A
SEMINAR REPORT
ON
"PROGRAMMABLE LOGIC CONTROLLER"

SUBMITTED

IN PARTIAL FULFILLMENT

FOR THE AWARD OF THE DEGREE OF

BECHELOR OF TECHNOLOGY

IN

DEPARTMENT OF ELECTRICAL ENGINEERING

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20010-11

CERTIFICATE

THIS IS TO CERTIFY THAT THE WORK, WHICH IS BEING PRESENTED IN THE SEMINAR “PROGAMMABLE LOGIC CONTROLLER“ SUBMITTED BY RAJESH KUMAR., A STUDENT OF FINAL YEAR B.TECH. IN ELECTRICAL ENGINEERING AS A PARTIAL FULFILLMENT FOR THE AWARD OF DEGREE OF BACHELOR OF TECHNOLOGY IS A RECORD OF STUDENT’S WORK CARRIED OUT UNDER MY GUIDANCE AND SUPERVISION.
THIS WORK HAS NOT BEEN SUBMITTED ELSE WHERE FOR THE AWARD OF ANY OTHER DEGREE.

DATE:	MANISH PAREEK
PLACE: S.E.C., SIKAR	SEMINAR GUIDE

YASWANT SINHA	YASWANT SINHA
SEMINAR INCHARGE	(H.O.D OF E..E. DEPTT.)

CANDIDATE DECLARATION

I hereby declare that the work, which is being presented in the Seminar, entitled "**Programmable logic controller"** in partial fulfillment for the award of Degree of "Bachelor of Technology" in Deptt. of **Electrical Engineering** and submitted to the Department of **Electrical Engineering, Sobhasaria Engineering College, Sikar**, Rajasthan Technical University is a record of my own investigations carried under the Guidance of MANISH PAREEK, Department of **Electrical Engineering**, **Sobhasaria Engineering College, Sikar.**

I have not submitted the matter presented in this Seminar anywhere for the award of any other Degree.

RAJESH KUMAR

Roll No.:07ESOEE019,

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MANISH PAREEK
(Seminar Supervisor)

ACKNOWLEDGEMENT

I would like to convey my sincere thanks to HOD EE, SEC, SIKAR for giving us such a wonderful opportunity to do enhance our skills through these seminars.

I take this opportunity to express my gratitude towards Mr. MANISH PAREEK for guiding our and boosting our moral and confidence at every step and provided us the opportunity to develop this project and sharpen our technical skills. We are worthy for his suggestions and valuable directions.

Thanks to all faculties of SEC,Sikar to provide such opportunities to give presentation and providing such valuable cooperation.

RAJESH KUMAR

ABSTRACT

Programmable logic controllers are the most widely used electronic devices in the control of production and assembly process in most automated factories due to its simplicity and versatility.

A programmable logic controller (PLC) is a user-friendly, microprocessor-based, specialized computer carrying out control functions of many types and levels of complexity in industrial applications.

In the coming sections the introduction to company and company profile can be overviewed. Functions of different departments in the company are also mentioned. After that a brief discussion of PLC, its advantages and disadvantages are given.

CONTENT

Chapter 1

INTRODUCTION

Control engineering has evolved over time. In the past humans were the main method for controlling a system. More recently electricity has been used for control and early electrical control was based on relays. These relays allow power to be switched on and off without a mechanical switch. It is common to use relays to make simple logical control decisions. The development of low cost computer has brought the most recent revolution, the Programmable Logic Controller (PLC). The advent of the PLC began in the 1970s, and has become the most common choice for manufacturing controls.PLCs have been gaining popularity on the factory floor and will probably remain predominant for some time to come.

Most of this is because of the advantages they offer.

- Cost effective for controlling complex systems.
- Flexible and can be reapplied to control other systems quickly and easily.
- Computational abilities allow more sophisticated control.
- Trouble shooting aids make programming easier and reduce downtime.
- Reliable components make these likely to operate for years before failure.

Electrolux Kelvinator Limited, India is a leading manufacturer and distributor of consumer white goods under the brands of Electrolux Kelvinator, Electrolux and Allwyn.With an annual turnover of over 1 billion Swedish Krona (SEK), they employ approximately 3700 people and the head office is located in Gurgaon, Haryana, India .The Company consists of five manufacturing plants in India. They are Shahjahanpur (Refrigerator –Rajasthan State, Butibori (Washing Machine) and Warora (refrigerator) -maharashtra state and Nandalur (refrigerator) and Sanathnagar (Compressor) Andhra Pradesh State.The sales function operates through four business units (BU) located at Gurgaon (north BU), Pune (west BU), Calcutta (East BU) and Chennai (south BU). In addition, there are eighteen market units spread across all over India .They have a Electrolux Technical Center situated in Butibori about 30 Kms from Nagpur city (state of maharashtra).

COMPANY PROFILE

The company was incorporated as a public limited company in August 1989 and was originally promoted by Maharaja International Ltd. to produce washing machine, refrigerator, and dishwasher. It started its commercial production in March 1992 at Shahjahanpur in Distt. Alwar. In February 1995, the company became a 51% subsidiary of AB Electrolux of Sweden and at present AB Electrolux is holding a stake of 75% in the equity share capital of the company and the company affairs being managed by Electrolux Management.

BACKGROUND OF AB ELECTROLUX

AB Electrolux was formed in 1919 by the merger of LUX and *ELECTROMEKANISKA*, AB of SWEDEN, AB Electrolux is a Multinational company registered in Stockholm, Sweden. It is one of the world's leading manufacturers of Household Appliances operating in 60 countries and Employing 111,000 people worldwide. Its product range include Refrigerators, Washing machine, Vacuum cleaners, Microwave ovens, Airconditioners, Dishwashers, Lawn movers Garden Tractors, And Aluminum product for industrial Application etc. It owns several global brand names which Include ELECTROLUX, WHITE WESTINGHOUSE, FRIGDAIRE, KELVINATOR, EUREKA ZANUSSI, AMERICOLD AND AEG.

AB Electrolux is providing Electrolux Kelvinator Ltd. (EKL) the latest technology, developed and presently used in the Electrolux Group's European facilities. This technology is environment friendly and energy efficient.
Maharaja International Ltd. was renamed to ELECTROLUX KELVINATOR Ltd. with effect from 8th Feb 1999. The company is at present engaged in the manufacturing of Domestic Refrigerators under famous brand name of **KELVINATOR**.

DETAILS OF SHAHJAHANPUR PLANT

The existing plant has a land covering an area of 81085 sq. meters and is free from Encumbrances and has a clear title. The company's existing Factory, Building includes total Refrigerator production facility, Utility Block, Stores, D&D with Auto-Cad Design Facility, Canteen and Administrative block and has a covered area of 27000 sq. meters.

It employs approx.1000 persons. It manufactures 3 different models of domestic refrigerators (i.e.165, 175L single door, 195/210/220L single door and 315L double door.

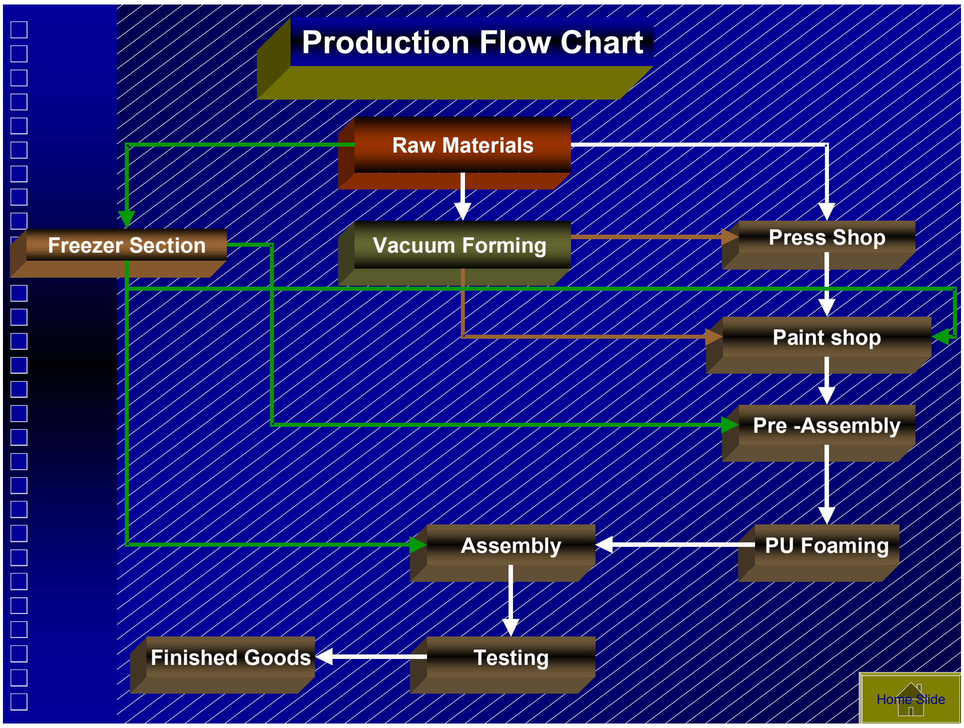
At present the company is producing approx. 4 lacks refrigerators per year. The

Company is catering the needs of domestic and neighboring countries. The plant received ISO 9001 certificate in February 2000, by D.N.V, B.V. Netherlands for manufacturing and design of refrigerators.

