Design & Implementation of Logic Gates in Pneumatic Circuit Design

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Abstract

In In modern world, Automation is developed in many fields. This Automation is achieved by developments in Pneumatics, Hydraulics, Electrical and Electronics. Apart from these fields, Pneumatics finds wide applications as they are the "LOW COST AUTOMATION". In order to understand the technical knowhow of the pneumatic logic circuits in a simple way, this paper describe the model system of pneumatic controlled logic circuit using compressed air is the control medium instead of electrical current. In industrial automation electrical and electronic devices control fluid power circuits. Relay logic control, Programmable logic controller, computer based control are the methods commonly used. But Air logic is one of the methods to control pneumatic system. The air logic circuit is similar to the normal function of relay, timers, pressure switches and counters. This paper will be very useful for the mechatronics students in understanding the automation of logical circuit in pneumatics.

Keywords: Logic Gates, AND Gate, OR Gate, NOT Gates, Pneumatic Circuit Design

I. INTRODUCTION

In modern competitive industrial world, automation had increased to a high level. These automations are created using various techniques; one of them is Logical type. Few examples some of the logical automation circuits used are stated below.

1) For Operators hand safety
2) Machine to functioning manual and auto mode.
3) For safe sequential of operation.
4) For counting operations
5) For time delaying functions
6) For repetitive operations which is un-economical to do manually
7) For controlling units
8) Logical testing operations
9) For logical memory circuits
10) Operation which requires keen attention for a simple operation

Environments with high levels of moisture or dust are excellent places for air logic controls. No danger from explosion or electrical shock is presented by the air-logic system. Water can splash on the controls without affecting their operation. If there is an external explosion, the control media — clean compressed air — cannot ignite. Some designers of pneumatic equipment prefer to use air-logic controls because only one utility service is needed to operate it. No electricity is necessary. This arrangement can be a selling point in user facilities where electrical and mechanical maintenance must be handled by different labor trades. Because there are no electrical devices involved, one craft works on both the air-logic circuit and machine parts. The components used for air logic controls are basically miniaturized 3- and 4-way air valves. The actions of these valves turn functions on or off just as relays or switches do, then exhaust the spent signal. The symbols that were developed for air logic are similar to electronic symbols

II. METHODOLOGY

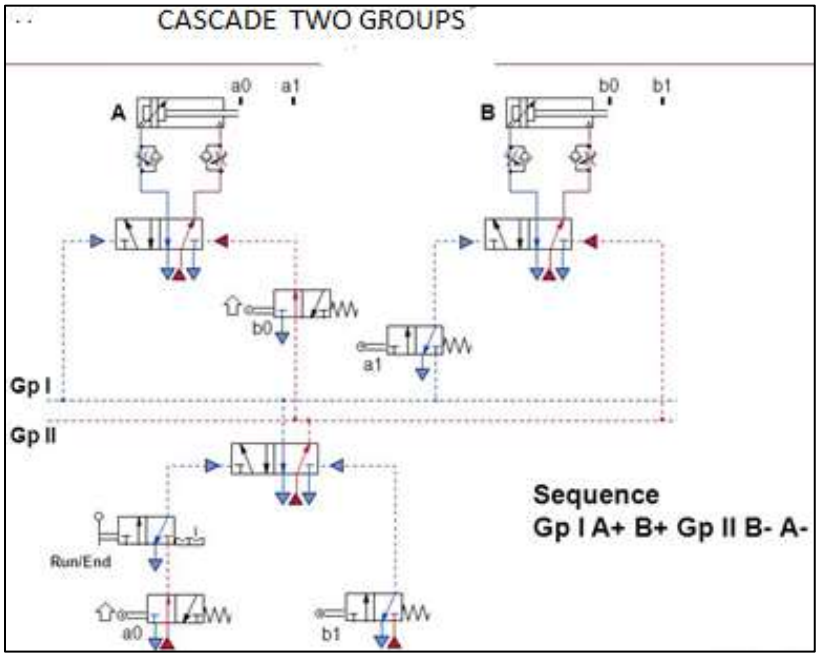
To describe this pneumatic controlled logical circuit design a prototype model kit was fabricated and shown in figure1. This sample kit was developed for 16 logical conditions for explaining the logic functions in easy understandable manner.

