NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

DC MOTOR CONTROL WITH PLC

Graduation Project
EE – 400

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Nicosia– 2004

ACKNOWLEDGEMENTS

It is my pleasure to take this opportunity to express my greatest gratitude to many individuals who have given me a lot of supports during my four-year Undergraduate program in the ***Near East University***. Without them, my Graduation Project would not have been successfully completed on time.

First I want to thanks to my supervisor ***Mr. Özgür Cemal Özerdem*** for supervising my project. Under his guidance, of I successfully overcome many difficulties and I learned a lot about electronıc and especially programmable logic control. In each discussion, he used to explain the problems and answer my questions. He always helped me a lot either in my study or my life and I felt expectional progress during his supervision.

I thank ***Prof.Dr. Şenol Bektaş*** for helping with our problems in school, I thank ***Prof. Dr Fakhreddin Sadıkoğlu (Mamedov)*** for helping us with our problems in our department. Esspecially I thank ***Mr. Cemal Kavalcıoğlu*** for helping my project and for solved my all problems

I want to represent all my thanks to my lectures who have been teached so much benefit knowledge and I will use them in my professional life.

Also I want to represent to all my thanks to my friends whose are ***Ercan Dursun*** and ***Mahmut Nedim Perihanoğlu***

Finally, I want to thanks for my family, especially my parents for being patientful during my undergraduate degree study. I could never have completed my study without their encouraging and growed up to me well and now I am being an Engineer.

ABSTRACT

Process control system is made up of a group of electronic devices and equipment that provide stability, accuracy and eliminate harmful transition statuses in production processes. Operating system can have different form and implementation, from energy supply units to machines.

When energizing the coil of a relay, polarity of the coil does not matter unless there is a diode across the coil The magnetic field produced by current in the armature of a dc generator effects the flux pattern and distorts the main field

The S7-200 series is a line of micro-programmable logic controllers (Micro PLCs) that can control a variety of automation applications.

TABLE OF CONTENTS

INTRODUCTION

Programmable Logic Controllers (PLCs) have a history that dates back to the 1960s, yet there are still many in the automation industry who've had little experience with them. When it comes to learning about these products, or making the jump from other areas of automation to applications that involve PLCs, the transition can sometimes be difficult. It's hard to know where to begin, and if you've been charged with the task of selecting one, it can be even harder to know which manufacturer or model to choose. To make the switch to PLCs, it's important to have a basic understanding of what they are, what they do, and which PLC is right for your application.

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.

The SIMATIC Controllers family comprises programmable controllers (PLCs), control systems incorporating PLC plus operator panel, PC-based control and distributed intelligence. The controllers are also available in failsafe and fault-tolerant versions for applications with high safety demands. Motion control integrated in the PLC provides the highest precision, dynamic and processing speed.

This gradiation project consists of introduction five chapter and conclusion

Chapter1 General Informations About Programmable Logic Controllers (PLC's)

Chapter2 Operatıons about programmable logic controllers. Program memory is the capacity for control software

Chapter3 Information about dc motor, cooling fan/ fan modules, relay and resistance

Chapter4 This chapter brief of the information about the S7-200 MICRO PLC

Chapter5 Explain of the this chapter practical implementation PLC

1. GENERAL INFORMATIONS ABOUT PROGRAMMABLE LOGIC CONTROLLERS (PLC's)

1.1 OVERVIEW

Generally speaking, process control system is made up of a group of electronic devices and equipment that provide stability, accuracy and eliminate harmful transition statuses in production processes. Operating system can have different form and implementation, from energy supply units to machines. As a result of fast progress in technology, many complex operational tasks have been solved by connecting programmable logic controllers and possibly a central computer. Beside connections with instruments like operating panels, motors, sensors, switches, valves and such, possibilities for communication among instruments are so great that they allow high level of exploitation and process coordination, as well as greater flexibility in realizing an process control system. Each component of an process control system plays an important role, regardless of its size. For example, without a sensor, PLC wouldn't know what exactly goes on in the process. In automated system, PLC controller is usually the central part of an process control system. With execution of a program stored in program memory, PLC continuously monitors status of the system through signals from input devices. Based on the logic implemented in the program, PLC determines which actions need to be executed with output instruments. To run more complex processes it is possible to connect more PLC controllers to a central computer.

1.2. What are PLCs and how do they work?

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).

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Programmable Logic Controller 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. PLCs are used in many "real world" applications. If there is industry present, chances are good that there is a plc present. If you are involved in machining, packaging, material handling, 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 a plc.

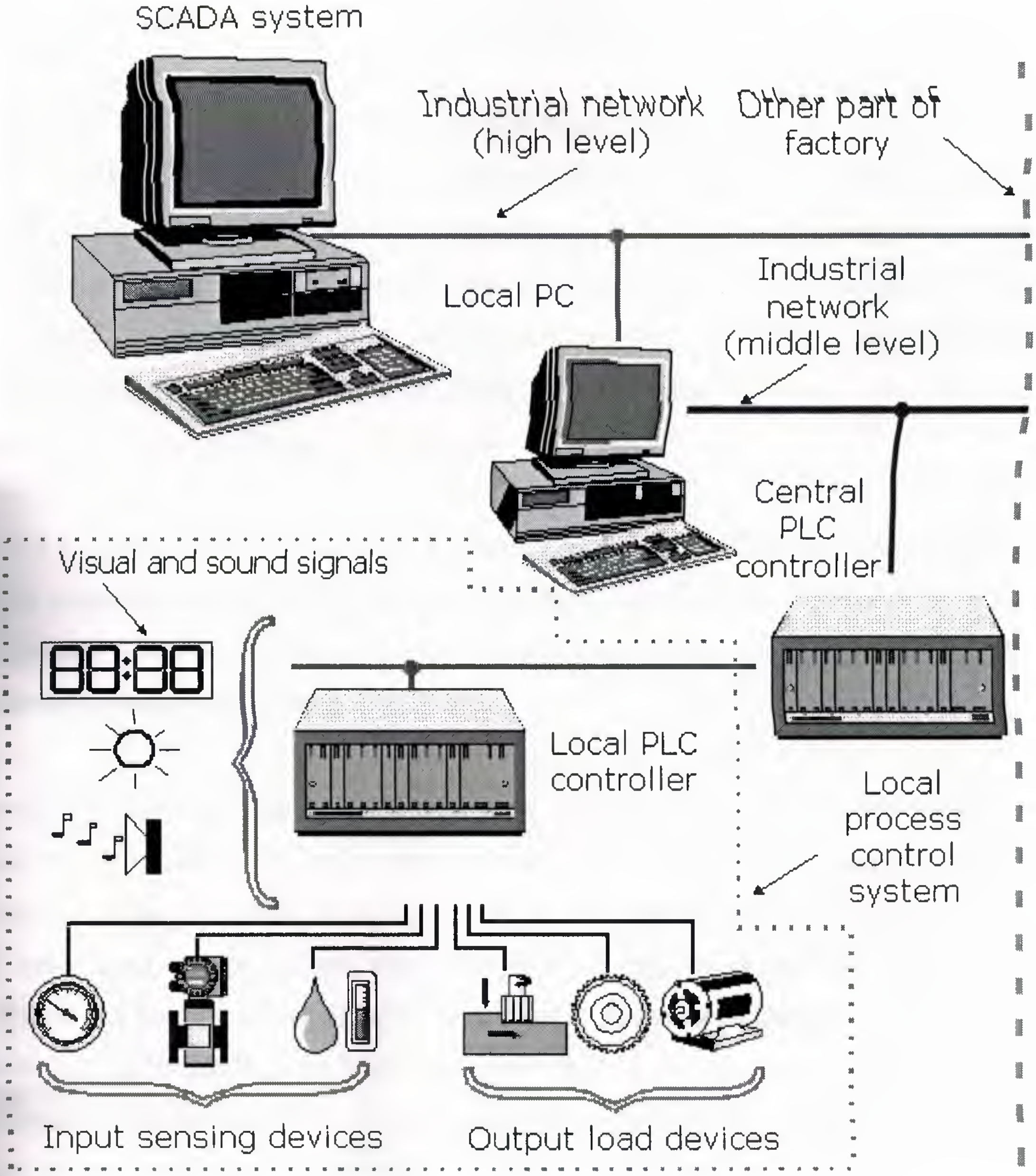


Figure 1.1. PLC process control system

1.3. A brief history

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.

Programmable Logic Controllers (PLCs) have a history that dates back to the 1960s, yet there are still many in the automation industry who've had little experience with them. When it comes to learning about these products, or making the jump from other areas of automation to applications that involve PLCs, the transition can sometimes be difficult. It's hard to know where to begin, and if you've been charged with the task of selecting one, it can be even harder to know which manufacturer or model to choose. To make the switch to PLCs, it's important to have a basic understanding of what they are, what they do, and which PLC is right for your application.

1.4. 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 accmmodate 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.

A drawing of the machine or process is a good start. This can help identify field devices and physical requirements for hardware locations. From the drawing, you can determine how many analog and/or discrete devices you will have. Discrete devices are those that operate in only two states: on and off. Examples of discrete devices include pushbuttons and switches. Analog devices, such as thermocouples, process transducers, and display meters, will supply or accept signals within a specified range, typically 0-10 volts or 4-20 mA.

Once the field device requirements and hardware locations are defined, you can begin the process of choosing a PLC that will meet your requirements. The worksheet on the following page is a basic summary of considerations for determining the type of PLC you will need, regardless of which manufacturers you are evaluating. Armed with this information, the next steps will be selecting, designing, programming, and installing your system.

When choosing a PLC, there are many factors to consider that, if not properly planned for, may affect your system's performance after installation. With proper planning, the selection of a PLC system can be done with relative ease.

1.5.WHY USE PLCs FOR INDUSTRIAL CONTROL?

One of the most important advantages of programmable logic controllers is their freedom from the need for frequent human involvement and their remote reprogramming and visual display capabilities. As programmable controllers have been manifactured for machine control they can be programmed on-line and their ladder-logic operating systems are very familiar for controlling the sequential steps typical of the system used in many industrial operation control boards.

Programmable controllers provide real-time (5 to 50 ms) control over process control operations such as mixing, heating and pumping and sorting product flows involving the operation of conveyors, diverters,pumps and valves etc.

Another use programmable controllers is to collect plant and process data such as quantity of product produced, product temperature, pressure, locations, time in process, percent complete and any other quantity that can be sensed. Additionally programmable controllers can report on the disposition of the facility, gather data on equipment run times, cycle counts and power monitoring, and power more diagnostics, preventive maintenance, safety and emergency shut-down and burner-management systems.

Programmable controller-based systems are cost effective for controlling both large and small process bacause they are modular, scalable, and flexible. These attributes allow for optimization of control of over the entire lifecycle of the system. Therefore to long-term cost of programmable controller-based systems is less then that of more specialezed dedicated control systems.

1.6. Advantages of PLC

The technology is a system integration of external analog electrical/logic circuit and the PSoC microcontroller and the signalling format/protocol easily interfaces as a slave controller to the commonly available industrial PLC's in the world market. The system would readily replace the practice of installing dedicated control/logic panels using multicore control cables all of which are expensive with high maintenance costs. The PLC will also interface to Packet Radio engines.

Working with assembler offers you a range of capabilities, which are not (all) available for 3GL- of 4GL-programmers.

Parry errors.

Usage of memory above the 16MB-line. Enterprises still can be found, that (are forced to) compile with Amode=24. By adding small assembler modules you can have your application programs run above the 16MB-line, easing the pressure on memory below the 16MB-line where it is most severely felt.

Dynamic memory management.

Programs that maintain data in tables, lists, or trees often do not know in advance how large these objects will have to grow. In assembler storage can be allocated and de-allocated dynamically, enabling you to grow or shrink your in-storage objects to the required size.

Optimization.

State-of-the-art compilers certainly do generate efficient code. They cannot, however, decide which optimizing criterion is of primary importance in any one of your specific programs. Because a programmer does have knowledge of the structure of your application, he can make that decision. He may for example choose to reduce the risk of page-steal, making the program run faster and reducing the pressure on the paging subsystem.

Data spaces.

Programs that need large amounts of working storage might well make use of data spaces. This reduces the need for allocating work datasets (which in turn reduces I/O) and at the same time saves on virtual storage with in your own address space, reducing the risk of out-of-storage abends.

Virtual look-aside facility.

VLF enables you to keep named data in virtual storage, outside of your own address space. For heavily used data that can be named (eg PDS-members in certain datasets) this can substantially reduce I/O-delays for your application.

Concurrent access to several datasets.

When an application needs access to records from two or more datasets, these records can be read and/or written at the same time. It is even possible to access several records within a single dataset at the same time. This concurrency can save considerably on I/O-wait time, especially when the datasets involved are on different volumes.

Subtasks.

By splitting one or subtasks off a task, that task can be sped up considerably. E.g. by eliminating the need to write data to a work-dataset. Or by leaving it to a subtask to create the required financial journal records, meaning that the sales-transaction itself can be handled that much faster.

Reent erability.

By making heavily used program segments reenterable they can be placed in common storage (by preference above the 16MB-line of course). This means that all programs using that code can be executed more efficiently, because the chance of a page fault in such a piece of code is minimal.

i. modularity

The modularity provides for cost-effective growth process control system with a wide variety of easily integrated hardware/software options lends itself to rapid, cost-effective optimization.

ii. Scalability

Scalability means that the control system can be easily and economically scaled up, or scalled down , to meet changing production and/or budget requirements.

iii. flexibility

System flexibility means that control equipment can be readily adapted to multiple purposes and can be adapted to changing process-control needs.

iv. Reliability

PLCs are widely used in market. It is strongly recommended that in selecting a PLCs brand a type, a choice of well-known brands are beter.

v. Environmental Resistivity

Industrial apliications needs industrial solutions. The vibration resistability, IP class of housing and electromagnetic compatibility and wider operating temperature are essentials of industrial systems. PLCs fit beter to industrial environment since they are intentionally built this for purpose.

vi. Service & Spare Parts

There are stil no common PLC instructions of manifacturers. PLC manifacturers provide PLCs on market until the parts are obsalete. Some new products are up-compatible with the obsolate one.

vii. Communication Abilities With Other Equipments

PLCs designed to construct a network between them. Communication between same brand and type of PLCs are not a problem. When multible brands and types are used to construct the application, the communications are a real problem.

The comperasion of the PLC with other control systems are given in table here it is obvious that PLC s are the best solution for the industrial control.

Table 1.1 The comparision of PLC with Relays, PC and Fixed Design Systems

Characteristics	Relay System	Digital Logic	Computers	PLC System
Prize	Fairly low	Low	High	Low
Physical size	Bulky	Very compact	Fairly compact	Very compact
Operating speed	Slow	Very fast	Fairly fast	Fast
Electrical noise immunity	Excellent	Good	Good	Good
Installation	Time-consiming to design and install	Desing time-consuming	Programming extremely time-consuming	Simple to program and install
Ease of changing function	Very difficult	Difficult	Quite simpe	Very simple
Ease of maintenance	Poor-large number of contacts	Poor if ICs soldered	Poor-several custom boards	Good-fewstandard cards
Capable of complicated operations	No	Yes	Yes	Yes

1.7. TYPES OF PLC

There are two types of PLC

1.7.1. Compact PLC

The compact of PLCs are manufactured such that all parts of the PLC including the power supply, I/O units, CPU and memories are placed in a box compact form. They are lower capacity PLCs and used in small to medim size industrial automation projects.

1.7.2. Modular PLC

They are formed by combining seperate modules together on a board. They can have various memory capacity, I/O numbers, power Supply up to necessary limits.

1.8. Categories 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 manifactures producing a range of PLCs with various levels of performance and facilities.
Classifying any microprocessor system in terms of memory size or whatever goes out of date the moment it is printed. As a result use the following as a guide only.

- Small:- upto 30 I/O ports; upto 1kbyte memory.
- Medium:- upto 100 I/O ports; upto 10kbyte memory.
- Large:- more than 100 I/O ports; more than 10kbyte RAM.

Many additional featurse should also be considered to evaluate properly any programmable controller such as its processor, cycle time, expension capabilities

Table 1.2 Categories of PLC

PC Size	Max I/O Points	User Memory Size
Small	*40/40*	*1K*
Medium	128/128	4K
Large	>128/>128	>4K

1.8.1. Small PLCs

The small PLCs are compact PLCs, which can be mounted on or beside the equipment to be controlled. They are used to replace hard-wired logic relays, timers, counters etc. That control a plan tor machinery.

Small programmable controllers can normally have their total I/O expanded by adding one by or two I/O modules.

A single process is normally used and programming facilities arwe basic not advanced. Program storage is by EPROM or battery backed RAM.

Smaller PLC controllers usually have only digital input lines while larger also accept analogue inputs through special units attached to PLC controller. One of the most frequent analogue signals are a current signal of 4 to 20 mA and milivolt voltage signal generated by various sensors. Sensors are usually used as inputs for PLCs. You can obtain sensors for different purposes. They can sense presence of some parts, measure temperature, pressure, or some other physical dimension, etc. (ex. inductive sensors can register metal objects).

Other devices also can serve as inputs to PLC controller. Intelligent devices such as robots, video systems, etc. often are capable of sending signals to PLC controller input modules (robot, for instance, can send a signal to PLC controller input as information when it has finished moving an object from one place to the other.)

1.8.2 Medium Sized PLCs

Modular construction with plug in modules based around the Euro card 19inch rack formadt or another rack mounting system is present. This construction allows the simple upgrading or expansion of the system by fitting additional I/O cards into the rack.

In general this type of PLC is applied to logic control tasks that cannot be met by small controllers due to inssufficient I/O numbers.

1.8.3. Large PLCs

When control of very large numbers of input and output point is necessary or complex control functions or required, a large programmable controller is required. Large PLCs are designed for use in large plants or on large machines.

1.9. PLC LAYOUT

Each PLC input is energized (turned on) when 24V dc is applied to it from a switching device. Normally 24V dc supply is internally generated from the mains input and is used for wiring up input devices. Switches that are connected to the input lines can be of the normally open or normally closed contact type. When the run input is energized, the outputs are switched according to the program and the condition of the inputs.

The output loads can be switched from relay, transistor or triac contacts inside the PLC. Relays are widely used this is fine provided that the maximum current rating for the relay contacts is not exceeded.

