

## Modelling and Simulation of Hydraulic Circuits Using 4/2-Way Hand-Lever Valves

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**Abstract:** The paper presents an overview of the efficiency for a hydraulic circuit with 4/2-way hand-lever valves. Thereby in this article we are studying three hydraulic circuits which contain 4/2-way hand-lever valves. The first hydraulic circuit contains the following devices: pump unit, tank, 4/2-way hand-lever valve, throttle valve, double acting cylinder (Dou 1-1). The second hydraulic circuit contains the following components: pump unit, tank, 4/2-way hand-lever valve, pressure relief valve, double acting cylinder (Dou 2-1), and 2-way flow control valve. The last circuit, which is actually a hydraulic system, contains the following components: pump unit, tank, 4/2-way hand-lever valve, non-return valves, 2-way flow control valve, double acting cylinders (Dou 3-1 and Dou 3-2).

**Keywords:** Valve, circuit, hand, lever, spring

### 1. Introduction

Hydraulic installations that have 4/2-way hand-lever valve are widely used in many areas such as: materials technology, thermal treatments, sealing technology, surface treatments, tribology, etc. With the help of 4/2-way hand-lever valves, the technician can easily configure the functions and options required for the hydraulic control system.

A 4/2-way hand-lever valve is a mechanically operated valve. Nevertheless, the 4/2-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 [1].

In the specialized papers, the 4/2-way hand-lever valve have the symbol below, Fig. 1.

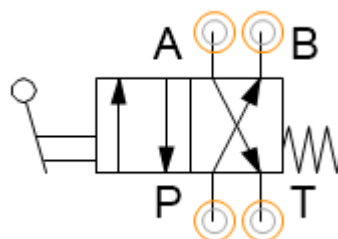


Fig. 1. Symbol of 4/2-way hand-lever valve

The 4/2-way hand-lever valve is mounted on a function plate equipped with four quick coupling connectors.

Where:

- A, B → working port.
- P → supply port.
- T → return-line port.

The component from 4/2-way hand-lever valve is fitted to the grid system of the slotted assembly board by means of the two blue levers, Fig. 2.



Fig. 2. 4/2-way hand-lever valve

Technical characteristics of a 4/2-way hand-lever valve are shown in Table 1.

Table 1: Technical characteristics

Parameter	Value	Unit
Minimum voltage	0.1 ... 300	V
Physical spring force	0.01 ... 100	N
Operating pressure	$15 \cdot 10^3$ ... $80 \cdot 10^3$	Pa
Nominal size	$7 \cdot 10^{-3}$	m
Grid dimension	$32 \cdot 10^{-3}$	m
Storage temperature	253.15 ... 333.15	K
Media temperature	263.15 ... 333.15	K
Ambient temperature	268.15 ... 313.15	K
Product weight	0.350	kg

## 2. Study of 4/2-way hand-lever valve

In practice, many pneumatic circuits have 4/2-way hand-lever valves because these devices are easy to use by technicians. Anyway, all 4/2-way hand-lever valves in the manuscript have return springs [2].

Below, the first pneumatic system with 4/2-way hand-lever valve is presented, Fig. 3.

