EXPERIMENT 2
ELECTRO-PNEUMATIC CONTROL

OBJECTIVE

Fluid Power takes an important role as a technology in the performance of mechanical work. Industrial field nowadays turn their sight to these mechanism because of many advantages despite of its disadvantages. It is important for engineering student to learn and understand about this concept, so they know what to do in real system.

REFERENCE

Anonymous. Pneumatics Control Technology-Chungpa EMT. 2011.
Peter Crosser and Frank Ebel. Pneumatics Basic-Level. 2007

EQUIPMENT REQUIRED

PN-7050	Air Service Unit	1 piece
PN-7051	Air distributer	1 piece
PN-7100	3/2-way valve with push button (N.C)	1 piece
PN-7101	3/2-way valve with push button (N.O)	1 piece
PN-7400	Pneumatic single-acting cylinder	1 piece
PN-7602	3/2-Way Single Solenoid Valve(N.C)	1 piece
PN-7610	5/2-Way Double Solenoid Valve	1 piece
PN-7402	Double Acting Cylinder with Air Cushion	1 piece
PN-7570	Electrical Limit Switch module(Left)	1 piece
PN-7570	Electrical Limit Switch module(Right)	1 piece
PN-7302	Different pressure valve (AND)	1 piece
PN-7301	Shuttle valve (OR)	1 piece
PN-7400	Pneumatic single-acting cylinder	1 piece
-	Power Supply Module	1 piece
-	Switch Module	1 piece
-	Relay Module	1 piece
-	Compressor	1 piece
-	Pneumatic Hose	Sufficiently
-	Electrical leads	Sufficiently

PRE-EXPERIMENT TASK

1. What is the difference of Pneumatic and Hydraulic system?
2. Why do we need the valves in that System? Explain briefly!
3. How do the 3/2-way valve and 5/2-way valve works?

INTRODUCTION

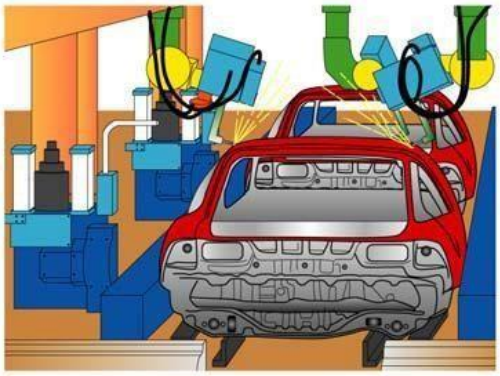
A pneumatic system is a system that uses compressed air to transmit and control energy. The principles of pneumatics are the same as those for hydraulics, but pneumatics transmits power using a gas instead of a liquid. Compressed air is usually used, but nitrogen or other inert gases can be used for special applications. With pneumatics, air is usually pumped into a receiver using a compressor. The receiver holds a large volume of compressed air to be used by the pneumatic system as needed. Atmospheric air contains airborne dirt, water vapor, and other contaminants, so filters and air dryers are often used in pneumatic systems to keep compressed air clean and dry, which improve reliability and service life of the components and system. Pneumatic systems also use a variety of valves for controlling direction, pressure, and speed of actuators.

Most pneumatic systems operate at pressures of about 100 psi or less. Because of the lower pressure, cylinders and other actuators must be sized larger than their hydraulic counterparts to apply an equivalent force. For example, a hydraulic cylinder with a 2 in. diameter piston (3.14 sq. in. area) and fluid pressure of 1,000 psi can push with 3140 lbs. of force. A pneumatic cylinder using 100 psi air would need a bore of almost 6½ in. (33 sq. in.) to develop the same force. Even though pneumatic systems usually operate at much lower pressure than hydraulic systems do, **pneumatics holds many advantages that make it more suitable for many applications**. Because pneumatic pressures are lower, components can be made of thinner and lighter weight materials, such as aluminum and engineered plastics, whereas hydraulic components are generally made of steel and ductile or cast iron. Hydraulic systems are often considered rigid, whereas pneumatic systems usually offer some cushioning, or "give." Pneumatic systems are generally simpler because air can be exhausted to the atmosphere, whereas hydraulic fluid usually is routed back to a fluid reservoir.

