

3/2-Way Pneumatic Solenoid Valves: An Overview

Dr. eng. **Tiberiu AXINTE**^{1,*}, Dr. eng. **Mihăiță CAZACU**², Dr. math. **Elena Gabriela CURCĂ**¹,
Eng. **Lidia CALANCEA**¹, Eng. **Mihai DIACONU**¹, Drd. eng. **Alexandru SAVASTRE**¹

¹ Research and Innovation Center for Navy, Romania

² Ovidius University of Constanta, Romania

*tibi_axinte@yahoo.com

Abstract: The paper presents importance of the 3/2-way solenoid valve in the electro-pneumatic circuit. Besides, in this article we present three electro-pneumatic circuits endowed with 3/2-way solenoid valve. Thus, the first electro-pneumatic circuit is composed of the following devices: compressed air supply, 3/2-way solenoid valve, throttle valve, single acting cylinder (SAC 1) and valve solenoid. The second electro-pneumatic circuit is composed of the following parts: compressed air supply, 3/2-way solenoid valve, throttle check valve, single acting cylinder (SAC 2), relay, valve solenoid and lamp. The last electro-pneumatic system is made of the following components: compressed air supply, 3/2-way solenoid valve, single acting cylinder (SAC 3), valve solenoid and logic module.

Keywords: Circuit, solenoid, valve, symbol

1. Introduction

Electro-pneumatic circuits that have 3/2-way solenoid valves are widely used in many areas of industrial automation.

In electro-pneumatic fields, pneumatic components (ex. single-acting cylinders) are controlled by using electrical and electronic circuits with 3/2-way solenoid valves, [1].

In direct-operated valves, the spool or poppet is moved directly by the 3/2-way solenoid valves.

These valve opens or closes by moving the spool or poppet. Various device (3/2-way solenoid valves) types include: push button, solenoid (coil), lever or foot pedal.

Based on stability, the pneumatic actuator can have:

- Monostable valves – return to their default position using spring force.
- Bistable valves – have a coil at each position are pulse-operated.

A 3/2-way solenoid valve is an electromechanically operated valve. However, the 3/2-way solenoid valves depend on: the characteristics of the electric current they use, the strength of the magnetic field they generate and the mechanism they use to regulate the air.

In the specialized papers, the valves have the symbol below, Fig. 1.

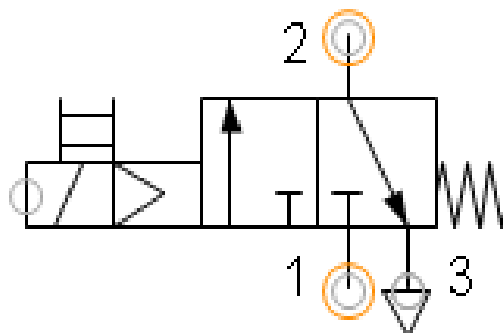


Fig. 1. Symbol of 3/2-way solenoid valve

Any 3/2 way valve has three ports and two positions that can be operated: pneumatically, mechanically, manually or electrically through a valve.

Some 3/2-way solenoid valves are equipped with a return spring, [2].

In these manuscript we use only MFH-3-1/4 pneumatic solenoid valve from Festo. These valves have one in an electro-pneumatic circuits, Fig. 2.



Fig. 2. 3/2-way solenoid valve type MFH-3-1/4

Technical characteristics of a 3/2-way solenoid valve are shown in Table 1.

Table 1: Technical characteristics

Feature	Value
Construction width	0.3 m
Standard nominal flow rate (DIN 1343)	0.013 m ³ /s
Pneumatic working port	G1/4
Operating pressure	15·10 ³ Pa...80·10 ³ Pa
Nominal size	7·10 ⁻³ m
Grid dimension	32·10 ⁻³ m
Storage temperature	253.15 K ... 333.15 K
Media temperature	263.15 K ... 333.15 K
Ambient temperature	268.15 K ... 313.15 K
Product weight	0.350 kg

2. Study of 3/2-way valve solenoid

Hydraulics involves the use of air (in our case) to perform quality mechanical work. In fact, the mechanical work is necessary to perform movements and generate forces in the electro-hydraulics circuits. All electro-hydraulic circuits are electro-controlled by an electrical source. The electro-hydraulic circuits are the voltage supply and then the signals are generated by 24V and sent to the 3/2-way solenoid valves for the directional control of the hydraulic fluid. Moreover furthermore, the function of hydraulic drives (e.g. single acting cylinder) is to convert stored energy into moving hydraulic fluid, [3].