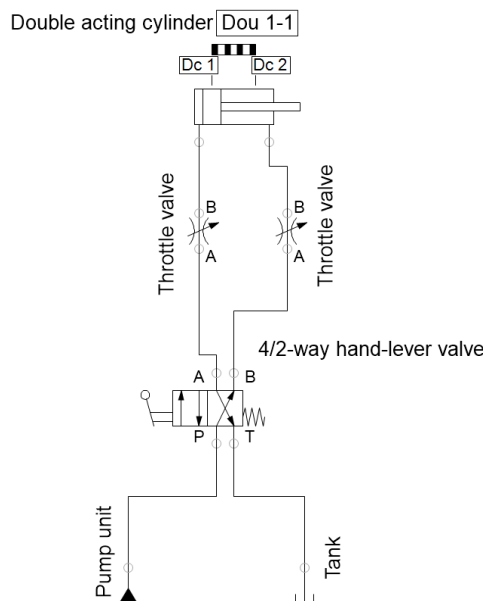


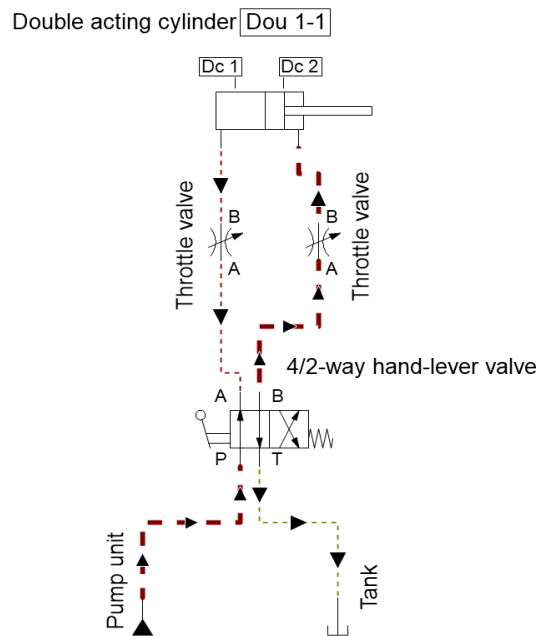
Fig. 3. First pneumatic circuit with 4/2-way hand-lever valve

Table 2 shows the six devices from the first pneumatic scheme with 4/2-way hand-lever valve.

**Table 2:** The devices of the first pneumatic scheme

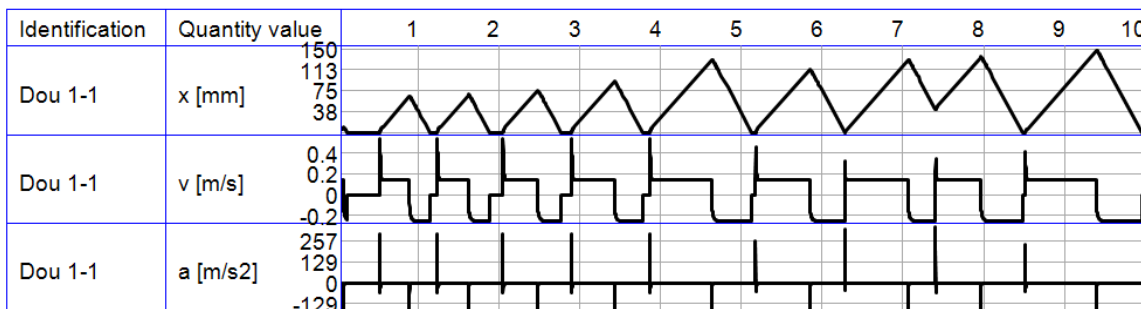
Description	Number of components
Pump unit	1
Tank	1
4/2-way hand-lever valve	1
Throttle valve	2
Double acting cylinder (Dou 1-1)	1

At first, the technician pushes the lever to the right from 4/2-way valve. Then, the piston rod moves from point Dc 1 to point Dc 2 [3]. After that, the piston rod returns from point Dc 2 to point Dc 1, because the 4/2-way valve has a spring, Fig.4.



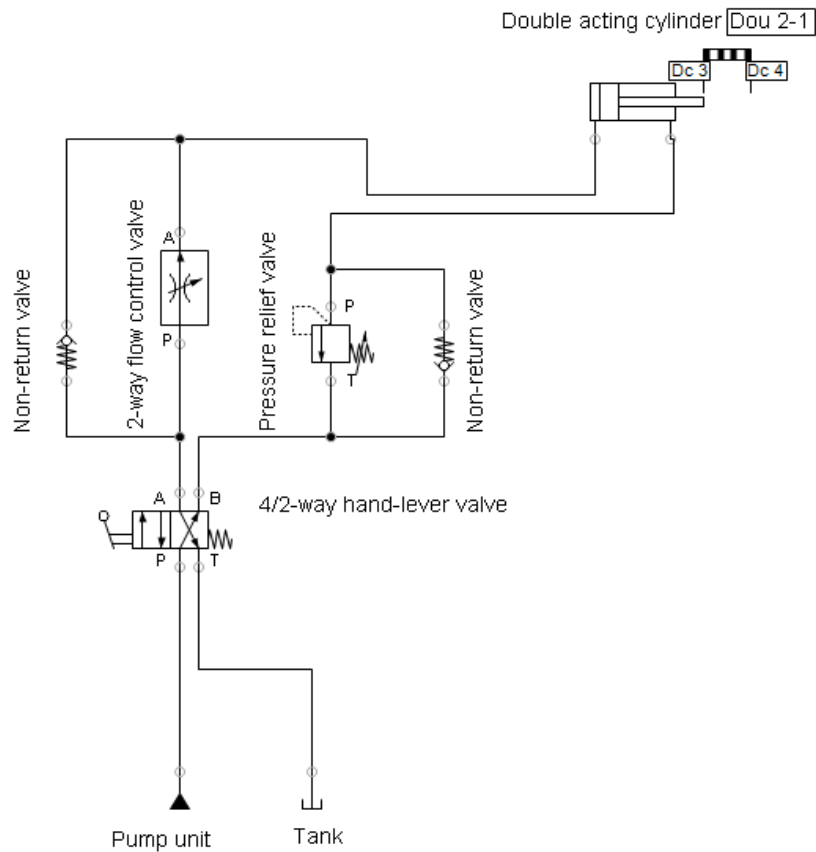
**Fig. 4.** First pneumatic circuit with 4/2-way hand-lever valve - Simulation

Depending on the valve, the parameters of the cylinder (distance, speed and acceleration) also change, Fig. 5.



