الجامعة التقنية الوسطى
الكلية التقنية الهندسية الكهربائية
قسم هندسة تقنيات الحاسوب

PROGRAMMABLE LOGIC CONTROLLER

(PLC)

المرحلة الثالثة
المادة: المسيطرات الرقمية

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"PLC"

1. Programmable Logic Controllers

A programmable logic controller (PLC) is an industrial grade computer or a digitally operating electronic computer which uses a control programming language to programming memory for the internal storage of instructions for implementing specific functions such as logic, sequencing, timing, counting and arithmetic to control through digital or analog modules. Figure (1). It has been designed to operate in the industrial environment and is equipped with special input/output interfaces.

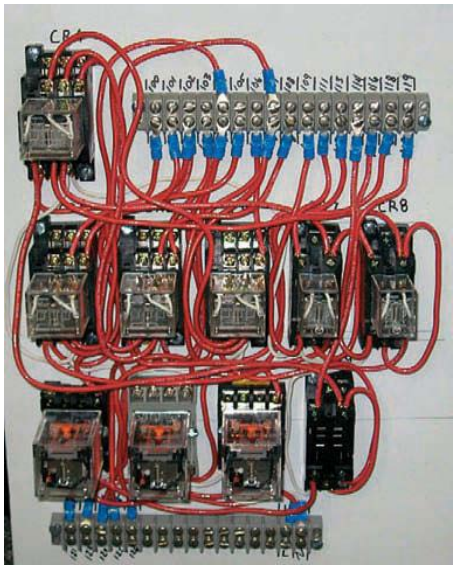
Figure 1: Programmable logic controller.

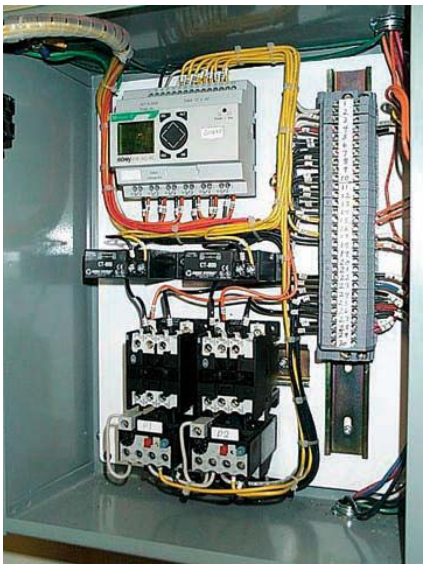
The programmable logic controller is designed for multiple input and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact.

A PLC is an example of a real-time system since the output of the system controlled by the PLC depends on the input conditions.

Programmable controllers offer several advantages over a conventional relay type of control. Relays have to be hardwired

to perform a specific function while the programmable controller has eliminated much of the hardwiring associated with conventional relay control circuits (Figure 2). It is small and inexpensive compared to equivalent relay-based process control systems.





(a) Relay based control panel.(b) PLC-based control panel.

Figure (2): Relay- and PLC-based control panels

- **PLCs provide many other mains benefits including:**
  1. Increased Reliability. Once a program has been written and tested, it can be easily downloaded to other PLCs. Since all the logic is contained in the PLC's memory, there is no chance of making a logic wiring error (Figure3).

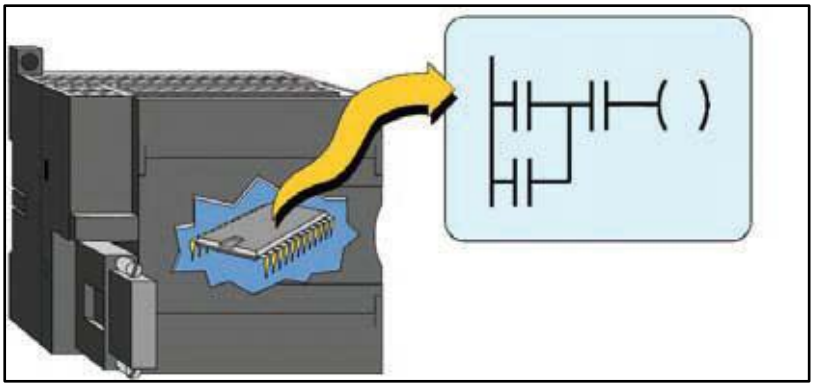


Figure (3): all the logic is contained in the PLC's memory.

