NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

ELEVATOR CONTROL WITH PLC

Graduation Project
EE - 400

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Dedicated to My Father and My Mother

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ABSTRACT

As PLC technology has advanced, so have programming languages and communications capabilities, along with many other important features. Today's PLCs offer *faster scan times, space efficient* high-density input/output systems, and special interfaces to allow non-traditional devices to be attached directly to the PLC. Not only can they communicate with other control systems, they can also perform reporting functions and diagnose their own failures, as well as the failure of a machine or process. Size is typically used to categorize today's PLC, and is often an indication of the features and types of applications it will accommodate.

In this graduation project Simatic S7-200 CPU 212 8 inputs, 6 outputs, 24 volt DC input 24 Volt DC output PLC is used, and an automation of a modeled and designed Elevator using a DC motor is realized by PLC programs.

INTRODUCTION

A Programmable Logic Controller was defined by Capiel (1982) as:
"A digitally operating electronic system designed for use in an industrial environment, which uses a programmable memory for the internal storage of instructions for implementing specific functions such as logic, sequencing, timing, counting and arithmetic to control through analog or digital input/output modules, various types of machines or processes." Which explains the device perfectly.

In the late 1960's PLC's were first introduced. The first PLC can be traced back to 1968 when Bedford Associates, a company in Bedford, MA, developed a device called a Modular Digital Controller for General Motors (GM). The MODICON, as it was known, was developed to help GM eliminate traditional relay-based machine control systems.

The aim of this thesis is the control of the Elevator and DC Motor with SIMATIC S7-200 MICRO/WIN PLC.

The Thesis consists of the introduction, four chapters, and conclusion.
Chapter-1 presents history of PLC, what is PLC?, types of PLC's, hardware of PLC's, and chapter concluded with a brief information about today's PLC's.
Chapter-2 presents the informations about Siemens SIMATIC S7-200 PLCs and application areas of this type of PLCs.
Chapter-3 presents the theoritical explanation about equipments used at project.
Chapter-4 presents practical implementation with PLC's.

1. PROGRAMMABLE LOGIC CONTROLLERS

1.1 OVERVIEW

The first PLC can be traced back to 1968 when Bedford Associates, a company in Bedford, MA, developed a device called a Modular Digital Controller for General Motors (GM). The MODICON, as it was known, was developed to help GM eliminate traditional relay-based machine control systems. Because relays are mechanical devices, they have limited lifetimes. They are also cumbersome, especially in large applications where thousands of them may exist. With so many relays to work with, wiring and troubleshooting could be quite complicated. Since the MODICON was an electronic device, not a mechanical one, it was perfect for GM's requirements, as well as for many other manufacturers and users of control equipment. With less wiring, simpler troubleshooting, and easy programming, PLC technology caught on quickly

1.2 History of PLC

In the late 1960's PLC's were first introduced. The primary reason for designing such a device was eliminating the large cost involved in replacing the complicated relay based machine control systems. Bedford Associates (Bedford, MA) proposed something called a modular digital controller (MODICON) to a major US car manufacturer. Other companies at the time proposed computer based upon the PDP – 8. The MODICON 084 brought the world's first PLC into commercial production. When production requirements changed so did the control system. This becomes very expensive when the change is frequent. Since relays are mechanical devices they also have a limited lifetime that required strict adhesion to maintenance schedules. Troubleshooting was also quite tedious when so many relays are involved. Now picture a machine control panel that included many, possible hundreds or thousands, of individual relays. The size could be mind-boggling. How about the complicated initial wiring of so many individual devices! These relays would be individually wired together in a manner that would yield the desired outcome. These new controllers also had to be easily programmed by maintenance and plant engineers. The lifetime had to be long and programming changes easily performed. The also had to survive the harsh industrial environment. That's a lot to ask! The answers were to use a programming technique most people were already familiar with and replace mechanical parts with solid-state ones.,In the mid70's the dominant PLC techniques were sequencer state machines and the bit-slice based CPU. The AMD 2901 and 2903 were quite popular in MODICON and A-B PLC's. Conventional microprocessors lacked the power to quickly solve PLC logic in all but the smallest PLC's. As conventional microprocessors evolved, larger and larger PLC's were being based upon them. However, even today some are still based upon the 2903. MODICON has yet the build a faster PLC then their 984A/B/X, which was based upon the 2901.

Communications abilities began to appear in approximately 1973. The first such system was MODICON's MODBUS. The PLC could now talk to other PLC's and they could be far away from the actual machine they were controlling. They could also now be used to send and receive varying voltages to allow them to enter the analogue world. Unfortunately, the lack of standardization coupled with continually changing technology has made PLC communications a nightmare of incompatible protocols and physical networks.

The 80's saw an attempt to standardize communications with General Motor's manufacturing automation protocol. It was also a time for reducing the size of the PLC and making them software programmable through symbolic programming on personnel computers instead of dedicated programming terminals or handheld programmers.

The 90's have seen a gradual reduction in the introduction new protocols, and the modernization of the physical layers of same of the more popular protocols that survived the 1980's. The latest standard has tried to merge PLC- programming languages less than one international standard. We now have PLC's that are programmable in function block diagrams, instruction list, C and structured text all at the same time! PC's are also being used to replace PLC's in some applications. The original company who commissioned the MODICON 084 has actually switched to a PC based control system.

1.3 What is a PLC ?

PLCs are often defined as miniature industrial computers that contain hardware and software that is used to perform control functions. A PLC consists of two basic sections:

the central processing unit (CPU) and the input/output interface system. The CPU, which controls all PLC activity, can further be broken down into the processor and memory system. The input/output system is physically connected to field devices (e.g., switches, sensors, etc.) and provides the interface between the CPU and the information providers (inputs) and controllable devices (outputs). To operate, the CPU "reads" input data from connected field devices through the use of its input interfaces, and then "executes", or performs the control program that has been stored in its memory system. Programs are typically created in ladder logic, a language that closely resembles a relay-based wiring schematic, and are entered into the CPU's memory prior to operation. Finally, based on the program, the PLC "writes", or updates output devices via the output interfaces. This process, also known as scanning, continues in the same sequence without interruption, and changes only when a change is made to the control program

A programmable logic controller (PLC) is a device that was invented to replace the necessary sequential relay circuits for machine control. The PLC works by looking at its inputs and depending upon their state, turning on / off its outputs. The user enters a program, usually via software, that gives the desired results.

PLC's are used in many real world applications. If there is industry present, changes are good that there is a PLC present. If you are involved in machining, packaging material handling, and automated assembly or countless other industries you are probably already using them. If you are not, you are wasting money and time. Almost any application that needs some type of electrical control has a need for PLC.

For example, let's assume that when a switch turned on, we want turn on a solenoid for 5 seconds and then turn it off regularly of how long the switch is on. We can do this with a simple external timer. But what will happen if the process included 10 switches and solenoids? We would need 10 external timers. What will happen if the process also needed to count how many times the switches individually turned on? We would need a lot of external counters.

As you see, if the process becomes more complicated, then we have to use a device the simplify that. We use PLC for this process. We can program the PLC to count its inputs and turn the solenoids for the specified time.

This site gives you enough information to be able to write programs for more complicated then the simple than above. We will take a look at what is considered to be the 'top 20' PLC instructions. It can be safely estimated that with affirm understanding of these instructions, that just one of them can solve more than 80 % of the applications in existence.

1.4 General Physical Build Mechanism

PLC's are separated into two according to their building mechanisms.

1.4.1 Compact PLC'S

Compact PLC's are manufactured such that all units forming the PLC are placed in a case. They are low price PLC with lower capacity. Small or medium size machine manufacturers usually prefer them. In some types compact enlargement module is present.

1.4.2 Modular PLC's

Combining separate modules together in a board forms them. They can have different memory capacity, I / O numbers, power supply up to the necessary limits.

Some examples: SIEMENS S5-115U, SIEMENS S7-200, MITSUBISHI PC40, TEXAS INSTRUMENT PLC'S, KLOCKNER-MOELLER PS316, OMRON C200H.

1.5 Programmable Controller

The need for low cost, versatile and easily commissioned controllers has resulted in the development of programmable-control systems standard units based on a hardware CPU and memory for the control of machines or processes. Originally designed as a replacement for the hard-wired relay and timer logic to be found in traditional control panels, PLC's provides ease and flexibility of control based on programming and executing simple logic instructions. PLC's have internal functions such as timers, counters and shift registers, making sophisticated control possible using even the smallest PLC.

A programmable control operates by examining the input signals from a process and carrying out logic instructions on these input signals, producing output signal to drive process equipment or machinery. Standard interfaces build into PLC's allow them to be directly connected to process actuators and transducers (pumps and valves) without the need for intermediate circuitry or relays.

Through using PLC's it became possible to modify a control system without having the disconnect or re-route a signal wire. It was necessary to change only the control program using a keypad or VDU terminal. Programmable controllers also require shorter installation and commissioning times than do hardwired systems. Although PLC's are similar to conventional computers in terms of hardware technology, they have specific features suited to industrial control:

- Rugged, noise immune equipment;
- Modular plug-in construction, allowing easy replacement\addition of units (input\output);
- Standard input\output connections and signal levels;
- Easily understood programming language (ladder diagram and function chart),
- Ease of programming and reprogramming in-plant.

These features make programmable controllers highly desirable in a wide variety of industrial-plant and process-control situations.

1.5.1 Background

The programmable controller was initially conceived by a group of engineers from General Motors in 1968, where an initial specification was provided: the controller must be:

1) Easily programmed and reprogrammed, preferably in-plant to alter its sequence of operations.

2) Easily maintained and repaired- preferably using plug-in modules.

a) More reliable in plant environment.

b) Smaller than it is relay equivalent.

3) Cost competitive, with solid-state and relay panels than in use.

This provoked a keen interest from engineers of all disciplines in how to PLC could be used for industrial control. With this came demands for additional PLC capabilities and facilities, which were rapidly implemented as the technology became available. The instruction sets quickly moved from simple logic instructions to include counters, timers and shift registers, than onto more advanced mathematical functions on the machines. Developments hardware were also occurring, with larger memory and greater numbers of input / output points featuring on new models. In 1976 became possible to control remote I / O racks, where large numbers of distant I / O points were monitored updated via a communications link, often several hundred meters from the main PLC. The Allan-Bradley Corporation in America introduced a microprocessor-based PLC in 1977. It was based on an 8080 microprocessor but used an extra processor to handle bit logic instruction at high speed.

The increased rate of application of programmable controllers within industry has encouraged manufacturers to develop whole families of microprocessor-based systems having various levels of performance. The range of available PLC's now extends from small self-contained units with 20 digital I / O points and 500 program steps, up to modular systems with add-on function modules:

- Analogue I/O;
- PID control (proportional, integral and derivative terms);
- Communications;
- Graphics display;
- Additional I/O;
- Additional memory.

This modular approach allows the expansion or upgrading of a control system with minimum cost and disturbance.

