



ثانوية التكنولوجيا التطبيقية
Applied Technology High School

Basic Pneumatics

Module 7: Logic functions

PREPARED BY

Academic Services

April 2012

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Module 7: Logic functions

Module Objectives

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

1. Demonstrate an understanding of different types of logic functions.
2. Identify the shuttle valve (OR function).
3. Identify the two pressure valve (AND function).
4. Draw the truth table for OR and AND functions.
5. Draw a pneumatic circuit diagram containing a logic function.
6. Construct a pneumatic circuit according to the requirements.
7. Simulate pneumatic circuit using Fluid SIM software.

Module Contents

	Topic	Page No.
1	Function of shuttle valve	3
2	Construction of shuttle valve	4
3	Truth table of OR	5
4	Circuit with two shuttle valves	6
5	Practical task 1 (Flap control)	7
6	Two pressure valve	10
7	Principle of operation of two pressure valve	11
8	Truth table of AND	12
9	Equivalent circuit to AND	13
10	Practical task 2 (Edge folding device)	14
11	Supplementary resources & References	17
12	Work sheets	19

1 Introduction to the shuttle valve:

Certain pneumatic systems, the supply of compressed air to a subsystem must be from more than one source to meet system requirements. In some systems, an emergency system is provided as a source of pressure in the event of normal system failure. The main purpose of the shuttle valve is to accept the pneumatic signals from two different locations. It is small and simple; yet, it is a very important component.

2 Shuttle valve (OR Function)

2.1 Function and Symbol

It gives output compressed air signal if any input has compressed air signal.

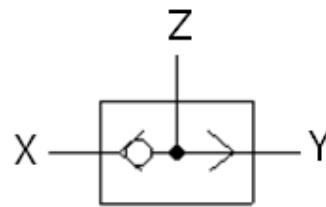
A shuttle valve is a type of valve which allows fluid to flow through it from one of two sources. Generally a shuttle valve is used in pneumatic systems, although sometimes it might be found in hydraulic systems.

Fig. (7.1.a) shows the picture of the shuttle valve.

Fig. (7.1.b) shows the ISO symbol of the shuttle valve.



(a) Shuttle valve



(b) ISO symbol of Shuttle valve.

Fig. 7.1

2.2 Construction

The basic structure of a shuttle valve is like a tube with three openings; one on each end, and one in the middle. A ball or other blocking valve element moves freely within the tube.

When the pressure is exerted through an opening on one end (port Y in Fig. 7.2.a) it pushes the ball towards the opposite end (port X). This prevents the fluid from travelling through that opening, but allows it to flow through the middle opening (port Z). In this way, two different sources can provide pressure without any backflow from one source to the other as shown in Fig. 5.2.a and Fig. 7.2.b.

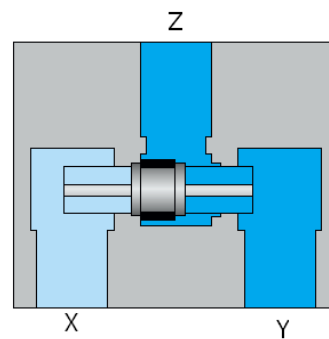
2.3 Principle of operation

In pneumatic logic, a shuttle-valve works as an OR gate

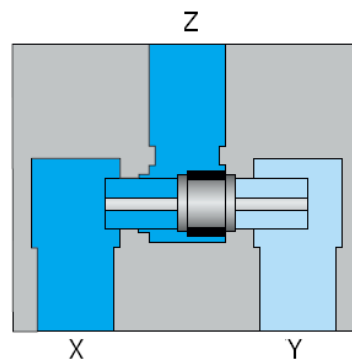
If a compressed air signal is applied to input X or input Y, this will produce a signal at output Z.

If there is no signal, there is also no output signal.

If signals are present at both inputs, the signal with the higher pressure reaches the output as shown in Fig. 7.2.



