UNIT IV

PROGRAMMABLE LOGIC CONTROLLER

- PLC Programming
- Selection of Programmable Logic Controller

4.12 Ladder Diagram

- Ladder diagram is a graphical method for representing and programming an event driven sequential process.
- A special schematic representation of hardware elements and its connection used to make combination of hardware and description of sequence of events is called **ladder diagram.**
- Ladder diagram consists of two parallel lines which indicates a.c. supply lines. There are number of horizontal lines connecting these parallel lines. These horizontal lines define a specific operations and are called as rung.
- The entire structure looks like a ladder hence it is called as ladder diagram.

4.12.1 Elements of Ladder Diagram

- Variaus elements used in ladder diagram are listed here,
  1. Relays
  2. Motors
  3. Solenoids
  4. Lamps or Indicaters
  5. Switches

4.13 PLC Ladder Programming

☞ [AU : Dec.-2016, 2 Marks]

- Ladder diagram is a method of programming of PLCs. Writing a program is equivalent to drawing switching circuit i.e. ladder diagram is a systematic way of representing system hardware and controller.
- Ladder diagram consists of two vertical lines representing power lines. Circuit devices are connected as horizontal (parallel) across the AC power lines, which looks like a rungs of the ladder.
- Each rung of ladder consists of number of input conditions and a single command output.
- In drawing ladder diagrams, certain conventions are adopted.

1. The vertical lines of diagram represent the power rails between which the circuits are connected.
2. Each rung of ladder defines one operation in the control process.
3. The ladder diagram must be read from left-to-right and top-to-bottom. Fig. 4.13.1

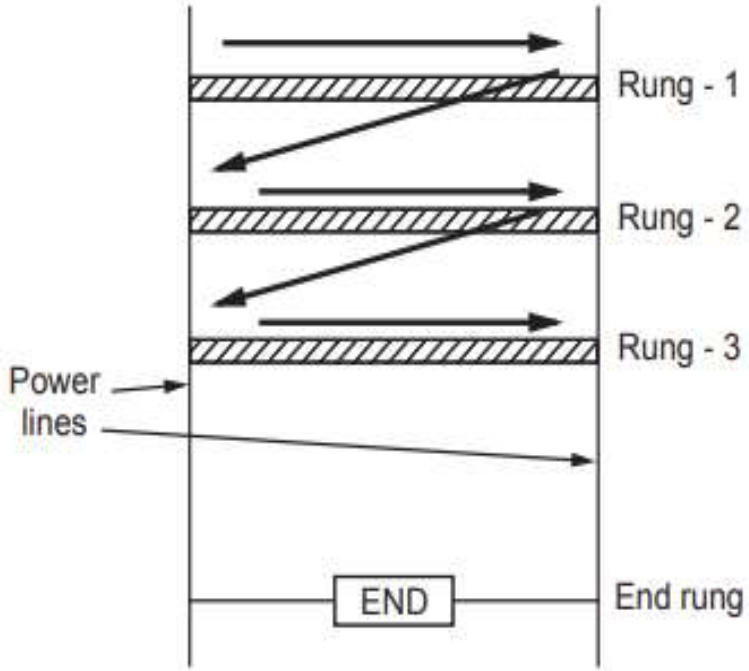

Fig. 4.13.1

4. In RUN mode, PLC goes through entire ladder program to the end. The end rung is clearly denoted then it comes back to the start. The process of going through all the rungs of program is termed as a **cycle**.

5. Each rung must start with atleast one input and one output.

   Inputs are control action e.g. closing contacts of switch. Outputs are device connected to PLC e.g. a motor.

6. Electrical devices are shown in their normal condition i.e. open or close contacts.

7. A particular device can appear in more than one rung in a ladder. Some identification number is used to identify device in each situation.

8. All inputs and outputs are identified by their addresses, the notation used depending on the PLC manufacturer. This is the address of the input or output in the memory of the PLC.

4.13.1 Symbols used in Ladder Diagram

A) Input devices

i) **Push button switch :** Input devices can be push button switches used to start or stop a system. The switch may be normally open (NO) or normally closed (NC) and may be activated by many sources.

Fig. 4.13.2 shows the symbols of push button switches.