NAME OF PLANT SHOPS

- Press shop
- Paint shop
- Vacuum forming shop
- Foaming area
- Pre-Assembly shop
- Final Assembly shop

Process Flow Chart



FUNCTION OF DIFFERENT DEPARTMENTS

PRODUCTION DEPARTMENT

1. To plan for the monthly & yearly targets of quality production for the year.
2. To co-ordinate with Q.A, Purchase. Maintenance for achieving the targets.
3. To achieve the average demerit value as prescribed for the year
4. To reduce the scrap cost per refrigerator.
5. To reduce the material consumable cost as per the value prescribed for the year.
6. To increase the productivity.
7. To solve day to day problems in production in various shops.
8. To study the process for further improvement & modification for quality & productivity.
9. To educate the Engineers, Staffs & Workers about quality
10. To carry out preventive actions for the non-conformities.

PLANT ENGG. DEPARTMENT

1. Plan for optimum utilization of plant machinery to achieve production targets.
2. Preparation of maintenance budget.
3. Plan & execution of preventive maintenance schedule.
4. To study & improve the working environment & conditions for critical machines.
5. Spare parts planning procuring &in degeneration of critical imported spares.
6. Installation & erection of new machines.
7. Plan & execution of block shut down on annual basis.
8. Maintenance of utilities.

9. Average break down % of plant to be 4.5% for the year.
10. Plan & execute energy conservation in plant.
11. To liaison & co-ordinate with the functionaries of government i.e. Rajasthan State Electricity Board, RIICO, Pollution Control Board & other deptt.
12. To develop the concept of TPM (Total Preventive Maintenance).

QUALITY ASSURANCE DEPARTMENT

1. Process Monitoring through instruction with QA executives.
2. Documenting trends in quality.
3. Control of the non –conforming products authorized for taking deviations.
4. Developing & implementation of plans for customer complaint resolution.
5. To reduce call rate.
6. Assessment of preliminary & on going process capability.
7. To reduce de merit value.
8. Monitoring inspection & testing at incoming, in-process & final stage.
9. Co-ordination calibration of equipment.
10. Co-ordination validation of inspection jigs & test status on product.
11. Providing inspection & test status on product.
12. To identity & implement statistical technical for process & product.
13. To verify the effectiveness of corrective & preventing actions.

MATERIALS DEPARTMENT

1. To identify the suitable vendors/suppliers for the procurement of BOM items, production consumables and indented items.
2. Preparation of procurement schedule against P O to different vendors based on monthly material plan.
3. To look after complete stores for the inventory and its proper storage accounting to take preventive measure in case of any shortage/excess.
4. To prepare dispatch schedule plan as per monthly corporate logistic indent to send finished goods at different branches /locations in India.

5. Liaison with private/union transport for in time dispatches
6. To ensure correct physical availability of material finish goods as per book balance.
7. To impart training to subordinate for the development purpose.
8. Assessment of preliminary & on going process capability.
9. To reduce call rate

DESIGN & DEVELOPMENT DEPARTMENT

1. Design & Development of new products /models.
2. Modification /Upgradation for existing product design.
3. System design /Performance testing of refrigerator.
4. Control of drawing specifications document & release of ECN.
5. Prototype & model making for development /testing.
6. Process support to shop floor.
7. Up gradation of product quality.

MANUFACTURING ENGG. DEPARTMENT

1. To formulate capital budget & investment plan.
2. To identify machine capacity & man power planning.
3. Selection of equipment & identification of suppliers for capital equipment.
4. Procurement of Equipment & machines.
5. Installation & commissioning of new machines.
6. To design & provide material handling equipment for better productivity.
7. To design moulds & tools for optimum production at vendor’s end.

HR DEPARTMENT

1. To maintain smooth & cordial industrial relation.
2. Man power planning for & present requirement.
3. To co-ordinate performance Appraisal/Review exercise.

4. To organize for identification of training needs of both blue &White collar employees & preparation of Annual Training Calendar & implementation of the same.
5. Organize recruitment as per approved standard force both for staff as well as workmen.
6. To ensure all statutory obligations under the various provisions of the labor laws.
7. To ensure smooth functioning of all welfare activities.
8. Responsible for the implementation of quality systems with regard to training.

COMMERCIAL DEPARTMENT

1. Responsible for Finance, Accounts, Costing, Excise & Administrative control of IT operation.
2. Responsible for finalization of monthly reporting to corporate & Electrolux Corporate Office.
3. Responsible for finalization of annual accounts & tax audit.
4. Responsible for annual budget preparation, monitoring of budget & profit improvement plan.
5. Monthly variance analysis of budget & actual.
6. Handling excise & sales tax.

MAINTAINANCE DEPPT.

1.0 PURPOSE

To establish and maintain a system for keeping all the machinery and equipment of plant in good working condition to ensure continuing process capability.

2.0 SCOPE

Applicable to all plant machinery and equipment including utilities, electrical installations used in the plant.

3.0 DEFINITION

FH (PE)	:	Functional Head (Plant Engineering)
Mnt.	:	Maintenance

Chapter 2

PROGRAMMABLE LOGIC CONTROLLER

SCOPE OF STUDY

Study of PLC System at Electrolux, Various Frequency Drives use and their programming, Power Supply, SCADA Package for MIMIC programs used for data transfer to PLC, Communication and Networking of PLC.

Following PLC Systems study in respect to their Operating Software, Hardware, and Programming of Small PLC Logic and necessary modification in existing Programs along with trouble shooting in PLC System

- Siemens PLC with S5 Series
- Siemens S7 (Micro Series) PLC Series
- Siemens S7 (Modular Series) PLC series

Along with PLC system study of Various Frequency Drive i.e. Micro Master Inverters with following scope of Study