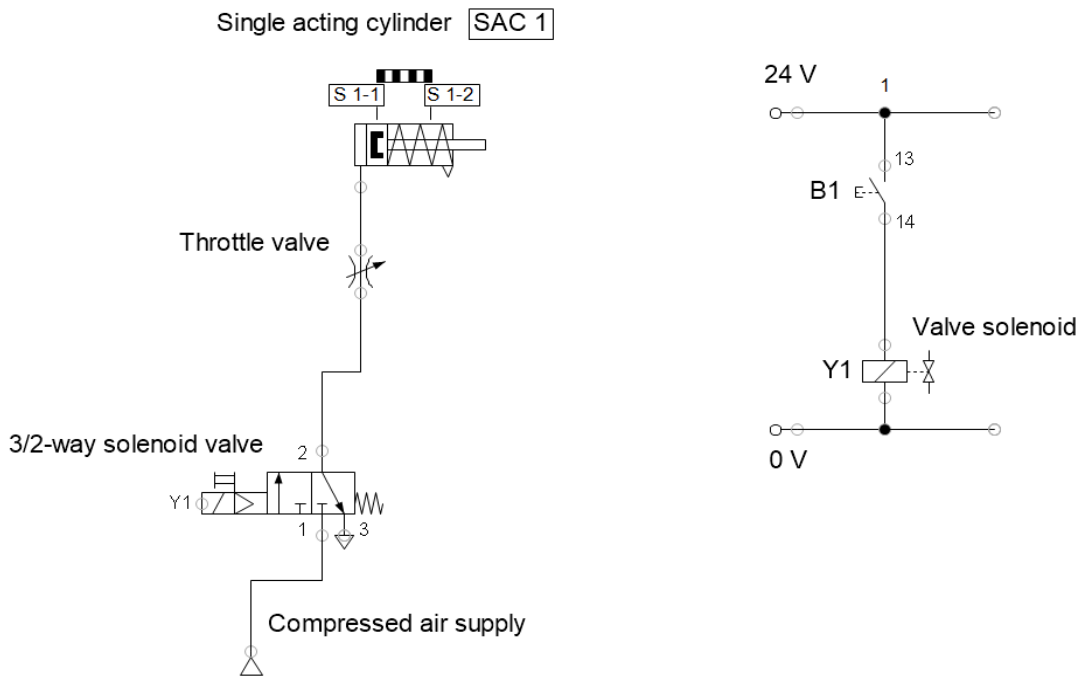


Fig. 3. First electro-pneumatic circuit with 3/2-way solenoid valve

First electro-pneumatic circuit made in this paper is designed as a simple scheme use only a single acting cylinder (SAC 1). Hence, 3/2-way solenoid valve from first electro-pneumatic control system has a spring-returned, Fig. 3. In the table below there are given five devices used in the first electro-pneumatic scheme with 3/2-way solenoid valve.

Table 2: Devices of first electro-pneumatic scheme

Description	Number of components
Compressed air supply	1
3/2-way solenoid valve	1
Throttle valve	1
Single acting cylinder (SAC 1)	1
Valve solenoid	1

The 3/2 – way solenoid valve with spring makes the connection between compressed air supply and throttle valve, [4]. If the operator presses B1 button, the piston rod moves from point S 1-1 to point S 1-2. After that, those both piston rods returns from point S1-2 to point S1-1, because the 3/2-way solenoid valve has a spring, Fig. 4.