Pneumatics also holds advantages over electromechanical power transmission methods. Electric motors are often limited by heat generation. *Heat generation is usually not a concern with pneumatic motors* because the stream of compressed air running through them carries heat from them. Furthermore, because pneumatic components require no electricity, they don't need the bulky, heavy, and expensive explosion-proof enclosures required by electric motors. In fact, even without special enclosures, electric motors are substantially larger and heavier than pneumatic motors of equivalent power rating. Plus, if overloaded, pneumatic motors will simply stall and not use any power. Electric motors, on the other hand, can overheat and burn out if overloaded. Moreover, torque, force, and speed control with pneumatics often requires simple pressure- or flow-control valves, as opposed to more expensive and complex electrical drive controls. And as with hydraulics, pneumatic actuators can instantly reverse direction, whereas electromechanical components often rotate with high momentum, which can delay changes in direction.

Factory automation is the largest sector for pneumatics technology, which is widely used for manipulating products in manufacturing, processing, and packaging operations. **Pneumatics is also widely used in medical and food processing equipment.** Pneumatics is typically thought of as pick-and-place technology, where pneumatic components work in concert to perform the same repetitive operation thousands of times per day. ***But pneumatics is much more.*** Because compressed air can have a cushioning effect, it is often called on to provide a gentler touch than what hydraulics or electromechanical drives can usually provide. In many applications, pneumatics is used more for its ability to provide controlled pressing or squeezing as it is for fast and repetitive motion. Moreover, electronic

Controls can give pneumatic systems positioning accuracy comparable to that of hydraulic and electromechanical technologies.



1a.Automobile Production Lines

1b. Pneumatic system of an automatic machine

Fig. 1(a,b) Common pneumatic systems used in the industrial sector

Pneumatics is also widely used in chemical plants and refineries to actuate large valves. It's used on mobile equipment for transmitting power where hydraulics or electromechanical drives are less practical or not as convenient and in on-highway trucking for various vehicle functions. And of course, vacuum is used for lifting and moving work pieces and products. In fact, combining multiple vacuum cups into a single assembly allows lifting large and heavy objects. Following are the use of pneumatics in a variety of applications i.e. used in controlling train doors, automatic production lines, mechanical clamps, etc.

Fluid power systems consist of multiple components that work together or in sequence to perform some action or work. People well versed in fluid power circuit and system design may purchase individual components and assemble them into a fluid power system themselves. However, many fluid power systems are designed by distributors, consultants, and other fluid power professionals who may provide the system in whole or in part. The major components of any fluid power system include:

- **a pumping device** — a hydraulic pump or air compressor to provide fluid power to the system
- **fluid conductors** — tubing, hoses, fittings, manifolds and other components that distribute pressurized fluid throughout the system
- **valves** — devices that control fluid flow, pressure, starting, stopping and direction
- **Actuators** — cylinders, motors, rotary actuators, grippers, vacuum cups and other components that perform the end function of the fluid power system.
- **support components** — filters, heat exchangers, manifolds, hydraulic reservoirs, pneumatic mufflers, and other components that enable the fluid power system to operate more effectively.

Electronic sensors and switches are also incorporated into many of today's fluid power systems to provide a means for electronic controls to monitor operation of components. Diagnostic instruments are also used for measuring pressure, temperature and flow in assessing the condition of the system and for troubleshooting.

EXPERIMENT

Experiment 1. Direct and Indirect Control

Direct control of single acting cylinder using 3/2-way valve with push button

A. Operational Procedure

1. Configure circuit in **Figure 1** for N.C circuit.
2. On the Air Service Unit, adjust the operating pressure in about 2-3 atm. Make sure to always check the pressure control valve in 'open' or 'closed' state.
3. Write initial condition of valve when it is depressed and released.
4. Whenever removing hose from device, make sure there isn't compressed air that flowing in the hose.
5. Configure circuit in **Figure 2** for N.O circuit.
6. Write initial condition of valve when it is depressed and released.

