PROGRAMMABLE LOGIC CONTROLLER

Introduction:

Most enterprises are struggling to change their existing business processes into agile, product- and customer-oriented structures to survive in the competitive and global business environment. Among their endeavor to overcome the obstacles, one of the frequently prescribed remedies for the problem of decreased productivity and declining quality is the automation of factories. As the level of automation increases, material flows and process control methods of the shop floor become more complicated. Currently, programmable logic controllers (PLC) are mostly adopted as controllers of automated manufacturing systems (AMSs), and the control logic of PLC is usually programmed using a ladder diagram. Early machines were controlled by mechanical means using cams, gears, levers and other basic mechanical devices. As the complexity grew, so did the need for a more sophisticated control system. This system contained wired relay and switch control elements. These elements were wired as required to provide the control logic necessary for the particular type of machine operation. This was acceptable for a machine that never needed to be changed or modified, but as manufacturing techniques improved and plant changeover to new products became more desirable and necessary, a more versatile means of controlling this equipment had to be developed. Hardwired relay and switch logic was cumbersome and time consuming to modify. Wiring had to be removed and replaced to provide for the new control scheme required. This modification was difficult and time consuming to design and install and any small "bug" in the design could be a major problem to correct since that also required rewiring of the system. A new means to modify control circuitry was needed. The development and testing ground for this new means was the U.S. auto industry. The time period was the late 1960's and early 1970's and the result was the programmable logic controller, or PLC. The PLC that was developed during this time was not very easy to program. The language was cumbersome to write and required highly trained programmers. These early devices were merely relay replacements and could do very little else. As more manufacturers become involved in PLC production and development, and PLC capabilities expand, the programming language is also expanding. This is necessary to allow the programming of these advanced capabilities. Also, manufacturers tend to develop their own versions of ladder logic language (the language used to program PLCs). This complicates learning to program PLC's in general since one language cannot be learned that is applicable to all types. Most system designers eventually settle on one particular manufacturer that produces a PLC that is personallycomfortable to program and has the capabilities suited to his or her area of applications.

Types of Automation:

Automation

Industrial automation (PLC)

Home automation (Microcontroller)

Microprocessor-Controlled Systems:

Instead of hardwiring each control circuit for each control situation, we can use the same basic system for all situations if we use a microprocessor-based system and write a program to instruct the microprocessor how to react to each input signal from, say, switches and give the required outputs to, say, motors and valves. Thus we might have a program of the form:

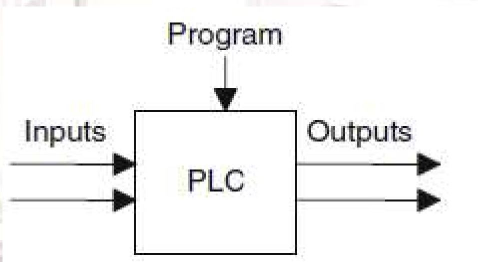
If switch A closes Output to motor circuit If switch B closes Output to valve circuit. By changing the instructions in the program, we can use the same microprocessor system to control a wide variety of situations. As an illustration, the modern domestic washing machine uses a microprocessor system. Inputs to it arise from the dials used to select the required wash cycle, a switch to determine that the machine door is closed, a temperature sensor to determine the temperature of the water, and a switch to detect the level of the water. On the basis of these inputs the microprocessor is programmed to give outputs that switch on the drum motor and control its speed, open or close cold and hot water valves, switch on the drain pump, control the water heater, and control the door lock so that the machine cannot be opened until the washing cycle is completed.

The Programmable Logic Controller:

The first programmable logic controller or PLC was invented by Richard E. Morley and the name of the 1st PLC was MODICON-084. Here 084 has a specific meaning. Richard E. Morley tried to design this till 84 times, 83 times he failed, but he got success in last time that was 84.