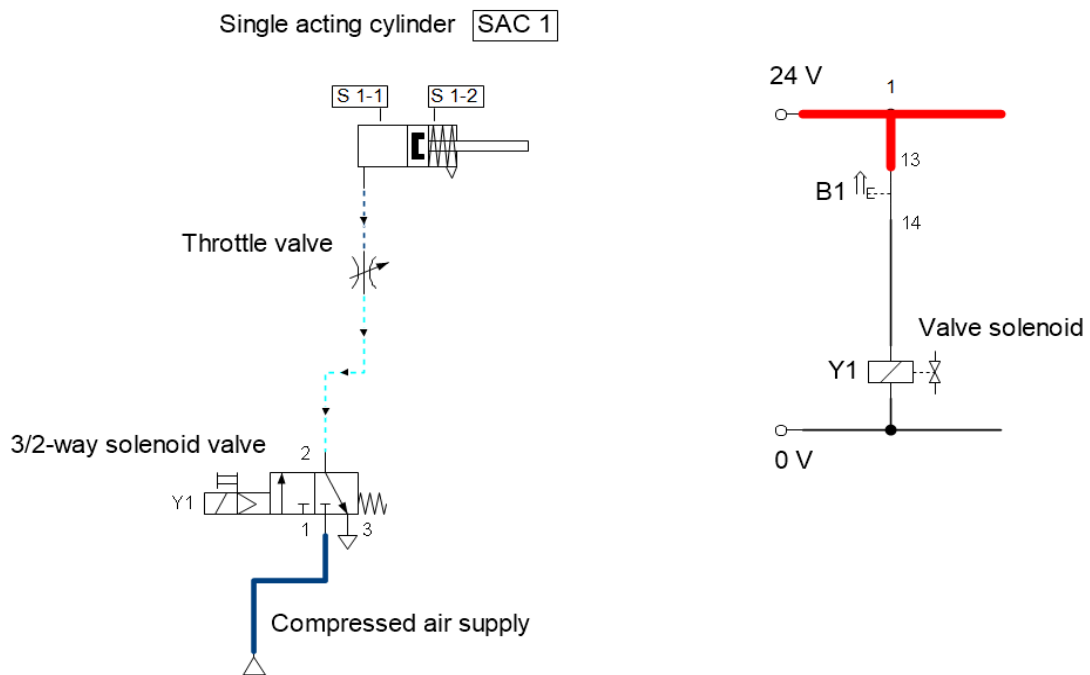


Fig. 4. First electro-pneumatic circuit with 3/2-way solenoid valve. Simulation

The usual parameters of single acting cylinder (SAC 1) are: position (x), velocity (v) and acceleration, Fig. 5.

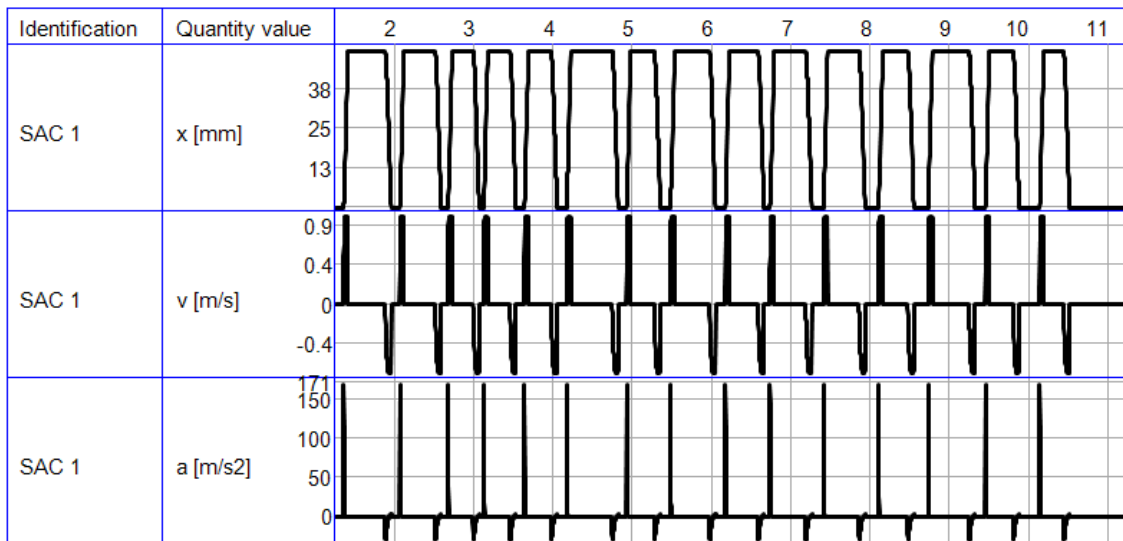


Fig. 5. Diagrams of parameters

The second electro-pneumatic installation has a single acting cylinder (SAC 2), Fig. 6.