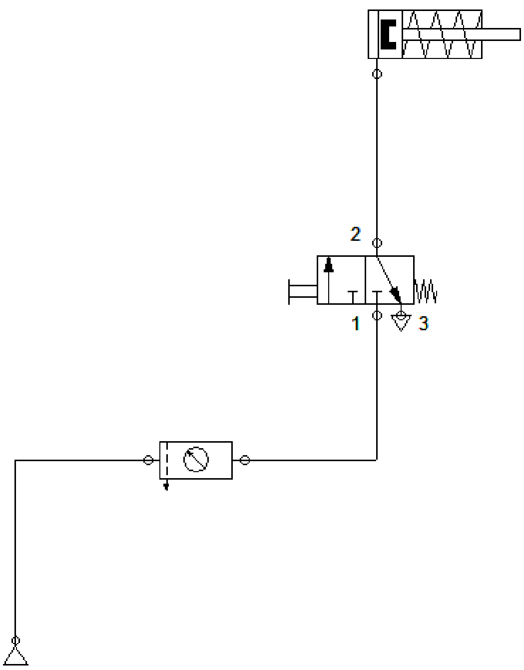


Figure 1. N.C Circuit

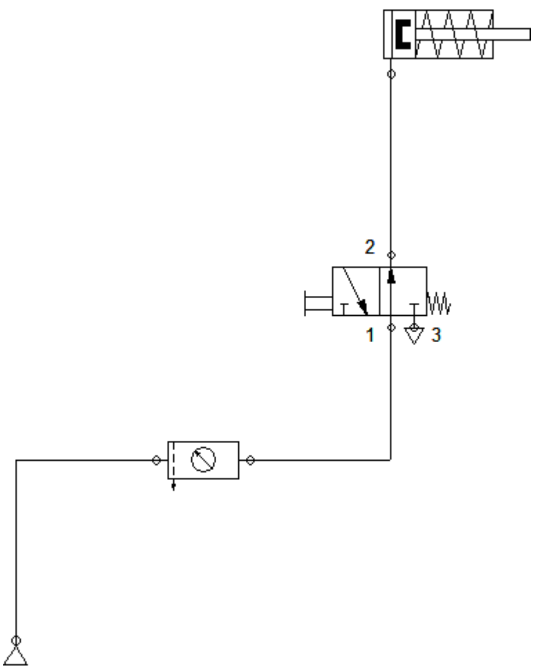


Figure 2. N.O Circuit

B. Experimental Data

Table 1.1

		Valve Type	
		Normally Open	Normally Closed
Condition	Depress		
	Release		

C. Experimental Analysis

1. Explain why we need different valve for this experiment!
2. Draw the state change diagram for each condition and explain the difference briefly!

Experiment 2. Direct and indirect control using logic circuit

A. Operational Procedure

1. Configure circuit in **Figure 3** for parallel circuit (AND function).
2. On the air service unit, adjust the operating pressure in about 2-3 atm. Make sure to always check the pressure control valve in ‘open’ or ‘closed’ state.
3. Write initial condition of valve when it is depressed and released.
4. Whenever removing hose from device, make sure there isn’t compressed air that flowing in the hose.
5. Configure circuit in **Figure 4** for parallel circuit (OR function).
6. Write initial condition of valve when it is depressed and released.

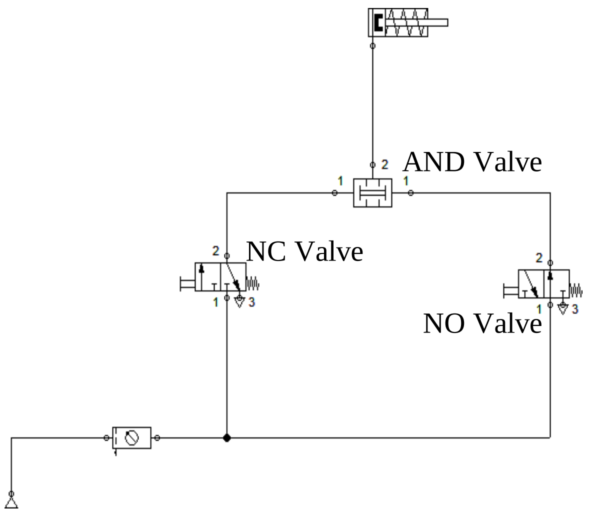


Figure 3. Parallel Circuit (AND)

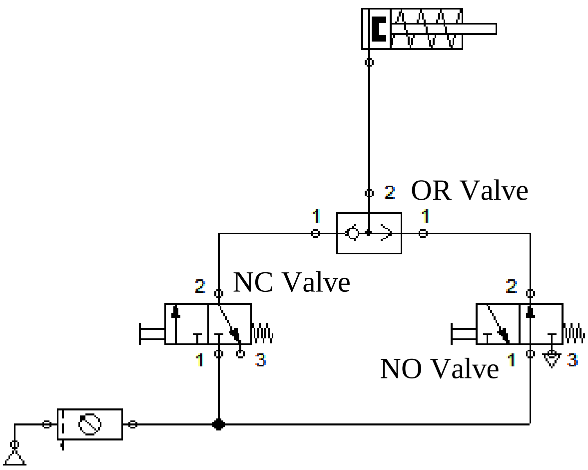


Figure 4. Parallel Circuit (OR)