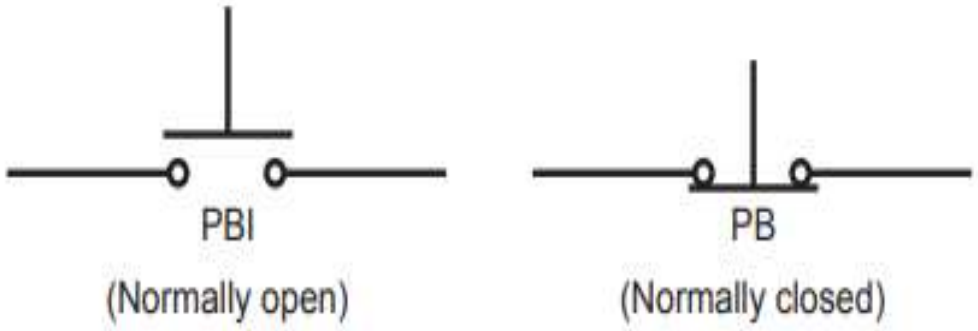

Fig. 4.13.2 Push button switches symbols

ii) **Limit switches :** Limit switches are used to sense presence or passage of a moving part. Fig. 4.13.3 shows a simple lever operated limit switch.

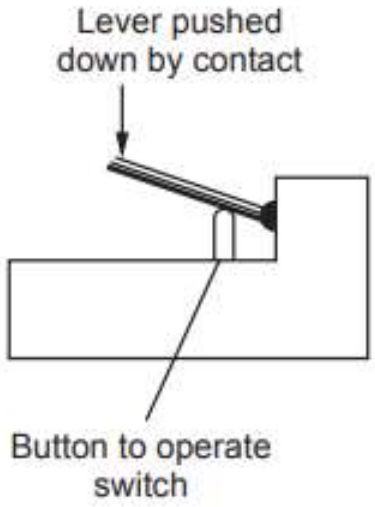

Fig. 4.13.3

The limit switch can be NO or NC type, its symbols are shown in Fig. 4.13.4.

Fig. 4.13.4 Limit switches symbols

- Some limit switches are attached to sensing device for sensing pressure, temperature and level. When any parameter (pressure, temperature or level) crosses certain limits they are actuated then NO contact will become NC and NC contact will become NO.

Fig. 4.13.5 shows symbols of these limit switches.

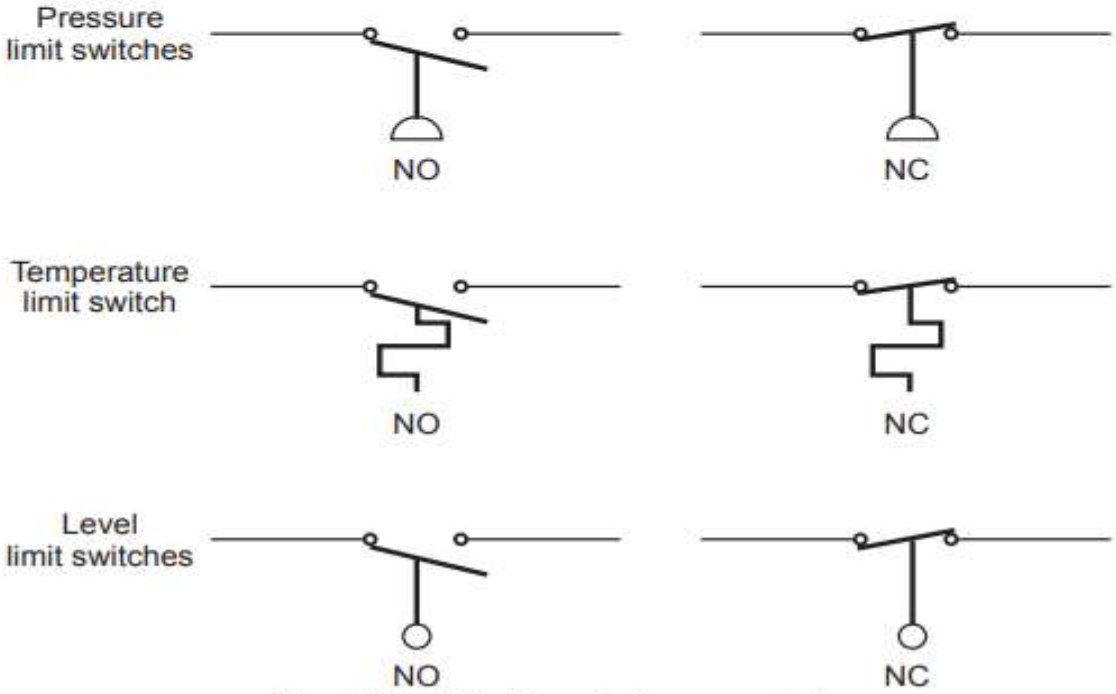

Fig. 4.13.5 Limit switches symbols

iii) **Relay contacts :** Actually control relay is an output device but once it is energized it's contacts NO or NC can be used as an input switch. Fig. 4.13.6 shows the representation of a control relay contacts.

