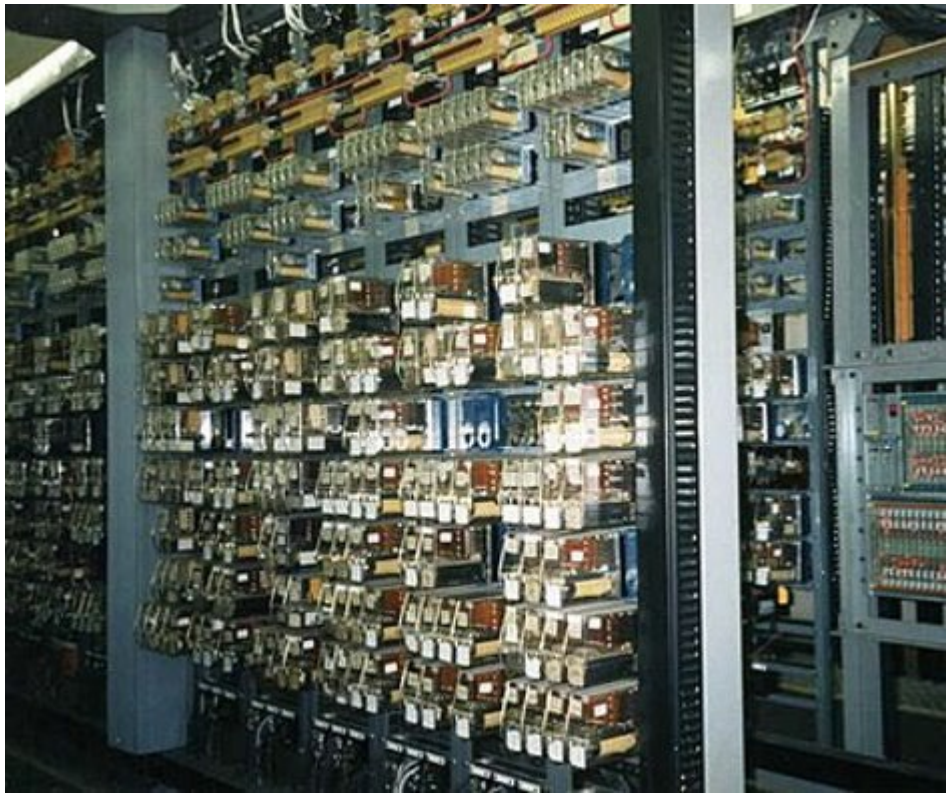
PLC Theory – Types of PLCs

What is a PLC?

- A Programmable Logic Controller, or PLC, is a ruggedized computer used for industrial automation.
- These controllers can automate a specific process, machine function, or even an entire production line.
- It is less powerful than traditional computers

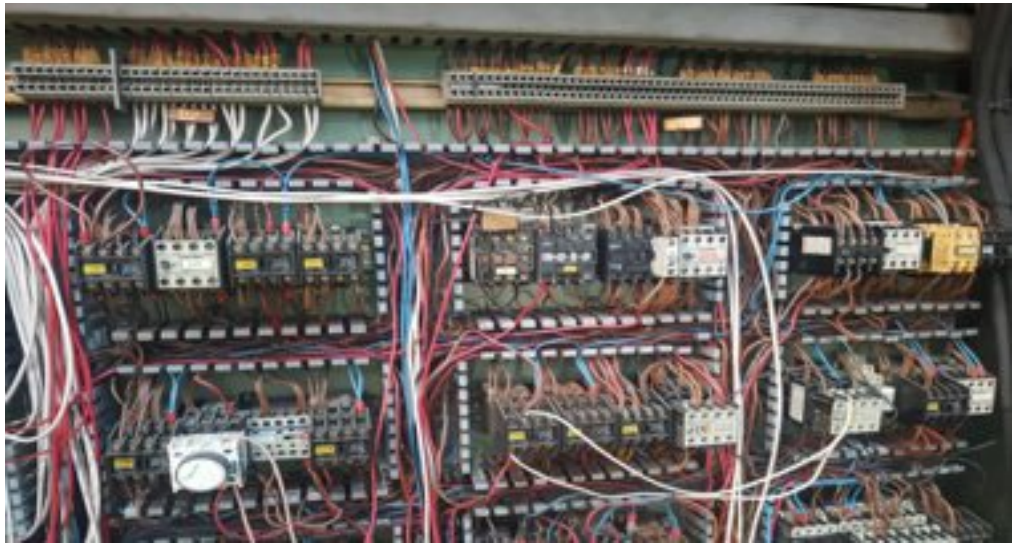
History of PLCs

- Before PLCs were commonplace industrial systems would be controlled by relay control panels
- These controllers used many relays, mechanical switches, times and counters