B. Experimental Data

Table 1.2

	Normally Open	Normally Closed	Cylinder Condition
AND	0	0	
	0	1	
	1	0	
	1	1	
OR	0	0	
	0	1	
	1	0	
	1	1	

Information: 0 = Released
1 = Depressed

C. Experimental Analysis

1. Explain why do need different valve for this experiment!
2. Draw the state change diagram for shuttle valve and check valve then explain the difference briefly!

Experiment 3. Indirect control of single acting cylinder

A. Operational Procedure

1. Configure circuit in **Figure 5** using roller lever valve (Right).
2. On the Air Service Unit, adjust the operating pressure in about 2-3 atm. Make sure to always check the pressure control valve in ‘open’ or ‘closed’ state.
3. Write initial condition of valve when it is depressed and released.
4. Whenever removing hose from device, make sure there isn’t compressed air that flowing in the hose.
5. Configure circuit in **Figure 6** using roller lever valve (Left).
6. Write initial condition of valve when it is depressed and released.

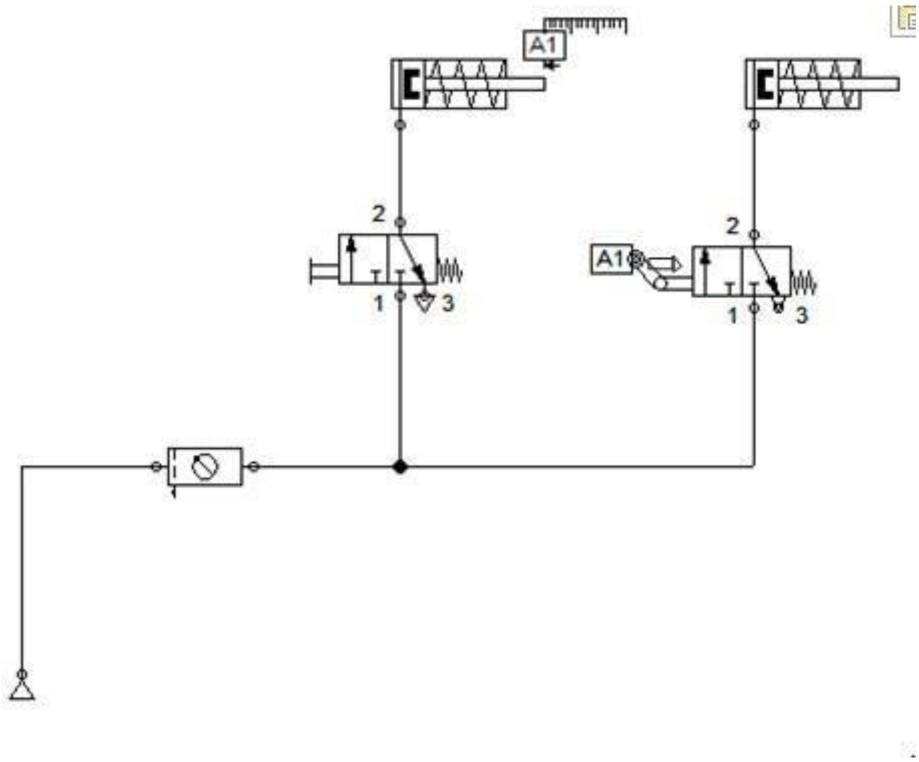


Figure 5. 3/2-way roller lever valve(Right)

