ثانويــة التكنولوجيــا التطبيقيــة
Applied Technology High School

PLC Fundamentals

Module 1: Introduction to PLC

PREPARED BY

Academic Services Unit

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Module 1: Introduction to PLC

Module Objectives

Upon successful completion of this module, students will be able to:

1. Differentiate between manual and automatic control.
2. Define a 'control system' and draw its block diagram.
3. Differentiate between digital and analog control.
4. Mention the main parts of a PLC.
5. Give examples of PLC applications and list the PLC manufacturers.
6. Identify the main parts of the Siemens LOGO! PLC Module.
7. Connect input and output devices to the LOGO! module, and program it through its Basic Control Unit using simple commands.

Module Contents:

1.1 Introduction

In everyday operations or industrial processes, we come across situations where there is a need to control some device or a physical quantity such as time, temperature, sound, light and so on, to get the required result or output. For example, do you think an airplane would be useful to a pilot, if he cannot make it go where he wants it to go? Or would an air-conditioner be useful, if the temperature in a room cannot be controlled? In both the examples, there is a need to **control** a process.

1.1.1 Manual & Automatic Control

Electrical control can be defined as using electrical signals such as current or voltage to enable or disable or direct a certain process. Electrical control can be achieved in different ways, for instance; based on human interaction we can say that the control is either manual or automatic.

Manual Control

Control is said to be done manually when a user performs an action for the system to function. For example, the user might flip the switch of a manual starter to start and stop a motor (fig 1.1)
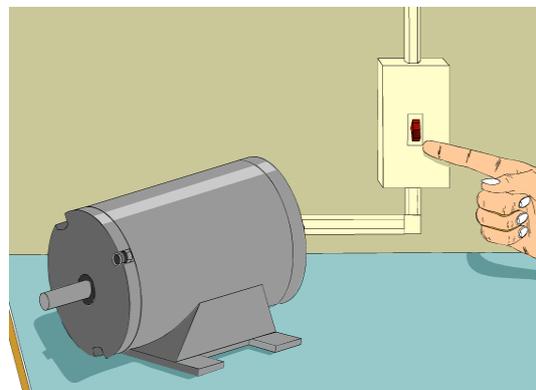

Fig 1.1: Example of Manual Control

Automatic Contol

Control is said to be automatic when the action is performed automatically in response to a set of conditions.

Fig 1.2: Example of Automatic Control

Machines can be controlled manually or automatically. Usually, there is a combination of manual and automatic control. For example, a process that is started manually may stop automatically when certain conditions are met.
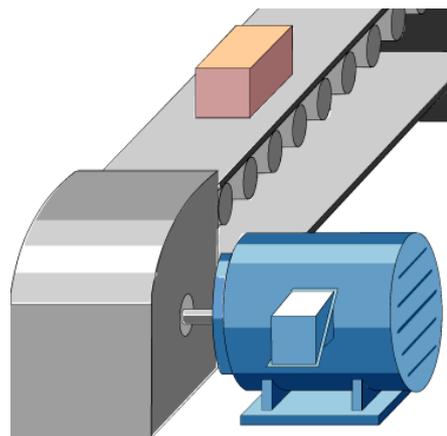

Fig 1.3: Manual & Automatic Control Example

A **Control System** is a system that can direct, command and regulate itself or another system. The control system starts with input signals that activate the process to control output devices. The block diagram of a control system is shown in fig 1.4:

Fig 1.4: Elements of a Control System

In terms of **output value,** a control system can be classified as either Discrete control (Digital control) or Continuous control (Analog control).

```
                    ┌─────────────┐
                    │   Control   │
                    └─────────────┘
                     ╱           ╲
                    ╱             ╲
        ┌───────────────────┐  ┌───────────────────┐
        │  Discrete control │  │ Continuous control│
        │     *Digital*     │  │     *Analog*      │
        └───────────────────┘  └───────────────────┘
```
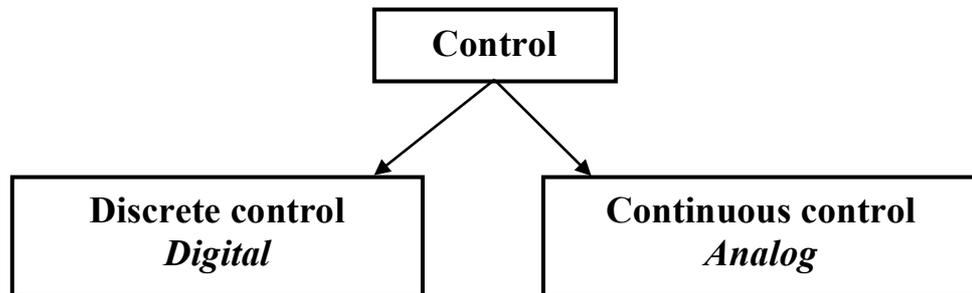
Fig 1.5: Types of control based on the output value

Discrete (digital) control: The value to be controlled can be either ON or OFF. Example: Turning a light ON and OFF.

Continuous (analog) Control: The value to be controlled varies smoothly. Example: Motor speed, light intensity, etc.

In this course we will study discrete control only.

Programmable Logic Controllers (PLCs)

A Programmable Logic Controller (or PLC) is a specialised digital controller that can control machines and processes. it monitors inputs, makes decisions, and controls outputs in order to automate machines and processes. Fig 1.7 shows a Simens LOGO! PLC, and Fig 1.8 demonstrates its function.
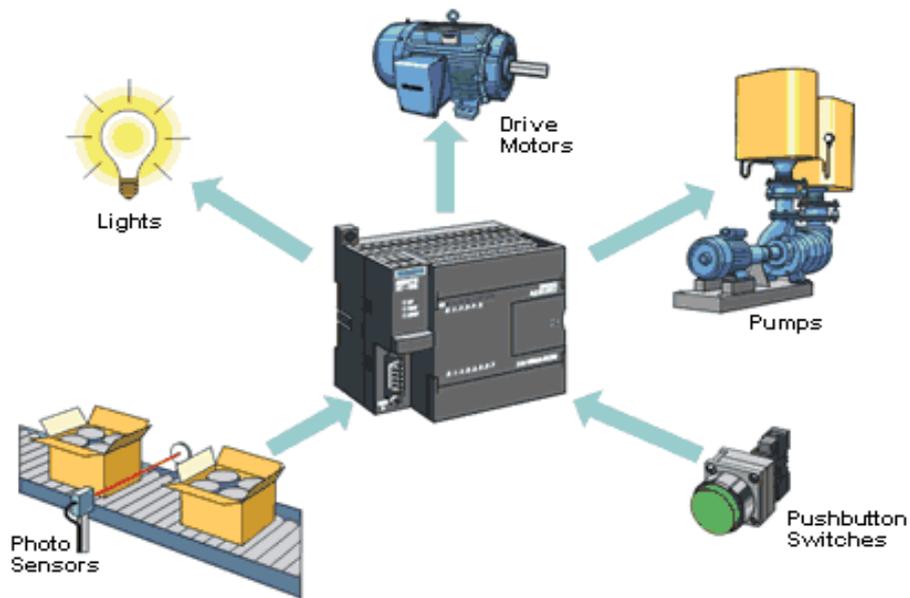

Fig 1.7: PLC

Fig 1.8: PLC function

PLC Advantages

- They are highly reliable, fast and flexible.
- They can handle severe conditions such as dust, humidity etc.
- They can communicate with other controllers.
- They are easy to program and troubleshoot.
- They include display units.

