

# Basic Mechatronics Workshop

## Module 3: Introduction to PLC

### Lecture-6

#### PLC Input / Output Set up,

(Parameter and Command, a contact, b contact, coil, M relay)

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# Lecture 6

## PLC Input / Output Set up, (Parameter and Command, a contact, b contact, coil, M relay)

### Objectives

Upon completion of this chapter, Student should be able to

- ✓ Explain the functions of major components of PLC
- ✓ Explain various programming approaches used in PLC
- ✓ Describe the functions of memory functions, timers and counters
- ✓ Convert the logic functions into ladder diagram
- ✓ Design PLC circuits for single and multi-actuators

## *Major Components of PLC*

As discussed earlier, A PLC is essentially a microcomputer consisting of hardware and software. The major components are

### 1. Hardware

- ✓ Power Supply module
- ✓ Input module
- ✓ Central processing unit
- ✓ Output modules

### 1. Software

PLC hardware have been explained in the previous chapter, in this chapter we has been focused on the PLC software.

## *PLC Software*

PLC consists of two parts: Operating systems and user program. The PLC operating system provides effective support ranging from the creation of project structure to the creation of user programs. The OS system is accessed through a graphical user interface window (also known as Main window). The main window contains all the functions needed to set up a project, configure the hardware, write and test programs. User program can be written in any standard PLC programming language like ladder diagram or statement list.

While processing a PLC program, the CPU scans and executes the main program cyclically; A program scan cycle consists of sequential operations that include input scan, program scan, and output scan. In the input scan, the CPU updates the process image input table, in the output scan; the CPU updates the process image output table. After the completion of each scan cycle, the CPU returns to the beginning of the next cycle and again repeats the cycle. The time taken to scan one program is called scan – cycle time.

# *Programming of PLC*

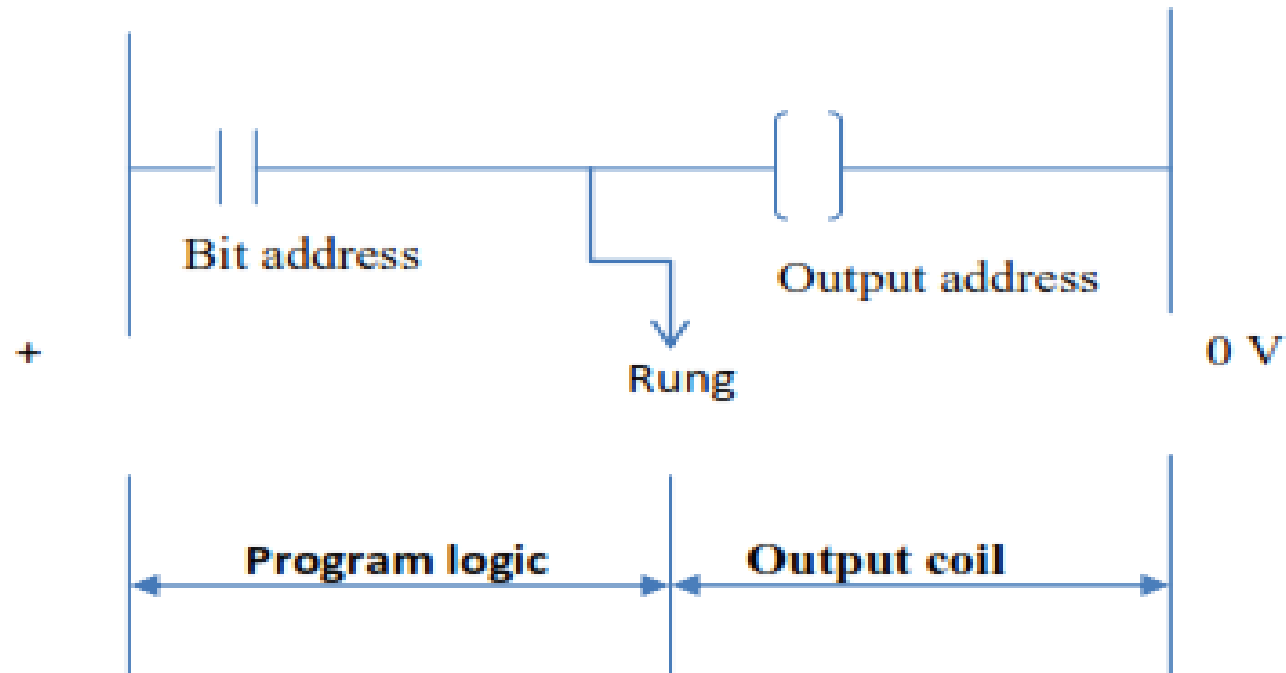
There are various approaches for entering the program into PLC they are

1. Ladder diagram based
2. Low level based on Boolean expressions
3. Functional blocks
4. High level language

Most of the programming methods used today for PLC are based on the ladder logic diagram. Therefore, the concept of ladder diagram is explained in the following sections