A. Description of the Circuit;

For example let us take output function of 1000 logic. This logic is obtained as explained below.
The outlet of selector switches 1 & 2 is connected to an 'AND GATE'. The property of the AND GATE is that (THE OUTPUT IS PRESENT WHEN BOTH THE INLETS OF THIS VALVE IS PRESSURIZED). If anyone inlet is pressurized means the output will be nil i.e. 'O'. If the difference in pressure of both the inlet is present means, the lowest input pressure will come in outlet. For reference, see truth table below.

Similarly other 15 functions are obtained. For others, truth table reference, see pneumatic circuit.

III. MEMORY CIRCUIT



The memory circuit is used to actuate 2 cylinders one after another Horizontal & Vertical in sequence. The sequence of working of memory circuit is not affected by the logical output. The logical output is only used to initiate it.

The signal generator of the 2 cylinders, valves V4 & V5 are connected to the main line from FRL. The inlet of valve 3 is connected to the logical circuit with a selector switch 3. The Air from the main line is always connected to the blind end of the cylinders through the valves V4 & V5. When the selector switches 1 & 2 are in correct combination to provide a logical output, air flows through valve V3 to the pilot port 12 of valve 4.

The position of valve 4 changes allowing air to the piston end of horizontal cylinder. At the end of the stroke the signal generator 1 opens allowing air to the pilot port 14 of valve 5. The position of valve 5 changes allowing air to the piston end of vertical cylinder. At the end of the stroke the signal generator 2 opens, allowing air to the pilot port 12 of valve 3. The valve 3 changes position and operates the pilot port 12 of valves V4 & V5 making the 2 cylinders to retract. A flow control valve is also attached to this line to achieve time delay. For continuous operation this line is connected to pilot port 14 of valve 3.

Type ZK – PK – 3 – 6 /3 consists of 3 separate and gates, each with 2 inlets X, Y and one outlet A. The outlet is pressured only as long as pressure is present at both inlets. If different pressure is present, the lower pressure is switched to outlet A.

A. Single Pilot 3/2 Valve;

The valve is activated by a pilot signal to part 14 of the valve body. The switching position is retained till the pilot signal is present.

1) Logic Function- 1000

	CONDITIONS	*S1*	*S2*	*OUTPUT*
i)	*Switches 1 & 2 are in ON*	*1*	*1*	*1*
ii)	*Switches 1 & 2 are in OFF*	*0*	*0*	*0*
iii)	*Switches 1 is in ON*	*1*	*0*	*0*
iv)	*Switches 2 is in ON*	*0*	*1*	*0*

2) Logic Function- 0100

	CONDITIONS	*S1*	*S2*	*OUTPUT*
i)	*Switches 1 & 2 are in ON*	*1*	*1*	*0*
ii)	*Switches 1 & 2 are in OFF*	*0*	*0*	*1*
iii)	*Switches 1 is in ON*	*1*	*0*	*0*
iv)	*Switches 2 is in ON*	*0*	*1*	*0*

3) Logic Function- 0010

	CONDITIONS	*S1*	*S2*	*OUTPUT*
i)	*Switches 1 & 2 are in ON*	*1*	*1*	*0*
ii)	*Switches 1 & 2 are in OFF*	*0*	*0*	*0*
iii)	*Switches 1 is in ON*	*1*	*0*	*1*
iv)	*Switches 2 is in ON*	*0*	*1*	*0*

4) Logic Function- 0001

	CONDITIONS	S1	S2	OUTPUT
i)	Switches 1 & 2 are in ON	1	1	0
ii)	Switches 1 & 2 are in OFF	0	0	0
iii)	Switches 1 is in ON	1	0	0
iv)	Switches 2 is in ON	0	1	1

5) Logic Function- 1100

	CONDITIONS	S1	S2	OUTPUT
i)	Switches 1 & 2 are in ON	1	1	1
ii)	Switches 1 & 2 are in OFF	0	0	1
iii)	Switches 1 is in ON	1	0	0
iv)	Switches 2 is in ON	0	1	0