2.More Flexibility. It is easier to create and change a program in a PLC than to wire and rewire a circuit. With a PLC the relationships between the inputs and outputs are determined by the user program instead of the manner in which they are interconnected (Figure4).

3. Lower Cost. PLCs were originally designed to replace relay control logic, and the cost savings have been so significant that relay control is becoming obsolete except for power applications.

4. Communications Capability. PLC can communicate with other controllers or computer equipment to perform such functions as supervisory control, data gathering, monitoring devices and process parameters, and download and upload of programs

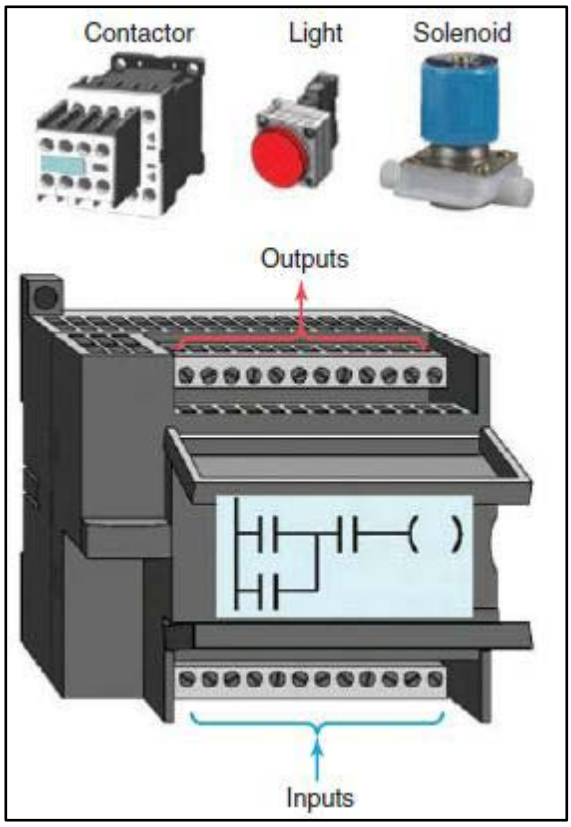


Figure (4): Relationships between the inputs and outputs are determined by the user program.

5. Faster Response Time:PLCs are designed for high speed and real-time applications. The programmable controller operates in real time, whichMeans that an event taking place in the field will result in the execution of an operation or output.

6. Easier to Troubleshoot:PLCs have resident diagnostics and overrideFunctions that allow users to easily trace and correct software andHardware problems. To find and fix problems, users can display theControl program on a monitor and watch it in real time as it executes as shown in (Figure5).

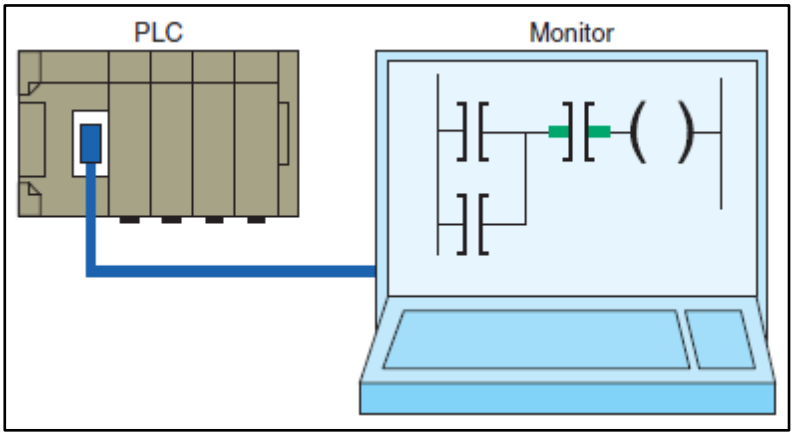


Figure (5): Control program can be displayed on a monitor in real time.

2. Parts of a PLC

A typical PLC can be divided into parts as illustrated in (Figure 6)these are:

1. Central processing unit (CPU).
2. Input/output (I/O) section.
3. Power supply.
4. Programming device.

The term architecture can referto PLC hardware, to PLC software,or to a combination of both.

