PROGRAMMABLE LOGIC CONTROLLER (PART-II)

Ladder Diagram

Programmable controllers are generally programmed in ladder diagram (or "relay diagram") which is nothing but a symbolic representation of electric circuits. Symbols were selected that actually looked similar to schematic symbols of electric devices, and this has made it much easier for electricians to switch to programming PLC controllers. Electrician who has never seen a PLC can understand a ladder diagram. Ladder diagram consists of one vertical line found on the left-hand side, and lines which branch off to the right. Line on the left is called a "bus bar", and lines that branch off to the right are instruction lines.

Objectives

Upon completion of this article, we will be able to

- Identify the parts of an electrical machine control diagram including rungs, branches, rails, contacts, and loads.
- Correctly design and draw a simple electrical machine control diagram.
- recognize the difference between an electronic diagram and an electrical machine diagram.
- Recognize the diagramming symbols for common components such as switches, control transformers, relays, fuses, and time delay relays.
- Understand the more common machine control terminology.

We shall begin with a study of the fundamental components used in electrical machine controls and their ladder diagram symbols.

EHC (Electrical Hardware Control)

There are two fundamental uses for switches. First, switches are used for operator input to send instructions to the control circuit. Second, switches may be installed on the moving parts of a machine to provide automatic feedback to the control system. There are many different types of switches, too many to cover in this text. However, with a basic understanding of switches, it is easy to understand most of the different types. To having the grip or command on a specific task or operation is known as control. ‘Switch’ is used as the most commonly used controller or Input device. Switch is the device that is responsible for the switching operation of the output that is connected to it.
From the actuation point of view switches are divided in to three types

Switch

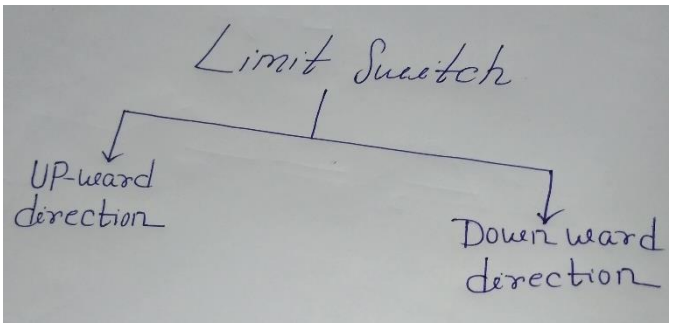
- **Mechanical actuation**
  - **Limit Switch**
- **Manual Actuation**
  - **Toggle Switch**
  - **Push Button Switch**
  - **Selector Switch**
- **Electrical Actuation**
  - **Relay**
  - **Contactor**
  - **Timer**
  - **Sensor***

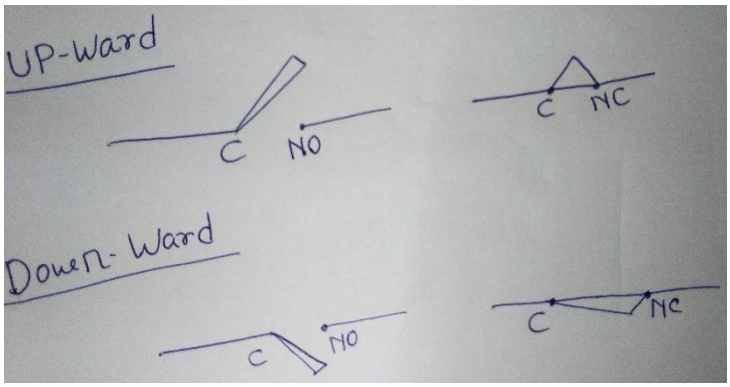
*(only digital types of sensors are used as switch)

- **Mechanical Switch:**

A mechanical switch generates an on/off signal or signals as a result of some mechanical input causing the switch to open or close. Such a switch might be used to indicate the presence of a workpiece on a machining table, the workpiece pressing against the switch and so closing it. The absence of the workpiece is indicated by the switch being open and its presence by it being closed.

