

Industrial Automation & PLC

Gazi Saiful Islam

Chief Instructor & Head of the
Department

Electronics Technology

Barishal Polytechnic Institute,

Barishal

Define Automation

- ▶ **Automation** is the technology by which a process or procedure is performed with minimal human assistance.



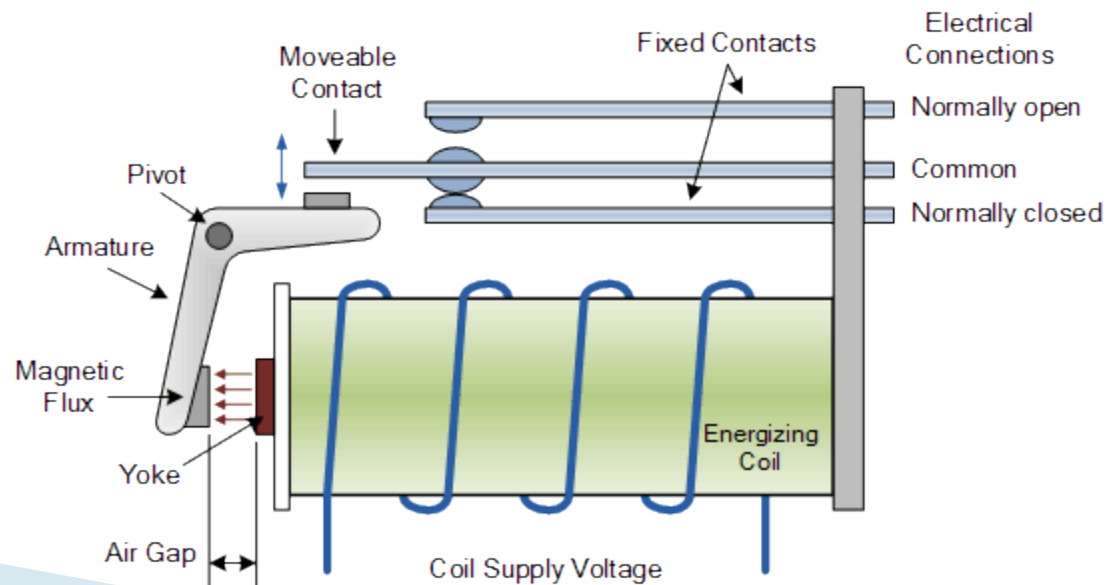
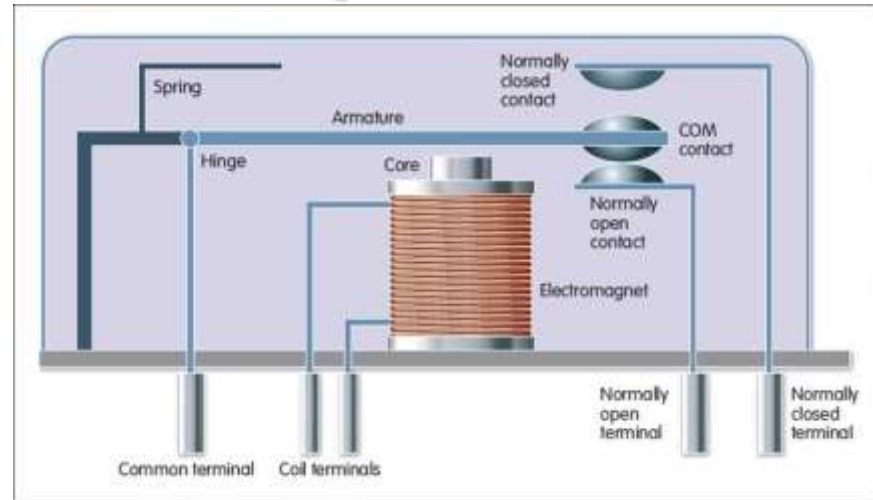
- ▶ The term *automation*, inspired by the earlier word *automatic* (coming from *automaton*), was not widely used before 1947, when Ford established an automation department.

Mention the application of automation in industry

- ▶ Automation covers applications ranging from a household thermostat controlling a boiler, to a large industrial control system with tens of thousands of input measurements and output control signals. In control complexity, it can range from simple on-off control to multi-variable high-level algorithms.
- ▶ One of the most important **application** areas for **automation** technology is **manufacturing**. To many people, **automation** means **manufacturing automation**.