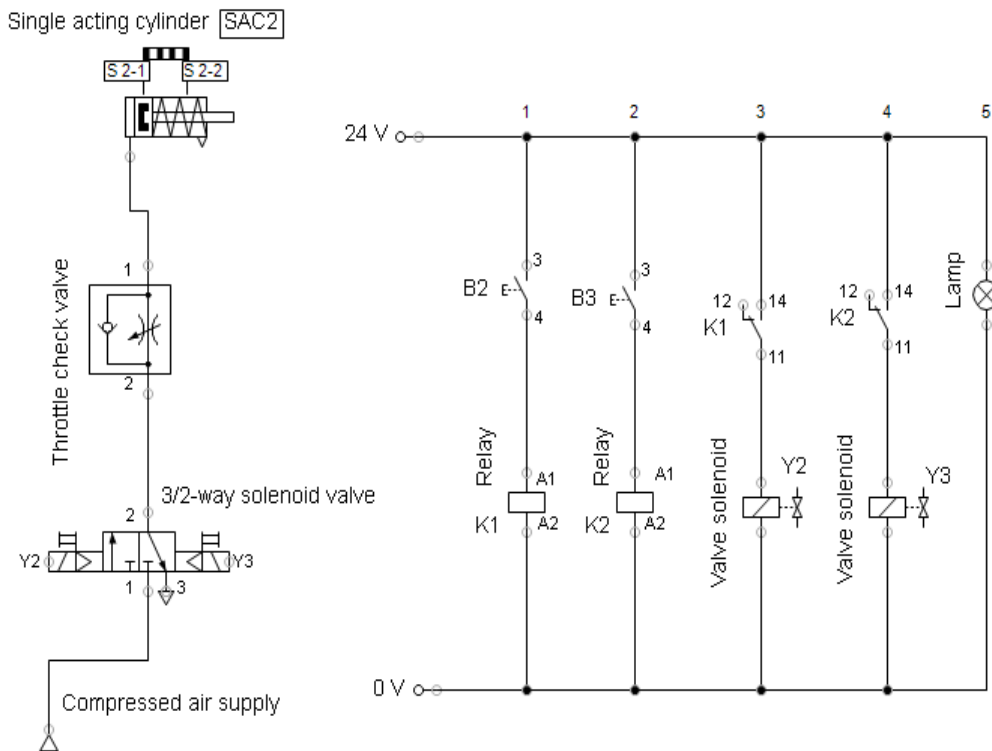


Fig. 6. Second electro-pneumatic circuit with 3/2-way solenoid valve

The simple electro-pneumatic system with 3/2-way solenoid valve have the following nine devices listed in the table below, [5].

Table 3: Devices of second electro-pneumatic scheme

Description	Number of components
Compressed air supply	1
3/2-way solenoid valve	1
Throttle check valve	1
Single acting cylinder (SAC 2)	1
Relay	2
Valve solenoid	2
Lamp	1

The second electro-pneumatic circuit with single acting cylinder (SAC 2) opens if the operator presses B2 button from 3/2-way solenoid valve and lamp shows green signal, Fig. 7.