- **Limit Switches**





A limit switch is an electromechanical device that consists of an actuator mechanically linked to a set of contacts. When an object comes into contact with the actuator, the device operates the contacts to make or break an electrical connection. Limit switches are usually not operator accessible. Instead they are activated by moving parts on the machine. They are usually mechanical switches but can also be light activated (such as the automatic door openers used by stores and supermarkets), or magnetically operated (such as the magnetic switches used on home security systems that sense when a window has been opened). An example of a mechanically operated limit switch is the switch on the refrigerator door that turns on the light inside. They are sometimes called cam switches

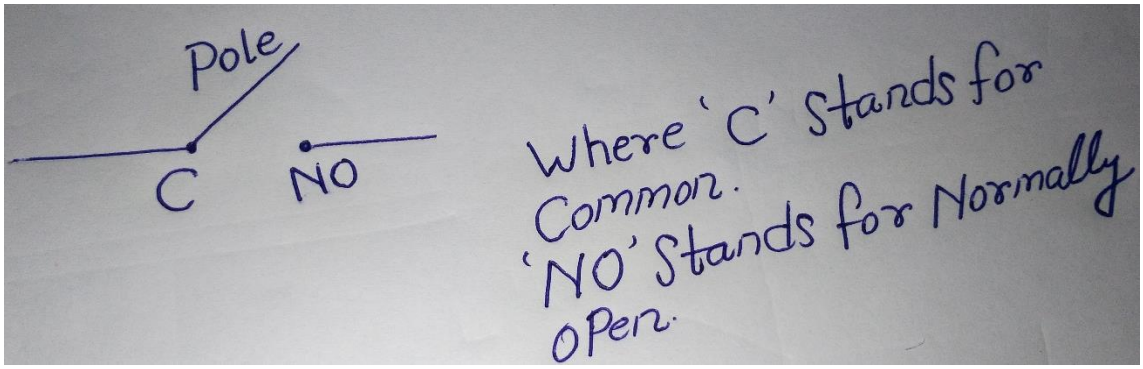
because many are operated by a camming action when a moving part passes by the switch. The N/O version is on the left and the N/C version is on the right. One of the many types of limit
switch is pictured.

- **Toggle Switch**

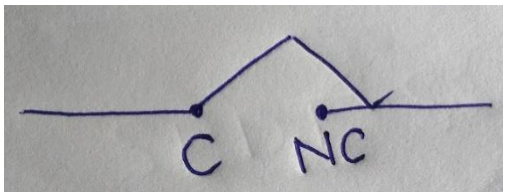
If a switch is changing its state with the help of toggling function then it is known as toggle switch. In Constructional point of view, toggle switch is divided into six types. These are

- SPST-Single pole single throw
- SPDT-Single pole double throw
- DPST-Double pole single throw
- DPDT-Double pole double throw
- SPCO-Single pole changeover/center off
- QPDT-Quadruple pole double throw

- **SPST Switch**- SPST stands for Single pole Single Throw where Single Pole Stands for Incoming and Single Throw Stands for Outgoing.



This is the diagram of a normally open SPST Switch.



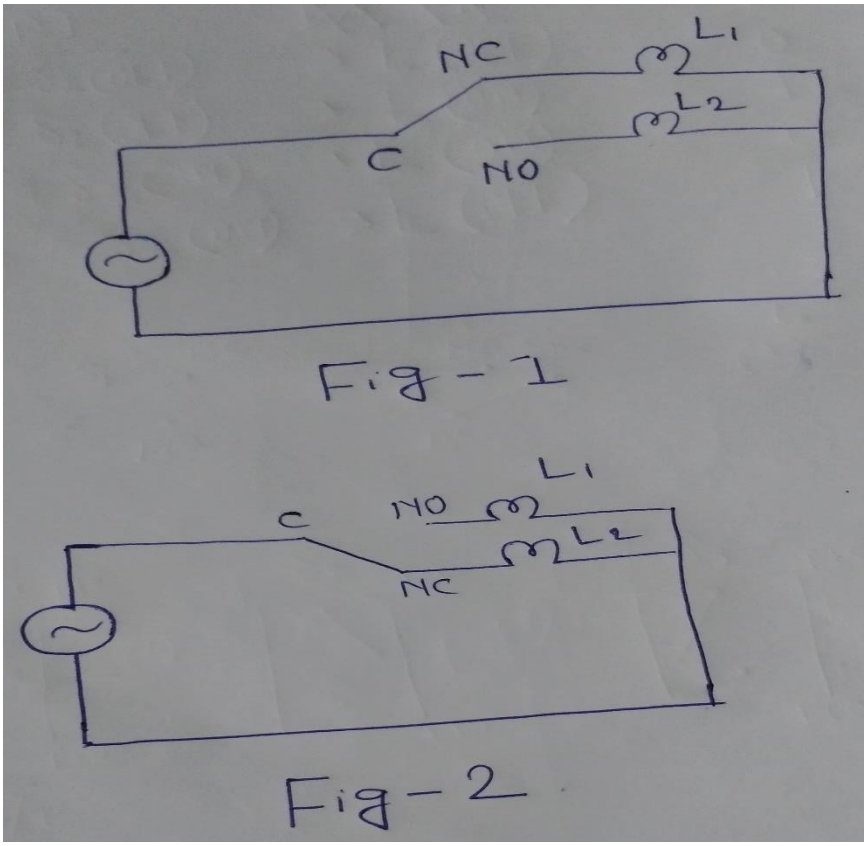
In this image 'NC' stands for Normally Close.