Examples of fixed **automation** include machining transfer lines found in the automotive **industry**, automatic assembly machines, and certain chemical processes.

Working principle of Electromechanical relay



Concept of relay in control process

Relay logic controlled systems are hard wired. The fundamental component of these systems is a relay. A relay is used to switch electric circuits on and off. Therefore it can be used to energize equipment and form logic operations to give process control in a system.

When you think about it, relay logic is just a mechanical computer. It switches relays on and off instead of using a silicon chip (that does computation with 1's and 0's).

How a Relay Works

A relay is an electromechanical device that consists of two basic components....

Relay coil.

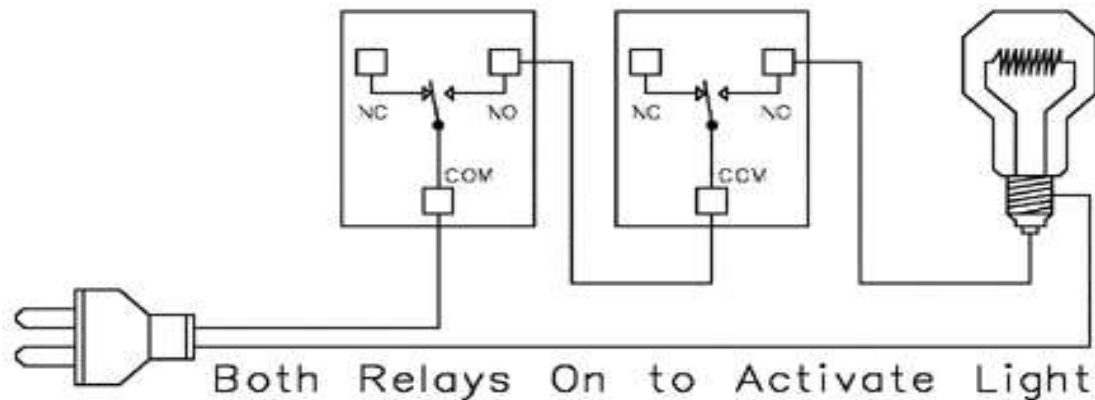
Relay Contact.

A relay coil is essentially copper wire wound around a chunk of iron that is used to produce an electromagnetic field that can attract metal. Think of a junk yard crane that is used to pick up scrap metal. It uses the same principle to generate a magnetic field that attracts metal.

A relay contact is basically a switch that is used to turn an electric circuit on or off.

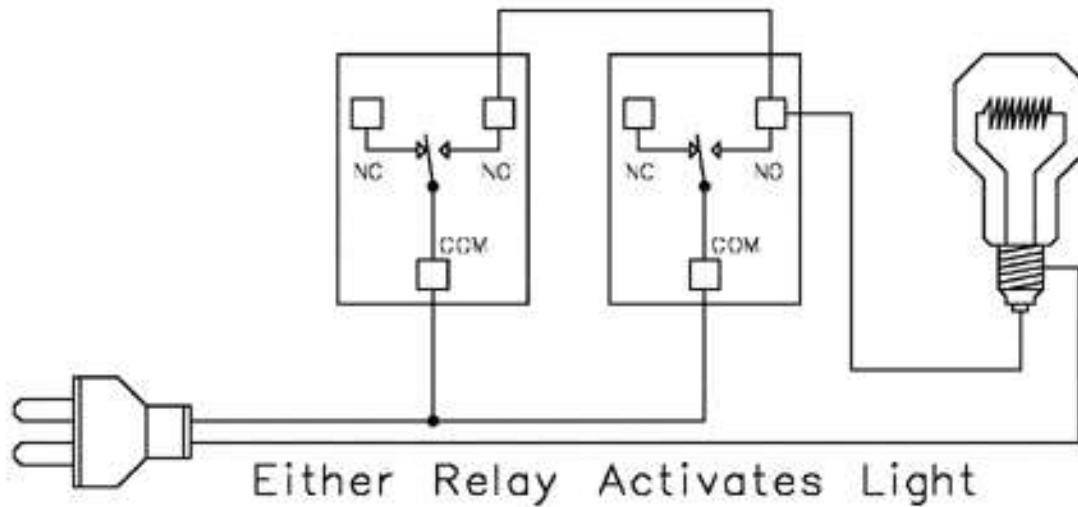
Use of relay to implement control logic AND, OR, NOT & FLIP-FLOP