History of PLCs

- The relay control panels took up a lot of space
- They were subject to wear and tear
- There was often wiring issues, and they would take a long time to solve as you had to trace wires
- They were also very time consuming to upgrade
- And upgrading or fixing would mean the shutting down of operation for a period for debugging



History of PLCs

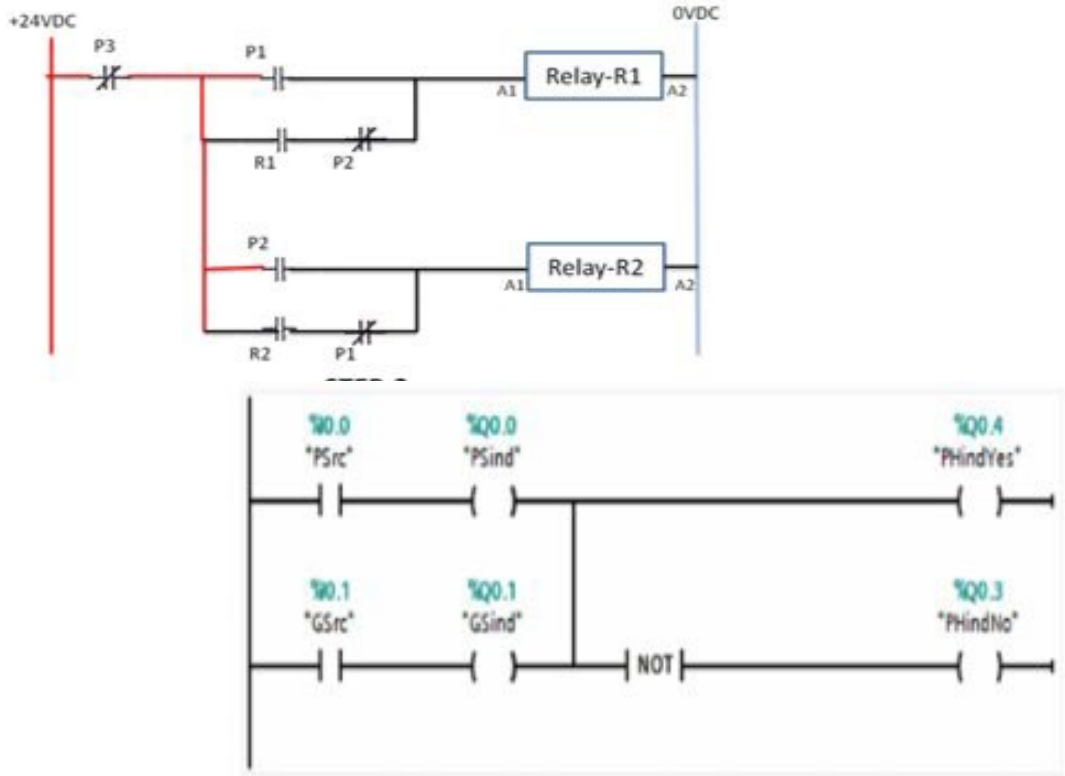
- In the 1960s General motors identified the requirement of a computer-controlled system

- They highlighted these requirements:

  - Solid state not mechanical
  - Easily modifiable inputs/outputs
  - Ease of programming
  - Be able to function in an industrial environment