In generally PLC divided into three sections;

1) The programming device
2) Central Processing Unit (CPU)
3) The input/output section

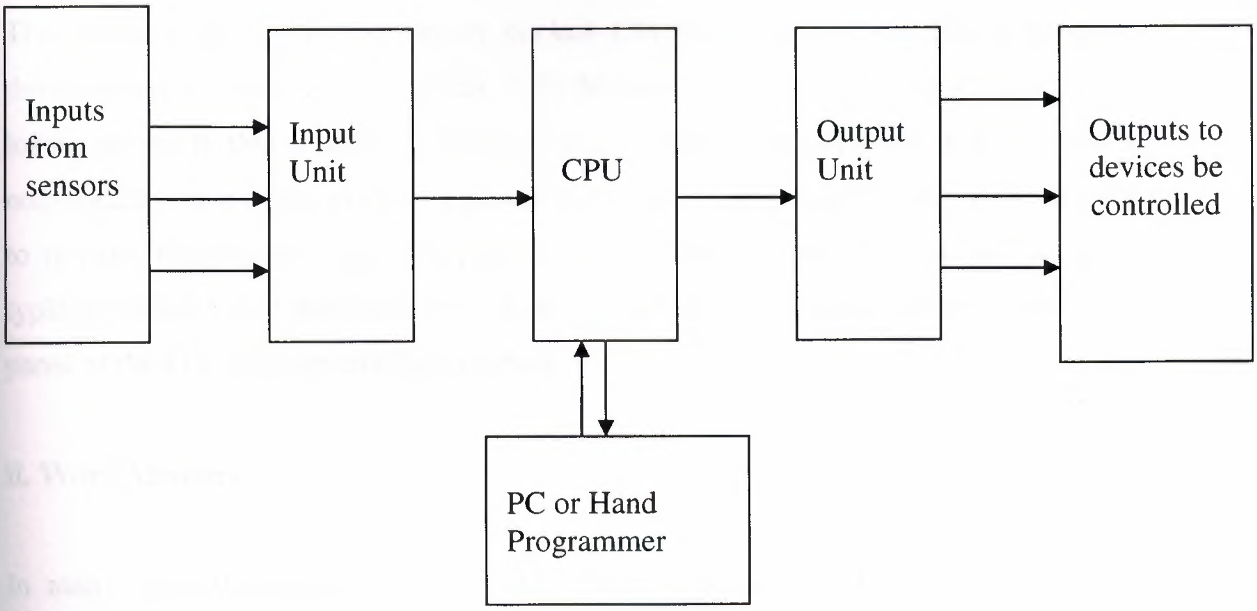


Figure 1.2 PLC operation section

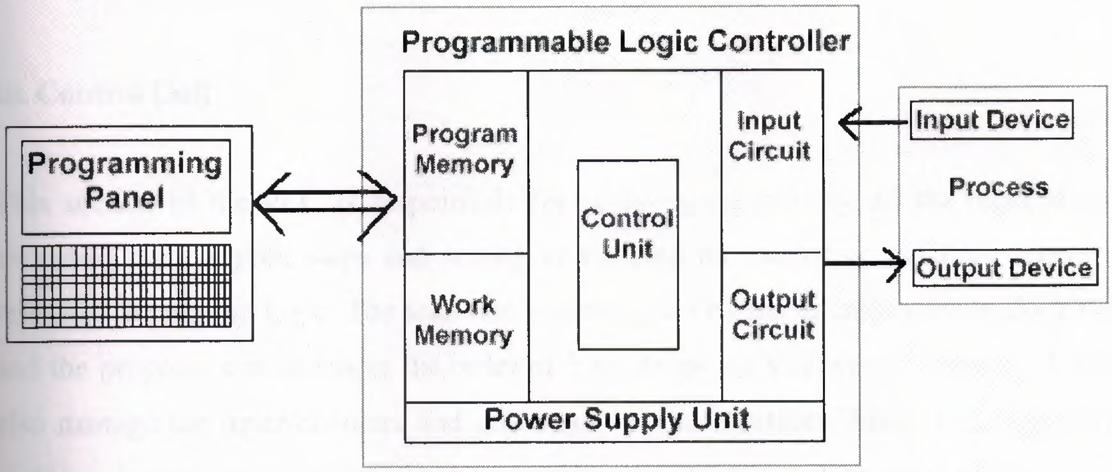


Figure 1.3 Programming logic controller structure

Now it will be considered each of the elements in the above block diagram.

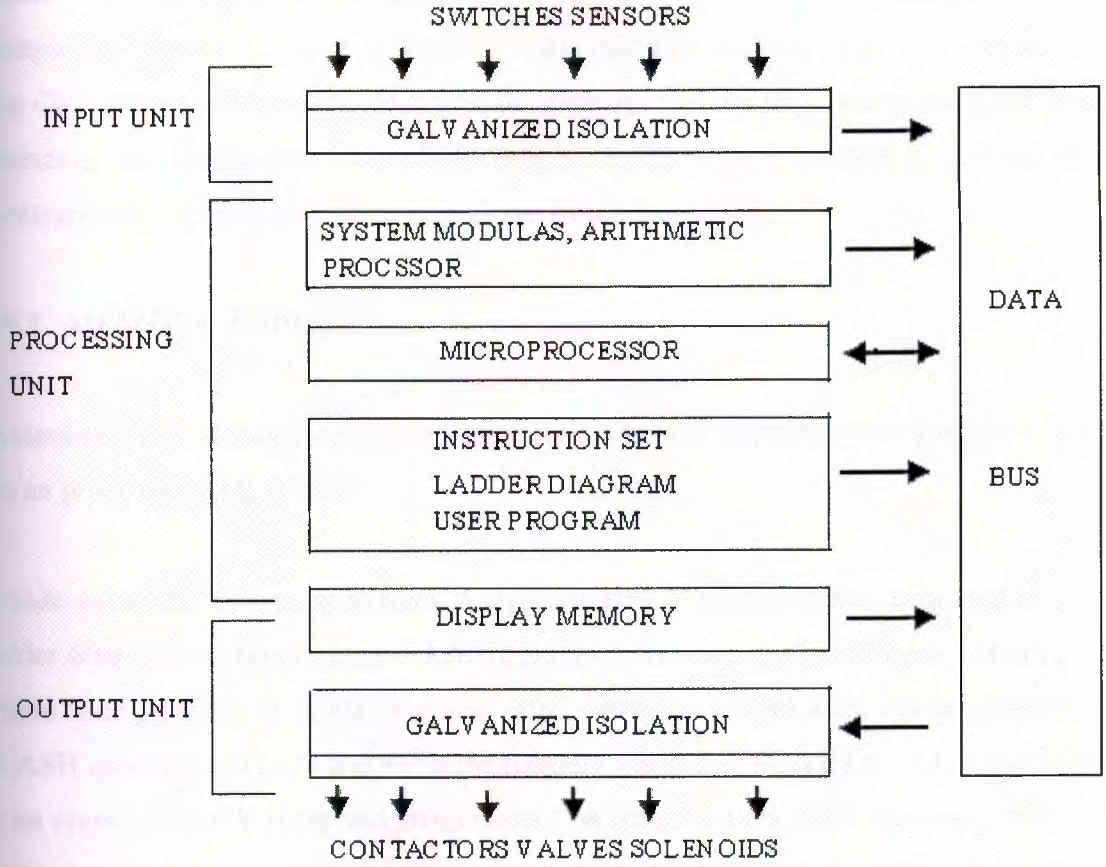


Figure 1.4 Block diagram representation of the internal structure of PLC

1.9.2. Central Processing Unit (CPU)

Central Processing Unit (CPU) is the brain of a PLC controller. CPU itself is usually one of the microcontrollers. A foretime these were 8-bit microcontrollers such as 8051, and now these are 16- and 32-bit microcontrollers. Unspoken rule is that you'll find mostly Hitachi and Fujicu microcontrollers in PLC controllers by Japanese makers, Siemens in European controllers, and Motorola microcontrollers in American ones. CPU also takes care of communication, interconnectedness among other parts of PLC controller, program execution, memory operation, overseeing input and setting up of an output. PLC controllers have complex routines for memory checkup in order to ensure that PLC memory was not damaged (memory checkup is done for safety reasons). Generally speaking, CPU unit makes a great number of check-ups of the PLC controller itself so eventual errors would be discovered early.

Within the CPU are the digital processor, memory, and power supply. These components interact to solve application logic and pass control signals to the outputs. The CPU reads the converted input signals, executes the user logic program stored in its memory, then writes the appropriate output signals to the switching devices. The application program is written in a language called ladder logic.

1.9.2. MEMORY TYPES

System memory (today mostly implemented in FLASH technology) is used by a PLC for an process control system.

A side from this operating system it also contains a user program translated from a ladder diagram to a binary form. FLASH memory contents can be changed only in case where user program is being changed. PLC controllers were used earlier instead of FLASH memory and have had EPROM memory instead of FLASH memory which had to be erased with UV lamp and programmed on programmers. With the use of FLASH technology this process was greatly shortened. Reprogramming a program memory is done through a serial cable in a program for application development.

User memory is divided into blocks having special functions. Some parts of a memory are used for storing input and output status. The real status of an input is stored either as "1" or as "0" in a specific memory bit. Each input or output has one corresponding bit in memory. Other parts of memory are used to store variable contents for variables used in user program. For example, timer value, or counter value would be stored in this part of the memory.

There are a few basic types of computer memory that are in use today.

RAM (Random Access Memory)

This memory is fast, but it will lose its contents. When power is lost, this is known as volatile memory. Every PLC uses this. Memory for the central CPU when running the PLC.

Memory Storege Capacity

The storage capacity of a memory device is determined by the number of binary digits in the binary number 2^10 A.4K-byte memory is capable of storing 4*1024 words, each of 8 bits, and has a total storage capacity of 32768 bits.

Clearly, the storage capacity of the user memory will determine the maximum program size. As a guide, a 1K-byte memory will hold 1024 program instructions and data if these are stored as groups of 8 bits.

Memory Size

Smaller programmable controllers normally have fixed memory size, due in part to the physical dimension of the unit.The varies in capacity between 300 and 1000 instructions depending of the manifacturer. This capacity may not appear large enough to 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 user's needs.

Memory Map

Memory mapping is used to describe the situation in which input/output ports are controlled by writing data into the allocation of memory adresses of ROM, RAM and I/O is called a memory map. Figure 1.5 illustrates a memory map for a typical PLC

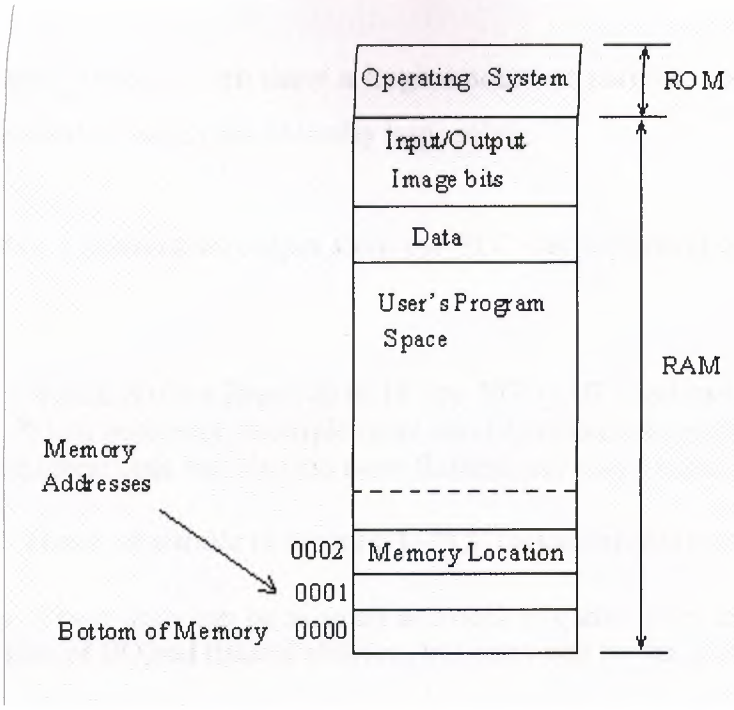


Figure 1.5 Memory Map

1.9.3. INPUTS AND OUTPUTS

Inputs to, and outputs from, a PLC are necessary to monitor and control a process.Both inputs and outputs can be categorized into two basic types: logical or continuous. Consider the example of a light bulb. If it can only be turned on or off, it is logical control. If the light can be dimmed to different levels, it is continuous. Continuous values seem more intuitive, but logical values are preferred because they allow more certainty, and simplify control. As a result most controls applications (and PLCs) use logical inputs and outputs for most applications. Hence, we will discuss logical I/O and leave continuous I/O for later. Outputs to actuators allow a PLC to cause something to happen in a process. Ashort list of popular actuators is given below in order of relative popularity.

Solenoid Valves - logical outputs that can switch a hydraulic or pneumatic flow.

Lights - logical outputs that can often be powered directly from PLC output boards.

Motor Starters - motors often draw a large amount of current when started, so they require motor starters, which are basically large relays.

Servo Motors - a continuous output from the PLC can command a variable speed or position.

- Rack - A rack is often large (up to 18" by 30" by 10") and can hold multiple cards. When necessary, multiple racks can be connected together. These tend to be the highest cost, but also the most flexible and easy to maintain.
- Mini - These are similar in function to PLC racks, but about half the size.
- Micro - These units can be as small as a deck of cards. They tend to have fixed quantities of I/O and limited abilities, but costs will be the lowest.

Outputs from PLCs are often relays, but they can also be solid state electronics such as transistors for DC outputs or Triacs for AC outputs. Continuous outputs require special output cards with digital to analog converters.

Inputs come from sensors that translate physical phenomena into electrical signals. Typical examples of sensors are listed below in relative order of popularity.

Proximity Switches - use inductance, capacitance or light to detect an object logically.

Switches - mechanical mechanisms will open or close electrical contacts for a logical signal.

Potentiometer - measures angular positions continuously, using resistance.

LVDT (linear variable differential transformer) - measures linear displacement continuously using magnetic coupling.

Inputs for a PLC come in a few basic varieties, the simplest are AC and DC inputs. Sourcing and sinking inputs are also popular. This output method dictates that a device does not supply any power. Instead, the device only switches current on or off, like a simple switch.

Sinking - When active the output allows current to flow to a common ground. This is best selected when different voltages are supplied.

Sourcing - When active, current flows from a supply, through the output device and to ground. This method is best used when all devices use a single supply voltage. This is also referred to as NPN (sinking) and PNP (sourcing). PNP is more popular.

i. Inputs

In smaller PLCs the inputs are normally built in and are specified when purchasing the PLC. For larger PLCs the inputs are purchased as modules, or cards, with 8 or 16 inputs of the same type on each card. For discussion purposes we will discuss all inputs as if they have been purchased as cards. The list below shows typical ranges for input voltages, and is roughly in order of popularity.

- 12-24 Vdc
- 100-120 Vac
- 10-60 Vdc
- 12-24 Vac/dc

- 5 Vdc (TTL)
- 200-240 Vac
- 48 Vdc
- 24 Vac

PLC input cards rarely supply power, this means that an external power supply is needed to supply power for the inputs and sensors. There are many trade-offs when deciding which type of input cards to use. DC voltages are usually lower, and therefore safer (i.e., 12-24V). DC inputs are very fast, AC inputs require a longer on-time. For example, a 60Hz wave may require up to 1/60sec for reasonable recognition. DC voltages can be connected to larger variety of electrical systems. AC signals are more immune to noise than DC, so they are suited to long distances, and noisy (magnetic) environments. AC power is easier and less expensive to supply to equipment. AC signals are very common in many existing automation devices.

Input adjustment interface

Adjustment interface also called an interface is placed between input lines and a CPU unit. The purpose of adjustment interface to protect a CPU from disproportionate signals from an outside world. Input adjustment module turns a level of real logic to a level that suits CPU unit (ex. input from a sensor which works on 24 VDC must be converted to a signal of 5 VDC in order for a CPU to be able to process it). This is typically done through opto-isolation, and this function it can be viewed in the figure1.6

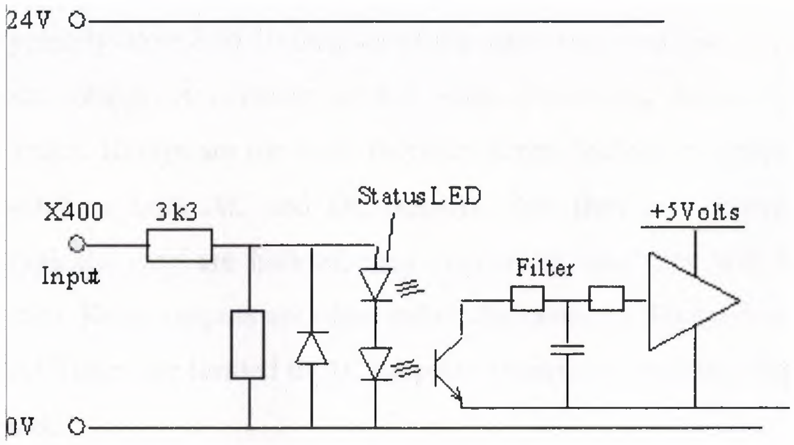


Figure1.6. Typical PLC input circuit with opto-isolation

Opto-isolation means that there is no electrical connection between external world and CPU unit. They are "optically" separated, or in other words, signal is transmitted through light. The way this works is simple. External device brings a signal which turns LED on, whose light in turn incites photo transistor which in turn starts conducting, and a CPU sees this as logic zero (supply between collector and transmitter falls under 1V). When input signal stops LED diode turns off, transistor stops conducting, collector voltage increases, and CPU receives logic 1 as information.

ii. Output

As with input modules, output modules rarely supply any power, but instead act as switches. External power supplies are connected to the output card and the card will switch the power on or off for each output. Typical output voltages are listed below, and roughly ordered by popularity.

- 120 Vac
- 24 Vdc
- 12-48 Vac
- 12-48 Vdc
- 5Vdc (TTL)
- 230 Vac

These cards typically have 8 to 16 outputs of the same type and can be purchased with different current ratings. A common choice when purchasing output cards is relays, transistors or triacs. Relays are the most flexible output devices in figure 1.7. They are capable of switching both AC and DC outputs. But, they are slower (about 10ms switching is typical), they are bulkier, they cost more, and they will wear out after millions of cycles. Relay outputs are often called dry contacts. Transistors are limited to DC outputs, and Triacs are limited to AC outputs. Transistor and triac outputs are called switched outputs.

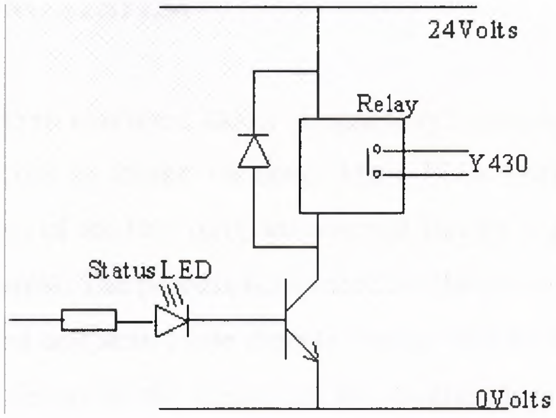


Figure 1.7. PLC output circuit(Relay Control)

Dry contacts - a separate relay is dedicated to each output. This allows mixed voltages (AC or DC and voltage levels up to the maximum), as well as isolated outputs to protect other outputs and the PLC. Response times are often greater than 10ms. This method is the least sensitive to voltage variations and spikes.