## *Ladder diagram*

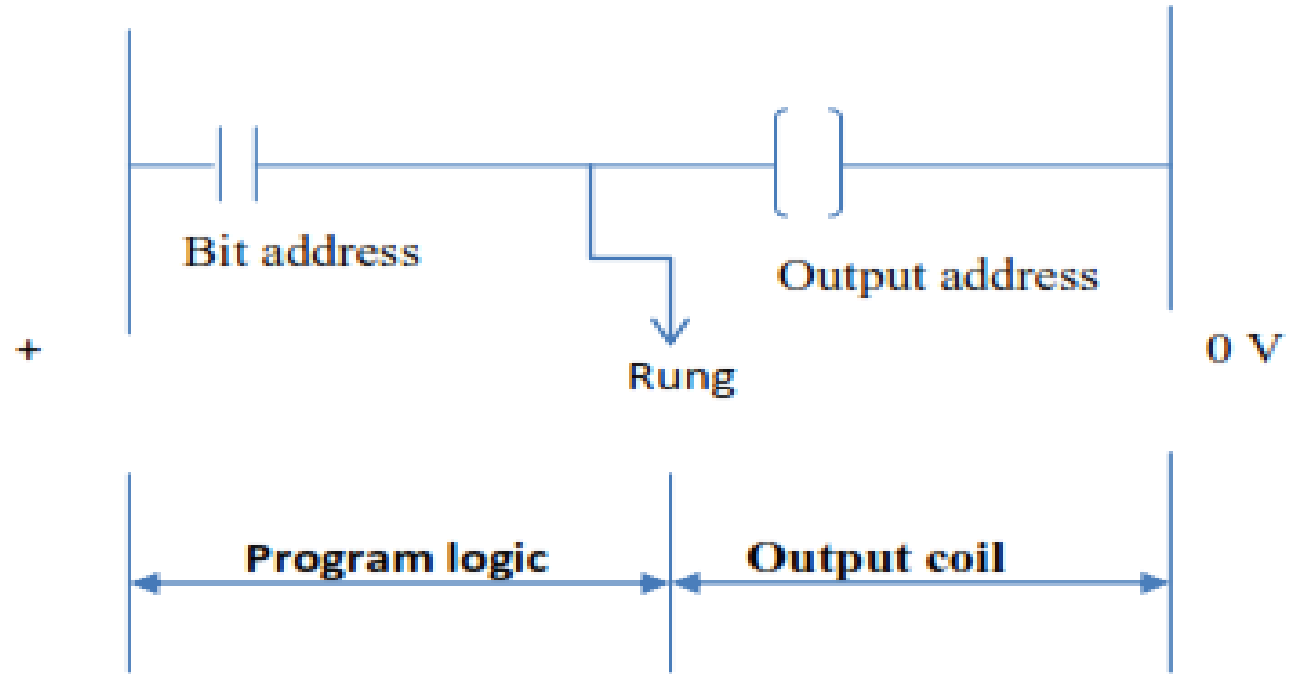
The ladder diagram has two vertical sides (also called rungs). The left side line represent line with a positive voltage and right side represent a line with zero voltage. Between these two sides are the horizontal rungs for the assumed power flow. The symbols representing the various program elements are placed on the rungs in order to realize the required control task



## *Ladder diagram*

There are five program elements/operations commonly used in PLC ladder diagram they are

1. PLC Bit logic operations
2. Timer Operations
3. Counter operations
4. Comparison operations
5. Arithmetic operations.



**PLC bit logic operations:** Some important programming elements for bit logic operations are

a. NO contact

b. NC contact

c. Coil

## ***NO Contact of PLC:***

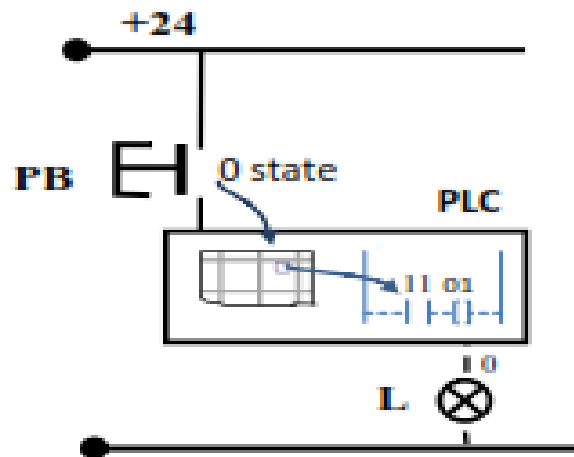
The PLC representation of NO contact is given in Figure 1.2. This contact scans for the signal state ON (1) at the specified bit address. Power flows through NO contact if the scanned bit address has a signal state ON (1). This contact is used for scanning the signal state of input devices or output devices or other internal program elements.



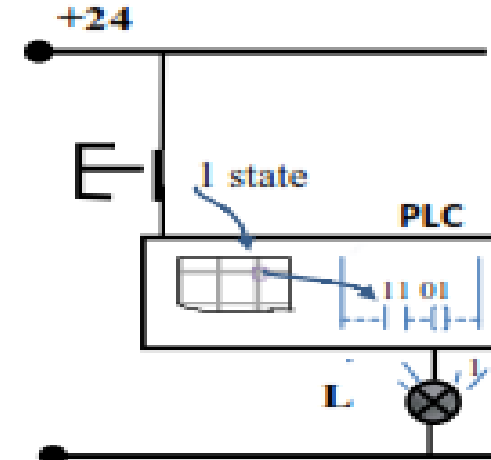
**NO program contact**



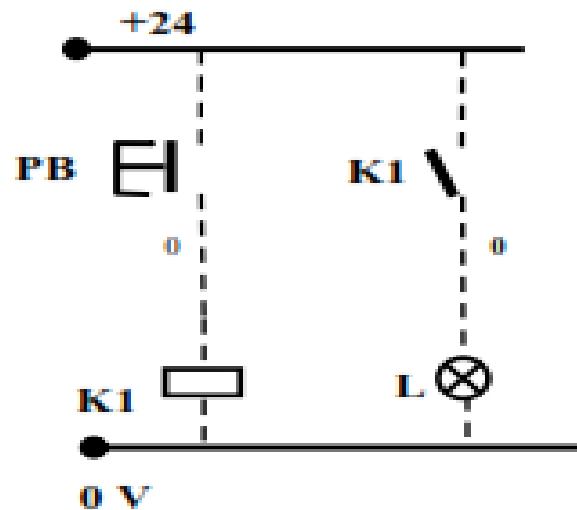
# PLC circuit with NO contact position using NO push button