Programmable controllers are developing at a virtually the same pace as microcomputers, with particular emphasis on small controllers, positioning\numeric control and communication networks. The market for small controllers has grown rapidly since the early 1980's when a number of Japanese companies introduced very small, low cost units that were much cheaper than others available at that time. This brought programmable controllers within the budget of many potential users in the manufacturing and process industries, and this trend continues with PLC's offering ever-increasing performance at ever-decreasing cost.

1.5.2. Terminology-PC or PLC

There are several different terms used to describe programmable controllers, most referring to the functional operation of the machine in question:

- PC programmable controller
- PLC programmable logic controller
- PBS programmable binary system

By their nature these terms tend to describe controllers that normally work in a binary environment. Since all but the smallest programmable controllers can now be equipped to process analogue inputs and outputs these labels are not representative of their capabilities. For these reason the overall term programmable controller has been widely adopted to describe the family of freely programmable controllers. However, to avoid confusion with the personal computer PC, this text uses the abbreviation PLC for programmable (logic) controller.

1.5.3. PLC Hardware Design

Programmable controllers are purpose-built computers consisting of three functional areas:

- Processing:
- Memory:
- Input / output:

Input conditions to the PLC are sensed and than stored in the memory, where the PLC performs the programmed logic instructions on these input states. Output conditions are then generated to drive associated equipment. *The action taken depends totally on the* control program held in memory.

In smaller PLC these functions are performed by individual printed circuit cards within a single compact unit, whilst larger PLC's are constructed on a modular basis with function modules slotted in to the back plane connectors of the mounting rack.

This allows simple expansion of the system when necessary. In both these cases the individual circuit board are easily removed and replaced, facilitating rapid repair of the system should faults develop.

In addition a programming unit is necessary to download control programs to the PLC memory.

a) Input/Output units

Most PLC'S operate internally at between 5 and 15 V d.c. (Common TTL and CMOS voltages), whilst process signals much greater, typically 24 V d.c. to 240 V a.c. at several amperes.

The I/O units form the interface between the microelectronics of the programmable controller and real world outside, and must therefore provide all, necessary signal conditioning and isolation functions. This often allows a PLC to be directly connected to process actuators and transducers (pumps and valves) without the need for intermediate circuitry and relays.

To provide this signal conversion programmable controllers are available with a choice of input / output units to suit different requirements.

For example:

Inputs:	5 V (TTL level) switched I/ P
	24 V switched I/ P
	110 V switched I/ P
	240 v switched I/ P
Outputs:	24 V 100 mA switched O/ P
	110 V 1mA
	240 V 1 A a.c. (triac)
	240 V 2 A a.c. (relay)

It is standard practice for all I/O channels to electrically isolated from the controlled process, using opto-isolator circuits on the I/O modules. An opto-isolator circuit consists of a light emitting diode and a phototransistor, forming an opto coupled pair that allows small signals to pass through, but will clamp any high voltage spikes or surges down to the same small level. This provides protection against switching transients and power-supply surges, normally up to 1500V.

In small self contained PLC's in which all I/ O points are physically located on the one casing, all inputs will be of one type (e.g. 24 V) and the same for outputs (e.g. all 240 V triac). This is because manufacturers supply on the standard function boards for economic reasons. Modular PLC's have greater flexibility of I/ O, however, since the user can select from several different types and combinations of input and output modules.

In all cases the input/output units are designed with the aim of simplifying the connections of process transducers and actuators to the programmable controller. For these purpose all PLC'S are equipped with standard screw terminals or plugs on every I\O point, allowing the rapid and simple removal and replacement of a faulty I/ O card. Every input\output point has a unique address or channel number, which is using during program development to specify to monitoring of an input or the activating of a particular output within the program. Indication of the status of input\output channels is provided by light-emitting diode (LED's) on the PLC or I/ O unit, making it simple to check the operation of process inputs and outputs from the PLC itself.

b) Central Processing Unit (CPU)

The CPU controls and supervises all operations within the PLC, carrying out programmed instructions stored in memory. An internal communications highway or bus system carries information to and from the CP, memory and I/ O units, under control of the CPU. The CPU is supplied with a clock frequency by an external quartz crystal or RC oscillator, typically between 1 and 8 megahertz depending on the microprocessor used and the area of application.

The clock determines the operating speed of the PLC and provides timing\synchronization for all elements in the system. Virtually all modern programmable controllers are microprocessor based using a micro as a system CPU. Some larger PLC's also employ additional microprocessor to control complex, time-consuming functions such as mathematical processing, three terms PID control.

c) Memory

For program storage all modern programmable controllers use semiconductor memory devices such as RAM read\write memory, or a programmable read-only memory of the EPROM or EEPROM families.

In the virtually all cases RAM is used for initial program development and testing, as it follows changes to be easily made in program. The current trend is to be providing CMOS RAM because of it is very low power consumption, to provide battery back up to this RAM in order to maintain the contents when the power is removed from the PLC system. This battery has a lifespan of at least one year before replacement is necessary, or alternatively a rechargeable type may be supplied with the system being recharge whenever the main PLC power supply is on.

This feature makes programs stored in RAM virtually permanent. Many users operate their PLC systems on this basis alone, since it permits future program alterations if and when necessary.

After a program is fully developed and tested it may be loaded (blown) into a PROM or EPROM memory chip, which are normally cheaper than RAM devices. PROM programming is usually carried out with a special purpose programming unit, although many programmable controllers now have this facility built-in, allowing programs in the PLC RAM to be down loaded into a PROM IC placed in a socket provided on the PLC itself.

In addition to program storage, a programmable controller may require memory for other functions:

1) Temporary buffer store for input\output channels status- I/O RAM
2) Temporary storage for status of internal function (timers, counters, marker relays)

Since these consist of changing data they require RAM read\write memory, which may be battery-backed in sections.

d) Memory Size

Smaller programmable controllers normally have a fixed memory size, due in part to the physical dimensions of the unit. This varies in capacity between 300 and 1000 instructions depending on the manufacturer. This capacity may not appear large enough to be very useful, but it has been estimated that 90 % of all binary control tasks can be solved using less than 1000 instructions, so there is sufficient space to meet most users needs.

Larger PLC's utilize memory modules of between 1K and 64K in size, allowing the system to be expanded by fitting addition RAM or PROM memory cards to the PLC rack.

As integrated circuit memory costs continue to fall, the PLC manufacturers are providing larger program memories on all products.

e) Logic Instruction Set

The most common technique for programming small PLC's is to draw s ladder diagram of the logic to be used, and then convert this in to mnemonic instructions, which will be keyed in to programming panel attached to the programmable controller. These instructions are similar in appearance to assembly-type codes, but refer to physical inputs, outputs and functions within the PLC itself.

The instruction set consists of logic instructions (mnemonics) that represent the actions that may be performed within a given programmable controller. Instructions sets vary between PLC's from different manufacturers, but are similar in terms of the control actions performed.

Because the PLC logic instruction set tends to be small, it can be quickly mastered and used by control technicians and engineers.

Each program instructions are made up of two parts: a mnemonic operation component or opcode, and an address or operand component that identifies particular elements.

f) Input/Output Numbering

These instructions are used the program logic control circuits that have been designed in ladder diagram form, by assigning all physical inputs and outputs with an operand suitable to the PLC being used. The numbering system used differs between manufacturers, but certain common terms exist. For example, Texas instrument and Mitsubishi use the symbol X to represent inputs, and Y to label outputs.

1.6 Types Of PLC

The increasing demand from industry for programmable controllers that can be applied to different forms and sizes of control tasks has resulted in most manufacturers producing a range of PLC's with various levels of performance and facilities.

Typical rough definitions of PLC size are given in terms of program memory size and the maximum number of input\output points the system can support. Table 1 gives an example of these categories.

Table : 1.1 Categories of PLC

PC size	Max I \ O points	Use memory size
Small	40 / 40	1K
Medium	128 / 128	4K
Large	> 128 / > 128	> 4K

However, to evaluate properly any programmable controller we must consider many additional features such as its processor, cycle time language facilities, functions, and expansion capabilities.

A brief outline of the characteristics of small, medium of large programmable controller is given below, together with typical applications.

1.6.1. Small PLC's

In general, small and 'mini' PLC's are designed as robust, compact units, which can be mounted on or beside the equipment to be controlled. They are mainly used the replaced hard-wired logic relays, timers, counters. That control individual items of plant or machinery, but can also be used to coordinate several machines working in conjunction with each other.

Small programmable controllers can normally have their total I/ O expanded by adding one or two I/ O modules, but if any further developments are required this will often mean replacement of the complete unit. This end of the market is very much concerned with non-specialist and users, therefore ease of programming and a 'familiar' circuit format are desirable. Competition between manufacturers is extremely fierce in this field, as they vie to obtain a maximum share in this partially developed sector of the market.

A single processor is normally used, and programming facilities are kept a fairly basic level, including conventional sequencing controls and simple standard functions: e.g. timers and counters. Programming of small PLC's is by way of logic instruction list (mnemonics) or relay ladder diagrams.

Program storage is given by EPROM or battery-backed RAM. There is now a trend towards EEPROM memory with on-board programming facilities on several controllers.

1.6.2 Medium-sized PLC's

In this range modular construction predominates with plug-in modules based around the Euro card 19-inch rack format or another rack mounting system. This construction allows the simple upgrading or expansion of the system. This construction allows the simple upgrading or expansion of the system by fitting additional I/ O cards in to the cards into the rack, since most rack, systems have space for several extra function cards. Boards are usually 'rugged zed' to allow reliable operation over a range of environments.

In general this type of PLC is applied to logic control tasks that can not be met by small controllers due to insufficient I\O provision, or because the control task is likely to be extended in the future. This might require the replacement of a small PLC, where as a modular system can be expanded to a much greater extent, allowing for growth. A medium-sized PLC may therefore be financially more attractive in the long term.

Communications of a single and multi-bit processor are likely within the CPU. For programming, standard instructions or ladder and logic diagrams are available. Programming is normally carried out via a small keypad or a VDU terminal. If different sizes of PLC are purchased from a single manufacturer, it is likely that programs and programming panels will be compatible between the machines.

1.6.3 Large PLC

Where control of very large numbers of input and output points is necessary and complex control functions are required, a large programmable controller is the obvious choice. Large PLC's are designed for use in large plants or on large machines requiring continuous control. They are also employed as supervisory controllers to monitor and control several other PLC's or intelligent machines. e.g. CNC tools.

Modular construction in Euro card format is standard, with a wide range of function cards available including analogue input output modules. There is a move towards 16-bit processor, and also multi-processor usage in order to efficiently handle a large range of differing control tasks.

For example;

- 16-bit processor as main processor for digital arithmetic and text handling.
- Single-bit processor as co-or parallel processor for fast counting, storage etc.
- Peripheral processor for handling additional tasks which are time-dependent or time-critical, such as:
  - Closed-loop (PID) control
  - Position controls
  - Floating-point numerical calculations
  - Diagnostic and monitoring
  - Communications for decentralized
  - Remote input\output racks.

This multi-processor solution optimizes the performance of the overall system as regards versatility and processing speed, allowing to PLC to handle very large programs of 100 K instructions or more. Memory cards can now provide several megabytes of CMOS RAM or EPROM storage.