AND GATE



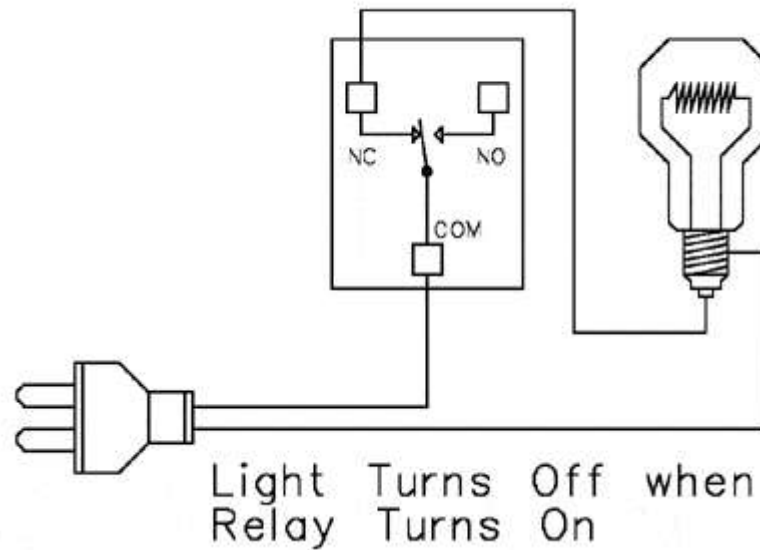
This sample demonstrates how two relays are wired in series to activate a light. Both relays must be activated for the light to turn on. Just like a **AND GATE**

OR GATE



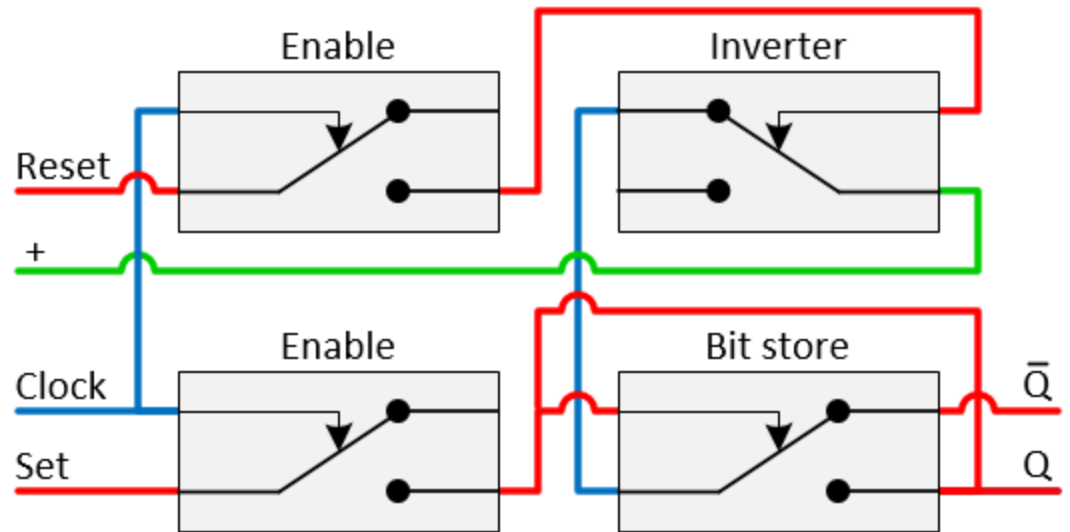
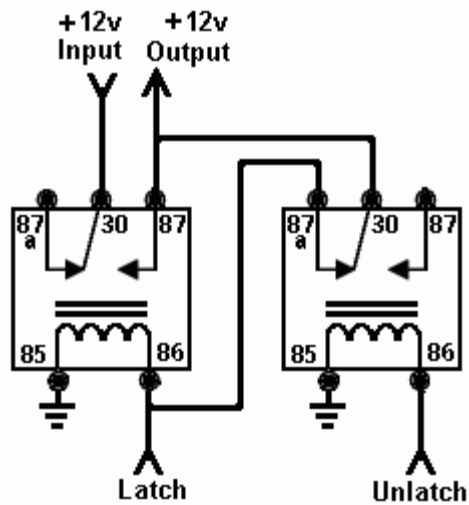
This sample demonstrates how any of two relays will activate a light. Turn on either relay and the light turns on. Both relays must be off for the light to turn off. Just like a **OR GATE**

NOT GATE



This sample demonstrates how a relay can be used to deactivate a light bulb. When the relay turns off, the light comes on. Only one power wire is switched with this sample using the COM (common) and NO (normally open) connections of a relay. Its just like a **Not Gate**

FLIP-FLOP



Explain relay logic ladder diagram.