So, what is 'NO' and 'NC'?

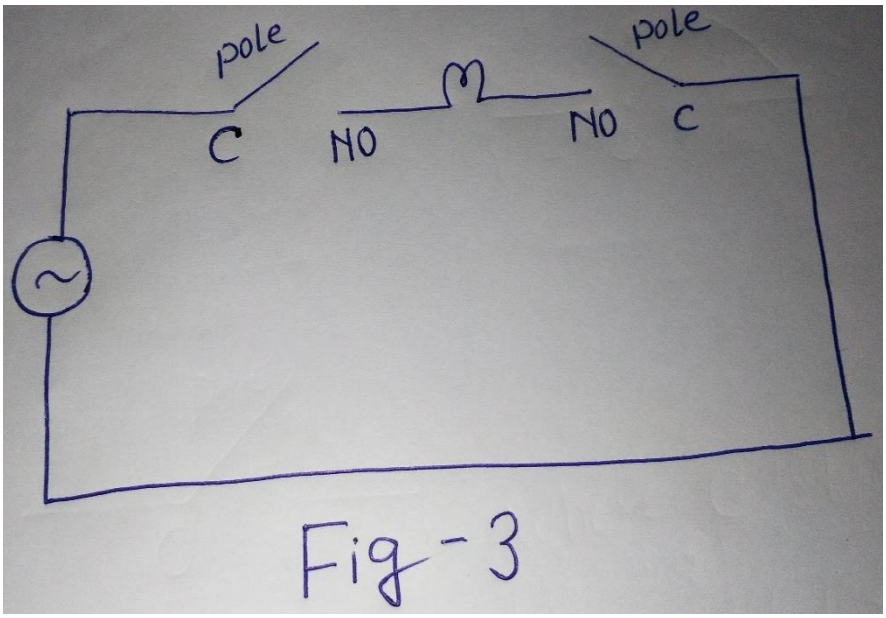
'NO' means Normally Open which means Open Circuit that is why it is not creating a path for the current.

‘NC’ means Normally Close, which means Close Circuit that is why it is creating a path for the current.

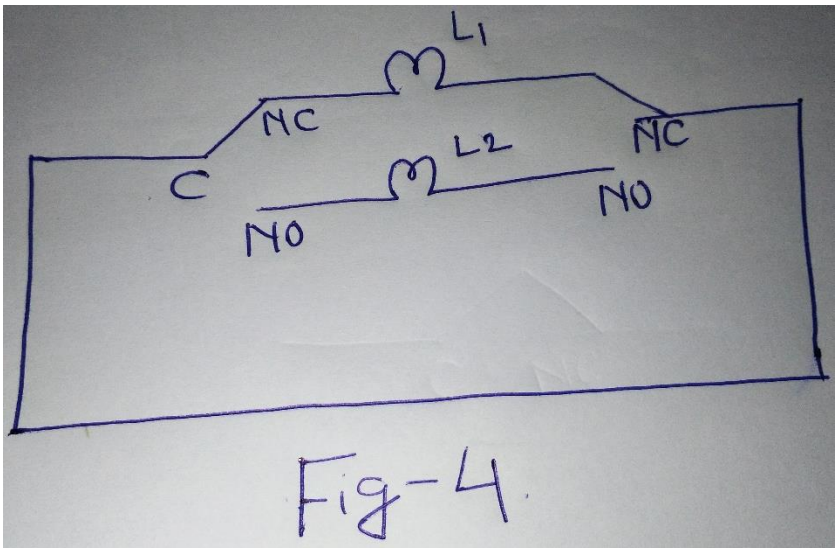
- **SPDT**- It is stands for Single Pole Double Throw. From Fig-1 and Fig-2 it is clear that there is only one pole present in these types of switches. And at a time, it can handle 2 outputs L_1 & L_2.



