

Basic Mechatronics Workshop

Module 3: Introduction to PLC

Lecture-5

PLC Introduction History and elements

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Lecture-5

PLC Introduction

History and elements

Objectives

Upon completion of this chapter, Student should be able to

- ✓ Define PLC and its function
- ✓ Explain the difference between hard wired control and PLC control
- ✓ Explain the different section of PLC
- ✓ List the advantages of PLC over electromagnetic relays.
- ✓ Explain the PLC hardware architecture.
- ✓ Learn hardwired and PLC system characteristics.

1. What is a PLC ?

- ▶ A Programmable Logic Controllers (PLC) is a miniature industrial grade computer that contains hardware and software - capable of being programmed to perform control functions



Image Source: Siemens



Image Source: Koyo

2. Before the PLC.

The development of the PLC can be compared analogously to the development of the Personal Computer,

Before the PC what were the computing devices:

- ▶ Abacus
- ▶ Slide Rule
- ▶ Table of Logarithms
- ▶ Electronic Calculator
- ▶ Personal Computer (Desktop, Laptop, Mobile Devices)



2. Before the PLC.

How were machines and industrial processes controlled before the advent of the PLC?

One of the means for controlling machines was through the use of

▶ **Power Relays** and their associated

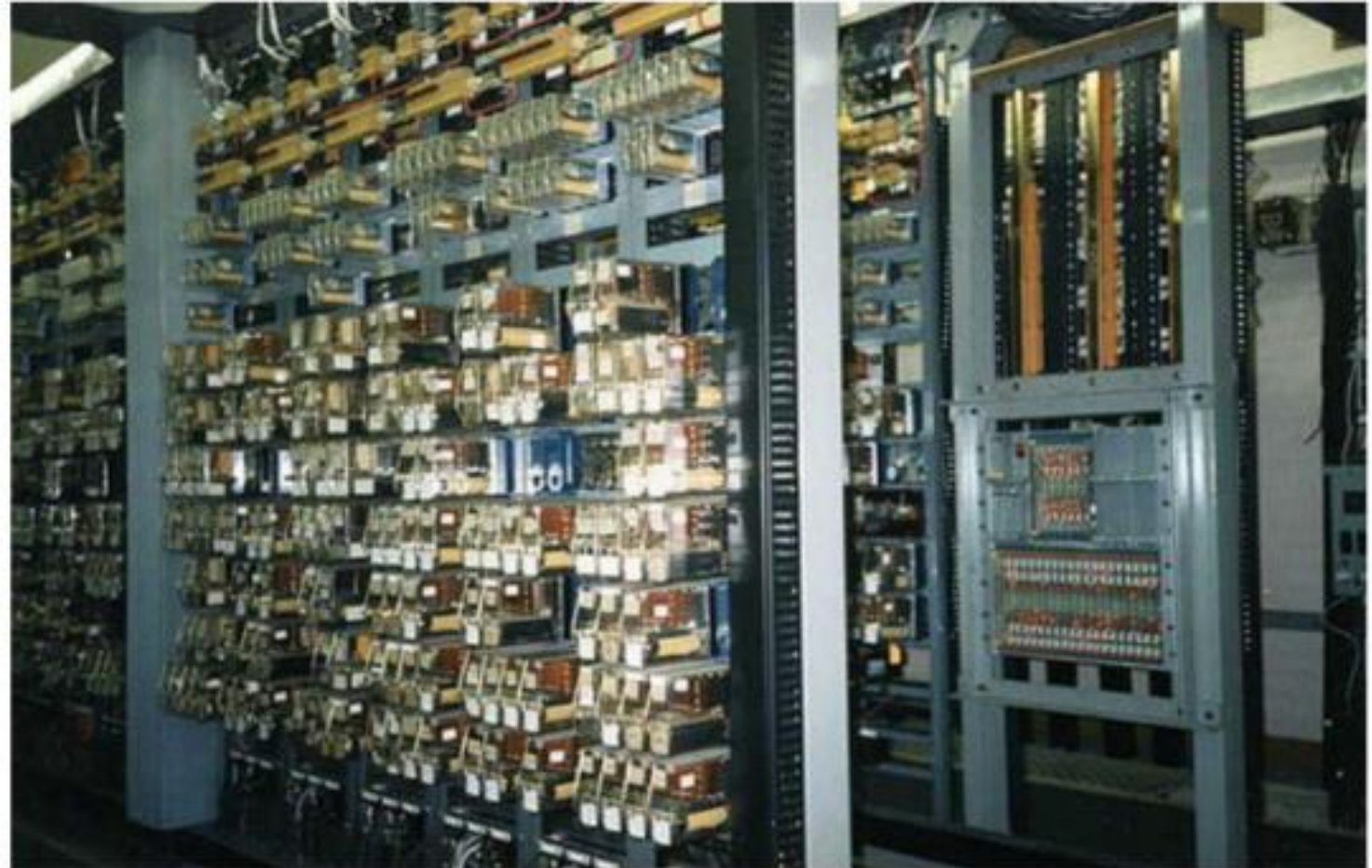
▶ **Control Relays**



2. Before the PLC.

What are the disadvantages of relay control systems?

