Chapter 1



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Chapter 1 Introduction to Programmable Controllers 1-1 Definition

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PRINCIPLES OF OPERATION

A programmable controller, as illustrated in Figure 1-5, consists of two basic sections:

- 1. The central processing unit
- 2. The input/output interface system



Figure Programmable controller block diagram

The central processing unit (CPU) governs all PLC activities.

The **Components** of CPU as shown in Figure:

- 1. The processor
- 2. The memory system
- 3. The system power supply

The **operation** of a programmable controller is relatively simple.

The input/output (I/O) system is physically connected to the field devices that are encountered in the machine or that are used in the control of a process.

These field devices may be discrete or analog input/output devices, such as *limit switches*, *pressure transducers*, *push buttons*, *motor starters*, *solenoids*, Etcetera (etc).

The I/O interfaces provide the connection between the CPU and the information providers (inputs) and controllable devices (outputs).

Scanning Operation or CPU operating cycle

During its operation, the CPU completes three processes:

- 1. Reading or accepts, the input data from the field devices via the input interfaces
- 2. writes, or updates, the output devices via the output interfaces.

The process of sequentially reading the inputs, executing the program in memory and updating the outputs.



Input/output interface

The input/output system forms the interface by which field devices are connected to the controller (see Figure)





Benefits of Input/output interface

- 1. The interface is make sure the various signals received from or sent to external field devices.
- Incoming signals from sensors (e.g., push buttons, limit switches, analog sensors, selector switches, and thumbwheel switches)

are wired to terminals on the input interfaces. Devices that will be controlled, like motor starters, solenoid valves, pilot lights, and position valves, are connected to the terminals of the output interfaces.

The system power supply provides all the voltages required for the proper operation of the various central processing unit sections

The process of CPU for PLC

There are three process as list :

- (1) It reads, or accepts, the input data from the field devices via the input interfaces.
- (2) It executes, or performs, the control program stored in the memory system.
- (3) It writes, or updates, the output devices via the output interfaces. SCAN



*How do I choose the right PLC?

In selecting a PLC, we need to consider the required input, output, and function of controller.

Types of controller : Rack , Mini, Micro, or software. Need to consider the followings when choosing a controller; -Num of logic input/output. -Memory required, 1K or few bytes. -Scan time, (price) - software, Availabilityof programming. -Comunications, serial or network.

PROCESS OF SELECTING A PLC

- Understand the process to be controlled -num. of input/output
 - -how the process is to be controlled?
 - -special needs, such as distance between parts of the process.
- 2. If not already specified, a single vendor should be selected. Factors considered:-
 - -manuals & documentation
 - -training

3.

- -the range of product available
- -shaping time for emergency replacement
- Plan the ladder logic for the controls

4. Count the program instruction

- Look for special program needs and check the PLC model
- Estimate the cost for suitable hardware, programming software, cables, manuals, training, or ask a quote from vendor or etc.

*The two major types of PLC

- 1- Fixed (Integrated or Compact) PLC2- Modular PLC2
- 1- Fixed (Integrated or Compact) PLC

This type of PLC is most commonly called the Fixed I/O PLC. "Fixed I/O" actually stands for Fixed "Input/Output". When you buy Compact PLCs, you will notice that the input section and the output sections of the PLC are integrated into the microcontroller itself.

This means that every type of output or input is fixed and is determined by the manufacturer.

Furthermore, the number of inputs and outputs may not be expanded in this type of PLC.



2. Modular PLC

The modular PLC is a type that allows multiple expansions of the PLC system through the use of modules, hence the term "modular".

Modules give the programmable logic controller additional features like increased number of I/O units, and they are usually easier to use because each component is independent of each other.

The power supply, communications module, Input/Output module are all separate to the actual microcontroller so you have to manually connect them to each other to create your PLC control system.



What are the advantages of using Modular PLC?

- 1- Scalability
- 2- Number of I/O
- **3- Easier Fault Detection**
- 4- Less Downtime

Output type of PLC

1- Relay Output.

Types of PLC: Relay output(Photo from plcs.net)

Relay outputs are suitable for both alternating current, and direct current <u>output devices</u>.

It's basically a Relay as an output, and the PLC controls the switching of the relay by running current through its coils. If you did not know yet, having current through a coil creates a magnetic field in the middle of the coil which attracts the metallic contacts of the relay.



problems with relays

However, one of the problems with relays rel is the mechanical wear and tear that it experiences during repetitive switching operations.

Hence, you should realize by now that the Relay type output is more suitable in infrequent switching operations e.g. activating a continuous-running device such as a motor.

2- Transistor Output

Transistors are semiconductor devices that are used for switching operations and are used inside microprocessors in a micro- or nano- scale.

In transistors, no mechanical or moving component is involved, so faster switching is achieved using this type of output.

A switching device that does not have moving components is called a solid-state device. You may have already heard this in storage devices: Solid-state drives.

Of course, you should already expect higher speeds from solid state drives as you would expect in solid state outputs of the PLC.



Anyway, only DC outputs may be handled by transistors because of their construction: they only allow one direction of current to flow after they

- have been switched.
- One advantage of this output type is that the PLC uses optoisolation to switch the transistor: hence isolating the PLC from the output's electrical source.

3- Triac Output

The triac is also a solid-state device that is an equivalent of two "mirrored" transistors (specifically, the bipolar junction transistor). Because the current can now flow in two directions, this type of PLC output may be used in controlling outputs that use Alternating Current.

3- Analog Output

The previously mentioned types of PLC outputs are designed for switching operations. This means that they are digital in nature because they only operate in the ON or OFF condition. Analog outputs are in a different realm. Usually, the Analog Output PLCs control speed of continuously running devices such as motors or turbines. Of course, the voltage/current ranges vary depending on the manufacturer and/or modules.



* Types of PLC according to Size

- *Figure 1-13 graphically illustrates programmable controller product ranges.
- Market can be segmented into five groups:
- 1. micro PLCs
- 2. small PLCs
- 3. medium PLCs
- 4. large PLCs
- 5. very large PLCs



Figure. PLC product ranges

In this course will considering LOGO's families

Siemens LOGO : Is the name of the family home to programmable controllers There are many types of LOGO ! As shown list:

1. LOGO! 12/24 RC 0BA5 2. LOGO! 230 RC **0BA6** 000000 3. LOGO! 230 RCE 0BA7 AC/DC 115..240V INPUT 8xAC/DC 4. LOGO! 12/24 RCE 0BA8 WARNING: DO NOT DISCONNECT WHILE CIRCUIT IS LIVE SIEMENS UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS SD ESC OK LOGO! 230RCE 6ED1 052-1FB00-0BA7 **OUTPUT 4xRELAY/10A** 1112 1112 1 1/1 2 LINK 00-10-06-04-91-07