A programmable logic controller (PLC) is an industrial computer that receives inputs from input devices and then evaluates those inputs in relation to stored program logic and generates outputs to control peripheral output devices. The I/O modules and a PLC functional block diagram are shown in Fig. 1.18. Input devices are sampled and the corresponding PLC input image table is updated in real time. The user’s program, loaded in the PLC memory through the programming device, resolves the predefined application logic and updates the output internal logic

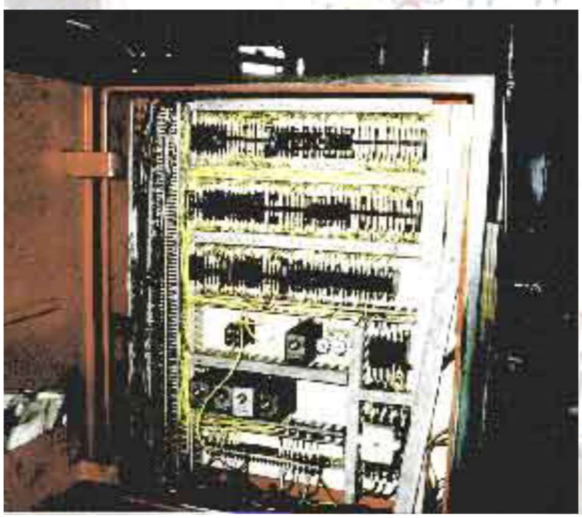
table. Output devices are driven in real time according to the updated output table values.
Standard interfaces for both input and output devices are available for the automation of any existing or new application. These interfaces are workable with all types of PLCs regardless of the selected vendor. Sensors and actuators allow the PLC to interface with all kinds of analog and ON/OFF devices through the use of digital I/O modules, analog-to-digital (A/D) converters, digital-toanalog (D/A) converters, and adequate isolation circuits. Apart from the power supply input and the I/O interfaces, all signals inside the PLC are digital and low voltage.
In other word, programmable logic controller (PLC) is a special form of microprocessor-based controller that uses programmable memory to store instructions and to implement functions such as logic, sequencing, timing, counting, and arithmetic in order to control machines and processes. In simple words, P.L.C. is a intermediate/electronics/super computerized device which control the no of input & output as per downloaded program. It is designed to be operated by engineers with perhaps a limited knowledge of computers and computing languages. They are not designed so that only computer programmers can set up or change the programs. Thus, the designers of the PLC have preprogrammed it so that the control program can be entered using a simple, rather intuitive form of language. Basic PLCs are available on a single printed circuit board. They are sometimes called single board PLCs or open frame PLCs. These are totally self-contained (with the exception of a power supply) and, when installed in a system, they are simply mounted inside a controls cabinet on threaded standoffs. Screw terminals on the printed circuit board allow for the connection of the input, output, and power supply wires. These units are generally not expandable, meaning that extra inputs, outputs, and memory cannot be added to the basic unit. However, some of the more sophisticated models can be linked by cable to expansion boards that can provide extra I/O. Therefore, with few exceptions, when using this type of PLC, the system designer must take care to specify a unit that has enough inputs, outputs, and programming capability to handle both the present need of the system and any future modifications that may be required. PLCs have the great advantage that the same basic controller can be used with a wide range of control systems. To modify a control system and the rules that are to be used, all that is necessary is for an operator to key in a different set of instructions. There is no need to rewire. The result is a flexible, cost-effective system that can be used with control systems, which vary quite widely in their nature and complexity. PLCs are similar to computers, but whereas



computers are optimized for calculation and display tasks, PLCs are optimized for control tasks and the industrial environment. Thus PLCs:
• Are rugged and designed to withstand vibrations, temperature, humidity, and noise
• Have interfacing for inputs and outputs already inside the controller

Conventional control panel:

At the outset of industrial revolution, especially during sixties and seventies, relays were used to operate automated machines, and these were interconnected using wires inside the control panel. In some cases, a control panel covered an entire wall. To discover an error in the system much time was needed especially with more complex process control systems. On top of everything, a lifetime of relay contacts was limited, so some relays had to be replaced. If replacement was required, machine had to be stopped and production too. Also, it could happen that there was not enough room for necessary changes. control panel was used only for one particular process, and it wasn't easy to adapt to the requirements of a new system. As far as maintenance, electricians had to be very skillful in finding errors. In short, conventional control panels proved to be very inflexible.



In this photo you can notice a large number of electrical wires, time relays, timers and other elements of automation typical for that period. Pictured control panel is not one of the more "complicated" ones, so you can imagine what complex ones looked like.
Most frequently mentioned disadvantages of a classic control panel are:
- Too much work required in connecting wires
- Difficulty with changes or replacements
- Difficulty in finding errors; requiring skillful work force
- When a problem occurs, hold-up time is indefinite, usually long.