1.6.4. Remote input\output

When large numbers of input / output points are located a considerable distance away from the programmable controller, it is uneconomic to run connecting cables to every point. A solution to this problem is to site a remote I/ O unit near to the desired I/ O points. This acts as a concentrator to monitor all inputs and transmit their status over a single serial communications link to the programmable controller. Once output signals have been produced by the PLC they are feedback along the communications cable to the remote I/ O unit, which converts the serial data into the individual output signals to drive the process.

1.6.5 Programming Large PLC's

Virtually any function can be programmed, using the familiar ladder symbols via a graphics terminal or personal computer. Parameters are passed to relevant modules either by incorporating constants in to the ladder, or via on screen menus for that module.

There may in addition be computer-oriented languages, which allow programming of function modules and subroutines.

There is progress towards standardization of programming languages; with programs becoming easier to over-view through improvement of text handling, hand improved documentation facilities. This is assisted by the application of personal computers as workstations.

1.6.6. Developments

Present trends include the integration of process data from a PLC into management databases, etc. This allows immediate presentation of information to those involved in scheduling, production and planning.

The need to pass process information between PC's and PLC sand other devices within a automated plants has resulted in the provision of a communications capability on all but the smallest controller. The development of local area networks (LAN) and in particular the recent MAP specification by General Motors (manufacturing automation protocol) provides the communication link to integrate all levels of control systems.

1.7.Today's PLC

As PLC technology has advanced, so have programming languages and communications capabilities, along with many other important features. Today's PLCs offer faster scan times, space efficient high-density input/output systems, and special interfaces to allow non-traditional devices to be attached directly to the PLC. Not only can they communicate with other control systems, they can also perform reporting functions and diagnose their own failures, as well as the failure of a machine or process. Size is typically used to categorize today's PLC, and is often an indication of the features and types of applications it will accommodate. Small, non-modular PLCs (also known as fixed I/O PLCs) generally have less memory and accommodate a small number of inputs and outputs in fixed configurations. Modular PLCs have bases or racks that allow installation of multiple I/O modules, and will accommodate more complex applications. When you consider all of the advances PLCs have made and all the benefits they offer, it's easy to see how they've become a standard in the industry, and why they will most likely continue their success in the future.

1.8. SUMMARY

In this chapter brief information about PLC history, what is PLC, general physical build mechanism, terminology-PC or PLC, hardware design of PLC's, types of PLC's and brief information about today's PLC was given.

2. AN OVERVIEW OF SIEMENS S7-200 MICRO-CONTROLLER

2.1. OVERVIEW

STEP 7-Micro/WIN supports the S7-200 CPUs by giving you the features to set up and manage your application project. A project consists of the program you enter with STEP 7-Micro/WIN, along with the documentation you write for the program and the configuration you set up for the CPU.

You have the option of selecting either Ladder or Statement List as your programming language. With the S7-200 CPUs, you have a basic program structure that gives you flexibility in setting up any subroutines or interrupts that you program.

2.2. Introduction to the Simatic S7-200 Micro PLC

The Simatic S7-200 series is a line of micro-programmable logic controllers (Micro PLCs) that can control a variety of automation applications. Figure 2.1 shows an S7-200 Micro PLC. The compact design, expandability, low cost, and powerful instruction set of the S7-200 Micro PLC make a perfect solution for controlling small applications. In addition, the wide variety of CPU sizes and voltages provides you with the flexibility you need to solve your automation problems.

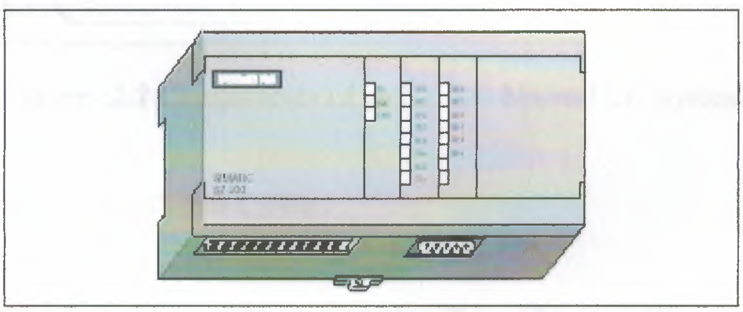


Figure :2.1 S7-200 Micro PLC

2.3. Comparing the Features of the S7-200 Micro PLCs

2.3.1 Equipment Requirements

Figure 2.2 shows the basic S7-200 Micro PLC system, which includes an S7-200 CPU module, a personal computer, STEP 7-Micro/WIN programming software, and a communications cable.

In order to use a personal computer (PC), you must have one of the following sets of equipment:

- A PC/PPI cable
- A communications processor (CP) card and multipoint interface (MPI) cable
- A multipoint interface (MPI) card. A communications cable is provided with the MPI card.

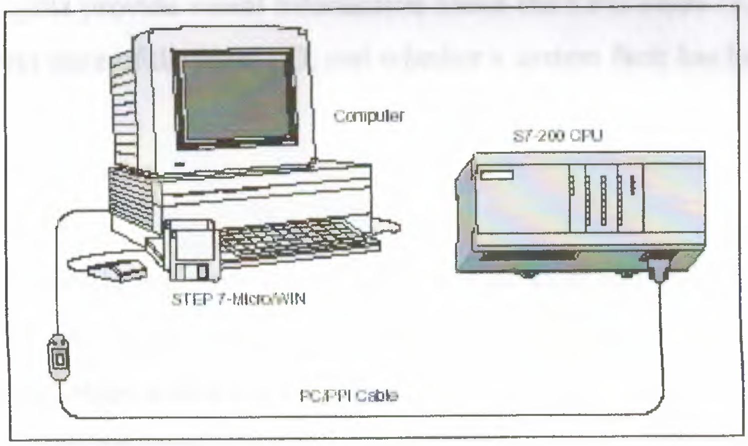


Figure :2.2 Components of an S7-200 Micro PLC System

2.3.2 Capabilities of the S7-200 CPUs

The S7-200 family indudes a wide variety of CPUs. This variety provides a range of features to aid in designing a cost-effective automation solution.

2.4. Major Components of the S7-200 Micro PLC

An S7-200 Micro PLC consists of an S7-200 CPU module alone or with a variety of optional expansion modules

2.4.1. CPU Module

The S7-200 CPU module combines 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 outputs are the system control points: the inputs monitor the signals from the field devices (such as sensors and switches), and the outputs control pumps, motors, or other devices in your process.
- The communications port allows you to connect the CPU to a programming device or to other devices. Some S7-200 CPUs have two communications ports.
- Status Lights 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.

2.4.2. Expansion Modules

The 7-200 CPU module provides a certain number of local I/O. Adding an expansion module provides additional input or output points. As shown in Figure 2.3, the expansion module comes with a bus connector for connecting to the base unit.

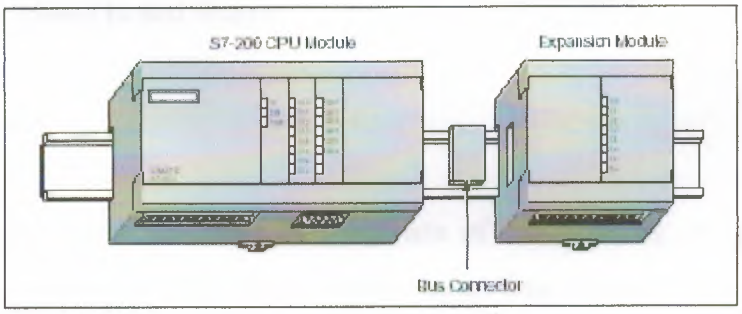


Figure :2.3 CPU Module with an Expansion Module

2.5. Programming Languages

2.5.1. Ladder Programs

In Ladder programs, the basic elements of logic are represented with contacts, coils, and boxes. A set of interconnected elements that make a complete circuit is called a network.

A hard-wired input is represented by a symbol called a contact. A normally open contact enables power flow when closed. A contact can also be normally closed. In this case, power flow occurs when the contact is opened.
A hard-wired output is represented by a symbol called a coil. When a coil has power flow, the output is turned on.

A box is a symbol for a complex operation performed within the CPU. The box simplifies programming of the operation. For example, boxes represent timers, counters, and math operations.

2.5.2. STL Programs

STL program elements are represented by a set of instructions for performing the desired functions. Instead of using the graphic display as shown by ladder programs, the STL program is shown in text format.

2.6. CPU Memory

The user memory in the S7-200 CPUs consists of three blocks: program, data, and configurable parameters. The blocks are defined according to usage:

Program memory stores the user program.

Data memory includes a temporary area for the program and storage of data. The temporary storage, calculations, and constants reside in data memory. Additionally, data for timers, counters, high-speed counters, and analog inputs and outputs are stored in data memory.

Configurable Parameter memory stores either the default or the modified parameters of the program setup. The configurable parameters include items such as protection level, password, station address, and retentive range information.

2.7. Simatic S7-200 Application Areas

The SIMATIC S7-200 series is a line of micro-programmable logic controllers (Micro PLCs) that can control a variety of automation applications. Compact design, low cost, and a powerful instruction set make the S7-200 controllers a perfect solution for controlling small applications. The wide variety of CPU sizes and voltages, and the windows-based programming tool, give you the flexibility you need to solve your automation problems.

2.7.1. The S7-200 is Characterized by the Following Properties

- Easy entry
- Uncomplicated operation
- Peerless real-time characteristics
- Powerful communications capabilities

The S7-200 achieves its full performance potential in distributed automation solutions thanks especially to the integrated ProFi Bus-DP connection. The application area of the SIMATIC S7-200 extends from replacing simple relays and contactors right up to more complex automation tasks.

The S7-200 also covers areas where previously special electronics have been developed for cost reasons. Application areas include:

- Baling processes
- Plaster & Cement mixers
- Suction Plants
- Centralized lubricating systems/flange lubricating systems

- Woodworking machinery
- Gate controls
- Hydraulic lifts
- Conveyor systems
- Food & Drink Industry
- Laboratories
- Modem applications via dial-up, leased-line, or radio remote monitoring (SCADA)
- Electrical Installations

2.7.2. Mechanical Features Include

Rugged, compact plastic housing using SIMATIC's prize-winning design
Easily accessible wiring and operator control and display elements protected by front covers

Installs on standard horizontal or vertical DIN rail or direct cabinet mounting with built-in mounting

2.7.3. Design Features

International standards; Meets the requirements through compliance with VDE, UL, CSA and FM standards.

The quality management system used during manufacturing has ISO 9001 certification; and Data back up; the user program and the most important parameter settings are stored in the internal EEPROM. A heavy-duty capacitor provides additional back up for all data over longer periods (typically up to 50 or 190 hours). An optional battery module ensures that the data remain stored for 200 days (typically) after power failure.

