

## Introduction

### **Motivation**

In 1968, the state of the art in control technology was the relay control system. Shortly, the *Programmable Controller* became the state of the art in control technology. Since then Programmable Controllers have made rapid inroads into virtually every manufacturing business and many service business.

In today's competitive world, a company must be efficient, Cost-effective and flexible if it wishes to survive. In manufacturing and process industries, this has resulted in a greatly increased demand for industrial control system in order to streamline operation in terms of speed, reliability, versatility and material, throughput.

Established control media, including relay logic and computer system can and do provide effective control of industrial processes and plant. However each of the above control media has limitation or disadvantages that may often be overcome through the use of a Programmable Controller.

A Programmable Logic Controller (PLC) is defined by Capiel (1982) as : *A digitally operating system designed for used in an industrial environment which uses a programmable memory for the internal storage of instructions for implementing specific function such as logic, sequencing, timing, counting and arithmetic to control through analog or digital input/output modules, various types of machines or processes.* [Ref 1. pp. xiii]

It is obvious from the foregoing that, the successful technician, engineering aid, engineer or supervisor involved in nearly any manufacturing business needs a basic knowledge of how programmable controllers can be used. This makes it interesting to study PLCs, find how the PLC is an economical, user-friendly device that has benefited from advances in microprocessor and memories technology, and how PLCs can be made to perform complicated control computations in sophisticated control networks.

### ***Contribution***

The internal operation of any programmable controller is essentially similar to any other microprocessor based system. Differences occur in the manner of input /output handling and the interface hardware. Since application programs vary in nature, there would be different approaches applicable for different setups. There are attempts made constantly in improving the power and operating speed of all programmable controllers, and also making them cost-effective and flexible. The main contributions of this Dissertation are:

- Study the basics of control technology and the use of programmable controllers as a control media.
- Describe the development of programmable controllers, leading to the internal design and operation of the Programmable Logic Controllers, which includes the basic understanding of the components of PLC system
- Develop a PLCs hardware system using Z80 processor.
- Examine fundamentals of PLC software facilities, including ladder programming and functions such as timers, internal auxiliary relay and data handing.
- Examine ladder program development for combination and sequential tasks.

- Reasonably understand the languages used to program these devices.
- Microprogramming : A Boolean-based language which has the logic statements used to establish the relationships among PLC's Inputs and Outputs.
- Develop a user friendly graphical interface to program ladder diagrams.
- Consider several advanced functions that are implemented on modern programmable controllers. The need for PLC communication is considered in the context of plant automation taking serial link, local area networks and Distributed control systems into account.
- Appendices contain typical PLC technical details, program listings, flowcharts, references.

A serial communication between the graphical interface and the PLC system gives rise to an Advanced Programmable Logic Controller system.

### ***Problem Description and Solution***

Designing the PLC, which is a controller needs a definitive approach, which takes cost and technical performance into account.

Generally the cost of system hardware is only a small part of the complete system which includes hardware, software design, training and documentation plus installation and maintenance.

There are several approaches made to improve technical performance. The basic programmable controller's operation, its hardware and software is associated with the programmable controller's application. Using programmable controllers in industrial situation

requires the operator to be familiar with programmable controller's programming. Several studies have been carried out using different language media to facilitate programming ease.

The main points associated with the PLC which are to be considered are:

- Estimation of the PLC hardware and software subsystems
- Selection of the programming device
- Selection of the programming language
- Creation of the communication software for communication between the PLC and its programming device

PLC programming hardware can be replaced with IBM compatible PCs. One can develop more sophisticated PLC system incorporating distributed process control which can control a big process control industry. The scheme is as follows:

- The PLC language is quite similar to computer assembly language. It includes statements such as LOAD, AND, OR and STORE. The address attached to the statement would identify a particular input/output signal. This could be achieved by microprogramming using the microprocessor mnemonic.
- Programming the PLC by means of one of these PLC mnemonic languages often requires the assistance of a computer programmer since plant personnel are usually unfamiliar with them. However, to use these computer level i.e. high level languages, one needs to have control over CRT and keyboard, which also needs a computer programmer. Hence by developing appropriate graphical software interface, it becomes more user friendly and also allows access to the ladder diagram by drawing it using keyboard while displaying the same ladder diagram on CRT. This software would include delete, insert, edit modes

to modify the ladder diagram and also file facilities. The computer languages are expected to mature in the future as knowledge of the computer becomes more widespread.

- To have distributed control, it is necessary to establish special communication interface between various execution units. Each execution unit should be properly addressed in terms of data flow. [Ref. 1 pp. 253-259].
- Ladder diagram developed for each execution unit (on a personal computer) should be dumped in memory of PLC execution unit. The entire operation is personal computer based. Hence it is possible to store the ladder diagrams of each execution unit on floppy disk or hardware and one can have printouts of the ladder diagram program for documentation. Personal computers can perform other functions like supervising all execution units, providing on line programming facility, simulating ladder diagram etc.
- All aspects of advanced manufacturing and control are dependent on the communication system, from simple machine to machine serial link to a local area network or a wide area networking where tens or hundreds of intelligent machines communicate with each other over a common data highway. For this reason, PLCs are studied in this Dissertation along with data communication and their applications in industrial automation.

The objectives of this Dissertation are to :

- Explain the overall details of PLC and its functions .
- Construct software to control the input and output of the PLC in low-level format.
- Construct a Graphical User Interface in the software.
- Explain the concept of ladder diagram and how it can be used in programming.

- Study serial communication and develop communication between PLC and PLC programming interface.
- Study Distributed control using Network (LAN) system.