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# A mini view of PLC

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**Abstract**
A Programmable logic controllers or PLCs are rugged computers used in industrial automation. These controllers can automate specific processes, machine functions and even entire production lines.

**Keywords:** Programmable, Computers, controllers, specific

## 1. Introduction

PLC stands for "Programmable Logic Controller". PLC is specially designed for reliable operation in harsh industrial environments (for example, extreme temperatures, humidity, dry and/or dusty conditions). It is used to automate industrial processes such as assembly lines in manufacturing plants, ore processing plants or wastewater treatment plants.

PLC has many functions of the personal computer you have at home. They all have power supply, CPU (central processing unit), input and output (I/O), memory and operating software (although it is different operating software). The biggest difference is that PLC can perform discrete and continuous functions that cannot be performed by PC, and PLC is more suitable for harsh industrial environments. PLC can be seen as a "robust" digital computer that manages electromechanical processes in an industrial environment.

PLC is an integral part of large-scale SCADA system and plays a vital role in the field of automation. The PLC can be programmed according to the operating requirements of the process. In production, due to changes in the nature of production, reprogramming will be required. In order to overcome this difficulty, a PLC-based control system was introduced. Before introducing various applications of PLC, we will first discuss the basic knowledge of PLC.

## 2. PLC Basics Knowledge

PLC was invented by Dick Morley in 1964. Since then, PLC has completely changed industry and manufacturing. PLC has a variety of functions, such as timing, counting, calculation, comparison and processing various analog signals [1].

Compared with the "hard-wired" control system, the main advantage of PLC is that you can return to and replace the PLC after programming the PLC, but the cost is very small (just the programmer's time). In a hard-wired control system, you basically have to unplug the wires and start from scratch (this is more expensive and takes longer). Let us look at an example to better understand this advantage. Imagine that you connected the light to the switch. Usually, the lamp works under two conditions-on and off. Now you will get a task, when you turn on the switch, the indicator light should only glow after 30 seconds. With this hard-wired setup, we are in trouble. The only way to achieve this is to completely reroute the circuit to add a timer relay. It is troublesome to make minor changes.

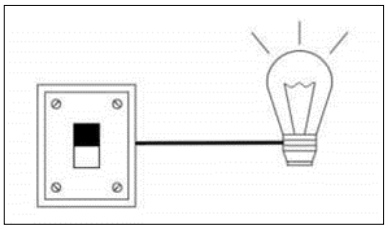

**Fig 1:** Light Switch

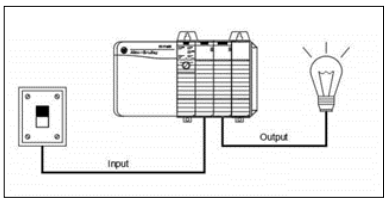


**Fig 2:** Light operated by a PLC

This is where the PLC appears, without any additional wiring and hardware to ensure that changes are made. Instead, simple code changes are required to program the PLC to turn on the light only 30 seconds after the switch is turned on. Therefore, by using PLC, easily combine multiple inputs and outputs. This is just a simple example-PLC can control larger and more complex processes. PLC can be customized according to application and user needs.

## 3. Types of PLCs

The two main types of PLC are fixed/compact PLC and modular PLC.

### 3.1 Compact PLC

In a single case, there will be many modules. It has a fixed number of I/O modules and external I/O cards. Therefore, it does not have the ability to expand the module. Each input and output will be determined by the manufacturer.

### 3.2 Modular PLC

This type of PLC allows multiple expansions through

"modules", so it is called a modular PLC. I/O components can be added. Since each component is independent of each other, it is easier to use.
According to the output, PLC is divided into relay output, transistor output and triac output PLC. The relay output type is most suitable for AC & DC output devices. Transistor output PLC uses switch operation and is used inside the microprocessor.

According to physical size, PLC is divided into micro, micro and nano PLC
Some PLC manufacturers include

- Alan Bradley
- ABB
- Siemens
- Mitsubishi PLC
- Hitachi PLC
- Delta PLC
- General Electric (GE) PLC
- Honeywell PLC

**4. How does PLC work**

The work of PLC can easily understand as a cyclic scanning method called scanning cycle.

- The PLC scanning process includes the following steps
- The operating system starts the cycle and monitors the time.
- The CPU start to read data from the input module & checks the status all inputs.
- The CPU start executing user programs or application programs written in ladder logic or any other PLC programming language.
- Then, the CPU performs internal diagnostic & communication tasks.
- Based on the program results, it writes data to the output module to update all outputs.
- This process will continue as the PLC is in run mode.

**5. PLC Programming Languages**

The IEC (International Electrotechnical Commission) standard allows some basic rules to standardize the PLC and its language.
According to IEC 61131–3 [2], only 5 languages are considered standard languages used on PLCs.

