solenoid.

Objectives

The students will be familiar with :
- 5/2 DCV, double solenoid.
- Relays.
- Switches.
- Indirect control circuit.

Background

We use a relay to indirectly control a solenoid valve.

Required components

<table>
<thead>
<tr>
<th>SR.</th>
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</tr>
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<tbody>
<tr>
<td>1</td>
<td>Double acting cylinder</td>
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<td>2</td>
<td>5/2 DCV, double solenoid</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Power supply</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Switches block</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Relays block</td>
<td>1</td>
</tr>
</tbody>
</table>
**Procedures**

1. Connect the pneumatic circuit according to the pneumatic circuit a).
2. Connect the electric circuit according to the electric circuit b).
3. Check that all parts are connected properly with each other.
4. Switch the power supply on and open the service unit.
5. Press switch S1 and explain what happens to the cylinder. Did the piston extend?

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6. Release the switch S1 and explain what happen to the cylinder. Did the piston retract?

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7. Press switch S2 and explain what happens to the cylinder. Did the piston retract?

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

**Conclusion**

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Assignment 3: Class work

4. Draw the I.S.O symbol of both
   - A 5/2 DCV, single solenoid.
   - A 5/2 DCV, double solenoid.

5. Explain the difference between direct and indirect control.

6. What is the function of a relay?

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

8. Draw a pneumatic and an electric circuit to control a double solenoid 5/2 DCV indirectly through N.C. relay and pushbutton switches.
Assignment 4: Home Work

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

1. What type of switch are switches S1, S2 and S3?

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

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

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.