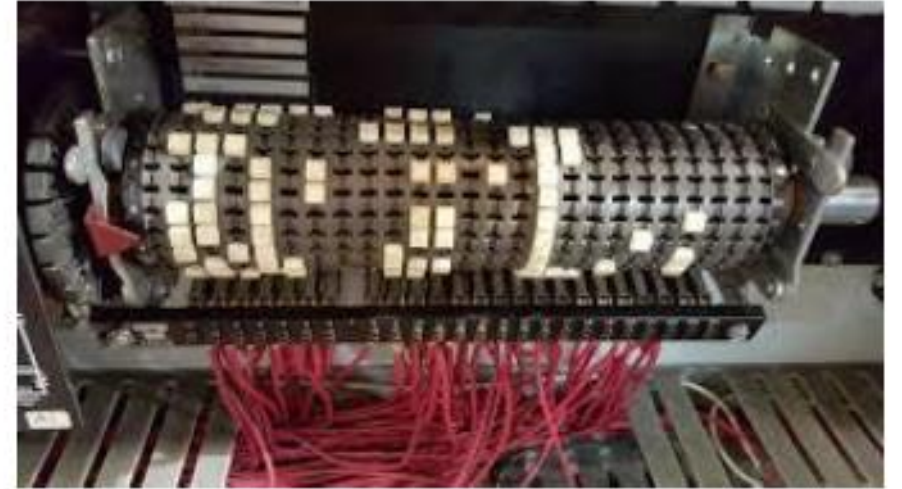
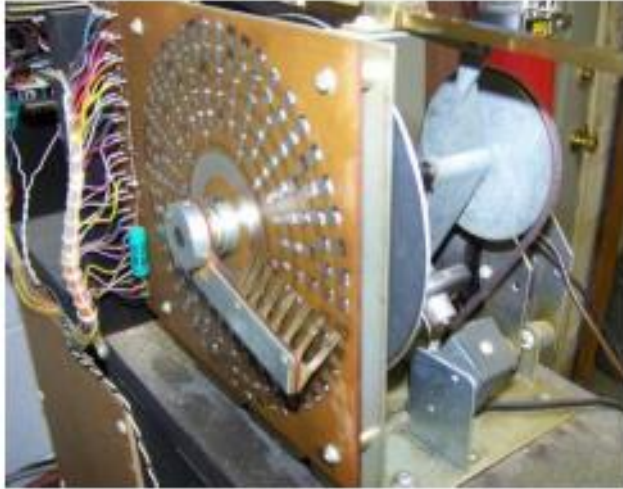
- ▶ Complexity,
- ▶ Costly
- ▶ Hardwiring,
- ▶ Logistical nightmare
- ▶ Troubleshooting problems
- ▶ Strict Maintenance routine
- ▶ Not easy to modify
- ▶ Etc, etc



2. Before the PLC.

Control devices:

- Rotary drum switch
- Limit switch
- Electromechanical Counter
- Fuses
- Control Transformers
- Motor Starter
- Solenoid Valves
- Pneumatic plunger timers
- etc



Advantages of the PLC.

- ▶ They are re-programmable
- ▶ Solid state switches last much longer than relays
- ▶ Complex logics can be easily represented
- ▶ Multiple devices can be embedded in one unit
- ▶ Can easily be scaled up or modified.
- ▶ Smaller physical size than hard-wire solutions.
- ▶ Easier and faster to make changes.
- ▶ PLCs have integrated diagnostics and override functions.
- ▶ Diagnostics are centrally available.
- ▶ Applications can be immediately documented.
- ▶ Applications can be duplicated faster and less expensively.

Advantages of the PLC.

- ▶ Connection between switches/output can be modified through software easily.
- ▶ Troubleshooting is Easier and Faster.
- ▶ Ease of Maintenance - less downtime.
- ▶ Easy to develop Programs by offline simulation
- ▶ Less amount of Space Needed
- ▶ Changes are easier and faster to implement,
- ▶ Integrated diagnostics

Disadvantages of the PLC.

- ▶ Most PLCs manufacturers offer only closed architectures for their products .
- ▶ PLC devices are proprietary, proprietary, which means that parts and from one manufacturer can't easily be used in combination with parts of another manufacturer, which limits the design and cost options.
- ▶ Subject to the limitations imposed by semiconductor based systems.
- ▶ Setup and training costs could be high

5. PLC - Configurations

PLCs are of two main configurations.

- Modular Configuration
- Fixed Configuration .

Modular Configuration



5. PLC - Configurations

PLCs are of two main configurations.