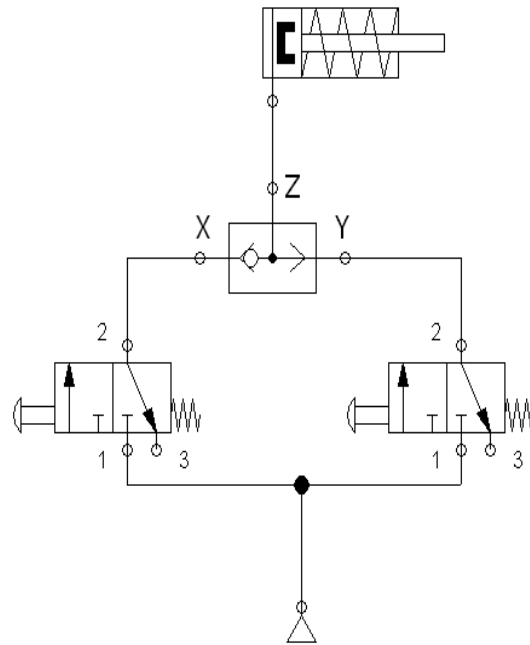
(a) Port (Y) is pressurized



(b) Port (X) is pressurized

Fig. 7.2

3 Truth table for shuttle valve (OR function)



Pneumatic circuit with one shuttle valve
Fig. 7.3

X	Y	Z
0	0	0
1	0	1
0	1	1
1	1	1

Truth table for OR function

Fig. 7.4

1: compressed air is available

0: compressed air is not available

OR function gives output compressed air signal if any input has compressed air signal

4 Circuit with two shuttle valves

Shuttle valves can be linked to create additional logic OR conditions as shown in Fig. 5.5 below. Operating any one of the three push buttons, results in extending the double acting cylinder.

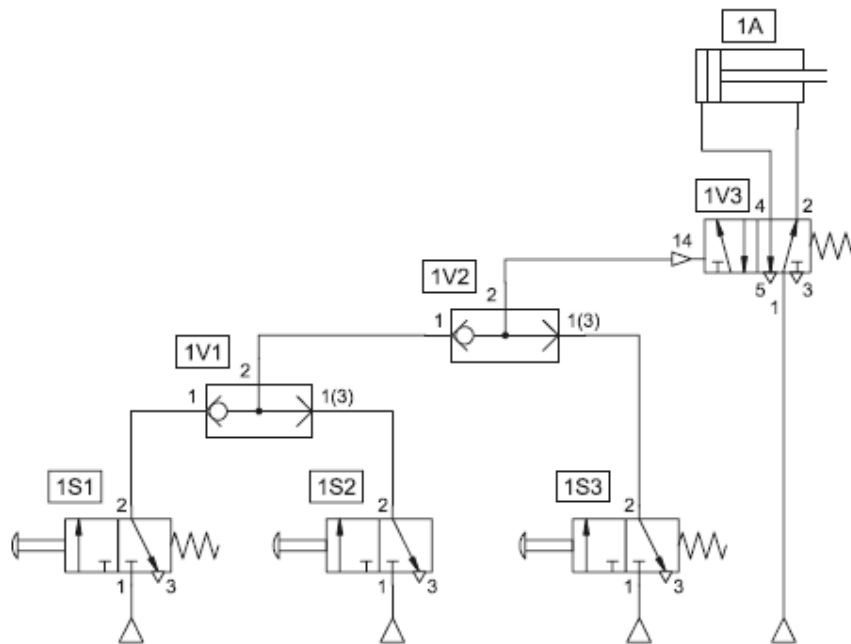


Fig. 7.5 Circuit diagram with two shuttle valves

5 Practical Task 1: Flap control

5.1 Learning objectives:

Upon the completion of this task, the students will be

- Familiar with the set-up and mode of operation of a normally closed 3/2- way valve.
- Able to recognize and sketch the shuttle valve.
- Able to explain and set up control from two different positions (locations).