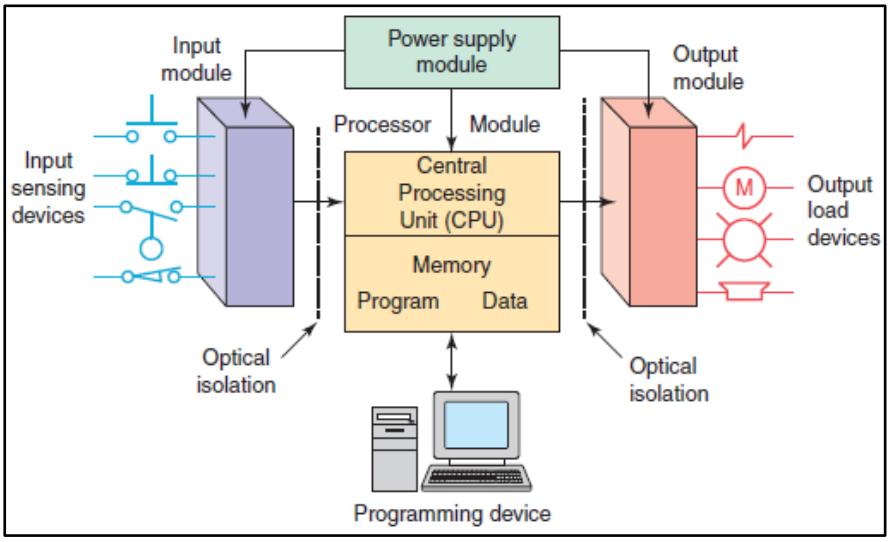


Figure (6):typical parts of a programmable logic controller.

There are two ways in which I/Os (Inputs/Outputs) are incorporated into the PLC:

1. Fixed type fixed I/O (Figure7) is typical of small PLCs that come in one package with no separate, removable units. The processor and I/O are packaged together, and the I/O terminals will have a fixed number of connections built in for inputs and outputs. The main advantage of this type of packaging is lower cost. One disadvantage of fixed I/O is its lack of flexibility.

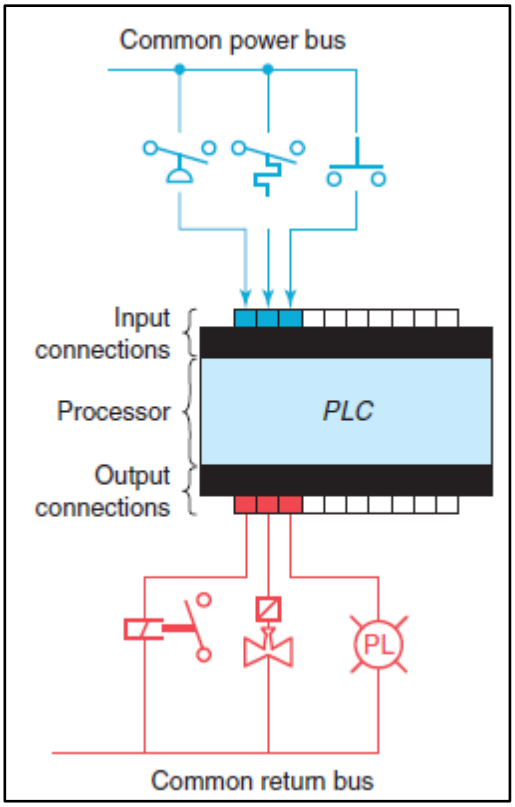


Figure (7): Fixed I/O configurations.

2. Modular I/O (Figure8)is divided by compartments into which separate modules can be plugged. This feature greatly increases your options and the unit's flexibility. You can choose from the modules available from the manufacturer and mix them any way you desire. The basic modular controller consists of a rack, power supply, processor module (CPU), input/output (I/O modules), and an operator interface for programming and monitoring. The modules plug into a rack. When a module is slid into the rack, it makes an electrical connection with a series of contacts called the backplane, located at the rear of the rack. The PLC processor is also connected to the backplane and can communicate with all the modules in the rack.

a) Power supply supplies DC power to other modules that plug into the rack.

b) The processor (CPU) is the "brain" of the PLC. A typical processor usually consists of a microprocessor for implementing the logic and controlling the communications among the modules.The processor requires memory for storing the results of the logical operations performed by the microprocessor. Memory is also required for the program EPROM or EEPROM plus RAM. The CPU controls all PLC activity and is designed so that the user can enter the desired program in relay ladder logic.