2.7.4. Benefits of the S7-200

a) Complete Automation Solution

The SIMATIC S7-200 Micro PLC is a full-featured programmable logic control system offering stand-alone CPUs, micro-modular expansion capability, and operator interface solutions. Almost any application that requires automation, from basic discrete or analog control, to intelligent networked solutions, can benefit by using the powerful S7-200 family of products.

b) Value for OEMs

Wherever central controllers or expensive custom electronic control systems are used, the SIMATIC S7-200 offers a significantly more economical alternative. Our off-the-shelf, compact solution, is packed with features, and is accepted around the world as a Micro PLC standard.

c) Real-time Speed & Versatility

The SIMATIC S7-200 offers real-time control with Boolean processing speeds of 0.37μs per instruction. This fast execution speed, combined with our 20Khz high-speed counters, interrupts, and 20KHz pulse outputs, provide quick responses in demanding real-time applications. The S7-200 has over 200 instructions, including math, PID, For/Next loops, subroutines, sequence control, and more.

d) Integrated Communications

All S7-200 CPUs offer at least one RS485 communication port with speeds up to 187.5Kbaud. This not only provides fast access for programming and maintenance, but also allows you to build master/slave networks with up to 31 stations.

Using our Freeport capability can also connect non-S7-200 devices, such as bar code readers, intelligent machines, etc.. With Freeport, you can easily adapt the S7-200 CPU to virtually any serial ASCII protocol.

2.8 Advantages

2.8.1. Accuracy

In relay control systems logical knowledge's carries in electro-mechanical contactors, they can lose data because of mechanical errors. But PLC's are microprocessor-based system so logical data are carried inside the processor, so that PLC's are more accurate than relay type of controllers.

2.8.2. Data Areas

Data memory contains variable memory, and register, and output image register, internal memory bits, and special memory bits. This memory is accessed by a byte bit convention. For example to access bit 3 of variable memory byte 25 you would the address V25.3.

The following Table 2.1 shows the identifiers and ranges for each of the data area memory types:

Table : 2.1 Data area memory types

Area Identifier	**Data Area**	**CPU 212**	**CPU 214**
I	Input	I0.0 to I7.7	I0.0 to I7.7
Q	Output	Q0.0 to Q7.7	Q0.0 to Q7.7
M	Internal memory	M0.0 to M15.7	M0.0 to M31.7
SM	Special Memory	SM0.0 to SM45.7	SM0.0 to SM85.7
V	Variable Memory	V0.0 to V1023.7	V0.0 to V4095.7

2.8.3. Logic Control of Industrial Automation

Everyday examples of these systems are machines like dishwashers, clothes washers and dryers, and elevators. In these systems, the output tend to be 220 V AC power signals to motors, solenoids, and indicator lights, and the inputs are DC or AC signals from user interface switches, motion limit switches, binary liquid level sensor, etc. Another major function in these types of controllers is timing.

2.8.4. Data Object

The S7-200 has six kinds of devices with associated data: timers, counters, analogue inputs, analogue outputs, accumulators and high-speed counters. Each device has associated data. For example, the S7-200 has counters devices. Counters have a data value that maintains the current count value. There is an also a bit value, which is set when the current value is greater than or equal to the present value. Since there are multiple devices are numbered from 0 to n. The corresponding data objects and object bits are also numbered.

The following Table 2.2 shows the identifiers and ranges for each of the data object memory types:

Table : 2.2 Data area object memory types

Area Identifier	Data Area	CPU 212	CPU 214
T	Timers	T0 to T63	T0 to T127
C	Counters	C0 to C63	C0 to C127
AI	Analogue Input	AIW0 to AIW0	AIW0 to AIW30
AQ	Analogue Output	AQW0 to AQW30	AQW0 to AQW30
AC	Accumulator	AC0 to AC3	AC0 to AC3
HC	High-speed Counter	HC0	HC0 to HC2

2.8.5. Flexibility

When the control needs a change, relay type of controllers modification are hard, in PLC, this chance can be made by PLC programmer equipment

2.8.6. Communication

PLC's are computer-based systems. That's why, they can transfer their data to another PC, or they can take external inputs from another PC. With this specification we can control the system with our PC. With relays controlled system it's not possible.

2.9. SUMMARY

An overview of Siemens S7-200 micro-controller would be examined in details.

3. THEORITICAL EXPLANATIONS ABOUT EQUIPMENTS USED AT PROJECT

3.1 OVERVIEW

In this chapter is about the theoritical explanations about equipments used at project.

3.2 Large Grain Elevators

Large grain elevators typically are controlled electronically from a control room. GIPSA personnel in the elevator also relay heavily on electronic monitoring to for official weights and for verifying that the grain which has been weighed and inspected is the same grain being loaded on the ship. Components of a monitoring or control system can be classified as follows:

3.2.1 Input Devices

These provide the monitoring/control system with raw information about the operation of the elevator. Examples are Limit Switches, Level Switches, Load Cells, and Potentiometers.

3.2.2 Output Devices

These operate the motors and hydraulic or pneumatic cylinders that power the elevator. Examples are Power Relays and Solenoid Valves. Input and ouput devices are often lumped together as "I/O" devices.

3.2.3 Logic Devices

These draw conclusions from the information provided by input devices, activate output devices, and alert human operators of conditions requiring their attention. Examples are Relay Logic Circuits, Programmable Logic Controllers, and Computers.

3.2.4 Indicating Devices

These convey information to human operators. Examples are indicator lights, dials, video displays, and audible alarms.

3.2.5 Controls

These allow input from human operators. Examples are Buttons, Keyboards, Mice, Trackballs, Touch screens, and Thumbwheels.

3.2.6 Limit Switches

Limit Switches are the most numerous input devices in an elevator. They tell the system the position of gates, doors, turnheads, or distributors, and the alignment of belts. A switch can only tell whether an object is present or absent at a certain location. A pair of switches can tell if a gate is completely closed or fully open, but not where the gate is if it is somewhere between those two limits. A limit switch can be operated by mechanical contact, by breaking a beam of light, or by detecting the disturbance of a magnetic field caused by a metal object.

The following diagram shows a mechanical limit switch wired to a pair of indicator lights. It has an actuator arm which operates the switch contacts when it is moved slightly by contact with a piece of equipment such as a slide gate. The arm is spring-loaded, so it returns from its actuated position to its normal position when the equipment moves away. In the diagram, you can operate the limit switch by moving the arm with a mouse.

A limit switch has at least two sets of contacts: "Normally Closed" (NC) and "Normally Open" (NO) . When the switch is in the normal position (nothing touching the arm), the Normally Closed contacts pass electricity, so the diagram shows the Normally Closed indicator light as lit. When the switch is in the actuated position, the Normally Open (NO) contacts pass electricity, so the Normally Open indicator light is lit. The "Common" wire carries electricity to both sets of contacts. The terminology of switches is the reverse of the terminology of gates: Switch contacts let electricity pass when they are closed. A gate lets grain pass when it is open. If you have a browser for Virtual

Reality Modeling Language (VRML), such as Cosmo Player from Silicon Graphics, you can operate an interactive 3-D model of the gates and limit switches under a shipping bin.

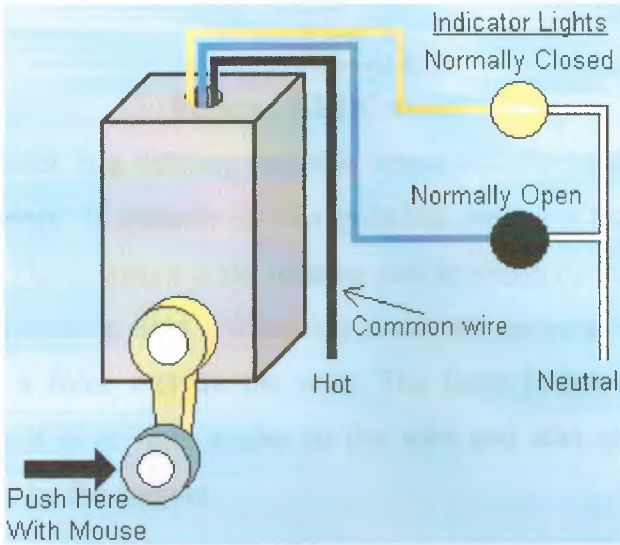


Figure : 3.1 Limit switch

3.3 DC Motors

Most devices in an airplane, from the starter to the automatic pilot, depend upon mechanical energy furnished by direct current motors. Many people are familiar with DC motors. If you have ever had a electric toy train or car as a child, you may know how a DC motor works. If you were like me you probably took one apart and couldn't put it back together. Usually the brush springs get lost. Direct Current electric motors provide speed adjustment opportunity under variable loads with their high productivity and easy control units. Sensitive speed control at the DC motors provide faster control in production and cause increase in work quality. With the new circuits produced by the latest electronic technology, it is possible to adjust the speed by changing the armature voltage and the torque by changing the armature current at the motors. A simple figure 3.2 is shown below for DC motors

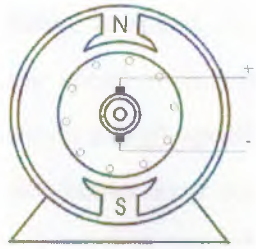


Figure : 3.2 DC motor

A direct current motor is a rotating machine which transforms direct current energy into mechanical energy. It consists of two principal parts - a field assembly and an armature assembly. The armature is the rotating part in which current carrying wires are acted upon by the magnetic field. Whenever a current carrying wire is placed in the field of a magnet, a force acts on the wire. The force is not one of attraction or repulsion; however, it is at right angles to the wire and also at right angles to the magnetic field set up by the magnet.

3.3.1 Types of DC Motors

There are three basic types of dc motors:

1) Series motors
2) shunt motors
3) compound motors.

They differ largely in the method in which their field and armature coils are connected.

a) Series DC Motor

In the series motor, the field windings, consisting of a relatively few turns of heavy wire, are connected in series with the armature winding. The same current flowing through the field winding also flows through the armature winding. Any increase in current, therefore, strengthens the magnetism of both the field and the armature. Because of the low resistance in the windings, the series motor is able to draw a large current in starting. This starting current, in passing through both the field and armature windings, produces a high starting torque, which is the series motor's principal advantage. The speed of a series motor is dependent upon the load. Any change in load is accompanied by a substantial change in speed. A series motor will run at high speed when it has a light load and at low speed with a heavy load. If the load is removed entirely, the motor may operate at such a high speed that the armature will fly apart. If high starting torque is needed under heavy load conditions, series motors have many applications. Series motors are often used in aircraft as engine starters and for raising and lowering landing gears, cowl flaps, and wing flaps.

b) Shunt DC Motor

In the shunt motor the field winding is connected in parallel or in shunt with the armature winding. The resistance in the field winding is high. Since the field winding is connected directly across the power supply, the current through the field is constant. The field current does not vary with motor speed, as in the series motor and, therefore, the torque of the shunt motor will vary only with the current through the armature. The torque developed at starting is less than that developed by a series motor of equal size. The speed of the shunt motor varies very little with changes in load. When all load is removed, it assumes a speed slightly higher than the loaded speed. This motor is particularly suitable for use when constant speed is desired and when high starting torque is not needed.

c) Compound DC Motor

The compound motor is a combination of the series and shunt motors. There are two windings in the field: a shunt winding and a series winding. The shunt winding is composed of many turns of fine wire and is connected in parallel with the armature winding. The series winding consists of a few turns of large wire and is connected in series with the armature winding. The starting torque is higher than in the shunt motor but lower than in the series motor. Variation of speed with load is less than in a series wound motor but greater than in a shunt motor. The compound motor is used whenever the combined characteristics of the series and shunt motors are desired. Like the compound generator, the compound motor has both series and shunt field windings. The series winding may either aid the shunt wind (cumulative compound) or oppose the shunt winding (differential compound).