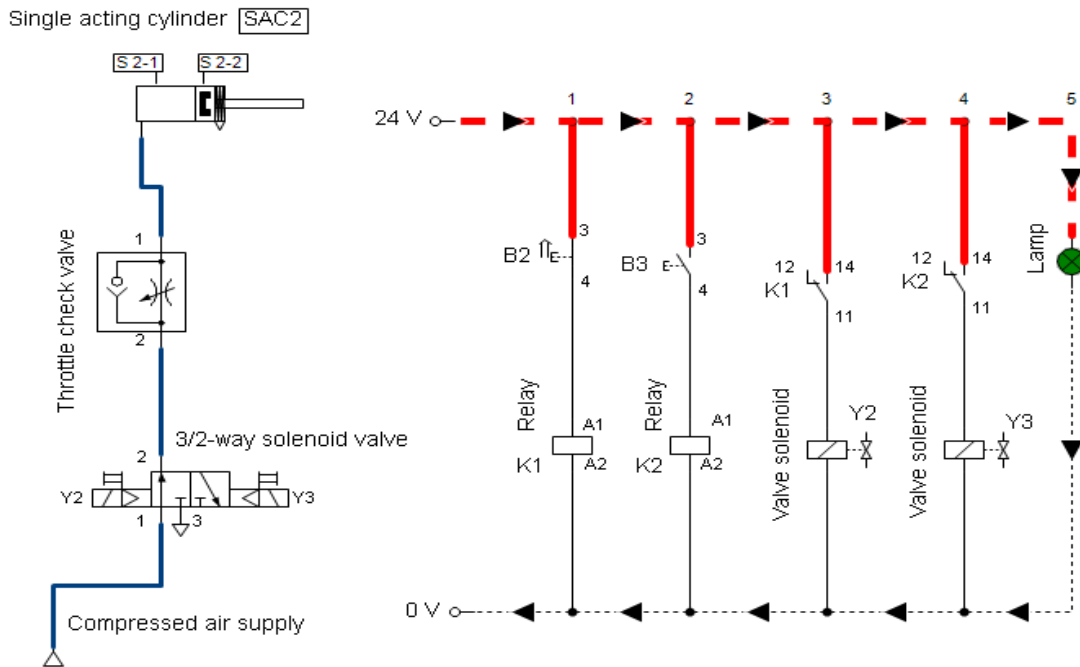


Fig. 7. Second electro-pneumatic circuit with 3/2-way solenoid valve. Simulation I

If the operator presses B3 button, the piston rod of the single acting cylinder (SAC 2) moves from point S 2-2 to point S 2-1.

And the same time the lamp shows green signal, Fig. 8.

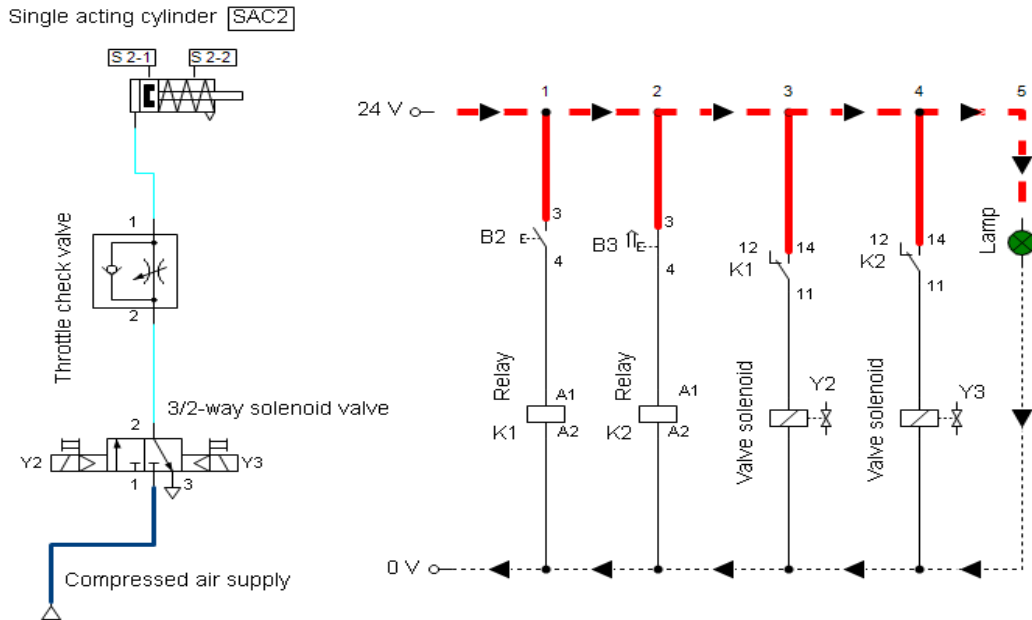


Fig. 8. Second electro-pneumatic circuit with 3/2-way solenoid valve. Simulation II

In addition, an electro-pneumatic circuit with a 3/2-way solenoid valve is studied together with a logic module, Fig. 9.