The PLC program is executed as part of a repetitive process referred to as a scan.

❖ **A typical PLC scan consist of four steps:**

1. CPU reading the status of inputs.
2. Executed application program.
3. CPU performs internal diagnostic and communication tasks.
4. All outputs are updated.

This process is repeated continuously as long as the PLC is in the run mode.

c) The I/O interface section: Used for connects a PLC to external field devices (Figure9).

• The main purpose of the I/O interface is to condition the various signals received from or sent to the external input and output devices. Input devices such as pushbuttons, limit switches, and sensors are hardwired to the input terminals. Output devices such as small motors, motor starters, solenoid valves, and indicator lights are hardwired to the output terminals.

• Input modules convert's signals from discrete or analog input devices to logic levels acceptable to PLC's processor.

• Output modules converts signal from the processor tolevels capable of driving the connected discrete or analogoutput devices

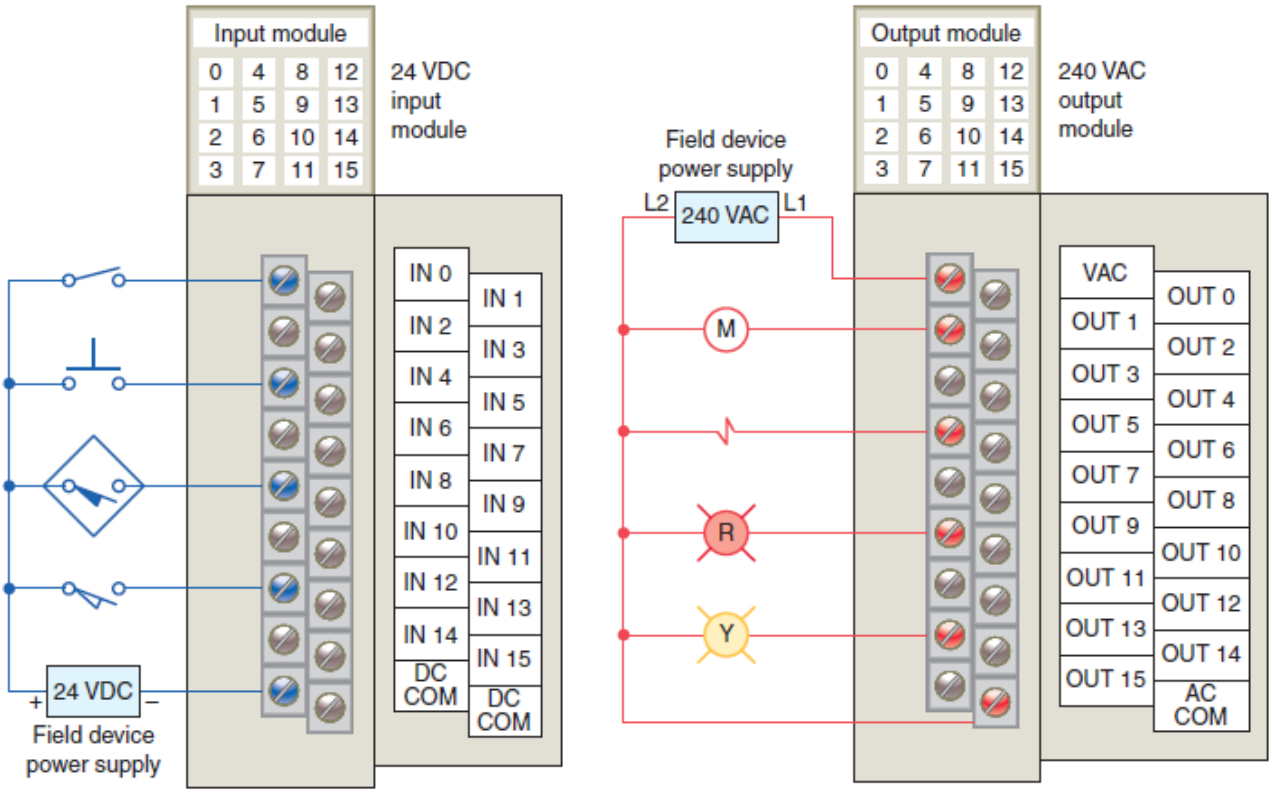


Figure (9): Typical PLC input/output (I/O) system connections.

d) Programming device is used to enter the desired program into the memory of the processor. The program can be entered using relay ladder logic, which is one of the most popular programming languages. It is a special language written to make it easy for people familiar with relay logic control to program the PLC.