The starting and load characteristics of the cumulative compound motor are some where between those of the series and those of the shunt motors.

3.3.2 Types of Duty

Electric motors are called upon to operate under various conditions. Some motors are used for intermittent operation; others operate continuously. Motors built for intermittent duty can be operated for short periods only and, then, must be allowed to cool before being operated again. If such a motor is operated for long periods under full load, the motor will be overheated. Motors built for continuous duty may be operated at rated power for long periods.

The *stator* is the stationary outside part of a motor. The *rotor* is the inner part which rotates. In the motor shown in figure 3.3 below number 1 is represents a magnet or winding with a north polarization, while number 2 represents a magnet or winding with a south polariztion. Opposite, 1 and 2 , polarities attract.

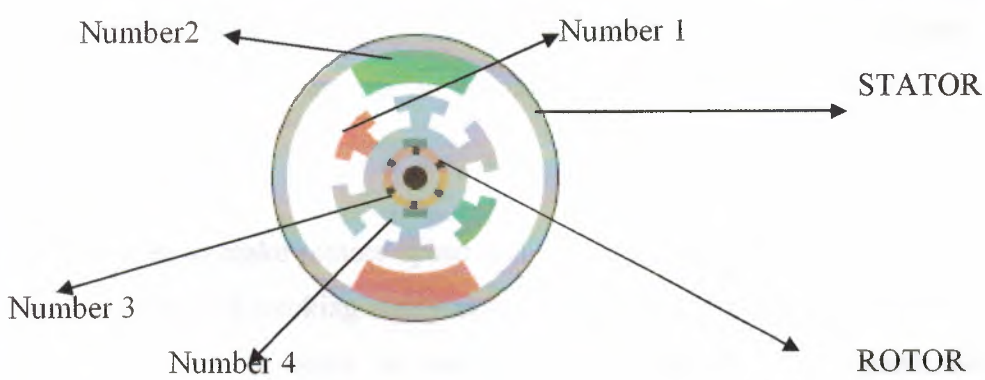


Figure :3.3 DC motor operation

The stator of a permanent magnet dc motor is composed of two or more permanent magnet pole peaces. The rotor is composed of windings which are connected to a mechanical commutator. In this case the rotor has three pole pairs. The opposite polarities of the energized winding and the stator magnet attract and the rotor will rotate until it is aligned with the stator. Just as the rotor reaches alignment, the brushes move across the commutator contacts and energize the next winding. In the figure shown above the commutator contacts are number 3 and the brushes are number 4.

Notice that the comutator is staggered from the rotor poles. If the connections of a dc motor are reversed the motor will change directions. Though it will not always work as well in both directions.

This is a permanent magnet dc motor. Two other types of dc motors are series wound and shunt wound dc motors. These motors also use a similar rotor with brushes and a commutator. However, the stator uses windings instead of permanent magnets. The basic principle is still the same. A series wound dc motor has the stator windings in series with the rotor. A shunt wound dc motor has the stator windings in parallel with the rotor winding. The series wound motor is more common. A series wound motor is also called a universal motor. It is universal in the sense that it will run equally wellusing either an ac or a dc voltage source. Reversing the polarity of both the stator and the rotor cancel out. Thus the motor will always rotate the same direction irregardless of the voltage polarity. A universal motor is in a sense an ac motor in that it will operate from an ac power source.

The moment is fixed at the DC shunt motors. The speed adjustment can be provided without steps homogeneously. Due to the feedback of tacho generator during load changes, high sensitivity can be provided in revolution. Thus stable line speeds are provided.

It is possible to make remote speed and torque adjustment at DC motors in addition to the availability of working many systems serially and parallel. The first DC motors were produced in order to work with completely straightened direct current source which has no wave, with their single solid bodies and commutation poles. It is now impossible to find such a source today and the required DC voltage have to be obtained from alternating current sources by straightening with thyristor control. The harmonics in DC voltages provided by this method, caused Eddy current losses in magnetic circuits and resulted with important commutation difficulties by causing more heat in their windings.

Therefore, motor types with sliced iron sheets have been developed in 1966. The main and commutating poles and whole body have been produced from sliced iron sheets. The Eddy current losses arising due to the harmonics in single solid bodies have been extensively eliminated. Since commutation and dynamic actions were improved, DC motors have been in better replying conditions to the controls. Today in DC motors, many copper wires have been replaced into slots on the cylinder laminated siliceous iron sheets, and their ends have been connected to the commutator. Brushes are pressing on the commutator. When coils are fed with current through the brush and in the case these wires are in the magnetic area, then the conductors are subject to the effect of the power. Finally a torque will be created accordingly.

3.3.3 Brushless DC Motors

Figure :3.4 Brushless DC Motors

Brushless DC motors are refered to by many aliases: brushless permanent magnet, permanent magnet ac motors, permanent magnet synchronous motors ect. The confusion arises because a brushless dc motor does not directly operate off a dc voltage source.

A brushless dc motor has a rotor with permanent magnets and a stator with windings. It is essentially a dc motor turned inside out. The brushes and commutator have been eliminated and the windings are connected to the control electronics. The control electronics replace the function of the commutator and energize the proper winding.

As shown in the figure 3.4 shown above the winding are energized in a pattern which rotates around the stator. The energized stator winding leads the rotor magnet, and switches just as the rotor aligns with the stator.
There are no sparks, which is one advantage of the bldc motor. The brushes of a dc motor have several limitations; brush life, brush residue, maximum speed, and electrical

noise. BLDC motors are potentially cleaner, faster, more efficient, less noisy and more reliable. However, BLDC motors require electronic control.

The first sketch shows two idealisations of the same simple motor--a coil in a field between two permanent magnets. On the left, the torque is considered as due to the forces F acting on the current carrying wires. This produces a magnetic dipole, as shown.

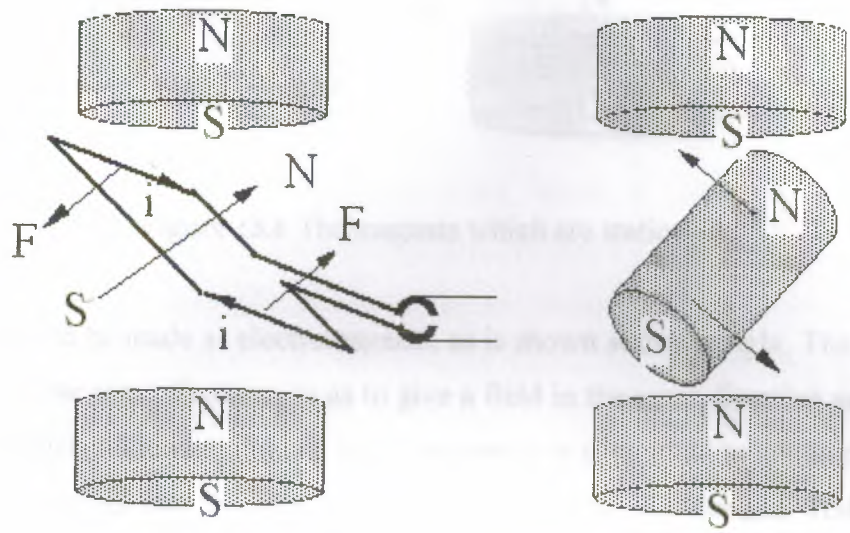


Figure :3.5 Magnetic dipole

In the figure 3.5 at right, this electromagnet is represented as a permanent magnet, and the same torque is seen to be that acting to align the central magnet.

Note the effect of the brushes (picture at left). When the plane of the rotating coil reaches horizontal, the brushes will break contact (nothing is lost, because this is the point of zero torque anyway--the forces act inwards). The momentum of the coil carries it past this break point and it the current now flows in the opposite direction, which reverses the magnetic dipole. So the rotor now continues to turn anticlockwise and starts to align in the opposite direction.

In practice, DC motors often have a high permeability core inside the coil, so that large magnetic fields are produced by modest currents. This is shown at left in the figure 3.6 below in which the 'stators' (the magnets which are stationary) are permanent magnets.

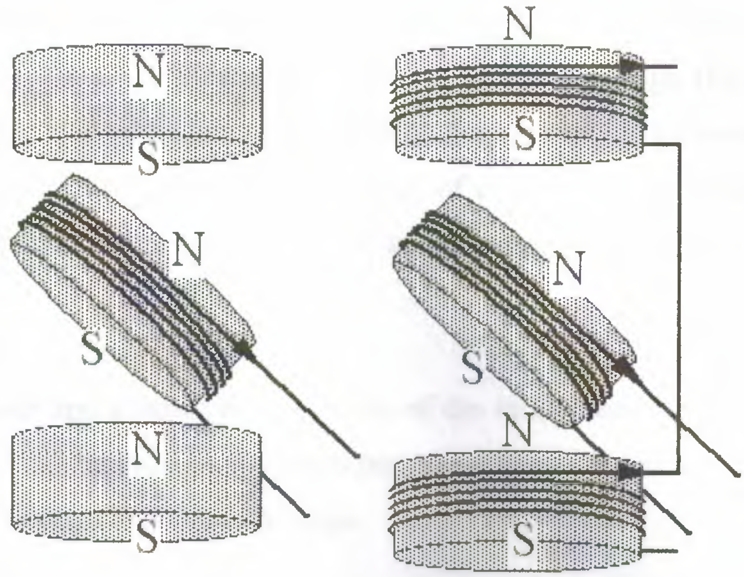


Figure :3.6 The magnets which are stationary

They, too, could be made as electromagnets, as is shown above at right. The two stators are wound in the same direction so as to give a field in the same direction and the rotor has a field which reverses twice per cycle because it is connected to brushes, which are omitted here.The brushed DC motor is one of the earliest motor designs. Today, it is the motor of choice in the majority of variable speed and torque control applications.

3.3.4 Advantages of DC Motors

- Easy to understand design
- Easy to control speed
- Easy to control torque
- Simple, cheap drive design

a) Easy to Understand Design

The design of the brushed DC motor is quite simple. A permanent magnetic field is created in the stator by either of two means:

- Permanent magnets
- Electro-magnetic windings

If the field is created by permanent magnets, the motor is said to be a "permanent magnet DC motor" (PMDC). If created by electromagnetic windings, the motor is often said to be a "shunt wound DC motor" (SWDC). Today, because of cost-effectiveness and reliability, the PMDC motor is the motor of choice for applications involving fractional horsepower DC motors, as well as most applications up to about three horsepower.

At five horsepower and greater, various forms of the shunt wound DC motor are most commonly used. This is because the electromagnetic windings are more cost effective than permanent magnets in this power range.

Opposing the stator field is the armature field, which is generated by a changing electromagnetic flux coming from windings located on the rotor. The magnetic poles of the armature field will attempt to line up with the opposite magnetic poles generated by the stator field. If we stopped the design at this point, the motor would spin until the poles were opposite one another, settle into place, and then stop which would make a pretty useless motor.