Programmable Logic Controller

Introduction of Frequency Drives Hardware

Programming of Frequency drives as per requirement

Function and Operation of Frequency drives

Application

Type of Frequency of Frequency Drives

Siemens Micro Master from 0.5 HP to 3.0 HP

Siemens Micro Master Vector Drive 3.0 HP

Omron Inverter 0.5 HP

Power Supply

DESCRIPTION OF PLC

INTRODUCTION TO PLC

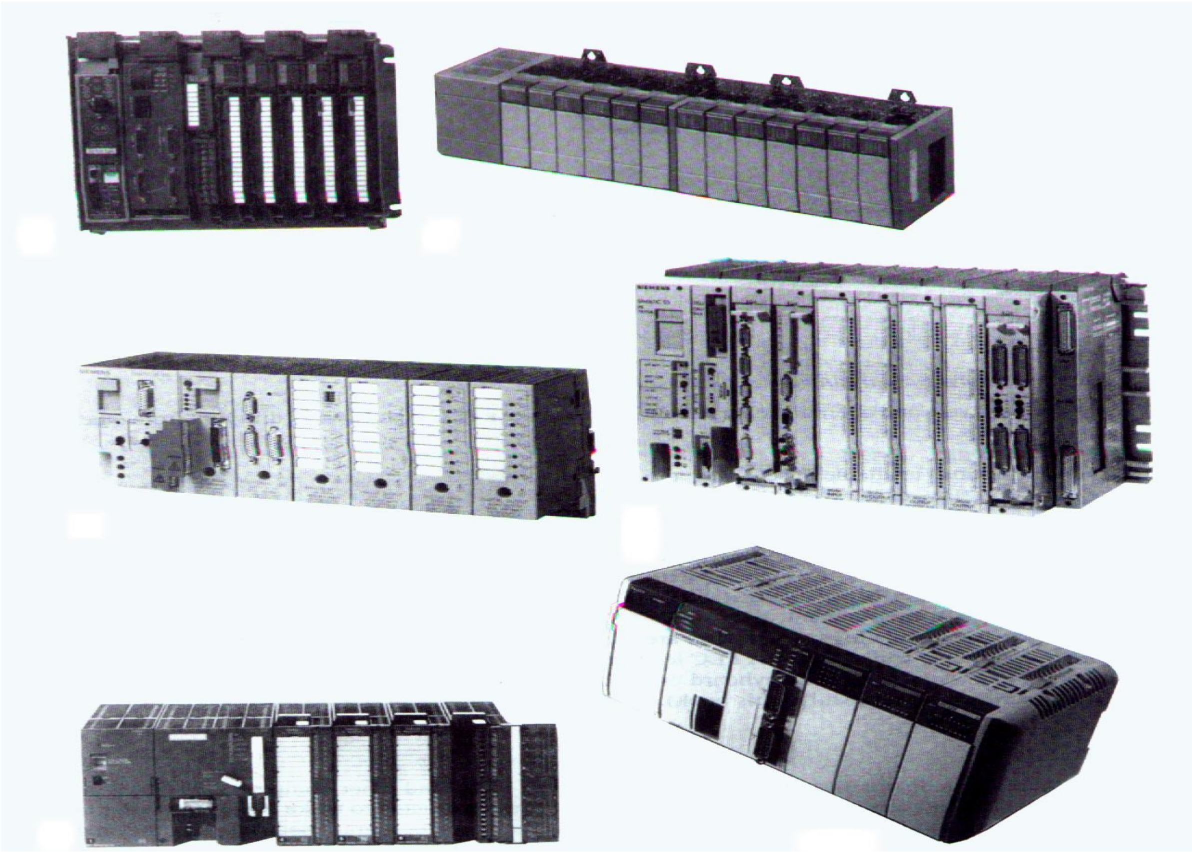
PLC refers to programmable logic control as the name suggests it is a computer used to control the different operations of a machine to which it has been connected.

The different operations to be performed are judged in sequence by the PLC as per the program installed in the PLC

PLC generally consists of a CPU, input and output ports. A CPU is of 2 type -:

- With an i/o device
- Without an i/o device

Different hardware is connected to the PLC so as to handle different operations of the machines to which it has been connected.

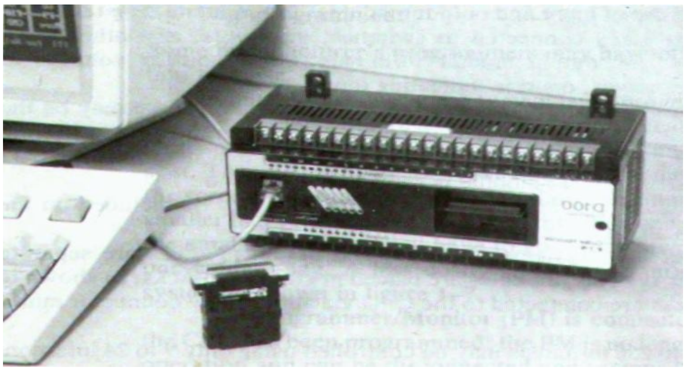


TYPICAL PLC

PARTS OF THE PLCS

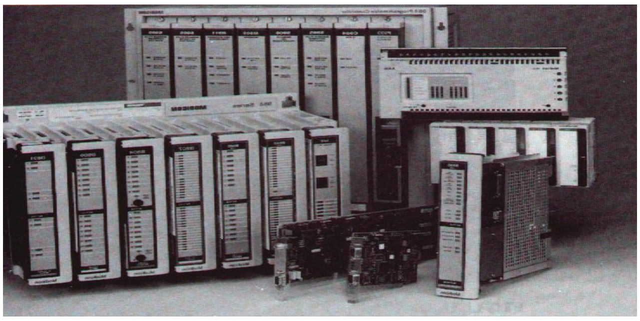
CPU Module

→ This module consists of a central processing unit (CPU) which acts as the brain of the system and its memory. It has a central processing unit CPU which takes merely .3ms to process 1024 binary statements and it is equally good at word oriented processing .The system include a number of CPUs FOR different performance requirements. CPU executes the user program provides the 5V supply for the 5v supply for the PLC back plane bus. It communicates with other modes by MPI (multi point interface).



Input/Output Modules(I/O Modules)

→ I/O modules allow the PLC to read sensors and control actuators. There exists a wide variety of I/O module types offered by the PLC manufacturers.



Power Supply Module

→ Power supply module provides power to the CPU and often provides power to drive sensors and low

power actuators connected to I/O modules. It converts line voltage (230 V ac/115V ac) into 24v dc which provide power.

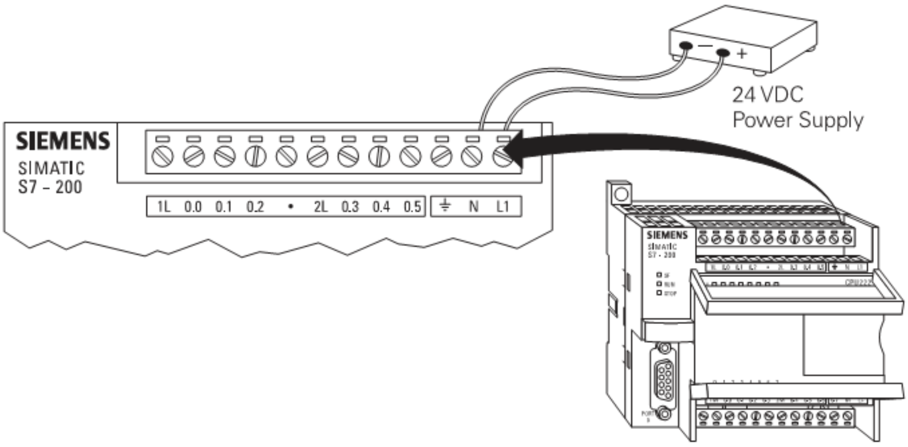
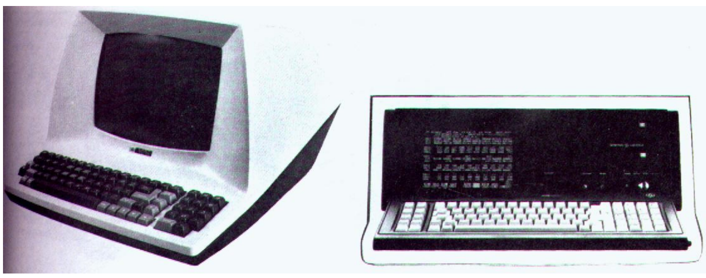


Fig. Power supply Unit

Peripheral Equipments

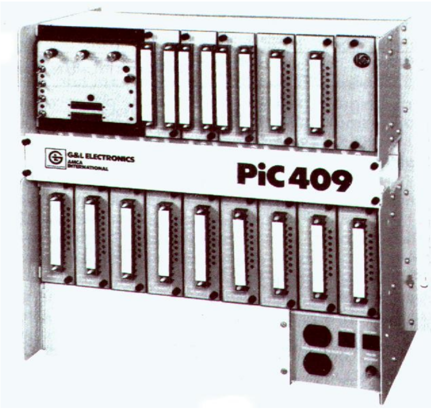
→ They are used for purposes such as preparing, storing and loading control programs,system monitoring
and even can be used for communicating with other computers with which the PLC may be networked.
Some examples can be;