Switched outputs - a voltage is supplied to the PLC card, and the card switches it to different outputs using solid state circuitry (transistors, triacs, etc.) Triacs are well suited to AC devices requiring less than 1A. Transistor outputs use NPN or PNP transistors up to 1A typically. Their response time is well under 1ms.

PLC controller output

Automated system is incomplete if it is not connected with some output devices. Some of the most frequently used devices are motors, solenoids, relays, indicators, sound signalization and similar. By starting a motor, or a relay, PLC can manage or control a simple system such as system for sorting products all the way up to complex systems such as service system for positioning head of CNC machine. Output can be of analogue or digital type.

Digital output signal works as a switch; it connects and disconnects line. Analogue output is used to generate the analogue signal (ex. motor whose speed is controlled by a voltage that corresponds to a desired speed).

1.10 PLC OPERATİNG SYSTEM

All PLC operating system execute a ladder program by scanning the logic states of the inputs and output stored in image memory. Most PLCs logic one rung at a time sequentially. The inputs of the first rung are scanned and the logic solved to determine the logic state of its output. The process is repeated for the second and third rung. When the end rung is reached and scan cycle repeats itselfso that each rung is scanned over and over again this is shown in the figure 1.8. the program logic might involve simple AND, OR, NOT functions and counting, timing, sequence and mathematical functions are available to the user the more sophisticated the operating the system more programming functions are provided. The speed at which a PLC scans the memory is called the scan rate. In other words a PLC works by continually scanning a program.

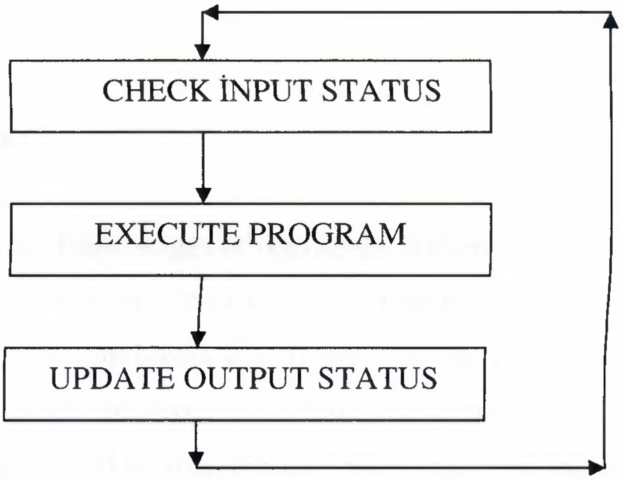


Figure 1.8 Scanning steps of PLC programs

CHECK İNPUT STATUS

First the PLC takes a look at each to input determine if it is on or off in sequence until reaching the last input thus the sensors connected to the them. It records this data into its memory to be used during the next step.

EXECUTE PROGRAM

The PLC executes your program one instruction your program one instruction at a time. May be your program said that if the first input was on then it should turn on the first output. Since it already knows which inputs are on/off from the previuos step it will be able to decide whether the first output should be turned on based on the state of the first input. İt will store the execution results for use later during the next step.

UPDATE OUTPUT STATUS

Finally the PLC updates the status of the outputs. İt updates the outputs based on which inputs were on during the first step and the results of executing your program during the second step. After the third step the PLC goes back to step one and repeats the steps continuously. One scan time it takes the execute the 3 steps listed above.

- Response Time
- Data Areas
- Data Object

All PLCs have four basic stages of operations that are repeated many times per second. Initially when turned on the first time it will check it's own hardware and software for faults. If there are no problems it will copy all the input and copy their values into memory, this is called the input scan. Using only the memory copy of the inputs the ladder logic program will be solved once, this is called the logic scan. While solving the ladder logic the output values are only changed in temporary memory. When the ladder scan is done the outputs will updated using the temporary values in memory, this is called the output scan. The PLC now restarts the process by starting a self check for faults. This process typically repeats 10 to 100 times per second as is shown in Figure 1.9.

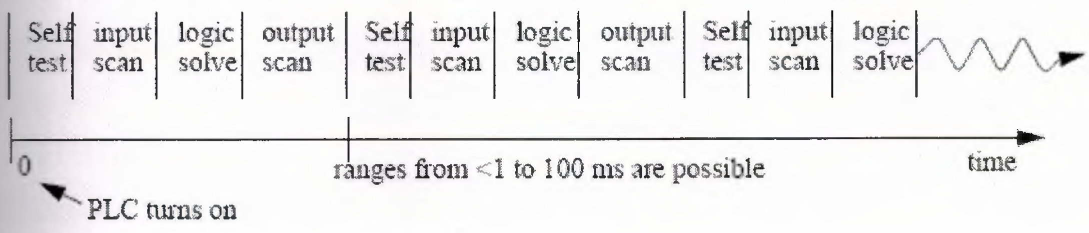


Figure 1.9. PLC Scan Cycle

SELF TEST - Checks to see if all cards error free, reset watch-dog timer, etc. (A watchdog timer will cause an error, and shut down the PLC if not reset within a short period of time - this would indicate that the ladder logic is not being scanned normally).

INPUT SCAN - Reads input values from the chips in the input cards, and copies their values to memory. This makes the PLC operation faster, and avoids cases where an input changes from the start to the end of the program (e.g., an emergency stop). There are special PLC functions that read the inputs directly, and avoid the input tables.

LOGIC SOLVE/SCAN - Based on the input table in memory, the program is executed 1 step at a time, and outputs are updated. This is the focus of the later sections.

OUTPUT SCAN - The output table is copied from memory to the output chips. These chips then drive the output devices.

SUMMARY

A PLC and computer are similar with inputs, outputs, memory, etc. The PLC continuously goes through a cycle including a sanity check, input scan, logic scan, and output scan. While the logic is being scanned, changes in the inputs are not detected, and the outputs are not updated. PLCs use RAM, and sometime EPROMs are used for permanent programs.

2. OPERATIONS ABOUT PROGRAMMABLE LOGIC CONTROLLERS

2.1. OVERVIEW

PLCs (programmable logic controllers) are the control hubs for a wide variety of automated systems and processes.

They contain multiple inputs and outputs that use transistors and other circuitry to simulate switches and relays to control equipment. They are programmable via software interfaced via standard computer interfaces and proprietary languages and network options.

Programmable logic controllers I/O channel specifications include total number of points, number of inputs and outputs, ability to expand, and maximum number of channels. Number of points is the sum of the inputs and the outputs. PLCs may be specified by any possible combination of these values. Expandable units may be stacked or linked together to increase total control capacity. Maximum number of channels refers to the maximum total number of input and output channels in an expanded system. PLC system specifications to consider include scan time, number of instructions, data memory, and program memory. Scan time is the time required by the PLC to check the states of its inputs and outputs. Instructions are standard operations (such as math functions) available to PLC software. Data memory is the capacity for data storage. Program memory is the capacity for control software.

Available inputs for programmable logic controllers include DC, AC, analog, thermocouple, RTD, frequency or pulse, transistor, and interrupt inputs. Outputs for PLCs include DC, AC, relay, analog, frequency or pulse, transistor, and triac. Programming options for PLCs include front panel, hand held, and computer.

Programmable logic controllers can also be specified with a number of computer interface options, network specifications and features. PLC power options, mounting options and environmental operating conditions are all also important to consider

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.

Many PLC configurations are available, even from a single vendor. But, in each of these there are common components and concepts. The most essential components are:

Power Supply - This can be built into the PLC or be an external unit. Common voltage levels required by the PLC (with and without the power supply) are 24Vdc, 120Vac, 220Vac.

CPU (Central Processing Unit) - This is a computer where ladder logic is stored and processed.

I/O (Input/Output) - A number of input/output terminals must be provided so that the PLC can monitor the process and initiate actions.

Indicator lights - These indicate the status of the PLC including power on, program running, and a fault. These are essential when diagnosing problems.

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.

2.2. 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 a 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 2.1. 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).

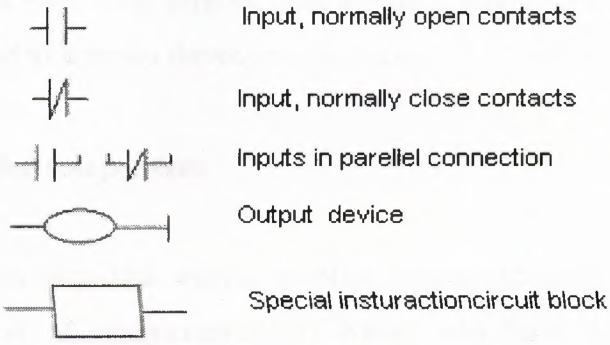

Input, normally open contacts
Input, normally close contacts
Inputs in parellel connection
Output device
Special insturactioncircuit block

Figure 2.1. Programming Elements

Programmable logic control or PLC is the most commonly used industrial automation technique in the world. It is universally applied for factory automation, process control and manufacturing systems.

Programmable logic control originated from the creation of computerised versions of relay control systems used to control manufacturing and chemical process systems. The programming is done using a special technique called ladder logic, which allows sequences of logical actions to be set up, interlinked and timed. A standard task in logic control is batch control and sequencing in a process system, as demonstrated in the PLC Trainer. This piece of equipment allows practical PLC systems to be built using a Programmable Logic Trainer based upon industry standard systems and a PLC Process equipped with relay control valves, contact switches and other standard logic control hardware found in batch production.

2.2.1. Logic Input and Output Units (I/O)

Inputs are wired to sensing devices such as button keypads, selector switches, photocells, motion detectors, etc. If an input senses that a sensor is closed, the input converts the voltage to a logic 1 signal understood by the CPU to be ON. A logic 1 signal indicates an On or CLOSED state, and a logic 0 signal indicates an OFF or OPEN state.

Ouputs are wired to switching devices such as lights, garage doors, heating systems, and other household appliances. Outputs switch the supplied control voltage that energizes or de-energizes the switching devices. If an output is turned ON by the CPU, the control voltage is switched to activate the switching device.

2.3. PLC controller components

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

2.4. System Block Diagram

The block diagram shows the major components of a PLC. The PLC monitors the state of the sensing devices by receiving signals from its inputs, solves a user logic program stored in its CPU, and then directs switching device activity by sending control signals to its outputs.

Systematic approach in designing an process control system

First, you need to select an instrument or a system that you wish to control. Automated system can be a machine or a process and can also be called an process control system. Function of an process control system is constantly watched by input devices (sensors) that give signals to a PLC controller. In response to this, PLC controller sends a signal to external output devices (operative instruments) that actually control how system functions in an assigned manner (for simplification it is recommended that you draw a block diagram of operations' flow).

Secondly, you need to specify all input and output instruments that will be connected to a PLC controller. Input devices are various switches, sensors and such. Output devices can be solenoids, electromagnetic valves, motors, relays, magnetic starters as well as instruments for sound and light signalization. Following an identification of all input and output instruments, corresponding designations are assigned to input and output lines of a PLC controller. Allotment of these designations is in fact an allocation of inputs and outputs on a PLC controller which correspond to inputs and outputs of a system being designed.

Third, make a ladder diagram for a program by following the sequence of operations that was determined in the first step.

Finally, program is entered into the PLC controller memory. When finished with programming, checkup is done forany existing errors in a program code (using functions for diagnostics) and, if possible, an entire operation is simulated. Before this system is started, you need to check once again whether all input and output instruments are connected to correct inputs or outputs. By bringing supply in, system starts working.

2.5. Programming a PLC controller

PLC controller can be reprogrammed through a computer (usual way), but also through manual programmers (consoles). This practically means that each PLC controller can programmed through a computer if you have the software needed for programming. Today's transmission computers are ideal for reprogramming a PLC controller in factory itself. This is of great importance to industry. Once the system is corrected, it is also important to read the right program into a PLC again. It is also good to check from time to time whether program in a PLC has not changed. This helps to avoid hazardous situations in factory rooms (some automakers have established communication networks which regularly check programs in PLC controllers to ensure execution only of good programs).

Almost every program for programming a PLC controller possesses various useful options such as: forced switching on and off of the system inputs/ouputs (I/O lines), program follow up in real time as well as documenting a diagram. This documenting is necessary to understand and define failures and malfunctions. Programmer can add remarks, names of input or output devices, and comments that can be useful when finding errors, or with system maintenance. Adding comments and remarks enables any technician (and not just a person who developed the system) to understand a ladder diagram right away. Comments and remarks can even quote precisely part numbers if replacements would be needed. This would speed up a repair of any problems that come up due to bad parts. The old way was such that a person who developed a system had protection on the program, so nobody aside from this person could understand how it was done. Correctly documented ladder diagram allows any technician to understand thoroughly how system functions.

2.6. Power supply

Electrical supply is used in bringing electrical energy to central processing unit. Most PLC controllers work either at 24 VDC or 220 VAC. On some PLC controllers you'll find electrical supply as a separate module. Those are usually bigger PLC controllers, while small and medium series already contain the supply module. User has to determine how much current to take from I/O module to ensure that electrical supply provides appropriate amount of current. Different types of modules use different amounts of electrical current.

This electrical supply is usually not used to start external inputs or outputs. User has to provide separate supplies in starting PLC controller inputs or outputs because then you can ensure so called "pure" supply for the PLC controller. With pure supply we mean supply where industrial environment can not affect it damagingly. Some of the smaller PLC controllers supply their inputs with voltage from a small supply source already incorporated into a PLC.

2.7. PLC controller inputs

Intelligence of an automated system depends largely on the ability of a PLC controller to read signals from different types of sensors and input devices. Keys, keyboards and by functional switches are a basis for man versus machine relationship. On the other hand, in order to detect a working piece, view a mechanism in motion, check pressure or fluid level you need specific automatic devices such as proximity sensors, marginal switches, photoelectric sensors, level sensors, etc. Thus, input signals can be logical (on/off) or analogue.

2.8. RELAYS

Although relays are rarely used for control logic, they are still essential for switching large power loads. Some important terminology for relays is given below.

Contactor - Special relays for switching large current loads.

Motor Starter - Basically a contactor in series with an overload relay to cut off when too much current is drawn.

Arc Suppression - when any relay is opened or closed an arc will jump. This becomes a major problem with large relays. On relays switching AC this problem can be overcome by opening the relay when the voltage goes to zero (while crossing between negative and positive). When switching DC loads this problem can be minimized by blowing pressurized gas across during opening to suppress the arc formation.

AC coils - If a normal relay coil is driven by AC power the contacts will vibrate open and closed at the frequency of the AC power. This problem is overcome by adding a shading pole to the relay.

The most important consideration when selecting relays, or relay outputs on a PLC, is the rated current and voltage. If the rated voltage is exceeded, the contacts will wear out prematurely, or if the voltage is too high fire is possible. The rated current is the maximum current that should be used. When this is exceeded the device will become too hot, and it will fail sooner. The rated values are typically given for both AC and DC, although DC ratings are lower than AC. If the actual loads used are below the rated values the relays should work well indefinitely. If the values are exceeded a small amount the life of the relay will be shortened accordingly. Exceeding the values significantly may lead to immediate failure and permanent damage.

- **Rated Voltage** - The suggested operation voltage for the coil. Lower levels can result in failure to operate, voltages above shorten life.

- **Rated Current** - The maximum current before contact damage occurs (welding or melting).

Relay operation

A normally open (NO) contact passes power when the associated coil (or input) is on. A normally closed (NC) contact passes power when the associated coil (or input) is off. A given coil (or input) can be associated with any number of both normally open and normally closed contacts.

2.9. LADDER LOGIC

2.9.1. "Ladder" diagrams

Ladder diagrams are specialized schematics commonly used to document industrial control logic systems. They are called "ladder" diagrams because they resemble a ladder, with two vertical rails (supply power) and as many "rungs" (horizontal lines) as there are control circuits to represent. If we wanted to draw a simple ladder diagram showing a lamp that is controlled by a hand switch, it would look like this in figure 2.2

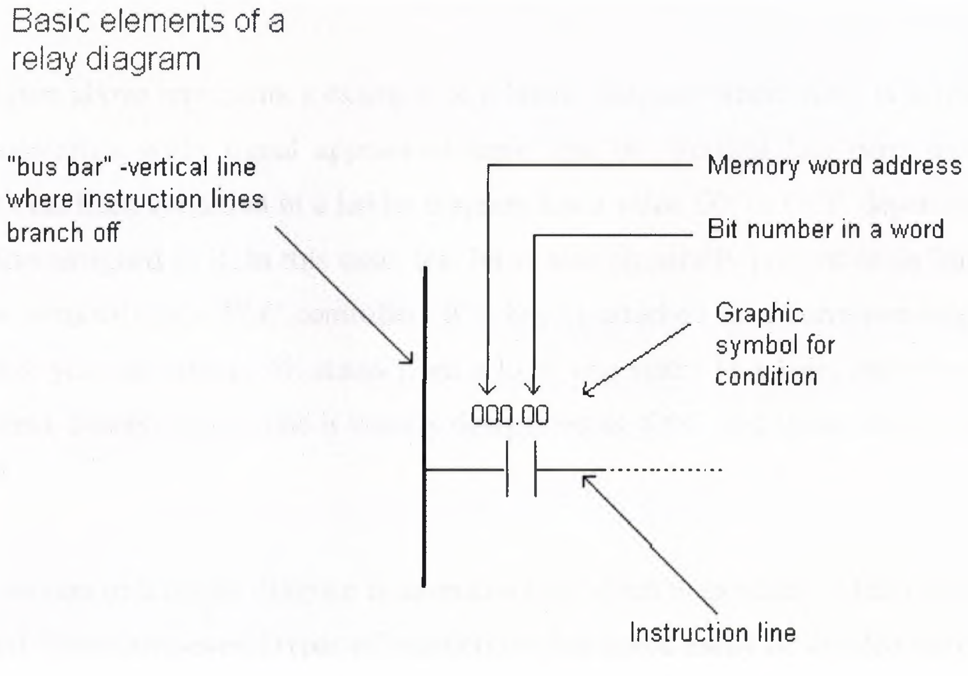

Basic elements of a relay diagram
"bus bar" -vertical line where instruction lines branch off
Memory word address
Bit number in a word
Graphic symbol for condition
000.00
Instruction line

Figure 2.2. Basic elements of a relay diagram

Most instructions require at least one operand, and often more than one. Operand can be some memory location, one memory location bit, or some numeric value -number. In the example above, operand is bit 0 of memory location IR000. In a case when we wish to proclaim a constant as an operand, designation # is used beneath the numeric writing (for a compiler to know it is a constant and not an address.)