Ladder diagrams, or Relay Ladder Logic (RLL), are the primary programming language for programmable logic controllers (PLCs). Ladder logic programming is a graphical representation of the program designed to look like relay logic. ... The relay diagram used electrical continuity to show a rung as electrically closed. The basic format for relay logic diagrams is as follows:

1. The two vertical lines that connect all devices on the relay logic diagram are labeled L1 and L2. The space between L1 and L2 represents the voltage of the control circuit.
2. Output devices are always connected to L2. Any electrical overloads that are to be included must be shown between the output device and L2; otherwise, the output device must be the last component before L2.
3. Control devices are always shown between L1 and the output device. Control devices may be connected either in series or in parallel with each other.
4. Devices which perform a STOP function are usually connected in series, while devices that perform a START function are connected in parallel.
5. Electrical devices are shown in their normal conditions. An NC contact would be shown as normally closed, and an NO contact would appear as a normally open device. All contacts associated with a device will change state when the device is energized.

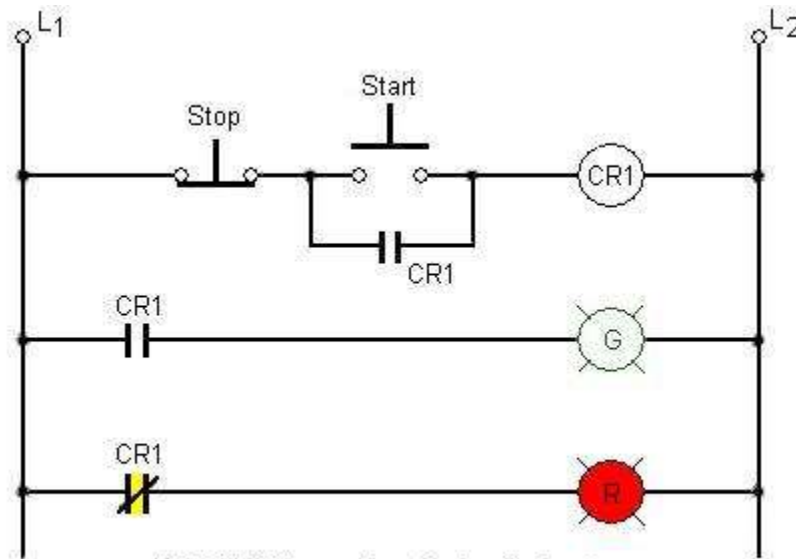
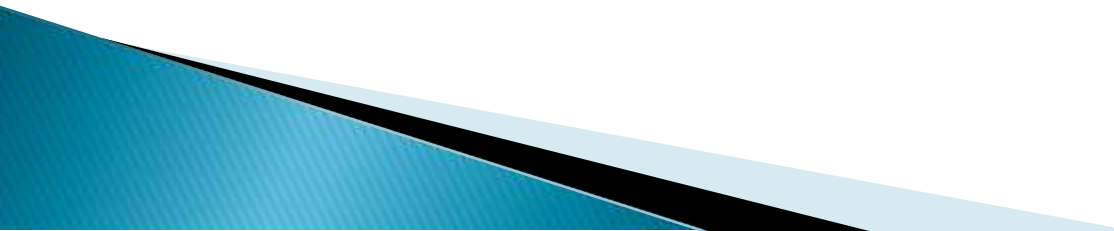


FIGURE 1 Example of relay logic diagram.

Figure 1 shows a typical relay logic diagram. In this circuit, a STOP/START station is used to control two pilot lights. When the START button is pressed, the control relay energizes and its associated contacts change state. The green pilot light is now ON and the red lamp is OFF. When the STOP button is pressed, the contacts return to their resting state, the red pilot light is ON, and the green switches OFF.