1.2 Basic PLC Operation

In the example shown in fig 1.12, pushbuttons are connected to the PLC's inputs and a motor is connected to the PLC's output. Here the pushbuttons are used to start and stop the motor.
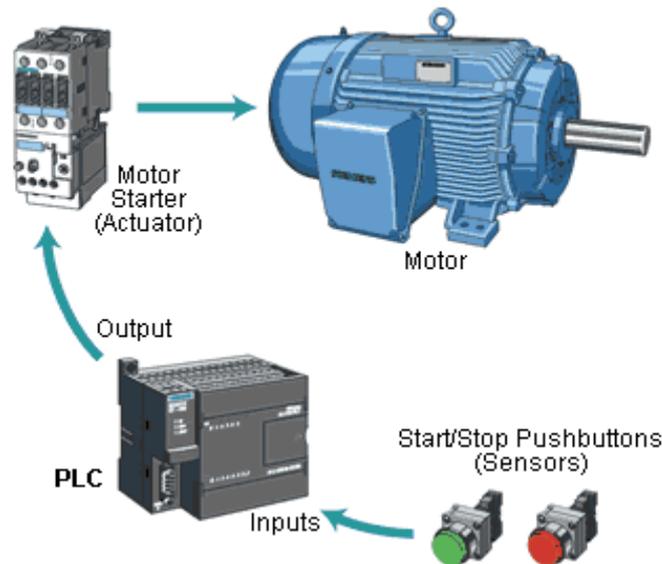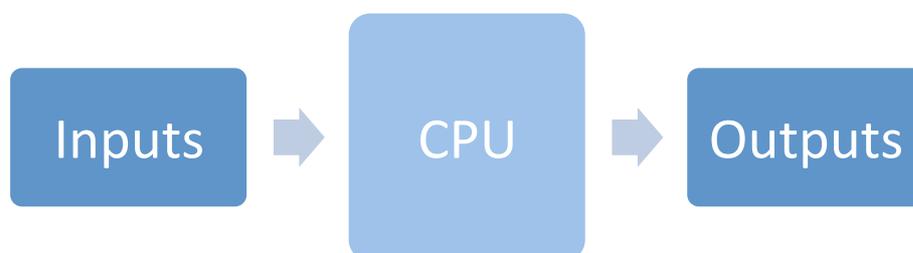
Fig 1.12: Motor control using a PLC

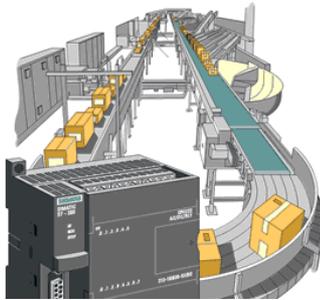**PLC Basic Parts**

A PLC consists of the following basic parts:

- Inputs
- Central Processing Unit (CPU)
- Outputs

➢ Examples of PLC input devices are sensors,switches,pushbuttons etc
➢ Examples of PLC output devices are valves, motors, solenoids etc

1.3 PLC Applications & Manufacturers

A PLC can be used in a wide range of applications, some of which are shown below:

Production and assembly lines

Automatic Doors

Traffic Lights

PLC Manufacturers

The PLC that will be introduced in this course is the **LOGO! PLC** from **Siemens**.The table below shows a list of other PLC Manufacturers.

| ABB	Mitsubishi	Siemens	
![ABB]	![MITSUBISHI]	![SIEMENS]	Toshiba
Bosch	Omron	Telemecanique	
![BOSCH]	![OMRON]	![Telemecanique]	![TOSHIBA]

1.4 Lab Activity

Objective: To familiarise with the Siemens LOGO! PLC Module, and program it through its LOGO! Basic Control Unit using simple commands.

Procedure: This lab activity will help you familiarize with the Siemens LOGO! Basic module. Initially, you will physically identify the main parts of the LOGO! Basic module, and later you will connect various input and output devices, and control them using simple commands.

1. The following are the main components of the LOGO! Basic PLC module:

   ▪ Power Supply connection

   ▪ Input connection

   ▪ Output connection

   ▪ Diplay unit (LCD)