Based on the figure2.3. above, one should note that a ladder diagram consists of two basic parts: left section also called conditional, and a right section which has instructions. When a condition is fulfilled, instruction is executed, and that's all!

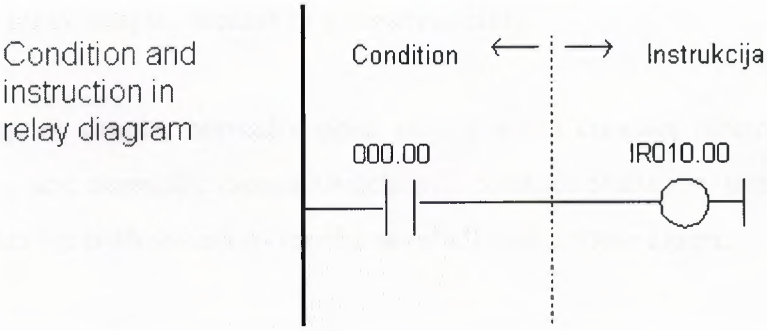


Figure 2.3. Condition and instrruction in relay diagram

The figure above represents a example of a ladder diagram where relay is activated in PLC controller when signal appears at input line 00. Vertical line pairs are called conditions. Each condition in a ladder diagram has a value ON or OFF, depending on a bit status assigned to it. In this case, this bit is also physically present as an input line (screw terminal) to a PLC controller. If a key is attached to a corresponding screw terminal, you can change bit status from a logic one status to a logic zero status, and vice versa. Status of logic one is usually designated as "ON", and status of logic zero as "OFF".

Right section of a ladder diagram is an instruction which is executed if left condition is fulfilled. There are several types of instructions that could easily be divided into simple and complex. Example of a simple instruction is activation of some bit in memory location. In the example above, this bit has physical connotation because it is connected with a relay inside a PLC controller. When a CPU activates one of the leading four bits in a word IR010, relay contacts move and connect lines attached to it. In this case, these are the lines connected to a screw terminal marked as 00 and to one of COM screw terminals.

2.9.2.Normally open and normally closed contacts

Since we frequently meet with concepts "normally open" and "normally closed" in industrial environment, it's important to know them. Both terms apply to words such as contacts, input, output, etc. (all combinations have the same meaning whether we are talking about input, output, contact or something else).

Principle is quite simple, normally open switch won't conduct electricity until it is pressed down, and normally closed switch will conduct electricity until it is pressed. Good examples for both situations are the doorbell and a house alarm.

If a normally closed switch is selected, bell will work continually until someone pushes the switch. By pushing a switch, contacts are opened and the flow of electricity towards the bell is interrupted. Of course, system so designed would not in any case suit the owner of the house. A better choice would certainly be a normally open switch. This way bell wouldn't work until someone pushed the switch button and thus informed of his or her presence at the entrance.

Home alarm system is an example of an application of a normally closed switch. Let's suppose that alarm system is intended for surveillance of the front door to the house. One of the ways to "wire" the house would be to install a normally open switch from each door to the alarm itself (precisely as with a bell switch). Then, if the door was opened, this would close the switch, and an alarm would be activated. This system could work, but there would be some problems with this, too. Let's suppose that switch is not working, that a wire is somehow disconnected, or a switch is broken, etc. (there are many ways in which this system could become dysfunctional). The real trouble is that a homeowner would not know that a system was out of order. A burglar could open the door, a switch would not work, and the alarm would not be activated. Obviously, this isn't a good way to set up this system. System should be set up in such a way so the alarm is activated by a burglar, but also by its own dysfunction, or if any of the components stopped working. (A homeowner would certainly want to know if a system was dysfunctional). Having these things in mind, it is far better to use a switch with normally closed contacts which will detect an unauthorized entrance (opened door interrupts the flow of electricity, and this signal is used to activate a sound signal), or a failure on the system such as a disconnected wire. These considerations are even more important in industrial environment where a failure could cause injury at work. One such example where outputs with normally closed contacts are used is a safety wall with trimming machines. If the wall doors open, switch affects the output with normally closed contacts and interrupts a supply circuit. This stops the machine and prevents an injury.

Concepts normally open and normally closed can apply to sensors as well. Sensors are used to sense the presence of physical objects, measure some dimension or some amount. For instance, one type of sensors can be used to detect presence of a box on an industry transfer belt. Other types can be used to measure physical dimensions such as heat, etc. Still, most sensors are of a switch type. Their output is in status ON or OFF depending on what the sensor "feels". Let's take for instance a sensor made to feel metal when a metal object passes by the sensor. For this purpose, a sensor with a normally open or a normally closed contact at the output could be used. If it were necessary to inform a PLC each time an object passed by the sensor, a sensor with a normally open output should be selected. Sensor output would set off only if a metal object were placed right before the sensor. A sensor would turn off after the object has passed. PLC could then calculate how many times a normally open contact was set off at the sensor output, and would thus know how many metal objects passed by the sensor.

Concepts normally open and normally closed contact ought to be clarified and explained in detail in the example of a PLC controller input and output. The easiest way to explain them is in the example of a relay.

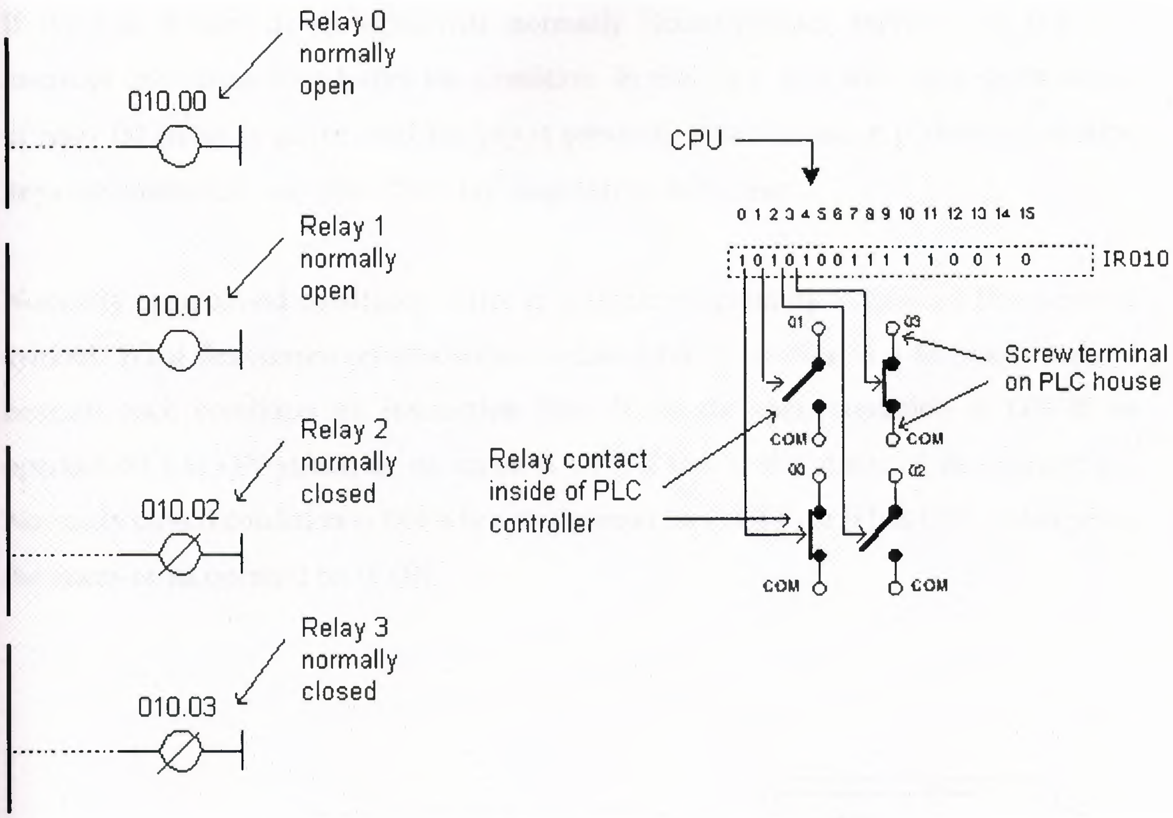


Figure2.4. Contact control

Normally open contacts would represent relay contacts that would perform a connection upon receipt of a signal. Unlike open contacts, with normally closed contacts signal will interrupt a contact, or turn a relay off. Previous picture shows what this looks like in practice. First two relays are defined as normally open , and the other two as normally closed. All relays react to a signal! First relay (00) has a signal and closes its contacts. Second relay (01) does not have a signal and remains opened. Third relay (02) has a signal and opens its contacts considering

it is defined as a closed contact. Fourth relay (03) does not have a signal and remains closed because it is so defined.

Concepts "normally open" and "normally closed" can also refer to inputs of a PLC controller. Let's use a key as an example of an input to a PLC controller. Input where a key is connected can be defined as an input with open or closed contacts. If it is defined as an input with normally open contact, pushing a key will set off an instruction found after the condition. In this case it will be an activation of a relay 00.

If input is defined as an input with normally closed contact, pushing the key will interrupt instruction found after the condition. In this case, this will cause deactivation of relay 00 (relay is active until the key is pressed). You can see in picture below how keys are connected, and view the relay diagrams in both cases.

Normally open/closed conditions differ in a ladder diagram by a diagonal line across a symbol. What determines an execution condition for instruction is a bit status marked beneath each condition on instruction line. Normally open condition is ON if its operand bit has ON status, or its status is OFF if that is the status of its operand bit. Normally closed condition is ON when its operand bit is OFF, or it has OFF status when the status of its operand bit is ON.

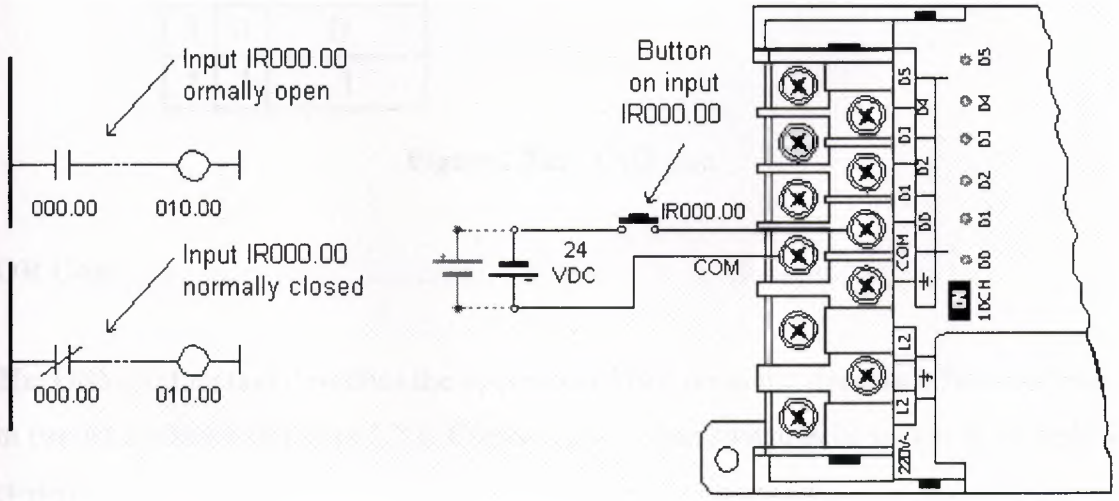
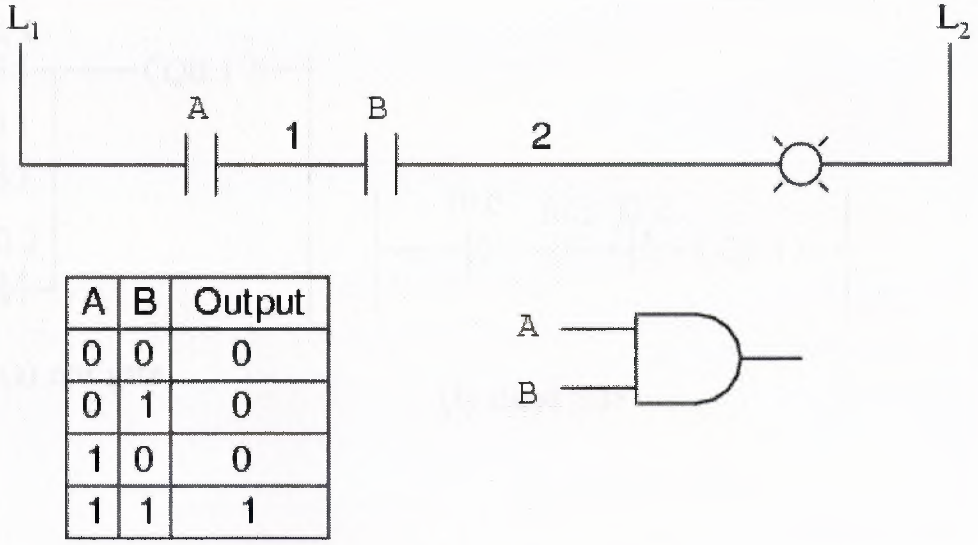


Figure 2.5 Normally open and normally closed

When programming with a ladder diagram, logical combination of ON and OFF conditions set before the instruction determines the eventual condition under which the instruction will be, or will not be executed. This condition, which can have only ON or OFF values is called instruction execution condition. Operand assigned to any instruction in a relay diagram can be any bit from IR, SR, HR, AR, LR or TC sector. This means that conditions in a relay diagram can be determined by a status of I/O bits, or of flags, operational bits, timers/counters, etc.

And Gate

The AND logic function describes the operation of two normally open single pole single through switches connected in series shown in figure2.7.a. Current flows only switch A and switch B are closed when A=1 and B=1.

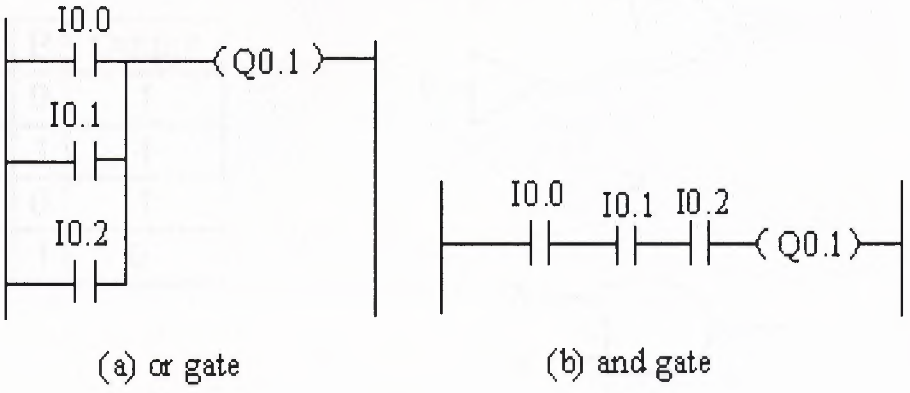


A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1

Figure2.7.a. AND gate

OR Gate

The ORlogic function describes the operation of two normally open switches connected in paralel as shown in figure 2.7.b. Current flows when switch A or switch B, or both, is closed.



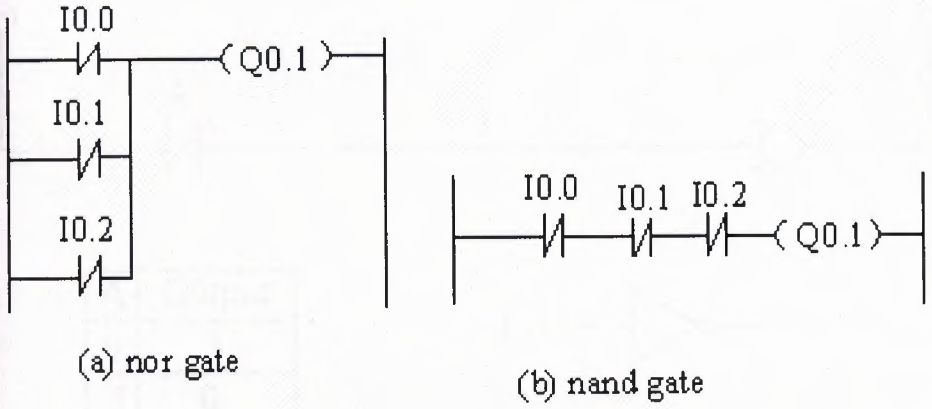
(a) or gate

(b) and gate

Figure2.7.b. Ladder diagram for and gate & or gate

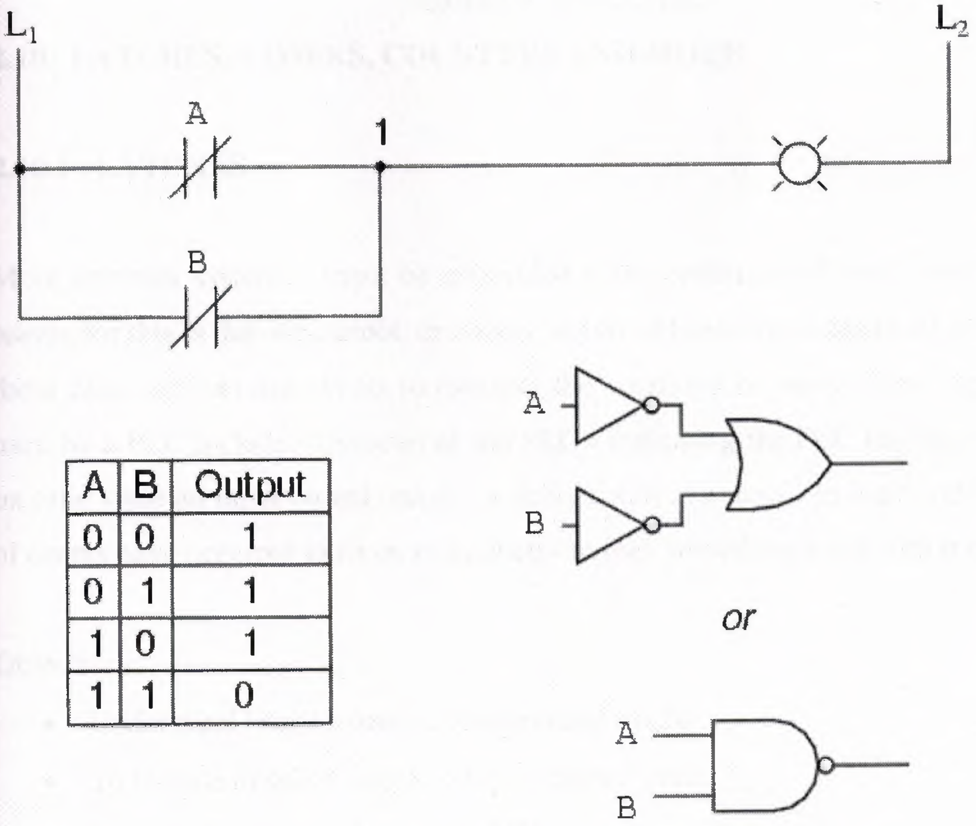
Nand gate

The AND logic function describes the operation of two normally close single pole single through switches connected in series shown in figure2.8. Current flows only switch A and switch B are closed when A=0 and B=0.