Control panel with a PLC controller:

With invention of programmable controllers, much has changed in how a process control system.

Typical example of control panel with a PLC controller is given in the following picture.

Advantages of control panel that is based on a PLC controller can be presented in few basic points:

1. Compared to a conventional process control system, number of wires needed for connections is reduced by 80%
2. Consumption is greatly reduced because a PLC consumes less than a bunch of relays
3. Diagnostic functions of a PLC controller allow for fast and easy error detection.
4. Change in operating sequence or application of a PLC controller to a different operating process can easily be accomplished by replacing a program through a console or using a PC software (not requiring changes in wiring, unless addition of some input or output device is required).
5. Needs fewer spare parts
6. It is much cheaper compared to a conventional system, especially in cases where a large number of I/O instruments are needed and when operational functions are complex.
7. Reliability of a PLC is greater than that of an electro-mechanical relay or a timer.

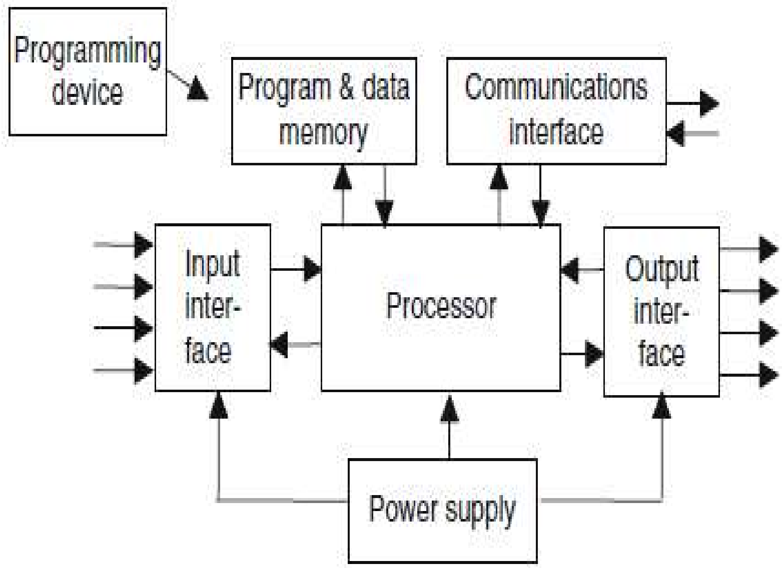
PLC controller components:

PLC is actually an industrial microcontroller system (in more recent times we meet processors instead of microcontrollers) where you have hardware and software specifically adapted to industrial environment. Block schema with typical components which PLC consists of is found in the following picture. Special attention needs to be given to input and output, because in these blocks you find protection needed in isolating a CPU blocks from damaging influences that industrial environment can bring to a CPU via input lines. Program unit is usually a computer used for writing a program (often in ladder diagram).

Hardware:

Typically, a PLC system has the basic functional components of processor unit, memory, power supply unit, input/output interface section, communications interface, and the programming device.

All hardware component/module are holded on Rack. And Rail is also used to hold the different modules in different rack.



• The processor unit or central processing unit (CPU) is the unit containing themicroprocessor. This unit interprets the input signals and carries out the control actions according to the program stored in its memory, communicating the decisions as action signals to the outputs.

• The power supply unit is needed to convert the mains AC voltage to the low DC voltage (5 V) necessary for the processor and the circuits in the input and output interface modules.

• The programming device is used to enter the required program into the memory of the processor. The program is developed in the device and then transferred to the memory unit of the PLC.

• The memory unit is where the program containing the control actions to be exercised by the microprocessor is stored and where the data is stored from the input for processing and for the output.

• The input and output sections are where the processor receives information from external devices and communicates information to external devices. The inputs might thus be from switches with the automatic drill, or other sensors such as photoelectric cells, as in the counter mechanism in temperature sensors, flow sensors, or the like. The outputs might be to motor starter coils, solenoid valves, or similar things. Input and output devices can be classified as giving signals that are discrete, digital or analog. Devices giving discrete or digital signals are ones where the signals are either off or on. Thus a switch is a device giving a discrete signal, either no voltage or a voltage. Digital devices can be considered essentially as discrete devices that give a sequence of on/off signals. Analog devices give signals of which the size is proportional to the size of the variable being monitored. For example, a temperature sensor may give a voltage proportional to the temperature.