**Fig. 5.** Graphs of parameters from the double acting cylinder (Dou 1-1)

Model of second pneumatic circuit with 4/2-way hand-lever valve is shown below, Fig. 6.



**Fig. 6.** Second pneumatic circuit with 4/2-way hand-lever valve

However, the second circuit is made of nine components, Table 3.

**Table 3:** The components of the second pneumatic circuit

Description	Number of components
Pump unit	1
Tank	1
4/2-way hand-lever valve	1
Non-return valve	2
Pressure relief valve	1
Double acting cylinder (Dou 2-1)	1
2-way flow control valve	1

If the technician pushes the lever to the right, then it is observed that the piston rod moves from point Dc 3 to point Dc 4 [4]. After that, the piston rod returns from point Dc 4 to point Dc 3, because the 4/2-way valve has a spring, Fig.7.

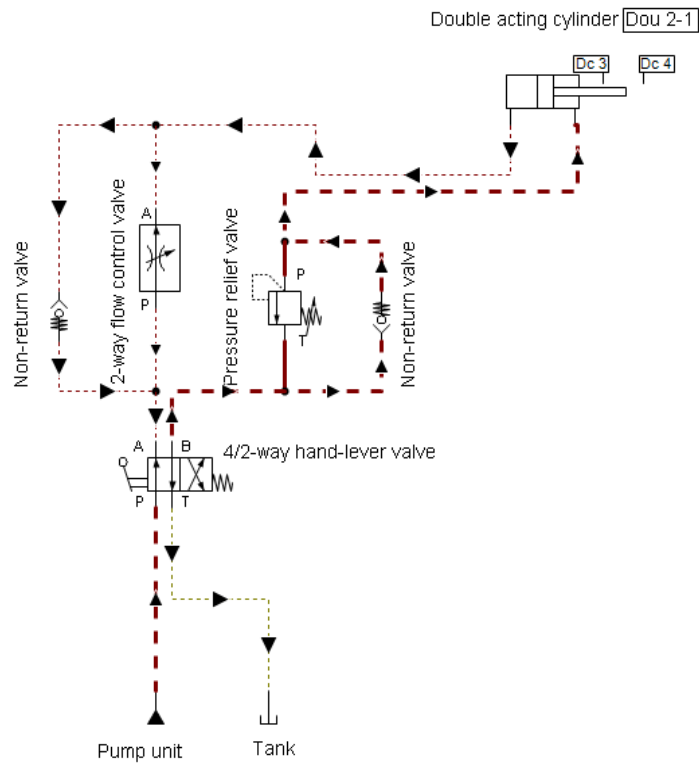


Fig. 7. Second pneumatic circuit with 4/2-way hand-lever valve - Simulation

The last circuit in the work contains two double acting cylinders (Dou 3-1 and 3-1), Fig. 8.