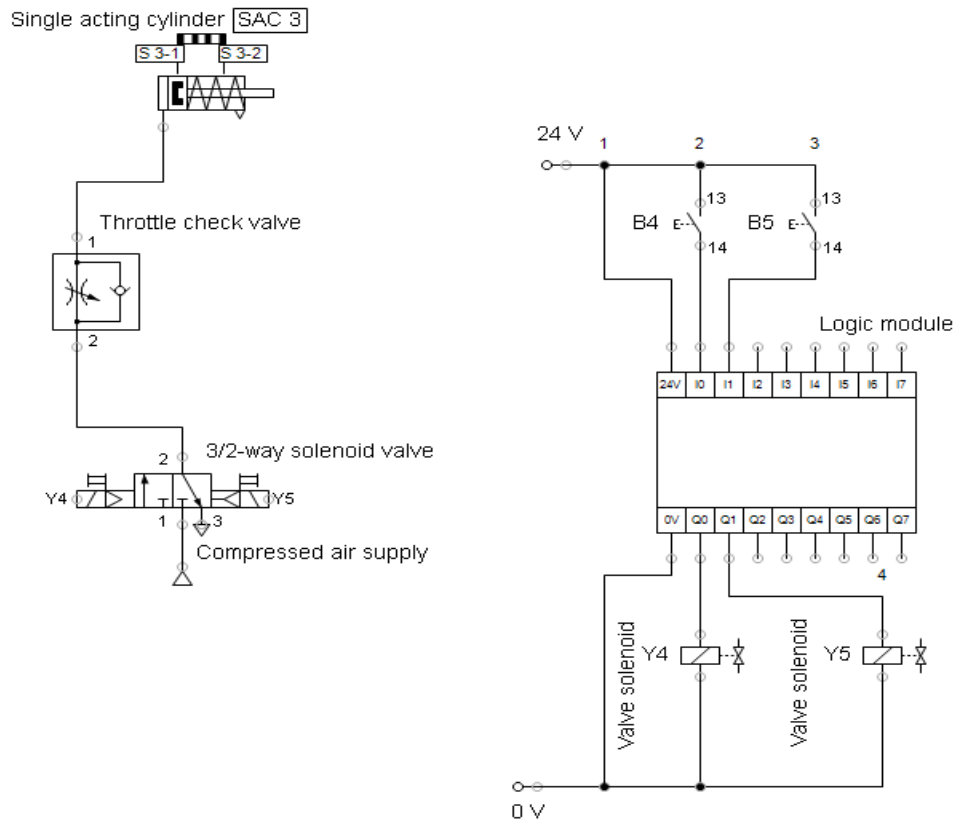


Fig. 9. Third electro-pneumatic circuit with single acting cylinder

The last of electro-pneumatic system with 3/2-way solenoid valve have the following seven devices listed in the table below, [5].

Table 4: Devices of second electro-pneumatic scheme

Description	Number of components
Compressed air supply	1
3/2-way solenoid valve	1
Throttle check valve	1
Single acting cylinder (SAC 3)	1
Valve solenoid	2
Logic module	1

Finally, if operator presses B4 button, the piston rod of the multi-position cylinder (2) moves from point S 3-1 to point S 3-2. After that, this piston rod returns from point S 3-2 to point S 3-1. Because of the single acting cylinder (SAC 3) has a spring, Fig. 10.