(a) nor gate

(b) nand gate

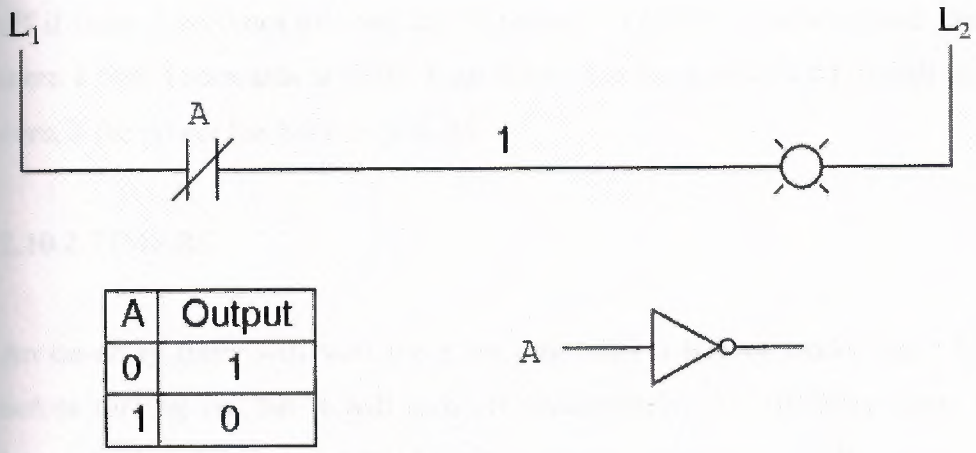


A	B	Output
0	0	1
0	1	1
1	0	1
1	1	0

Figure 2.8. NAND gate

Inverter Gate

The truth values of NOT A are invers the inverse of A so we define NOT A by tabulating its truth values against those of a as shown in figure 2.9



A	Output
0	1
1	0

Figure2.9. İnverter gate

2.10. LATCHES, TIMERS, COUNTERS AND MORE

2.10.1 . LATCHES

More complex systems cannot be controlled with combinatorial logic alone. The main reason for this is that we cannot, or choose not to add sensors to detect all conditions. In these cases we can use events to estimate the condition of the system. Typical events used by a PLC include; first scan of the PLC - indicating the PLC has just been turned on time since an input turned on/off - a delay count of events - to wait until set number of events have occurred latch on or unlatch - to lock something on or turn it off

Objectives:

- Understand latches, timers, counters and MCRs.
- To be able to select simple internal memory bits.
- Latches, timers, counters and MCRs
- Design examples

- Internal memory locations are available, and act like outputs

A latch is like a sticky switch - when pushed it will turn on, but stick in place, it must be pulled to release it and turn it off. A latch in ladder logic uses one instruction to latch, and a second instruction to unlatch. The output with an L inside will turn the output *D* on when the input *A* becomes true. *D* will stay on even if *A* turns off. Output *D* will turn off if input *B* becomes true and the output with a *U* inside becomes true (Note: this will seem a little backwards at first). If an output has been latched on, it will keep its value, even if the power has been turned off.

2.10.2.TIMERS

An on-delay timer will wait for a set time after a line of ladder logic has been true before turning on, but it will turn off immediately. An off-delay timer will turn on immediately when a line of ladder logic is true, but it will delay before turning off. Consider the example of an old car. If you turn the key in the ignition and the car does not start immediately, that is an on-delay. If you turn the key to stop the engine but the engine doesn't stop for a few seconds, that is an off delay. An on-delay timer can be used to allow an oven to reach temperature before starting production. An off delay timer can keep cooling fans on for a set time after the A retentive timer will sum all of the on or off time for a timer, even if the timer never finished. A nonretentive timer will start timing the delay from zero each time.

Typical applications for retentive timers include tracking the time before maintenance is needed. A non retentive timer can be used for a start button to give a short delay before a conveyor begins moving.

2.10.3. COUNTERS

There are two basic counter types: count-up and count-down. When the input to a count-up counter goes true the accumulator value will increase by 1 (no matter how long the input is true.) If the accumulator value reaches the preset value the counter *DN* bit will be set. A count-down counter will decrease the accumulator value until the preset value is reached.

2.10.4. Timer / Counter operation

- Timer runs, increasing the (integer) accumulated value, when accum < preset & both inputs ("in" & "enable/reset") are on.
- Counter increases the accumulated value when accum < preset, the bottom input "enable/reset" is on, and the top input "in" goes on.
- Output ("out") is on when accum = preset.
- Accum is reset to zero when enable/reset is off.

SUMMARY

Normally open and closed contacts. Relays and their relationship to ladder logic. Ladder logic is the main programming method used for PLCs.PLC outputs can be inputs, as shown by the seal in circuit. Programming can be done with ladder logic, mnemonics, SFCs, and structured text, latches, tımers, counters and more.

3. INFORMATION ABOUT DC MOTOR, COOLING FAN/ FAN MODULES, RELAY AND RESİSTANCE

3.1 Overview

The elementary dc generator that the commutator mechanically reverses the armature loop connections to the external circuit. This occurs at the same instant that the voltage polarity in the armature loop reverses. Effective voltage is the equivalent level of dc voltage, which will cause the same average current through a given resistance. Speed control of DC drives is possible via a voltage multiplier or electronically.

Resistors are used as part of electrical networks and incorporated into microelectronic semiconductor devices. A resistor is an electrical component designed to have an electrical resistance that is independent of the current flowing through it.

In some cases you may need to switch multiple things at the same time using one output. A single output connected to multiple relays will allow you to open continuity and/or close continuity simultaneously on multiple wires.

3.2 Effects Of Addıng Addıtıonal Coıls And Poles

The effects of additional coils may be illustrated by the addition of a second coil to the armature. The commutator must now be divided into four parts since there are four coil ends figure3.1. The coil is rotated in a clockwise direction from the position shown. The voltage induced in the white coil, decreases for the next 90° of rotation. The voltage induced in the black coil ıncreases from zero to maximum at the same time. Since there are four segments in the commutator, a new segment passes each brush every 90° instead of every 180° . This allows the brush to switch from the white coil to the black coil at the instant the voltages in the two coils are equal. The brush remains in contact with the black coil as its induced voltage increases to maximum, level B in the graph. It then decreases to level A, 90° later. At this point, the brush will contact the white coil again. Effects of additional coils. The ripple effect of the voltage when two armature coils are used. Since there are now four commutator segments in the commutator and only two brushes, the voltage cannot fall any lower than at point A. Therefore, the ripple is limited to the rise and fall between points A and B on the graph. By adding more armature coils, the ripple effect can be further reduced. Decreasing ripple in this way increases the effective voltage of the output.

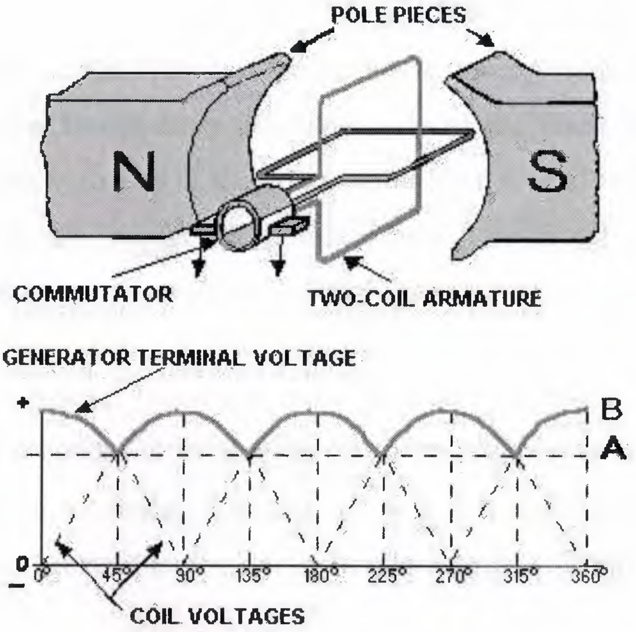


Figure3.1. Effects of adding additional coils and poles

Effective voltage is the equivalent level of dc voltage, which will cause the same average current through a given resistance. By using additional armature coils, the voltage across the brushes is not allowed to fall to as low a level between peaks. Practical generators use many armature coils. They also use more than one pair of magnetic poles. The additional magnetic poles have the same effect on ripple as did the additional armature coils. In addition, the increased number of poles provides a stronger magnetic field (greater number of flux lines). This, in turn, allows an increase in output voltage because the coils cut more lines of flux per revolution.

For the remainder of this discussion, refer to figure 3.2. parts A through D. The step-by-step description of the operation of a dc generator. When the armature loop rotates clockwise from position A to position B, a voltage is induced in the armature loop which causes a current in a direction that deflects the meter to the right. Current flows through loop, out of the negative brush, through the meter and the load, and back through the positive brush to the loop. Voltage reaches its maximum value at point B on the graph for reasons explained earlier. The generated voltage and the current fall to zero at position C. At this instant each brush makes contact with both segments of the commutator. As the armature loop rotates to position D, a voltage is again induced in the loop. In this case, however, the voltage is of opposite polarity. The voltages induced in the two sides of the coil at position D are in the reverse direction to that of the voltages shown at position B. Note that the current is flowing from the black side to the white side in position B and from the white side to the black side in position D. However, because the segments of the commutator have rotated with the loop and are contacted by opposite brushes, the direction of current flow through the brushes and the meter remains the same as at position B. The voltage developed across the brushes is pulsating and unidirectional (in one direction only). It varies twice during each revolution between zero and maximum. This variation is called RIPPLE. A pulsating voltage, such as that produced in the preceding description, is unsuitable for most applications. Therefore, in practical generators more armature loops (coils) and more commutator segments are used to produce an output voltage waveform with less ripple.

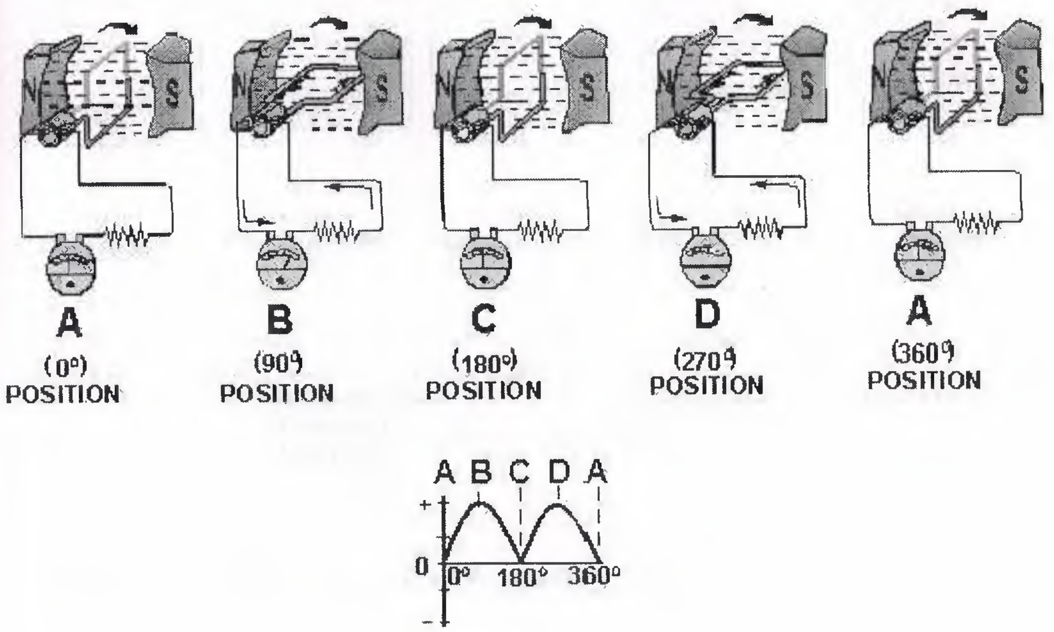


Figure3.2. Effects of commutation.

Figure3.2. shown from points A, B, and C. The terminal voltage will be the same as it was from A to C except that the polarity is reversed (as shown by the meter deflection at position D). The voltage output waveform for the complete revolution of the loop is shown on the graph in figure 3.3.

3.2.1 The Elementary Dc Generator

A single-loop generator with each terminal connected to a segment of a two-segment metal. The two segments of the split metal ring are insulated from each other. This forms a simple commutator. The commutator in a dc generator replaces the slip rings of the ac generator. This is the main difference in their construction. The commutator mechanically reverses the armature loop connections to the external circuit. This occurs at the same instant that the polarity of the voltage in the armature loop reverses. Through this process the commutator changes the generated ac voltage to a pulsating dc voltage as shown in the graph of figure 3.3. This action is known as commutation. Commutation is described in detail later in this chapter.

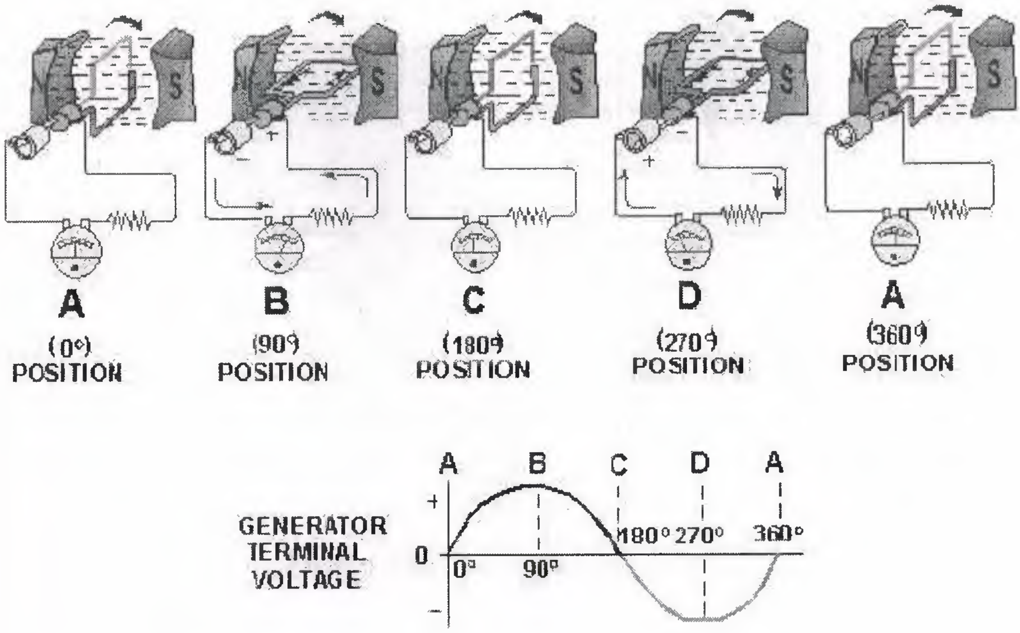


Figure 3.3. Output voltage of an elementary generator during one revolution.

3.2.2 Elemantery Generator

The pole pieces (marked N and S) provide the magnetic field. The pole pieces are shaped and positioned as shown to concentrate the magnetic field as close as possible to the wire loop. The loop of wire that rotates through the field is called the armature. The ends of the armature loop are connected to rings called slıp rıngs. They rotate with the armature. The brushes, usually made of carbon, with wires attached to them, ride against the rings. The generated voltage appears across these brushes. The elementary generator produces a voltage in the following manner (fig. 3.4.). The armature loop is rotated in a clockwise direction. The initial or starting point is shown at position A. (This will be considered the zero-degree position.) At 0° the armature loop is perpendicular to the magnetic field. The black and white conductors of the loop are moving parallel to the field. The instant the conductors are moving parallel to the magnetic field, they do not cut any lines of flux. Therefore, no emf is induced in the conductors, and the meter at position A indicates zero. This position is called the neutral *plane.*

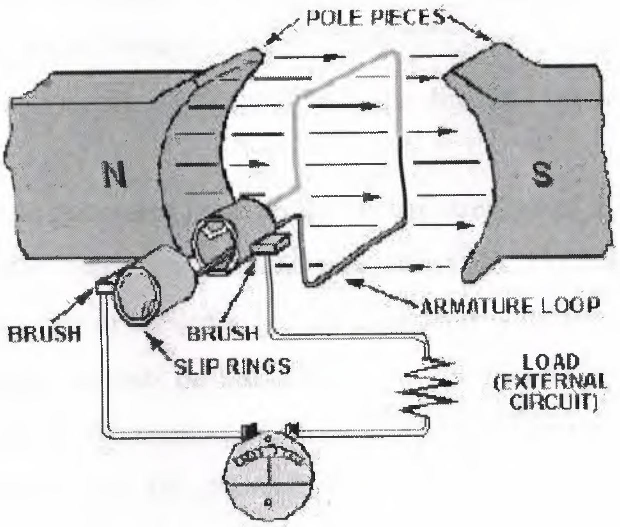


Figure 3.4. The elementary generator

As the armature loop rotates from position A (0°) to position B (90°), the conductors cut through more and more lines of flux, at a continually increasing angle. At 90° they are cutting through a maximum number of lines of flux and at maximum angle. The result is that between 0° and 90° , the induced emf in the conductors builds up from zero to a maximum value. Observe that from 0° to 90° , the black conductor cuts DOWN through the field. At the same time the white conductor cuts UP through the field. The induced emfs in the conductors are series-adding. This means the resultant voltage across the brushes (the terminal voltage) is the sum of the two induced voltages. The meter at position B reads maximum value. As the armature loop continues rotating from 90° (position B) to 180° (position C), the conductors which were cutting through a maximum number of lines of flux at position B now cut through fewer lines. They are again moving parallel to the magnetic field at position C. They no longer cut through any lines of flux. As the armature rotates from 90° to 180° , the induced voltage will decrease to zero in the same manner that it increased during the rotation from 0° to 90° . The meter again reads zero. From 0° to 180° the conductors of the armature loop have been moving in the same direction through the magnetic field. Therefore, the polarity of the induced voltage has remained the same. This is shown by points A through C on the graph. As the loop rotates beyond 180° (position C), through 270° (position D), and back to the initial or starting point (position A), the direction of the cutting action of the conductors through the magnetic field reverses. Now the black conductor cuts UP through the field while the white conductor cuts DOWN through the field. As a result, the polarity of the induced voltage reverses. Following the sequence shown by graph points C, D, and back to A, the voltage will be in the direction opposite to that

The amount of voltage generated depends on (1) the strength of the magnetic field, (2) the angle at which the conductor cuts the magnetic field, (3) the speed at which the conductor is moved, and (4) the length of the conductor within the magnetic field. The polarıty of the voltage depends on the direction of the magnetic lines of flux and the direction of movement of the conductor. To determine the direction of current in a given situation, the left-hand rule for generators is used. This rule is explained in the following manner. Extend the thumb, forefinger, and middle finger of your left hand at right angles to one another, as shown in figure 3.5. Point your thumb in the direction the conductor is being moved. Point your forefinger in the direction of magnetic flux (from north to south). Your middle finger will then point in the direction of current flow in an external circuit to which the voltage is applied. Figure 3.5. Left-hand rule for generators. The elementary generator The simplest elementary generator that can be built is an ac generator. Basic generating principles are most easily explained through the use of the elementary ac generator. For this reason, the ac generator will be discussed first. The dc generator will be discussed later. An elementary generator consists of a wire loop placed so that it can be rotated in a stationary magnetic field. This will produce an induced emf in the loop. Sliding contacts (brushes) connect the loop to an external circuit load in order to pick up or use the induced emf.