- Modular Configuration
- Fixed Configuration



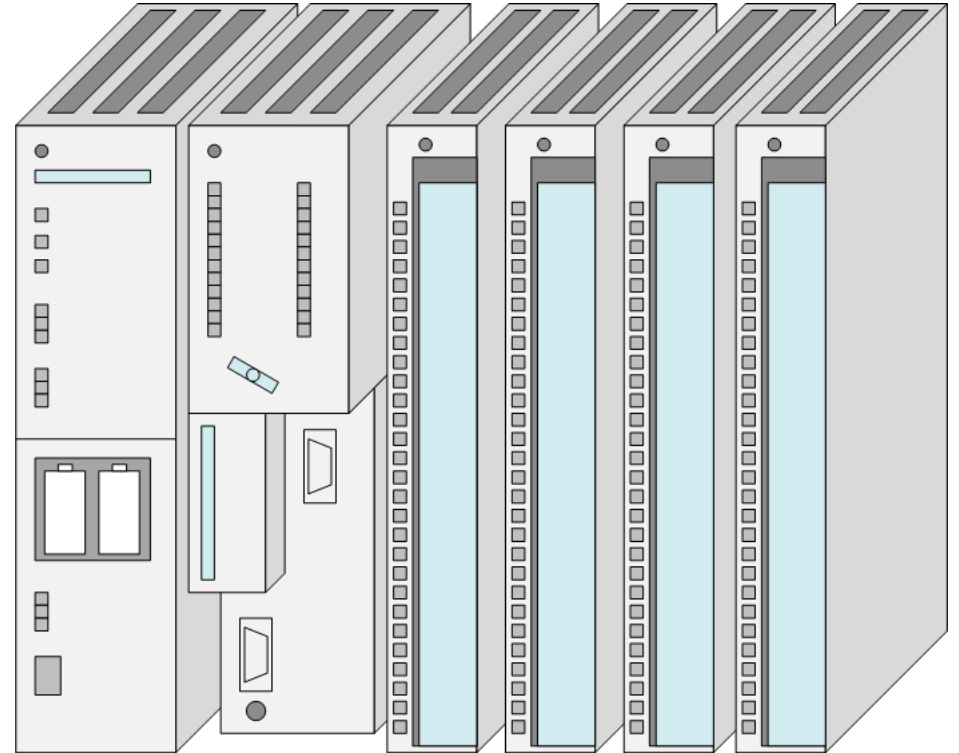
Fixed Configuration

SIMATIC Controller (PLC)

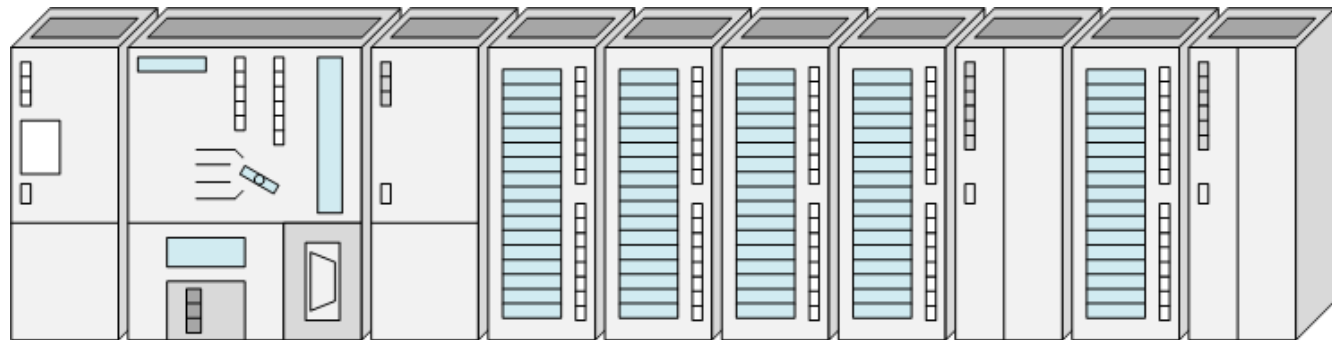
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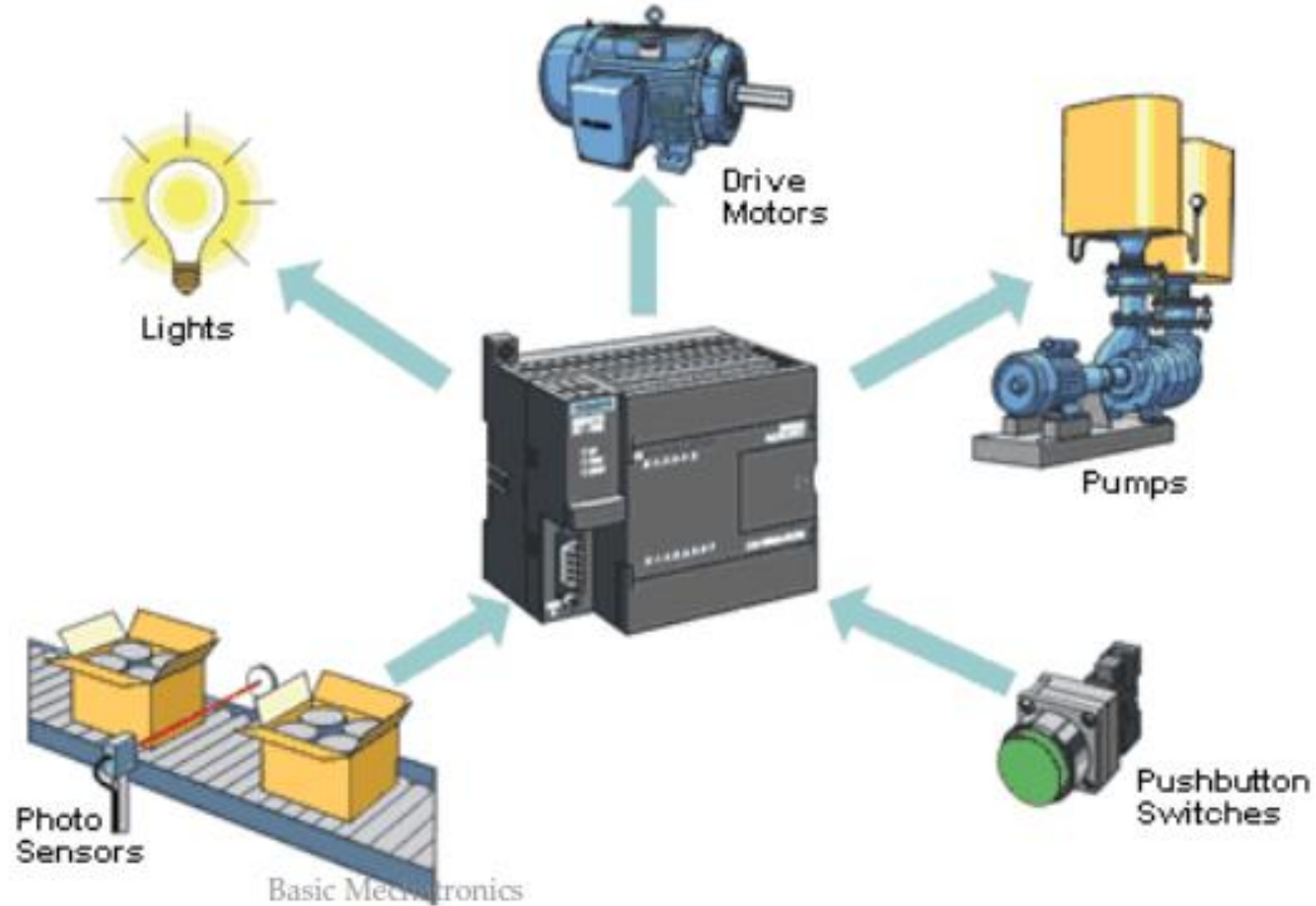
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PLC systems consists of three division