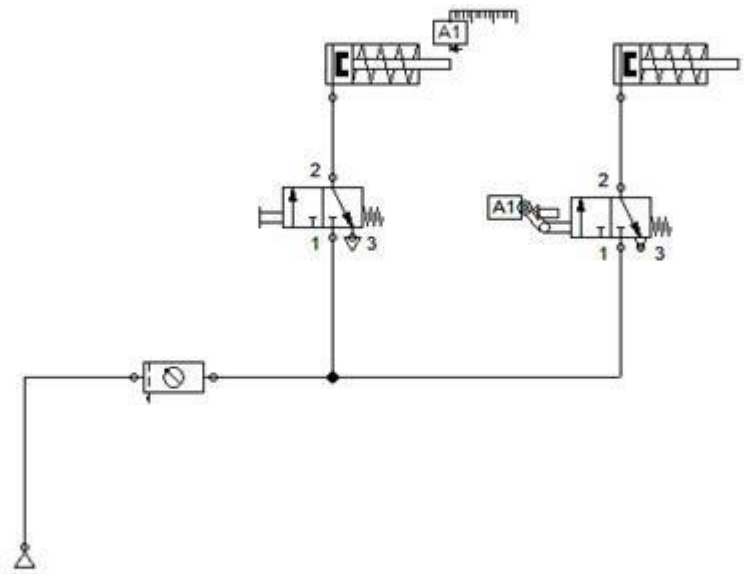


Figure 6. 3/2-way roller lever valve(Left)

B. Experimental Data

Table 1.3

		Roller Lever Type	
		Left	**Right**
Condition	**Released**		
	Depressed		

C. Experimental Analysis

1. Explain why we need two cylinders for this experiment!
2. Why we need to place the position of the roller in the right place (cylinder retract and extend) explain briefly!

Experiment 4. Direct control of single acting cylinder using relay control

A. Operational Procedure

1. Ensure 24V DC power supply is switched “off”
2. Following the pneumatic and electrical circuit like **Figure 7** and **Figure 8**
3. Switch ‘on’ the compressor
4. On Air service unit, adjust the pressure in value 2-3 atm. Check the pressure control valve condition open or closed.
5. Switch ‘on’ the 24V DC power supply
6. Depress push button PB3 and observe the action of cylinder
7. Depress push button PB4 and observe the action of cylinder
8. Depress push button PB3 and PB4, observe the action of cylinder.
9. Write the data observation
10. Switch ‘off’ the compressor
11. Remove all pneumatic tubing and electrical leads

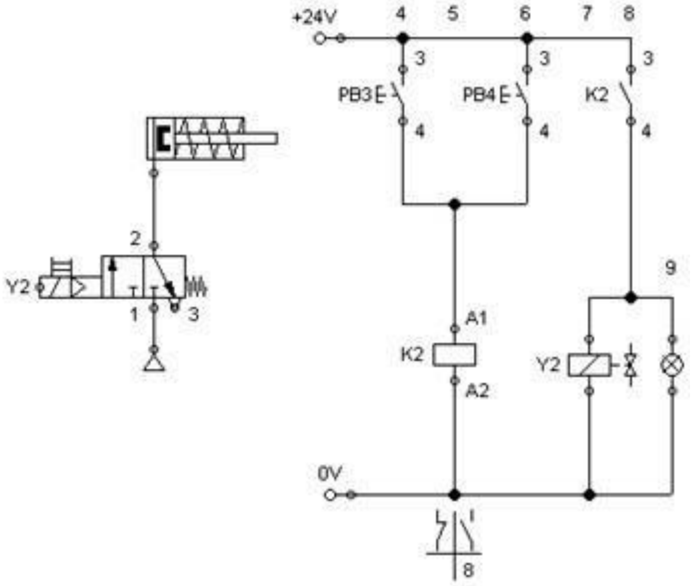


Figure 7. Circuit Parallel (OR) function

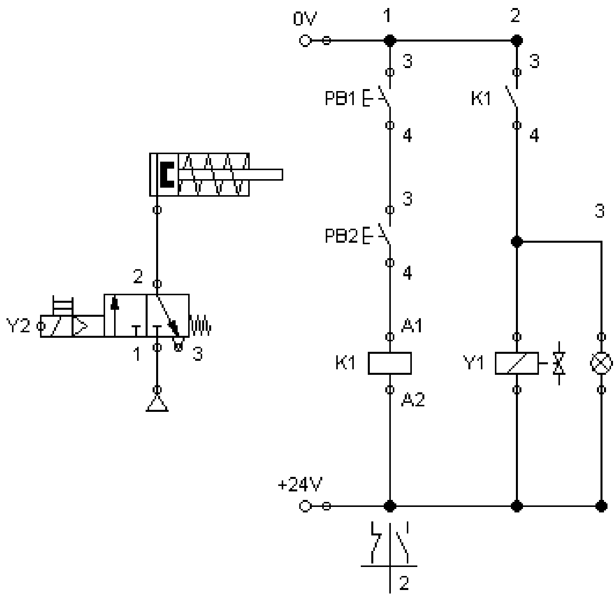


Figure 8. Circuit Series (AND) function

B. Experimental Data

Table 1.4 Experimental Data Circuit Series OR

PB3	PB4	LED on Solenoid	LED	Acting Cylinder
Depress	Release			
Release	Depress			
Depress	Release			
Depress	Depress			