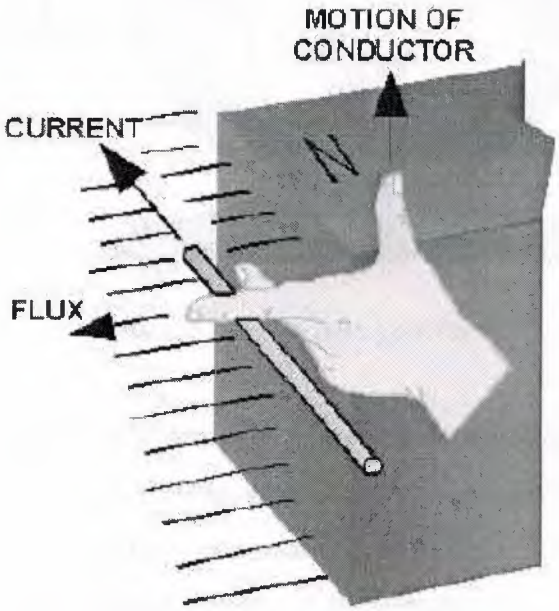


Figure 3.5. Left-hand rule for generators.

3.3 Electromagnetıc Poles

Nearly all practical generators use electromagnetic poles instead of the permanent magnets used in our elementary generator. The electromagnetic field poles consist of coils of insulated copper wire wound on soft iron cores, as shown in figure 3.6. The main advantages of using electromagnetic poles are (1) increased field strength and (2) a means of controlling the strength of the fields. By varying the input voltage, the field strength is varied. By varying the field strength, the output voltage of the generator can be controlled. Figure 3.6. Four-pole generator.

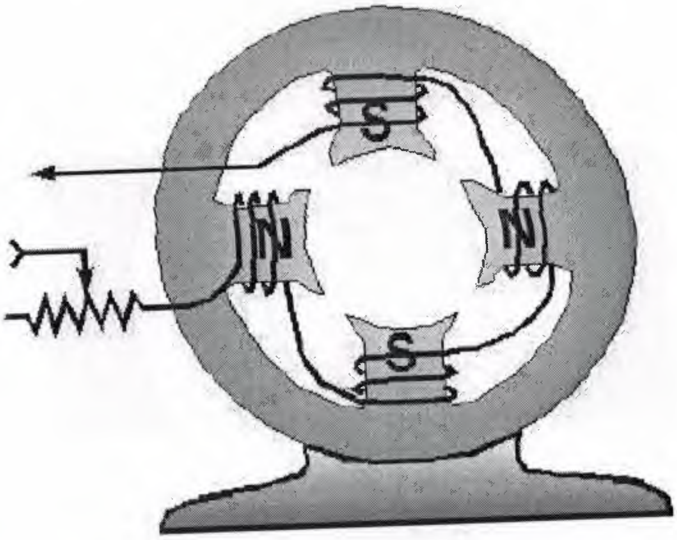


Figure 3.6 Four-pole generator

Commutation is the process by which a dc voltage output is taken from an armature that has an ac voltage induced in it. The elementary dc generator that the commutator mechanically reverses the armature loop connections to the external circuit. This occurs at the same instant that the voltage polarity in the armature loop reverses. A dc voltage is applied to the load because the output connections are reversed as each commutator segment passes under a brush. The segments are insulated from each other. In figure 3.7, commutation occurs simultaneously in the two coils that are briefly short-circuited by the brushes. Coil B is short-circuited by the negative brush. Coil Y, the opposite coil, is short-circuited by the positive brush. The brushes are positioned on the commutator so that each coil is short-circuited as it moves through its own electrical neutral plane. As you have seen previously, there is no voltage generated in the coil at that time. Therefore, no sparking can occur between the commutator and the brush. Sparking between the brushes and the commutator is an indication of improper commutation. Improper brush placement is the main cause of improper commutation.

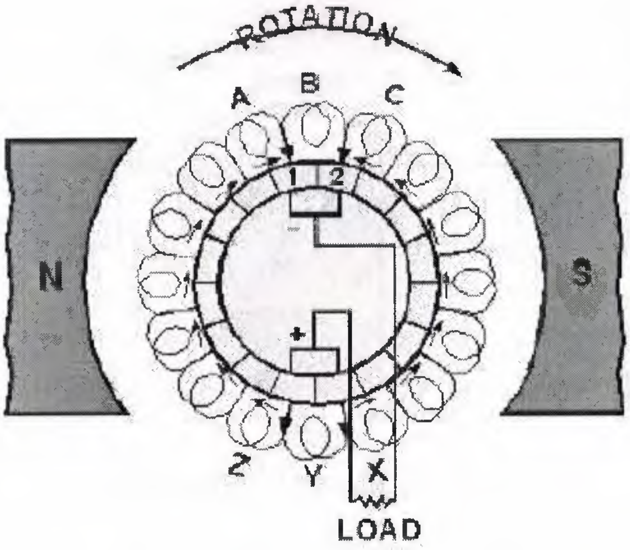


Figure 3.7. Commutation of a dc generator

3.4 Armature Reactıon

The magnetic field produced by current in the armature of a dc generator affects the flux pattern and distorts the main field. This distortion causes a shift in the neutral plane, which affects commutation. This change in the neutral plane and the reaction of the magnetic field is called armature reactıon. You know that for proper commutation, the coil short-circuited by the brushes must be in the neutral plane. Consider the operation of a simple two-pole dc generator, shown in figure 3.8. View A of the figure shows the field poles and the main magnetic field. The armature is shown in a simplified view in views B and C with the cross section of its coil represented as little circles. The symbols within the circles represent arrows. The dot represents the point of the arrow coming toward you, and the cross represents the tail, or feathered end, going away from you. When the armature rotates clockwise, the sides of the coil to the left will have current flowing toward you, as indicated by the dot. The side of the coil to the right will have current flowing away from you, as indicated by the cross. The field generated around each side of the coil is shown in view B of figure 3.8. This field increases in strength for each wire in the armature coil, and sets up a magnetic field almost perpendicular to the main field.

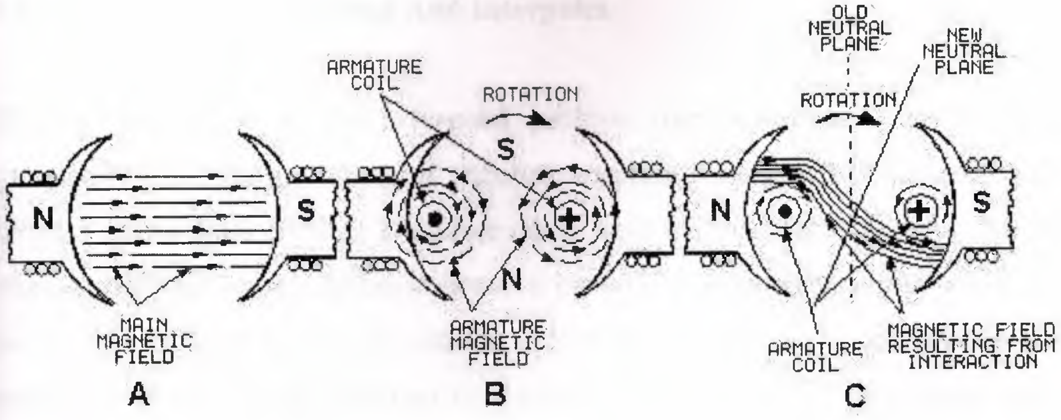


Figure3.8. Armature reaction.

Two fields the main field, view A, and the field around the armature coil, view B. View C of figure 3.8 shows how the armature field distorts the main field and how the neutral plane is shifted in the direction of rotation. If the brushes remain in the old neutral plane, they will be short- circuiting coils that have voltage induced in them. Consequently, there will be arcing between the brushes and commutator. To prevent arcing, the brushes must be shifted to the new neutral plane

Armature Losses

In dc generators, as in most electrical devices, certain forces act to decrease the efficiency. These forces, as they affect the armature, are considered as losses and may be defined as follows:

1. I^2R, or copper loss in the winding
2. Eddy current loss in the core
3. Hysteresis loss (a sort of magnetic friction) the resistance of the pieces is much higher. (Resistance is inversely proportional to cross-sectional area.)

The currents in the individual pieces of the laminated core are so small that the sum of the individual currents is much less than the total of eddy currents in the solid iron core.

3.4.1 Compensatıng Wındıngs And Interpoles

Shifting the brushes to the advanced position (the new neutral plane) does not completely solve the problems of armature reaction. The effect of armature reaction varies with the load current. Therefore, each time the load current varies, the neutral plane shifts. This means the brush position must be changed each time the load current varies. In small generators, the effects of armature reaction are reduced by actually mechanically shifting the position of the brushes. The practice of shifting the brush position for each current variation is not practiced except in small generators. In larger generators, other means are taken to eliminate armature reaction. compensatıng wındıngs or ınterpoles are used for this purpose (fig. 3.9). The compensating windings consist of a series of coils embedded in slots in the pole faces. These coils are connected in series with the armature. The series-connected compensating windings produce a magnetic field, which varies directly with armature current. Because the compensating windings are wound to produce a field that opposes the magnetic field of the armature, they tend to cancel the effects of the armature magnetic field. The neutral plane will remain stationary and in its original position for all values of armature current. Because of this, once the brushes have been set correctly, they do not have to be moved again.

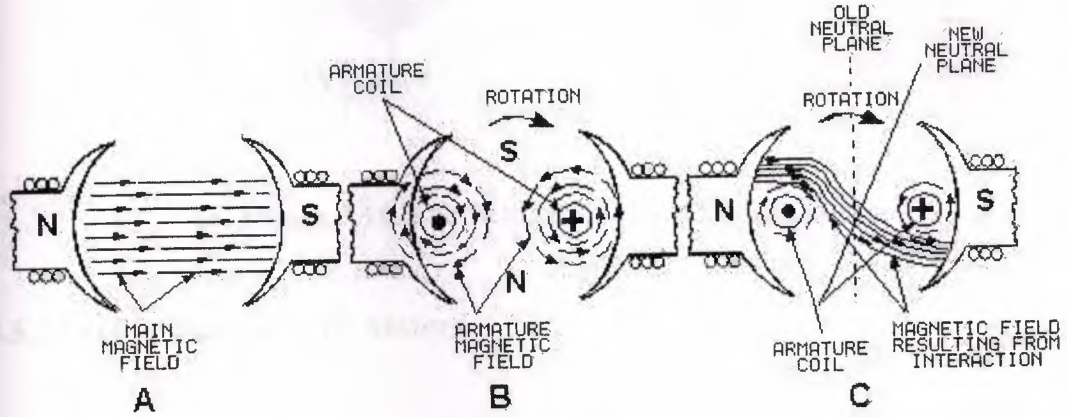


Figure 3.9. Armature reaction.

Motor reaction in a generator. The interaction between the conductor field and the main field of the generator weakens the field above the conductor and strengthens the field below the conductor.

3.5 Magnetic Field

There are two primary electrical circuits of the DC motor, the field or stator and the armature. The armeture windings are made up of current-carrying conductors that terminate at the commutator. DC voltage is applied to the armeture through carbon brushes that right on the commutator.

Small DC motors, such as the one illustrated, can use permanent magnet stators. Large industrial motors use a electromagnetic stators. When voltage is applied to the stator windings an electro magnetic field, with North and South poles, is established. This field is static, that is, non-rotational.

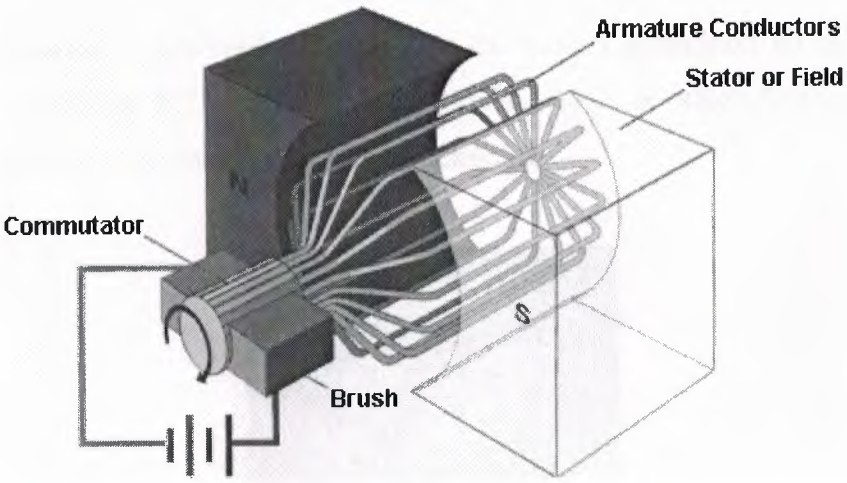


Figure 3.10. The field or stator and the armature

3.5.1 Cooling Fan / Electric Motors

With increased comfort, their possible uses become more diverse and complex. In the field of electric actuator development, Continental Temic offers key concepts for automotive applications.

Competencies

- Electric motors/actuators (DC - Direct Current/ EC – Electronically Commutated)
- Cooling fan modules (DC/EC)
- HVAC (Heating/ventilation/air conditioning)- blowers
- Mechatronic drive modules

The product range extends from fan modules for cooling systems to heating and air conditioning blowers including motors for the electronic seat adjustment as well as actuators e.g. for levelling systems.

DC single and dual fan applications using brushholders with integrated PWM (Pulse Width Modulation) control enable significant reduction of emission and costs.

Cost optimization is achieved with our new EC motors generation by mechatronical integration. With our EC motors, developed on the basis of state-of-art expertise, we can claim a leading role in this specialized technology

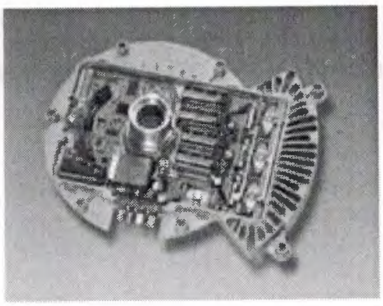


Figure 3.11. Integrated power electronics for cooling fans

3.5.2 Cooling Fan/ Fan Modules

Electric cooling fans which can be controlled as required and are integrated in the engine management system are a good way of providing the cooling capacity actually required for a combustion engine. Increasingly, they are also taking over the function of the viscofan and the additional air conditioning fan driven by the combustion engine.

Speed control of DC drives is possible via a voltage multiplier or electronically (e.g. a chopper). Brushless (EC) cooling fans with combined power electronics and speed regulation are already in series production. Depending on customers' requirements, fan modules can be assembled on-site, balanced, tested or supplied just-in-time. The product palette ranges from approx. 60 W to 800 W, speeds are between 1,400 and approx. 4,300 rpm and impeller wheel diameters vary from 290 to 520 mm.

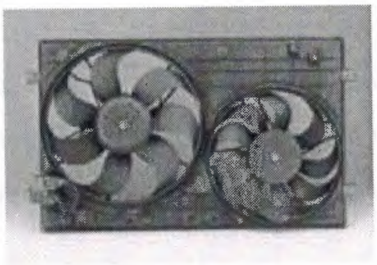


Figure3.12. Dual DC cooling fan

3.5.3 Heating/ ventilation/ air-conditioning blowers

Blowers for heating/air-conditioning below a defined volume of air into the interior of an automobile. High efficiency and low noise levels have priority. We have know-how needed to design ideal blower modules in close and direct contact with the system suppliers.

3.6 Resistors

Resistors are used as part of electrical networks and incorporated into microelectronic semiconductor devices. The critical measurement of a resistor is its resistance, which serves as a ratio of voltage to current and is measured by the SI unit ohm. A component has resistance 1 ohm if a voltage of 1 volt across the component results in a current of 1 ampere, or amp, which is equivalent to a flow of 6.25 × 1018 electrons per second in the opposite direction.

Some resistors are long and thin, with the actual resisting part in the centre, with a conducting metal leg on each side. The photo on the right shows a row of commonly used resistors in a bandolier. Resistors used in computers and other devices are typically much smaller, often in surface-mount (Surface-mount technology) packages without leads.

Any physical object is a kind of resistor. Most metals are conductors, and have low resistance to the flow of electricity. The human body, a piece of plastic, or even air has a resistance that can be measured. Materials that have very high resistance are called insulators.

Superconducting materials at very low temperatures have zero resistance. Insulators (such as air, diamond, or other non-conducting materials) may have extremely high (but not infinite) resistance, but break down and admit the flow of current under sufficiently high voltage.

The resistance of a component can be calculated from its physical characteristics. Resistance is proportional to the length of the resistor and to the material's resistivity, a physical property of the molecules that comprise the resistor, and inversely proportional to cross-sectional area.

Standard resistors are sold in values from a few milliohms to about a gigohm; only a limited range of values called preferred values are available. In practice, the discrete component sold as a "resistor" is not a perfect resistance, as defined above. Resistors are often marked with their tolerance (maximum expected variation from the marked resistance). On color coded resistors a rightmost silver band denotes 10% tolerance, a gold band 5% tolerance, and a red band 2% tolerance. Closer tolerance resistors, called precision resistors, are also available.