However, we are smarter than that. The section of the rotor where the electricity enters the rotor windings is called the commutator. The electricity is carried between the rotor and the stator by conductive graphite copper brushes (mounted on the rotor) which contact rings on stator. Imagine power is supplied.

The motor rotates toward the pole alignment point. Just as the motor would get to this point, the brushes jump across a gap in the stator rings. Momentum carries the motor forward over this gap. When the brushes get to the other side of the gap, they contact the stator rings again and the polarity of the voltage is reversed in this set of rings! The motor begins accelerating again, this time trying to get to the opposite set of poles. (The momentum has carried the motor past the original pole alignment point.) This continues as the motor rotates.In most DC motors, several sets of windings or permanent magnets are present to smooth out the motion.

b) Easy to Control Speed

Controlling the speed of a brushed DC motor is simple. The higher the armature voltage, the faster the rotation. This relationship is linear to the motor's maximum speed. The maximum armature voltage which corresponds to a motor's rated speed (these motors are usually given a rated speed and a maximum speed, such as 1750/2000 rpm) are available in certain standard voltages, which roughly increase in conjuntion with horsepower. Thus, the smallest industrial motors are rated 90 VDC and 180 VDC. Larger units are rated at 250 VDC and sometimes higher. Specialty motors for use in mobile applications are rated 12, 24, or 48 VDC. Other tiny motors may be rated 5 VDC. Most industrial DC motors will operate reliably over a speed range of about 20:1 -- down to about 5-7% of base speed. This is much better performance than the comparible AC motor. This is partly due to the simplicity of control, but is also partly due to the fact that most industrial DC motors are designed with variable speed operation in mind, and have added heat dissipation features which allow lower operating speeds.

c) Easy to Control Torque

In a brushed DC motor, torque control is also simple, since output torque is proportional to current. If you limit the current, you have just limited the torque which the motor can achieve. This makes this motor ideal for delicate applications such as textile manufacturing.

d) Simple, Cheap Drive Design

The result of this design is that variable speed or variable torque electronics are easy to design and manufacture. Varying the speed of a brushed DC motor requires little more than a large enough potentiometer. In practice, these have been replaced for all but sub-fractional horsepower applications by the SCR and PWM drives, which offer relatively precisely control voltage and current.Large DC drives are available up to hundreds of horsepower. However, over about 10 horsepower careful consideration should be given to the price/performance tradeoffs with AC inverter systems.

3.3.5 Disadvantages of DC Motors

- Expensive to produce
- Can't reliably control at lowest speeds
- Physically larger
- High maintenance
- Dust

3.4 Light Emitting Diode

LED's are special diodes that emit light when connected in a circuit. They are frequently used as "pilot" lights in electronic appliances to indicate whether the circuit is closed or not. A a clear (or often colored) epoxy case enclosed the heart of an LED, the semi-conductor chip.

The two wires extending below the LED epoxy enclosure, or the "bulb" indicate how the LED should be connected into a circuit. The negative side of an LED lead is indicated in two ways:

1) by the flat side of the bulb.
2) by the shorter of the two wires extending from the LED.

The negative lead should be connected to the negative terminal of a battery. LED's operate at relative low voltages between about 1 and 4 volts, and draw currents between about 10 and 40 milliamperes. Voltages and currents substantially above these values can melt a LED chip.

The most important part of a light emitting diode (LED) is the semi-conductor chip located in the center of the bulb as shown at the right. The chip has two regions separated by a junction. The p region is dominated by positive electric charges, and the n region is dominated by negative electric charges. The junction acts as a barrier to the flow of electrons between the p and the n regions. Only when sufficient voltage is applied to the semi-conductor chip, can the current flow, and the electrons cross the junction into the p region.

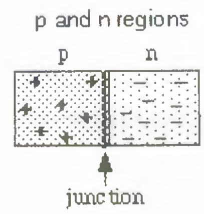


Figure : 3.7 LED semiconductor chip

In the absence of a large enough electric potential difference (voltage) across the LED leads, the junction presents an electric potential barrier to the flow of electrons.

3.4.1 Causes of the LED for Emitting Light and Determining the Color of the Light

When sufficient voltage is applied to the chip across the leads of the LED, electrons can move easily in only one direction across the junction between the p and n regions. In the p region there are many more positive than negative charges. In the n region the electrons are more numerous than the positive electric charges. When a voltage is applied and the current starts to flow, electrons in the n region have sufficient energy to move across the junction into the p region. Once in the p region the electrons are immediately attracted to the positive charges due to the mutual Coulomb forces of attraction between opposite electric charges. When an electron moves sufficiently close to a positive charge in the p region, the two charges "re-combine".

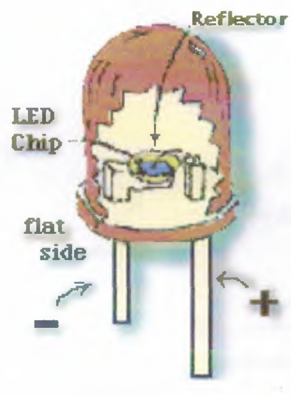


Figure :3.8 Light emitting diode

Each time an electron recombines with a positive charge, electric potential energy is converted into electromagnetic energy. For each recombination of a negative and a positive charge, a quantum of electromagnetic energy is emitted in the form of a photon of light with a frequency characteristic of the semi-conductor material (usually a combination of the chemical elements gallium, arsenic and phosphorus). Only photons in a very narrow frequency range can be emitted by any material. LED's that emit different colors are made of different semi-conductor materials, and require different energies to light them.

3.5 Interfacing Relays and Solenoids

A relay is mechanical switch or set of switches that are penned or closed by a magnetic field generated when electrical current is passed through a coil. See Figure 3.9. In the context of a relay, the switches are called contacts. When no current passes through the coil, it is said to be deenergized, the contacts are in their ''normal'' state: normally open or normally closed. When the coil is energised, the contacts switch to the opposite state. Like optocouplers, relays provide electrical isolation between an input circuit (the coil) and output circuits, the circuits connected to the contact. They are used to drive heavy loads. A relatively small voltage applied to the coil circuit opens and closes heavy-duty contacts that can switch high voltages and currents. A very common application of relay is to start and stop and electrical motor. A solenoid is similar to a relay.

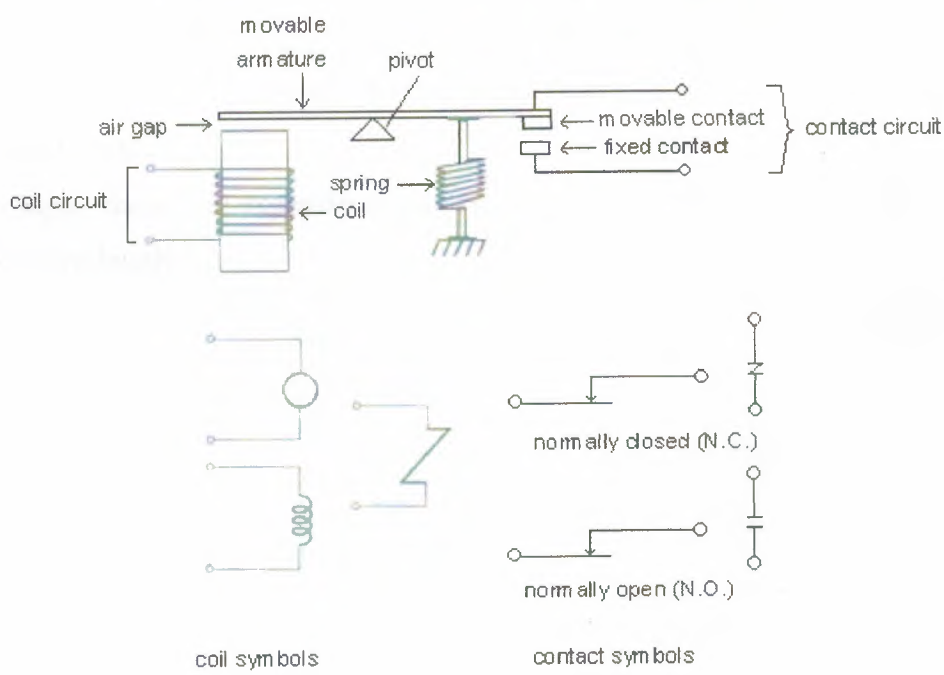


Figure : 3.9 The electromechanical relay.

Except in stead of opening and closing switches when its coil energised, it opens or closes a mechanical value. Solenoids are used the control flow of liquids and gases. Relays and solenoids are both very slow in comparison to electronic switching speeds, so they are used only when the load is to be switched in or out of a circuit for long intervals of time. An example of such a load is the fan motor in an air conditioning system.

Figure 3.10 shows a circuit used to drive a relay coil. One of the problems with driving a relay is that a very large voltage spike appears across the coil terminals.

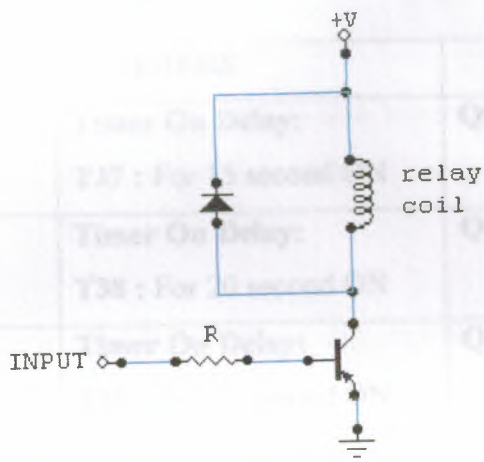


Figure : 3.10 A relay-driver circuit.

3.6. SUMMARY

In this chapter theoritical explanations about equipments used at project would be studied in the details

4. PRACTICAL IMPLEMENTATION WITH PLC

4.1 OVERVIEW

The main aim of this chapter is to control the Elevator and also control of the DC motor with same PLC program. In this PLC program will be used these inputs and outputs and the steps of program will be given.

Table 4.1 Inputs, Outputs, and Timers that used in the Program

INPUTS	TIMERS	OUTPUTS
I0.0 : First floor call	**Timer On Delay:** **T37 :** For 15 second ON	**Q0.0 :** Elevator up
I0.1 : Second floor call	**Timer On Delay:** **T38 :** For 20 second ON	**Q0.1 :** Elevator down
I0.2 : Third floor call	**Timer On Delay:** **T39 :** For 20 second ON	**Q0.2 :** Elevator lamp
I0.3 : First floor limit sensor	**Timer On Delay:** **T40 :** For 10 second ON	**Q0.3 :** First floor indicator lamp
I0.4 : Second floor limit sensor		**Q0.4 :** Second floor indicator lamp
I0.5 : Third floor limit sensor		**Q0.5 :** Third floor indicator lamp
I0.6 : Door sensor		

4.2 Explanation of the Networks that will be used in the operation

NETWORK-1:

When somebody presses to first floor calling push button, Elevator goes to first floor from which it is present, up to open first floor limit sensor I.03.

NETWORK-2:

When somebody presses to second floor calling push button, If elevator present at first floor it will go to second floor, up to open second floor limit sensor I.04.