Fig. 4.13.6 Control relay contact symbols

B) Output devices

- The output ports of PLC are of relay type or optoisolator with transistor or triac types depending on devices connected to them which are to be switched ON or OFF. Generally, the digital signal from an output channel of PLC is used to control an actuator which controls a process. The actuator is a device which transforms the electrical signal into some powerful action which controls the process.
- Some output devices are : Relays, contactors, valves, motors, solenoid and lights for visual indications. Fig. 4.13.7 shows the symbols of output devices.

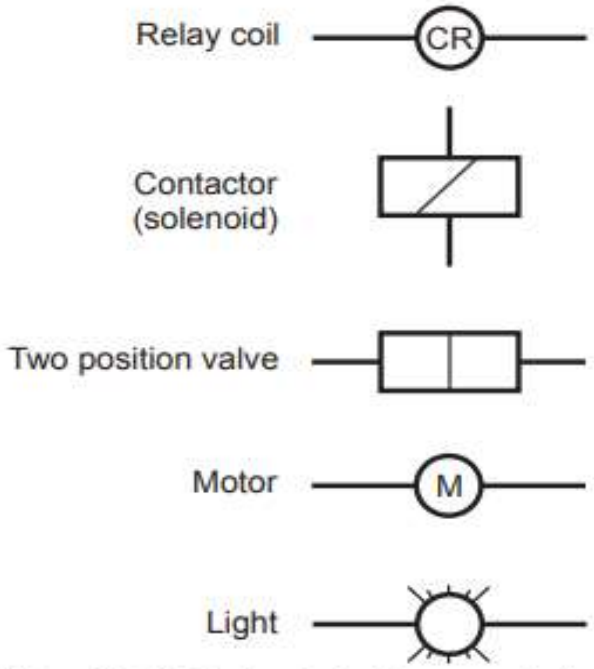

Fig. 4.13.7 Output device symbols

4.14 Selection Criteria of PLC

- PLC selection criteria consists of :

1. System (task) requirements
2. Application requirements
3. Electrical requirements
4. Speed of operation
5. Communication requirements
6. Operator interface
7. Physical environments
8. What input/output capacity is required ?
9. What type of inputs/outputs are required ?
10. What size of memory is required ?
11. What speed is required of the CPU ?
12. Software

4.15 PLC Programming

4.15.1 Structure of Rung

- Fig. 4.15.1 shows a ladder rung, starting with the input, normally open symbol for input contact is shown by | |.

Fig. 4.15.1 A ladder rung

- In drawing ladder diagrams the addresses of each element are appended to it's symbol. When wiring up the inputs and outputs to the PLC, relevant input addresses must be connected to the input and output terminals with it's output addresses.

4.14 Selection Criteria of PLC

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1. System requirements

- The starting point in determining any solution must be to understand what is to be achieved.
- The program design starts with breaking down the task into a number of simple understandable elements, each of which can be easily described.

2. Application requirements

- Input and output device requirements. After determining the operation of the system, the next step is to determine what input and output devices the system requires.
- List the function required and identify a specific type of device.
- The need for special operations in addition to discrete (On/Off) logic
- List the advanced functions required beside simple discrete logic.

3. Electrical Requirements

- The electrical requirements for inputs, outputs, and system power; When determining the electrical requirements of a system, consider three items :
  i. Incoming power (power for the control system);
  ii. Input device voltage; and
  iii. Output voltage and current.

4. Speed of Operation

- How fast the control system must operate (speed of operation) ?
- When determining speed of operation, consider these points :
  - How fast does the process occur or machine operate ?
  - Are there "time critical" operations or events that must be detected ?
  - In what time frame must the fastest action occur (input device detection to output device activation) ?
  - Does the control system need to count pulses from an encoder or flow-meter and respond quickly ?

Thank You


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5. Communication

- If the application requires sharing data outside the process, i.e. communication. Communication involves sharing application data or status with another electronic device, such as a computer or a monitor in an operator's station.
- Communication can take place locally through a twisted-pair wire, or remotely via telephone or radio modem.

6. Operator Interface

- If the system needs operator control or interaction. In order to convey information about machine or process status, or to allow an operator to input data, many applications require operator interfaces.
- Traditional operator interfaces include pushbuttons, pilot lights and LED numeric display.
- Electronic operator interface devices display messages about machine status in descriptive text, display part count and track alarms.
- Also, they can be used for data input.

7. Physical Environment

- The physical environment in which the control system will be located. Consider the environment where the control system will be located.
- In harsh environments, house the control system in an appropriate IP-rated enclosure.
- Remember to consider accessibility for maintenance, troubleshooting or reprogramming.