   ▪ Control Panel

   ▪ Module Slot with caps

   Identify the LOGO! Basic PLC module components that are marked in the figure, and write them in the table provided:
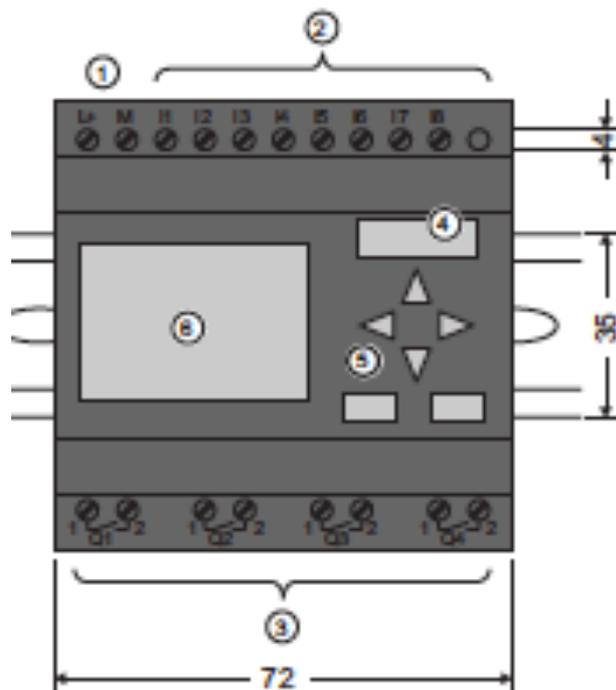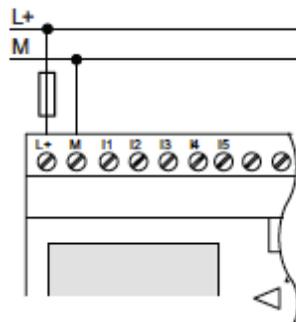
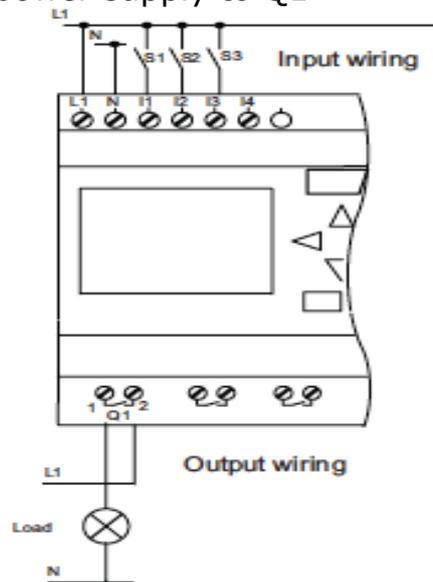| Number	Part Name	Function
1		
2		
3		
4		
5		
6		

2. Connect input and output devices, and program the LOGO!

a) Connect the power supply to the LOGO unit as shown below:

L^+ = 24 V, M = 0V

b) Connect the following circuit:

- Switch 1 (S1) to I1
- Switch 2 (S2) to I2
- Switch 3 (S3) to I3
- Lamp and power supply to Q1

c) Set the day, time and date

Follow the steps below to set the day, time and date.
- ➢ Switch on the power supply.
- ➢ Press the *ESC* key on the LOGO! Basic module
- ➢ Select *Set*
- ➢ Select Clock
- ➢ Press the ▲ and ▼ to change the day and press *OK* to confirm.
- ➢ Move to date by using the side arrows.
- ➢ Follow the same procedure to set the date and year and press *OK* to confirm.
- ➢ Press ESC to return to the main screen.

d) Enter your first program on LOGO! using the on-board keys.

The digital inputs are denoted by the letter I such as I_1, I_2 and so on, and the digital outputs are denoted as Q_1, Q_2 and so on. Program the PLC to turn on Q1 when S1 is pressed

Press ESC to come to the main screen and follow the steps below:

Step 1	Step 2	Step 3	Step 4
>Program.. Card.. Setup.. Start	Edit.. >Clear Prg Password	Clear Prg >No Yes	>Program.. Card.. Setup.. Start
Step 5	**Step 6**	**Step 7**	**Step 8**
>Edit.. Clear Prg Password	>Edit Prg Edit Name AQ in Stop Memory?	Q1	I1 — Q1

Observation:

1. Press ESC to return to the main screen and press *start* to run the program.

    Press S1 and observe the result. What do you observe?

    _____

2. Stop and clear the program. Repeat the steps by changing the input to I2. What do you observe?

    _____

3. Stop and clear the program. Repeat the steps by changing the input to I3. What do you observe?

    _____

1.5 Review Exercise

A. Classify the following control systems into manual or automatic Write the corresponding letter in the provided table.

   a. The room temperature inside a house was maintained at 23° C using a sensor.

   b. Your father changes the tire of his car.

   c. A selector switch is used to operate the bottle filing machine.

   d. The lights are turned OFF automatically when there is no one inside the room.