A personal computer (PC) is the most commonly used programming device. Most brands of PLCs have software

available so that a PC can be used as the programming device. This software allows users to create, edit, document, store, and troubleshoot ladder logic programs.
There are three main Types of programming device:
1. Hand held unit with LED / LCD display.
2. Desktop type with a CRT display.
3. Compatible computer terminal.

A program is a user-developed series of instructions that directs the PLC to execute actions. A programming language provides rules for combining the instructions so that they produce the desired actions. Relay ladder logic (RLL) is the standard programming language used with PLCs.

3. Principles of Operation

The components of simple control are shown in the ***relay ladder diagram*** of Figure (10). The motor starter coil (M) is energized when both the pressure and temperature switches are closed or when the manual pushbutton is pressed. The input field devices (pressure switch, temperature switch, and pushbutton) are used and hardwired to an appropriate input module. The output field device (motor starter coil) would also be used and also hardwired to an appropriate output module.

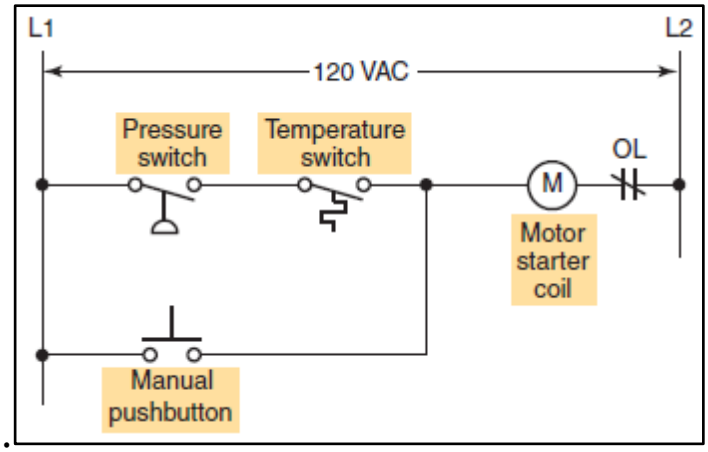


Figure (10): Process control relay ladder diagram.

Next, the **PLC ladder logic program** would be constructed and entered into the memory of the CPU. A typical ladder logic program for this process is shown in Figure (11). The format used is similar to the layout of the hardwired relay ladder circuit. The individual symbols represent instructions, whereas the numbers represent the instruction location addresses. To program the controller, you enter these instructions one by one into the processor memory from the programming device. Each input and output device is given an address, which lets the PLC know where it is physically connected. During the program scan the controller monitors the inputs, executes the control program, and changes the output accordingly.

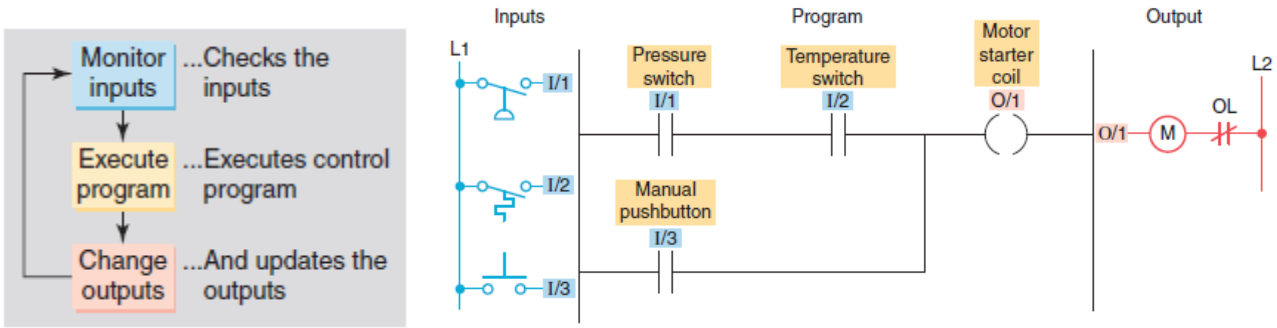


Figure (11): Process control PLC ladder logic program with typical addressing scheme.