Programmable Logic Controllers

Introduction to PLCs

Outline

• Introduction
• Definition and History of the PLC
• Example PLCs
• Overall PLC System
• PLC Advantages and Disadvantages
Definition And History Of The PLC

• A PLC is a user-friendly, microprocessor-based specialized computer that carries out control functions of many types and levels of complexity.
• Its purpose is to monitor crucial process parameters and adjust process operations accordingly.
• Used extensively because the PLC
  – Is easy to set up and program
  – Behaves predictably
  – Ruggedized

Definition And History Of The PLC

• It can be programmed (to a degree), controlled, and operated by a person unskilled in operating (programming) computers.
• Essentially, a PLC's operator draws the lines and devices of ladder diagrams with a keyboard/mouse onto a display screen.
• The resulting ladder diagram is converted into computer machine language and run as a program.
Example PLCs

Allen-Bradley PLC5  Allen-Bradley SLC500

Allen-Bradley Micrologix  Allen-Bradley Picocontroller

PLC basics

• Some PLCs are
  – integrated into a single unit (Picocontroller),
  – whereas others are modular (PLC5, SLC500)
  – The Micrologix product lies somewhere between
    the PLC5 and the Picocontroller

• Integrated PLCs are sometimes called
  brick PLCs because of their small size
  – These PLCs have embedded I/O (i.e. the I/O is a
    part of the same unit as the controller itself)
  – Modular PLCs have extended I/O
**Components in a PLC system**

- CPU module, containing the processor and memory
- Input and output modules, to allow the PLC to read sensors and control actuators
  - A wide variety of types are available
- Power supply for the PLC, and often sensors and low power actuators connected to I/O modules
- A rack or bus so the PLC can exchange data with I/O modules

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**PLC in a automated system**

![Diagram of PLC in an automated system]
Additional PLC components

- **A programming unit** is necessary to create, edit and download a user program to the PLC.
- Additional components can include:
  - **Network interfaces**: to allow PLCs to function in a networked environment.
  - **Communication adapters**: for remote I/O devices: so I/O devices do not have to be physically close to the CPU module.
  - **Operator interface**: devices: allow monitoring and/or data entry by operators.

Definition And History Of The PLC

- The PLC takes the place of much of the external wiring required for control of a process.
- The PLC will operate any system that has output devices that go on and off (known as discrete, or digital, outputs).
- It can also operate any system with variable (analog) outputs.
- The PLC can be operated on the input side by on-off devices (discrete, or digital) or by variable (analog) input devices.
Definition And History Of The PLC

- The first PLC systems evolved from conventional computers in the late 1960s and early 1970s.
  - These first PLCs were installed primarily in automotive plants.
- Traditionally, the auto plants had to be shut down for up to a month at model changeover time.
- The early PLCs were used along with other new automation techniques to shorten the changeover time.

Definition And History Of The PLC

- One of the major time-consuming changeover procedures had been the wiring of new or revised relay and control panels.
- The PLC keyboard reprogramming procedure replaced the rewiring of a panel full of wires, relays, timers, and other components.
- The new PLCs helped reduce changeover time to a matter of a few days.
PLC Advantages

• **Flexibility**
  - In the past, each different electronically controlled production machine required its own controller; 15 machines might require 15 different controllers.
  - Now it is possible to use just one model of a PLC to run any one of the 15 machines.
  - Furthermore, you would probably need fewer than 15 controllers, because one PLC can easily run many machines.
  - Each of the 15 machines under PLC control would have its own distinct program (or a portion of one running program).

PLC Advantages

• **Implementing Changes and Correcting Errors**
  - With a wired relay-type panel, any program alterations require time for rewiring of panels and devices.
  - When a PLC program circuit or sequence design change is made, the PLC program can be changed from a keyboard sequence in a matter of minutes.
  - No rewiring is required for a PLC-controlled system.
  - Also, if a programming error has to be corrected in a PLC control ladder diagram, a change can be typed in quickly.
PLC Advantages

• Large Quantities of Contacts
  - The PLC has a large number of contacts for each coil available in its programming.
  - Suppose that a panel-wired relay has four contacts and all are in use when a design change requiring three more contacts is made.
    • Time would have to be taken to procure and install a new relay or relay contact block.
  - Using a PLC, however, only three more contacts would be typed in.
    • Contacts are now a “software” component

• Lower Cost
  - Increased technology makes it possible to condense more functions into smaller and less expensive packages.
  - Now you can purchase a PLC with numerous relays, timers, and counters, a sequencer, and other functions for a few hundred dollars.

• Pilot Running
  - A PLC programmed circuit can be evaluated in the lab. The program can be typed in, tested, observed, and modified if needed, saving valuable factory time.
PLC Advantages

• Visual Observation
  – A PLC circuit's operation can be seen during operation directly on a CRT screen.
  – The operation or mis-operation of a circuit can be observed as it happens.
  – Logic paths light up on the screen as they are energized.
  – Troubleshooting can be done more quickly during visual observation.

PLC Advantages

• Ladder or Boolean Programming Method
  – The PLC programming can be accomplished in the ladder mode by an engineer, electrician or possibly a technician. Alternatively, a PLC programmer who works in digital or Boolean control systems can also easily perform PLC programming.

• Reliability and Maintainability
  – Solid-state devices are more reliable, in general, than mechanical systems or relays and timers. Consequently, the control system maintenance costs are low and downtime is minimal.
PLC Advantages

• **Documentation**
  - An immediate printout of the true PLC circuit is available in minutes, if required.
  - There is no need to look for the blueprint of the circuit in remote files.
  - The PLC prints out the actual circuit in operation at a given moment.
  - Often, the file prints for relay panels are not properly kept up to date. A PLC printout is the circuit at the present time; no wire tracing is needed for verification.

PLC Disadvantages

• **Fixed Program Applications**
  - Some applications are single-function applications. It does not pay to use a PLC that includes multiple programming capabilities if they are not needed.
  - Their operational sequence is seldom or never changed, so the reprogramming available with the PLC would not be necessary.

• **Fail-Safe Operation**
  - In relay systems, the stop button electrically disconnects the circuit; if the power fails, the system stops.
  - This, of course, can be programmed into the PLC; however, in some PLC programs, you may have to apply an input voltage to cause a device to stop. These systems may not be fail-safe.