1. **Input section** – Consists of pushbuttons, switches and sensors which are connected to specific input addresses in the program. They transfer address information to the processing section
2. **Processing section** –The microprocessor receives the input signals from input sections and executes the information (called instructions) in the software program and sends the processed signals to output section
3. **Output section** –Takes the signal from processing section and modify the signal from the processor to operate output devices connected to specific output addresses.

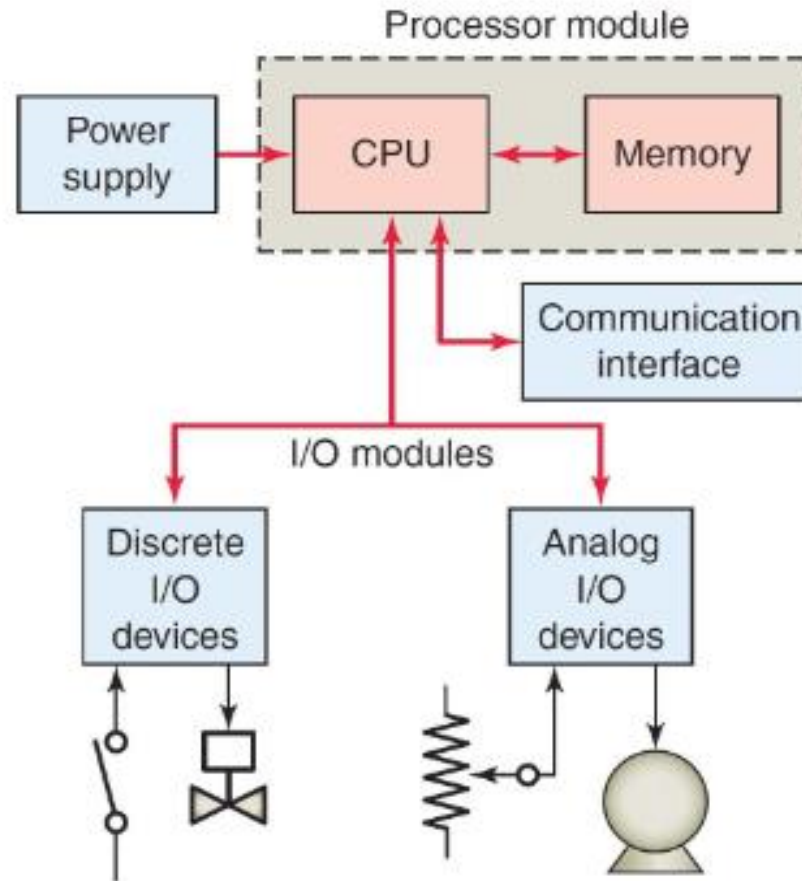
PLCs (Programmable Logic Controllers)