5.2 Problem Description:

A flip control is used to empty granular material from a container. This machine can be operated from two different locations using two push button valves. By pressing any one of two pushbutton valves the flap is closed and the granular material is emptied from its container. After releasing the pushbutton valve the flap control is closed again as shown in the Fig. 7.6 below.

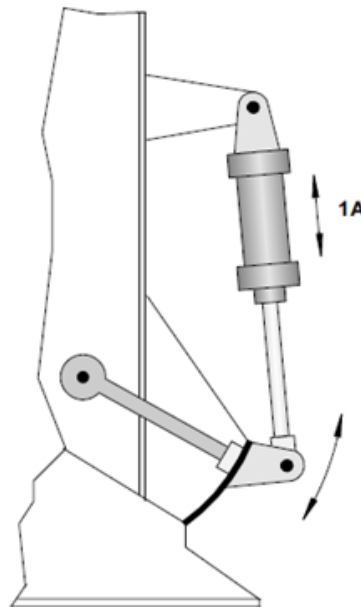


Fig. 7.6 Postional schetch

5.4 Solution

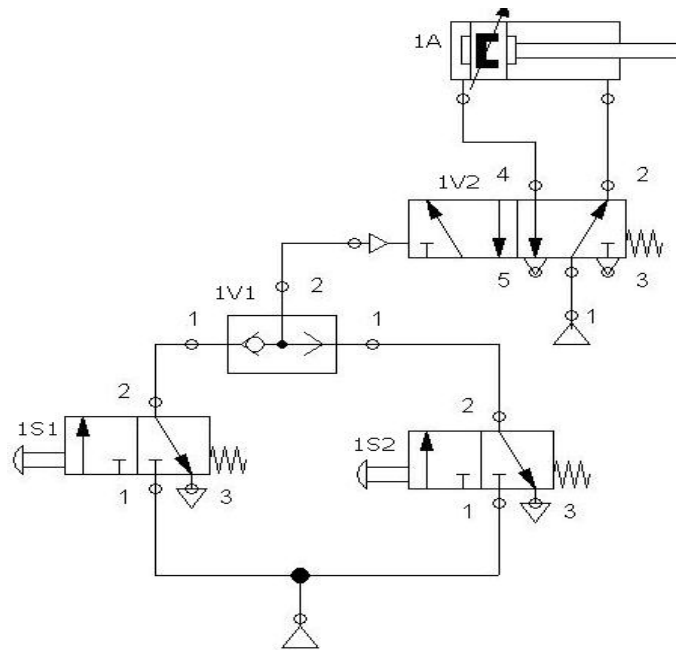


Fig. 7.7 Circuit diagram

5.5 Solution description

In the initial position, the piston rod of cylinder 1A assumes the retracted end position. The power valve (1V2) is in the left hand switching position.

Step 1-2

If the 3/2 way valve (1S1) or (1S2) is actuated. Pressure is applied at the output of the shuttle valve (1V1). The 5/2 way valve (1V2) reverses. The cylinder travels to its forward end position. If any 3/2 way valve remain actuated, the cylinder remains in the forward end position.

Step 2-3

If the two push buttons (1S1) or (1S2) are released, the power valve (1V2) is no longer pressurized; the valve reverses through the spring. The cylinder travels to its initial position.

6 Introduction to the Two (Dual) Pressure Valve (AND function):

In certain industrial processes and machines (metal cutting, high capacity presses, forming tools, etc...) where some hazards are incorporated, special measures have to be taken in consideration in order to avoid unexpected accidents. One of these measures is using the Two (dual) Pressure Valve. Using this valve will force the operator to use his two hands in order to operate the machine.

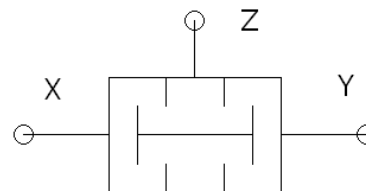
6.1 Function and symbol

It gives output compressed air signal if all inputs have compressed air signals applied at the same time.