**Here is the most popular PLC programming language**

1. Ladder Diagram (LD)
2. Sequential Function Chart (SFC)
3. Functional block diagram (FBD)
4. Structured text (ST)
5. Instruction list (IL)

**6. Programming**

The programmable logic controller is suitable for engineers who have no programming background. Therefore, a graphical programming language called Ladder Diagram (LD, LAD) was first developed, which is similar to a schematic diagram of a system constructed by electromechanical relays. It was adopted by many manufacturers & later standardized in the IEC 61131-3 control system programming standard. As of 2015, it is still widely used due to its simplicity [3].

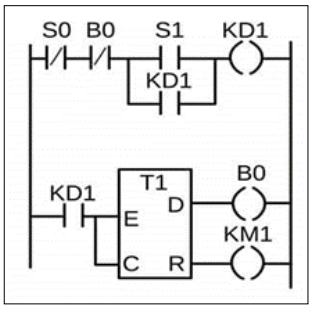


**Fig 3:** Example of a ladder diagram logic

As of 2015, most PLC systems follow the IEC 61131-3 standard, which defines two text programming languages: structured text (ST; similar to Pascal) and instruction list (IL); and three graphic languages: trapezoid Figure, function block diagram (FBD) and sequential function diagram (SFC) [3, 4]. The Instruction List (IL) was deprecated in the third edition of the standard [5]. Modern PLCs can be programmed in many ways, from relay-derived ladder logic to programming languages, such as BASIC and C's special adapted dialects.
Although the basic concepts of PLC programming are common to all manufacturers, the differences in I/O addresses, memory organization and instruction sets mean that PLC programs can never be perfectly interchanged between different manufacturers. Even within the same product line of a single manufacturer, different models may not be directly compatible.
PLC programs are usually written using programming equipment, which can be in the form of desktop consoles, special software on personal computers, or handheld programming equipment [6]. Then, download the program directly or through the network of the PLC. It is stored in non-volatile flash memory or battery-powered RAM. In some PLC, the program transfers the program from the personal computer to the PLC through the programming board, and then writes the program into a removable chip, such as EPROM.
Programs written on personal computers can be easily copied and backed up to external storage. The manufacturer develops programming software for its controller. In addition to being able to program PLCs in multiple languages, they simulate offline [6]. Hardware diagnosis and maintenance, software debugging also provides regular functions, for example, the program can be uploaded for backup & recovery.

**7. Basic Functions**

The most basic function of a programmable controller is to simulate the function of an electromechanical relay. The discrete input has a unique address, and PLC instructions can test whether the input status is on or off. Just as a series of relay contacts perform a logical "AND" function, unless all contacts are closed, current is not allowed to flow, so if all input bits are open, a series of "Check for Continuity" commands will output Storage bit power supply. Similarly, a set of parallel instructions can be performing a logical OR. In the electromechanical relay wiring diagram, a set of contacts that control a coil called a "ladder" "step", the concept is also used to describe PLC logic.
Some models of PLC limit the number of serial and parallel instructions in logical "lines". Each rung output sets or clears a storage bit, which may be associated with a physical

output address, or it may be an "internal coil" that is not physically connected. Such an internal coil can be used as a common element in multiple individual steps, for example. Unlike physical relays, there is usually no limit to the number of inputs, outputs or internal coils that can be referenced in the PLC program.

Some PLCs enforce strict left-to-right and top-to-bottom execution sequences to evaluate rung logic. This is different from electromechanical relay contacts. In a sufficiently complicated circuit, electromechanical relay contacts may transfer current from left to right or from right to left according to the configuration of the surrounding contacts. Depending on the programming style, eliminating these "secret paths" may be an error or a function [8].

PLC's higher-level instructions can be implemented as function blocks that perform some operations when enabled by logic inputs and generate signal outputs (such as completion or errors), while internal operations may not correspond to variables of discrete logic.

## 8. Advantages of PLC

1. **Reduced space:** PLC is a completely solid-state device, so its structure is extremely compact compared to hard-wired controllers that use electromechanical devices.
2. **Higher service life and reliability:** these devices are very rugged. The possibility of defects/damage is very small because there are very few movement mechanisms here.
3. **Economic:** Since the probability of defects is very small, it can be regarded as a one-time investment. In this way, PLC is undoubtedly the most economical system. The cost of PLC will recover in the short term.
4. **Energy saving:** The average power consumption is only 1/10 of the power consumption controlled by the equivalent relay.
5. **Easy to *maintain*:**

- Modular replacement
- Easily troubleshoot
- Use the programming unit for error diagnosis.

6. **Huge flexibility:** If you need to make any changes, there is no need to rewire. It can perform complex functions such as arithmetic operations, counting, comparison, delay generation, etc. It has high processing speed and greater flexibility in analog and digital processing. You can also perform "online" / "offline" programming.
7. **Shorten the project time:** Only after the task is completely defined can the hard-wire control system be built. However, for PLC, the structure and wiring of the controller have nothing to do with the definition of the control program.
   Easy to store and archive: This is because it is compatible with PC-AT, printers and floppy disks.

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