NETWORK-3:

When somebody presses to second floor calling push button, If elevator present at third floor it will go to second floor, up to open second floor limit sensor I.04.

NETWORK-4:

When somebody presses to third floor calling push button, which floor that elevator present, it will go to third floor, up to open third floor limit sensor I.05.

NETWORK-5:

When one of the memory contacts M0.3 or M 0.5 active, Motor moves towards top, up to see limit switch that present at which floor. When door of the elevator open at same time there is no any movement at motor.

NETWORK-6:

When one of the memory contacts M0.2 or M 0.4 active, Motor moves towards bottom, up to see limit switch that called out. When door of the elevator open , there is no any movement at motor.

NETWORK-7:

Motor that works to any direction or motor does not work, according to opening and closing condition of door lamp to be on 15 second.

NETWORK-8:

Motor that works to any direction, M0.0 memory contact operates 15 second and even motors stop, lamp will be active 15 second.

NETWORK-9:

After motor stops M0.0 memory contact will be active and lamp will operate 15 second.

NETWORK-10:

When door will be opened, T38 timer becomes active and Lamp operates 20 second.

NETWORK-11:

When door will be closed and motor does not work T39 timer will be active and lamp operates 20 second.

NETWORK-12:

When T38 timer will be active and motor does not operates M0.1 memory contact becomes active and extinguishes lamp 20 second later.

NETWORK-13:

When first floor limit sensor I0.3 will be active red leds start to operate. If cabin stop at floor led operates contiunal or if cabin leaves from floor led operates 10 second.

NETWORK-14:

When second floor limit sensor I0.4 will be active green leds start to operate. If cabin stop at floor led operates contiunal or if cabin leaves from floor led operates 10 second.

NETWORK-15:

When third floor limit sensor I0.5 will be active yellow leds start to operate. If cabin leaves from floor led operates 10 second.

NETWORK-16:

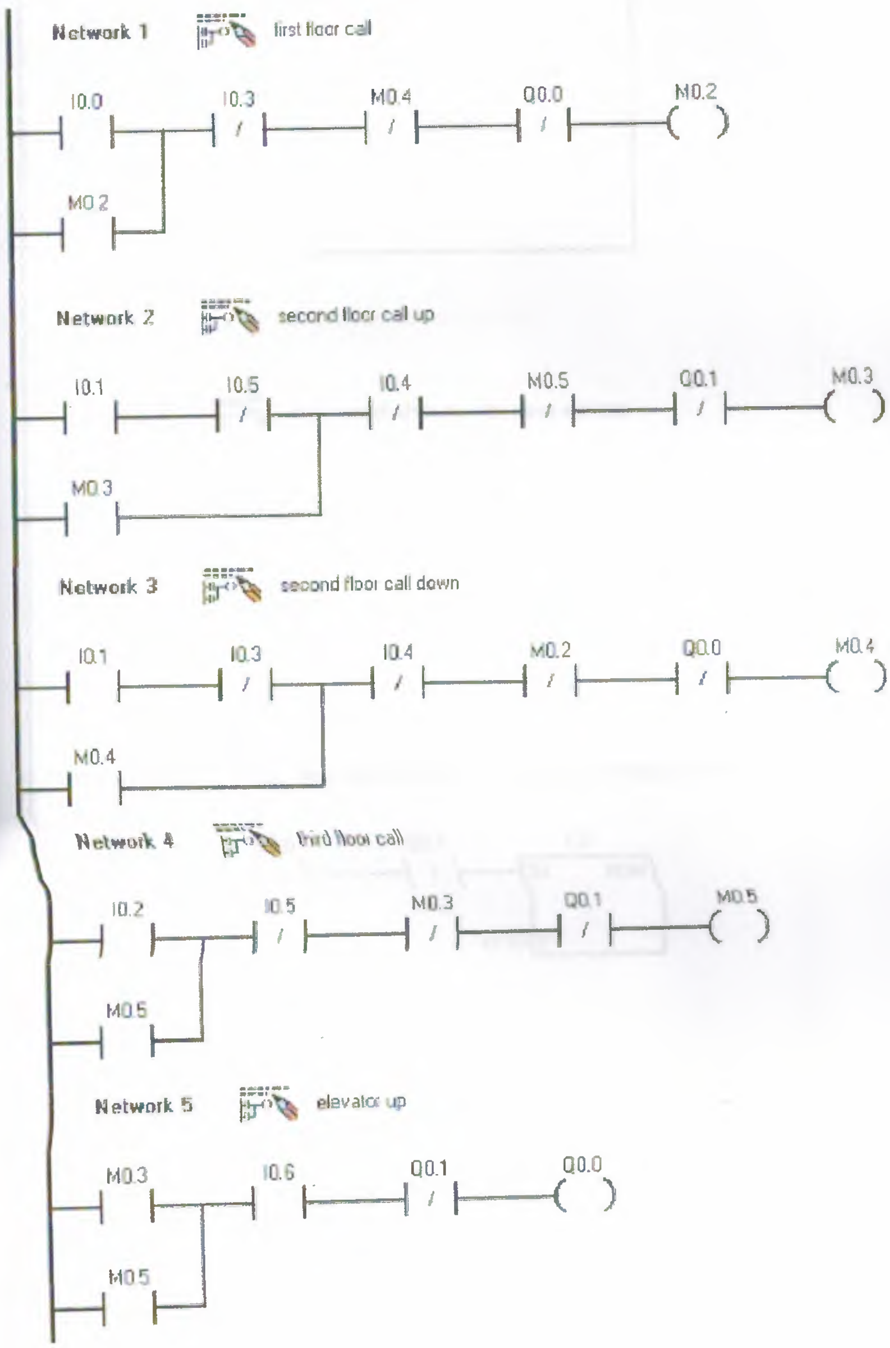
When any of floor lamps starts to operate, T40 timer will be active and changes contacts 10 second later. According to position of cabin, floor closes to determined lights.

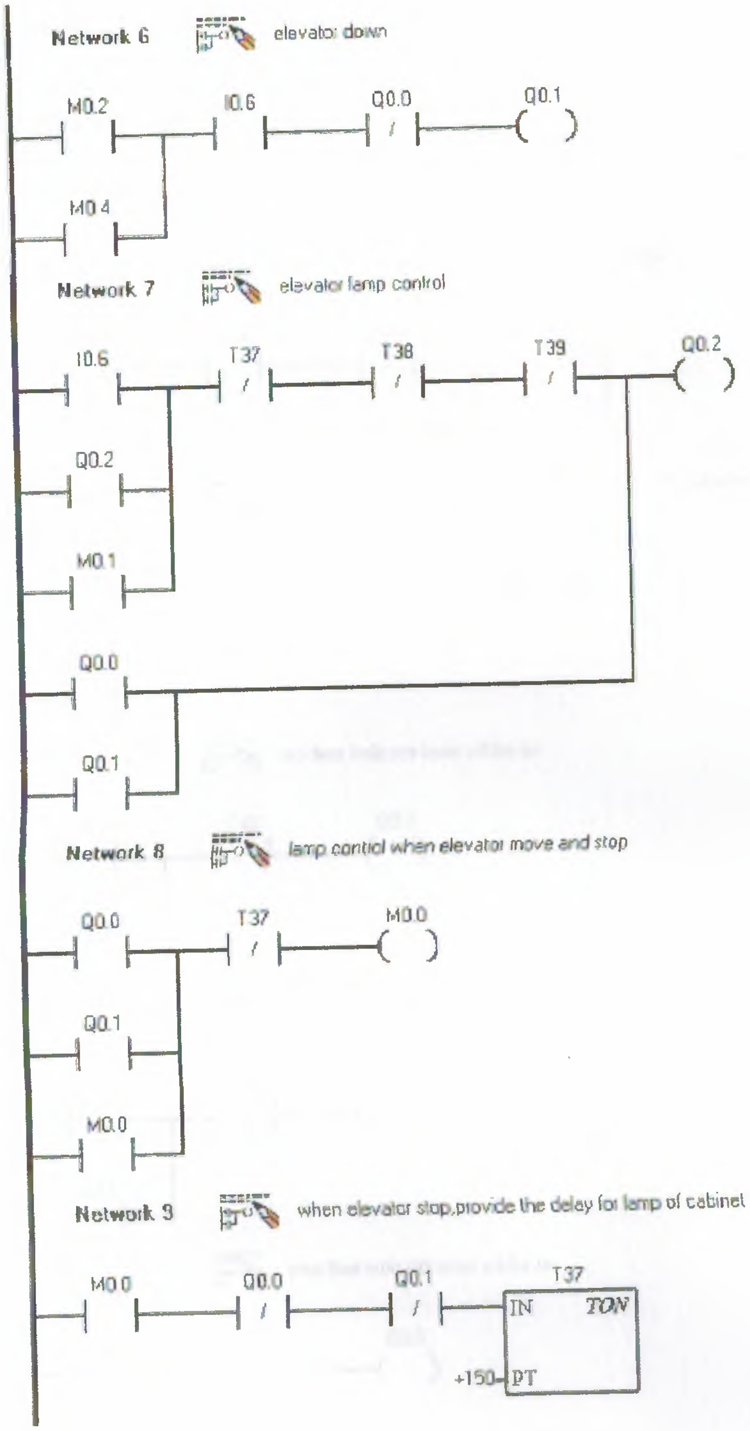
NETWORK-17:

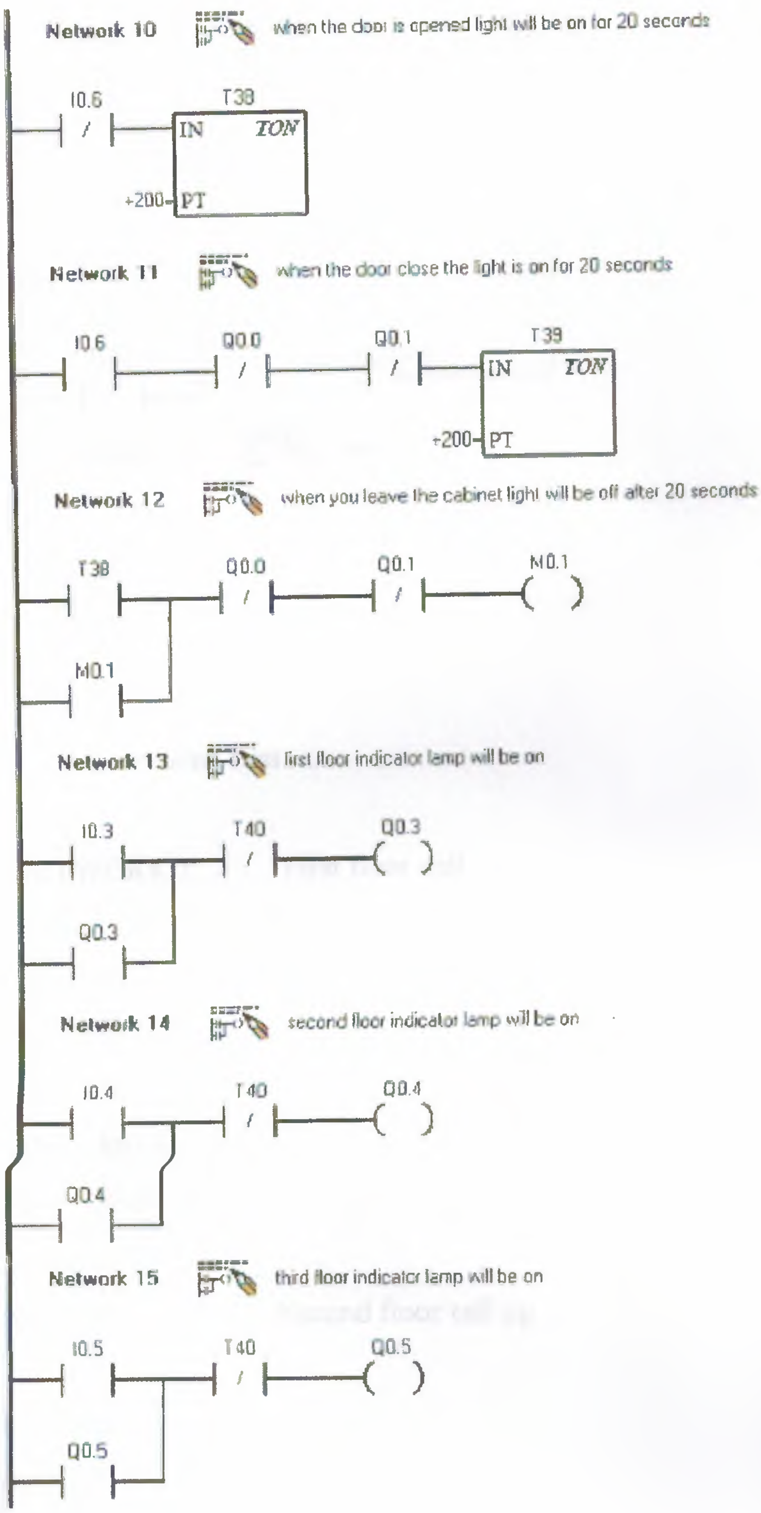
Program stop.

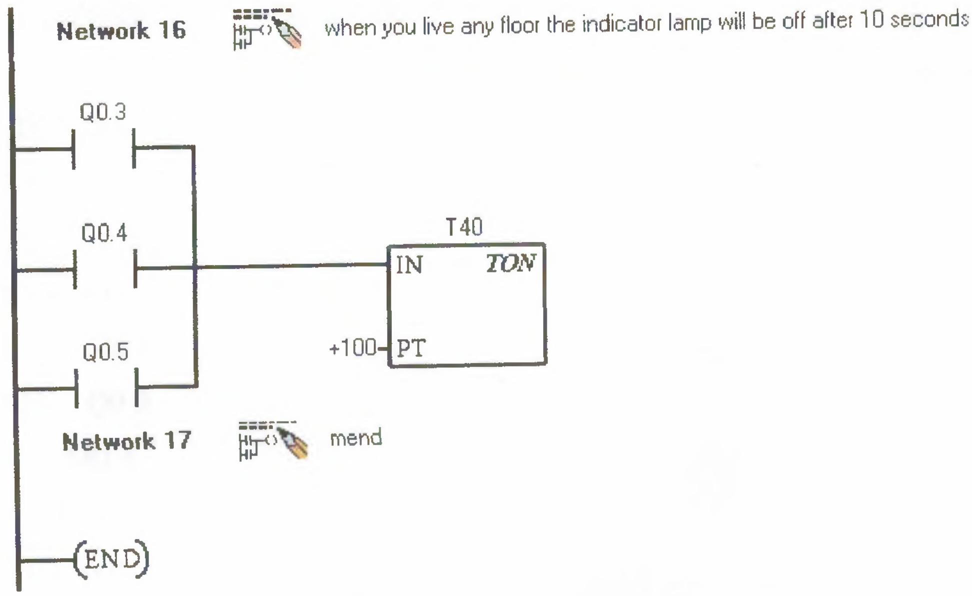
4.3 Ladder Diagram and Statement List of the Program

4.3.1 Ladder Diagram




Network 6
elevator down
M0.2
I0.6
Q0.0
Q0.1
M0.4
Network 7
elevator lamp control
I0.6
T37
T38
T39
Q0.2
Q0.2
M0.1
Q0.0
Q0.1
Network 8
lamp control when elevator move and stop
Q0.0
T37
M0.0
Q0.1
M0.0
Network 9
when elevator stop,provide the delay for lamp of cabinet
M0.0
Q0.0
Q0.1
T37
IN
TON
+150
PT


Network 10
when the door is opened light will be on for 20 seconds
I0.6
T38
IN
TON
+200
PT
Network 11
when the door close the light is on for 20 seconds
I0.6
Q0.0
Q0.1
T39
IN
TON
+200
PT
Network 12
when you leave the cabinet light will be off after 20 seconds
T38
Q0.0
Q0.1
M0.1
M0.1
Network 13
first floor indicator lamp will be on
I0.3
T40
Q0.3
Q0.3
Network 14
second floor indicator lamp will be on
I0.4
T40
Q0.4
Q0.4
Network 15
third floor indicator lamp will be on
I0.5
T40
Q0.5
Q0.5



4.3.2 Statement List

NETWORK 1 First floor call

LD I0.0
O M0.2
AN I0.3
AN M0.4
AN Q0.0
= M0.2

NETWORK 2 Second floor call up

LD I0.1
AN I0.5
O M0.3
AN I0.4
AN M0.5
AN Q0.1
= M0.3

NETWORK 3 Second floor call down

```
LD   I0.1
AN   I0.3
O    M0.4
AN   I0.4
AN   M0.2
AN   Q0.0
=    M0.4
```

NETWORK 4 Third floor call

```
LD   I0.2
O    M0.5
AN   I0.5
AN   M0.3
AN   Q0.1
=    M0.5
```

NETWORK 5 Elevator up

```
LD   M0.3
O    M0.5
A    I0.6
AN   Q0.1
=    Q0.0
```

NETWORK 6 Elevator down

```
LD   M0.2
O    M0.4
A    I0.6
AN   Q0.0
=    Q0.1
```

NETWORK 7 Elevator lamp control

```
LD   I0.6
O    Q0.2
O    M0.1
AN   T37
AN   T38
AN   T39
LD   Q0.0
O    Q0.1
OLD
=    Q0.2
```

NETWORK 8 Lamp control when elevator move and stop

```
LD   Q0.0
O    Q0.1
O    M0.0
AN   T37
=    M0.0
```

NETWORK 9 When elevator stop,provide the delay for lamp of cabinet

```
LD   M0.0
AN   Q0.0
AN   Q0.1
TON  T37, +150
```

NETWORK 10 When the door is opened light will be on for 20 seconds

```
LDN  I0.6
TON  T38, +200
```

NETWORK 11 When the door close the light is on for 20 seconds

```
LD   I0.6
AN   Q0.0
AN   Q0.1
TON  T39, +200
```

NETWORK 12 When you leave the cabinet light will be off after 20 seconds

```
LD   T38
O    M0.1
AN   Q0.0
AN   Q0.1
=    M0.1
```

NETWORK 13 First floor indicator lamp will be on

```
LD   I0.3
O    Q0.3
AN   T40
=    Q0.3
```

NETWORK 14 Second floor indicator lamp will be on

```
LD   I0.4
O    Q0.4
AN   T40
=    Q0.4
```

NETWORK 15 Third floor indicator lamp will be on

```
LD   I0.5
O    Q0.5
AN   T40
=    Q0.5
```

NETWORK 16 When you live any floor the indicator lamp will be off after 10 seconds

LD Q0.3

O Q0.4

O Q0.5

TON T40, +100

NETWORK 17 Program stop

MEND

Figure 4.1 Inside of elevator

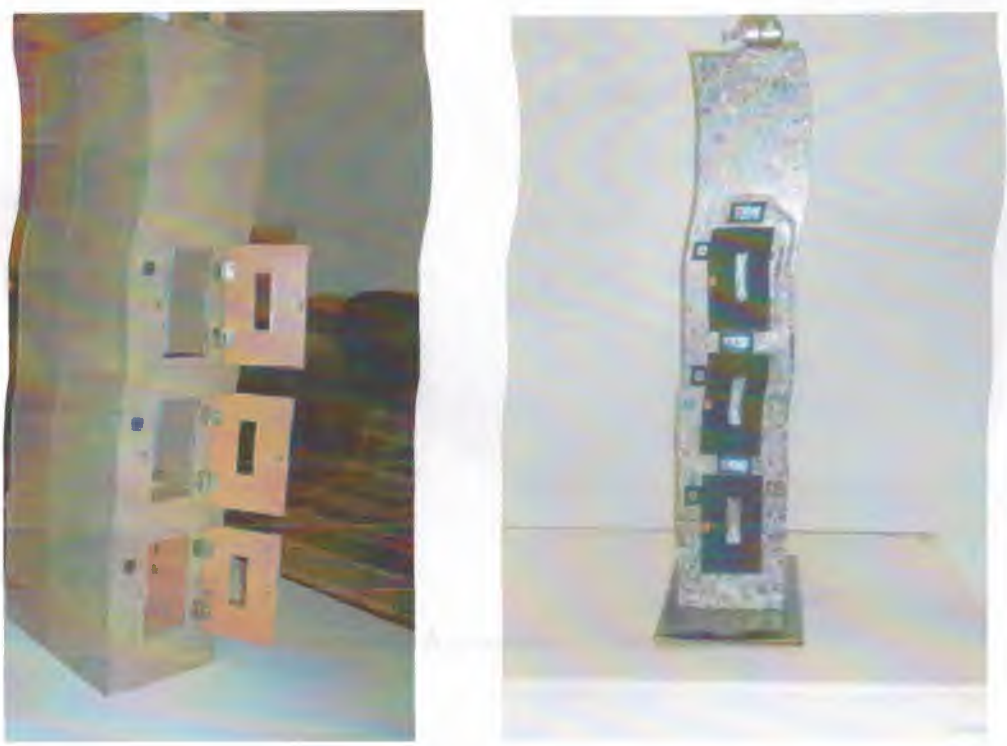


Figure 4.2 Mechanism of Elevator

Figure 4.3 Appearance of elevator

4.4. SUMMARY

The main aim of this chapter was to control the Elevator and also control of the DC motor with same PLC program. In these PLC program that used above these inputs, outputs and steps of program would be given.

CONCLUSION

In this project Siemens S-7 200 PLC was used , for controllig of elevator. It has many advantageous in the industrial automation and building automation. The Siemens S-7 200 PLC can be used easily at different application areas.

In this project these main devices were used; Siemens S-7 200 PLC, limit switch DC motor,relay and led diode

This project is about building an elevator system model which is controlled by PLC, ıt has seven sensors, six actuators and the PLC program uses four timer for delay. When any floor calling button was pushed the cabin will go to that floor. If any door was opened, system will stop automatically and the lamp is controlled according to the position of the doors and the motor.

There are more complex real life applications systems similar. This model can be used as an experimental set for PLC education and some future applications may be added like weight sensors, and emergency button.

The system can be improved by adding some more control equipment.

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