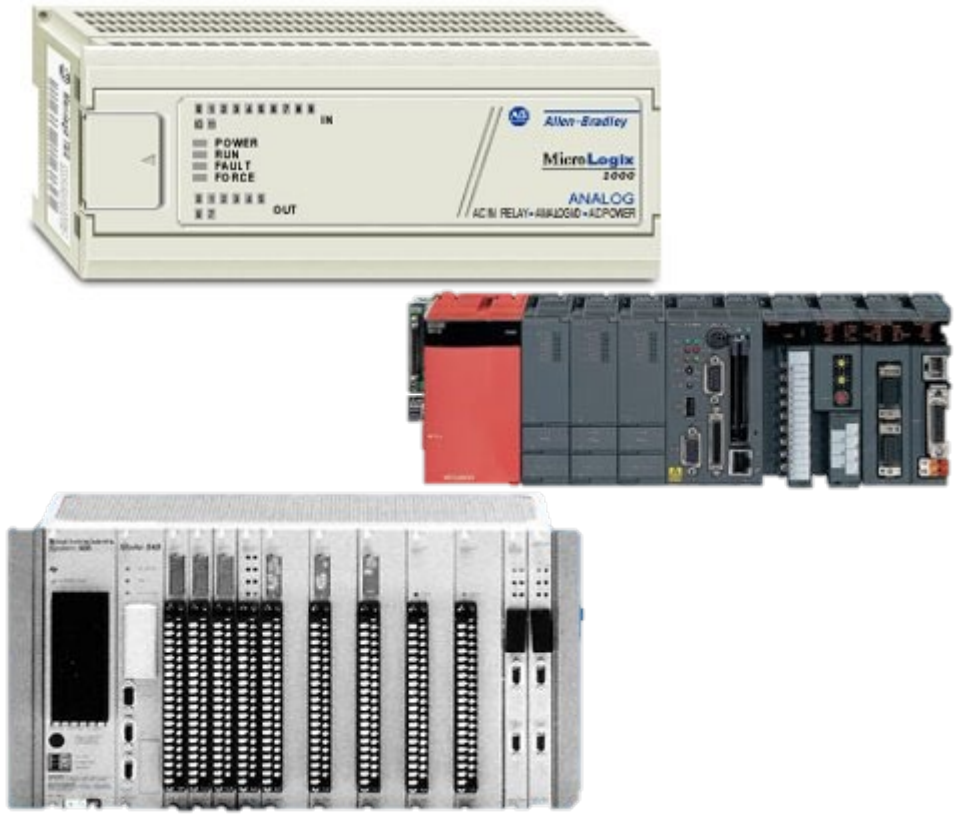
History of PLCs

- They developed a graphical programming language based on Relay Logic Diagrams
- This made the adaptation much easier and meant not a lot of retraining had to be done
- This programming language became known as “Ladder Logic”



Types of PLCs

- There are several different types if PLCs:
  - Unitary
  - Modular
  - Rack Mounted



Unitary PLCs

- A compact Programmable Logic Controller (PLC) with all components in a single housing.

- Features
  - Built-in processor, power supply, and input/output (I/O) interfaces.
  - Typically limited I/O capacity
  - Non-expandable – I/O count is fixed.

Unitary PLCs

- Advantages:
  - Simple to install and configure.
  - Cost-effective for small automation tasks.
  - Ideal for space-constrained applications.
- Limitations:
  - Not suitable for complex or large-scale systems.
  - Limited programming and communication options.

Modular PLCs

- A type of PLC system made up of separate, interchangeable modules (CPU, power supply, I/O, communication, etc.).

- Features
  - Expandable I/O – modules can be added as needed.
  - Customizable to suit specific applications.
  - Typically mounted on a rack or chassis.

Modular PLCs

- Advantages:
  - Scalable – suitable for medium to large automation systems.
  - Easier maintenance and upgrades (modules can be swapped).
  - Supports advanced communication and networking..
- Limitations:
  - Higher cost compared to unitary PLCs.
  - Requires more installation space and setup time.

Rack Mounted PLCs

- A type of modular PLC where all modules are mounted into a standardized rack or chassis.

- Features
  - Centralized backplane allows modules to communicate and share power/data.
  - Supports a wide range of module types (CPU, analog/digital I/O, comms, etc.).
  - High-performance and highly customizable.

Rack Mounted PLCs

- Advantages:
  - Ideal for large, complex, or mission-critical systems.
  - Simplified wiring and module replacement.
  - High reliability and robust design.
- Limitations:
  - Expensive initial investment.
  - Requires significant panel space and skilled installation.

Comparison

Feature	Unitary PLC	Modular PLC	Rack-Mounted PLC
Structure	All-in-one, compact housing	Separate, interchangeable modules	Centralized rack for modules
Expandability	Fixed I/O, no expansion	Expandable by adding modules	Highly expandable with many module options
Installation Space	Small, compact	Moderate space required	Requires significant space for rack and modules
Applications	Small to medium systems	Medium to large systems	Large, complex, and critical systems
Cost	Lower cost, cost-effective for small tasks	Moderate to high cost	High cost, typically used in large installations
Maintenance	Basic maintenance, limited modularity	Easy module replacement and upgrades	Centralized maintenance and module swapping
Typical Use Cases	Simple tasks like lighting control or HVAC	Manufacturing lines, conveyor systems	Power plants, large factory-wide systems

Unitary with Modular Capabilities

- A compact PLC with built-in components that also supports limited expansion through add-on modules.

- Features
  - All-in-one base unit (CPU, I/O, power supply).
  - Expansion ports or slots for limited I/O or communication modules.
  - Often DIN-rail mountable like standard unitary PLCs.

Unitary with Modular Capabilities

- Advantages:
  - Maintains compactness while offering some flexibility.
  - Cost-effective upgrade path from basic to more advanced control.
  - Easier to scale than pure unitary PLCs.
- Limitations:
  - Expansion capacity is limited compared to full modular or rack-mounted systems.
  - Add-on modules are often proprietary.

Which PLC to use?

- When deciding which PLC to use for a project we have several considerations:
  - PLC speed of operation
  - I/O count
  - Power requirements
  - Communications
  - Company standards
  - PLC cost
  - Versatility