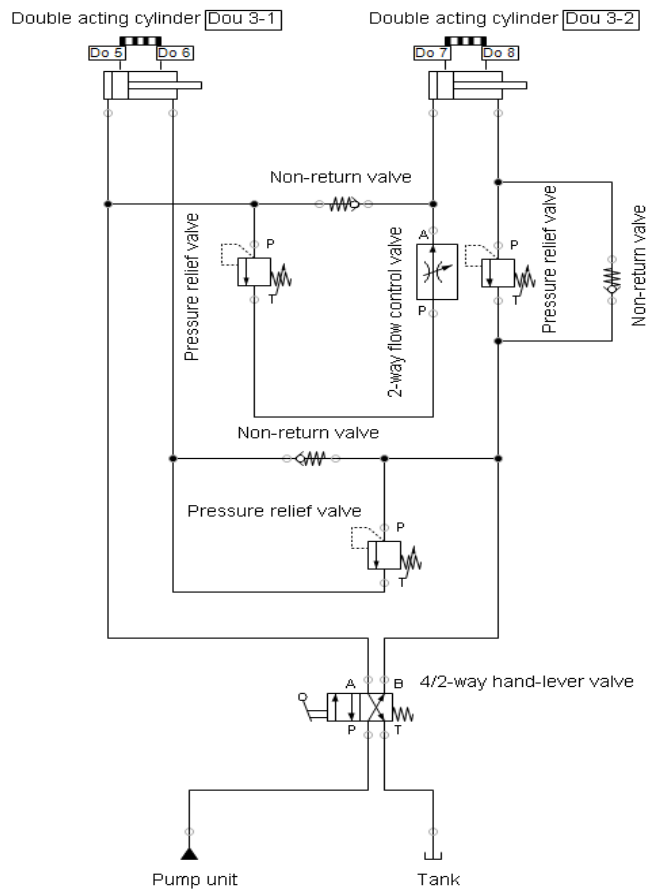


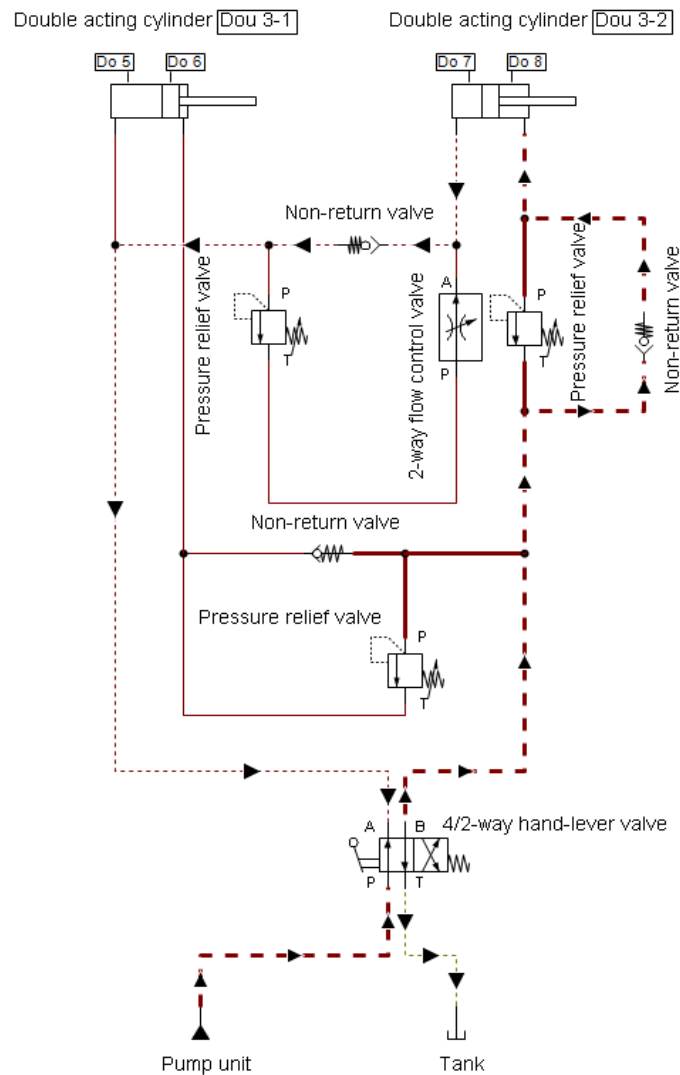
Fig. 8. Third pneumatic circuit with 4/2-way hand-lever valve

Although the third circuit has eleven components, the hydraulic scheme is not complicated (Table 4).

**Table 4:** The components of the third hydraulic circuit

Description	Number of components
Pump unit	1
Tank	1
4/2-way hand-lever valve	1
Non-return valve	3
Pressure relief valve	2
Double acting cylinder (Dou 3-1)	1
2-way flow control valve	1
Double acting cylinder (Dou 3-2)	1

Hence, the technician pushes the lever of 4/2-way hand-lever valve to the right. The piston rod of the double acting cylinder (Dou 3-1) moves from point Do 5 to point Do 6. Also, after five seconds, then piston rod of the double acting cylinder (Dou 3-2) moves from point Do 7 to point Do 8 [5]. Considering the fact that the 4/2-way hand-lever valve contains a spring, then both piston rods return to their original points, Fig. 9.



**Fig. 9.** Third pneumatic circuit with 4/2-way hand-lever valve - Simulation

### 3. Conclusions

The 4/2-way hand-lever valves are the actuators which are the most utilised on the hydraulic installations.

Advantages of hydraulic installations equipped with such valves are:

- High rigidity, high precision and fast response;
- High driving force, suitable for direct driving of heavy loads;
- Long life span;
- Easy-to-achieve security protection;
- Low maintenance cost;
- Energy efficiency.

Furthermore, the 4/2-way hand-lever valves from hydraulic installations are flexible and compact.

In the future, we want to design hydraulic systems with 4/2-way hand-lever valves more complex, necessary in the naval field.

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