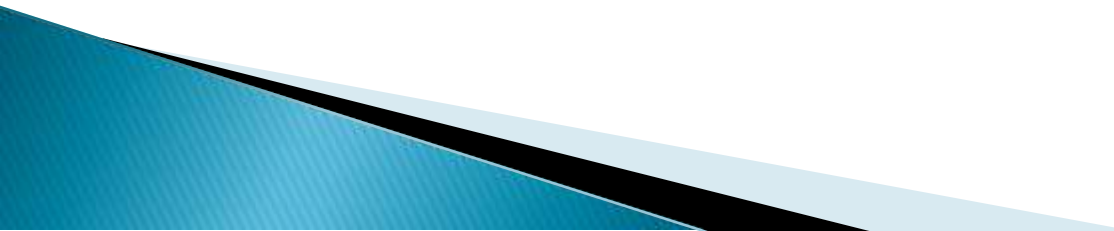
Limitations of Relay

The **relay** is easily affected by the high voltage surges. Thus, precaution should be taken for avoiding the damages through voltage spikes. The working of the **relay** depends on the electrical components. In Critical Circuit Relay Logic also more critical. More relay means more expensive and more space need in circuits.



Define PLC.

In old days, electrical control was mostly based on relays(Contactors) (i.e. Relay logic). Since from 1970 PLCs(Programmable Logic Controllers) have become most common choice for manufacturing / process control. A programmable logic controller (**PLC**) is a small, modular solid state computer with customized instructions for performing a particular task. **PLCs**, which are used in industrial control systems (ICS) for a wide variety of industries, have largely replaced mechanical relays, drum sequencers and cam timers.



Difference between Computer and PLC.

PLCs are designed to be operated in industrial environment with wide range of ambient temperature, vibration and humidity conditions. It is not effected by the electrical noise present in the industrial environment.

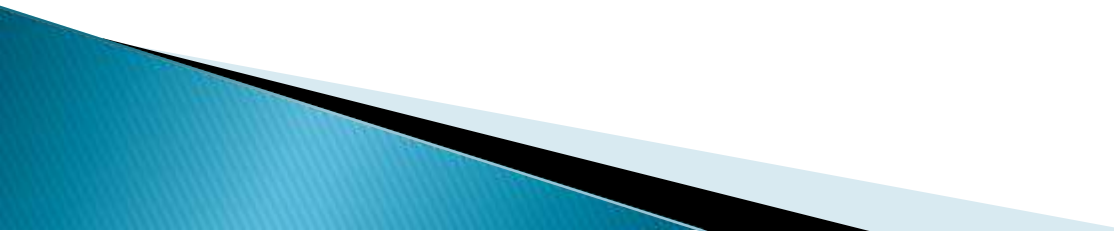
- In computer, the inputs are floppy drives and CD Roms and output is a printer, but in PLC the inputs are signals from control elements like push-buttons, limit switches, temperature switches, pressure switch and transducer etc., installed on the machines to be controlled. Also the output are final control elements like contactors, solenoids, positioning valves, indication lights, an so forth.
- The PLC is not a disc based system like PC. With a disc based system there is a continuous checking of what to do next. With a PLC the answer of what to do next is inherent, there is no consulting. The PLC program is stored in battery backed RAM or EPROM.

Another important difference between PLC and PC is That the PLC contains the operating systems and application programs in ROM memory. The operating system does not have to load an application program, as it is already in ROM. It is difficult to differentiate between PLCs, 'BIOS', operating system and application program. • Another major difference between PLC and computer is the programming language. PLC is not programmed in one of the high language used for programming a computer. As PLC is designed to be operated by plant engineers and maintenance personnel with limited knowledge of computers, it is designed to be programmed using RELAY LADDER LOGIC. However some PLCs are available which can be programmed using FORTRAN and BASIC, but relay ladder logic programming is the most popular. Some PLCs are also programmed using, Boolean Algebra, Statement lists and Control system flow chart languages.

Another major difference is that troubleshooting is simplified in most PLCs because they include fault indicators, blown-fuse indicators, input and output status indicator, and written fault information that can be displayed on the programmer.

Difference between Microcontroller and PLC.

A Programmable logic controller (PLC) is simply a special purpose computing device designed for use in industrial control systems and other systems where the reliability of the system is high. They were initially developed to replace hardwired relays, sequences and timers used in the manufacturing process by the automation industry, but today they have scaled and are being used by all kind of manufacturing processes including robot based lines. These days, there is probably no single factory in the world that does not have a machine or equipment running on PLCs. The main reason for their wide adoption and use can be found deeply rooted in their ruggedness and ability to withstand the rough handling/environment associated with manufacturing floors. They are also a good example of real time operating systems as they have high ability to produce outputs to specific inputs within a very short timeframe which is a key requirement for industrial settings as a second delay could disrupt the entire operation.