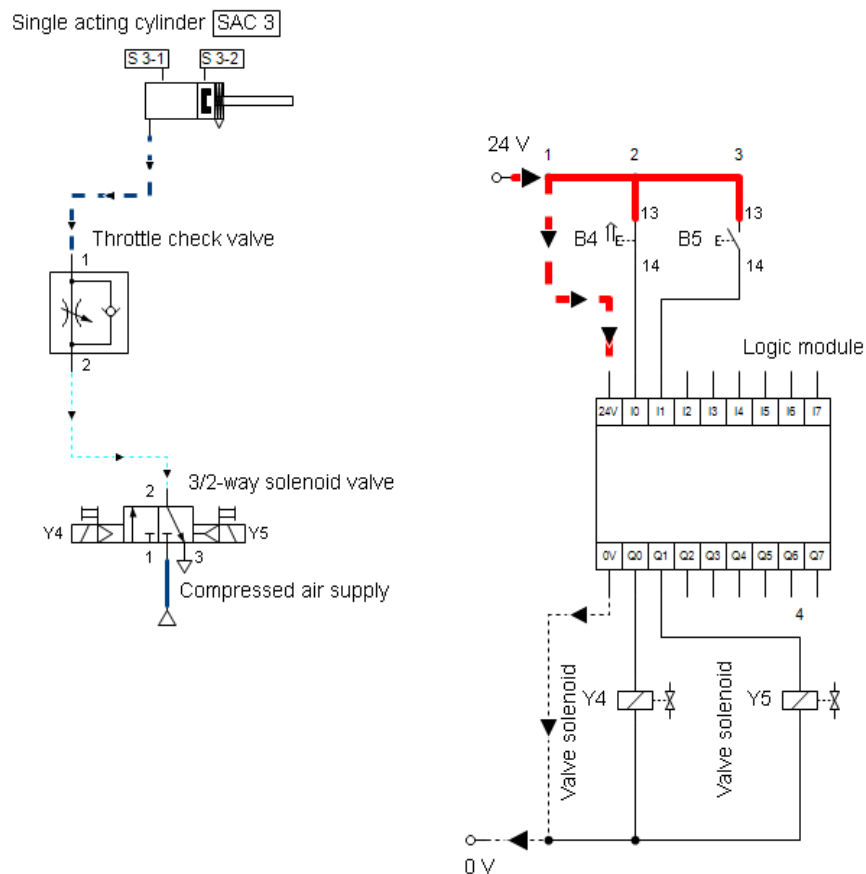


Fig. 10. Third electro-pneumatic circuit with single acting cylinder. Simulation.

3. Conclusions

Electro-pneumatic circuits with 3/2-way solenoid valves is an integration of electrical and mechanical components with compressed air source.

On the other hand, the 3/2-way solenoid valves are control units that, when electrically energized or disconnected, either close or allow air to flow.

Electro-pneumatic circuit with 3/2-way solenoid valves to have a bright future in technology, especially in the design and simulation of pneumatic suits.

Below are some advantages of electro-pneumatic circuits with 3/2-way solenoid valves:

- Greater reliability.
- Less moving parts subjected to wear compared to mechanical control systems.
- Reduced installation complexity.
- Less components and hoses, leads to less effort in planning and commissioning especially with large and complex systems.
- The control system can be easily modified and adapted.
- It is easier to change wiring and modify programs rather than changing mechanical components and hose networks.
- Easy handling.
- Less complexity
- Secure mounting.
- Environmentally-friendly coupling system.

In the future, we want to perform simulations of electro-pneumatic circuits with 3/2-way solenoid valves to perform various complex activities.

References

- [1] Radoi, R., M. Blejan, I. Dutu, G. Sovaiala, and I. Pavel. “Determining the step response for a pneumatic cylinder positioning system.” *Hidraulica Magazine*, no. 2 (June 2014): 25-31.
- [2] Pereyras, J. “Development of a Basic Electro-Pneumatic Control trainer.” *Asian Journal of Multidisciplinary Studies* 2, no. 2 (2019).
- [3] Rojas Suárez, J. P., J.A. Pabón León, and M.S. Orjuela Abril. “Development of an electro-pneumatic system for the practical training of pneumatic process in the university environment.” Paper presented at the 1st STEAM Education Congress (1st STEAMEC), San José de Cúcuta, Colombia, June 10-11, 2021. *Journal of Physics: Conference Series* 2073 (2021): 012016.
- [4] Tripathy, S., A. Das, B. Sahu, and D.K. Srivastava. “Electro-pneumatic variable valve actuation system for camels engine: Part I – development and characterization.” *Energy* 193 (February 2020): 116740.
- [5] Selvam, C. “Design & Fabrication of Electro-Pneumatic Gantry Type Sorting Robot.” *International Research Journal of Engineering and Technology (IRJET)* 9, no. 12 (2022): 787-794.