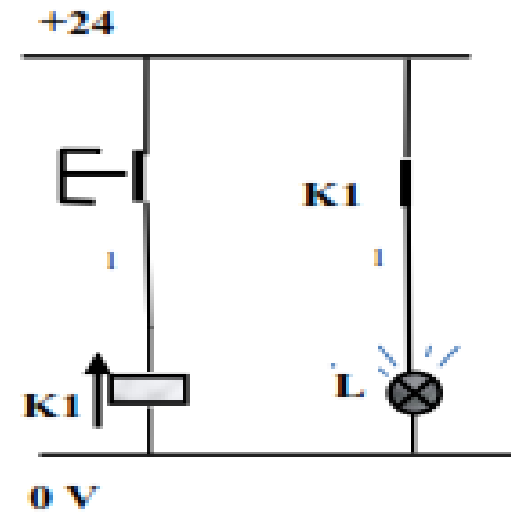
a) PLC circuit – PB open



b) PLC circuit – PB

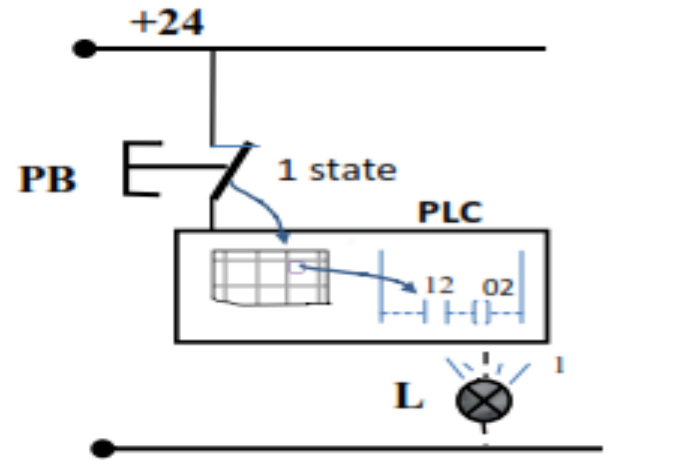


a) Relay circuit – PB open

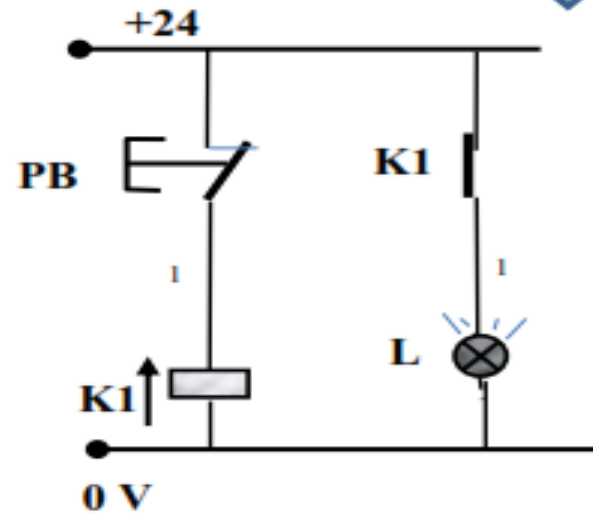


b) Relay circuit – PB closed

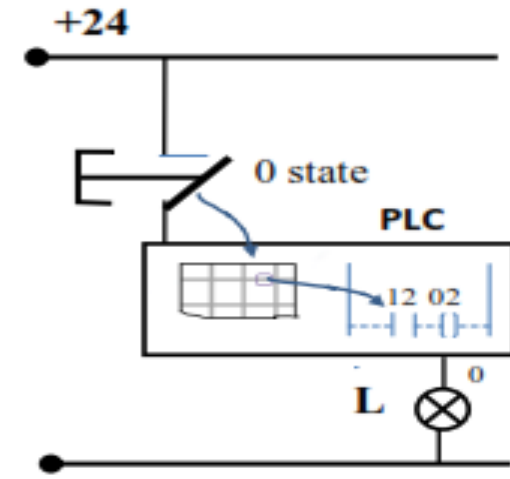
# PLC circuit with NO contact position using NC push button