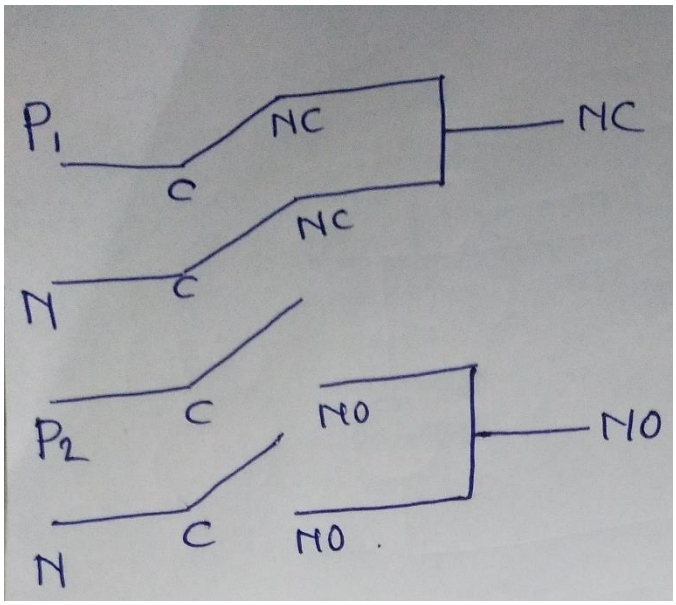
- **DPST**-It is stands for Double Pole Single Throw. From Fig 3 we can easily find out that there are 2 nos. of poles but has only one throw which means it can handle only one output at a time.



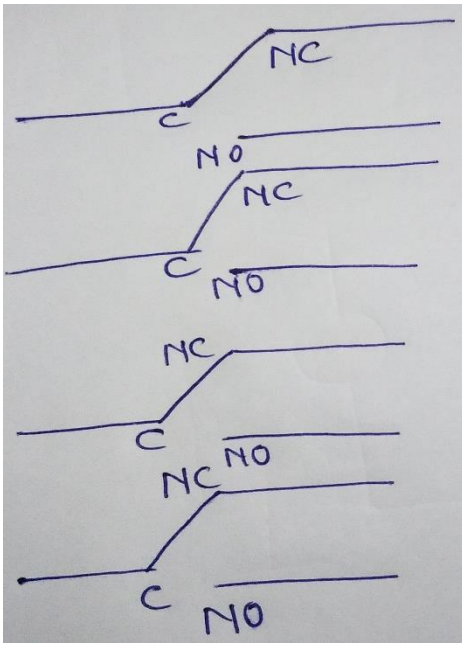
- **DPDT**- It is stands for Double Pole Double Throw. From This Diagram it is clear that this switch has 2 poles & it can handle 2 nos. of output at a time as it has double throw.



- **SPCO**- It is stands for Single pole Change Over/Center Off. Generally, it is it is used for car indicator system.



- **QPDT**-It is stand for quadruple pole double throw. So, in its constructive part, it has 4 poles and double throw means it can handle up to 2 nos. of output at a time.