Table 1.5 Experimental Data Series AND

PB1	PB2	LED on Solenoid	LED	Acting Cylinder
Depress	Release			
Release	Depress			
Depress	Release			
Depress	Depress			

C. Experimental Analysis

1. Explain why do need relay for this experiment!
2. Draw the state change diagram for each condition and explain the function of solenoid in the valve briefly!

Experiment 5. Application of electro-pneumatic

A. Equipment Required

1. Ensure 24V DC. power supply is switched “off”
2. Following the pneumatic and electrical circuit like **Figure 9**
3. Switch ‘on’ compressor
4. On Air service unit, adjust the pressure in value 2-3 atm. Check the pressure control valve condition open or closed
5. Switch ‘on’ the 24V DC power supply
6. Depress push button PB1 and observe the action of cylinder
7. Depress push button PB2 and observe the action of cylinder.

8. Write the data observation
9. Switch ‘off’ the compressor
10. Remove all pneumatic hosing and electrical leads

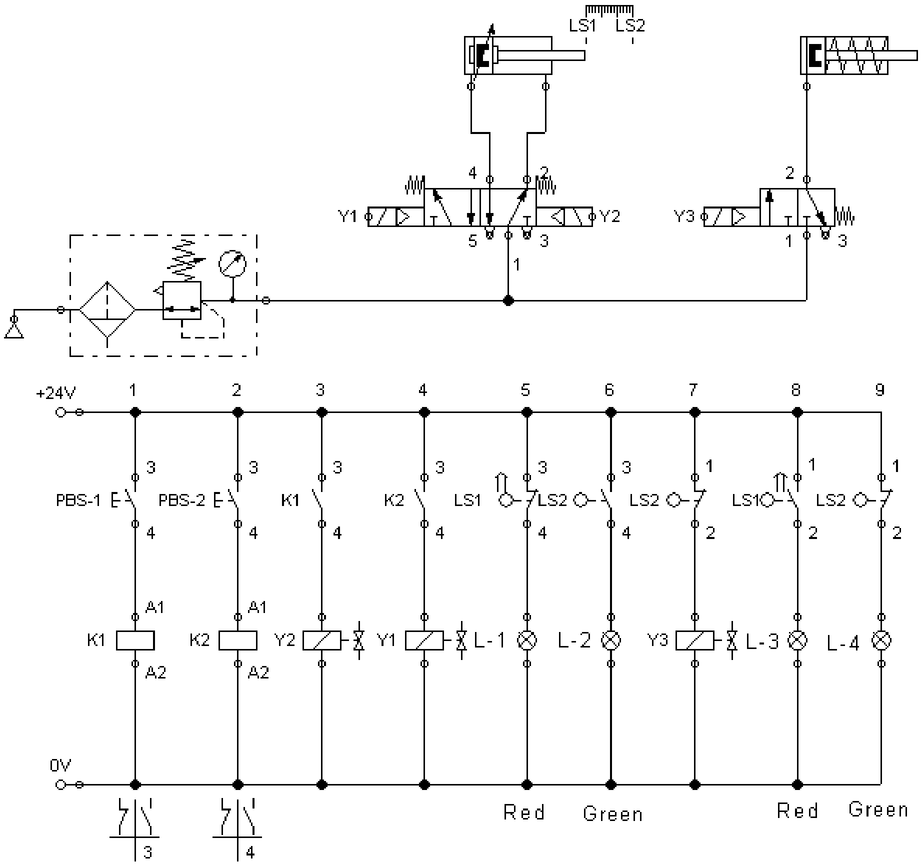


Figure 9. Pneumatic and electrical circuit ‘Barrier Control with Indicator Lamp’

B. Experimental Data

Table 1.6 Experimental Data ’ Barrier Control with Indicator Lamp’.

PB1	PB2	LED-1	LED-2	LED-3	LED-4	Single Acting Cylinder	Double Acting Cylinder
Release	Release						
Depress	Release						
Release	Depress						

C. Experimental Analysis

1. Explain why we need Pressure Control Unit for this experiment and explain each of component function!

2. Draw the state change diagram for each condition!