1. Programmer/Monitor (PM) which is used to program instructions and monitor them.



2. Racks and chassis for mounting the other three parts.

Programmable Logic Controller



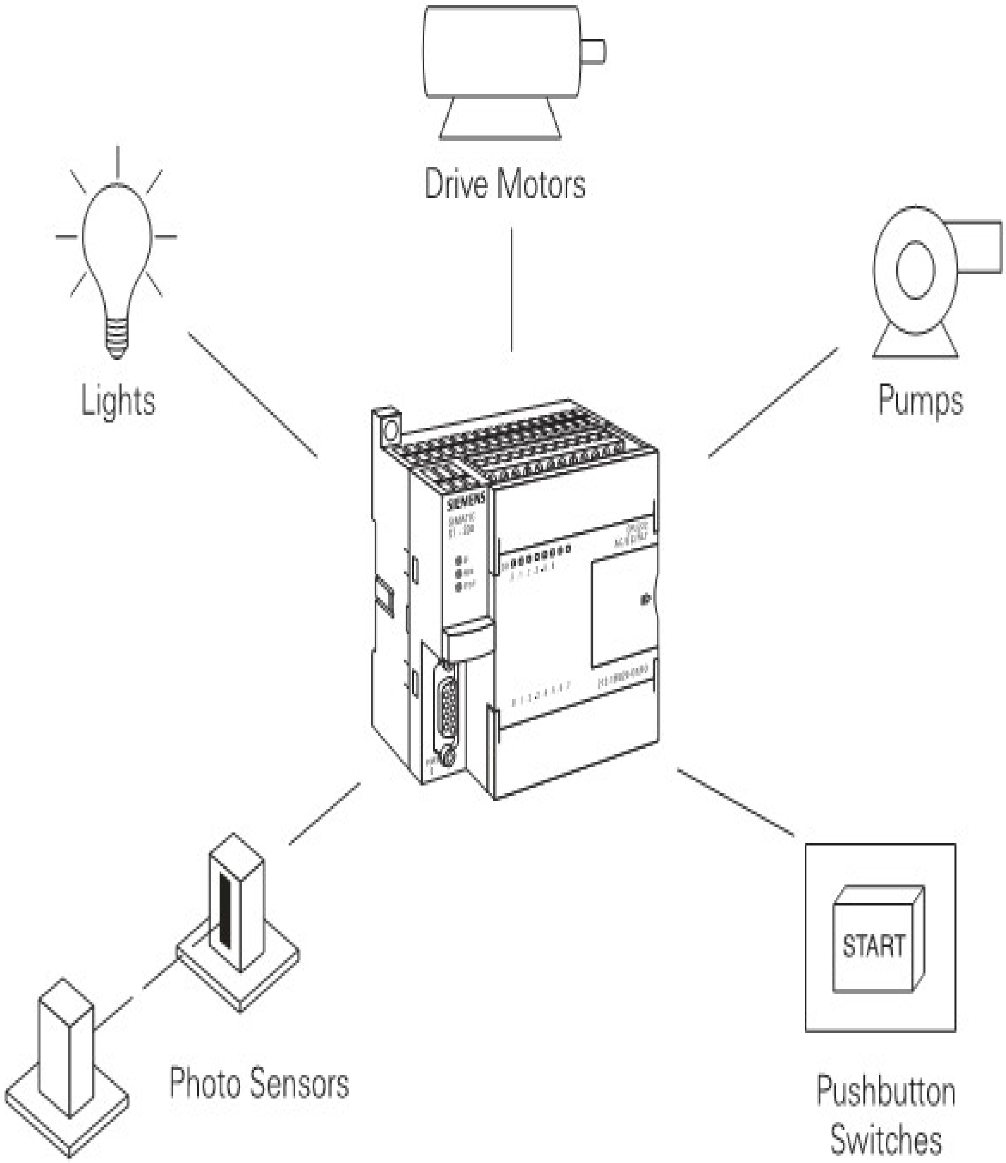
USE OF THE PLC

➢ PLC is used -:

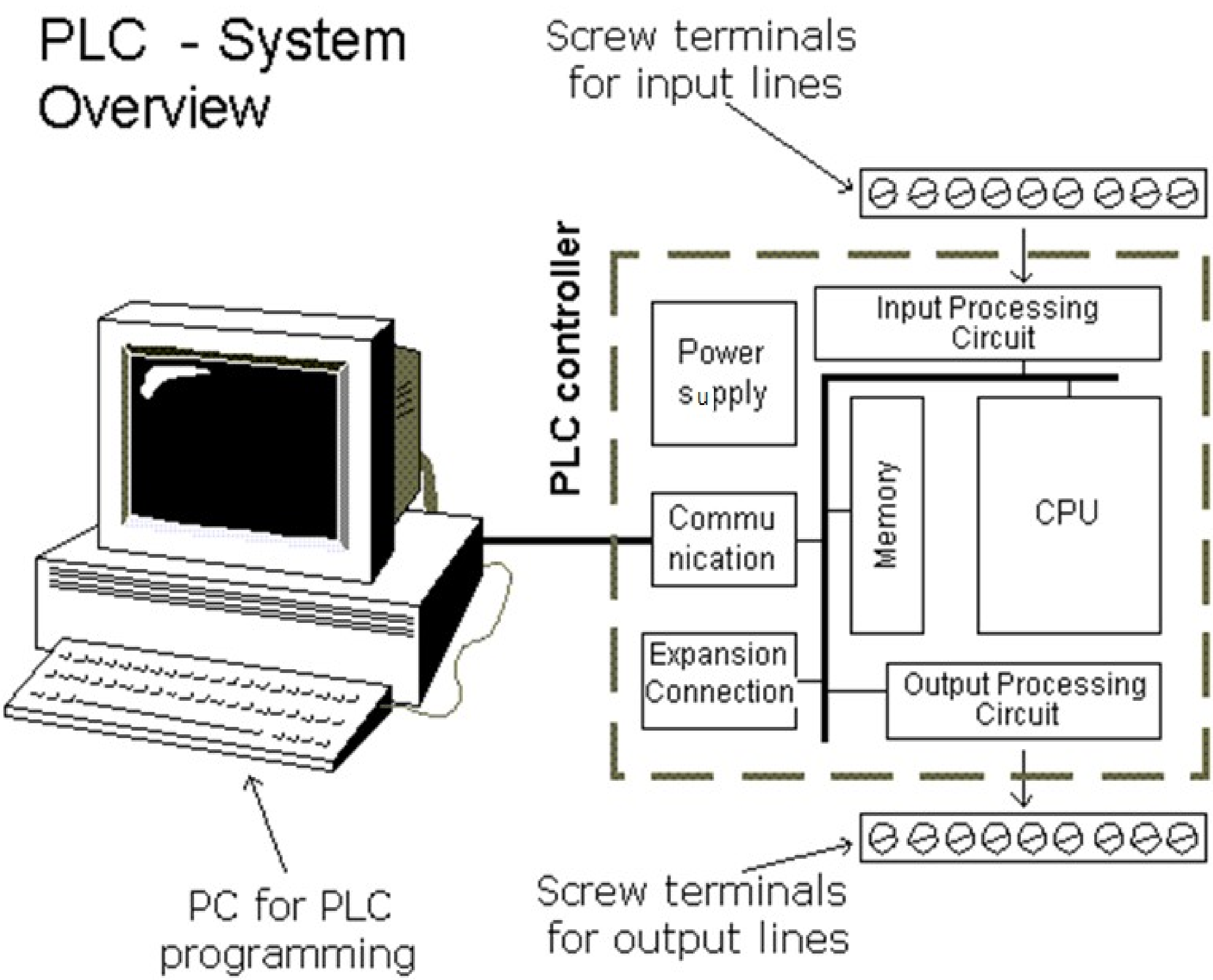
1. To control different functions done by the machine
2. To provide protection to the people working manually on the machine and to the machine in case of
3. some power failure or some cases of short circuit also.
4. To operate the machine automatically.

Various production equipment that can be connected to PLCs include:

- Thermocouples
- Strain gauge
- Position encoder
- Servo valves
- Electrical motors
- Linear motors
- Stepping motors



A program is fed to the PLC to make machines operate as per the requirement for the different operations of the machines.