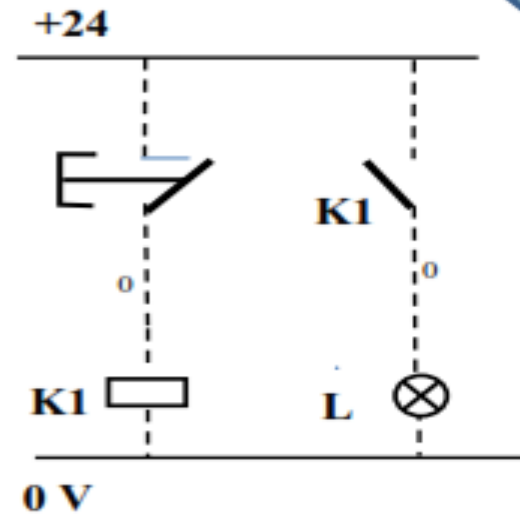
a) PLC circuit – PB Closed



a) Relay circuit – PB closed

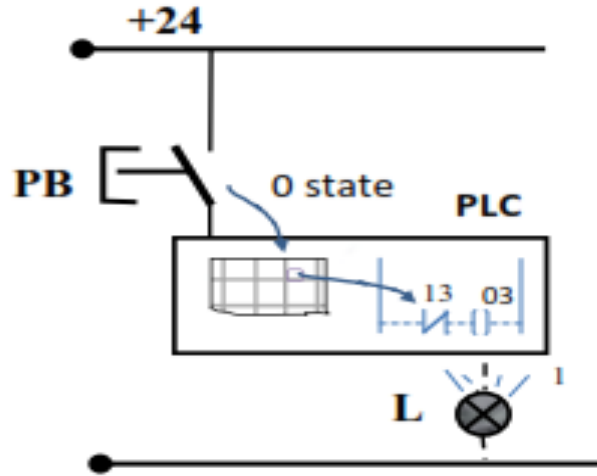


b) PLC circuit – PB open

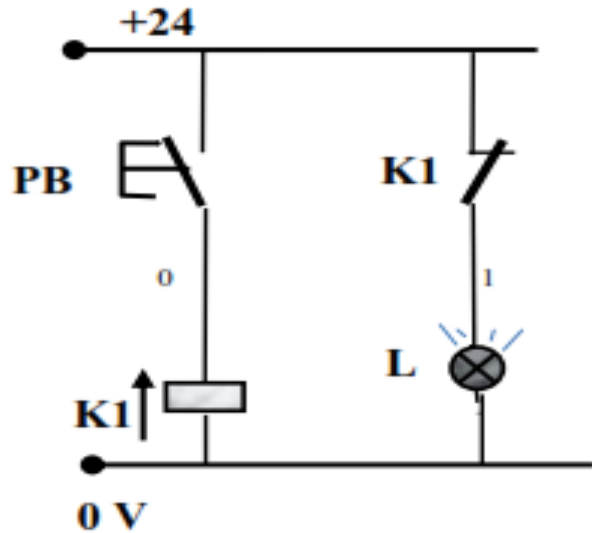


b) Relay circuit – PB open

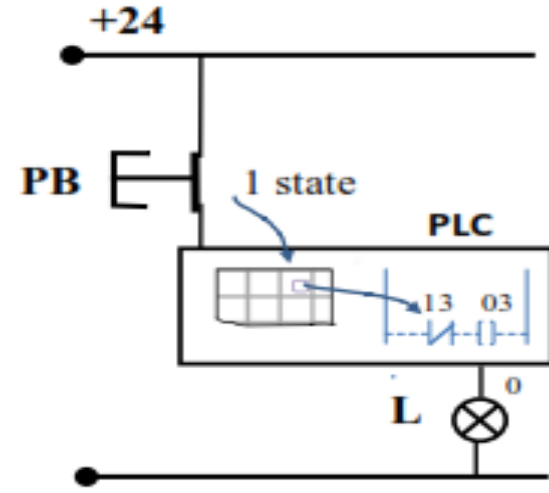
# PLC circuit with NC contact position using NO push button



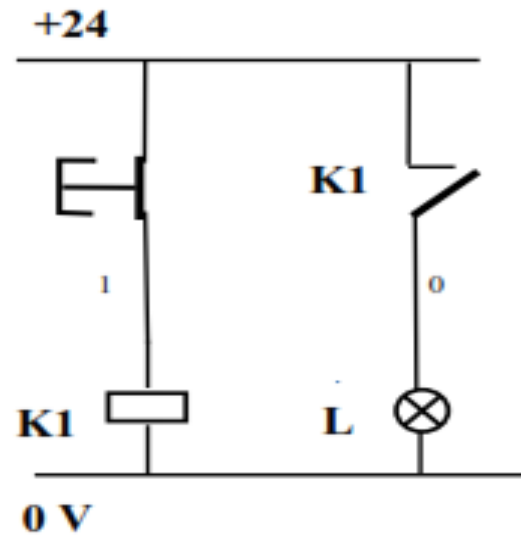
a) PLC circuit – PB Released



a) Relay circuit – PB released

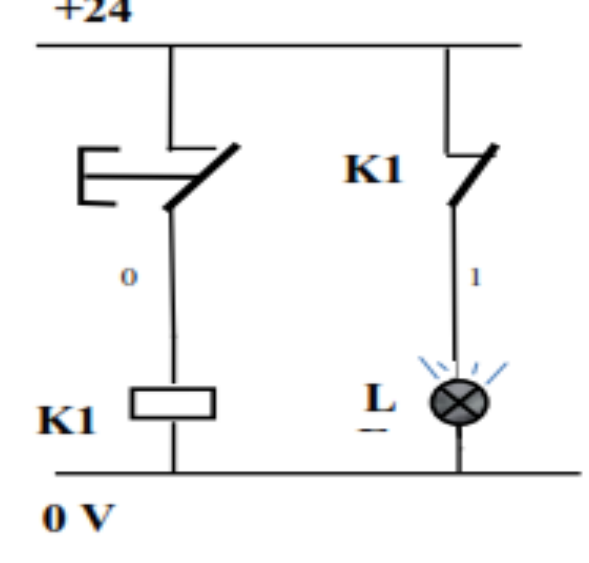
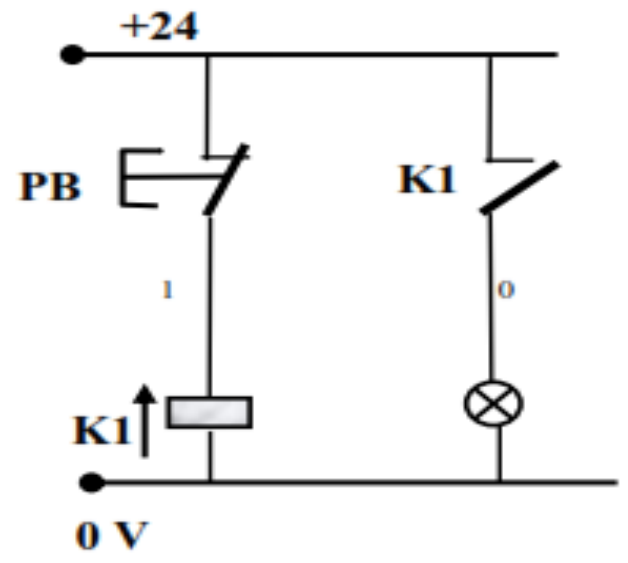
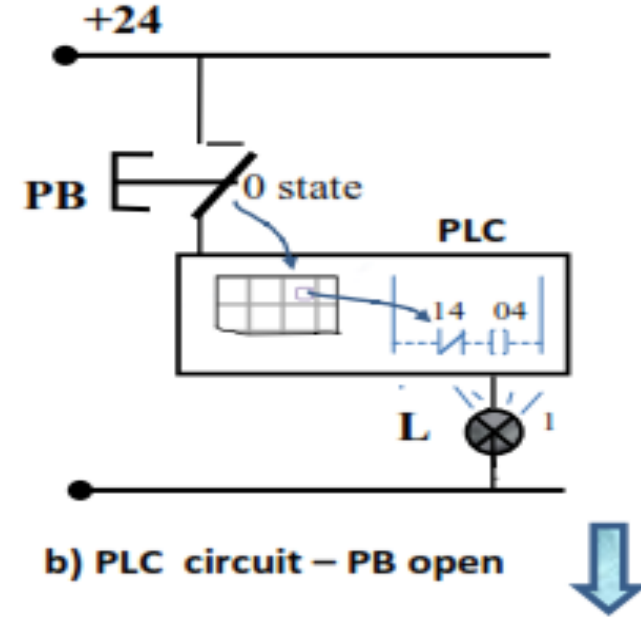
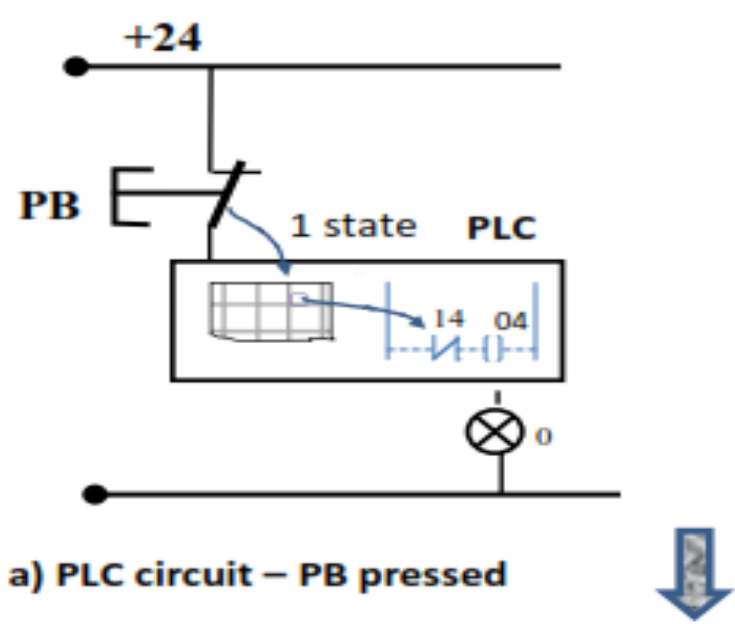