Push Button Switch: The most common switch is the pushbutton. It is also the one that needs the least description because it is widely used in automotive and electronic equipment applications. There are two types of pushbutton, the momentary and maintained. The **momentary** pushbutton switch is activated when the button is pressed, and deactivated when the button is released. The deactivation is done using an internal spring. The **maintained** pushbutton activates when pressed but remains activated when it is released. Then to deactivate it, it must be pressed a second time. For this reason, this type of switch is sometimes called a push-push switch. The on/off switches on most desktop computers and laboratory oscilloscopes are maintained pushbuttons. The contacts on switches can be of two types. These are normally open (N/O) and normally closed (N/C). Whenever a switch is in it's deactivated position, the N/O contacts will be open (non-conducting) and the N/C contacts

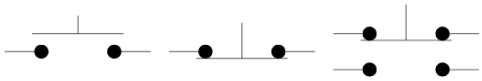


Figure 1-4 - Momentary Pushbutton Switches

will be closed (conducting). Figure 1-4 shows the schematic symbols for a normally open pushbutton (left) and a normally closed pushbutton (center). The symbol on the right of Figure 1-4 is a single pushbutton with both N/O and N/C contacts. There is no internal electrical connection between different contact pairs on the same switch. Most industrial switches can have extra contacts “piggy backed” on the switch, so as many contacts as needed of either type can be added by the designer. The schematic symbol for the maintained pushbutton is shown in Figure 1-5. Note that it is the symbol for the momentary pushbutton with a “see-saw” mechanism added to hold in the switch actuator until it is pressed a second time. As with the momentary switch, the maintained switch can have as many contacts of either type as desired.

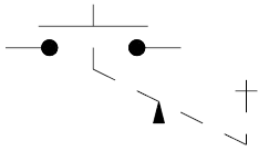
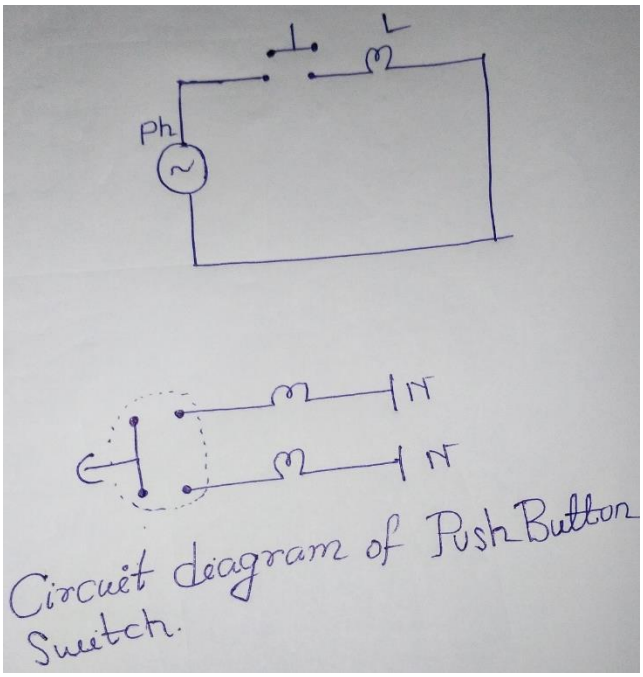