This valve is very similar to the shuttle valve in shape and construction, but the function and the principle of operation is different. It is used for the logic AND connections. The picture and the symbol of the valve are shown in Fig. 7.8. (a) and (b) respectively



(a) Two pressure valve



(b) ISO symbol of Two pressure valve.

Fig. 7.8

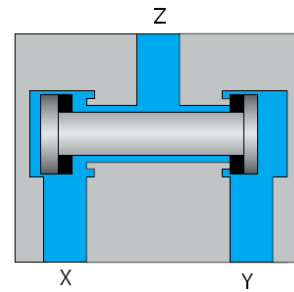
6.2 Principle of operation

In pneumatic logic, a two pressure-valve works as an AND gate. If a compressed air signal is applied to input X and input Y at the same time, this will produce a signal at output Z as shown in Fig. (7.9.a). However, if there is no signal, there is also no output signal.

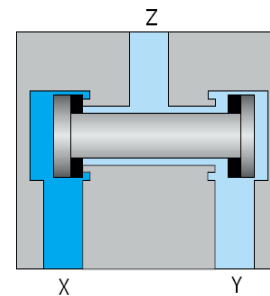
If only one input signal is applied, there will be no output signal as shown in Fig. (7.9.b).

In case of time differences between the input signals, the signal arriving last reaches the output.

In case of pressure differences between the input signals, the signal with the lower pressure reaches the output.



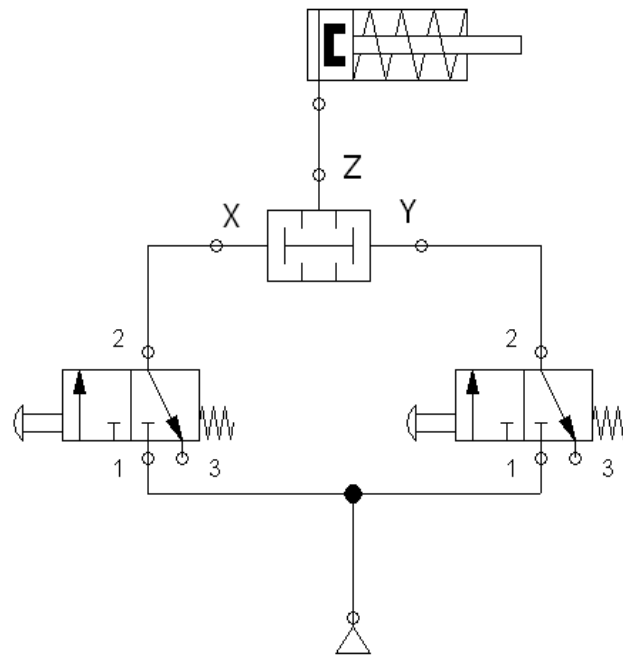
(a) The two Inlets X and Y are pressurized