• The communications interface is used to receive and transmit data on communication networks from or to other remote PLCs. It is concerned with such actions as device verification, data acquisition, synchronization between user applications, and connection management.

TO BE CONTINUED…………………………….

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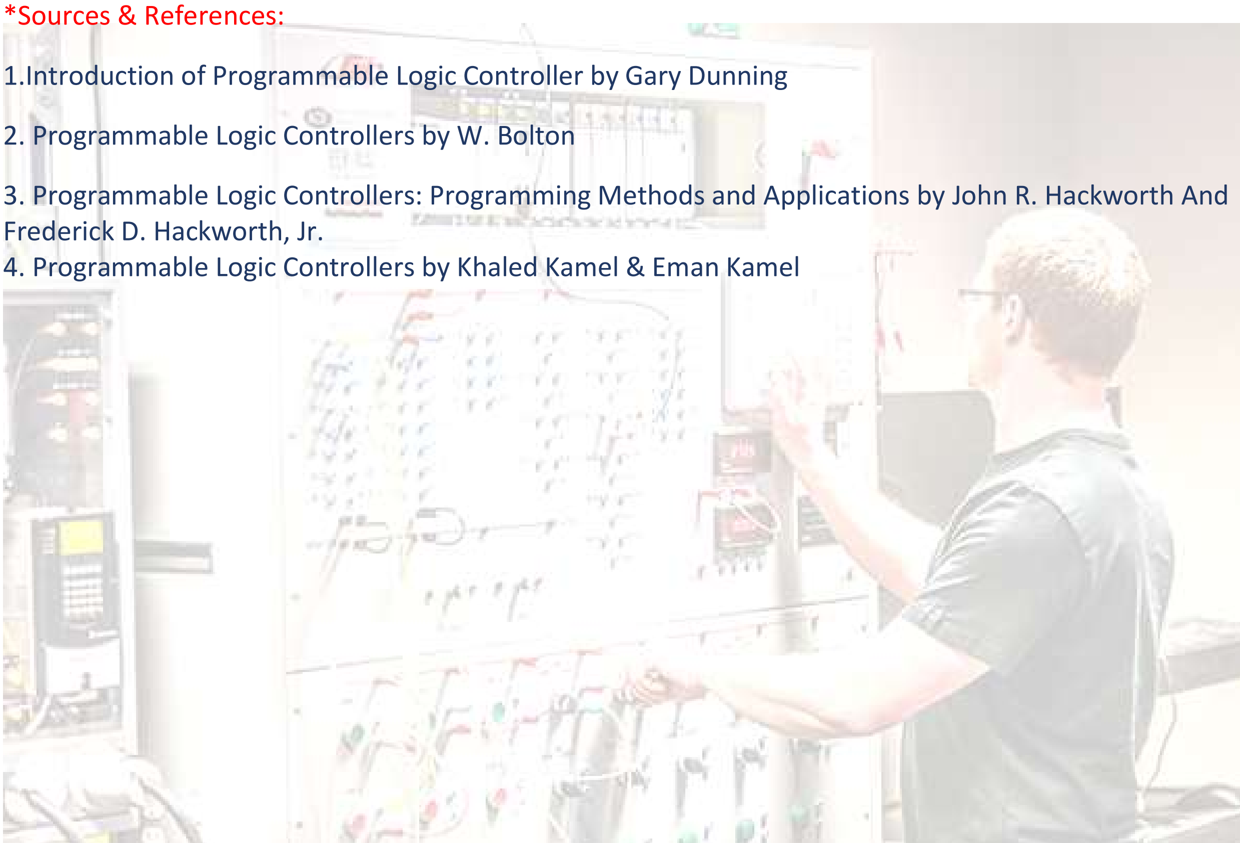

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My name is Tamal Roy. I have passed Diploma in Electronics & Instrumentation Engineering form North Calcutta Polytechnic in the year 2017. I have also worked for 'Aimil Ltd.' and 'G.E. Healthcare' as a service engineer and presently I am appearing in the 2nd year of B.tech.