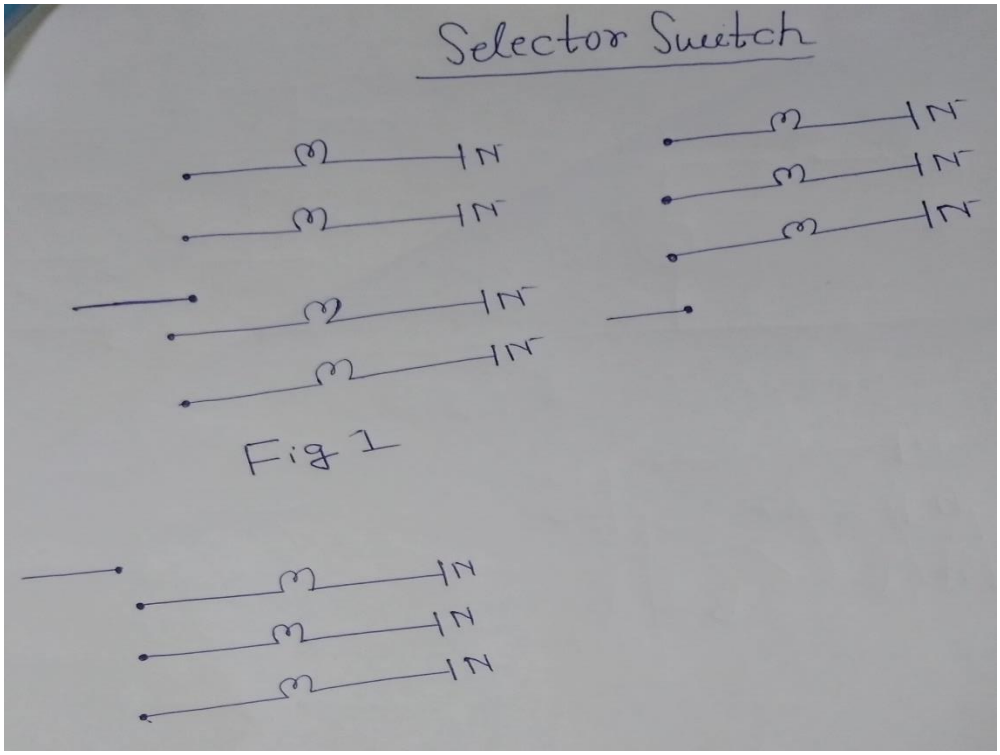
Figure 1-5 - Maintained Switch

- **Pushbutton Switch Actuators**

The actuator of a pushbutton is the part that you depress to activate the switch. The switch on the right is an **extended** pushbutton. Obviously, the actuator extends beyond the sleeve which makes the button easy to depress by finger, palm of the hand, or any object. It is intended for applications where it is desirable to make the switch as accessible as possible such as STOP, PAUSE, or BRAKES. The three types of switch actuators are not generally used for applications that would be required in emergency situations nor for operations that occur hundreds of times per day. For both of these applications, a switch is needed that is the most accessible of all switches. These types are the **mushroom head** or **palm head** pushbutton (sometimes called **palm switches**, for short).



- **Selector Switch:**



These are often chosen when more than 2 positions are needed, such as three speed fans or a CB radio with multiple frequencies of reception or “channels”. A selector switch is also known as a rotary switch. An automobile ignition switch, and an oscilloscope’s vertical gain and horizontal time base switches are examples of selector switches. Selector switches use the same symbol as a momentary pushbutton, except a lever is added to the top of the actuator. The switch on the left is open when the selector is turned to the left and closed when turned to the right. The switch on the right side has two sets of contacts. The top contacts are closed when the switch selector is turned to the left position and open when the selector is turned to the right. The bottom set of contacts work exactly opposite. There is no electrical connection between the top and bottom pairs of contacts. In most cases, we label the selector positions the same as the labeling on the panel where the switch is located. For the switch on the right in Figure 1-9, the control panel would be labeled with the STOP position to the left and the RUN position to the right.

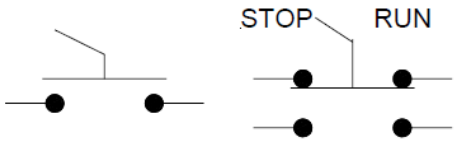


Figure 1-9 - Selectors

- **Indicator Lamps**

All control panels include indicator lamps. They tell the operator when power is applied to the machine and indicate the present operating status of the machine. Indicators are drawn as a circle with “light rays” extending on the diagonals. Although the light bulbs used in indicators are generally incandescent (white), they are usually covered with colored lenses. The colors are usually red, green, or amber, but other colors are also available. Red lamps are reserved for safety critical indicators (power is on, the machine

is running, an access panel is open, or that a fault has occurred). Green usually indicates safe conditions (power to the motor is off, brakes are on, etc.). Amber indicates conditions that are important but not dangerous (fluid getting low, machine paused, machine warming up, etc.). Other colors indicate information not critical to the safe operation of the machine (time for preventive maintenance, etc.). Sometimes it is important to attract the operator's attention with a lamp. In these cases, we usually flash the lamp continuously on and off.

***In next part we will discuss about Timer, Counter, Sensor, Relay & Contactors.

TO BE CONTINUED……

*Sources & References:
1.Introduction of Programmable Logic Controller by Gary Dunning
2. Programmable Logic Controllers by W. Bolton
3. Programmable Logic Controllers: Programming Methods and Applications by John R. Hackworth And Frederick D. Hackworth, Jr.
4. Programmable Logic Controllers by Khaled Kamel & Eman Kamel

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