

Introduction to Programmable Logic Controllers – Part I

Module 1: Introduction to PLC Hardware

In this course module, the PLC hardware is discussed. After studying this module, the student will know the major components of a PLC and the functions of these components.

The PLC system

A programmable logic controller consists of the following components:

- Central Processing Unit (CPU)
- Memory
- Input modules
- Output modules and
- Power supply.

A PLC hardware block diagram is shown in Figure 1.1. The programming terminal in the diagram is not a part of the PLC, but it is essential to have a terminal for programming or monitoring a PLC. In the diagram, the arrows between blocks indicate the information and power flowing directions.

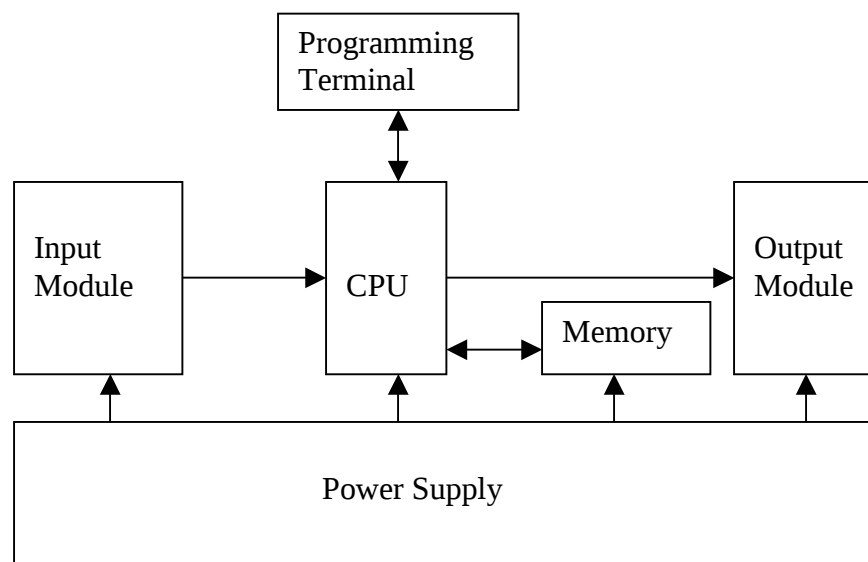


Figure 1.1 PLC Hardware Block Diagram

CPU

Like other computerized devices, there is a Central Processing Unit (CPU) in a PLC. The CPU, which is the “brain” of a PLC, does the following operations:

- Updating inputs and outputs. This function allows a PLC to read the status of its input terminals and energize or deenergize its output terminals.
- Performing logic and arithmetic operations. A CPU conducts all the mathematic and logic operations involved in a PLC.
- Communicating with memory. The PLC’s programs and data are stored in memory. When a PLC is operating, its CPU may read or change the contents of memory locations.
- Scanning application programs. An application program, which is called a *ladder logic program*, is a set of instructions written by a PLC programmer. The scanning function allows the PLC to execute the application program as specified by the programmer.
- Communicating with a programming terminal. The CPU transfers program and data between itself and the programming terminal.

A PLC’s CPU is controlled by operating system software. The operating system software is a group of supervisory programs that are loaded and stored permanently in the PLC’s memory by the PLC manufacturer.

Memory

Memory is the component that stores information, programs, and data in a PLC. The process of putting new information into a memory location is called *writing*. The process of retrieving information from a memory location is called *reading*.

The common types of memory used in PLCs are Read Only Memory (ROM) and Random Access Memory (RAM). A ROM location can be read, but not written. ROM is used to store programs and data that should not be altered. For example, the PLC’s operating programs are stored in ROM.

A RAM location can be read or written. This means the information stored in a RAM location can be retrieved and/or altered. Ladder logic programs are stored in RAM. When a new ladder logic program is loaded into a PLC’s memory, the old program that was stored in the same locations is over-written and essentially erased.

The memory capacities of PLCs vary. Memory capacities are often expressed in terms of *kilo-bytes* (K). One byte is a group of 8 bits. One bit is a memory location that may store one binary number that has the value of either 1 or 0. (Binary numbers are addressed in Module 2). 1K

memory means that there are 1024 bytes of RAM. 16K memory means there are 16 x 1024 = 16384 bytes of RAM.

Input modules and output modules

A PLC is a control device. It takes information from inputs and makes decisions to energize or de-energize outputs. The decisions are made based on the statuses of inputs and outputs and the ladder logic program that is being executed.

The input devices used with a PLC include pushbuttons, limit switches, relay contacts, photo sensors, proximity switches, temperature sensors, and the like. These input devices can be AC (alternating current) or DC (direct current). The input voltages can be high or low. The input signals can be digital or analog. Differing inputs require different input modules. An input module provides an interface between input devices and a PLC's CPU, which uses only a low DC voltage. The input module's function is to convert the input signals to DC voltages that are acceptable to the CPU. Standard discrete input modules include 24 V AC, 48 V AC, 120 V AC, 220 V AC, 24 V DC, 48 V DC, 120 V DC, 220 V DC, and transistor-transistor logic (TTL) level.

The devices controlled by a PLC include relays, alarms, solenoids, fans, lights, and motor starters. These devices may require different levels of AC or DC voltages. Since the signals processed in a PLC are low DC voltages, it is the function of the output module to convert PLC control signals to the voltages required by the controlled circuits or devices. Standard discrete output modules include 24 V AC, 48 V AC, 120 V AC, 220 V AC, 24 V DC, 48 V DC, 120 V DC, 220 V DC, and TTL level.

Power Supply

PLCs are powered by standard commercial AC power lines. However, many PLC components, such as the CPU and memory, utilize 5 volts or another level of DC power. The PLC power supply converts AC power into DC power to support those components of the PLC.

Programming Terminal

A PLC requires a programming terminal and programming software for operation. The programming terminal can be a dedicated terminal or a generic computer purchased anywhere. The programming terminal is used for programming the PLC and monitoring the PLC's operation. It may also download a ladder logic program (the sending of a program from the programming terminal to the PLC) or upload a ladder logic program (the sending of a program from the PLC to the programming terminal). The terminal uses programming software for programming and "talking" to a PLC.

Related web sites:

<http://www.plcs.net>

<http://www.sea.siemens.com/step/templates/lesson.mason?plcs:1:1:1>