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INDUSTRIAL AUTOMATION WITH PLC

PLC OPERATION

A programmable logic controller, commonly known as PLC, is a solid-state, digital, industrial computer using integrated circuits instead of electromechanical devices to implement control functions. It was invented in order to replace the sequential circuits which were mainly used for machine control. They are capable of storing instructions, such as sequencing, timing, counting, arithmetic, data manipulation and communication, to control machines and processes.

According to NEMA (National Electrical Manufacture's Association, USA), the definition of PLC has been given as

"Digital electronic devices that uses a programmable memory to store instructions and to implement specific functions such as logic, sequencing, timing, counting, and arithmetic to control machines and processes."

Basic parts of PLC:-

All programmable controllers contain a CPU, memory, power supply, I/O modules, and programmable devices. The basic parts of the PLC are as follows:-

1. Processor
2. Memory
3. Input/output devices
4. Programming panel or unit
5. Power supply

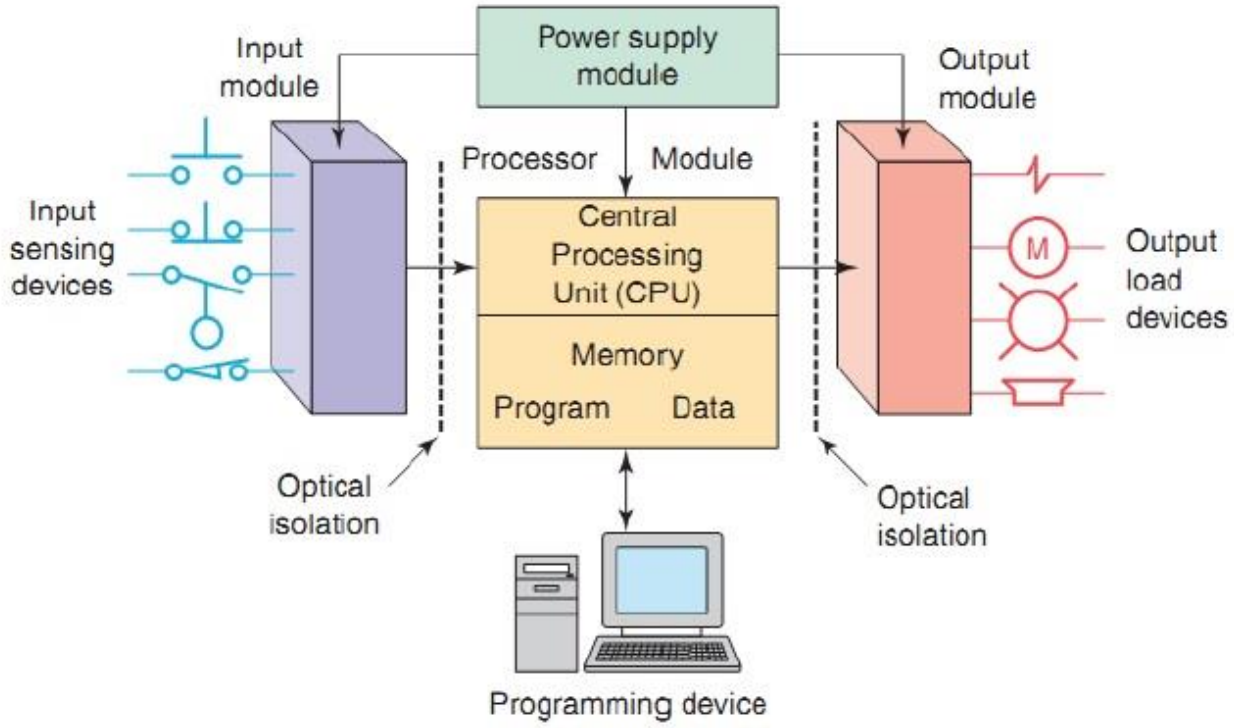

Fig: Basic Parts of PLC

Processors module:-

The processor module is the brain of the PLC. The intelligence of the PLC is derived from the microprocessor being used which has tremendous computing and controlling capability. Central processing –unit (CPU) performs the following tasks:-

- Scanning
- Execution of the program
- Peripheral and external device communication
- Self- diagnost

The power of PLCs depends on the type of microprocessors being used. Small size PLCs use 8-bit microprocessors whereas higher-order controllers use bit-slice microprocessor in order to achieve faster instruction execution

Modern-day PLCs vary widely in their capabilities to control real-world devices, like some processors are able to handle the I/O devices as few as six and some are able to handle 40000 or more. The no. of input/output control of PLCs depends on the hardware, software, overall capacity and memory capability of the PLCs.