Manual	Automatic

B. Differentiate between manual and automatic control that are demonstrated in the below picture. Write your answer in the space provided.
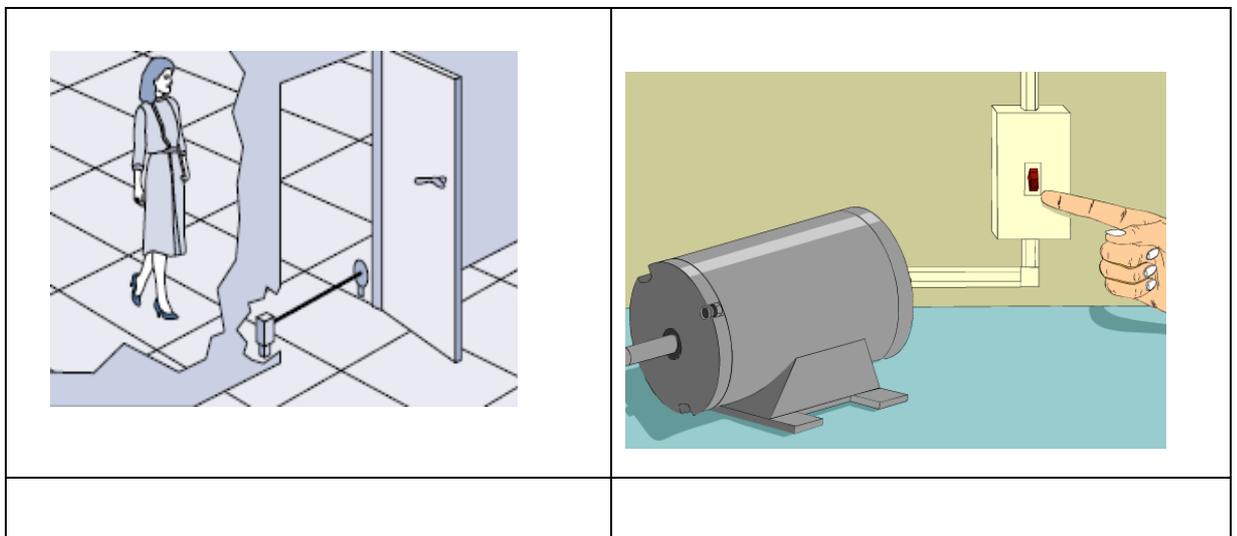
C. Classify the following into discrete or continuous control system. Write the corresponding letter in the provided table.
  a. Varying the speed of a fan.
  b. Turing a lamp ON or OFF.
  c. Controlling the volume level of music.
  d. Maintaining room temperature at a set point.
  e. Varying the brightness of a dimmer lamp.

Discrete control system	Continuous control system

D. In a certain PLC application, the lamp L1 must be ON when both switches S1 and S2 are pressed, and lamp L2 must turn ON when switch S3 is pressed. The output expressions are as follows: Q1 = I1, Q2 = I3. Make the required hardware connections on the figure below, and label the inputs and outputs.
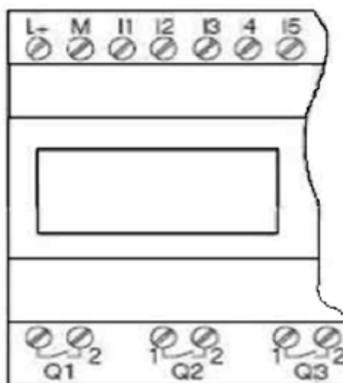
1.6 Assignment

Complete the following task using one of the suitable Microsoft Office tools.

Use the internet to identify one commercial application and two industrial applications of a PLC other than the ones listed in the module, and prepare a powerpoint presentation or a poster that lists those PLC applications.

The powerpoint slides (or the poster) must include the following contents:

➤ Assignment Title: PLC Applications

➤ Title of application-1, picture and brief description.

➤ Title of application-2, picture and brief description.

➤ Title of application-3, picture and brief description.