A resistor is an electrical component designed to have an electrical resistance that is independent of the current flowing through it. The common type of resistor is also designed to be independent of temperature and other factors. Resistors may be fixed or variable. Variable resistors are also called potentiometers or rheostats in figure 3.13

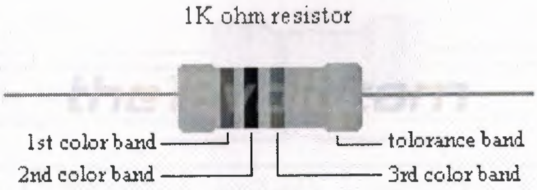


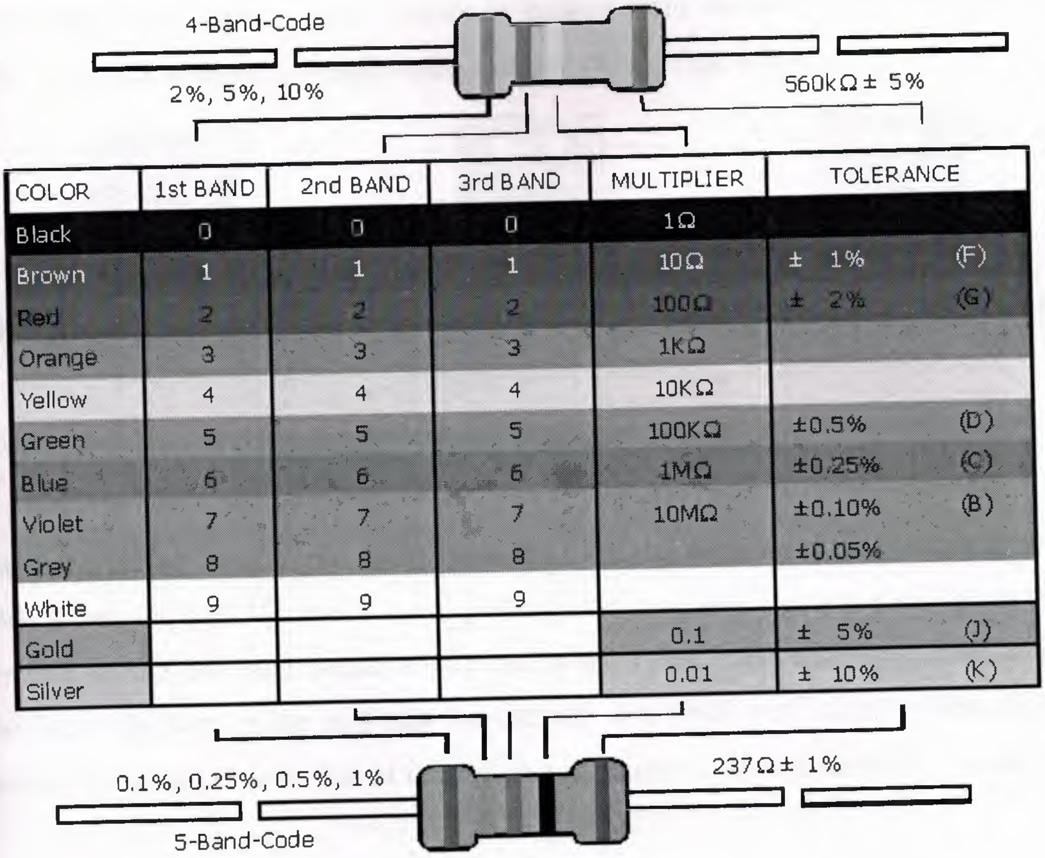
Figure 3.13 Resistor

3.6.1 How to read the code

First find the tolerance band, it will typically be gold (5%) and sometimes silver (10%). Starting from the other end, identify the first band - write down the number associated with that color; in this case Blue is 6. Now 'read' the next color, here it is red so write down a '2' next to the six. (it should have '62' so far.) Now read the third or 'multiplier' band and write down that number of zeros. In this example it is two so we get '6200' or '6,200'. If the 'multiplier' band is Black (for zero) don't write any zeros down.

If the 'multiplier' band is Gold move the decimal point one to the left. If the 'multiplier' band is Silver move the decimal point two places to the left. If the resistor has one more band past the tolerance band it is a quality band.

Read the number as the '% Failure rate per 1000 hour' This is rated assuming full wattage being applied to the resistors. (To get better failure rates, resistors are typically specified to have twice the needed wattage dissipation that the circuit produces) 1% resistors have three bands to read digits to the left of the multiplier. They have a different temperature coefficient in order to provide the 1% tolerance.



COLOR	1st BAND	2nd BAND	3rd BAND	MULTIPLIER	TOLERANCE
Black	0	0	0	1Ω	
Brown	1	1	1	10Ω	± 1% (F)
Red	2	2	2	100Ω	± 2% (G)
Orange	3	3	3	1KΩ	
Yellow	4	4	4	10KΩ	
Green	5	5	5	100KΩ	±0.5% (D)
Blue	6	6	6	1MΩ	±0.25% (C)
Violet	7	7	7	10MΩ	±0.10% (B)
Grey	8	8	8		±0.05%
White	9	9	9		
Gold				0.1	± 5% (J)
Silver				0.01	± 10% (K)

Figure3.14. Read the resistance code

3.7 Relays

SPDT Relay : (Single Pole Double Throw Relay) an electromagnetic switch, consist of a coil (terminals 85 & 86), 1 common terminal (30), 1 normally closed terminal (87a), and one normally open terminal (87).

When the coil of the relay is at rest (not energized), the common terminal (30) and the normally closed terminal (87a) have continuity. When the coil is energized, the common terminal (30) and the normally open terminal (87) have continuity.

The diagram above center shows the relay at rest, with the coil not energized. The diagram above right shows the relay with the coil energized. As you can see the coil is an electromagnet that causes the arm that is always connected to the common (30) to pivot when energized whereby contact is broken from the normally closed terminal (87a) and made with the normally open terminal (87) in figure 3.15

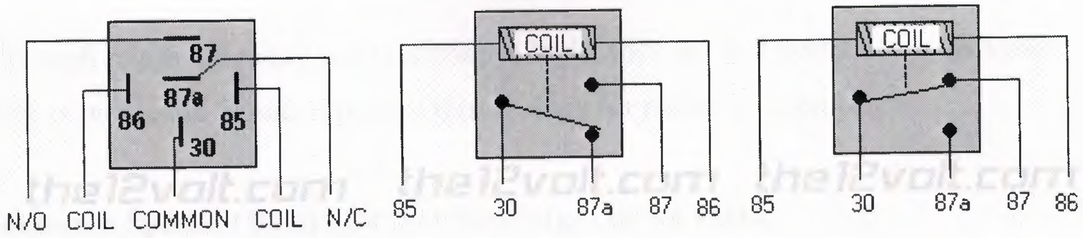


Figure3.15 Relay open and close contact

When energizing the coil of a relay, polarity of the coil does not matter unless there is a diode across the coil. If a diode is not present, you may attach positive voltage to either terminal of the coil and negative voltage to the other, otherwise you must connect positive to the side of the coil that the cathode side (side with stripe) of the diode is connected and negative to side of the coil that the anode side of thediode is connected.

Diodes are most often used across the coil to provide a path for current when the current path to the relay is interrupted (i.e. switched off, coil no longer energized). This allows the coil field to collapse without the voltage spike that would otherwise be generated. The diode protects switch or relay contactsand other circuits that may be sensitive to voltage spikes. (JimR, contributor, install bay member)

The coil of an SPDT relay that we most commonly use draws very little current (less than 200 milliamps) and the amount of current that you can pass through a relay's common, normally closed, and normally open contacts will handle up to 30 or 40 amps. This allows you to switch devices such as headlights, parking lights, horns, etc., with low amperage outputs such as those found on keyless entry and alarm systems, and other components. In some cases you may need to switch multiple things at the same time using one output. A single output connected to multiple relays will allow you to open continuity and/or close continuity simultaneously on multiple wires.

There are far too many applications to list that require the use of a relay, but we do show many of themost popular applications in the pages that follow. If you are still unclear about what a relay does or if you should use one after you browse through the rest of this section, please post a question at the12volt's install bay.

Although relays are rarely used for control logic, they are still essential for switching large power loads. Some important terminology for relays is given below.

Contactor Special : Relays for switching large current loads.

Motor Starter : Basically a contactor in series with an overload relay to cut off when too much current is drawn.

Arc Suppression : When any relay is opened or closed an arc will jump. This becomes a major problem with large relays. On relays switching AC this problem can be overcome by opening the relay when the voltage goes to zero (while crossing between negative and positive). When switching DC loads this problem can be minimized by blowing pressurized gas across during opening to suppress the arc formation.

AC coils : If a normal relay coil is driven by AC power the contacts will vibrate open and closed at the frequency of the AC power. This problem is overcome by adding a shading pole to the relay.

The most important consideration when selecting relays, or relay outputs on a PLC, is the rated current and voltage. If the rated voltage is exceeded, the contacts will wear out prematurely, or if the voltage is too high fire is possible. The rated current is the maximum current that should be used. When this is exceeded the device will become too hot, and it will fail sooner. The rated values are typically given for both AC and DC, although DC ratings are lower than AC. If the actual loads used are below the rated values the relays should work well indefinitely. If the values are exceeded a small amount the life of the relay will be shortened accordingly. Exceeding the values significantly may lead to immediate failure and permanent damage.

- Rated Voltage - The suggested operation voltage for the coil. Lower levels can result in failure to operate, voltages above shorten life.

- Rated Current - The maximum current before contact damage occurs (welding or melting).

SUMMARY

This chapter give the information about dc motor, coolıng fan/ fan modules, relay and resistance. Explain of the how this equipment work to low voltage.

4. INFORMATION ABOUT THE S7-200 MICRO PLC

4.1 OVERVIEW

The S7-200 series is a line of micro-programmable logic controllers (Micro PLC's) that can control a variety of automation applications. 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.

The Micro PLC SIMATIC S7-200 is truly in a class of its own: it's both compact and highly powerful - especially in relation to its real-time response it's fast and features great communications options. But there's more to it than that: the Micro PLC SIMATIC S7-200 has a consistently modular design for customized solutions which aren't too large for the present but open-ended enough to be expanded anytime in the future. All this make the SIMATIC S7-200 a real economic alternative in open loop control for the lower performance range.

4.2 Product Overview and Installation

The Text Display 200 (TD 200) is a text display and operator interface for the S7-200 family of programmable logic controllers. Figure4.1 shows an S7-200 Micro PLC.

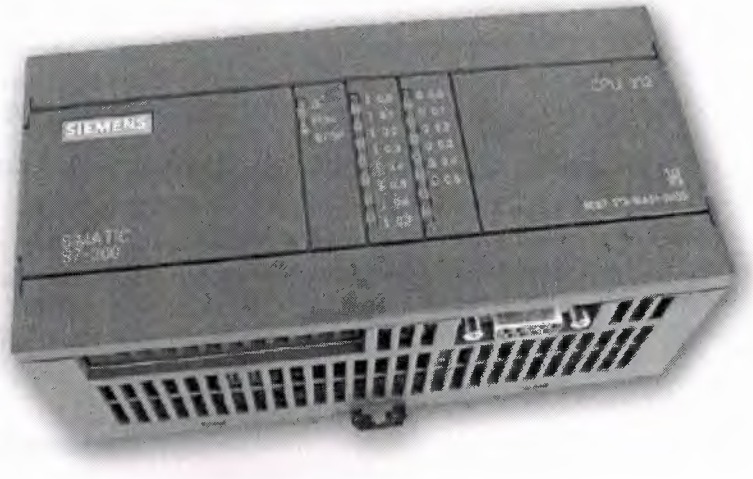


Figure 4.1 S7-200 Micro PLC

The following is a list of TD 200 features:

- Displays messages read from the S7-200 CPU.
- Allows adjustment of designated program variables.
- Provides ability to force/unforce I/O points.
- Provides ability to set the time and date for CPUs that have real- time clocks.
- Provides menus and prompts in six languages (English, German, French, Spanish, Italian, and Chinese)
- Provides multiple character sets to support English, Western European, Slavic, and Chinese languages.

The TD 200 receives its power either from the S7-200 CPU through the TD/CPU cable or from a separate power supply.

The TD 200 functions as a network master when it is connected to one or more S7-200 CPUs. The TD 200 is also designed to operate with other masters in a network. Multiple TD 200s can be used with one or more S7-200 CPUs connected to the same network. This manual provides you with hardware configuration directions and programming examples that require additional equipment. The following is a list of additional equipment that is necessary to set up and use your TD 200:

- S7-200 series programmable logic controller
- S7-200 programming device
- Programming cable appropriate for your programming device

This manual uses the terms programmable logic controller and S7-200 CPU (or CPU) interchangeably.

4.3 Related Information

Refer to the following documentation for more detailed information about selected topics:

SIMATIC S7-200 Programmable Controller System Manual provides information about installing and programming the S7-200 Micro PLC's, including the following topics:

- Installing and wiring the S7-200 CPU and expansion I/O modules, and installing the STEP 7-Micro/WIN software
- Designing and entering a program
- Understanding features of the CPU, such as data types and addressing modes, the CPU scan cycle, password-protection, and network communication

This manual also includes descriptions and examples for the programming instructions, typical execution times for the instructions, and the data sheets for the S7-200 equipment.

The following description are an introduction to general isolation chararacteristics of the S7-200 family, but same features may be different on specific products. Consult the data sheet in product for this for specifications of which circuits include isolation boundaries and the ratings of the boundaries . Isolation boundaries rated less than 1500VACare designed as functional isolation only, and should not be depended on as safety boundaries.

- CPU logic references is the same as DC sensor supply M
- CPU logic references is the same as the input power supply M on a CPU with DC power supply.
- CPU communications ports have the same reference as CPU logic.
- Analog inputs and outputs are not isolated from CPU logic.
- CPU logic is isolated from ground to 100VDC.
- DC digital inputs and outputs are isolated from CPU logic to 500 VAC
- DC digital inputs and outputs groups are isolated from each other by 500VAC.
- Relay outputs, AC outputs and AC inputs are isolated from CPU logic to 1500VAC

Expansion Modules

The S7-200 module provides a certain number of local I/O. Adding an expension module provides additional input or output points. As shown in figure4.2. the expansion module caries with a bus connector for connecting to the base unit.

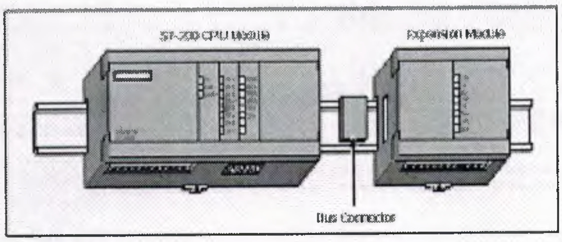


Figure 4.2. The expansion module caries with a bus connector for connecting to the base unit

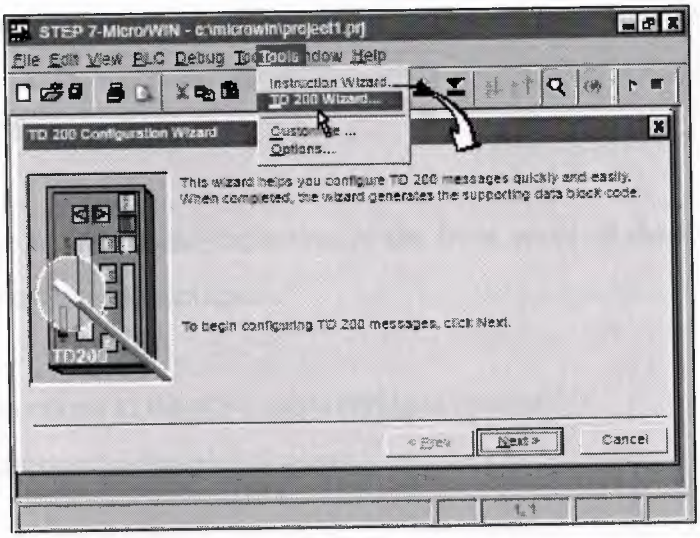
4.4 Starting the STEP 7-Micro/WIN TD 200 Configuration Wizard

STEP 7-Micro/WIN provides a "wizard" that makes it easy to configure the parameter block and the messages in the data memory area of the S7-200 CPU. The TD 200 Configuration Wizard automatically writes the parameter block and message texts to the data block editor after you finish choosing the options and creating the messages. This data block can then be downloaded to the CPU. For detailed information about the TD200 parameter block and message formats.

This chapter contains the procedure for creating a sample TD 200 application. Use the instructions in this example to create a TD 200 parameter block and three messages using the TD 200 Configuration Wizard. The first message is text only.

The second message contains both text and embedded data. The third message is a text message that requires acknowledgement by the operator. The example also shows how to use the function keys to enable a message and how to use the acknowledge- and edit-notification bits within your program. To open the wizard, select the menu command Tools > TD 200 Wizard... as shown in Figure 4.3

To navigate through the dialog boxes of the wizard, click on "Next>." Click on the "<Prev" button to go back to a previous dialog box if you need to change or review any of the parameters you have defined. In the final dialog box, click on "Finish" to validate and save the parameter block and close the wizard. To view the configured parameter block and messages, open the STEP 7-Micro/WIN data block editor.


STEP 7-Micro/WIN - c:\microwin\project1.prj
File Edit View PLC Debug Tools Window Help
Instruction Wizard...
TD 200 Wizard...
Customize ...
Options...
TD 200 Configuration Wizard
TD200
< Prev
Next >
Cancel
1, 1

This wizard helps you configure TD 200 messages quickly and easily. When completed, the wizard generates the supporting data block code.

To begin configuring TD 200 messages, click Next.

Figure 4.3 Accessing the TD 200 Configuration Wizard

Slots in the S7-200

The CP 243-2 can be inserted in all slots for expansion modules in the S7-200 programmable controller (CPUs 22x).

Possible Restrictions

There may, however, be restrictions depending on the CPU or power supply unit being used in terms of the following:

- Expandability with several expansion modules,
- Electrical restrictions
- The maximum current consumption from the S7 backplane bus must not be exceeded.

Connection, Display and Control Elements

On the front panel, you have access to all the connection, display and control elements of the CP 243-2.

During operation, the connection and control elements are protected by a front cover.

Terminal Block Connections

The terminals are located under the cover of the front panel of the CP 243-2. The CP 243-2 has the following connections:

- Two connections to the AS-i cable (bridged internally)
- One connection for functional ground

4.5. Modes of the CP 243-2

This modes have two operations (standard operation, extended operation)

4.5.1 Standard Operation

In this type of operation, the user program accesses the user data of the AS-i slaves and the diagnostic data of the CP 243-2. Programming is simple and this type of operation is adequate for the majority of automation tasks.

In standard operation, no commands or special parameters are transferred to the slaves. This type of operation corresponds to the profile M0 of the AS-i master specification.

4.5.2 Extended Operation

In extended operation, the user program uses the command interface of the CP 243-2.This means that the entire range of functions in the AS-i system is available to the

PLC programmer. In particular, the AS-i master calls (for example to assign parameters *to slaves) are available. This type of operation corresponds to the profile M1e of the AS-i master specification. SIMATIC C7 series the complete system. With the* SIMATIC S7 family of programmable controls rapidly becoming a standard for the industry, the new SIMATIC C7 is the logical next step in PLCs.