7. Parts of a PLC.

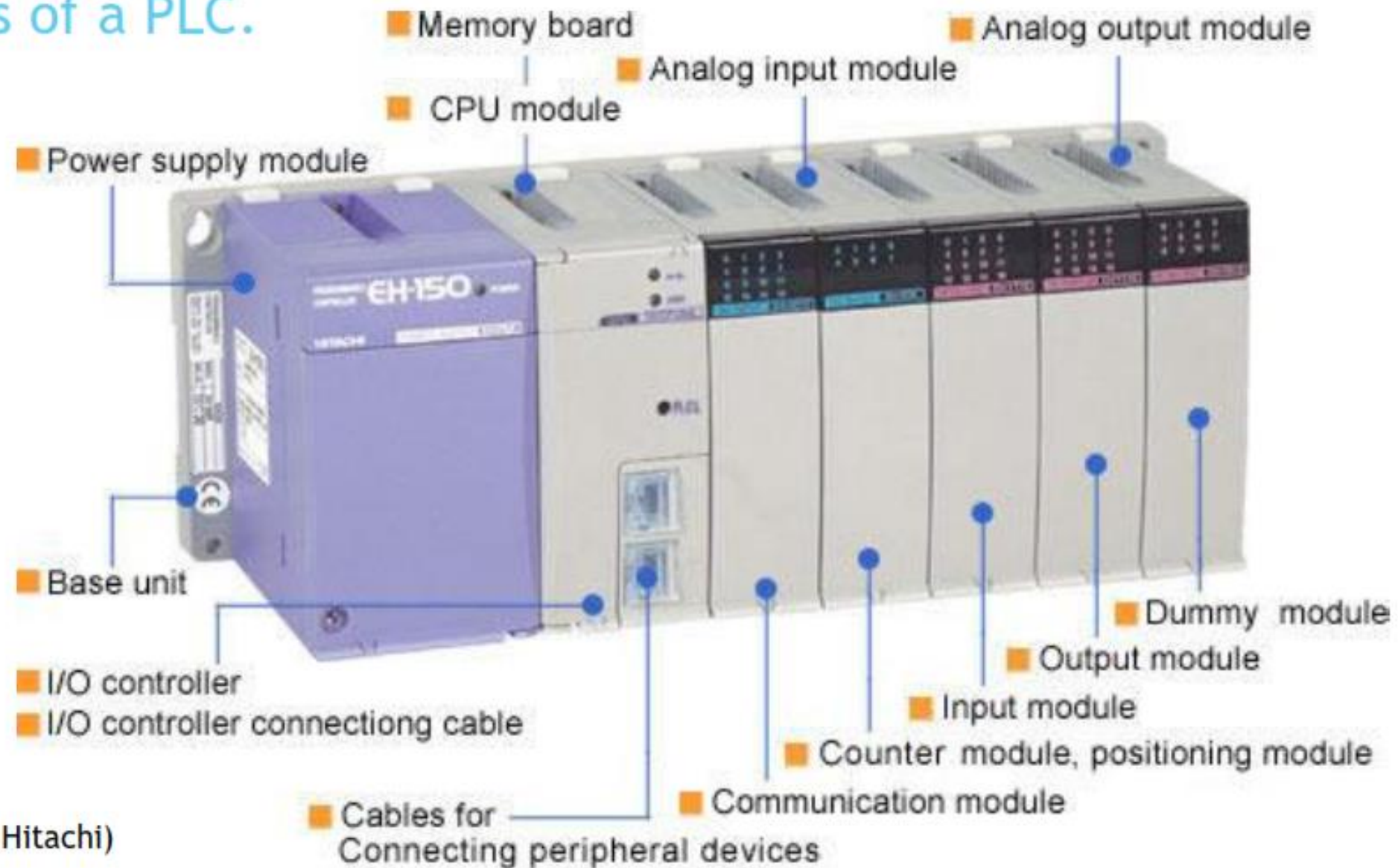
Basic parts of a PLC

- Power Supply
- Processor Module
 - CPU
 - Memory
- Communication Interface.
 - HMI - Status
 - HMI - Programming
- I/O Modules
 - Discrete/Digital Inputs
 - Analog Inputs
- Output Modules



Sections of a PLC module.
(Courtesy: Mitsubishi Automation)

7. Parts of a PLC.



(Courtesy: Hitachi)

7. Parts of a PLC.

- Power Supply

The system power supply plays a major role in the total system operation. Its responsibility is not only to provide internal DC voltages to the system components (i.e., processor, memory, and input/output interfaces), but also:

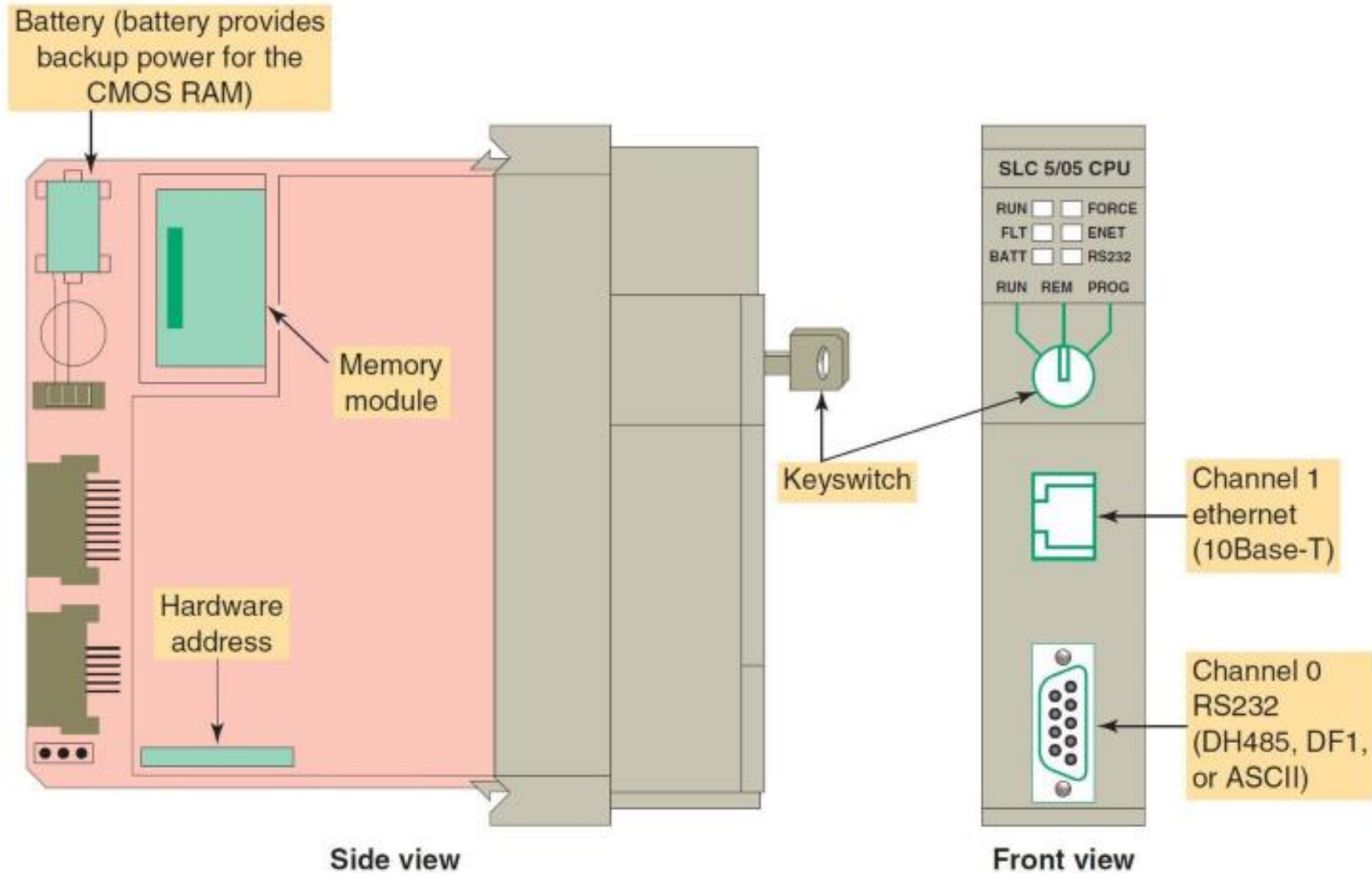
- a) to monitor and regulate the supplied voltages and warn the CPU if something is wrong.
- b) The power supply, then, has the function of supplying well-regulated power and protection for other system components.



PLC Power Supply (Courtesy: Allen Bradley)