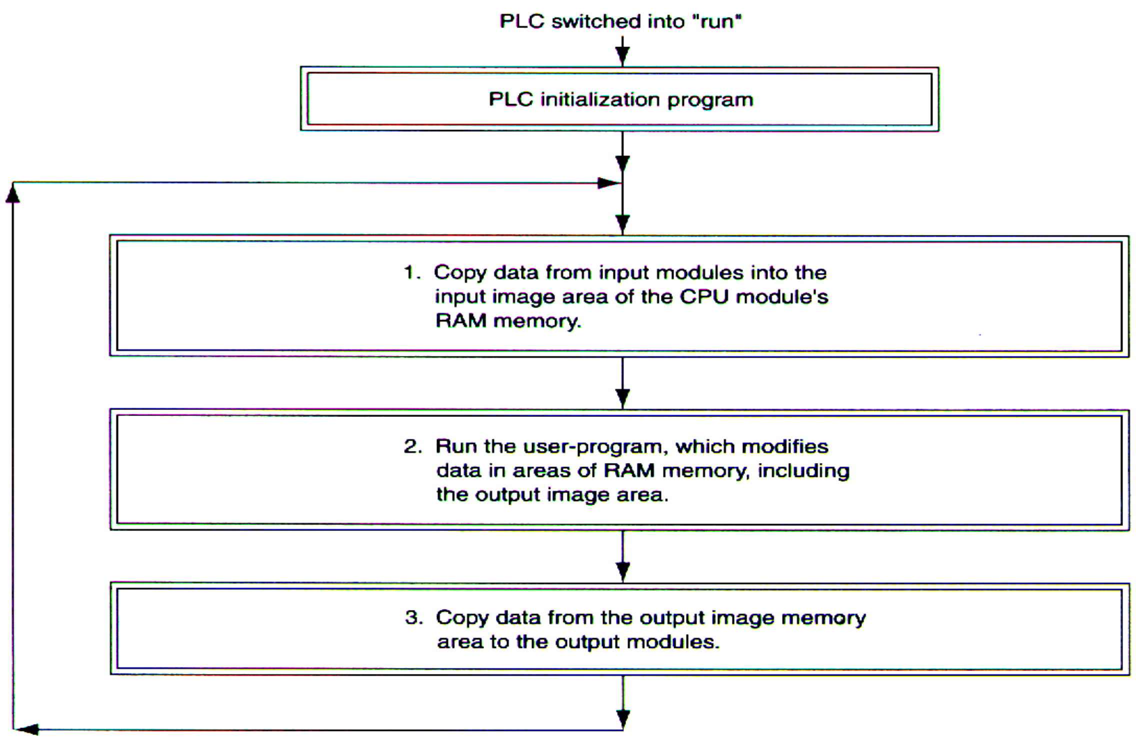
Several production equipment such as transducers and sensors can be interfaced with the PLCs. These interfaces generally include:

- RS-232C Interface,
- RS-422A Interface,
- IEEE-488/GPIB Bus Interface,
- Twisted-pair cable,
- Co-axial cable,

- Optical fibre cable

PLCs may be programmed with a variey of devices, the major two of which are:
- The hand-held programmer (used in small to medium sized PLCs),
- The desktop PLC programming unit (used in debugging and diagnosting features).

STANDARD PLC SCAN CYCLE



Each PLC operational cycle is made up of three separate parts:

- Input scan at which input terminals are read and the input status table is updated,
- Program scan at which data in the input status table is applied to the user program,the program is executed and the output status table is executed
- Output scan at which data associated with the output status table is transferred to output terminals.

TYPE & MAKE OF PLC

- Different companies which manufacture PLC wchich are generally used are

1. SEIMENS
2. OMRON
3. ALLEN BRADLEY

- PLC are manufactured by the SEIMENS in 2 version they are -:

1. S5
2. S7

- Further S7 has 2 versions -:

1. 200 (Micro Series)
2. 300 (Modular Series)

- Depending on the number of the input modules connected to the PLC

The languages been used

1. LAD-ladder
2. Cascade Statement Function CSF
3. STL –statement line

- We have interfacing of the plc to the pc or vice versa through different modes

1. TTY-text to text interface (interface between single pc to single plc)

2. PPI- point to point interface (connections of different pc to a number of plc)
3. MPI-multiple point interface (connection of number of plc to more than one plc)

INTRODUCTION TO S7 (MICRO SERIES) PLC

The S7-series is a line of micro-programmable logic controllers (micro PLCs) that can control a variety of automation applications. It's a compact design, expandability, low cost and powerful instruction set make the S7-200 controllers a perfect solution for controlling many applications In addition, the wide variety of CPU sizes and voltages provide you with the flexibility you need to solve your automation problems. The S7-212/213/214/215/216 CPUs combine a central processing unit (CPU), power supply, and discrete I/O points into a compact, stand – alone device. The CPU executes the program and stores the data for controlling the automation task or process. The power supply provides electrical power for the base unit and for any expansion module that is connected.The inputs and the outputs are the system control points: the input monitors the signals from the field devices (such as sensors and switches), and the outputs control pumps, motors, or other devices in your process.

The communication port allows you to connect the CPU to a programming device or to other devices. Status lights are been provided to provide visual information about the CPU mode (RUN or STOP), the current state of the local I/O, and whether a system fault has been detected.

The S7 Micro Series programming software offers powerful programming and debugging tools which make you more effective and this means cost savings.

We use the programming in the same manner as the Windows applications User programs are written using simply mouse clicks, tool bars, or simply drag & drop operations .It have the following properties: -

- 4 or 6 independent hardware counters at the rate of 30 kHz each for interfacing to incremental encoders or high-speed pulse trains.

- 4 independent interrupt input with 0.2ms input filter times to adjust reaction times for maximum process response.

- 2 high speed pulse outputs at the rate of 20khz each either pulse width modulation or pulse train output , e.g. for control of stepper motor , drives or temperature .

- High-speed analog inputs signal conversion with 25micro seconds, 12 bit resolution.

- Real time clock.

- 2 timed interrupts (adjustable from 1ms in intervals of 1 ms) for precise control of processes that change over time.

EEPROM CARTRIDGE

A small optional EEPROM cartridge saves significant time and money.
We can use it easily copy, update or replace your applications program on your S7-200 CPU.

And if required, one can mail a program rapidly and at a low cost, using the cartridge. Simply turn off the power and the user program is updated in a flash.

BATTERY CARTRIDGE

To guarantee that applications data are never lost , the optional battery module permits long term backup for typically 200 days beyond the internal backup of 5 days.

REAL TIME CLOCK

Whether we require it to count operating hours, preheat rooms or provide time stamps for messages; the real time clock of the S7-200 is software controlled to provide exact seconds and dates even taking leap years into account.

ANALOG POTENTIOMETERS

With the S7 –200 ‘s analog potentiometers we can optimize our process by means of a screwdriver. We can set memory values, timer values, counter presets or other variables without

INTRODUCTION OF SIEMENS S7 (MODULAR SERIES) PLC

Siemens has introduced a mini PLC in the PLC family. It is an ideal choice when the job calls for something fast and powerful. It has a program memory for up to 16k statements, 1024 digital inputs and outputs and an MPI interface for programming devices and operator panels. The speed of the PLC of CPU, the most powerful one is 0.3ms to process 1024 binary statements It holds an incredible 256 digital i/o's in addition to the CPU. Every module has 16/32 isolated channels.

The S7-300 needs a 24v DC power supply. This is provided by load current supply modules, which convert the 120/230v AC line voltage to the 24v DC operating voltage.

The S7-300 series is the is an advance version of the S5 series .The additions have been made to the programming languages Statement List, Ladder Diagram and Functional block Diagram. The instruction set can be used in all blocks and in all programming languages.

S7-300 has central data storage and a perfectly matched suite of individual functions. This means that we need to enter only the data once, at a single user interface. And we can use the same functions for every task. From configuring and programming to startup and documentation. We can write the program in any language and switch from one to another as we want.