b) PLC circuit – PB pressed



b) Relay circuit – PB pressed

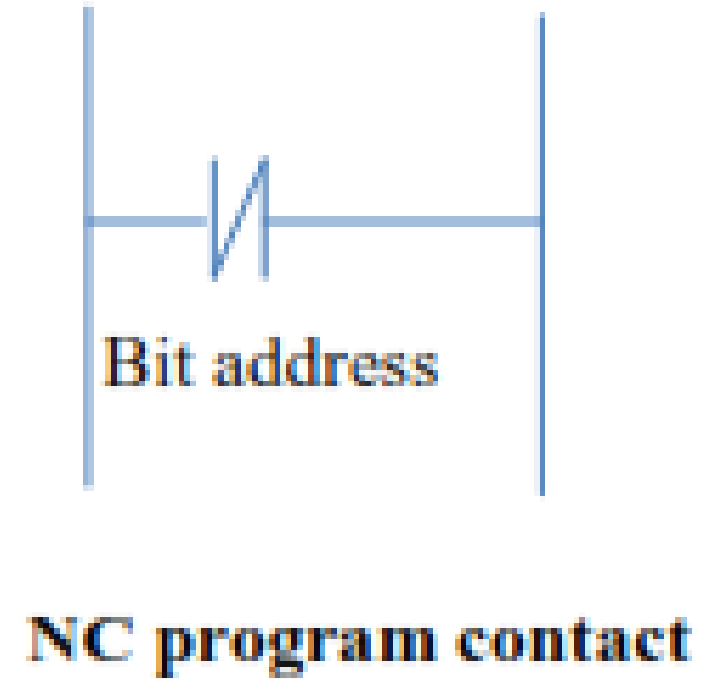
# PLC circuit with NC contact position using NC push button



## *NC Contact of PLC:*

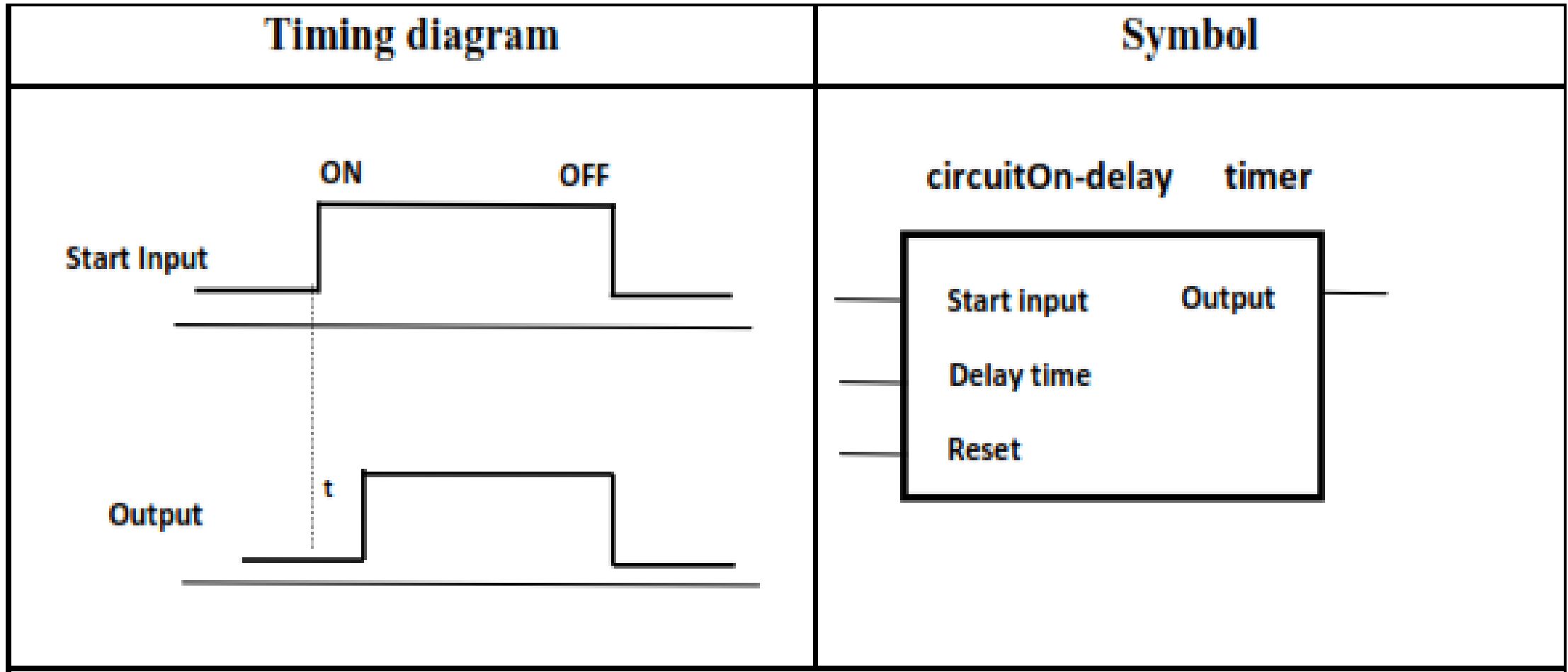
The PLC representation of NC contact is given in Figure

This contact scans for the signal state OFF (0) at the specified bit address. Power flows through NC contact if the scanned bit address has a signal state OFF (0). This contact is used for scanning the signal state of input devices or output devices or other internal program elements.