SIMATIC C7-620 products are complete automation and operator interface systems with amazing features built into one efficient unit. The C7-620 incorporates these key elements: SIMATIC S7-300 PLC, COROS Operator

Panel, I/O and I/O expansion interface and network communications. The PLC side of the C7-620 is based on the S7-314 CPU with the performance needed for mid-level automation tasks.

The C7-620 is expandable to a maximum 512 digital and 64 analog inputs and outputs in up to 32 S7-300 I/O modules. It cables over to as many as three local S7-300 expansion rails up to 10 meters apart. The unit features a built-in RS232/TTY serial output port from the OP side for easy printing of messages and alarms. A Multi-Point Interface (MPI) port for peer-to-peer communications provides 187.5 kbaud global data exchange with up to 31 other SIMATIC S7 PLCs, operator interfaces and programmers. The C7 series can be programmed remotely via the network. The C7-623 and 624 units are identical in size to the C7-620, but offer operator interface upgrades up to 256 kbyte text and configuration data memory.

Compatible

The C7-620 is a compatible member of the SIMATIC family, offering the same Windows-based programming tools and communications. The PLC side of the C7 series is programmed with STEP7 programming software, with the MMI side configured with ProTool. This compatibility reduces the learning curve for operators. The built-in MPI port provides C7 with compatible communications to other SIMATIC systems. The soon-to-be-released C7-626 will have the same I/O, size and general features as the C7-623/624 and will offer an optional built-in PROFIBUS-DP master interface. The new

C7 series incorporates the latest production-enhancing features of a PLC and an MMI. Tack on the 60% reduction in size by combining the two into a single compact unit and the fact that it is compatible with existing and future SIMATIC units, and there are plenty of reasons to explore the new C7 series for your application.

4.6 Concepts of the S7-200 PRogramming Languages

The S7-200 CPU (and step7-MİcroWin) supports the following programming laguages

- Statement List (STL) is a set of mnemonic instructions that represent functions of the CPU
- Ladder Logic (LAD) is a graphical language that resembles the electrical relay diagrams for the equipment

Step 7-Micro/WİN also provides two repressentations for displaying the adresses and the programming instructions in the program international and simatic. Both tha international and simatic representations refer the same S7-200instruction set. There is a direct correspondence between the international and SİMATİC representation; both representations have the same functionally.

4.6.1 CP 243-2 as Expansion Module in the S7-200

The CP 243-2 occupies 2 consecutive expansion module slots in the S7-200

- Digital module 8DI/8DO
- Analog module 8AI/8AO

i. Digital Module

The digital module occupies 8 input and 8 output bits in the address area of the digital inputs and outputs. The S7-200 CPU and the CP 243-2 are coordinated via the digital module.

The data to be addressed in the analog module by the user program is selected using bank select bits.

ii. Analog Module

The analog module occupies 16 input and 16 output bytes in the address area of the analog inputs and outputs. Data exchange with the AS-i slaves is handled via the analog module.

The bank select mechanism means that a larger data area in total can be addressed in the analog module than the addressable data area in the S7-200 CPU for the expansion module.

iii. Meaning of the Data in the Analog Module

The analog module of the CP 243-2 consists of four areas:

- Identification register, 8 bits (I/O module identifier)
- Error register, 8 bits
- 8 analog input words (8 AI)
- 8 analog output words (8 AO)

The most important functions handled via these areas are shown in the diagram below figure 4.4

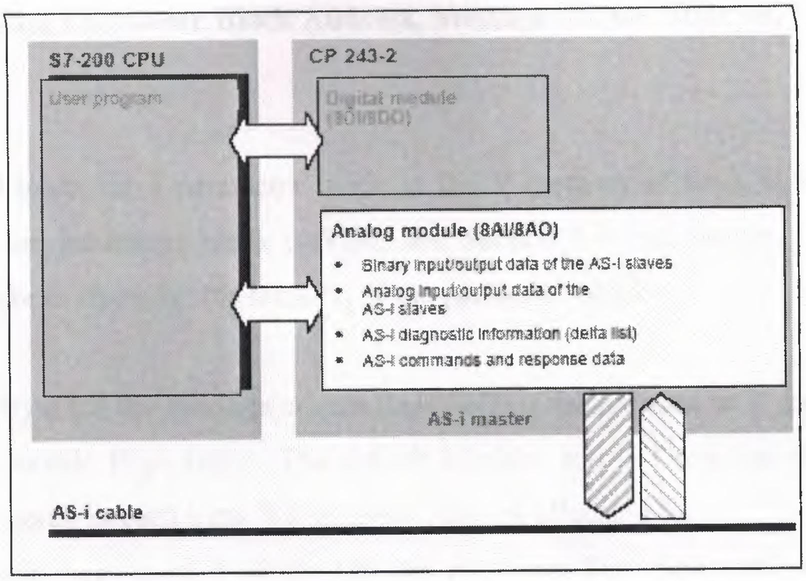

S7-200 CPU
User program
CP 243-2
Digital module (8DI/8DO)
Analog module (8AI/8AO)
Binary input/output data of the AS-i slaves
Analog input/output data of the AS-i slaves
AS-i diagnostic information (delta list)
AS-i commands and response data
AS-i master
AS-i cable

Figure 4.4 Data in the Analog Module

iv. Identification Register in the Analog Module Meaning

The identification register signals the I/O module identifier to indicate the existence of an 8AI/8AO analog module with the value specified below.

The address at which the program can access the identification register depends on the slot in which the CP 243-2 is inserted.For further information about the special bit memory and its structure for I/O modules

v. Identification Register in the Analog Range of Values

The identification register can be read via the special bit memory area of the S7-200 CPU. It provides the fixed value 1FH.

4.6.2 Specifying Parameter Block Address, Message Enable Address, and Message Location

The TD 200 looks for a parameter block in the V memory of the CPU. The default location for the parameter block is VB0. See Section 3.8 and Section D.1 for more information about changing the location of the parameter block.

The starting byte for the message enable flags defines the location in V memory which the message enable flags begin. The default location is 14. There are eight message enable flags stored in each byte. Whole bytes must be allocated for message enable flags even if all the bits are not used. The "Starting byte for enable flags" field specifies how many bytes of V memory are needed for message enable flags

The starting byte for message information defines the starting location of the first message in V memory. Messages are placed consecutively in memory. Either 20 or 40 bytes are reserved for each message.

Values for the parameter block, enable flags, and message information starting addresses are CPU-specific. See the SIMATIC S7-200 Programmable Controller. System Manual for the valid address ranges for specific CPUs. For this example, set the parameter block starting byte to 0, the enable flags address to 14, and the message information starting address to 40.

i. Software Support for Configuring a TD 200

Some programming packages include a configuration utility for entering the parameter block and messages for the TD 200.

STEP 7-Micro/DOS uses Utility 24 for configuring the TD 200. STEP 7-Micro/WIN provides a "wizard" that makes it easy to configure the parameter block and the messages in the data memory area of the S7-200 CPU .Refer to your programming software and its documentation to determine whether it supports a TD 200 configuration utility.

ii. Understanding How Messages Are Displayed

The messages that the TD 200 displays are stored in the CPU. These messages contain ASCII text, embedded values, and format information. The CPU enables the messages through the use of a table of message-enable bits. There must be one message bit allocated in V memory for each configured message. When the program in the CPU says to display a message, the program sets that particular message-enable bit. The TD 200 continuously polls the message-enable bits, and if one of the bits is set, the TD 200 reads the corresponding message from the CPU and writes the message to the display.

iii. Understanding How the TD 200 Uses the Parameter Block

A TD 200 parameter block contains the TD 200 configuration information, and must be created in the data memory (V memory) area of the S7-200 CPU in order to establish an interface between the CPU and the TD 200. The TD 200 monitors the CPU for either a parameter block identifier (ASCII characters "TD") or an ofset to the parameter block.

If the TD 200 does not find the parameter block identifier ("TD") in VW0, it uses the value stored in VW0 as an offset to the TD 200 parameter block. When the parameter block identifier is found, the next 8, 10, or 12 bytes provide the TD 200 with configuration information.

This can change the V memory address for the parameter block by means of a setup menu. This allows you to connect two TD 200 units to one CPU, with each TD 200 displaying different messages. Two TD 200s connected to a single CPU. The parameter blocks for each of the TD 200 are stored in different V memory locations.

CPU 222

Superior compact solution. Masters all requirements from complex machines right up to small plant solutions.

8/6 inputs/outputs (I/O) + max. 2 modules = 78 E/A

Inputs/outputs: 14, expandable with max. 2 modules

Program memory: 4 KByte

Data memory: 2 KByte

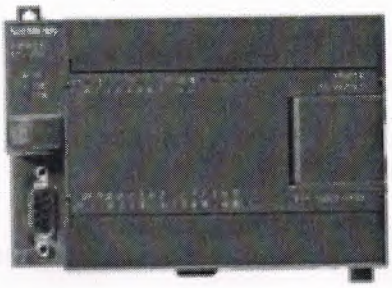


Figure 4.6 CPU222

SUMMARY

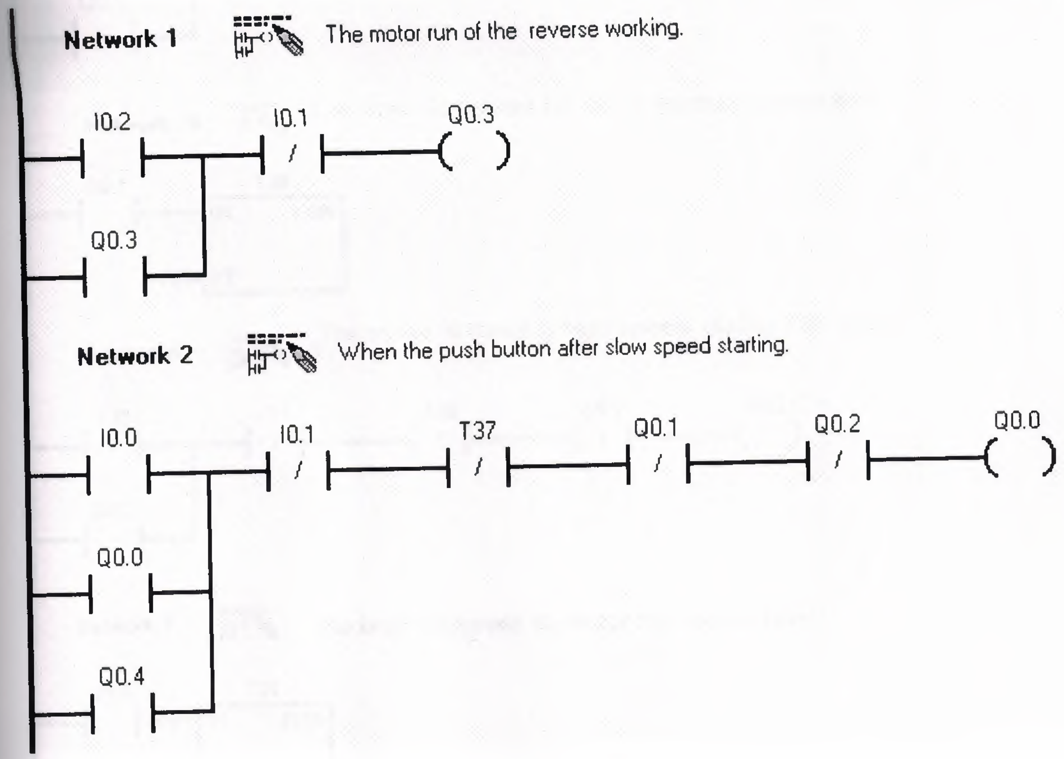
Brief information about SIMATIC S7-200 MICRO PLC was presented at this chapter. The controls engineers and technicians provide a full range of support for PLC-based industrial systems, including logic design, programming with simatic controller.

5.PRACTICAL IMPLEMENTATION PLC

5.1 Overview

This chapter have to brief practical PLC, ladder diagram and explanation ladder diagram(statement list) of the explanation

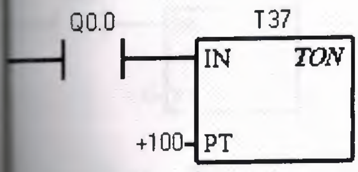
5.2 Ladder Diagram



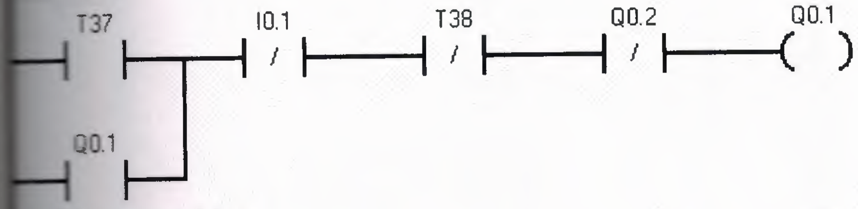
Network 1 The motor run of the reverse working.

Network 2 When the push button after slow speed starting.

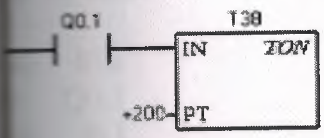
Network 3 Start timer if slow speed is reached.



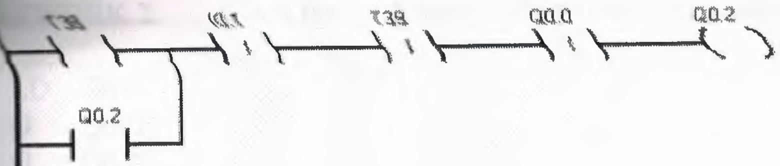
Network 4 The motor running is medium speed until T38 timer.



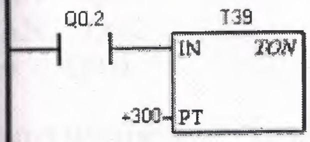
Network 5 The timer designate for motor medium speed time



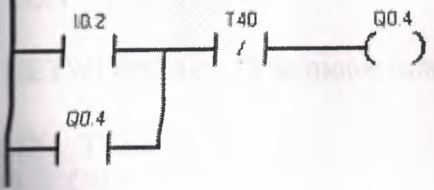
Network 6 The motor is running high speed during T39 time

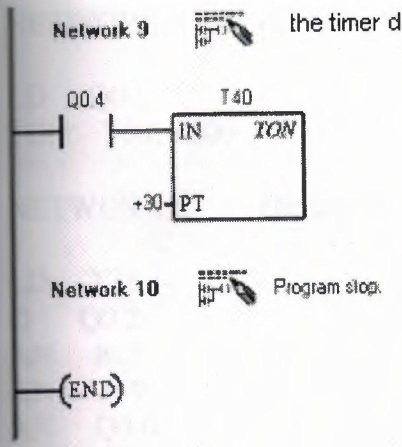


Network 7 The timer designate for motor high speed time



Network 8 When the I0.2 push button after motoring reverse running





Network 9 the timer designate for motor reverse time

Network 10 Program stop.

5.3 Statement List

NETWORK 1 The motor run of the reverse working.

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

NETWORK 2 When the push button after slow speed starting.

```
LD    I0.0
O     Q0.0
O     Q0.4
AN    I0.1
AN    T37
AN    Q0.1
AN    Q0.2
=     Q0.0
```

NETWORK 3 Start timer if slow speed is reached.

```
LD    Q0.0
TON   T37, +100
```

NETWORK 4 The motor running is medium speed until T38 timer.

```
LD    T37
O     Q0.1
AN    I0.1
AN    T38
AN    Q0.2
=     Q0.1
```

```
NETWORK 5      The timer designate for motor medium speed time.

LD    Q0.1
TON   T38, +200

NETWORK 6      The motor running is high speed during T39 timer.

LD    T38
O     Q0.2
AN    I0.1
AN    T39
AN    Q0.0
=     Q0.2

NETWORK 7      The timer designate for motor high speed time.

LD    Q0.2
TON   T39, +300

NETWORK 8      When the I0.2 push button after motoring reverse running.

LD    I0.2
O     Q0.4
AN    T40
=     Q0.4

NETWORK 9      The timer designate for motor reverse time.

LD    Q0.4
TON   T40, +30

NETWORK 10      Program stop.

MEND
```

5.4 List of input output assignments

I0.0	Start1
I0.1	Stop1
I0.2	Start2 (for reverse)
Q0.0	Slow speed
Q0.1	Medium speed

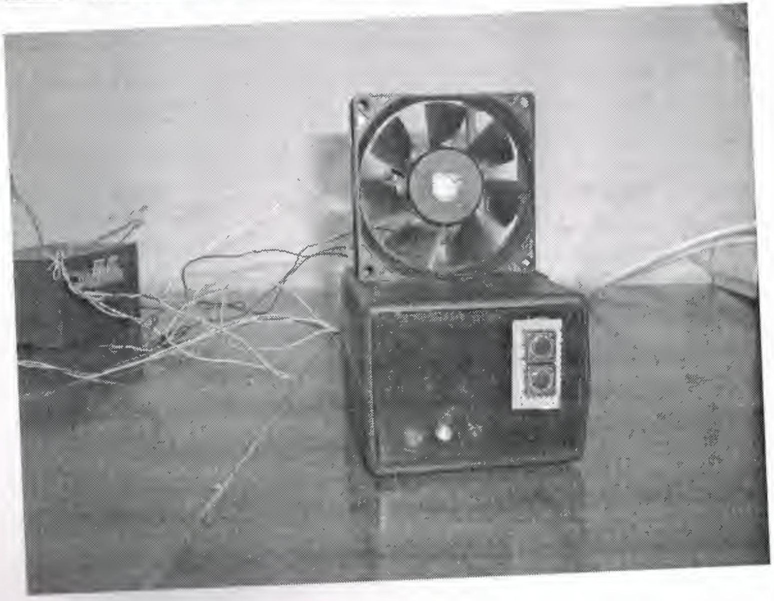
Q0.2 High speed

Q0.3 Start reverse

Q0.4 Run reverse

SUMMARY

This chapter explain of the DC motor control program memory is the capacity for control software. The program including DC motor speed control and run ways (normally run 3 others speeds, reverse run)



CONCLUSION

PLC controller is use the central part of an process control system. With execution of a program stored in program memory, PLC continuosly monitors status of the system through signals from input devices.

PLC system specifications to consider include scan time, number of instructions, data memory, and program memory. Scan time is the time required by the PLC to check the states of its inputs and outputs. Instructions are standard operations available to PLC software. Data memory is the capacity for data storage. Program memory is the capacity for control software.

This occurs at the same instant that the voltage polarity in the armature loop reverses. Effective voltage is the equivalent level of dc voltage, which will cause the same average current through a given resistance. Speed control of DC drives is possible via a voltage multiplier or electronically.

This project was about the DC motor control with PLC. The work done is connecting series resistors with various values to the outputs of a PLC and using this various outputs the DC motor was supplied by 24 volts DC and the speed control of a DC motor was achieved, practically in laboratory medium.

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