S7-300 consists of the following components-:

1. Power Supply (PS)

2. Central Processing Unit(CPU)
3. Signal Modules(SM)
4. Function Modules(FM)
5. Communication Processor (CP)

POWER SUPPLY (PS):

It converts line voltage (230 V ac/115V ac) into 24v dc which provide power to S7-300 it is switching mode power supply

CENTRAL PROCESSING UNIT (CPU):

It has a central processing unit CPU which takes merely .3ms to process 1024 binary statements and it is equally good at word oriented processing .The system include a number of CPUs FOR different performance requirements.
CPU executes the user program provides the 5V supply for the 5v supply for the S7-300 back plane bus. It communicates with other modes by MPI (multi point interface).

COMMUNICATION PROCESSOR (CP):

It means how to interface PLC to PC or PC to PLC. We also interface other devices to PLC.

We can interface it by three ways

1. MPI
2. PPI
3. TTY

In S7-300 we use MPI for interfacing. In communication process we use two types of connector:

1. RS485 PLC)
2. RS232 (PC)

Every module has 16/32 channels; it can be increased till 250 digital I/O

PLC OPERATION

The PLC program is executed as part of a repetitive process referred to as a scan. A PLC scan starts with the CPU reading the status of inputs. The application program is executed using the status of the inputs. Once the program is completed, the CPU performs internal diagnostics and communication tasks. The scan cycle ends by updating the outputs, then starts over. The cycle time depends on the size of the program, the number of I/Os, and the amount of communication required.

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Chapter 3

PROGRAMMING

The first PLCs were programmed with a technique that was based on relay logic wiring schematics. This eliminated the need to teach the electricians, technicians and engineers how to program a computer but, this method has stuck and it is the most common technique for programming PLCs today. An example of ladder logic can be seen in Figure 6. To interpret this diagram imagine that the power is on the vertical line on the left hand side, we call this the hot rail. On the right hand side is the neutral rail. In the figure there are two rungs, and on each rung there are combinations of inputs (two vertical lines) and outputs (circles). If the inputs are opened or closed in the right combination the power can flow from the hot rail, through the inputs, to power the outputs, and finally to the neutral rail. An input can come from a sensor, switch, or any other type of sensor. An output will be some device outside the PLC that is switched on or off, such as lights or motors. In the top rung the contacts are normally open and normally closed. This means if input A is on and input B is off, then power will flow through the output and activate it. Any other combination of input values will result in the output X being off. There are other methods for programming PLCs. One of the earliest techniques involved mnemonic instructions. These instructions can be derived directly from the ladder logic diagrams and entered into the PLC through a simple programming terminal. Sequential Function Charts (SFCs) have been developed to accommodate the programming of more advanced systems. These are similar to flowcharts, but much more powerful.

LADDER LOGIC

Ladder logic is the main programming method used for PLCs. As mentioned before, ladder logic has been developed to mimic relay logic. The decision to use the relay logic diagrams was strategic one. By selecting ladder logic as the main programming method, the amount of retraining needed for engineers and tradespeople was greatly reduced. Modern control systems still include relays, but these are rarely used for logic. A relay is a simple device that uses a magnetic field to control a switch, as pictured in Figure 2. When a voltage is applied to the input coil, the resulting current creates a magnetic field. The magnetic field pulls a metal switch (or reed) towards it and the contacts touch, closing the switch. The contact that closes when the coil is energized is called normally open. The normally closed contacts touch when the input coil is not energized. Relays are normally drawn in schematic form using a circle to represent the input coil. The output contacts are shown with two parallel lines. Normally open contacts are shown as two lines, and will be open (non-conducting) when the input is not energized. Normally closed contacts are shown with two lines with a diagonal line through them. When the input coil is not energized the normally closed contacts will be closed (conducting).

Relays are used to let one power source close a switch for another (often high current) power source, while keeping them isolated. An example of a relay in a simple control application is shown in Figure. In this system the first relay on the left is used as normally closed, and will allow current to flow until a voltage is applied to the input A. The second relay is normally open and will not allow current to flow until a voltage is applied to the input B. If current is flowing through the first two relays then current will flow through the coil in the third relay, and close the switch for output C. This circuit would normally be drawn in the ladder logic form. This can be read logically as C will be on if A is off and B is on. The example in Figure 3 does not show the entire control system, but only the logic. When we consider a PLC there are inputs, outputs, and the logic.

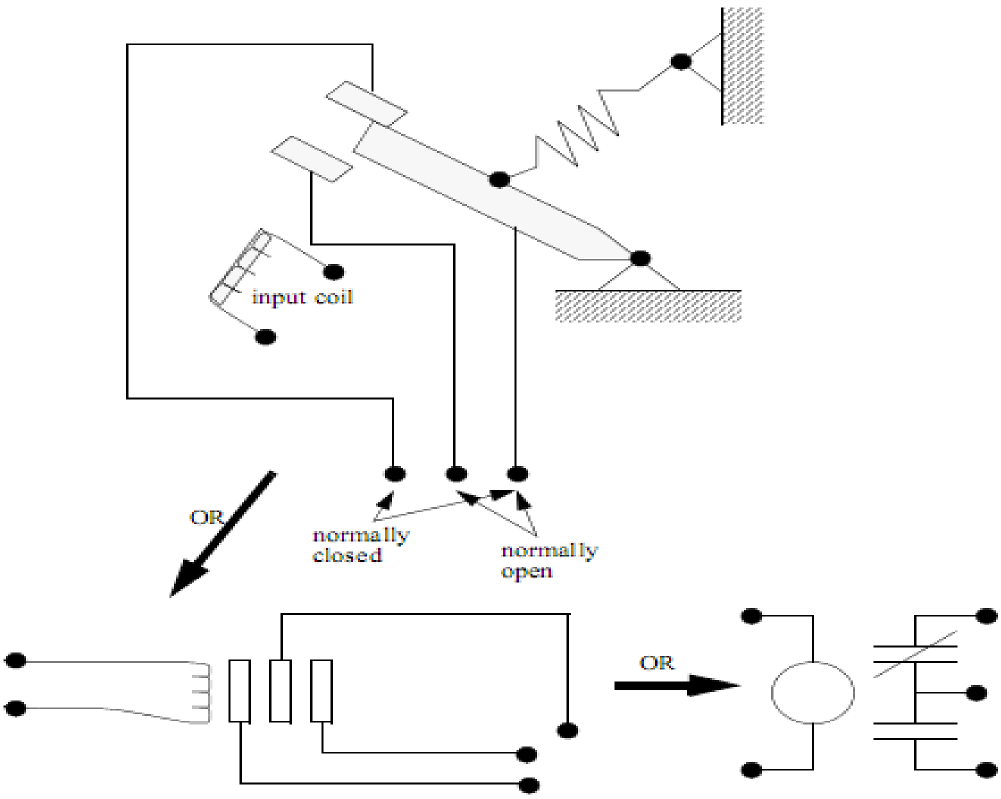


Figure shows a more complete representation of the PLC. Here there are two inputs from push buttons. We can imagine the inputs as activating 24V DC relay coils in the PLC. This in turn drives an output relay that switches 115V AC, that will turn on a light. Note, in actual PLCs inputs are never relays, but outputs are often relays. The ladder logic in the PLC is actually a computer program that the user can enter and change. Notice that both of the input push buttons are normally open, but the ladder logic inside the PLC has one normally open contact, and one normally closed contact. Do not think that the ladder logic in the PLC needs to match the inputs or outputs. Many beginners will get caught trying to make the ladder logic match the input types. Many relays also have multiple outputs (throws) and this allows an output relay to also be an input simultaneously. The circuit shown in Figure 5 is an example of this, it is called a seal in circuit. In this circuit the current can flow through either branch of the circuit, through the contacts labelled A or B. The input B will only be on when the output B is on. If B is off, and A is energized, then B will turn on. If B turns on then the input B will turn on, and keep output B on even if input A goes off. After B is turned on the output B will not turn off.

PLC Connections

When a process is controlled by a PLC it uses inputs from sensors to make decisions and update outputs to drive actuators, as shown in Figure 10. The process is a real process that will change over time. Actuators will drive the system to new states (or modes of operation). This means that the controller is limited by the sensors available, if an input is not available, the controller will have no way to detect a condition.