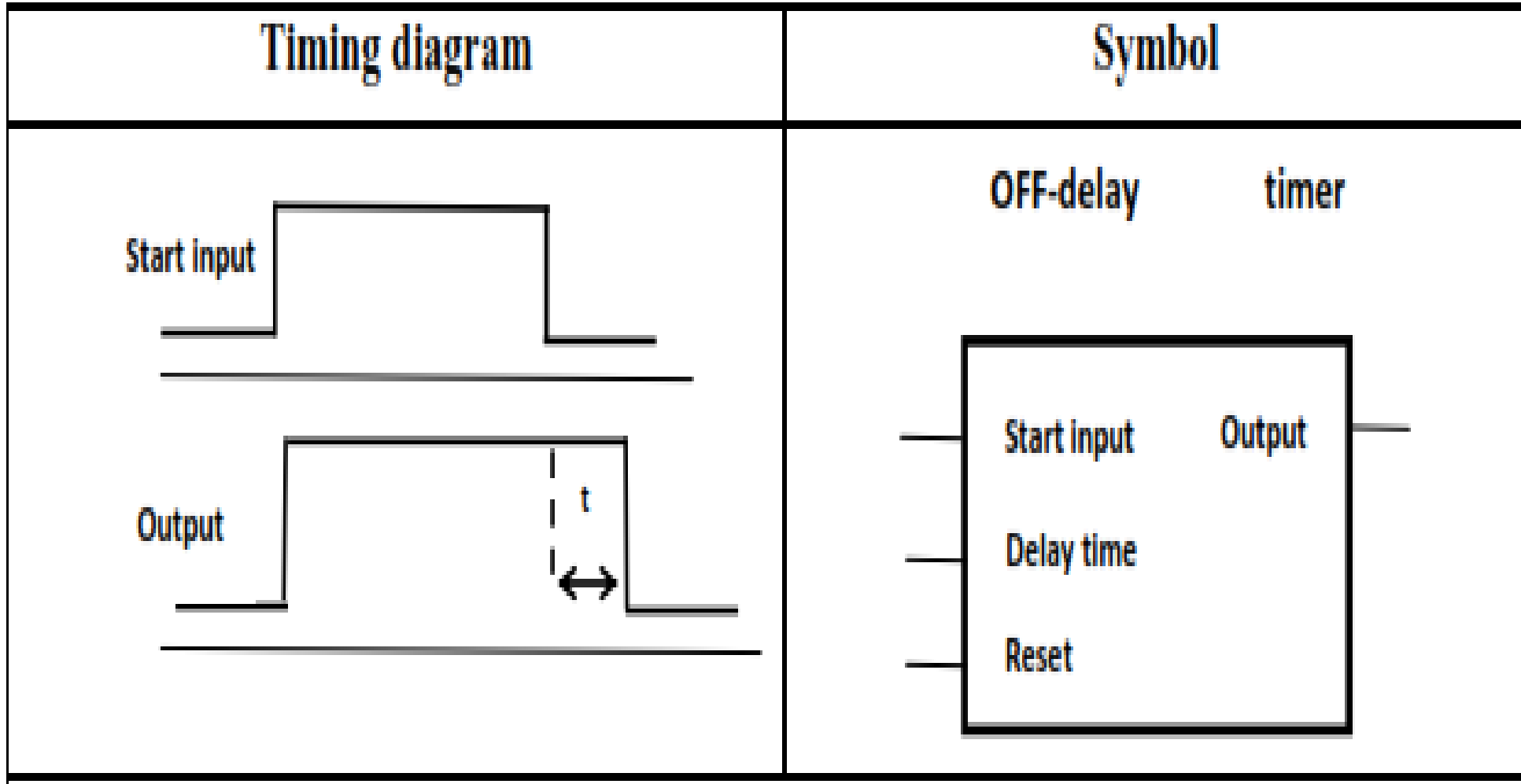
# Plc Timer

## PLC On delay timer



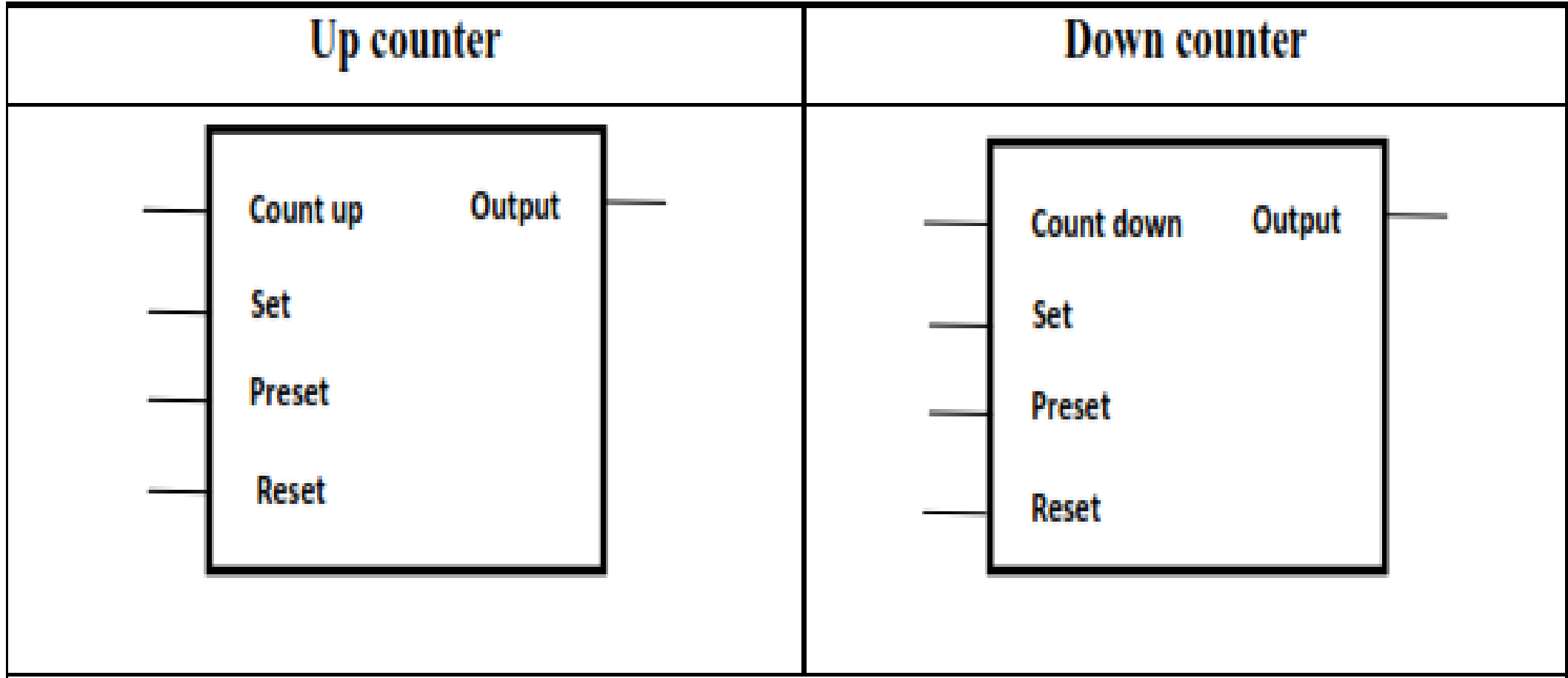
# Plc Timer

## OFF delay timer



# *PLC COUNTERS*

## Up and down counter



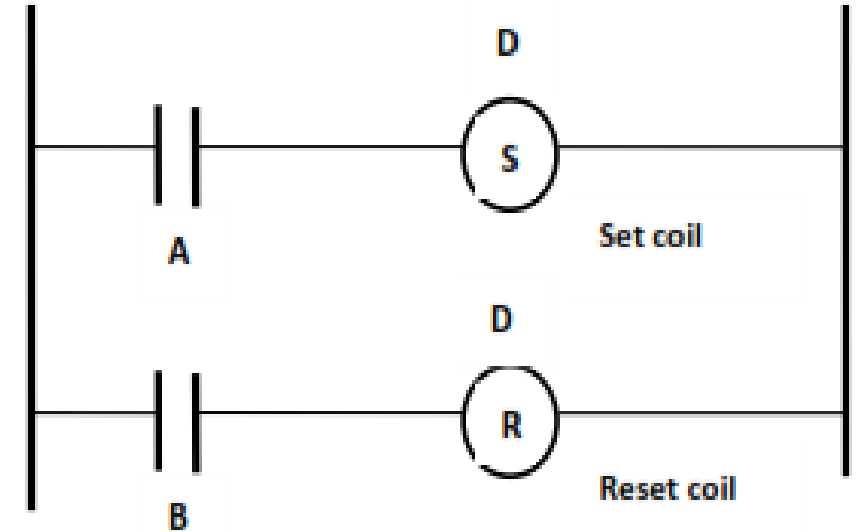


# *PLC Memory elements*

## **ladder logic latch**

Memory elements are used to store intermediate values. Memory function are achieved using flags (bit memory locations) and system memory. Specified bit memory can be set or reset using a set coil.