6) Logic Function- 1010

	CONDITIONS	S1	S2	OUTPUT
i)	Switches 1 & 2 are in ON	1	1	1
ii)	Switches 1 & 2 are in OFF	0	0	0
iii)	Switches 1 is in ON	1	0	1
iv)	Switches 2 is in ON	0	1	0

7) Logic Function- 1001

	CONDITIONS	S1	S2	OUTPUT
i)	Switches 1 & 2 are in ON	1	1	1
ii)	Switches 1 & 2 are in OFF	0	0	0
iii)	Switches 1 is in ON	1	0	0
iv)	Switches 2 is in ON	0	1	1

8) Logic Function- 0101

	CONDITIONS	S1	S2	OUTPUT
i)	Switches 1 & 2 are in ON	1	1	0
ii)	Switches 1 & 2 are in OFF	0	0	1
iii)	Switches 1 is in ON	1	0	0
iv)	Switches 2 is in ON	0	1	1

9) Logic Function- 0011

	CONDITIONS	S1	S2	OUTPUT
i)	Switches 1 & 2 are in ON	1	1	0
ii)	Switches 1 & 2 are in OFF	0	0	0
iii)	Switches 1 is in ON	1	0	1
iv)	Switches 2 is in ON	0	1	1

10) Logic Function- 0110

	CONDITIONS	S1	S2	OUTPUT
i)	Switches 1 & 2 are in ON	1	1	0
ii)	Switches 1 & 2 are in OFF	0	0	1
iii)	Switches 1 is in ON	1	0	1
iv)	Switches 2 is in ON	0	1	0

11) Logic Function- 1110

	CONDITIONS	S1	S2	OUTPUT
i)	Switches 1 & 2 are in ON	1	1	1
ii)	Switches 1 & 2 are in OFF	0	0	1
iii)	Switches 1 is in ON	1	0	1
iv)	Switches 2 is in ON	0	1	0

12) Logic Function- 1101

	CONDITIONS	S1	S2	OUTPUT
i)	Switches 1 & 2 are in ON	1	1	1
ii)	Switches 1 & 2 are in OFF	0	0	1
iii)	Switches 1 is in ON	1	0	0
iv)	Switches 2 is in ON	0	1	1

13) Logic Function- 1011

	CONDITIONS	S1	S2	OUTPUT
i)	Switches 1 & 2 are in ON	1	1	1
ii)	Switches 1 & 2 are in OFF	0	0	0
iii)	Switches 1 is in ON	1	0	1
iv)	Switches 2 is in ON	0	1	1

14) Logic Function- 0111

	CONDITIONS	S1	S2	OUTPUT

i)	*Switches 1 & 2 are in ON*	*1*	*1*	*0*
ii)	*Switches 1 & 2 are in OFF*	*0*	*0*	*1*
iii)	*Switches 1 is in ON*	*1*	*0*	*1*
iv)	*Switches 2 is in ON*	*0*	*1*	*1*

15) Logic Function- 1111

	CONDITIONS	*S1*	*S2*	*OUTPUT*
i)	*Switches 1 & 2 are in ON*	*1*	*1*	*1*
ii)	*Switches 1 & 2 are in OFF*	*0*	*0*	*1*
iii)	*Switches 1 is in ON*	*1*	*0*	*1*
iv)	*Switches 2 is in ON*	*0*	*1*	*1*

16) Logic Function- 0000

	CONDITIONS	*S1*	*S2*	*OUTPUT*
i)	*Switches 1 & 2 are in ON*	*1*	*1*	*0*
ii)	*Switches 1 & 2 are in OFF*	*0*	*0*	*0*
iii)	*Switches 1 is in ON*	*1*	*0*	*0*
iv)	*Switches 2 is in ON*	*0*	*1*	*0*

IV. CONCLUSION

Fundamentals of logic gate circuit used in industrial automation are presented and implemented with a fabricated kit. Basic of the logic gate and logic gate symbol based on Boolean algebra is briefly descried in this circuit design. The rules are to be followed in developing the logic sequences are then presented.

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