The CPU upon receiving instruction from the memory together with feedback on the status of the I/O devices generates commands for the output devices. These commands control the devices on a machine or a process. Devices such as solenoid valves, indicator lamps, relay coils and motor starters and typical loads to be controlled.

The machine or process input elements transmit the signal to input modules which in turn, generates a logic signal to the CPU.CPU monitors the input like selector switches, pushbuttons, etc.

The operating system is the main workhouse of the system and hence performs the following tasks:-

- Executions of the application program
- Management of memory
- Communication between programmable controller and other units
- I/O handling of interfaces
- Resource sharing
- Diagnostics

Note: - operating system stored in ROM (non–volatile) memory, whereas application programs are stored in RWM (read-write memory).

Input modules:-

There are many types of input modules to choose from. The type of input module selection depends upon the process, some example of input modules are limit:-switches, proximity switches and push buttons, etc. nature of input classification can be done in three ways, namely:-

- Low/high frequency
- Analog/digital (two-bit, multi-bit)

- Maintained or momentary
- 5V/24V/110V/220V switched

Some most industrial power systems are inherently noisy:- electrical isolation is provided between the input and the processor. Electromagnetic interference (EMI) and radio frequency interference (RFI) can cause severe problems in most solid-state control systems. The component used often to provide electrical isolation within I/O cards is called an optical isolator or optocoupler. Typically, there are 8 to 32 input points on anyone's input modules. Each input point is assigned a unique address by the processor.

Output modules:-

Output modules can be used for devices such as solenoids, relays, contactors, pilot lamps and led readouts. Output cards usually have 6 to 32 output points on a single module. Output cards, like input cards, have electrical isolation between the load being connected and the PLC. Analog output cards are a special type of output modules that use digital to analog conversion. The analog output module can take a value stored in a 12-bit file and convert it to an analog signal. Normally, this signal is 0-10 volts dc or 4-20ma. This analog signal is often used in equipment, such as motor-operated valves and pneumatic position control device. Each output point is identified with a unique address.

Addressing scheme:-

Each I/O device has to be identified with a unique address for exchange of data. Different manufacturer apply different method to identify I/O devices. One of the addressing schemes may be "X1 X2 X3 X4 X5" where

- X1 = Input or output designation fixed by hardware (I/P = 1, O/P = 0)
- X2 = I/O rack number in PLC (user designation)
- X3 = Modules slot number in I/O rack (fixed by hardware)
- X4 X5 = terminal number (fixed by hardware)

For example," 1 2 3 13" implies that input is at rack 2, module slot no.3 and terminal address no.13.

Programming unit:-

It is an external, electronic handheld device that can be connected to the processors of the PLC when programming changes are required. Once a program has been coded and is considered finished, It can be burned into ROM. The contents of ROM cannot be altered, as it is not affected by power failure. Nowadays EPROM/EEPROM is provided in which the program can be debugged at any stage. Once the program is debugged, the programming unit is disconnected; and the PLC can operate the process according to the ladder diagram or the statement list.

Communications in PLC:-

There are several methods of how a PLC can communicate with the programmer, or even with another PLC. PLCs usually built-in communication ports for at least RS232, and optionally for RS 485, and Ethernet. Modbus is the lowest common denominator communication protocol. Others are various field buses such as profibus, inter bus-s, foundation field bus, etc.

PLCs are becoming more and more intelligent .in recent years, PLCs have been integrated into industrial networks, and all the PLCs in an industrial environment have been plugged into a network. The PLCs are then supervised by a control centre. There exist many types of networks, SCADA (supervisory control and data acquisition).

Operation of PLC:-

During program execution, the processor reads all the inputs, and according to the control application program, energizes and de-energizes the outputs. Once all the logic has been solved, the processors will update all the outputs. The process of reading the inputs, executing the control application program, and updating the output is known as a scan.

During the scan operation, the processor also performs housekeeping tasks. The inputs to the PLCs are sampled by the processor and the contents are stored in memory. The control program is executed, the input value stored in memory is used in control logic calculations to determine the value of output. The outputs are then updated.

The cycle consisting of reading of inputs, executing the control program, and actuating the output is known as “scan” and the time to finish this task is known as “scan time”. The speed at which PLC scan depends upon the clock speed of the CPU. The time to scan depends upon the following parameter:-

- Scan rate
- Length of the program
- Types of functions used in the program

Faster scan time implies the inputs and outputs are updated frequently. Due to advance techniques of ASIC (application-specific integrated circuit) within the microcomputer for specific functions, the scan time of different PLCs has reduced greatly.