A latch in ladder logic uses one instruction to latch and a second instruction to unlatch, as shown in Figure.



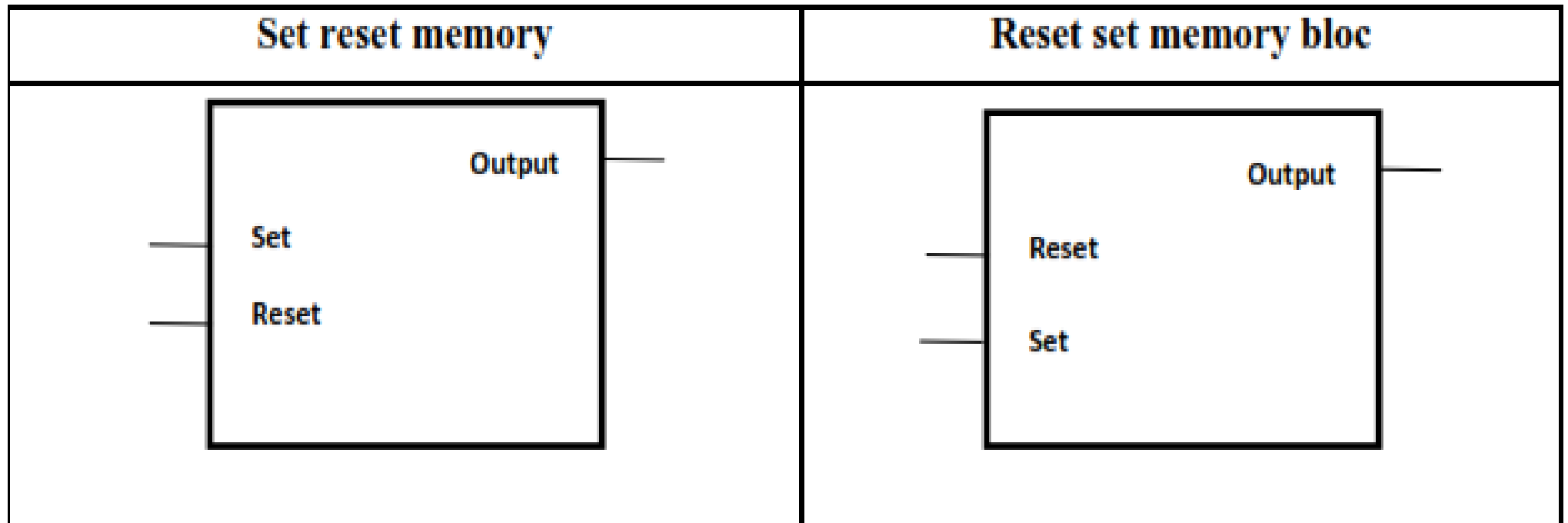
The output with an S inside will turn the output D on when the input A becomes true. D will stay on even if A turns off. Output D will turn off if input B becomes true and output with a R inside becomes True.