7. Parts of a PLC.

- CPU (Controller/ Processor)
- Memory



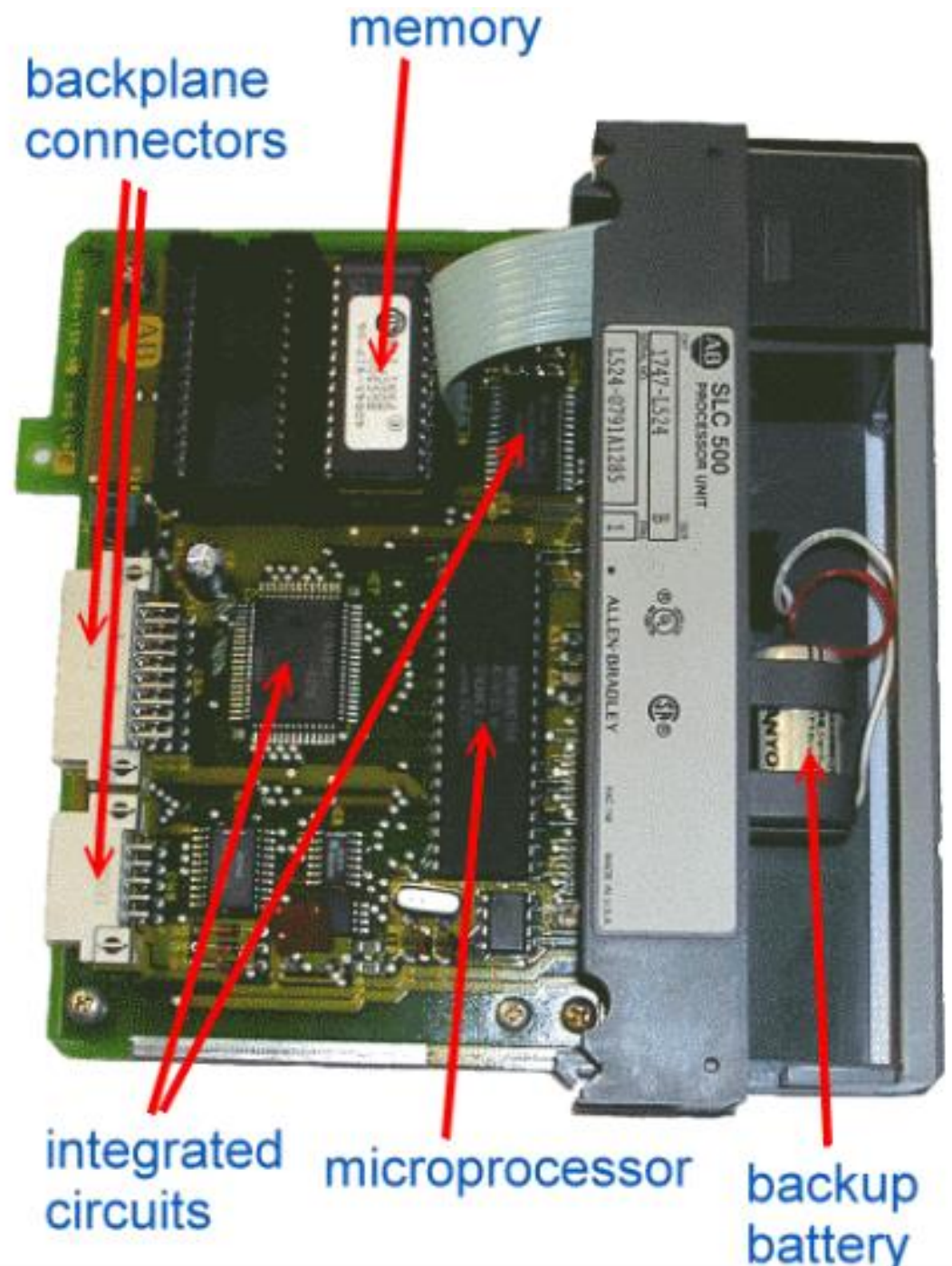
Typical Processor Module

7. Parts of a PLC.

- CPU (Controller/ Processor)
 - Memory
-
- Processors are either modular or built into the PLC
 - They vary in processing speed and memory options.
 - Processor is optimized for high speed control and not general purpose computing.