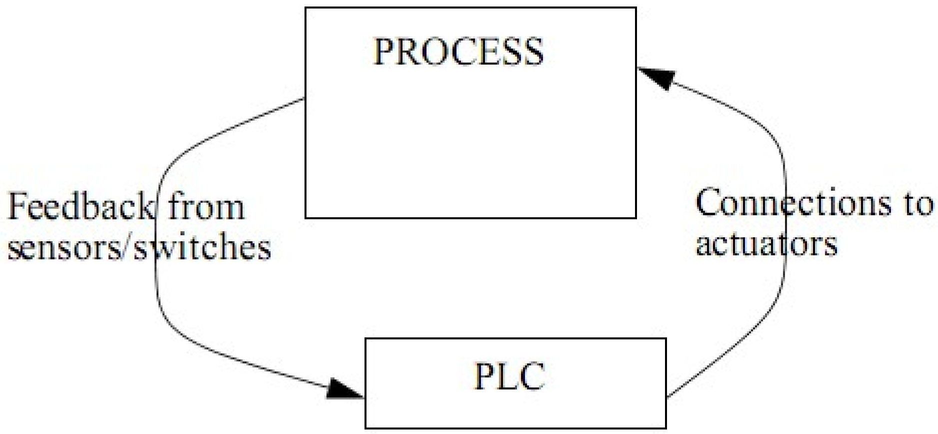


Fig. The Separation of Controller and Process

LADDER LOGIC INPUTS

The control loop is a continuous cycle of the PLC reading inputs, solving the ladder logic, and then changing the outputs. Like any computer this does not happen instantly. Figure shows the basic operation cycle of a PLC. When power is turned on initially the PLC does a quick sanity check to ensure that the hardware is working properly. If there is a problem the PLC will halt and indicate there is an error. For example, if the PLC power is dropping and about to go off this will result in one type of fault. If the PLC passes the sanity check it will then scan (read) all the inputs. After the inputs values are stored in memory the ladder logic will be scanned (solved) using the stored values not the current values. This is done to prevent logic problems when inputs change during the ladder logic scan. When the ladder logic scan is complete the outputs will be scanned (the output values will be changed). After this the system goes back to do a sanity check, and the loop continues indefinitely. Unlike normal computers, the entire program will be run every scan. Typical times for each of the stages are in the order of milliseconds.

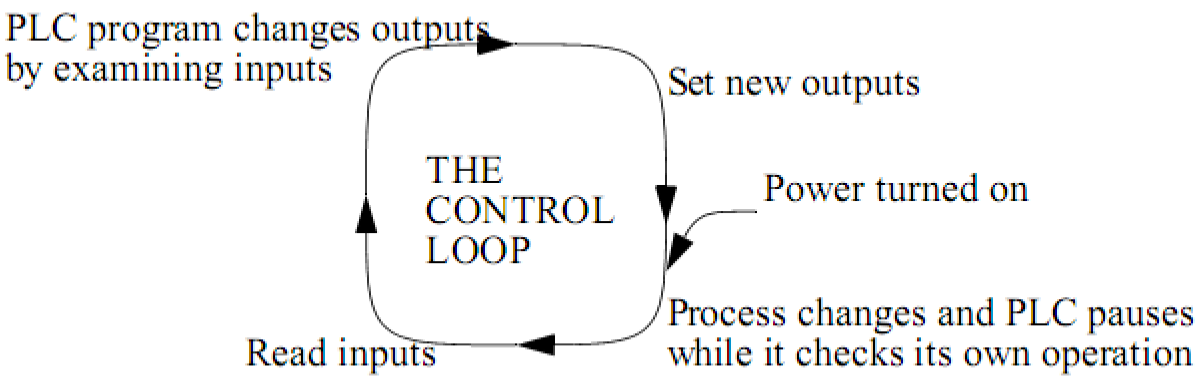
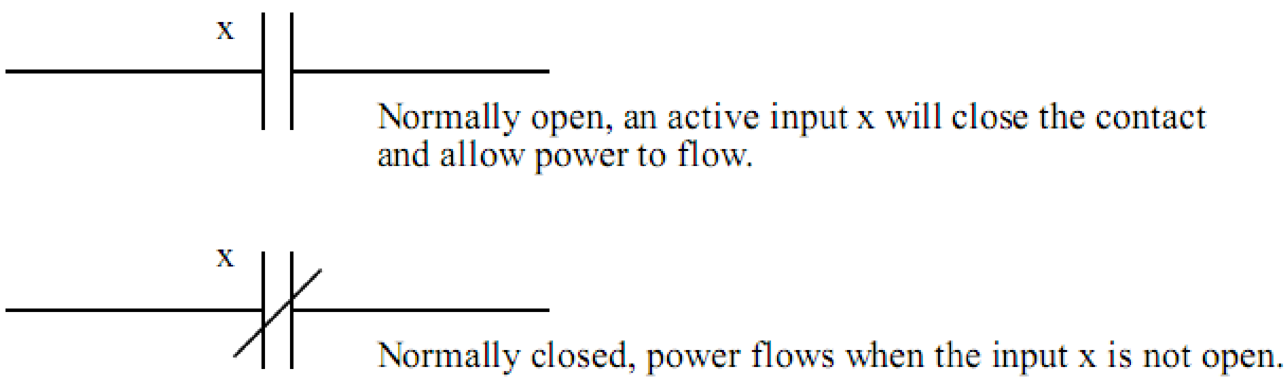
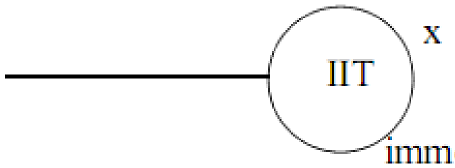


Fig. The Scan Cycle of a PLC

Ladder Logic Inputs PLC inputs are easily represented in ladder logic. In Figure 12 there are three types of inputs shown. The first two are normally open and normally closed inputs, discussed previously. The IIT (Immediate InpuT) function allows inputs to be read after the input scan, while the ladder logic is being scanned. This allows ladder logic to examine input values more often than once every cycle. (Note: This instruction is not available on the ControlLogix processors, but is still available on older models.)



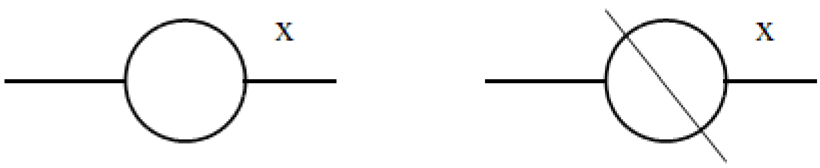


immediate inputs will take current values, not those from the previous input scan. (Note: this instruction is actually an output that will update the input table with the current input values. Other input contacts can now be used to examine the new values.)

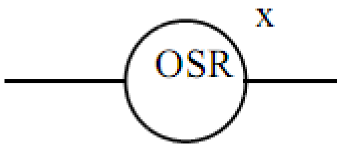
Fig. Ladder Logic Inputs

LADDER LOGIC OUTPUTS

In ladder logic there are multiple types of outputs, but these are not consistently available on all PLCs. Some of the outputs will be externally connected to devices outside the PLC, but it is also possible to use internal memory locations in the PLC. Six types of outputs are shown in Figure . The first is a normal output, when energized the output will turn on, and energize an output. The circle with a diagonal line through is a normally on output. When energized the output will turn off. This type of output is not available on all PLC types. When initially energized the OSR (One Shot Relay) instruction will turn on for one scan, but then be off for all scans after, until it is turned off. The L (latch) and U (unlatch) instructions can be used to lock outputs on. When an L output is energized the output will turn on indefinitely, even when the output coil is de-energized. The output can only be turned off using a U output. The last instruction is the IOT (Immediate OutpuT) that will allow outputs to be updated without having to wait for the ladder logic scan to be completed. When power is applied (on) the output x is activated for the left output, but turned off for the output on the right.



An input transition on will cause the output x to go on for one scan (this is also known as a one shot relay)



When the L coil is energized, x will be toggled on, it will stay on until the U coil is energized. This is like a flip-flop and stays set even when the PLC is turned off.

Some PLCs will allow immediate outputs that do not wait for the program scan to end before setting an output. (Note: This instruction will only update the outputs using the output table, other instruction must change the individual outputs.)