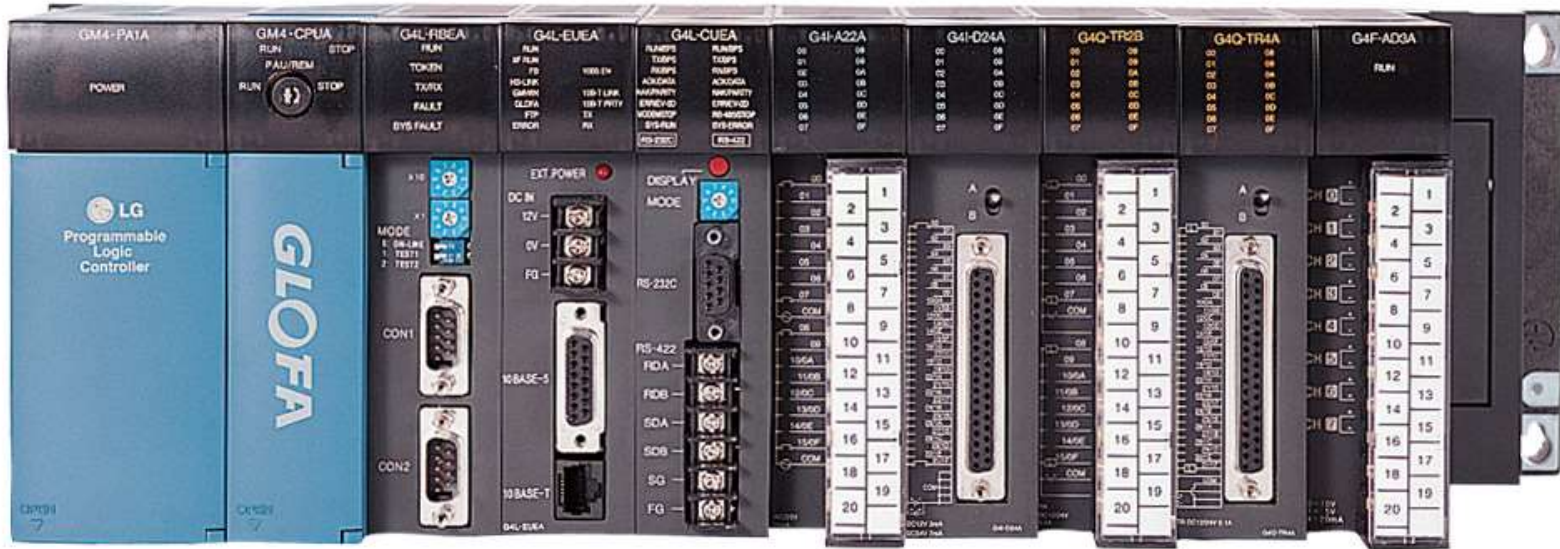


Microcontrollers on the other hand are small computing devices on a single chip that contain one or more processing cores, with memory devices embedded alongside programmable special and general purpose input and output (I/O) ports. They are used in all sort of day to day devices especially in applications where only specific repetitive tasks need to be performed. They are usually bare and cannot be used as standalone devices without the necessary connections. Unlike PLCs, **they do not have interfaces like display, and switches built in** as they usually just have GPIOs to which these components can be connected.