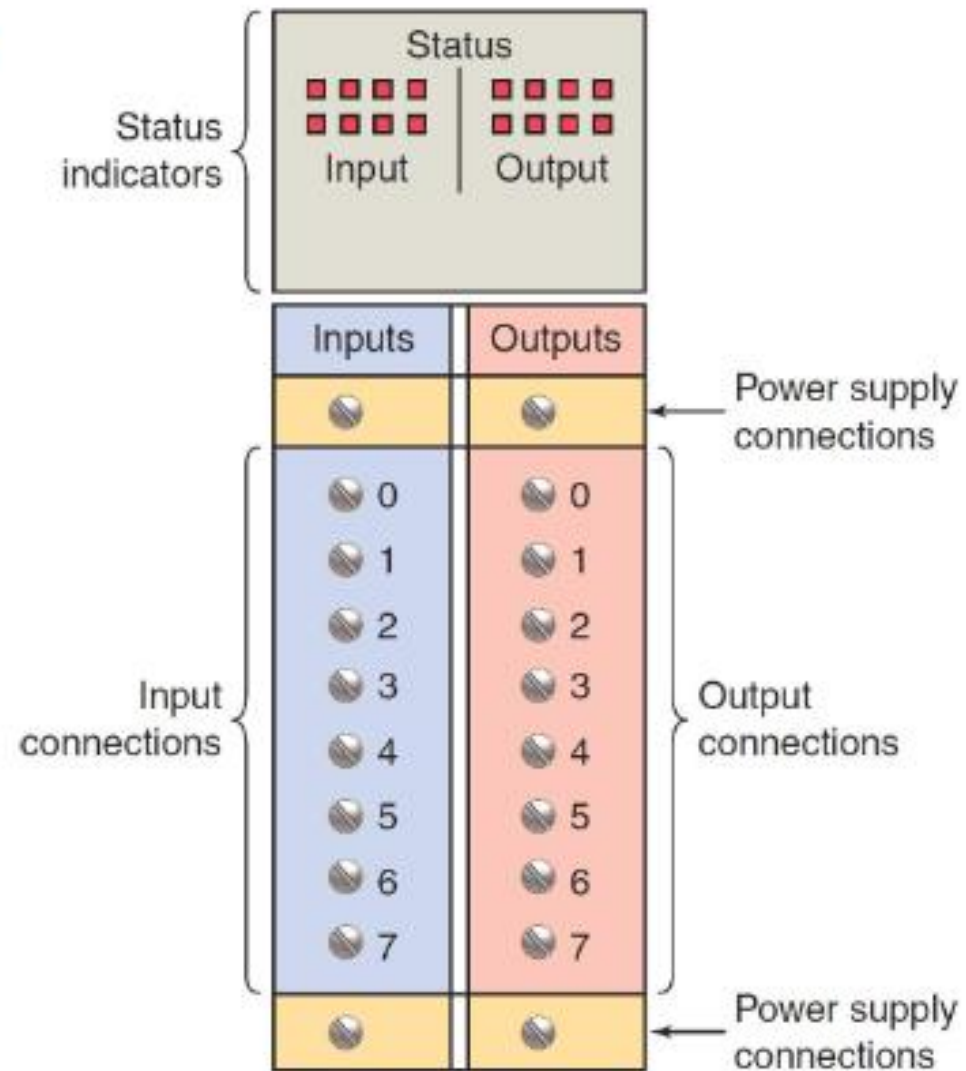
Allen Bradley SLC 500 CPU

(Courtesy: Allen Bradley)



7. Parts of a PLC.

- I/O Module



Typical I/O Module
(Courtesy: Rockwell Automation)

7. Parts of a PLC.

Discrete devices are inputs and outputs that have only two states: on and off.

Discrete I/O modules perform four tasks in the PLC:

- Sense when a signal is received from a field device.
- Convert the input signal to the correct voltage level for the particular PLC.
- Isolate the PLC from fluctuations in the input signal's voltage or current.
- Send a signal to the processor indicating which sensor originated the signal.

Examples of discrete input devices:

ON/SWITCHES

Limit switches.

Push buttons

Output can control ON OFF devices only

7. Parts of a PLC.

Analog I/O modules deals with signals that are continuously changing. They are needed for precise control of the process under the control of the PLC.

Examples,

- Temperature
- Pressure
- Humidity
- Density
- Fluid Level

Analog devices represent physical quantities that can have an infinite number of values. Typical analog inputs and outputs vary from 0 to 20 milliamps, 4 to 20 milliamps, or 0 to 10 volts.

7. Parts of a PLC.

Communication Modules

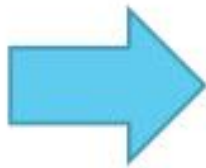
Used to establish point-to-point connections with other intelligent devices for the exchange of data.

Such connections are normally established with computers, operator stations, process control systems, and other PLCs.

Communication modules allow the user to connect the PLC to high-speed local networks that may be different from the network communication provided with the PLC.



Serial Communication Module
(Courtesy: www.automationdirec.com)

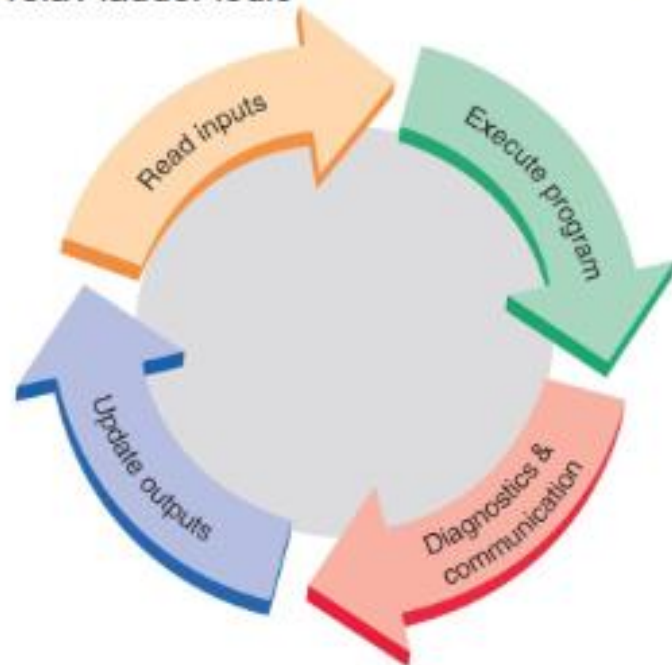


8. The PLC in Operation.

The *processor* (CPU) is the “brain” of the PLC.

What the CPU does:

- Implements the logic and controlling the communications among the modules.
- Stores program information and logical operations results in memory - EPROM or EEPROM plus RAM.
- Controls all PLC activity.
- Enables user to enter in the desired program in relay ladder logic



PLC - Program Execution Cycle



Typical PLC CPU (Courtesy: Rockwell Automation)