(b) Port X only is pressurized

Fig. 7.9

7 Truth table for the Two Pressure Valve (AND function)



Circuit diagram for AND function

Fig. 7.10

X	Y	Z
0	0	0
1	0	0
0	1	0
1	1	1

Truth table for AND function

Fig. 7.11

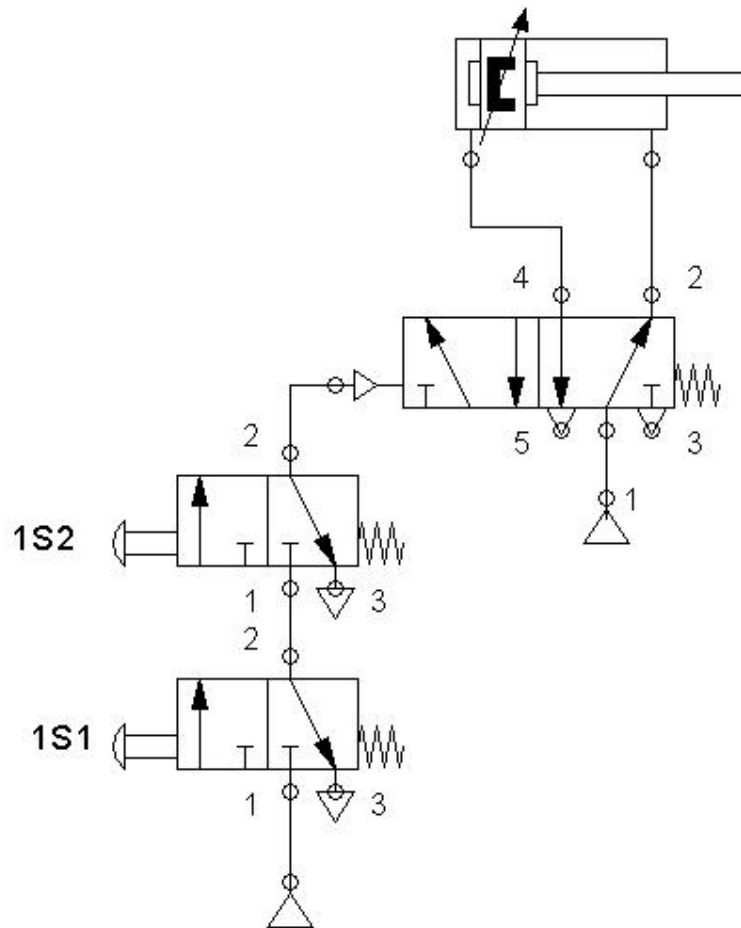
1: compressed air is available

0: compressed air is not available

AND function gives output compressed air signal if all inputs have compressed air signals applied at the same time.

8 Equivalent circuit to AND function

The two pressure valve circuit is equivalent to the two input signaling devices in series (1S1 and 1S2). One after the other (3/2 way valve, N/C). The signal output is passed all the way through only if both signal elements are operated as shown in Fig. 7.12.



Equivalent circuit to AND function

Fig. 7.12

9 Practical Task 2: Edge folding device

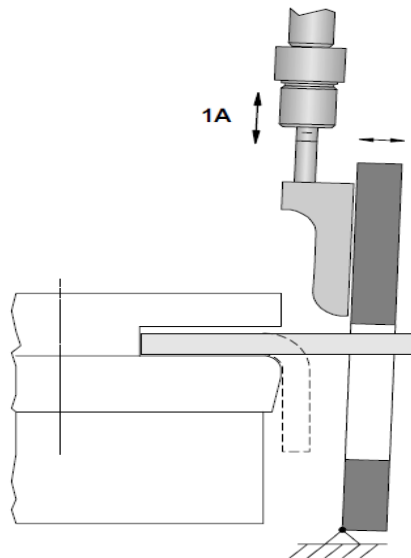
9.1 Learning objectives:

Upon the completion of this task, the students will be

- Familiar with the set-up and mode of operation of a normally closed 3/2- way valve and 5/2 way valve.
- Able to recognize and sketch the Two Pressure Valve.
- Able to construct a complete circuit with different conditions.

9.2 problems Description:

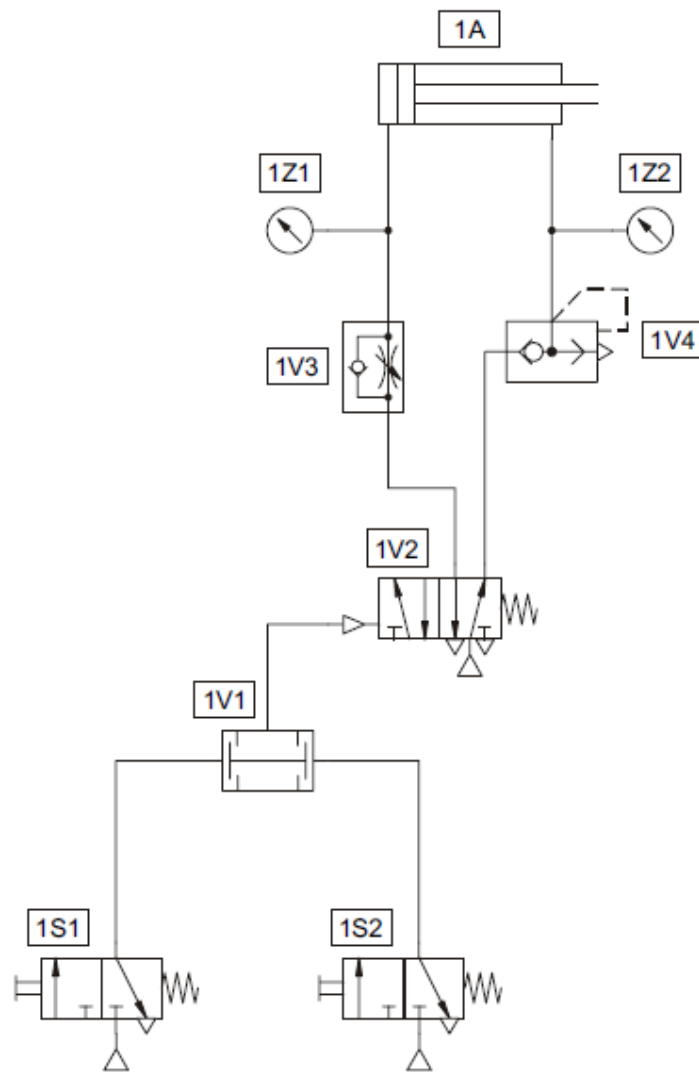
In order to maintain a safe operating environment for the forming machine operator, the forming machine that is shown in Fig. (7.13) has to be operated by two push button valves at the same time. Operation of the two push button valves causes the forming tool of an edge-folding device to fall down rapidly. If both or even just one push button is released, the double acting cylinder (1A) slowly returns to the initial position.



Postional schetch

Fig. 7.13

9.4 Solution



Circuit diagram

Fig. 7.14

9.5 Solution description

In the initial position, the piston rod of cylinder (1A) assumes the retracted end position. The power valve (1V2) is in the left hand switching position.

Step 1-2

If both 3/2 way valves (1S1) and (1S2) are actuated. Pressure is applied at the output of the two pressure valve (1V1). The 5/2 way valve (1V2) reverses. The piston chamber of cylinder (1A) is supplied with unrestricted compressed air via the one way flow control valve (1V3). The cylinder travels to its forward end position. As the chamber on the piston rod side is rapidly exhausted through the quick exhaust valve (1V4) the cylinder motion is very fast. If both 3/2 way valves remain actuated, the cylinder remains in the forward end position.

Step 2-3

If at least one of the two push buttons (1S1) or (1S2) is released, the power valve (1V2) is no longer pressurized; the valve reverses through the spring. The actuator travels to its initial position under conditions of flow restriction (1V3).

10. For further reading, you can use the following links:

- 1- www.Fest-didactic.com
- 2- <http://www.eng2all.com/vb/t28932.html>
- 3- <http://www.logiclab.hu/lesson.php?fe=2>

11. Supplementary recourses

1. Pneumatics video from Festo.
2. FluidSIM software.

12. References

- 1- Festo manuals and workbook TP101
- 2- Festo manuals and textbook TP101

Worksheet 1

Draw the symbol of single acting cylinder

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Draw the symbol of shuttle valve (OR function)

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Draw the symbol of two pressure valve (AND function)

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What is the function of shuttle valve?

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What is the function of two pressure valve?

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Draw the truth table of OR function with two inputs

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Draw the truth table of AND function with two inputs

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Worksheet 2

A) Draw pneumatic circuit that controls the single acting cylinder under the following conditions:

1- The cylinder has to be operated by any one of four valves in different locations

2-Any valve/s will activate the cylinder.

Draw here the pneumatic circuit.