## *PLC Memory elements*

### **ladder logic latch**

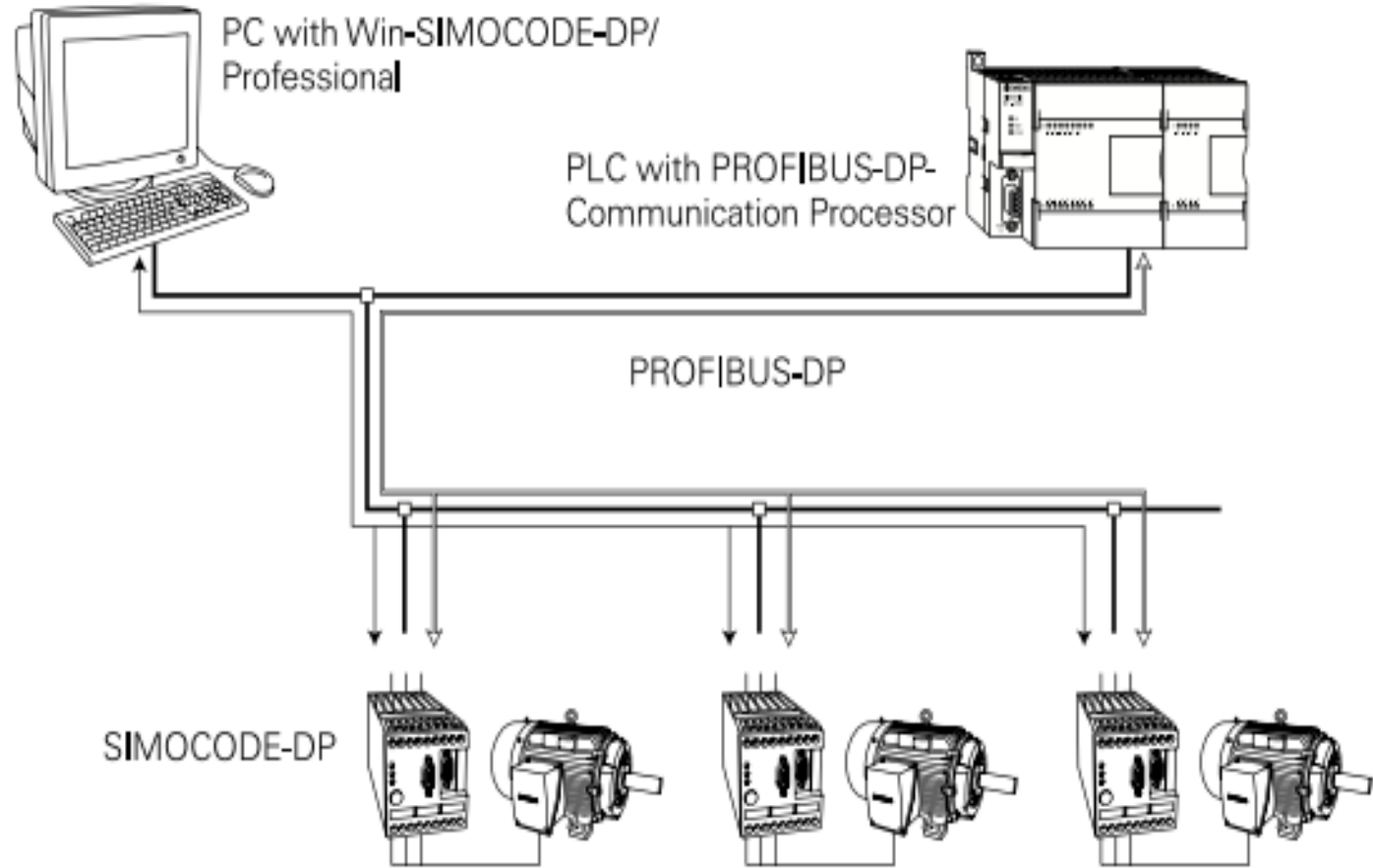
Both set coil and reset coil can be combined in one box as shown in Figure. Following instructions are to be followed while writing a program for memory function

- ✓ Setting up a memory location
- ✓ Resetting up a memory location



# ***PROFIBUS DP***

In any complex process the need for rapid information flow is critical. PROFIBUS DP is an open communication system based upon international standards developed through industry associations.



PROFIBUS DP allows the connection of several field devices, such as SIMOCODE-DP, on a single bus for communication to a PLC or computer. PROFIBUS DP is suitable as a replacement for costly parallel wiring.

# *Areas of Application of a PLC*

PLC are *widely* used in Industries due to following reasons.

- ✓ Cost of PLC automation is less and PLC is very versatile
- ✓ PLC can be commissioned and installed easily
- ✓ Programming of PLC is quite simple. Ladder programming is flexible
- ✓ They are not hard-wired control. They can be programmed and reprogrammed to accommodate frequent changes in program
- ✓ Monitoring of online work process is easy, therefore trouble shooting, and maintenance of PLC is not a difficult task
- ✓ They can be classified as low cost automation devices
- ✓ They can be used in harsh environment where humidity and temperature are high. Their working is not affected by vibration and shock
- ✓ They can be used to execute complex mathematical algorithms, servomotor control, Stepping control, axis control, self – diagnosis, on line monitoring, condition monitoring, system trouble shooting, communicating to other PLCs, data acquisition, Networking, storage and report generation
- ✓ PLC are most suitable for low cost automation, where frequent changes to the control requirement would be expected during their operational life like in Batch type of production systems.