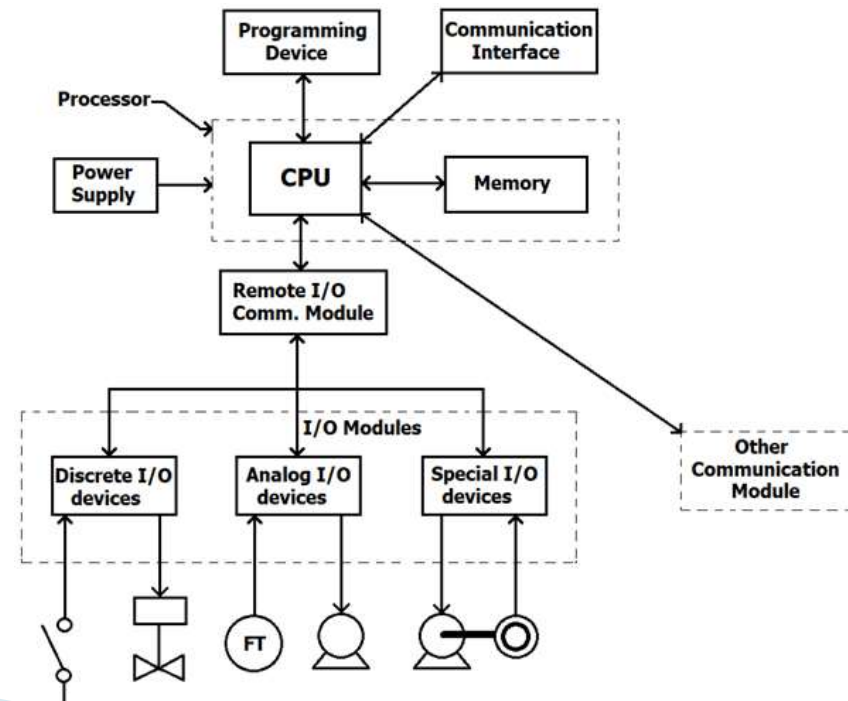
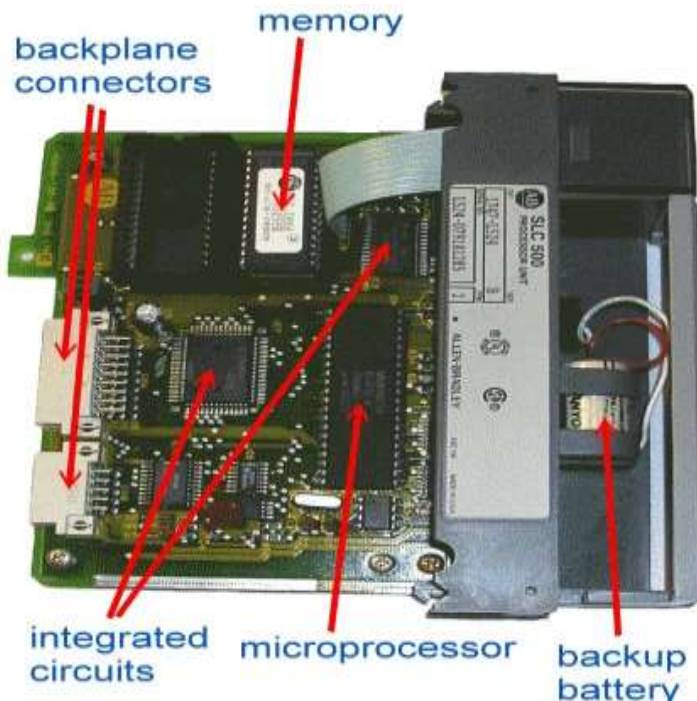
List the component that makes up a typical PLC.

The basic components include a power supply, central processing unit (CPU or processor), co-processor modules, input and output modules (I/O), and a peripheral device.



PLCs Architecture:

PLCs generally can be referred to as a high level microcontroller. They are essentially made up of a processor module, the power supply, and the I/O modules. The processor module consists of the central processing unit (CPU) and memory. In addition to a microprocessor, the CPU also contains at least an interface through which it can be programmed (USB, Ethernet or RS232) along with communication networks. The power supply is usually a separate module, and the I/O modules are separate from the processor. The types of I/O modules include discrete (on/off), Analog (continuous variable), and special modules like motion control or high-speed counters. The field devices are connected to the I/O modules.



Configuration of typical PLC

The **configuration** is the entire body of software (program and data) that corresponds to a **PLC** system. Generally, a **configuration** equates with the program and data for one **PLC**. In large complex systems that require multiple cooperating **PLCs**, each **PLC** has a separate **configuration**.

Number of Inputs: Input signals the PLC can accept

Number of Outputs: Output signals the PLC can provide

DC Input : Discrete DC voltage or current level

AC Input: Discrete AC voltage or current level.

Transistor Input: Input from a solid-state device such as a sensor; typically includes choice of sinking or sourcing

Other Input: Other unlisted or specialized input.

DC Output Discrete DC voltage or current level

AC Output Discrete AC voltage or current level.

Relay Output Switch type output; contacts are open or closed.

Analog Output Variable voltage or current level, e.g., 0–10V, 4–20 mA current loop, etc.

Transistor Output Solid–state switch output;

Other Output Other unlisted or specialized output.

Scan Time:Time required by the PLC to check the states of its inputs and outputs.

Data Memory: Capacity for data storage.

Program Memory:Capacity of memory for control software.

PLC Programming Language: LD,ST,IL,SFC,FBD,RLL etc.