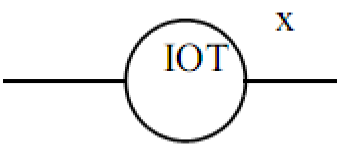


Fig. Ladder Logic Outputs

Note: Outputs are also commonly shown using parentheses -( )- instead of the circle. This is because many of the programming systems are text based and circles cannot be drawn.

PROJECT ON S5 SERIES PLC

At Electrolux one of machine named as MARISTED-1 Used to Cabinet Foaming for Refrigerators having S5 Series PLC used for the Automatic control of the machine. This machine program required to be modified to avoid accident in machine because of malfunctioning of Input devices (Limit Switches) and to ensure smooth trouble free operation of Machine

Machine PLC Details

MRSDT1

Power Supply-AC 230V/115V

DC 24V 2A

SIEMENS S5-100U

CPU 103

DI 8X24V DC- 10 in no.

DO 8X115/230V AC /0.5 A –10 in no.

Chapter 4

Functionality

The functionality of the PLC has evolved over the years to include sequential relay control, motion control, process control, distributed control system and networking. The data handling, storage, processing power and communication capabilities of some modern PLCs are approximately equivalent to desktop computers. PLC-like programming combined with remote I/O hardware, allow a general-purpose desktop computer to overlap some PLCs in certain applications. Regarding the practicality of these desktop computer based logic controllers, it is important to note that they have not been generally accepted in heavy industry because the desktop computers run on less stable operating systems than do PLCs, and because the desktop computer hardware is typically not designed to the same levels of tolerance to temperature, humidity, vibration, and longevity as the processors used in PLCs. In addition to the hardware limitations of desktop based logic, operating systems such as Windows do not lend themselves to deterministic logic execution, with the result that the logic may not always respond to changes in logic state or input status with the extreme consistency in timing as is expected from PLCs. Still, such desktop logic applications find use in less critical situations, such as laboratory automation and use in small facilities where the application is less demanding and critical, because they are generally much less expensive than PLCs.

In more recent years, small products called PLRs (programmable logic relays), and also by similar names, have become more common and accepted. These are very much like PLCs, and are used in light industry where only a few points of I/O (i.e. a few signals coming in from the real world and a few going out) are involved, and low cost is desired. These small devices are typically made in a common physical size and shape by several manufacturers, and branded by the makers of larger PLCs to fill out their low end product range. Popular names include PICO Controller, NANO PLC, and other names implying very small controllers. Most of these have between 8 and 12 digital inputs, 4 and 8 digital outputs, and up to 2 analog inputs. Size is usually about 4" wide, 3" high, and 3" deep. Most such devices include a tiny postage stamp sized LCD screen for viewing simplified ladder logic (only a very small portion of the program being visible at a given time) and status of I/O points, and typically these screens are accompanied by a 4-way rocker push-button plus four more separate push-buttons, similar to the key buttons on a VCR remote control, and used to navigate and edit the logic. Most have a small plug for connecting via RS-232 or RS-485 to a personal computer so that programmers can use simple Windows applications for programming instead of being forced to use the tiny LCD and push-button set for this purpose. Unlike regular PLCs that are usually modular and greatly expandable, the PLRs are usually not modular or expandable, but their price can be two orders of magnitude less than a PLC and they still offer robust design and deterministic execution of the logic.

Features

Control panel with PLC (grey elements in the center). The unit consists of separate elements, from left to right; power supply, controller, relay units for in- and output

The main difference from other computers is that PLCs are armored for severe conditions (such as dust, moisture, heat, cold) and have the facility for extensive input/output (I/O) arrangements. These connect the PLC to sensors and actuators. PLCs read limit switches, analog process variables (such as temperature and pressure), and the positions of complex positioning systems. Some use machine vision. On the actuator side, PLCs operate electric motors, pneumatic or hydraulic cylinders, magnetic relays, solenoids, or analog outputs. The input/output arrangements may be built into a simple PLC, or the PLC may have external I/O modules attached to a computer network that plugs into the PLC.

System scale

A small PLC will have a fixed number of connections built in for inputs and outputs. Typically, expansions are available if the base model has insufficient I/O.

Modular PLCs have a chassis (also called a rack) into which are placed modules with different functions. The processor and selection of I/O modules is customised for the particular application. Several racks can be administered by a single processor, and may have thousands of inputs and outputs. A special high speed serial I/O link is used so that racks can be distributed away from the processor, reducing the wiring costs for large plants.

User interface

See also: User interface
See also: List of human-computer interaction topics

PLCs may need to interact with people for the purpose of configuration, alarm reporting or everyday control.

A Human-Machine Interface (HMI) is employed for this purpose. HMIs are also referred to as MMIs (Man Machine Interface) and GUIs (Graphical User Interface).

A simple system may use buttons and lights to interact with the user. Text displays are available as well as graphical touch screens. More complex systems use programming and monitoring software installed on a computer, with the PLC connected via a communication interface.

Communications

PLCs have built in communications ports, usually 9-pin RS-232, but optionally EIA-485 or Ethernet. Modbus, BACnet or DF1 is usually included as one of the communications protocols. Other options include various fieldbuses such as DeviceNet or Profibus. Other communications protocols that may be used are listed in the List of automation protocols.

Most modern PLCs can communicate over a network to some other system, such as a computer running a SCADA (Supervisory Control And Data Acquisition) system or web browser.

PLCs used in larger I/O systems may have peer-to-peer (P2P) communication between processors. This allows separate parts of a complex process to have individual control while allowing the subsystems to co-ordinate over the communication link. These communication links are also often used for HMI devices such as keypads or PC-type workstations.

Example

As an example, say a facility needs to store water in a tank. The water is drawn from the tank by another system, as needed, and our example system must manage the water level in the tank.

Using only digital signals, the PLC has two digital inputs from float switches (Low Level and High Level). When the water level is above the switch it closes a contact and passes a signal to an input. The PLC uses a digital output to open and close the inlet valve into the tank.

When the water level drops enough so that the Low Level float switch is off (down), the PLC will open the valve to let more water in. Once the water level rises enough so that the High Level switch is on (up), the PLC will shut the inlet to stop the water from overflowing. This rung is an example of seal-in (latching) logic. The output is sealed in until some condition breaks the circuit.

```
|                                          |
|   Low Level      High Level              Fill Valve     |
|------[/]------|------[/]----------------------(OUT)---------|
|              |                           |
|              |                           |
|              |                           |
|   Fill Valve  |                               |
|------[ ]------|                              |
|                                          |
|                                          |
```

An analog system might use a water pressure sensor or a load cell, and an adjustable (throttling) dripping out of the tank, the valve adjusts to slowly drip water back into the tank.

In this system, to avoid 'flutter' adjustments that can wear out the valve, many PLCs incorporate "hysteresis" which essentially creates a "deadband" of activity. A technician adjusts this deadband so the valve moves only for a significant change in rate. This will in turn minimize the motion of the valve, and reduce its wear.

A real system might combine both approaches, using float switches and simple valves to prevent spills, and a rate sensor and rate valve to optimize refill rates and prevent water hammer. Backup and maintenance methods can make a real system very complicated.

Programmable logic controller

Chapter 5

COMPARISON

PC Vs PLC

* PLCs are constructed for a specific purpose with a smaller program, whereas PCs perform general tasks.
* PLCs are sequential-type controllers which can process individual steps in a program in order.
* PLCs do majority of the control jobs whereas PCs handle most of the data and math functions.
* PLCs can be programmed, controlled and operated by a person unskilled in operating computers.
* Dedicated application to a specific function using a relatively small control program.
* Rapid simultaneous execution of the individual steps in the program.
* The PLC can operate any system that has input/output devices that go on and off ass well as any system with variable input/outputs.

ADVANTAGES & DISADVANTAGES OF PLCS

ADVANTAGES

- Increase in flexibility,
- Faster implementation of changes and correction,
- Lower cost,
- Easy visualization of process running,
- Increased visual observations,
- Increased operation speed,
- Increased reliability and maintainability,
- Increased security,
- Reprogramming capability,

- Elimination of wiring.

DISADVANTAGES

- Too much work required in connecting wires.
- Difficulty with changes or replacements.
- Difficulty in finding errors; requiring skillful work force.
- Fixed program applications,
- High initial investment cost.

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